Contents

APFNet's Workshop on
Degraded Forest Rehabilitation and Sustainable Forest Management

(1-12 July, 2014)

1. Introduction

Degradation of forest ecosystems remains a major problem in almost all countries and this is particularly severe in the more densely populated tropical countries. The Global Partnership on Forest Landscape Restoration estimates the extent of degraded lands worldwide as about 2.00 billion hectares. As per an estimate of the International Tropical Timber Organization (ITTO) there are 500 million ha of degraded primary and secondary forests in the tropics. In addition there are 350 million hectares of tropical forest land, which is so degraded that forest regrowth has not occurred and which are mostly occupied by grasses and shrubs. In South East Asia alone about 117 million ha or over 50% of the forest land is considered as degraded.

FAO defines forest degradation as "changes within a forest that affect the structure and functions of the stand or site and thereby lowers its capacity to supply products and services". The major concern therefore is the impact of degradation on human wellbeing through reducing the flow of goods and services. Vast tracts of forests are unable to produce the full potential of products and services and output most often remains far below the potential. This is particularly a cause of concern considering the increasing demand for food, fuel, fibre and a whole range of ecological services like maintaining and improving watershed values, improving carbon sequestration and storage, protecting biological diversity and enhancing the aesthetic values of landscapes. 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.

In many countries unscientific agriculture has been a major factor that contributed to land degradation. Escalating demand for food and other products has led to cultivation of marginal areas, which lose their productivity within a short period and are then abandoned. Faulty water management practices have led to salinization leading to loss of productivity. Vast stretches of grasslands – especially Imperata cylindrica (or Aalang alang) – in South and South East Asia is an outcome of shifting cultivation followed by annual fires that prevent the process of natural restoration.

Efforts to rehabilitate degraded lands have a long history and a wealth of experience has been gained based on the work done during the last many decades. The ITTO Guidelines on restoration, management and rehabilitation of degraded and secondary forests (ITTO 2002) outlines the principles and actions at two levels namely (a) policy, planning and management level and (b) stand level. Most often the outcomes of restoration/ rehabilitation efforts have been mixed. There is an urgent need to improve the quality of forest restoration/ rehabilitation

at the site/ landscape level and to find effective ways to undertake these activities in the context of broader environmental, social and economic needs and interests. In fact restoration of productivity is an integral part of rebuilding the natural capital to ensure that the present and future generations are able to enjoy the full range of goods and services that the land is able to produce.

It is in this context that the APFNet is organizing this Workshop to provide an opportunity to assess the current state of knowledge on restoration of degraded forests and to assess the future directions drawing upon the wealth of knowledge available on the subject.

Objectives and Outputs

- Assess the current state of rehabilitation of degraded forests in the Asia-Pacific region, particularly focusing on East Asia and South East Asia.
- Analyze the economic, social and environmental issues involved in forest degradation and their implications on rehabilitation/ restoration efforts;
- Examine the future scenarios for forest rehabilitation taking into the major drivers that cause ecosystem degradation, giving due attention to emerging policies relating to climate change mitigation and adaptation.
- Provide an opportunity to share knowledge on rehabilitation experience in the participating countries and to identify future options, particularly drawing upon successes and failures and the emerging approaches for adopting ecosystem approaches for restoration.

Key Issues and Questions

Taking advantage of the vast experience and knowledge accumulated so far through a process of dialogue and discussion, the Workshop will attempt to address the following issues/ questions:

- Are the efforts to rehabilitate/ restore degraded ecosystems making any impact and what is the net effect? Are the efforts able to catch up with the pace of degradation?
- How do we determine the right level of intervention to ensure a process of sustainable ecosystem recovery?
- What are the myths and misconceptions relating to rehabilitation of degraded forests? How do we overcome them and pursue a sustainable approach towards ecosystem management?
- What are the major drivers impacting ecosystem degradation and what should be done to counter them? What are the future scenarios in this regard?
- How do we actually measure the outcomes of ecosystem restoration? Based on these indicators how much of the ongoing restoration efforts can be regarded as true restoration?

- What is the economics of restoration of degraded forests? How do we measure the economic, social, cultural and environmental importance of ecosystem restoration?
- What should be done to increase the flow of resources in support of ecosystem restoration? How effective are the international initiatives in support of rehabilitation of degraded forests?
- What should be done to improve the policy, legal and institutional environment for increased investment in restoration and rebuilding the natural capital?
- What is the feasibility of the ecosystem approach to restoration of degraded forests adopting a landscape approach? What is the experience so far in this regard?
- More questions will emerge during the course of the Workshop and the entire thrust will be to provide an opportunity for objective and critical thinking.

Main Topics/Areas

The Workshop will attempt to provide a broad analytical framework to assess the current state of forest rehabilitation specifically focusing on the following:

- Global overview of the problem
- Drivers of degradation and long term scenarios.
- Rehabilitation technologies: Lessons learnt and what needs to be done
- Economics of rehabilitation of degraded areas
- Policy and institutional aspects of landscape restoration, including community level involvement
- Environmental dimensions of and ecosystem restoration
- Macro-level issues – Policy, planning and management of restoration efforts at the national level
- Micro-level issues: Dealing with site level issues relating to rehabilitation

Workshop Structure and Training Appraoches

The workshop structure is designed to provide the maximum learning opportunity to the participants and the entire thrust will be on dialogue, group work, discussions and debates.

- **Thematic lectures**

  Keynote lectures will be delivered by invited resource persons and will cover fundamental and topical issues related to workshop topics;

- **Participant presentation**

  Participants are required to make presentations during the workshop based on their case study/ country reports;

- **Working groups and discussions**

  Participants will be encouraged to take part in the training actively via the lectures and group discussions;

- **Field visits**

  Field visits will showcase performance and practices of Degraded Forest Rehabilitation and Sustainable Forest Management after the indoor section.

Targeted Participants

The workshop is designed for forestry and forest land use policy makers, planners and managers, specifically dealing with degraded forest restoration from the Asia and Pacific developing economies, especially in the East, South and South East Asia region. A Depending on availability of funds a limited number of participants from other tropical regions will be accepted especially to facilitate sharing of experience. The total number of participants will be limited to 15. Participants from each economy will be invited to ensure sufficient learning opportunities and broad exchange of ideas, and are required to submit a paper of at least 4,000 words (in Microsoft Word) and a 30-minute presentation (in Microsoft Power Point) following the outlines for presentation during the workshop.

Expense and Cost of Participation

The workshop organizer will cover the training costs of international travel (round-trip economy class air tickets), full board accommodation, field visits, as well a certain amount of per diem during the workshop. Other expenses such as visa application expenses and personal expenses will NOT be covered.

Workshop Venue

Golden Spring Hotel (金泉大酒店 Jin Quan Da Jiu Dian in Chinese pronunciation)

Address: No.93 East Renming Road, Kunming City, Yunnan Province, China.

Tel: 86-871-63196888

Workshop Advisors

1) Mr. Qu Guilin, Executive Director of APFNet Secretariat
2) Mr. Lu De, Assistant Executive Director of APFNet Secretariat
3) Prof. Chen Baokun, Director General of SWFU Administrative affairs Board

Workshop Secretariat /Working Group

1) Dr. C.T.S.Nair, APFNet Consultant/Workshop Facilitator,
2) Prof. Shen Lixin, Executive Director of APFNet-KTC
3) Ms. Pan Yao, Program Officer, APFNet-KTC
4) Ms. Wang Jun, Administrative Officer, APFNet-KTC

*Contact Persons in Case of Emergency

1) Ms. Pan Yao (Workshop Secretariat), (+86) 13629635716 (Mobile)
2) Prof. Shen Lixin (Workshop Director), (+86) 13708468944 (Mobile)

2. Workshop Schedule

Part 1: Indoor session (1 -5 & 10 -11 July, 2014)

(Golden Spring Hotel, Kunming City)

Day 1: Tuesday, 1 July 2014

- **Arrival of participants and check in Golden Spring Hotel**
- **Registration**

DAY 2: Wednesday, 2 July2014

Time	Agenda	Presenter/ Facilitator
0800 - 0830	Breakfast on 2nd Floor in the Hotel	APFNet -KTC
0830 – 0900	**Opening ceremony** • Welcome remarks • Introductory remarks • Vote of thanks	Chair: Prof. Shen Lixin
0900 - 0930	Icebreaker – Getting to know each other	Dr. C.T.S. Nair
0930 - 1000	Introduction to the course	Dr. C.T.S. Nair
1000 - 1030	Coffee break and group photo	
1030 - 1150	**Lecture 1:**Rehabilitation of degraded forest lands: A global overview --- Discussion(Q & A) : 10 min.	Dr. David Lamb
1200 - 1330	Lunch	
1330 - 1430	**Lecture 2**: Drivers of forest degradation and probable future scenarios --- Discussion(Q & A) : 10 min.	Dr. C.T.S. Nair
1430 - 1520	**Participant's presentation 1:** Rehabilitation of degraded forests in Bangladesh ➢ Overview of the situation ➢ Case study of Mymensingh Division --- Presentations: 40 min. --- Discussion(Q & A) : 10 min.	Dr. M. Al-Amin & Mr. M.M. Khan
1520 - 1550	Coffee break	
1550 – 1630	**Participant's presentation 3:** Rehabilitation of degraded forests in Cambodia --- Presentation: 30 min. --- Discussion(Q & A) : 10 min.	Mr. Ken Piseth

1630 - 1730	**Group Work**: Development of a model proposal for degraded forest rehabilitation	Dr. C.T.S. Nair & Prof. Shen Lixin
1830 - 2030	Welcome dinner	
DAY 3: Thursday3July 2014		
0830 - 0900	Review of topics/ issues addressed on Day 2	Selected Participants
0900 - 1010	**Lecture 3:** Policy and institutional issues in the restoration of degraded forest lands --- Discussion (Q & A): 10 min.	Dr. David Lamb
1010- 1040	Coffee break	
1040 - 1150	**Lecture 4**: Financing forest restoration: opportunities and challenges. --- Discussion(Q & A) 10min.	Dr. C.T.S. Nair
1200 - 1330	Lunch	
1330 - 1440	**Lecture 5**: Ecosystem approach to forest restoration --- Discussion(Q & A) 10min.	Dr. David Lamb
1440 - 1520	**Participant's presentation 4:**Rehabilitation of degraded forests in China --- Presentation: 30 min. --- Discussion(Q & A): 10 min	Mr. Jiang Jun
1520 - 1550	Coffee break	
1550 - 1630	**Participant's presentation 5:**Rehabilitation of degraded forests in Malaysia --- Presentation: 30 min. --- Discussion(Q & A) : 10 min	Ms. Jennifer Anak Francis
1630 - 1730	**Group work: Development of a model proposal for degraded forest rehabilitation**	Dr. C.T.S. Nair & Prof. Shen Lixin
Day 4: Friday 4 July 2014		
0830 - 0900	Review of topics addressed on Day 3	Selected Participants
0900 - 1010	**Lecture 6:** A Comparative analysis of policies and practices relating to rehabilitation of degraded forest lands --- Discussion(Q & A) : 10 min	Dr. David Lamb
1010-1030	Coffee break	
1030 -1110	**Participant's presentation 6:** Rehabilitation of degraded forests in Mongolia --- Presentation: 30 min. --- Discussion (Q & A) : 10 min.	Ms. Yangiv Ariunzul

1110 - 1150	**Participant's presentation 7:** Degraded forest rehabilitation in the Myanmar --- Presentation: 30 min. --- Discussion (Q & A): 10 min.	Dr. Chaw Chaw Sein
1200 -1330	Lunch	
1330 - 1410	**Participant's presentation 8:** Rehabilitation of degraded forests in Nepal --- Presentation: 30 min. --- Discussion (Q & A) : 10 min.	Mr. Rom Raj Lamichhane
1410 -1450	**Participant's presentation 9:**Degraded forest rehabilitation in the Philippines --- Presentation: 30 min. --- Discussion (Q & A) : 10 min.	Ms. Aurea Parot Lachica
1450 -1510	Coffee break	
1510 -1550	**Participant's presentation 10:**Rehabilitation of degraded forests: The Sri Lankan experience --- Presentation: 30 min. --- Discussion(Q & A): 10 min	Mr. Wasantha Tikri & Bandara Dissanayake
1550 - 1630	**Participant's presentation 11:** Sustainable Forest Management and Rural Development in Lao PDR --- Presentation: 30 min. --- Discussion(Q & A): 10 min	Mr. Airyai Vongxay
1630 - 1730	**Group work: Development of a model proposal for rehabilitation of degraded forests**	Dr. C.T.S. Nair & Prof. Shen Lixin
Day 5: Saturday, 5 July 014		
0830 - 0900	Review of topics addressed on Day 4	Course participants
0900 - 1000	**Lecture 7:** The science and technology of rehabilitation of degraded forests --- Discussion(Q & A) : 10 min	Dr. C.T.S. Nair
1000 – 1020	Coffee break	
1020 -1110	**Participant's presentation 11:** Rehabilitation of degraded forests in Thailand --- Presentation: 40 min. --- Discussion(Q & A) : 10 min	Ms.Wondee Supprasert & Ms.Utharat Phuphiboon
1110 - 1150	**Participant's presentation 12:**Forest rehabilitation experience in Vietnam --- Presentation: 30 min. --- Discussion(Q & A) : 10 min	Ms.Nguyen Tuong Van

1200 - 1330	Lunch	
PM	**Logistics for field trip** (Free afternoon: sight-seeing in Kunming city)	
Day 6 to Day 9: 6 July (Sunday) to 9 July (Thursday) 2014 **Field trip to Pu'er City and visits to ongoing forest rehabilitation efforts**		
6 July 2014	Depart for Pu'er	Ms. Pan Yao
7-8 July 2014	Field visit in Pu'er	Prof. Shen Lixin
9 July 2014	Return to Kunming	Ms. Pan Yao
Day 10: Friday, 10July 2014		
0830-0900	Review of field visit in Puer	
0900 -1010	**Lecture 8**: Forest restoration in the context of traditional landscape management systems in the humid tropics --- Discussion(Q & A): 10 min	Dr. Louis Putzel (CIFOR)
1010 - 1040	Coffee break	
1040 - 1150	**Lecture 9**: Forest restoration and livelihoods in Asia --- Discussion(Q & A): 10 min	Dr. Louis Putzel (CIFOR)
1200 - 1330	Lunch	
1330 - 1500	**Lecture 10**: A synthesis of key findings and conclusions of the workshop --- Discussion(Q & A): 10 min	Dr. C.T.S. Nair
1500 - 1530	Coffee break	
1530 - 1730	**Group Work: Steps to strengthen degraded forest rehabilitation in member economies**	Dr. C.T.S. Nair
Day11: Saturday, 11July 2014		
0830 - 1000	Presentation of model proposal for degraded forest rehabilitation	Course participants
1000 - 1030	Coffee break	
1030 - 1100	Course evaluation	
1100 - 1150	**Closing ceremony** • Award of certificates • Remarks by organizers • Remarks by participants • Vote of thanks	

1200-1300	Lunch	
PM	Visit APFNet-KTC and Southwest Forestry University (SWFU)	
1800	***Farewell Dinner at SWFU***	
Day 12: Sunday 12 July 2014 **--- Departure of participants**		

Part 2: Field Trip Session

6 – 9 July, 2014

Pu'er City, Yunnan Province, China

06 July 2014

07:00 - 07:45	Breakfast at Golden Spring Hotel
07:50 - 08:00	Boarding bus
08:00 - 12:00	Drive from Kunming to Mojiang Country
12:00 - 13:00	Lunch in Mojiang Coutry .
13:00 - 15:00	Drive from Mojiang to Pu'er City and check in Shuangfeng Hotel (Double Phoenix Hotel)
16:00 - 17:30	Visit Pu'er Fine Variety Ecological Tea Garden
18:00 - 19:00	Dinner (hosted by Local Government and Forestry Bureau)
Evening	Free (City sightseeing)

07 July 2014

08:00 - 08:30	Breakfast at Shuangfeng Hotel
08:30 - 09:30	Introduction to forestry development in Pu'er City
09:30 - 11:30	Cultivation Base for Rare and High Value Medicinal Herbs under Natural Forests
12:00 - 13:00	Lunch
13:00 -17:30	Visit program of upland conversion for forestation, upland Agroforestry Practice in villages and visit Caiyanghe Nature reserves
18:00 - 19:00	Dinner
Evening	Free

08 July 2014

08:00 - 08:30	Breakfast at Shuangfeng Hotel
08:30 - 11:30	Visit the Demonstration Site of Logging Ban Programs of Protection Forests for Ecological Function in Wanzhangshan Forest Farm

12:00 - 13:00	Lunch
13:00 - 15:00	Visit Forestry Industry Enterprises (Rosin/Colophony)
15:00 - 17:00	Visit Private Owned Plywood Processing Factory
18:00 - 19:00	Dinner
Evening	Free

09 July 2014

08:00 - 08:45	Breakfast at Shuangfeng Hotel
08:45 - 09:00	Check-out
09:00 - 11:30	Drive from Pu'er City back to Kunming,
11:30 - 12:30	Lunch in Mojiang Country
12:30 - 16:30	Mojiang Country to Kunming City
16:30 - 17:00	Arrive in Kunming and check in at Golden Spring Hotel
18:30 - 17:30	Dinner
Evening	Free

Profile of Kunming City

Fig.1

Kunming, the capital of Yunnan Province (Fig.1), dates back more than 2400 years and owes its importance as the gateway to the celebrated Silk Road that facilitated trade with Tibet, Sichuan, Myanmar and India. Today, the city is the political, economical and cultural center of Yunnan and the provincial center for transport, science and technology. Consequently, it has become the most popular spot for tourism in Southwest China. Kunming enjoys a pleasant climate and does its best to live up to its title of 'the City of Eternal Spring'. The average temperature is expected to be 15ºC-23ºC during September, with slightly lower temperatures in the morning and evening.

Some 26 ethnic minorities such as Yi, Bai, Miao, Dai, Hani inhabit the region and each group has its own festivals - the Torch Festival and the Golden Temple Fair, for example. The hugely successful 1999 International Horticultural Exposition enhanced Kunming's influence in the world and, as a result, more and more foreigners come to discover this enchanting part of China. Its alluring highland scenery, bewitching karst landform, varied and exotic habitats and customs, and places of historical interest can be found at major scenic spots such as Dianchi Lake, Stone Forest, the Village of Ethnic Culture, and Grand View Pavilion. Kunming is also renowned for many delicious local dishes, the most famous being Across the Bridge Rice Noodles and Xuanwei Ham. You can enjoy them both at local restaurants or the night markets where you will find many pubs, bars and cafes that serve good quality meals.

3. List of Participants

NO	NAME	ECOMONY	INSTITUTE	TITLE	E-MAIL
1	Al-Amin M	Bangladesh	Institute of Forestry and Environmental Sciences, University of Chittagong	Professor	prof.alamin@yahoo.com
2	Mohammad Moyeenuddin Khan	Bangladesh	Mymensingh Forest Division, Forest Department	Divisional Forest Officer	moyeenfd@gmail.com
3	Piseth Ken	Cambodia	Department Forest Plantation and Private Forest Development in Forestry Administration	Technical Officer	ken_piseth@yahoo.com
4	Guo Wenfu	China	Research Office of Experimental Center of Tropical Forestry, Chinese Academy of Forestry	Deputy Director	guo_wf@hotmail.com
5	Jiang Jun	China	Institute of Forest Resource Information Techniques, Chinese Academy of Forestry	PhD Condidate	linda_jiangjun@163.com
6	Airyai Vongxay	Lao PDR	REDD+ office, Department of forestry, Ministry of Agriculture and forestry	Technical staff	airyaivxf9@gmail.com
7	Jennifer Anak Francis	Malaysia	Forestry Department Peninsular Malaysia	Assistant Director	jennifer@forestry.gov.my
8	Yangiv Ariunzul	Mongolia	"NUM-ITC-UNESCO" International Laboratory, National University of Mongolia	Researcher	ya_ariunzul@yahoo.com
9	Chaw Chaw Sein	Myanmar	Forest Research Institute	Staff officer	chaw.chaw4@gmail.com
10	Rom Raj Lamichhane	Nepal	Gazzeted II Class, Ministry of Forest and Soil Conservation	Planning officer	romrajlamichhane@yahoo.com
11	Aurea Parot Lachica	Philippine	DENR – Forest Management Bureau	Senior Forest Management Specialist	auparot@yahoo.com
12	Wasantha Tikiri Bandara Dissanayake	Sri Lanka	Forest Department	Conservator of Forests (Planning & Monitoring)	dissaforest@yahoo.com
13	Utharat Phuphiboon	Thailand	Royal Forest Department	Forestry Technical Officer	utharat@hotmail.com
14	Wondee Supprasert	Thailand	Forest Industry Organization	Assistant director	Wondee310@yahoo.com
15	Nguyen Tuong Van	Viet Nam	Propaganda and Personnel Development Division of Forest Protection Department	Forest Ranger	meotinhin@gmail.com

4. Personal Profile of Resource Persons

1) Dr. C. T. S. Nair (Email: ctsnair47@gmail.com)

Dr. C.T.S. Nair, who was with the Indian Forest Service, is currently a freelance consultant in natural resources management with particular focus on economics, policy, institutions and science and technology. He has a multi-disciplinary background with Bachelors degree in zoology, Post-Graduate diploma in forestry, M.Phil in Applied Economics (Jawaharlal Nehru University) and doctorate in Forest Economics (University Wales, Bangor, United Kingdom).

Having worked in India and abroad in various capacities for over four decades, Dr. Nair has a highly diverse experience profile. With the Indian Forest Service he served as Divisional Forest Officer with the Kerala Forest Department and as Forest Economist and later as Director at the Kerala Forest Research Institute. He has also worked in the Ministry of Environment and Forests, Government of India as Deputy Inspector General of Forests, in charge of forestry research and education and forest policy and was closely involved in the finalization of the 1988 forest policy of India.

Dr. Nair was with the Food and Agriculture Organization of the United Nations for about 20 years and worked in various capacities, including as Forest Economist in Sudan (for 3.5 years), Senior Programme Advisor (Forestry Research Support Programme for Asia-Pacific - FORSPA- FAO Regional Office, Bangkok – for about 6 years), and in various capacities in the Forestry Department, FAO Headquarters, Rome for 10 years (including as Senior Forestry Officer (Economic Analysis), Chief of the Planning and Statistics Branch, Chief of the Forest Economics Service and Chief Economist of the Forestry Department). In Sudan he played a key role in the newly established Forests National Corporation, especially in developing programmes and projects and undertaking detailed economic assessment including a very comprehensive assessment of demand and supply of wood in the entire Northern Sudan. As Senior Programme Advisor of FORSPA in Bangkok he was instrumental in strengthening networking of forestry research institutions in the Asia-Pacific and capacity building in research planning. An important contribution in this regard is the setting up the Asia-Pacific Association of Forestry Research Institutions (APAFRI) and the TEAKNET. For his outstanding contribution to tropical forestry, in 1997 the Commonwealth Forestry Association awarded him the Tom Gill Memorial medal.

After his retirement from FAO in September 2009 Dr. Nair rejoined the Government of Kerala as the Executive Vice President of the Kerala State Council for Science, Technology and Environment and as the Principal Secretary, Science and Technology Department. During that period he also served as the Chairman of the Kerala State Coastal Zone Management Authority.

Dr. Nair has over 100 publications dealing with economics, policy and institutional analysis. Some of his notable contributions include the "Forestry Outlook Study for Africa (including 5 sub-regional outlook reports)", "People, forests and trees in West and Central Asia: Outlook for 2020", "Asia-Pacific Forests and Forestry to 2020" South Asian Forests and Forestry to 2020", and the "State of World's Forests 2009". He has also written extensively on policy,

economics and institutional issues including on forest administration, research and education.

Dr. Nair continues to work on forestry issues especially on policy analysis, long term outlook studies, institutional reform and human resource development. Very recently (May-June 2013), he coordinated/ facilitated the 6th Executive Forest Policy Course organized by FAO in collaboration with the SAARC Forestry Centre, APAFRI and other organizations.

2）Prof. David Lamb (Email: david.lamb@uq.edu.au)

Particular interests and expertise

Although Prof. David Lamb has broad interests in ecology and conservation biology his particular expertise lies in forest restoration and rehabilitation of degraded forests and land. Much of his experience has been gained in tropical and sub-tropical regions of the Asia-Pacific region. Prof. David Lamb has been especially concerned with forms of reforestation that improve livelihoods but which also generate some biodiversity and other conservation benefits.

Education background

Diploma of Forestry, Australian Forestry School, Canberra; 1963
BSc (Forestry), University of Western Australia; 1964
MSc, Australian National University; 1968
PhD, Australian National University; 1972

Employment history

Following graduation as a forester I initially worked on watershed management for the then Forest Research Institute in Canberra (which subsequently became the CSIRO Division of Forestry Research). Prof. David Lamb then returned to post graduate studies at the Australian National University where he undertook a MSc and PhD. He subsequently worked for some years in the Forestry Department of Papua New Guinea. Returned to Australia in 1977 and joined the University of Queensland where he taught forest ecology until retired in 2006.

He has continued his association with the University of Queensland through honorary appointments with the School of Agriculture and Food Science and with the Center for Mined Land Rehabilitation.

Since retirement he has also undertaken consultancies with the World Bank, FAO and AusAID in China, Vietnam and the Pacific.

3) Dr. Louis Putzel (E-mail:L.Putzel@cgiar.org)

Particular interests and expertise

Dr. Louis Putzel current primary research interest relates to smallholder and community forest management, which includes a range of activities from timber production to restoration of forests degraded by activities such as logging and agriculture.

In addition, over the past 10 years, he has been researching the forestry-related role of China worldwide. This work includes studies on the effects of Chinese demand for timber from Latin America and Africa and the engagement of Chinese enterprises investing in the forest sector and other industries affecting forests in African countries. More recently, he began to work with partners within China on a project focused around the Conversion of Cropland to Forest Programme (also known as the Sloping Land Conversion Programme, or "grain for green"), in which over 20 million ha have been converted from cropland to forest in what is arguably the world's largest payment for environmental services scheme. This project is in the process of expanding to include research with partners in a number of countries in Southeast and South Asia, focusing on the environmental and smallholder livelihoods effects of re/afforestation in hilly and mountainous regions.

Education background

2010: City University of New York, Ph.D. in Biology – Plant Sciences
1999: Columbia University, School of International and Public Affairs (SIPA),
Master of International Affairs, Environmental Policy Studies
1999: Columbia University, Center for Environmental Research and Conservation,
Certificate in Conservation Biology
1988: Columbia College
Bachelor of Arts, East Asian Languages and Cultures
1987: East China Normal University (Shanghai)
Advanced Chinese Course

Employment history

In the 1990s, Dr. Louis Putzel worked in the private sector in Hong Kong and Beijing before returning to pursue his master's studies. In the early 2000s, he worked for several years on conflict resolution programmes in Central Africa. From 2004 to 2009, he was based at the New York Botanical Garden, from where he coordinated a network of ethnobotanists and taught courses in forest ecology and ethnobotany to New York City high school students. Upon obtaining Dr. Louis Putzel doctorate based on work related to the timber trade from Peruvian Amazonia to China, entitled "The tree that held up the forest: Shihuahuaco (*Dipteryx* spp.) and the Chinese timber trade", he joined CIFOR where currently conducting research and manage projects on a number of topics related to Chinese forestry, smallholder forest management, and forest restoration for ecosystem services in hilly and mountainous landscapes.

5. Outlines of Keynote Lectures

Lecture 1: Rehabilitation of degraded forest lands: A global overview

--- by Prof. Lamb David

Many are concerned about the very large areas of degraded land that have now accumulated around the world. Degradation is difficult to define and therefore difficult to map. Nonetheless many governments and other organizations wish to reforest some of this degraded land. However, there is great uncertainty about how much of this is actually available for forest restoration – not all landowners are interested in reforestation.

In addition, there are also a number of other factors that may limit our capacity to undertake large scale reforestation (either in large contiguous blocks or in many small individual plantings). These include the fact that populations are growing and there is a rising need for food production. Further, the effects of climate change on future vegetation patterns are unclear (where to plant and what to plant?). On the other hand, public attitudes are changing and there is increasing interest in reforestation for environmental protection. In addition, markets for timber products remain attractive and markets for the ecosystem services supplied by forests (e.g. carbon storage, watershed protection) appear to be increasing. While large-scale reforestation seems an attractive solution we must be aware of some possible negative outcomes. For example, reforestation for the national benefit can sometimes be seen as a 'land grab' by local communities. This raises the interesting question of how to share the costs as well as the benefits of reforestation?

Lecture 2: Drivers of forest degradation and probable future scenarios

--- by Dr. C.T.S. Nair

Throughout the history of civilization, human beings have modified their environment with varying positive and negative consequences. Hunter gatherer societies probably had minimal impacts and their interventions were within the limits of nature's ability to recover itself. The transition from a hunter gatherer society to an agrarian society, initially through slash and burn cultivation and subsequently through intensive settled agriculture has been a major driver of deforestation and degradation, especially when agricultural practices significantly altered the ecosystem components and processes. Development of an industrial society has brought about a major change in the use of land and forests, changing their structure and functions, accentuating the degradation process.

Deforestation and degradation are often different manifestation of the same problems and an outcome of the collective impact of a number of drivers. A clear understanding of these drivers and how they directly and indirectly lead to degradation as also rehabilitation/ restoration is necessary to craft initiatives to reverse the process. Often many of the interventions are not based on such an understanding resulting in failures. In fact the history of degraded forest rehabilitation/ restoration are full of examples of failed initiatives, mostly stemming from the absence of an understanding of the drivers of degradation.

Broadly the drivers of forest degradation can be grouped as proximal and distant. Proximal drivers are those that are apparent visible, for example agricultural expansion, logging, collection of products beyond the limits of sustainability, mining, etc. Underlying these proximal drivers are the more fundamental and distant drivers. These include (a) changes in demography, (b) economic changes, (c) changes in policy and institutional environment, (d) environmental changes and (e) technological developments. The collective impact of these including how societies respond to them differs significantly between countries and over time, accentuating or countering the process of forest degradation. Some of the key issues that the lecture discusses are:

- Key drivers that have contributed to forest degradation in the last few decades;
- How societies have responded to these changes and to what extent rehabilitation/ restoration efforts have been crafted taking into account the underlying drivers.
- Future scenarios for forest degradation in some of the Asia-Pacific countries taking into account how some of the critical drivers are likely to evolve.
- Implications of climate change on forest degradation and the efficacy of society's responses.

Lecture 3: Policy and institutional issues in the restoration of degraded forest lands

--- by Prof. Lamb David

Policies are the objectives or principles used to guide collective action while institutions are the methods by which these policies are carried out. There are three broad categories of policy relevant to forest restoration (i) those that remove impediments and simply enable landholders to carry it out (e.g. by providing tenure) (ii) those that actively encourage landholders to carry out reforestation by providing incentives or subsidies of various kinds (e.g. cash grants) and (iii) those that require landholders in certain areas to carry it out (e.g. at former mine sites or on steep land). Much attention has been given to the second of these and the types of incentives that are offered. Rather less attention has been given to the question of how effective these various policies are and how we (as citizens or taxpayers) can get value-for-money.

The institutional arrangements needed to manage industrial forestry programs are not necessarily the same ones needed to encourage forest restoration on degraded lands. As reforestation to overcome degradation becomes more important new institutional arrangements may be needed. Some institutions will necessarily operate at the national level but some regional and local bodies will be required as well, especially to encourage reforestation by private landholders. The scale over these different institutions operate and responsibilities of each deserves discussion – what should each body do? How do they relate to existing government agencies (or non-government bodies)? How effective is each and how should they be held accountable? Likewise we need to consider who is on each body and how representative they are of 'their' stakeholders.

Lecture 4: Financing forest restoration: opportunities and challenges

--- by Dr. C.T.S. Nair

Rehabilitation and restoration of degraded forest lands require substantial investment and resource constraints continue to be a major challenge confronting governments and other stakeholders. Consequently the scale of rehabilitation/ restoration is far from adequate to keep pace with the rate of deforestation/ degradation. Rebuilding the natural capital involves both direct and indirect costs and requires upfront investments as also foregoing immediate uses, imposing costs on society. Ultimately allocation of resources

for rehabilitation largely depends on the overall ability and willingness of society to allocate the required resources.

There are different sources of financing rehabilitation/ restoration of degraded forests. Broadly they can be grouped as (a) domestic and (b) external. Domestic funding consists of resources allocated by governments, private sector (including farmers), local communities and civil society organizations. External funding largely consists of assistance –grants and loans – provided by multilateral and bilateral organizations, international civil society organizations, etc.

Ability to mobilize domestic funding largely depends on the overall economic situation and the priority that society assigns to rehabilitation/ restoration. Historically governments have been the major source of funding rehabilitation initiatives. Largely this has been due to two factors: the preponderance of public ownership, limiting the involvement of other stakeholders in rehabilitation initiatives and the public goods nature of benefits from rehabilitation. Economically better off countries – which is reflected in the ability of governments to mobilize resources through taxation – have been able to invest significantly in degraded forest rehabilitation. Most rehabilitation efforts continue to be funded from the annual government budget. Realizing the limitations of this a number of governments have established special programmes with long term dedicated financial support to strengthen rehabilitation initiatives.

Other sources of domestic funding, especially from private sector are in the early stages of development and are at best important on a smaller scale. Much of the allocation of funding for rehabilitation by private sector is geared to enhancing production of wood, in particular industrial timber. Increasing emphasis on compliance to corporate social and environmental responsibility however could enhance private funding in support of degraded forest rehabilitation contributing to social and environmental objectives. Mobilizing private funding however requires appropriate public policies, including addressing issues like land tenure, security of investments and so on.

Global environmental concerns especially loss of biodiversity and climate change have led to a number of international initiatives, leading to significant international funding for rehabilitation of degraded lands. Several bilateral and multilateral agencies have extended support for rehabilitation of degraded forests. A major challenge as regards external funding is its sustainability: rehabilitation efforts require long term commitment and sometimes changing donor policies and priorities could affect continued international support.

In the recent years payment for environmental services like carbon sequestration, watershed protection and biodiversity conservation has become an important means of funding forest rehabilitation. There are several instances of utility companies contributing to upland rehabilitation, especially to improve the supply of clean water and power to down-stream users. Carbon sequestration is another service gaining grounds in the context of climate change mitigation policies and the emergence of carbon markets. Implementation of REDD+ through compensating land owners to refrain from deforestation and degradation and encouraging sustainable management is receiving considerable attention. Yet many challenges persist in making PES a viable means of financing rehabilitation/ restoration of degraded forests.

Some of the key issues that financing forest restoration needs to take into account are:

- Currently there is over-reliance on public funding – national and international – in support of rehabilitation of degraded forests.
- No single source of funding will suffice to meet the future needs of rehabilitation and countries will have to resort to multiple sources.
- Diverse approaches will have to be devised to tap into the different sources of funding;
- Policy and institutional changes will be inevitable to tap into private financing;
- Enhancing transparency, accountability and efficiency will be critical in mobilizing financial resources from different sources.

Lecture 5: Ecosystem approach to forest restoration

--- by Prof. Lamb David

The so-called Ecosystem Approach is an attempt to reconcile biodiversity conservation with the need to improve human livelihoods. It seeks to promote the management of natural resources in a way that is both sustainable and equitable. In the case of forest restoration there are five basic steps to be taken (i) to identify the area that might be available for reforestation and the relevant stakeholders associated with this land (ii) to determine the goods and services these communities require and the types of reforestation able to supply these goods and services (iii) to identify the economic conditions of the stakeholders and the consequences of this for the proposed reforestation methods (e.g. do they have the resources, knowledge or capacity to undertake reforestation?) (iv) to consider the broader landscape context in which this reforestation will be carried out (because many ecosystem services are generated by processes operating at a landscape scale) and (v) to develop a process of adaptive management to monitor the silvicultural, ecological, economic and social impact of reforestation so that the program can be fine-tuned or adjusted if necessary. The Ecosystem Approach is one that forces silviculturalists to think of reforestation in terms of the ecological and socio-economic context in which it happens and not just in terms of the trees planted.

Lecture 6: A comparative analysis of policies and practices relating to rehabilitation of degraded forest lands

--- by Prof. Lamb David

Large-scale reforestation began over 100 years ago in many countries. What have we learned from this experience and how relevant is this knowledge for future reforestation practices? Surprisingly similar silvicultural practices and policies have arisen in different parts of the world irrespective of how much natural forest remained (e.g. the types of species planted, the silvicultural techniques used and the types of forest products

produced). In most countries the early reforestation programs were developed by government agencies in order to develop timber resources for industrial development. Only later did private enterprise become engaged (i.e. the market signal was initially not strong enough to attract private enterprise and only became so once the risks associated with tree-growing had been resolved). Similar policies developed in many countries to encourage tree-planting by companies (e.g. help in acquiring land, financial assistance and taxation breaks). Reforestation increased rapidly in the second half of the 20th century as a consequence.

In more recent years the identity of forest growers has begun to change and new policies are developing in many countries to encourage smallholders to use some of their land for forests. There is also increased interest in encouraging reforestation for protection rather than just production. Both of these changes mean that the policies and practices used to encourage industrial reforestation in the past may no longer be suitable and will have to change. In future – unlike the past - there will not be a broad similar single set of policies and practices. Instead a variety of different arrangements will be needed depending on local circumstances. Some of these future possibilities will be discussed.

Lecture 7: The science and technology of rehabilitation of degraded forests

--- by Dr. C.T.S. Nair

Improvements in science and technology are vital in the successful rehabilitation of degraded forests. In fact some of the earliest research efforts in forestry has been focused on the development of knowledge about rehabilitating degraded forests that have lost their productivity, especially of wood. Considering the emphasis on wood production, rehabilitation research efforts in the past have largely focused on (a) ensuring regeneration of commercially important species in logged over areas especially through assisted natural regeneration and (b) establishing tree cover on degraded land to enhance the production of goods and services. Research has focused on providing a better understanding of ecosystem processes and species-site matching leading to a wide array of management practices, especially addressing enhancing productivity, managing the risks from pests, diseases, fire and other factors that adversely affect rehabilitation and productivity.

Obviously science and technology have evolved in line with the objectives of the land owners/managers. Inadequate understanding of the complex ecosystem processes have encouraged simplification of the ecosystem or rather simple approaches to rehabilitation, especially through monoculture, primarily focused on wood production. The economic dimension received most attention in rehabilitation efforts. This however is undergoing changes, especially in the context of the involvement of multiple stakeholders and increasing thrust on fulfilling social and environmental objectives. Rehabilitation is no more just planting and maintaining commercially valuable tree species. A whole array of technologies has evolved to deal with differing ecological conditions and the needs of diverse stakeholders.

Developments in science especially outside the forest sector have led to the development of more nuanced and refined rehabilitation approaches. There is a much better understanding of the ecosystem processes and the developments in synthesizing information from a wide array of areas (aided by developments in remote sensing and computational technologies) are helping to provide improved approaches to rehabilitate degraded ecosystems. Undoubtedly developments in geographical information system enabling the integration of a wealth of information are providing powerful tools for highly refined site-specific interventions.

However science and technology will have to confront a number of new challenges. Risks and uncertainties related to managing ecosystems stemming from climate change will require immediate attention. Climate change in addition to contributing to degradation, especially in the context of sea level rises, shifts in distribution and patterns of rainfall, droughts and the increasing frequency and intensity of extreme climatic events, outbreak of pests and diseases, spread of invasive species, etc. could also pose major challenges in developing appropriate rehabilitation strategies and practices. Adapting to risks and uncertainties associated with the different climate change scenarios will remain a major challenge for science and technology.

Some of the major challenges that science and technology will have to confront in the context of rehabilitating the vast tracts of degraded forest lands include:

- Development of more refined rehabilitation approaches to address the multitude of uncertainties, especially on account of climate change;
- Integrating the different streams of knowledge and information and providing more holistic approaches that balances economic, social and environmental objectives. This will also include local/ traditional knowledge that has hitherto remained at the margins.
- Meeting the science and technology needs of different stakeholders, in particular rural communities for enabling their active engagement in landscape rehabilitation and management. This will require science and technology to be more people-centric and people-empowering, necessitating significant changes in the institutional arrangements for science and technology development.

Lecture 8: Forest restoration in the context of traditional landscape management systems in the humid tropics

--- by Dr. Louis Putzel (CIFOR)

The term "forest restoration" can be taken to mean a return of a given piece of land to a former state of forest cover. The degree to which that forest cover reflects characteristics of the prior ecosystem is highly variable in terms of areal scale, tree species diversity and distribution, successional stage, age of stands and individual trees, genetic diversity within populations of particular species, and provision of habitat for animals and a variety of other ecosystem services. Many of the government-sponsored reforestation programs

currently underway in Asia succeed in restoring tree cover but fail to achieve other qualities associated with healthy "natural" forest ecosystems.

At the same time, in many places throughout the humid tropics, traditional smallholder and community landscape management systems feature forest restoration activities. These activities occur at different spatial and temporal scales and employ techniques based on traditional knowledge, scientific silvicultural practices imparted by extension services, or a hybrid of the two. Forest restoration by smallholders and communities is carried out in agricultural fallows and has also been observed in areas where logging has recently taken place. Such traditional landscapes management systems occasionally feature a great diversity of land cover types, tree species diversity, successional stages, etc., and are worthy of continued study. Particular aspects to be discussed are the conditions under which smallholder/community landscape management systems feature processes of forest restoration, and how such processes compare to programmes implemented by the state in terms of the variables mentioned above.

Lecture 9: Forest restoration and livelihoods in Asia

--- by Dr. Louis Putzel (CIFOR)

Forest restoration and rehabilitation activities are conducted in a variety of landscapes – ranging from degraded wastelands to productive agricultural lands – and for a number of reasons. These include provision of timber stocks and NTFPs and/or ecosystem services such as flood control, erosion prevention and soil conservation, biodiversity conservation, carbon sequestration, and development of scenic areas for ecotourism. But who benefits from these activities, and who bears the opportunity costs associated with designating lands as forest? With the many re/afforestation schemes currently underway throughout Asia, many models of livelihood development and/or compensation have been tried. These range from smallholder timber production schemes sponsored through land allocations (e.g. in Vietnam) and credit schemes (such as in Indonesia) to large-scale payment for ecosystem service schemes such as China's conversion of cropland to forest programme (CCFP).

From the available literature and some current research by CIFOR's Sloping Lands in Transition (SLANT) project, this session will explore the livelihoods outcomes of some of Asia's most important re/afforestation programmes. Discussion will focus on who the direct and indirect beneficiaries of such programmes are (or are intended to be); to what degree and under what conditions forestry is a sustainable livelihoods option for local people in different parts of Asia; and how state programs to increase forest cover relate to broader trends such as power relationships between different ethnic groups and rural-to-urban migration.

Lecture 10: A synthesis of key findings and conclusions of the workshop

--- by Dr. C.T.S Nair

The fourth one is a synthesis of the key findings and conclusions based on the presentations and discussions during the workshop.

6. PPT Files of Keynote Lectures

(1) Rehabilitation of degraded forest lands: A global overview

--- by Prof. Lamb David

(2) Drivers of forest degradation and probable future scenarios

--- by Dr. C.T.S. Nair

(3) Policy and institutional issues in the restoration of degraded forest lands

--- by Prof. Lamb David

(4) Financing forest restoration: opportunities and challenges

---by Dr. C.T.S. Nair

(5) Ecosystem approach to forest restoration

--- by Prof. Lamb David

(6) A comparative analysis of policies and practices relating to rehabilitation of degraded forest lands

--- by Prof. Lamb David

(7) The science and technology of rehabilitation of degraded forests

--- by Dr. C.T.S. Nair

(8) Forest restoration in the context of traditional landscape management systems in the humid tropics

--- by Dr. Louis Putzel (CIFOR)

(9) Forest restoration and livelihoods in Asia

--- by Dr. Louis Putzel (CIFOR)

(10) A synthesis of key findings and conclusions of the workshop

--- by Dr. C.T.S Nair

7. PPT Files of Participant Presentations

(1) Bangladesh: Participatory Forest Management In Degraded Forests: Perspective REDD+ IN Bangladesh

---By Prof. Al-Amin

(2) Bangladesh: Social Forestry: An Appropriate Approach for Rehabilitation of Degraded Forest and Sustainable Forest Management

---By Mr. Mohammad Moyeenuddin Khan

(3) Cambodia: Forest Restoration and Plantation in Cambodia

---By Mr. Piseth Ken

(4) Malaysia: Sustainable Forest Management in Peninsular Malaysia

---By Ms. Jennifer Anak Francis

(5) Myanmar: Degraded Forest Rehabilitation and Sustainable Forest Management in Myanmar

---By Dr. Chaw Chaw Sein

(6) Nepal: Rehabilitation of Degraded Forest in Nepal

---By Mr. Rom Raj Lamichhane

(7) Philippine: Philippine Forest Situation

---By Ms. Aurea Parot Lachica

(8) Sri Lanka: Rehabilitation & Restoration of Forest in Sri Lanka

---By Mr. Wasantha Tikiri Bandara Dissanayake

(9) Thailand: Development of an Integrated Forest Management in Thailand

---By Ms.Utharat Pupaiboon

(10) Thailand: The Degraded Forest Rehabilitation and Sustainable Forest Management: SFM Activities in Forest Industry Organization in Thailand

---By Ms.Wondee Supprasert

(11) Viet Nam: Restoration and Sustainable Management of the Forest Ecosystem in the Central highlands in the Period 2013-2020, Vision 2030

---By Ms. Nguyen Tuong Van

(12) Viet Nam: An Overview of Viet Nam Forest Rehabilitation

---By Ms. Nguyen Tuong Van

8. Reading Materials From Resource Persons

A. Reading materials provided by Dr. CTS. Nair

(1). Chokkalingam U, AP Caradang, JM Pulhin, RD Lasco, RJJ Peras and T Toma 2006. One Century of Forest Rehabilitation in the Philippines: Approaches, Outcomes and Lessons, Centre for International Forestry Research.

http://www.icraf.org/sea/Publications/files/book/BK0104-06.PDF

(2). FAO 2010. Asia-Pacific Forests and Forestry to 2020: Asia-Pacific Forestry Outlook Study II, FAO Regional Office, Bangkok.

http://www.fao.org/docrep/012/i1594e/i1594e00.htm

(3). FAO 2013. Papers presented during the Expert Meeting on Strengthening Finance for Sustainable Forest Management through National Forest Funds, 24 to 25 October 2013, CIFOR.

(4). FAO 2014. PaIUCN/WWFyment for ecosystem services for forests (PES) and forest financing, Committee on Forestry, 22nd Session, June 2014,COFO/2014/4.5.

(5). FAO 2014. Forest and Landscape Restoration Mechanism, Committee on Forestry, 22nd Session. June 2014. COFO/2014/6.4 Rev.1

(6). Gilmour DA, Nguyen Van Sam and Xiang Tsechalicha 2000. Rehabilitation of degraded forest ecosystems in Cambodia, Lao PDR and Vietnam: An Overview, IUCN/WWF/GTZ.

http://www.mekonginfo.org/assets/midocs/0001716-environment-rehabilitation-of-degraded-forest-ecosystems-in-cambodia-lao-pdr-thailand-and-vietnam.pdf

(7). Hilderbrand RH, AC Watts and AM Randle 2005. The myths of restoration ecology, Ecology and Society, Vol 10(1).

http://ohvec.org/issues/mountaintop_removal/articles/myths_of_restoration.pdf

(8). ITTO. 2002. ITTO Guidelines for Restoration, Management and Rehabilitation of Degraded Secondary Forests, ITTO Policy Development Series, International Tropical Timber Organization.

http://www.itto.int/policypapers_guidelines/

(9). Liu Dachang 2003. Rehabilitation of degraded forests to improve livelihood of poor farmers in South China, Centre for International Forestry Research.

(10). Mansourian S, D. Vallauri and N. Dudley Ed. 2005. Forest Restoration in Landscapes: Beyond Planting Trees, WWF International, Springer, New York.

(11).Shigeo Kobayashi 2004. Landscape rehabilitation of degraded tropical forest ecosystems: Case study of the CIFOR/Japan Project in Indonesia and Peru, Elsevier BV.

http://www.aseanbiodiversity.info/Abstract/53003714.pdf

(12). Wil de Jong, Do Dinh Sam and Trien Van Hung. 2006. Forest Rehabilitation in Vietnam: Histories, Realities and the Future. Centre for International Forestry Research.

http://www.cifor.org/publications/pdf_files/Books/BDeJong0601.pdf

B. Reading materials provided by Prof. Lamb David

(1). Anon. 2014. Forests and water: A synthesis of the contemporary science and its relevance for community forestry in the Asia–Pacific region. RECOFTC, Bangkok.

http://www.recoftc.org/site/resources/Forests-and-water-A-synthesis-of-the-contemporary-science-and-its-relevance-for-community-forestry-in-the-Asia-Pacific-region.php

(2). Brancalion et al. 2013. How to Organize a Large-Scale Ecological Restoration Program? The Framework Developed by the Atlantic Forest Restoration Pact in Brazil. Journal of Sustainable Forestry 32: 728-744

Describes some of the institutional arrangements being developed to encourage a large-scale reforestation program in the Atlantic forest region of Brazil. See also http://www.pactomataatlantica.org.br/index.aspx?lang=en

(3). Elliott, S. Blakesly, D. and K. Hardwick 2013. Restoring Tropical Forests: A Practical Guide. Royal Botanic Gardens, Kew.

An updated version of Elliott et al 2006. How To Plant a Forest: The Principles and Practice of Restoring Tropical Forests. Both available at www.forru.org.

(4). Koch, J. and R. Hobbs. 2007. Synthesis: Is Alcoa successfully restoring a Jarrah forest ecosystem after bauxite mining in Western Australia? Restoration Ecology 15: S137-S144.

An account of a very successful forest restoration program following bauxite mining in a biodiversity hot-spot (available via Google Scholar).

(5). Laestadius et al. 2011. Mapping opportunities for forest landscape restoration Unasylva 62 (238) 47.

Describes methods for assessing, at a global scale, the potential availability of land for restoration [available from http://www.fao.org/forestry/unasylva/en/

(6). Lamb, D. 2011. Regreening the Bare Hills: Tropical Forest Restoration in the Asia-Pacific region. Springer, Dordrecht.

An overview of different types of reforestation across the region and some of the factors influencing its adoption.
See[http://www.springer.com/life+sciences/forestry/book/978-90-481-9869-6]. It is excessively expensive but a cheaper ebook version is available from Springer and through Apple iTunes (ISBN 978-90-481-9870-2)

(7). Lamb, D. and Gilmour, D. 2003. Rehabilitation and Restoration of Degraded Forests. International Union for the Conservation of Nature. Gland.

This gives a general account of some of the main ideas and principles together with some case studies
[http://cmsdata.iucn.org/downloads/rehabilitation_and_restoration_of_degraded_forests.pdf]

(8). Le et al. 2004 Making the Most of Market Chains: challenges for small-scale farmers and traders in upland Vietnam. IIED, London.

An account of the difficulties in marketing forest products with suggestions on how this might be improved. Available at http://pubs.iied.org/9313IIED.html

(9). Sayer et al. 2013 Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. Proceedings of National Academy of Sciences 110: 8349-8356.

An outline of approaches to dealing with reforestation at a landscape scale (available Google Scholar).

(10). Shepherd, G. 2004. *The Ecosystem Approach: Five Steps to Implementation*. International Union for the Conservation of Nature. Gland.

An outline of the Ecosystem Approach and ways it might be implemented. Deals primarily with natural and agricultural systems rather than reforestation.
[http://www.iucn.org/about/union/commissions/cem/cem_resources/?373/The-Ecosystem-Approach-Five-Steps-to-Implementation]

(11). Soares-Filho et al. 2014. Cracking Brazil's forest code. Science 344: 363-364.

An account of recent changes to forest policies in Brazil (available via Google Scholar).

(12). Wang et al. 2012. An auction scheme for land use change in Sichuan Province, China. Journal of Environmental Planning and Management 55: 1269.

An account of trials to test reverse auctions in China

(13). Assisted natural forest regeneration in Philippines (Film)

http://www.youtube.com/watch?v=9RPDsi7mkSE

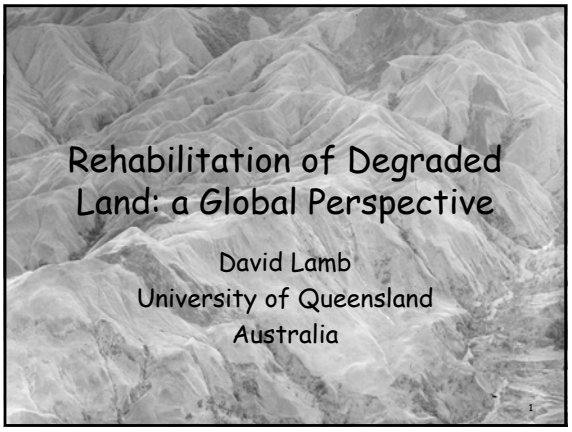
(14) Forest Restoration Research Unit, Thailand (Film)

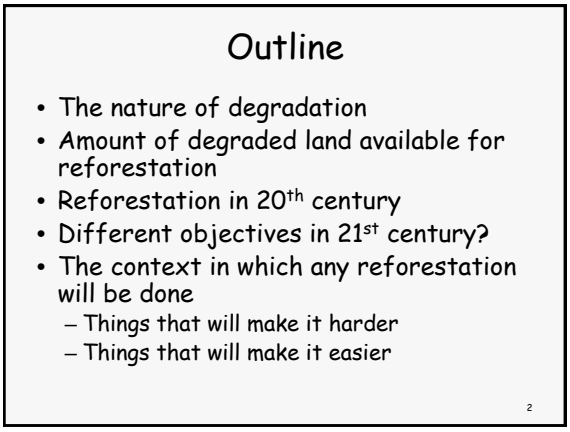
http://www.youtube.com/watch?v=bB3YmfH5Ikk

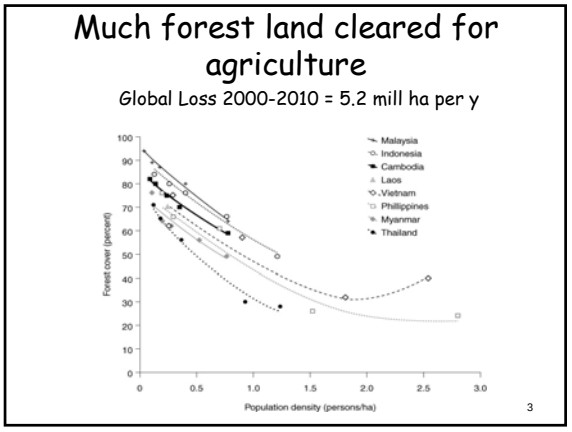
Attached Files:

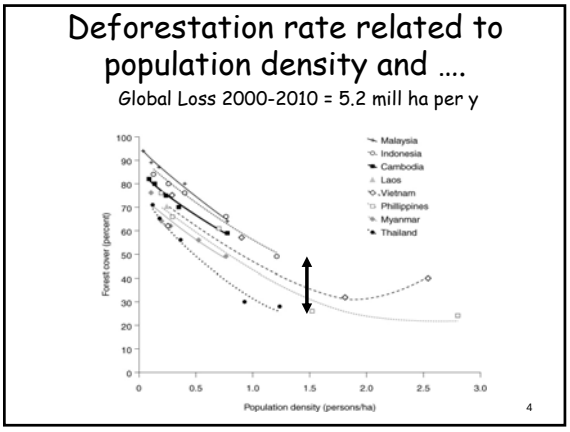
6. PPT Files of Keynote Lectures

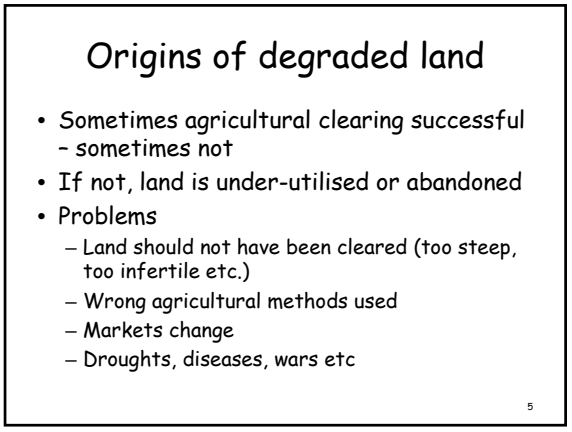
(1) Rehabilitation of Degraded Land: a Global Perspective

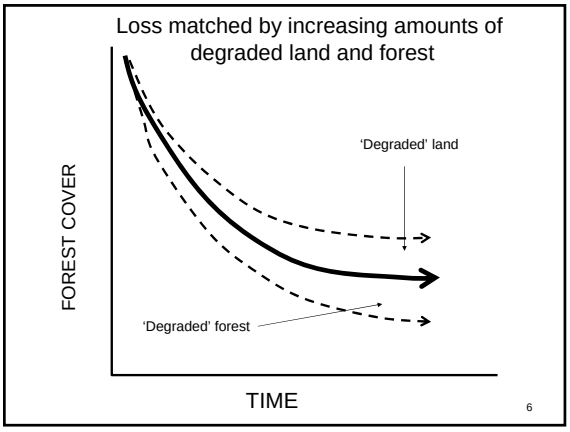












Defining "Degraded"

- Not all cleared land is degraded
  e.g. Some farmland 'marginal' but still usable
- "Degraded land" is difficult to define – a perceptual term?
  - E.g. Compare ideas of a farmer and a wildlife conservationist
- Definition: *changes causing a reduction in capacity of land to supply goods and services*
- Difficult to define boundaries and map

7

How much degraded land is available for reforestation?

- Not all degraded land available for reforestation
  - Perhaps still (poorly) used
  - Even if not used - owners unwilling to allow others to reforest
- Estimates of available land vary
  - 2,000 to 3,500 mill ha*

*Laestadius et al 2011 Unasylva 62 (238); Benetiz et al 2007 Ecological Economics 60: 572

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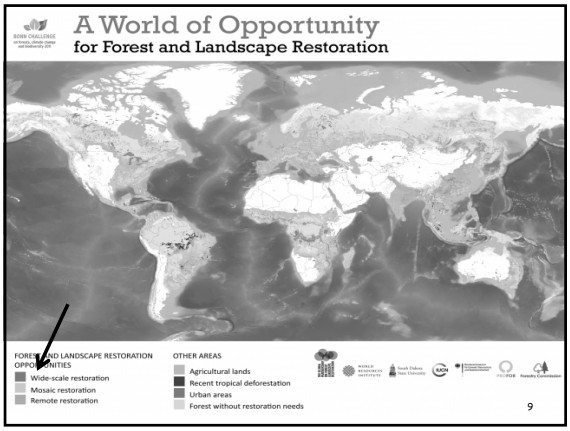

9

Reforestation in 20th Century

- Large-scale reforestation begins in early 20th century (mainly only small trials before then)
- Objectives
  - Supply timber
  - Improve employment in rural areas
- Mostly done by government Forestry Departments
  - Research on species and silviculture
  - Reduce risks and make reforestation more attractive to private companies

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Can undertake reforestation in different ways

- Natural regrowth
- Direct seeding
- Planting seedlings

During 20th century

- Industrial plantation model develops
  - Single species (mostly *Pinus, Eucalyptus, Acacia, Poplar, Tectona*)
  - Establish as seedlings
  - Density around 1100 tph
  - Heavy early weed control
  - Fixed rotation (5-80 years)
- Private timber companies become involved
- But by end of 20th Century
  - Interest amongst smallholders
  - Use of multi-species plantings
  - increasing interest in ecosystem services

12

Smallholders important as well as industrial growers

Area of productive plantations in 2005 (x1000ha)

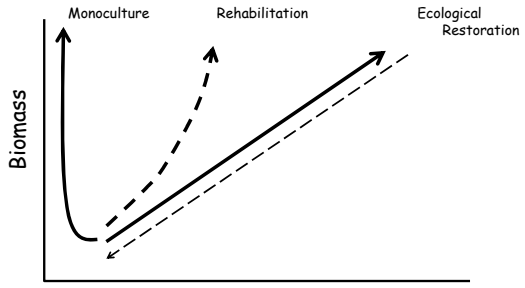
	Public	Corporate	Smallholder	Other (NGOs?)
Global	77,352	27,176 ⟷	49,980	492
SE Asia	6,758	636	2,302*	65

* May be under-estimate
- Indonesia and Myanmar classify all plantations as publicly owned
- Thailand same except rubber

(Source: FAO 2006 Planted Forests and Trees Working Paper FP38)

13

Different types of reforestation Production vs Ecosystem Services



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Reforestation for Production and Ecosystem Services

- Production (or Goods)
  - Pulpwood
  - Sawlogs
  - NTFPs
- Ecosystem services
  - Soil protection
  - Provision of clean water
  - Habitats for biodiversity conservation
  - Carbon storage
  - Pollination
  - Recreation

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Examples of increasing interest in reforestation to supply ecosystem services

Country	Scale (m ha)	Date and Purpose
Korea	2	1950s; originally production, but later ecosystem services
Vietnam	5	1998; 3 m ha production, 2 m ha for protection
China	32*	2001; protection forests (* this just in Sloping Land Conversion Program)
Brazil	15	2009; Ecosystem services; Atlantic Forest Restoration Pact; >80 species
India	5	2010; Ecosystem services
Philippines	1.5	2011; National Greening Program; protection (and some production?)

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International interest in reforestation for ecosystem services

Event	Activity
Convention on Biological Diversity	Restore 15% degraded ecosystems by 2020
UN Convention to Combat Desertification	Achieve zero net land degradation by 2030
UN Environmental Program	Restore degraded ecosystems
UN Conference on Sustainable Development (Rio+20)	Facilitate forest restoration
Asia-Pacific Economic Cooperation	Increase forest cover by 20 mill ha by 2020
Bonn Challenge (IUCN)	Restore 150 mill ha by 2020

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Outline

- The nature of degradation
- Amount of degraded land available for reforestation
- Reforestation in 20th century
- Different objectives in 21st century?
- The context in which any reforestation will be done
  - Things that will make it harder
  - Things that will make it easier

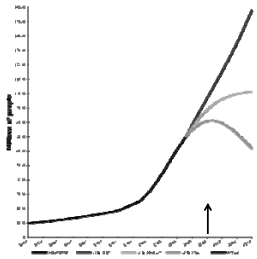
18

The context for future reforestation

Will be harder because -

•Growing population

•Rural poverty still present



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The context for future reforestation

Will be harder because -

•Growing population

•Widespread rural poverty

•Need more land for food production??

– More production via large agri-business or small scale?

– Small scale have "yield gaps" - solve using existing technology?

– But limited water? more expensive fertilisers? higher energy costs?

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The context for future reforestation

Will be harder because

•Growing population

•Widespread rural poverty

•Need more land for food production

•Uncertain land tenure

– Tree planting unattractive if farmer lacks tenure

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The context for future reforestation

Will be harder because

•Growing population

•Widespread rural poverty

•Need more land for food production

•Uncertain land tenure

•Uncertain impacts of climate change

– on food production

– location of future agricultural areas

– tree species to use in particular locations

22

The context for future reforestation

May be easier because

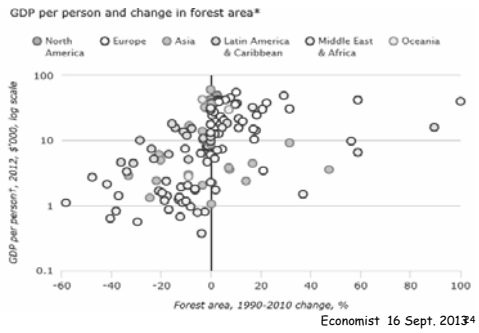
•Land tenure is being settled

•Decrease in area of natural forests means there are markets for timber

•Standards of living are rising

23

More reforestation as income rises?



Economist 16 Sept. 2013

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The context for future reforestation

May be easier because
- Land tenure is been settled
- Markets for timber
- Standards of living are rising
- Increased interest in environmental protection

25

Chinese attitudes to environmental degradation (n = 5000)

Question	Response (%)
Is China's environment degraded?	Agree 91 (c.f. 44% in 1999)
Is it worth spending RMB 300 bill on the Grain for Green Program	Agree 78
Would you personally donate money?	Agree 73
Which is most important Economy? Environment? Both?	 13 37 45

Cao et al. 2009 Ambio 38: 55

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The context for future reforestation

May be easier because
- Land tenure is being settled
- Markets for timber
- Standards of living are rising
- Increased interest in environmental protection
- Interest in combatting climate change
- Interest in markets for ecosystem services

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The context for future reforestation

May be easier because
- Land tenure is being settled
- Markets for timber
- Standards of living are rising
- Increased interest in environmental protection
- Interest in combatting climate change
- Interest in markets for ecosystem services
- Legal obligations to overcome degradation

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The context for future reforestation

May be easier because
- Land tenure is being settled
- Markets for timber
- Standards of living are rising
- Increased interest in environmental protection
- Interest in combatting climate change
- Legal obligations to overcome degradation
- Interest in markets for ecosystem services
- Urbanisation

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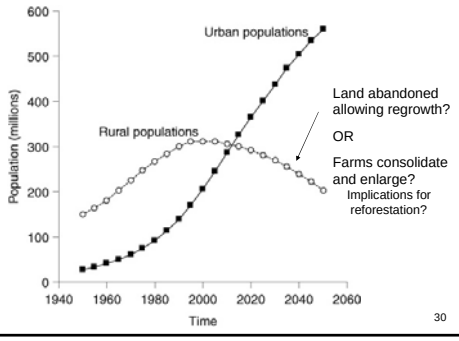
Urbanisation in SE Asia

http://esa.un.org/unup/Country-Profiles/country-profiles_1.htm



30

The context for future reforestation

May be easier because
- Land tenure is being settled
- Markets for timber
- Standards of living are rising
- Increased interest in environmental protection
- Interest in combatting climate change
- Legal obligations to overcome degradation
- Interest in markets for ecosystem services
- Urbanisation
- Aging populations?

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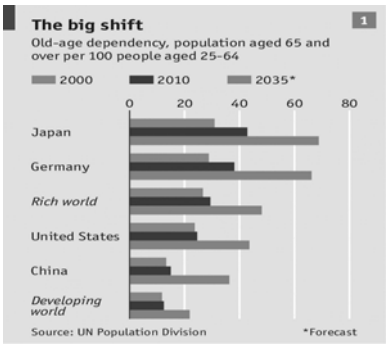
Will aging populations mean tree-growing is a more attractive land use?



Economist
26 April 2014

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Summary - future reforestation

Harder
- Growing population
- Widespread rural poverty
- Need more land for food production
- Uncertain land tenure
- Uncertain impacts of climate change on food production and location of agricultural areas

Easier
- Land tenure is been settled
- Markets for timber
- Standards of living are rising
- Increased interest in environmental protection
- Interest in combatting climate change
- Legal obligations
- Interest in markets for ecosystem services
- Urbanisation
- Aging

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Are there risks in undertaking large-scale reforestation?

- "Land grabs" – customary land owners displaced
- Natural forests replaced by plantations
- Diverse, heterogeneous agricultural landscapes replaced by a simple plantation monoculture
- Reforestation will deplete ground-waters
- Exotic plantation species will become invasive

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Take-home message

- Reforestation is a relatively recent land use activity
- In future - likely to be more emphasis on reforestation for ecosystem services and not just timber products
- Opportunities for reforestation will vary
  - Some places more difficult
  - Other places more attractive
- Reforestation is not always beneficial – can sometimes have costs

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Questions to ponder

1. Who owns the world's degraded lands? What are implications for reforestation?
2. How to balance the need for more food production and the need to restore forests?
3. Do international concerns over forest restoration make any difference on the ground?
4. Reforestation can be financed when trees are being grown for timber – but how to pay for reforestation to provide ecosystem services?
5. Will forms of reforestation developed for industrial-scale growers suit smallholders?

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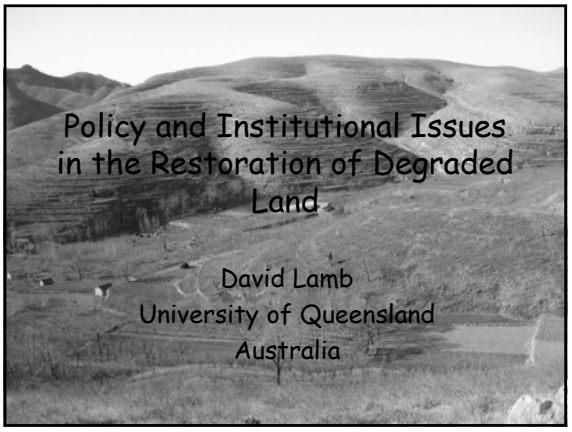
(2) Policy and Institutional Issues in the Restoration of Degraded Land



Outline

- Definitions
- Examples of significance of policies
- Policies to Enable reforestation
- Policies to Encourage reforestation
- Policies to Regulate reforestation
- Institutions to implement these policies

Why are Policies and Institutions important?

- Need policies to promote and guide reforestation.
- Need institutions to implement these policies

Definitions

- Policies
  - are principles or protocols to guide decisions and allow collective action to provide public goods
  - Example: deciding to encourage farmers to grow trees as well as having state owned plantations
- Institutions
  - Organisations and codes of behaviour that can help promote collective action and limit self-interest
  - Example: a national land-use planning body

Silvicultural knowledge important but other issues too

- How to encourage reforestation?
- How to balance competing alternatives?
  - Agriculture vs forestry
  - Forest production vs forest protection?
  - National interest vs local interest?
- How to ensure value-for-money from subsidies?
- How to ensure benefits are shared?
- How to ensure decisions are implemented?
- How to decide what to do if they are not?

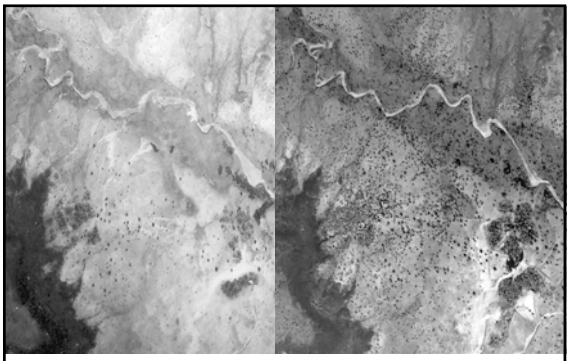
Example of the importance of good policy - Niger

- original policy
  - tried to 'modernise' agriculture by requiring trees be cleared from fields
  - At same time State claimed ownership of certain high-value species
  - Result - widespread, clearing, erosion and shortage of fuel
- New policy
  - encourage natural regeneration
  - Result – increase in tree cover (over 5 mill ha)

Achieved at no cost to state

POLICY 1
Regrowth cleared

POLICY 2
Enable regrowth from old stumps



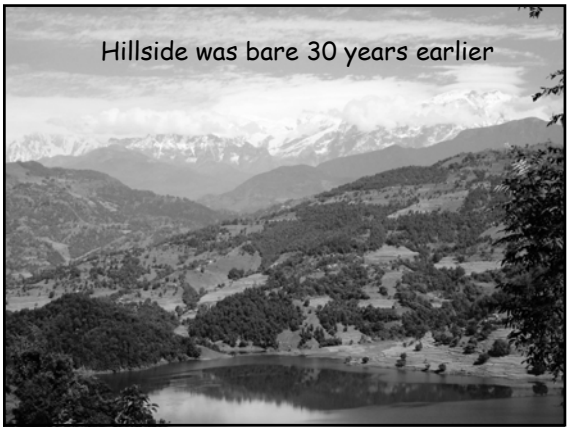
Niger

1975 2003

Example of importance of good policy - Nepal

- Original policy
  - Government declares all forest 'state-owned
  - Tries to establish plantations
  - Not very effective
- In meantime
  - Farmers begin encouraging regrowth on their land as natural forests shrink
- New policy
  - allows communities to establish and own forests on their land
  - Result - massive increased in forest cover

Achieved at no cost to state



Three types of policies relevant to reforestation

1. Policies enabling reforestation
   Create a 'level-playing field' for reforestation
2. Policies encouraging reforestation
   "carrots" to deliberately encourage reforestation
3. Policies to regulate the ways in which reforestation carried out
   "sticks" to ensure reforestation is done in certain situations

1. Policies to enable reforestation

- Grant land tenure and property rights.
  - Tenure provides
    - Access to land
    - Right to harvest any trees grown on land
    - Right to sell land (?)
  - Tenure does not guarantee reforestation takes place – but absence of tenure will
  - Special restoration concessions in Indonesia on badly logged land (c.f. logging concessions)

1. Policies to enable reforestation

- Grant land tenure and property rights
- Remove disincentives to reforestation
  - Prevent unregulated logging of natural forests (lowers timber price)
  - Scrap requirements for needing permits to fell trees on farmland (too complex for many landowners)
  - Remove taxes on transport goods to market*

*Le et al 2004 Making the Most of Market Chains: challenges for small-scale farmers and traders in Vietnam. IIED, London
http://pubs.iied.org/9313IIED.html

1. Policies to enable reforestation

- Grant land tenure
- Remove disincentives
- Give more power to landholders
  - Allow landholders to make decisions about role of reforestation (e.g. Niger, Nepal)
  - Try to link community and national interests
  - Do through development of appropriate institutions

1. Policies to enable reforestation

- Grant land tenure
- Remove disincentives
- Give more power to landholders
- Popularise reforestation as a new land use
  - Some traditional farmers opposed to reforestation
  - Many are unfamiliar with opportunities it offers
  - Need information and capacity building
  - Develop ways of improving economic benefits
    - Information on markets and marketing
    - Information on improving timber quality (e.g. pruning)
    - New business opportunities

New businesses arising from reforestation

Outline

- Definitions
- Examples of significance of policies
- Policies to Enable reforestation
- Policies to Encourage reforestation
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2. Policies to encourage

- What if these 'enabling' policies are not enough?
- Offer incentives (= subsidies)
- These make reforestation more attractive to landholders (overcome opportunity costs)
- Incentives common in agriculture*
  - Agriculture 37% global subsidies
  - Forestry 3% global subsidies

(*Bull et al. 2006. Forest Policy and Economics 9: 13)

2. Policies to encourage

- Indirect incentives
  - Build new roads to link plantations and markets
  - Provide seedlings (free or at subsidised rates)
  - Provide fertilisers (free or subsidised cost)
  - Offer tools (free or at subsidised cost)
  - Provide access to off-farm employment
  - Provide silvicultural knowledge
  - Provide market and marketing knowledge
  - Ensure markets are fair and equitable

2. Policies to encourage

- Direct incentives
  - Pay farmer to retire land from agriculture and protect natural regeneration
  - Give grants to purchase and plant seedlings
  - Give cheap loans with long periods before repayments fall due.
  - Provide loan guarantees
  - Provide taxation concessions for plantation investors
  - Give grants to undertake reforestation (sometimes in specific areas)
  - Create markets for ecosystem services as well as timber

Problems with direct incentives

- Are open to abuse
  - Incentives should be catalysts but not drivers of change
- Best incentives are those that generate public benefits rather than private benefits:
- Examples
  - Research (to reduce risks)
  - Infrastructure (roads, etc. for market access)
  - To ensure critical lands are reforested to generate a public (not private) benefit

Problems with direct incentives 2

- Difficult to know if value-for-money
- Hard to quantify some benefits (especially of ecosystem services)?
- Hard to quantify costs of reforestation?
  - Actual planting costs at a particular area
  - A landholders opportunity costs (cost of not doing something)
- Use 'Reverse' or 'Conservation' Auctions

Reverse auctions

- Landowners have better idea of true costs of reforestation than government
- Hence, government invite landowners to submit reforestation bids
  - Area to be reforested?
  - What this will cost?
- Compare bids – which has best value for money?
  - Area reforested per $ of incentive payment
  - Social impact per $
  - Environmental outcomes per $

Wang et al. 2012. An auction scheme for land use change in Sichuan Province, China. Journal of Environmental Planning and Management 55: 1269

Three types of policies relevant to reforestation

1. Policies enabling reforestation
   Create a 'level-playing field' for reforestation
2. Policy to encourage
   "carrots" to deliberately encourage reforestation
3. Policies to regulate the ways in which reforestation carried out
   "sticks" to ensure reforestation is done in certain situations

3. Policies to regulate the ways in which reforestation carried out

- Sometimes
  - some areas must be reforested
  - certain types of reforestation must be done
- Examples
  - Old mine sites or polluted land
  - Eroding areas within important watersheds
  - Degraded areas within National Parks

(and markets not sufficient to attract growers)

Example 1 - restoration of old mine sites

- Best policy is if
  - Permit to mine is conditional on agreement to rehabilitate after mining
- Miners then required to
  - Post a 'performance bond'
  - Reforest and meet certain standards
    - Restore original biota?
    - Restore stable landscapes - no erosion or leachates?
    - New forest become self-sustaining?
  - Only refund bond and release from legal liability when standards met!

Topsoil not saved –
few natives can establish

Topsoil saved and respread
All natives re-established

Example 2 - reforestation of eroding lands

- Best policy is where
  - Locations clearly defined and need for reforestation given
  - Type of reforestation is specified
  - There is compensation for those disadvantaged by reforestation
  - Stakeholders are involved in decision-making
    - Which locations (fine-tune to balance local and national interests) ?
    - How much compensation needed?

Outline

- Definitions
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- Institutions to implement these policies

Institutions

- Definition
  - Organisations and codes of behaviour that help promote collective action
- Purpose
  - Help state, businesses and communities coordinate actions and implement policies
  - Institutions used to develop protection forests different to those used to develop production forests?
- Types
  - Some traditional and some new
  - National, regional and local
  - Formal and informal
  - With and without government participation

Desirable properties of reforestation institutions

- Scale of institutions matches area of responsibility

Scale matches area of responsibility

- National
  - National land use planning (e.g. Agriculture vs forestry vs conservation)
  - Allocate budgets and subsidies
  - Links with industry and markets
  - PES (including C markets)
  - Research strategies
- Local
  - Local land use planning
  - Administer subsidies
  - Foster grower groups
  - Coordinate growers to meet PES objectives
  - Settle disputes
  - Assist in marketing

Desirable properties of reforestation institutions

- Scale of institutions matches area of responsibility
- Involve representatives of stakeholders
  - How to identify these?
  - How to prevent takeover by an elite?
  - How to avoid becoming too big or complex?

Desirable properties of reforestation institutions

- Scale of institutions matches area of responsibility
- Involve representatives of stakeholders
- Involve representatives of other sectors (agriculture, water, conservation)

Desirable properties of reforestation institutions

- Scale of institutions matches area of responsibility
- Involve representatives of stakeholders
- Involve representatives of other sectors (agriculture, water, conservation)
- Transparent and accountable
  - Everybody knows who is responsible for decisions (including about funding)

Desirable properties of reforestation institutions

- Scale of institutions matches area of responsibility
- Involve representatives of stakeholders
- Involve representatives of other sectors (agriculture, water, conservation)
- Transparent and accountable
- Constantly monitor outcomes
  - Silvicultural
  - Economic
  - Social

Policies must be based on facts.

Some mis-understandings about reforestation from the last 100 years

Sometimes heard	Actual fact
Only foresters and ecologists can restore forests	Farmers can establish forests if they believe it is in their interest
Forests can only be established by planting seedlings	Forest can often be established by natural regeneration
New forests prevent floods	No - not over large areas
New forests make streams flow again	No - usually reduce water low (unless soils badly degraded and trees improve infiltration rates)
All forests are equally effective in preventing erosion	No - only if thick litter and understorey present or if structurally complex

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Take home message

- Having correct policies is critical to encourage reforestation (Niger, Nepal)
- Is not all about cash incentives
- If incentives - then for public benefit and not private gain
- Need national and local institutions
- Need to be monitored to ensure desired outcome being achieved

Questions to ponder

1. If direct incentives are needed to get things going – when can they be removed?
2. How big should a 'performance' bond be (e.g. for miners)?
3. How to involve local landholders in local institutions?
4. How to monitor/evaluate the worth of a local institution (when is change needed)?

(3) Ecosystem Approach to Forest Restoration

Outline

- The broader context for reforestion – the Ecosystem Approach
- Stakeholders and what they want
- Forms of silviculture to meet their needs
- Economic constraints
- Landscape planning
- Adaptive management

2

Common silvicultural questions

- What types of species?
- What number of species (and the proportions of each)?
- The role of natural regrowth?
- The possibility of direct seeding?

3

But the bigger picture is …

•What will be the consequences of reforestation for communities?

•Who will benefit?

•Who will bear most of the costs?

•How to ensure benefits and costs are shared equitably?
- Landholder vs community vs state

4

Means we must also consider broader ecological and socio-economic context

- The Ecosystem Approach
- Formulated by Convention on Biodiversity to guide activities
- Has 12 principles
- Can be organised into 5 steps

http://www.iucn.org/about/union/commissions/cem/cem_resources/?373/The-Ecosystem-Approach-Five-Steps-to-Implementation

5

Ecosystem Approach - Five steps

1. Determine the area to be reforest and the main stakeholders involved
2. Determine the goods and ecosystem services required and the most suitable types of reforestation
3. Identify economic issues affecting stakeholders and how these influence reforestation choices
4. Consider landscape context in which reforestation will be done
5. Plan for adaptive management to achieve long-term objectives

6

STEP 1. Determine the area to be reforested and the identity of main stakeholders

Grower	Reforestation area
State	Degraded lands? Watersheds?
Corporations	Good land close to transport
Households	Own land
NGOs	Anywhere? Areas of conservation interest?

Other stakeholders wanting reforestation include – industry (resources), neighbours (erosion control) , water users, conservation bodies

7

Recall - smallholders important as well as industrial growers

Area of productive plantations in 2005 (x1000ha)

	Public	Corporate	Smallholder	Other (NGOs?)
Global	77,352	27,176 ⟷	49,980	492
SE Asia	6,758	636	2,302*	65

* May be under-estimate
- Indonesia and Myanmar classify all plantations as publicly owned
- Thailand same except rubber

(Source: FAO 2006 Planted Forests and Trees Working Paper FP38)

8

STEP 2. Determine the goods and ecosystem services required and type of reforestation needed

Grower	Object and type of reforestation preferred
State	Originally: want timber resources [*plantation monocultures*] Now: also environmental protection [*rehabilitation and Ecological Restoration*]
Corporation	Want timber [*plantation monocultures]*
Household	Want diverse goods and services (to reduce risk) [*plantation monocultures and species mixtures*]
NGOs	Want mostly ecosystem services [*species mixtures and Ecological Restoration*]

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STEP 3. Economic issues affecting stakeholders and implications for reforestation methods

Grower	Issues
State	May want to reforest cleared land to supply ecosystem services but face competition for funds from other sectors
Corporate	Need assistance to get large areas of land Most attractive plantations have short rotations
Household	Often have only small areas of land, Need access to capital and knowledge
NGO	Mostly have only short-term funding

ALL: only limited market for supply of ecosystem services?

10

Implications

- Traditional industrial timber plantation model will continue to be used

BUT should not be the standard

- Reforestation is not just about how to grow trees

Need to be aware of socio-economic constraints and impacts of reforestation

11

STEP 4. Consider the landscape context

- The landscape is not uniform
- Some areas more critical than others
- Choose strategic locations for reforestation
- Where are these?
  - Economic: Near roads and markets
  - Erosion: reforest hills rather than flat land?
  - Conservation: areas of high conservation value?

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Where will reforestation provide greatest economic benefit?

Where will reforestation provide greatest environmental benefit?

Reforestation for Conservation	Better	Worse
Single or several		
Buffers		
Broad buffers		
Corridors		
Broad corridors		

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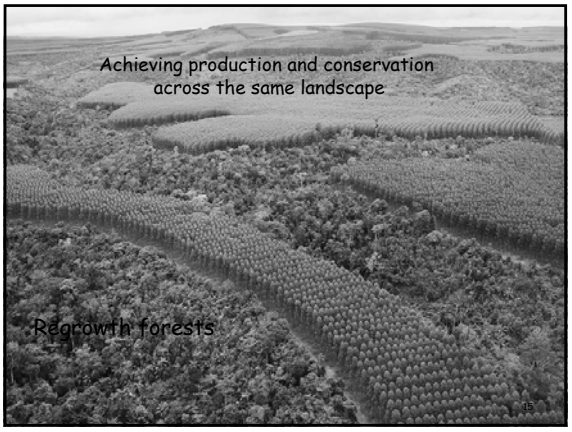

15

STEP 4: consider landscape context
But who decides these landscape design issues?

- Governments because
  - only they can see the 'big picture' and balance local and national interests?
  - Can optimise outcomes with sophisticated models
- BUT governments often ignore views of local landholders

16

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- Landholders because
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- BUT individual landholders will make localised and unconnected decisions ('the tyranny of small decisions')

17

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  - Because only they can see the 'big picture' and balance local and national interests?
  - Can optimise outcomes with sophisticated models
  - BUT governments often ignore views of local landholders
- Landholders
  - Because it is their land?
  - BUT individual landholders will make localised and unconnected decisions ('the tyranny of small decisions')
- Other stakeholders
  - Because they have a legitimate interest in the outcome?
  - BUT get benefits without paying for costs?

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Making choices when designing landscapes

Attribute	Optimising models best when	Not so good when
Numbers of stakeholders	Lower	Higher
Funds for incentives or compensation	Ample	Limited
Ecological knowledge	Substantial	Patchy
Institutions and legal frameworks	Stronger	Weaker
Formal land tenure	Widespread	Less common

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STEP 4: consider landscape context How to implement a new design?

- Best if top-down AND bottom-up
- Participatory (all stakeholders)
- Collaborative (shared decision-making)
- Facilitated (at least at beginning)
- Compensation when needed

Landuse planning in Laos

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Step 4: consider landscape context Planning Forest Landscape Restoration

1. Develop a landscape view of the problem
   - Gather information (scientific and local)
   - Establish patterns of tenure, location of disputes etc.
2. Engage with stakeholders (or representatives)
3. Identify possibilities or 'visions' of future
   - How much reforestation?
   - Where should it be done?
   - What types of reforestation?
4. Decide on approach to use (where, type, how much?)
   - Need for compensation/incentives?
5. Monitor and adaptive management

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STEP 5. Plan for Adaptive Management

- Changes often occur
  - Ecological (competition, fires, diseases, insects)
  - Markets (interest in services as well as timber)
  - Social attitudes (increased interest in recreation, tourism)
- Need to monitor and - if necessary – adapt methods (= 'Adaptive Management')
- BUT monitoring is costly – must be informative

22

MONITORING A common approach

Funds allocated

↓

Planting is done?

↓

Seedlings survive?

↓

Trees grow?

23

MONITORING A common approach

Funds allocated

↓

Planting is done?

↓

Seedlings survive?

↓

Trees grow?

BUT SO WHAT?

DOES THIS LEAD ANYWHERE?

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MONITORING
Better approach is one which

- Assesses the development of the new forests over time
- Also
  - assesses socio-economic impact
  - assesses who gains and if anyone loses
- Done by posing specific questions

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MONITORING
Some silvicultural/ecological questions

PRODUCTION

1.Tree survival rate? (Is this acceptable?)

2.Is weed control still needed?

3.Are disturbances occurring?

4.Is there complete forest cover in reforested area?

5.How rapidly are the trees growing? (Is this acceptable?)

26

MONITORING
Some silvicultural/ecological questions

ECOSYSTEM SERVICES

1.Are the preferred species now present?

2.Are sufficient species present?

3.Is erosion still occurring?

4.Are regional water resources stable or improving? (Quantity? Quality?)

5.Are the trees reproducing?

6.Are wildlife species colonising the new forests?

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MONITORING
Some socio-economic questions

1. Are farmers protecting their trees?
2. Are they pruning and thinning?
3. Are they increasing the size of their plantings?
4. Are new farmers beginning to plant trees?
5. Are private nurseries being developed?
6. Are there tree-growers associations to share knowledge etc?

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MONITORING
Some socio-economic questions

7. Have any farmers sold their trees yet?

8. What were the prices?

9. Were they happy with the price?

10. Is there a market for higher-quality logs

11. Is there a market for Ecosystem Services?

12. Are prices increasing or decreasing
    agricultural crops?
    timber?
    land?

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Keys to good monitoring

- Be aware that monitoring is costly (money and time)
- Plan monitoring at start
  - what is an indicator of 'success' (or failure)? What is trigger for action?
  - where to monitor?
  - How often to monitor? (and how long)
  - who will do it (and who will pay)
- Have specific questions (yes/no?)
- Type of monitoring will change as forest gets older?
- Answers to questions must allow adaptive management

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The Ecosystem Approach – thinking behind the 5 steps

- Reforestation is about more than just planting trees
- Its about how reforestation is integrated into landscape management
  - Which trees and why?
  - Where should they be planted?
  - Who benefits and does anyone lose out?
  - How would you know answers to these questions?

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Future reforestation

- We want
  - production to improve livelihoods
  - better conservation outcomes
- Can reforestation achieve both?

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Can we restore forest to improve livelihoods and conservation benefits?

1. Improve conservation outcomes but don't improve livelihoods
   e.g. Reforestation on degraded hills that displaces customary landowners without fair compensation

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Can we restore forest to improve livelihoods and conservation benefits?

1. Improve conservation outcomes but don't improve livelihoods
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2. Damaging for conservation and don't improve livelihoods
   e.g. plantations replace natural forest but no benefit to local community

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Can we restore forest to improve livelihoods and conservation benefits?

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   e.g. plantations replace natural forest but no benefit to local community
3. Damaging for conservation but improve livelihoods
   e.g. plantations replace natural forests but local community benefits (e.g. joint venture with company)

35

Can we restore forest to improve livelihoods and conservation benefits?

1. Improve conservation outcomes but don't improve livelihoods
   e.g. Reforestation on degraded hills that displaces customary landowners
2. Damaging for conservation and don't improve livelihoods
   e.g. plantations replace natural forest but no benefit to local community
3. Damaging for conservation but improve livelihoods
   e.g. plantations replace natural forests but local community benefits (e.g. joint venture with company)
4. Improve conservation outcomes AND improve livelihoods
   e.g. strategically targeted reforestation and farm forestry using multi-species plantings

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Take home message

- Need to chose forms of reforestation that will match needs of the future
- Need to consider the landscape context
- Need to consult with landholders and other stakeholders to share cost as well as benefits
- Need to be aware that situations can change and be able to act if they do

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Questions to ponder

1. What is "success"?
2. How to make reforestation attractive to farmers?
3. How to carry out reforestation on a landscape scale in ways that generate household and national benefits?

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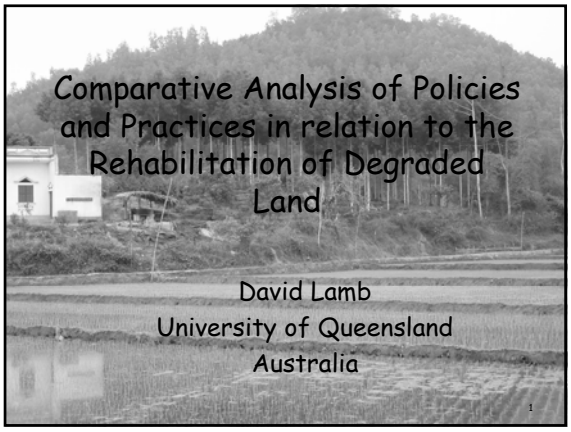
(4) Comparative Analysis of Policies and Practices in Relation to the Rehabilitation of Degraded Land

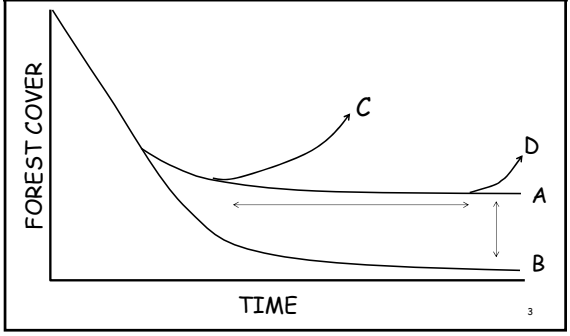


Outline

- The Forest Transition
- Examples of different forest policies
- Policy lessons
- Practice lessons
- Some issues for the future

2

The Forest Transition - pathway affected by policies?



3

Questions arising from the Forest Transition

- What defines the deforestation threshold? (i.e. where rate of deforestation slows)
- What triggers the start of reforestation? (Markets? Urbanisation?)
- Who does reforestation?
- What land is used?
- Does it reduce further deforestation?
- Who benefits?

4

What have we learned about reforestation in the last 100 years?

- Large-scale reforestation really only began in early 1900s
- Largely initiated by government
- Governments later seek to involve private landowners
- Several case studies to
  - examine policies and practices
  - Seek lessons

5

Case Study 1: Britain

- Began in 1920s when little residual forest left (<5%)
- Policy Objective: to create a new timber resource (self-sufficiency?)
- Land used: purchased poor farmland on open market
- Had to develop new practices - establish research stations

6

Case Study 1: Britain (continued)

- All planting done with government funds
  - But by 1950s some private growers
- Public attitudes change – so policy change
  - Services rather than just timber
  - Emphasis on financial efficiencies
- Private growers become dominant by 1980s
  - Sell government plantations
  - Offer grants and taxation incentives to private growers

7

Case Study 1: Britain (continued)

- Current government policy is
  - Leave production forests to private sector
  - Reduce subsidies offered
- Current practices
  - Convert remaining monocultures to mixtures

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Case Study 2: South Korea

- Heavily degraded in 20C
- Reforestation began in 1970s
- Series of Plans
- Initial policy
  - produce firewood
  - stabilise hills

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Case Study 2: South Korea

- Later Plans - objective changed as national GDP grew
  - New objective to provide sawlogs
  - Objective now is multi-purpose forests
- Practices
  - Initially a few fast growing species
  - Later a much wider variety
- Outcome - successfully transformed a degraded landscape

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Case Study 3: Algeria

- Dry country - lost most of forest area
  - 1830 forests cover 5mill ha
  - 1930 forests cover 2 mill ha
  - 1960 forests cover 1 mill ha (<1%)
- Policy - in 1970s the "Green Dam" in 200-300 mm rainfall zone near Sahara
  - Forest corridor to be 20-30 km wide and 1000 km long
- Planted by army (i.e. not forestry agency)
  - Use only a few species tolerant of conditions

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Case Study 3: Algeria

The green dam to 'hold back the Sahara Desert'

To be 20-30 km wide and 1000 km long

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Case Study 3: Algeria

- A failure - graziers unhappy – lose pastures – seen as a threat
- Forests could not be protected
  - burned and grazed
  - most trees lost
  - Abandoned 1990
- More recent policy and practices
  - Not a corridor – but more patchy
  - Greater variety of species
  - More local consultation
  - Reforestation linked with other agricultural activities

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Case Study 4: Chile

- Natural forests composed of slow-growing species – poor regeneration after logging
- Policy - clear these and establish plantations using exotic pines and eucalypts
- Early plantings by state forestry departments
- Later policy
  - Aim to build an industrial timber resource
  - Rely on private timber companies

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Case Study 4: Chile

- Private reforestation increased in 1970s
- Incentives for reforestation
  - Help to get land (people displaced)
  - Big financial subsidies
  - Tax concessions
- Outcome
  - Loss of natural forest
  - Major (new) forest resource
  - Industrialisation (pulpmills) and significant export income

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Case Study 5: Brazil

- Active reforestation policy while still being heavily forested
- Reforestation accelerates in 1965
- (Mostly) use cleared farmland
- Policy objective – to develop an industrial timber resource for pulp industry

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Case Study 5: Brazil

- Policies
  - Private companies rather than state
  - Aim at export income
  - Assist
    - Access to land (near cost not in Amazon)
    - Financial and tax concessions
- Practices
  - Mostly exotic species (especially *Eucalyptus*)
  - Short rotations
- Outcome
  - Big forest industry

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Policies: some lessons

- Reforestation can generate significant economic benefits (Brazil, Chile)
- But, in early days, timber markets alone were not enough to attract reforestation (all)
- The identity of growers is changing (state then industry now industry+farmers)

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Policies: some lessons

- Early reforestation usually done on cleared and degraded land – BUT - more some have also cleared natural forests (e.g. Chile)
- The benefits of reforestation have not always been evenly shared (Chile, Algeria)
- Markets and conditions have changed over time [within time of a rotation!] (UK, South Korea)

20

Policies: some lessons

- Early reforestation usually done on cleared and degraded land – BUT - more recently have also cleared natural forests (e.g. Chile)
- The benefits of reforestation have not always been evenly shared (Chile, Algeria)
- Markets and conditions have changed over time [within time of a rotation!] (UK, South Korea)

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Practices: some lessons

- Some common practices have evolved
- Recognize need for
  - Good nursery stock
  - Good site preparation
  - Good weed control
  - Soil nutrient deficiencies corrected
    - Identify (omission pot trial, foliar analyses)
    - Fertilisers used to correct specific deficiencies
      - How much? When? What type?
  - Plantings are protected
- Also recognize need to
  - Have an identified market
  - Have a sufficiently large forest to sustain a market

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Outline

- The Forest Transition
- Examples of different forest policies
- Policy lessons
- Practice lessons
- Some issues for the future

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Some issues for the future

1. How to encourage reforestation by additional landholders?
2. How to encourage development of new markets?
3. How to encourage landscape or regional reforestation?

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1. Policies to encourage reforestation

Landholders more likely to be interested if they

- See reforestation as an opportunity
  - Local buyers for goods or services
  - Attractive prices
  - No restrictions on harvesting or selling
- Have knowledge of techniques to use
  - Tree growing a new land use?
- Have sufficient land
  - Have land tenure
  - Have sufficient land
- Have capacity to do something
  - Power to make decisions
  - Have resources ($, seedlings, etc)

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2. How to encourage development of new markets?

Possible markets for forest growers

A. Timber and forest products
- International
- National
- Local

B. Ecosystem services

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Case Study: Small sawmills in Vietnam

- Market for many tree growers are small local sawmills
- Are often dis-regarded
- These take small logs
- Provide local employment and cheap products for local communities
- Profitability of these determines profitability of tree-growing?

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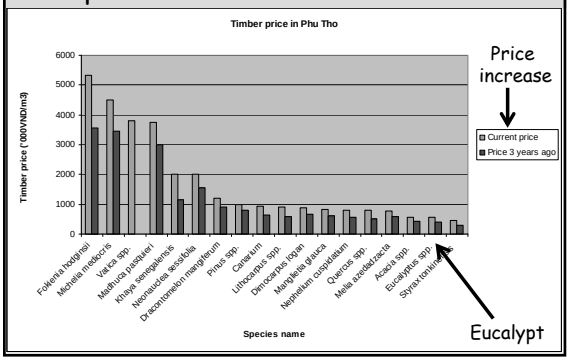
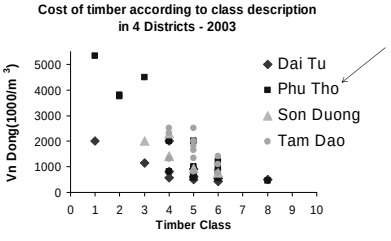
Higher log prices for certain native species rural sawmills in Vietnam



Price of timber varies according to quality class and mill location



- Phu Tho and Tam Dao high price – good road system
- Dai Tu and Son Duong low price – poor road system

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2. How to encourage development of new (timber) markets?

A. Timber markets for forest growers

Need policies to encourage industries like these to increase market opportunities for (smaller) growers

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2. How to encourage development of new markets?

B. Possible markets for Ecosystem Services

•A new and evolving market (Payment for Ecosystem Services = PES)

•Buyers are those wanting clean water, carbon stored, habitats for biodiversity etc.

•Sellers are (planted) forest owners

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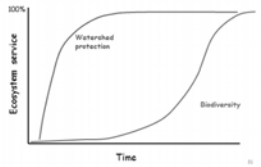
Markets for Ecosystem Services

- Not all types of reforestation able to supply all services (e.g. compare pulpwood plantations and Ecological Restoration)
- Some services only supplied by older forests



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2. How to encourage development of new markets (for environmental services)?

Need policies concerning

•What types of forest?

•How big an area must be reforested?

•Where must this be done? Random or strategic locations?

•How to coordinate multiple landholders across a landscape to supply a service?

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Some issues for the future

1. How to encourage reforestation by additional landholders?
2. How to encourage development of new markets?
3. How to encourage landscape or regional reforestation?

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3. How to encourage landscape or regional reforestation?

- Need national policies to provide a framework (a "vision" or incentive?)
- Need local institutions to implement
  - Perception - Publicise opportunities
  - Knowledge - Provide technical advice
  - Capacity – help landholders to participate

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Case Study: Brazil Atlantic Forest Restoration Pact

- Concern about deforestation in Amazon
- Policy
  - Require some forests retained on all private land
  - Reforestation if necessary
- In Atlantic forest region
  - 20 % cover
  - 80 species
- Atlantic Forest Restoration Pact formed to build on these laws and national policies

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Case Study: Brazil Atlantic Forest Restoration Pact

- Regional consortium of 160 bodies
  - NGOs, Government agencies, Universities, landholders, Private Companies
- Objective: Ecological Restoration to restore native forests
  - Currently: 60,000 ha
  - Objective: 15 mill ha by 2050
- Techniques used: mixed species plantings
- Website http://www.pactomataatlantica.org.br/index.aspx?lang=en

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Case Study: Brazil Atlantic Forest Restoration Pact

- Regional consortium of 160 bodies
  - NGOs, Government agencies, Universities, Private landholders, Companies,

Include:
plantation owners
Nurseries
Planting businesses

- Objective: Ecological Restorati
native forests
  - Currently: 60,000 ha
  - Objective: 15 mill ha by 2050
- Techniques used: mixed species plantings
- Website http://www.pactomataatlantica.org.br/index.aspx?lang=en

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Take home message

- Past policies and practices provide a guide to the future but new policies and practices will be needed as well
- There is no single way – there is no "recipe"
- Key Policies and Practices will be those
  - –that encourage reforestation by smallholders
  - –that deal with future ecological and economic environments

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Other policy and practice questions

- Who owns the degraded lands and what are the policy implications?
- How to share costs and benefits? How to link national and private interests?
- Do we need more research? If so, in what areas?
- How to design reforestation methods able to tolerate future climates?

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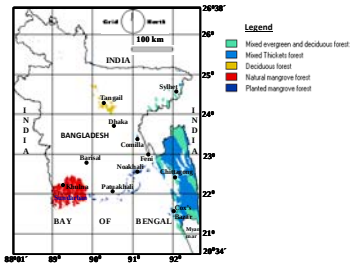
7. PPT Files of Participant Presentations

(1) Banglasesh: Participatory Forest Management In Degraded Forests: Perspective REDD+ IN Bangladesh

PARTICIPATORY FOREST MANAGEMENT IN DEGRADED FORESTS: PERSPECTIVE REDD+ IN BANGLADESH

Prof. M. Al-Amin PhD

Institute of Forestry and Environmental Sciences
University of Chittagong, Chittagong- 4331
Bangladesh



Map 1. Forest cover in Bangladesh (Al-Amin, 2011)

Land uses of Bangladesh

Land Use Category	Area (M Ha)	Percent
Agriculture	9.57	64.9
State Forest		
Classfied	1.52	10.3
Unclassified	0.73	5.0
Private Forest		
Homestead	0.27	1.8
Tea/Rubber Garden	0.07	0.5
Urban and others		
Urban	1.16	7.9
Water	0.94	6.4
Other	0.49	3.2
Total	**14.75**	**100**

Forest Land uses of Bangladesh

Category of Forests	Area (M Ha)	Percentage
Forest Department Managed Forests	1.52	10.30
Unclassed State Forest	0.73	4.95
Village Forest	0.27	1.83
Total	**2.52**	**17.08**

Ecologically forest Lands of Bangladesh

Types of Forest	Area (m ha)	Percentage
Natural Mangrove Forest and Plantation	0.73	4.95
Tropical evergreen and semi-evergreen Forest	0.67	4.54
Tropical moist deciduous Forest	0.12	0.81
Total	**1.52**	**10.3**

Table: Countries at risk from climate change effects

FLOOD	STORM	COASTAL 1M	COASTAL 5M
Bangladesh	Philippines	All low-lying Island States	All low-lying Island States
China	Bangladesh	Vietnam	Netherlands
India	Madagascar	Egypt	Japan
Cambodia	Vietnam	Tunisia	Bangladesh
Mozambique	Moldova	Indonesia	Philippines
Lao PDR	Mongolia	Mauritania	Egypt
Pakistan	Haiti	China	Brazil
Sri Lanka	Samoa	Mexico	Venezuela
Thailand	Tonga	Myanmar	Senegal
Vietnam	China	Bangladesh	Fiji
Benin	Honduras	Senegal	Vietnam
Rwanda	Fiji	Libya	Denmark

GPG2003 adopted six land categories to ensure consistent and complete representation of all land categories, covering all the geographic area of a country.

Main land categories	Subcategories *(based on transformation)*	Disaggregated level	C-pools	Non-CO_2 gases
Forest land	Forest land remaining forest land	- Evergreen, deciduous etc. - Eucalyptus, secondary forest	AGB, BGB, DOM, litter and soil carbon	CH_4, N_2O
	Land converted to forest land			
Cropland	Cropland remaining cropland	- Irrigated, unirrigated - Paddy, irrigated, rain-fed - Coconut, coffee, tea, etc.		
	Land converted to cropland			
Grassland	Grassland remaining grassland	- Climatic regions		
	Land converted to grassland			
Wetland	Wetland remaining wetland	- Peat land - Flooded land		
	Land converted to wetland			
Settlements	Settlement remaining settlement			
	Land converted to settlements			

CO_2 emissions and removal are estimated for all C-pools namely:
Above-ground biomass (AGB), below-ground biomass (BGB), soil carbon, dead organic matter (DOM) and woody litter
Non-CO_2 gases estimated include: *CH_4, N_2O, CO and NO_X*

Paradigm shift of management strategies:

From the "specialized shop" to "emporium of diverse functions and services".

Major shift lies on enforcing laws with punishment are now converted to accentuate on the awareness of the people of the society about the resource, sharing the resource and also considering livelihood of the local people.

CASE STUDY

Cox's Bazar South Forest Division is situated in the extreme south-eastern Region of Bangladesh. It lies between 20˚ 50' and 21˚51' N latitude and 92˚0' and 92˚15'E longitude.

Teknaf is a upazilla of Cox's Bazar, the southeast district in Bangladesh, situated by the border of Myanmar

Table 1: Range Wise Forest Land and Manpower

Range	Beat	Staff	Reserved Forest (ha)	Protected Forest (ha)	Total area (ha)
Teknaf	4	15	6011.13	613.20	6624.33
Hoaikong	4	14	5186.29	10.87	5197.16
Silkhali	3	12	2956.27	22.21	2978.48
Total	11	41	14153.69	646.28	14799.97

Natural Forests

Table 2: Duli Garjan (*Dipterocarpus alatus*) Forest at Silkhali

Range	Location	Dominant Species	Volume (m^3/ha.)
Silkhali	Silkhali	Dhuli Garjan: *Dipterocarpus alatus*	340.89

Plantation Forests

Table 3: Volume of Plantation Forest of Teknaf Wildlife Sanctuary

Location	Planted Species	Volume (m^3/ha.)
Teknaf Sadar	**Agar (*Acquillaria agallocha)***	**89.09**
Kerontoli	**Akashmoni (*Acacia auriculiformis*)**	**93.90**
Kerontoli	Teak (*Tectona grandis*)	7.10
Domdomia	**Akashmoni (*Acacia auriculiformis*)**	**81.31**
Boroitali	Sal (*Shorea robusta*)	30.00
Silkhali	**Jhau (*Casuarina equisetifolia*)**	**104.90**
Nature Park	**Akashmoni (*Acacia auriculiformis*)**	**214.64**
Shaplapur	**Jhau (*Casuarina equisatifolia*)**	229.9
Silkhali	**Jhau (*Casuarina equisatifolia*)**	209.3

Bamboo Resources

Table 4: Bamboo Stock at Teknaf Sadar Beat

Range	Beat	Yield (culm/ha)
Teknaf	Teknaf Sadar	791

Cane Resources

Table 5: Cane stock at Teknaf Sadar Beat

Range	Beat	Yield (clump/ha)
Teknaf Sadar	Teknaf Sadar	381

Socio-economic status

Table 6: Educational status

Location/village name	Illiterate (%)	Literate (%)					
		Pri	Sec	S.S.C	H.S.C	Gra	Total
Shilkhali	40	45	15	0	0	0	60
Teknaf	30	40	15	10	5	0	70
Shaplapur	80	15	5	0	0	20	20
Jailer dip	90	10	0	0	0	0	10
Average	60	55	8.75	2.5	1.25	5	40

Table 7: Monthly Average Income Status

Location	Income/ month(tk) average
Shilkhali	5950 (US$ 77)
Teknaf	6550 (US$ 84)
Shaplapur	8700 (US$ 111)

Table 8: Dependency on Forest

Area	Fuelwood	Timber Extraction	Fuelwood + Timber Extraction	Seedling Cutting
Shilkhali	20			
Shaplapur	32	1	47	
Holbunia		20		
Dochakmapara	29			
Jahajpura		5		15
Madargunia		17		
Shilcharipara	23		1	
Total	104	43	48	15
Percentage (%)	50	20	23	7

Decisive findings....

Plantations (in Table 3 with bold marks) of the study area under participated approach with a benefit sharing system, where forest department will get 45%, Local beneficiary will 45% and 10% for future tree program of sell proceed.

The plantations (Table 3: Agar 89.09 cum/ha; Akasmoni: 93.9, 81.31 and 214 cum/ha; Jhau 229.9 and and 209.3 cum/ha) under participated management have showed (clear and identical) more volume production then the conventional forest management practices (Teak 7.10 cum/ha, Sal : 30.00 cum/ha in table 3).

The socio-economic study revealed that the people of the study area are not highly educated and the illiteracy rate is very high which lead the people more dependent on the adjacent forest for their regular livelihood.

Recommends.....

Participatory forest management approach with a blend of the road map of REDD+ may not only conserve the forest as a sink of carbon but also may be an option to uplift the socio-economic condition of this area.

Acknowledgements

Heartfelt gratitude to Hon' able Vice Chancellor, University of Chittagong for his kind permission; organizer of the training program more particularly sponsoring authority APFNET and the students of 8th semester of IFESCU for their kind assistance

(2) Bangladesh: Social Forestry: An Appropriate Approach for Rehabilitation of Degraded Forest and Sustainable Forest Management

Social Forestry:

An Appropriate Approach for Rehabilitation of Degraded Forest and Sustainable Forest Management

(A case study in Mymensingh Forest Division, Bangladesh).

PRESENTED BY

Mohammad Moyeenuddin Khan
Divisional Forest Officer
Mymensingh Forest Division
Forest Department, Bangladesh

1. Abstract :

- Since Bangladesh is the most densely populated country in the world, the Forest land of this country is under great threat of encroachment. Forest resources were also at threat to meet the local demand. In such as reality, Forest Department introduced the participatory Social Forestry approach like woodlot plantation, agro-forestry plantation, strip plantation on the sides of roads, railways and embankments etc.
- When the Participants started to get the share, they become more inspired in the social forestry practices. The forest lands getting its wilderness get-up day by day. Now a-days, the Participants are too much inspired and encouraged that they want to be a participant in Social Forestry Programmes by any means.

2. Introduction

In Bangladesh, Social forestry was introduced, in 1981, with an objective for restoration/ rehabilitation of the forest lands with the involvement of local people.

2.1 Objectives of Social Forestry

1. To meet the needs for fuel wood, small timber, bamboo, fodder and other minor forest produces on sustained basis.
2. To provide employment opportunities to the rural population .
3. To develop cottage industries in rural areas
4. To utilize the available land to the best advantage according to its production capacity.
5. To provide efficient soil and water conservation.
6. To improve aesthetic value of the area and to meet the recreational needs of the population

2.2 Social Forestry Achievements

Table: Summary of Harvested Social Forestry Plantation (1999-00 to 2012-13)

Area Felled km/ha	Timber Quantity (Thousand Cubic m.)	Fuel wood Quantity (Thousand Cubic m.)	Poles (Thousand Nos)	Total sale Proceed (Crore Tk)	Participant Involved (Thousand Nos)	Participant Share (Crore Tk)	Tree Farming Fund (Crore Tk)	GOB Revenue (Crore Tk)
23,253 ha & 10,729 km	4,46,580	4,95,110	4542.16	461.91	105.92	208.34	45.19	190.46

3. Key element relating to the case study:

3.1 Forest policy :

The Forest policy of Bangladesh, 1994 has given importance to the social Forestry Programme, and it illustrates the guidelines to restoration/rehabilitation of the forest lands through Social Forestry activities. It imparts importance on the proper management of the hydrology and geology as well as the forest resources and bio-diversity conservation through tree planting. The forest policy also given emphasis on the social forestry activities in the marginal lands and in the fallow lands.

3.2 Forest Act and Social Forestry Rules :

In the light of forest policy, 1994, The forest Act,1927 has been amended in 2000 for successful implementation and sustainable management of the Social Forestry Programme. Social Forestry rules has been promulgated in 2004 and was amended to make it time be-fitting and more effective in 2010. It illustrates the complete guidelines for Social Forestry system.

3.3 Different aspects of social forestry rules, 2004 (amended in 2010):

- **Selection of beneficiary**:

1. The beneficiaries shall be selected by the Forest Department in consultation with the local Government organization of that area and the non-Government organization associated with social forestry of that area. Generally, the beneficiaries shall be selected from amongst the local inhabitants living within one kilometer of the respective plantation site of Social Forestry and shall preferably be from amongst the following persons-
2. landless persons:
3. owners or occupants of less than 50 decimals of land;
4. destitute women:
5. unprivileged community:
6. poor ethnic minority:
7. poor forest villagers and
8. insolvent freedom fighters or insolvent successor of freedom fighters.
9. In the event of insufficient number of beneficiaries from within one kilometer of the plantation site, such beneficiaries residing in the nearest areas may be selected.
10. The selected beneficiaries must be willing to associate themselves with social forestry activities.

- **Duties and functions of Forest Department in social Forestry-**

The forest department shall have the following duties and functions in implementing social forestry programs-

(a) Selection of beneficiaries,
(b) Making work plan for plantations,
(c) providing technical advice to the beneficiaries in respect of raising social forestry and its management
(d) making agreement with different parties of Social Forestry
(e) monitoring of social forestry activities and reviewing of Tree Farming Fund.
(f) to impart training and marketing of final harvest and distribution of its income among all parties
(g) to cancel agreement with beneficiaries in case of failure to perform duties
(h) to develop necessary guidelines to beneficiaries in extraction and utilization of forest produces of social forestry programs initiated by local community in accordance with approved work plans, etc.

- **Duties and functions of beneficiaries under agreement-**

The beneficiaries under agreement shall have the following duties and functions-

(a) To Participate in the development or social forestry management plan,

(b) To Prepare work plans jointly with the forest department,

(c) Raising seedlings for plantation,

(d) Planting trees and taking care of planted trees, maintenance and protection of trees planted,

(e) Thinning and pruning of trees as per approved plan,

(f) Attending meetings related to social forestry being invited,

(g) Any other activity as per approved plan, etc.

- **Distrbution of income derived from social forestry-**

(1) The branches derived from pruning and trees felled during first thinning and the fruits of fruit bearing trees and agricultural crops grown, shall be receivable in full by the beneficiaries.

(2) The income derived from trees felled at anytime after the first thinning and after completion of rotation shall be distributed as follows, namely:

(a) in the case of woodlot, latex and fruits produced from rubber plantation and a Agro-forestry in the forest under the control of the forest department.

Parties	Receivable rate
(i) Forest Department	45%
(ii) Beneficiaries	45%
(iii) Tree Farming Fund	10%

(b) in the case of protection and development of sal forest-

(i) Forest Department 65%
(ii) Beneficiaries 25%
(iii) Tree Farming Fund 10%

(c) in the case of strip plantation raised on lands owned or occupied by a person or public or statutory body other than the forest department-

(i) Forest Department 10%
(ii) the person/body owning or occupying the land 20%
(iii) Beneficiaries 55% (iv) Local union parishad 5%
(iv) Tree Farming Fund 10%

(d) in the case of plantation in charland and foreshore-

(i) Forest Department 25%,
(ii) Beneficiaries 45%
(iii) the land owner or person occupying the land 20%
(iv) Tree Farming Fund 10%

(e) in case of gully and pond bank rehabilitation and Plantation in Barind tracts-

(i) Forest Department 25%,
(ii) Beneficiaries 45%,
(iii) the land owner or person occupying the land 20%, (iv) Tree Farming Fund 10%

(f) in case of existing plantation and natural forest, except sal forests-

(i) Forest Department 50%,
(ii) Beneficiaries 40%
(iii) Tree Farming Fund 10%

(g) in case of social forestry initiated by social community in land under the Forest Department or under mangrove afforestation; controlled production of honey, fishes, hogla and grass in the said plantation-

(i) Forest Department 25%
(ii) Beneficiaries 75%

(h) in case of social forestry initiated by local community in land either semi-Government or autonomous body-

(i) Forest Department 10%
(ii) Beneficiaries 75%
(iii) the land owning agency 15%

3.4 Sustainability of Social Forestry Programmes

- **The Social Forestry Rules**

The Forest Act,1927 has been amended in 2000 to support and encourage Social Forestry/ participatory forestry activities in the country. Social Forestry Rules,2004 have been promulgated and has been amended in 2010 to make it more effective and time be-fitting. Forest Act and Social Forestry Rules will provide legal support to participatory forestry and will also ensure sustainability to social forestry programmes.

- **The Tree Farming Fund (TFF)**

Participatory plantations are being raised from development budget using both government and loan money. Participatory Forestry cannot be made sustainable using government fund only. Tree Farming Fund (TFF) has been developed using 10% money from the final harvest to reduce dependency on Government and donor fund. The Ministry of Finance has approved TFF. The participants will operate the TFF. TFF will provide 50% of the replanting cost. The remaining 50% cost will be provided by the project. If TFF doesn't cover 50% of the replanting cost, the participant will contribute voluntary labour to cover the gap. TFF and participatory labour contribution will make participatory forestry sustainable.

3.5 Major Social Forestry Activities

- Social Forestry was initiated by Bangladesh Government with Communality Forestry Project with the financial help from Asian Development Bank (ADB) in 1981-82 (Duration 1981-82 to 1986-87). Under this project 4892.0 hac. woodlot 121.0 hac agro-forestry and 4288.0 km. strip plantation was raised besides, 22158 no. of participants/village leaders/ NGO workers were trained up in social forestry under this project.
- The Thana Afforestation and Nursery Development Project was implemented from 1989-90 to 1994-95. under this project 19,562.00 hac of woodlot plantation, 5,180.0 hac. of agro-forestry plantation, and 18,800.00 km of strip plantation was raised. Besides 90,900.00 hac. of participants/village leaders/ NGO workers were trained up in Social Forestry by this project.

- In 1995-96 and 1996-97 fiscal year under Extended Social Forestry Project 582.00 hac. woodlot plantation, 967.00 hac agro-forestry plantation and 3658.00 km strip plantation was raised. Besides, 5,000 participants/village leaders/ NGO workers were trained up in social forestry.
- From 1995-96 to 2001-02, under Costal Green Belt Project 8,934.00 km strip plantation and 665.00 hac foreshore plantation was raised. Besides, 48,561 nos. of participants/village leader/ NGO workers were trained up in Social Forestry.
- Then from 1997-98 to 2005-06 under Forestry Sector Project 12,375.00 hac. woodlot, 3,708.00 hac agro-forestry, 1,035.00 hac block plantation, 1,850.00 hac charland forestation, 14,353.00 km strip plantation, 1,050.00 hac. enrichment plantation and 6,187.00 hac assisted natural regeneration (ANR) in degraded sal Forest was raised. Besides, 1,39,801 participants/village leaders/ NGO workers were trained up in Social Forestry.

- Under Poverty Alleviation through social forestry project (March,2010 to December, 2013) 300.0 hac charland afforestation (new), 50.00 hac. charland afforestation (2nd rotation), strip plantation (new) along the roads, railways, embankments etc. 7,100.00 km, strip plantation (2nd rotation) along the roads, railways, embankments 10,563.00 km, was raised. Besides, 70,530.00 participants/village leaders/ NGO workers were trained up in Social Forestry.

Besides these, Co-ordinated Reed land afforestation project (duration 2005-2010), Social Forestry for Forest Resource Development and Management Project (duration 2006-08), Agar Plantation Project (duration 2007-2012), Poverty Alleviation through Participatory Forestry (duration 2006-08) Projects were implemented with the concept of Social Forestry to restore and rehabilitate the degraded Forests of Bangladesh.

4. Lessons learnt

4.1 Social Forestry activities in Mymensingh Forest Division:

The Forest lands under the jurisdiction of Mymensingh forest Division was dominated with sal trees (shorea robusta) in association with other associate species But due to tremendous socio-anomic and political pressure and due to evolvement of industrialization this forest is in danger and under great threat of degradation.

In Mymensingh Forest Division approximately 20.0 crore taka has been distributed as dividends among 10,000 nos. of social forestry participants (beneficiaries).

SL. NO.	Year wise Plantation			Amount of felled plantation	
	Year	Woodlot and agro-forestry block plantation (Hac)	Strip plantation (Km)	Woodlot and agro-forestry block plantation (Hac)	Strip plantation (Km)
01.	2000-2001	1182.46	206.0	614.07	0.0
02.	2001-2002	1274.53	288.0	849.55	108.00
03	2002-2003	1135.80	145.0	785.38	85.0
04	2003-2004	2500.0	200.0	1325.0	40.0
05	2004-2005	1656.95	155.0	745.0	65.0
06	2005-2006	1567.60	165.0	178.0	65.0
07	2006-2007	400.0	10.0	0.0	0.0
08	2007-2008	625.0	10.0	0.0	10.0
09	2008-2009	130.0	3.40	0.0	0.0
10	2009-2010	150.0	29.0	0.0	29.0
11	2010-2011	83.10	110.0	0.0	0.0
12	2011-2012	100.97	136.0	54.45	46.0
13	2012-2013	719.36	77.00	669.36	47.0
TOTAL		**11526.79**	**1534.40**	**5220.81**	**495.00**

Statement of benefit sharing amongst different parties of social forestry.

Total sell value of plantation (Tk)	Total sell value of plantation (Tk)	Deposited Revenue (Tk)	TFF Deposit (Tk)	Amount of Divideds of different parties of social forestry programme (Tk)	
				Participants	Other Parties
5220.81 Hac of block plantation (Woodlot and Agro-forestry) and 495.00 Km. strip Plantation	49,92,31,702.0	21,53,48,880.0	4,99,27,021.0	21,19,71,461.0	2,19,84,340.0

In every year, through social forestry vast area of forest land is rehabilitated. The amount of plantation raised (new and 2nd rotation) during last decade under social forestry programme is given below:

year of plantation	Area of plantation						No of participants/ beneficiary
	Woodlot (hac)		Agro forestry (km)		Strip (km)		
	New	2nd rotation	New	2nd rotation	New	2nd rotation	
2000-2001	305.0	570.85	43.22	0.0	200.0	0.0	1118 Nos
2001-2002	290.0	659.56	135.0	190.0	180.0	108.0	1513 Nos
2002-2003	250.0	625.38	98.18	160.0	81.62	15.0	1230 Nos
2003-2004	1075.0	1081.0	98.18	255.0	90.0	37.62	2635 Nos
2004-2005	786.95	745.0	125.0	0.0	90.0	65.0	1811 Nos
2005-2006	1303.58	174.0	90.0	0.0	100.0	64.0	1732 Nos
2006-2007	400.0	0.0	0.0	0.0	0.0	0.0	400 Nos

year of plantation	Area of plantation						No of participants/ beneficiary
	Woodlot (hac)		Agro forestry (km)		Strip (km)		
	New	2nd rotation	New	2nd rotation	New	2nd rotation	
2007-2008	625.0	0.0	0.0	0.0	0.0	0.0	625 Nos
2008-2009	130.0	0.0	0.0	0.0	0.0	0.0	325 Nos
2009-2010	150.0	0.0	0.0	0.0	0.0	0.0	375 Nos
2010-2011	83.10	0.0	0.0	0.0	40.0	0.0	722 Nos
2011-2012	46.52	36.13	0.0	18.22	110.0	46.0	1941 Nos
2012-2013	50.0	449.69	0.0	130.74	30.0	32.0	1950 Nos
Total :	**5495.15**	**4341.61**	**589.58**	**753.96**	**921.62**	**367.62**	**16377**

From the above list it is found that 589.58 hac (area of newly plantation) of degraded forest land has been restored/rehabilitated completely from degradation during last decade. Besides 4,341.61 hac. of land (area of 2nd rotation plantation) became more rehabilitated through 2nd and 3rd rotation plantation during that period.

Comparison of output of same plantation (with same area) between 1st time felling and 2nd time felling:

Name of Range	Name of beat	Area of plantation (hac)	Year of establishment	Year of felling	Output of the plantation	Comment (1st felling / 2nd felling)
Sadar Range	Gopalpur beat	26.31	1990-91	2000-2001	Wood- 1000.0 cft fuel wood-5000.0 cft	1st felling
Sadar Range	Gopalpur beat	26.31	2000-01	2011-2012	Wood- 12947.0 cft fuel wood-16299.0 cft	2nd felling
Sadar Range	Gopalpur beat	40.49	1990-91	2000-2001	Wood- 4787.0 cft fuel wood-8000.0 cft	1st felling
Sadar Range	Gopalpur beat	40.49	2000-01	2011-2012	Wood- 23944.85 cft fuel wood-23472.0 cft	2nd felling
Sadar Range	Gopalpur beat	52.63	1992-93	2002-2003	Wood- 1100.0 cft fuel wood-14340.0 cft	1st felling
Sadar Range	Gopalpur beat	52.63	2002-03	2012-13	Wood- 28942.13 cft fuel wood-32146.0 cft	2nd felling
Bhaluka range	Habirbari beat	40.00	1991-92	2001-2002	Wood- 2403.25 cft fuel wood-4235.0 cft	1st felling
Bhaluka range	Habirbari beat	40.00	2001-02	2011-2012	Wood- 15701.97 cft fuel wood-28210.0 cft	2nd felling

Name of Range	Name of beat	Area of plantation (hac)	Year of establishment	Year of felling	Output of the plantation	Comment (1st felling / 2nd felling)
Bhaluka range	Kadigarh beat	34.74	1991.92	2001-2002	Wood- 5752.23 cft fuel wood-6895.0 cft	1st felling
Bhaluka range	Kadigarh beat	34.74	2001-02	2011-2012	Wood- 22814.82 cft fuel wood-21626.0 cft	2nd felling
Rangtia range	Sadar beat	31.00	1991-92	2001-2002	Wood- 7298.03 cft fuel wood-1033.0 cft	1st felling
Rangtia range	Sadar beat	31.00	2001-02	2011-2012	Wood- 35198.33 cft fuel wood-12654.93 cft	2nd felling
Rangtia range	gazni beat	30.73	1991-92	2001-2002	Wood- 5108.23 cft fuel wood-5657.0 cft	1st felling
Rangtia range	gazni beat	30.73	2001-02	2011-2012	Wood- 24162.37 cft fuel wood-15676.14 cft	2nd felling
Rangtia range	gazni beat	45.97	1991-92	2001-2002	Wood- 3697.53 cft fuel wood-1290.0 cft	1st felling
Rangtia range	gazni beat	45.97	2001-02	2011-2012	Wood- 20055.36 cft fuel wood-17382.0 cft	2nd felling

Name of Range	Name of beat	Area of plantation (hac)	Year of establishment	Year of felling	Output of the plantation	Comment (1st felling / 2nd felling)
Rangtia range	tawakuchua beat	53.00	1991-92	2001-2002	Wood- 5790.36 cft fuel wood-15907.0 cft	1st felling
Rangtia range	tawakuchua beat	80.97	2001-02	2011-2012	Wood- 29678.49 cft fuel wood-59521.0 cft	2nd felling
Modhutila range	Somescura beat	40.49	1991-92	2001-2002	Wood- 3206.63 cft fuel wood-4395.0 cft	1st felling
Modhutila range	Somescura beat	40.49	2001-02	2011-2012	Wood- 19844.39 cft fuel wood-122749.0 cft	2nd felling

The felling data of the same plantation (on the same piece of land with same area) at the 1st time felling and the 2nd time felling shows that the production at the 2nd time feeling of the plantation (volume of timber, fuel wood etc) gives several times production than that of 1st time felling. It revels that the participants (beneficiaries) become more inspired when they got the dividends after first time felling. The participants become more sincere on their duties to protect the trees of 2nd rotation plantation. They put more trust on forest department i.e. on Government when they get their dividends. Besides, the achievement of the beneficiaries of the Social Forestry Programme spread all through the country, thus the participants become inspired and more conscious about the protection of the plantation.

5. The way forward:

The Social Forestry programmes should be run as per direction of the Social Forestry Rules,2004 (ammended in 2010) properly to make it viable and successful. In woodlot, agro-forestry, block plantation or any after plantation pruning and thinning as per prescription of the social forestry agreement should be carried out in proper time. If it is not done in time, the participants become dis-hearted and frustrated, they become discouraged to protect the trees/ seedlings.

5.1 Future Prospect:

The Potential land available for the Social Forestry practices are as follows :

Sl no.	Available Land	Area in Million Hectare
01.	Degraded & denuded land of Un -classed State Forest Land	1.00
02.	Khas lands	0.56
03.	Degraded government forest land	0.27
04.	Marginal strip land	0.08
05.	Homestead marginal land	0.27
06.	Degraded tea garden land	0.06
07.	Degraded private forest land	0.05
08.	Cropland Agro-forestry on private agricultural lands	2.36
(29% of the total agricultural land is above normal flood level & suitable for cropland agro-forestry)		
Total Available Land for Social Forestry		**4.65**

In total about 4.65 million hectare land is available for this purpose, which is about 31% of the country's total land surface. Considering size of Bangladesh and her forest area, the potential land available for Social Forestry production system is quite significant.

5.2 Anticipated production

If all the available 4.65 million hectare of land is brought under Social Forestry production system then 4.65 million hectare of land would be available for planting annually under Social Forestry production system of 10 years rotation. The area will produce 46.5 million cubic meter of timber and firewood annually (at the moderate rate of 10 cu m/ha/year, production). Moreover the system will provide food, income and employment opportunities for the farmers.

6. Summary :

Social Forestry Programmes played a very important role to restore/rehabilitate the degraded forest lands of Bangladesh. The barren lands are now under green cover and the forests getting their wilderness nature. The local people surrounding forest areas are directly involved in planning and execution of afforestration programmes. The people who were engaged in illegal felling of forest trees, now they become the guard of the forest. They are getting opportunity to cultivate intermediary agricultural crops in association with tree seedlings.

Besides, it is playing vital role for environmental balance, reduction of climate change, Forest Resource creation, protection from desertification, environmental improvement and bio-diversity conservation etc.

The social forestry has been evolved as an appropriate technology for restore and rehabilitate the degraded forests of Bangladesh and for the sustainable forest management. Government policy has been formulated to bring the unutilized fallow lands (either agricultural land or forestland) under social forestry activities. Now-a-days social forestry became the only technology for restoration and rehabilitation of the degraded forest lands. The modernized, appropriate and time-befitting Social Forestry rules has given fulfill ness to the social forestry programmes.

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- Primary data collected from Mymensingh Forest Division.

(3) Cambodia: Forest Restoration and Plantation in Cambodia

FOREST RESTORATION AND PLANTATION IN CAMBODIA

Department of Forest Plantation and Private Development
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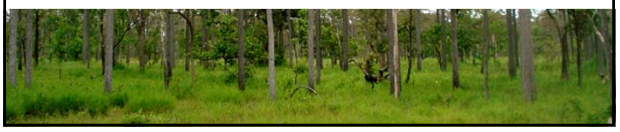

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1) Biophysical conditions
2) Current Situation of Forest Cover in Cambodia
3) Deforestation
4) National Forest Programme 2010-2029
5) Structure Management of Forestry Administration
6) Structure Management of Department of Forest Planation and Private Forest Development
7) Forest Restoration and Plantation
8) Challenges

Biophysical conditions

- Cambodia is a tropical country located on the peninsula of mainland Southeast Asia with a land area of 181,035 km2.
- It is adjacent to the gulf of Thailand and has a coastline around 440 km. Its land border of 2,438 km runs along Thailand to the west, Vietnam to the east and Laos PDR to the north.
- Cambodia's population is 14,073,461 (MoP/NIS, 2008), about 90 % are living in the central lowlands region along the Mekong River and around Tonle Sap Lake which is characterized with fertile soils and abundant water resources. (MAFF/SAW, May 2009).

Biophysical conditions (Con't)

- The Agriculture sector is the main economic driver, accounting for 34.4% of GDP in 2009; it also accounts for more than 60% of the total employment in the country.
- The majority of our rural population is subsistence farmers, 75 % of these, as well as landless families; depend on access to natural resource for essential products, energy and food, particularly in times of hardships. Forests also provide household opportunities for diversification, supplementary income, and employment created by forest product-based enterprise.

Current Situation of Forest Cover in Cambodia

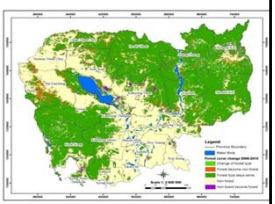
Forest Cover in 2010

- Evergreen Forest : 3,499,185 ha (19.27%)
- Semi-Evergreen Forest : 1,274,789 ha (7.02%)
- Deciduous Forest: 4,481,214 ha (24.68%)
- Other Forest : 1,108,600 ha (6.1%)

The forest land of Cambodia is 10,363,789 ha, (57.07%) of the total land area.

-Non Forest : 7,796,885 ha (42.93%)

TOTAL AREA: 18,160,674 (100%)



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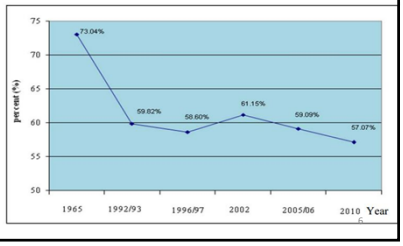
Deforestation

- Assessment data in 1965 documented the forest cover remaining as 73.04% of the total land area.
- In 1993 the forest cover had declined to 59.82% and it continued to decline, reaching 58.60% of the total land area by 1997.
- In 2002 the forest area was assessed as 61.15% of the total land area, decreasing to 59.09% in 2006 and 57.07% in 2010.

No	Assessment by year	Land				Total Area (ha)
		Forest land		Non forest land		
		Ha	%	Ha	%	
1	1965	13,227,100	73	4,883,400	27	18,110,500
2	1992/93	10,859,695	60	7,293,290	40	18,152,985
3	1996/97	10,638,209	59	7,514,776	41	18,152,985
4	2002	11,104,293	61	7,056,383	39	18,160,677
5	2005/06	10,730,781	59	7,429,893	41	18,160,674
6	2010	10,363,789	57	7,796,885	43	18,160,674



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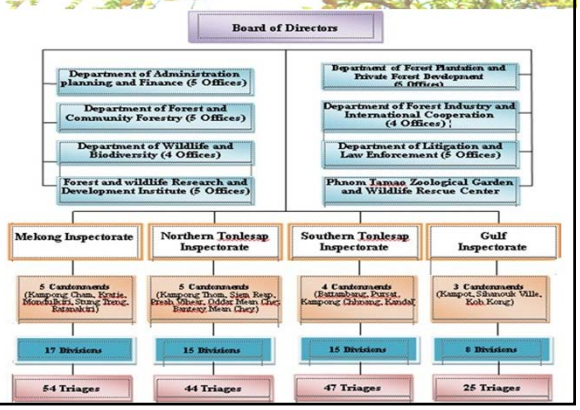
National Forest Programme 2010-2029

- Forest Demarcation, Classification and Registration
- Conservation and Development of Forest Resource and biodiversity
- Forest Law Enforcement and Governance
- Community Forestry Programme
- Capacity and Research Development
- Sustainable Forest Financing

Structure of Forestry Administration



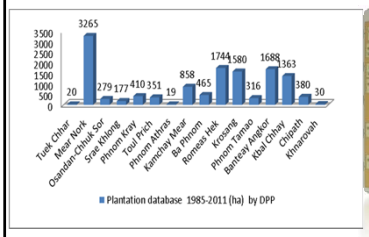
Structure of Department of Forest Planation and Private Forest Development

Department of Forest Planation and Private Forest Development

- Administration and Planning office
- Forest Plantation, Nurseries and Park Management office
- Tree Seed and Genetic Resource office
- Agro-Forest office
- Private Forest and Partnership office

Structure of Department of Forest Planation and Private Forest Development (con't)

- Department of forest plantation and private forest development has 16 forest restoration and plantation stations, 25 nurseries and 6 agro-forestry pilots.
  - ❖ Forest restoration and plantation stations

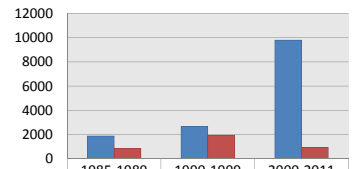


Forest Restoration and Plantation

Tree Species

- Cassisa Siamea Lam
- Dipterocarpus alatus Roxb,
- Eucalyptus
- Hopeaodorata Roxb
- Peltophorum dosyrrhachis Kurz,
- Tectona grandis L.t,
- Dalbergia cochinchinensis Pierre.

Forest Plantation Statistics (ha)



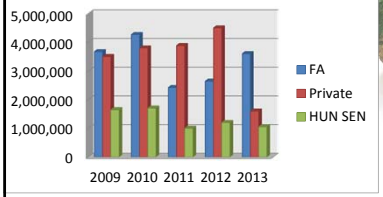
	1985-1989	1990-1999	2000-2011
FA	1885	2665	9795
FA.P.M	853	1947	931

Forest Restoration and Plantation (Con't)

Dal. cochinchinensis (eight months) *at Siem Reap province*

Forest Restoration and Plantation (Con't)

- Seedling plantation nurseries for distribution to Residents



13

Forest Restoration and Plantation (Con't)

❖ Seedling production for large scale plantation

Clone acacia seedling at Mea Nork pulp wood planting station

15

Forest Restoration and Plantation (Con't)

❖ **Maintenance – replanting previous plantation from year 1 to year 5 (Continued)**

Clearing in hybrid acacia plantation, which planted in 2008

Growing trees, aged 2 years.

16

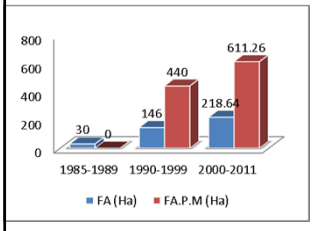
Forest Restoration and Plantation (Con't)

❖ Planted forest in degradation areas

17

Forest Restoration and Plantation (Con't)

- The Arbor Day



Forests where forest restoration is needed

CHALLENGES

- There are still destroy forest plantation in some forest restoration and plantation stations in order to land encroachment
- Lack of support and cooperate from partners and NGOs on forest restoration and plantation
- Forest fire and disaster on new seedling in some forest restoration and plantation stations

20

Thank you

(4) Malaysia: Sustainable Forest Management in Peninsular Malaysia

SUSTAINABLE FOREST MANAGEMENT IN PENINSULAR MALAYSIA

1

PRESENTATION OUTLINE

1. Forest Area
2. Cross-Section of Forest Types
3. Forest Types
4. Forest Functional Classification
5. Sustainable Forest Management
6. Selective Management System
7. Forest Management Operation
8. Certification
9. Conclusion

2

FOREST AREA, 2010

PENINSULAR MALAYSIA
5.86 million hectares
(44.4%)

State Land / Alienated Land
0.35 million hectares
(6.0%)

Permanent Reserved Forests
4.92 million hectares
(83.9%)

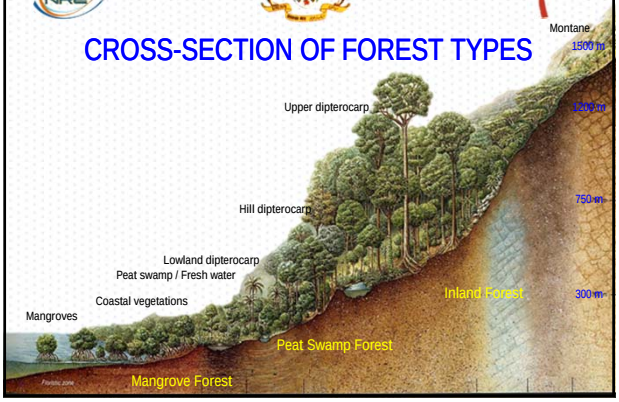
Production
2.82 million hectares
(57.3%)

Protection
2.10 million hectares
(42.7%)

National Park / Wildlife & Bird Sanctuary
0.59 million hectares
(10.1%)

3

CROSS-SECTION OF FOREST TYPES



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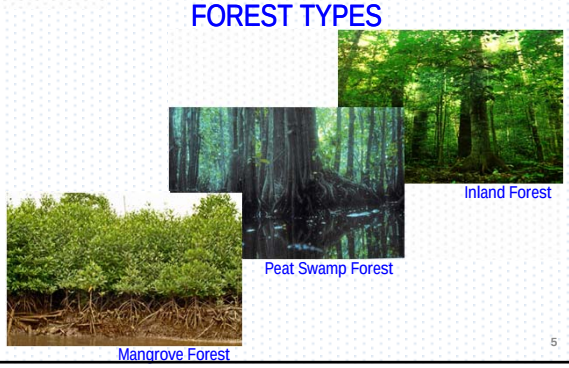
FOREST TYPES



5

4.92 mill ha
PRF

2.82 mill ha
Production Forest

- For the supply in perpetuity, at reasonable rates of all forms of forest produce which can be economically produced within the country and are required for agricultural, domestic, industrial purposes and for export.

2.10 mill ha
Protection Forest

- For ensuring favourable climatic and physical conditions of the country
- The safeguarding of water resources
- Soil fertility
- Environmental quality
- Preservation of biological diversity
- The minimization of damage by floods and erosion to rivers and agricultural lands

6

FOREST FUNCTIONAL CLASSIFICATION

PRFs are classified under the following classifications:

i.timber production forest under sustained yield;
ii.soil protection forest;
iii.soil reclamation forest;
iv.flood control forest;
v.water catchment forest;
vi.forest sanctuary for wild life;
vii.virgin jungle reserved forest;
viii.amenity forest;
ix.education forest;
x.research forest;
xi.forest for federal purposes; and
xii.state park forest.

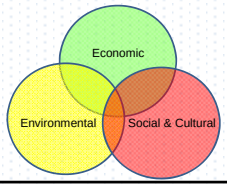
Protection Forests

7

SUSTAINABLE FOREST MANAGEMENT

"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 and services without undue reduction in its inherent values and future productivity and without undue undesirable effects on the physical and social environment"

ITTO 1992



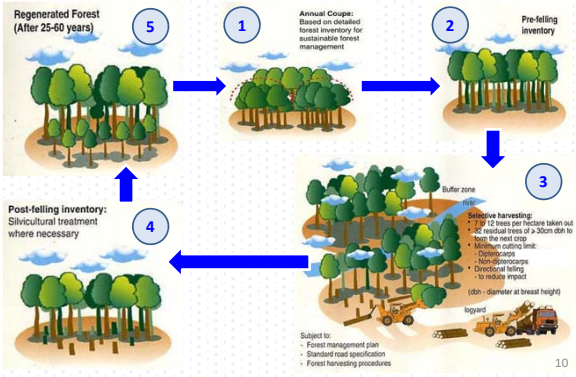
8

SELECTIVE MANAGEMENT SYSTEM

Year	Operation
n-2 to n-1	Pre-felling forest inventory of 10% sampling intensity using systematic-line-plots to determine appropriate cutting limits
n-1 to n	Tree marking incorporating directional felling ▪ Marking of trees to be felled ▪ Marking of seed trees ▪ Marking of protection and protected trees ▪ Demarcating boundaries of buffer zone for watercourses
n	Felling of trees
n¼ to n½	Forest survey to determine damage to residuals and royalty on short logs and tops
n+2 to n+5	Post-felling forest inventory of 10% sampling intensity using systematic-line-plots to determine residual stocking and appropriate silvicultural treatments
n+10	Forest inventory to determine regeneration status of the forest

9

FOREST MANAGEMENT OPERATION



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CERTIFICATION

- MC&I (2002) based on FSC Principles and Criteria;
- 8 FMU in Peninsular Malaysia has been successfully certified under this standard.

11

CONCLUSION

Peninsular Malaysia is committed to the implementation of SFM as enshrined in the resolution of the UNCED. While focusing on economic growth and development, Peninsular Malaysia will give equal emphasis to promote conservation of its natural resources and to give adequate attention to social aspects as well.

12


THANK YOU
http:// www.forestry.gov.my
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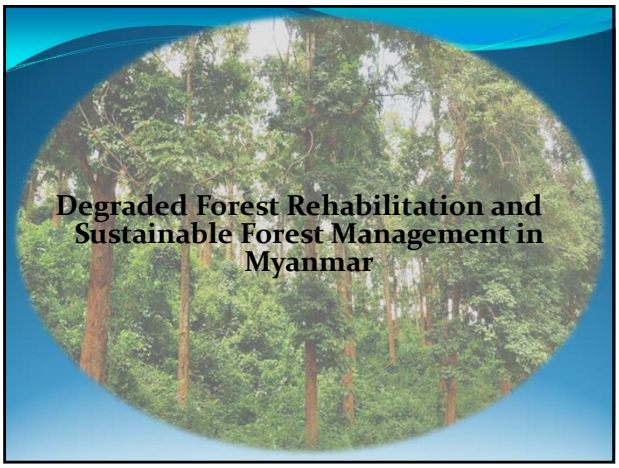
(5) Myanmar: Degraded Forest Rehabilitation and Sustainable Forest Management in Myanmar



Contents

- Introduction
- Forest Resources in Myanmar
- Forest Resources Management
- Policy , Legislations and Institutional Arrangement
- Major Drivers of Forest Degradation
- Forest Rehabilitation Activities
- Sustainable Forest Rehabilitation and Management for the Conservation of Trans-boundary Ecological Security in Montane Mainland Southeast Asia-Pilot Demonstration Project in Myanmar

Introduction

Country Profile

Population
58.6 million (2010)

Location
- located in main-land Southeast Asia
- **Latitudes = 9° 58′ to 28° 29′ North**
- **Longitudes = 92° 10′ to 101° 10′ East**

Area
- **Total land area = 676,577 km²**
- **Length (north to south) = 2,051 km**
  Maximum width (west to east) = 936 km

- **Climate**
- **Temperature**
  25° C to 33° C (Rainy Season)
  10° C to 25° C (Cold Season)
  32° C to 38° C (Hot Season)
  43° C (Maximum Temperature)
- **Rainfall**

Minimum rainfall = 500 mm
Maximum rainfall = 5, 000 mm

- ✓ Forest cover - 31,773,000 ha
- ✓ 135 different nationalities
- ✓ 70% of total population lives in rural areas
- ✓ More than 12 million people, or 24% of the total population, are living in the mountainous areas.
- ✓ Agriculture and forestry industries are the main organs of the Myanmar economy of the country

Forest Resources in Myanmar

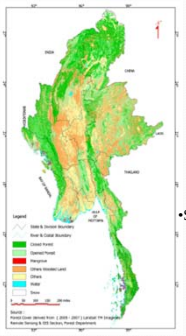
Major Forest Types

- Mangrove forest
- Tropical evergreen forest
- Mixed deciduous forest
- Dry forest
- Deciduous Indaing (Dipterocarp) forest
- Hill and temperate evergreen foest

Scrub land

47% of total country's area is forested

Permanent forest estate (PFE)



Sr. No.	Legal Classification	Area (km²)
1.	Permanent Forest Estate	197,899.36
2.	Reserve Forests	121,842.91
3.	Protected Public Forest	40,949.60
3.	Protected Areas system	35,106.85

•Source: Planning and Statistic Division, Forest Department, 2011

Policy target
❖RF+PPF – 30% of total country's area
❖PAS – 10% of total country's area

Forest Resources Management

- MOECAF has a long history in forest management dating back to 19 century.
- **Myanmar Selection System** (MSS) has been practiced for the sustainable management of forest resources of Myanmar.
- **C & I for SFM** – 7 Criteria and 51 Indicators at the National Level
- **National Forest Management Plan (2001-2030)** has been implementin according to the guiding principles of Master Plan

  - **Forest Management Unit (FMU) is District Level.**
  - **63 District (63 FMU) across the country.**

  It includes 5 categories:
  - ✓ **Production Working Circle (PWC),**
  - ✓ **Planted Forests Working Circle (PFWC),**
  - ✓ **Local Supply / Community Forestry Working Circle (LS/CFWC)**
  - ✓ **Watershed Forests Working Circle (FWC) and**
  - ✓ **Non-wood Forest Products Working Circle (NFPWC)**

MSS is practiced within the bound of :

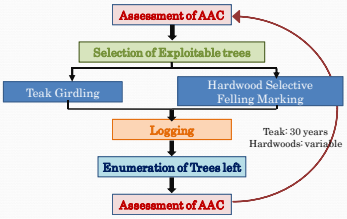
(1) Space/Area limit (Felling series-30 Blocks)

(2) Size/Girth limit **(63 cm or 73 cm DBH)**

(3) Time limit (a felling cycle of 30 years)

Fixing of Annual Allowable Cut for teak and hardwood

Cultural treatments: Improvement felling, thinning, climber cutting etc.



Plantation Forestry

1856 Small scale plantation initiated using Taungya method

1941 The extent of plantations reach 47,167 ha

1980 Large scale plantations began

1984 Annual plantation target reached 30,000 ha

1998 Special teak plantation programme was launched to increase timber production

2005 Private plantation was started to provide development of private sector and national economy, and also sustainable forest.

Present, Annual planting rate about 40,000 ha (teak and other commercial species)

Types of forest plantations

Plantation type	Area (ha)	% of total area
Commercial	541,781	56.00
Industrial	215,088	22.23
Village supply	73,624	7.61
Watershed	136,984	14.16
Total	967,477	100

Source: Natural Forest and Plantation Division

- Tree improvement programme
- Seed production areas (SPAs)
- Teak hedge gardens and shoot-cutting techniques
- Tissue culture
- Genetic conservation of teak

Policy, Legislation and Institutional Arrangement

POLICY IMPERATIVES

Myanmar Forest Policy 1995

PROTECTION of soil, water, wildlife, biodiversity and environment;

SUSTAINABILITY of forest resources to ensure perpetual supply of both tangible and intangible benefits

BASIC NEEDS of the people for fuel, shelter, food and recreation;

EFFICIENCY to harness, in the socio-environmentally friendly manner, the full economic potential of the forest resources;

PARTICIPATION of the people in the conservation and utilization of the forests;

PUBLIC AWARENESS about the vital role of the forests in the well being and socio-economic development of the nation.

National Forest Policy

- Recognize that plantation forestry is not a substitute for natural forest management
- A system of environmental pricing based on "Polluter Pays" to compensate for environmental and ecological degradation.

- **Legal aspect**

The important instruments supporting for rehabilitation of forest in Myanmar are as follows:

- Forest law (1992);
- Myanmar Forest Policy (1995);
- Protection of wildlife and wild plants and conservation of natural areas law (1994);
- Community forestry instructions (1995) and
- Environmental Conservation Law (2012)

Environmental Conservation Law, 2012

Objectives

Section 3

(c) to enable to emerge a healthy and clean environment and to enable to conserve natural and cultural heritage for the benefit of present and future generations;

(d) to reclaim ecosystems as may be possible which are starting to degenerate and disappear;

(e) to enable to manage and implement for decrease and loss of natural resources and for enabling the sustainable use beneficially;

The following provisions of Duties and Powers relating to the Env Conv. of the Ministry are stipulated in EC Law

Section 7

(a) To specify categories and classes of hazardous wastes generated from the production and use of chemicals or other hazardous substances in carrying out industry, agriculture, mineral production, sanitation and other activities;

(b) To prescribe categories of hazardous substances that may affect significantly at present or in the long run on the environment;

(c) To promote and carry out the establishment of necessary factories and stations for the treatment of solid wastes, effluents and emissions which contain toxic and hazardous substances;

(j) To prescribe the terms and conditions relating to effluent treatment in industrial estates and other necessary places and buildings and emissions of machines, vehicles and mechanisms;

(m) To lay down and carry out a system of EIA and SIA as to whether or not a project or activity to be undertaken by any Government department, organization or person may cause a significant impact on the environment;

(o) To manage to cause the polluter to compensate for environmental impact, cause to contribute fund by the organizations which obtain benefit from the natural environmental service system, cause to contribute a part of the benefit from the businesses which explore, trade and use the natural resources in environmental conservation works;

Environmental Quality Standards

Section 10. The Ministry may, with the approval of the Union Government and the Committee, stipulate the following environmental quality standards:

(a) suitable surface water quality standards in the usage in rivers, streams, canals, springs, marshes, swamps, lakes, reservoirs and other inland water sources of the public;
(b) water quality standards for coastal and estuarine areas;
(c) underground water quality standards;
(d) atmospheric quality standards;
(e) noise and vibration standards;
(f) emissions standards;
(g) effluent standards;
(h) solid wastes standards;
(i) other environmental quality standards stipulated by the Union Government.

Monitoring

Section 13. The Ministry shall, under the guidance of the Committee, maintain a comprehensive monitoring system and implement by itself or in co-ordination with relevant Government departments and organizations in the following matters:

(a) the use of agro-chemicals which cause to impact on the environment significantly;
(b) transport, storage, use, treatment and disposal of pollutants and hazardous substances in industries;
(c) disposal of wastes which come out from exploration, production and treatment of minerals, industrial mineral raw materials and gems;
(d) carrying out waste disposal and sanitation works;
(e) carrying out development and constructions;
(f) carrying out other necessary matters relating to environmental pollution.

Responsibilities of project proponent/ business owner for reducing environmental impact

Section 14. A person causing a point source of pollution shall treat, emit, discharge and deposit the substances which cause pollution in the environment in accord with stipulated environmental quality standards.

Section 15. The owner or occupier of any business, material or place which causes a point source of pollution shall install or use an on-site facility or controlling equipment in order to monitor, control, manage, reduce or eliminate environmental pollution. If it is impracticable, it shall be arranged to dispose the wastes in accord with environmentally sound methods.

Responsibilities of project proponent/ business owner for reducing environmental impact

Section 16. A person or organization operating business in the industrial estate or business in the SEZ or category of business stipulated by the Ministry:

(a) is responsible to carry out by contributing the stipulated cash or kind in the relevant combined scheme for the environmental conservation including the management and treatment of waste;
(b) shall contribute the stipulated users' charges or management fees for the environmental conservation according to the relevant industrial estate, SEZ and business organization;
(c) shall comply with the directives issued for environmental conservation according to the relevant industrial estate, SEZ or business.

Institutional Arrangement

Organizational Structure of MOECAF - Myanmar

Ministry of Environmental Conservation and Forestry (MOECAF)

- Forest Dept.
- Dry Zone Greening Dept.
- Env. Conservation Dept.
- Planning & Statistics Dept.
- Myanmar Timber Enterprise
- Survey Dept.

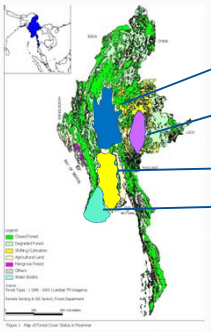
Six institutions under the Ministry of Environmental Conservation and Forestry are performing their specific duties and responsibilities mainly related to forestry and environment.

Major Drivers of Deforestation

- ✓ overexploitation;
- ✓ illegal logging;
- ✓ shifting cultivation;
- ✓ expansion of agricultural land;
- ✓ fuelwood collection;
- ✓ urbanization;
- ❖ infrastructure development;
- ❖ mining and
- ❖ conversion of forest into other land uses
- ❖ Natural disaster

Rehabilitation and Reforestation Activities

National-Level Large-scale Reforestation Zones



Central Dry Zone: Rainfall 700 mm/yr	Desert-like formation and land degradation
Upland Watershed Zone: Rainfall 1473/yr	Serious soil erosion
Bago Yoma Zone: Rainfall 1993 mm/yr	Rapid deforestation
Mangrove-Delta Zone: Rainfall > 3500 mm/yr	Natural disaster and livelihood

- Making significant contribution towards the rehabilitation of the annual deforestation
- Implementing to achieve 2.27 million acres of CF by 2030
- CF establishment, (up to now 5.4% of the target, FUG ? , member ?)
- Nation-wise tree planting (30 millions) since 1997
- Planting teak trees (2,073,251 trees) in 2013
- Village housing program: planting hardwood trees for each household in the village, One village- one forest
- Promoting to use Efficient stove
- Under 4th Step-Reform strategy: Private sector development in all sectors
- (in new forest law) ownership of teak shared to Private sector, Communities
- (Until 2013 December, 807356 acres of private teak plantation, have been already established by 201 private companies,

Greening Activities in the Dry Zone of Central Myanmar

• Implementing in 54 townships of 12 districts

The four main tasks:

• **Establishment of plantations (Environmental greening)**

Four major types of plantations

a). Village supply plantation;
b). Watershed plantation;
c). Plantation for greening of mountain; and
d). Other greening plantation

• **Protection of remaining natural forest**

- annually 80,000 ha have been protected to rehabilitate the existing 0.73 million hectares of natural degraded forest since 1997

• **Introducing and promotion of the utilization of fuel substitutes**

- cooking stoves, Fuel briquette, agricultural residues

• **Management and development of water resources**

- Construction of small ponds, river water-pumping system, utilization of underground water,

Updating the Relevant Policy

Existing Policy and Legal Instruments, Institution as inform in earlier report

- **Community Forestry Instruction, CFI, 1995**
- **Myanmar Forest Policy, 1995**
- **Environmental Law issued in 2012 March 30,**

Updates

- **Department of Environmental Conservation organize d under MOECAF**
- **Survey Department moved under MOECAF**
- **Government's reform strategy, followed by all ministries**
- **Foreign Direct Investment in Forestry sector**
- **Land Scrutinizing Committee to formulate a National Land Use Policy**
- **National Working Group on CF**

- 2013 June 13, on Newspaper of New Light of Myanmar "1,213 villages officially recognized by Ministry of Home Affair, (24447. 44 acres of village area, 295,319 acres of paddy fields) a total of 345,889.13 Acre (**140,036 ha**) excluded from reserved forest and demarcated as permanent village land use as first stage,
- Other villages which has **more than 50 households** located in reserved forests and officially not recognized will be affected soon by above instructions.
- Amendment of forest law to **support national land use plan and promotion of community forestry, privatization of teak,** etc; has been approved by attorney general office

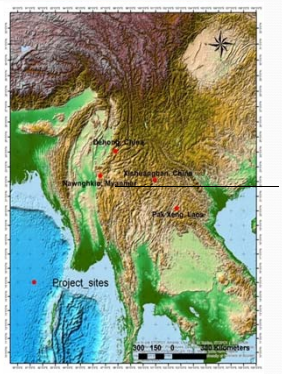
Environmental Restoration Measures

- Bago Yoma Greening Project
- National-wide tree planting programme
- Forestry development in border areas
- Efforts to eliminate shifting cultivation
- Managing watersheds
- Ecosystem restoration of Inle Lake
- Conservation of mangrove ecosystem

Sustainable Forest Rehabilitation and Management for the Conservation of Trans-boundary Ecological Security in Montane Mainland Southeast Asia– Pilot Demonstration Project in Myanmar

- Introduction
- Forest rehabilitation in community based forest management
- Establishment of community forest in shifting cultivation areas
- Management plan for community forestry with agro-forestry
- Community forestry with conservation of existing natural forest
- Home Garden
- Plan Activities for 2014

Project Site



Nawnghkio Township, Shan State in Myanmar

Introduction

In accordance with participatory land use plan of the target village located near the Nyuak-Htauk reserved forest, there are residence area,

- private farm lands,
- shifting cultivation lands in reserved forest and unclassed forest,
- spiritual forests, spring water forests and forests where villagers collect fuelwood for home consumption.

- Different forest rehabilitation strategies were designed for each land use systems that are required forest rehabilitation based on the base line assessment.
- Sustainable forest rehabilitation plan for home garden, shifting cultivation lands, spiritual forests and spring water resources were formulated through participatory process involving local communities, authorities and scientists.

Forest rehabilitation in community based forest management

Forest rehabilitation plan was prepared based on scientific literature on best practices, field survey, local perceptions and concerns, involvement of local officials and local FD staff.

- **Establishment of community forest in shifting cultivation areas**

✓The pilot demonstration site is located in the reserved forest where local communities have being practicing shifting cultivation significantly since after 1988.

✓Total area is 24.3 ha, of which, 8.41 ha is affected by shifting cultivation while other 15.89 ha is degraded secondary forest areas covered with Teak (*Tectona grandis*) and some hardwoods species such as Thit-ya (*Shorea obtusa*) and In-gyin (*Shorea siamensis*).

✓Along with increased population and industrialization of agriculture, swidden Taungya is likely to change into sedentary agriculture.

✓ Nowadays, the commons crops planted in the Taung-ya include maize, groundnut, sesame and paddy

- Maize becomes commercial crop for the local community because of ensure market access and simple processes compared to other crops.
- The industrialization of agriculture with intensive use of inputs has increased productivity and farmers' income,
- On the other hand, it may lead to reduce agro-ecosystems to prevent erosion and mitigate climate change.
- To demonstrate good practices for forest rehabilitation in such area, community forestry model was introduced to address real needs of communities as well as to rehabilitate the degraded natural forest.

Maize and groundnut cultivation in Taungya

Management plan for community forestry with agro-forestry

- Community forest user group was organized with nine households who are doing Taungya in 8.41 ha of cultivated land.
- According to the present vegetation and land use, two management strategies were designed under community forestry i.e. agro-forestry and conservation of existing natural forests.
- Individual member, thus, will manage agro-forestry plot as well as natural forests plot.
- Management plan to manage agro-forestry and natural forest was prepared by collaboration among user group members, authorities, elder people and scientists.

To accomplish preparing management plan to meet the objectives of the project,the following activities were conducted.

- Gathering community information and identify village needs through village meeting and informal interview by scientists.
- Presenting concept of community forestry and agro-forestry in the village meeting
- Sharing economic outcomes of agro-forestry using example from other user group
- Facilitating local communities to develop preferable agro-forestry design including preferable species to be planted
- Confirming developed agro-forestry design in the meeting
- Discuss about conservation of existing natural forest

Discussion about Demonstration Plot

Raising Awareness the Agroforestry Technology

Conservation of remaining natural forests

- Make a consensus meeting among user members for conservation of natural forest by the help of scientists
- Site visit to Wundwin township community forest to study the present rehabilitation practices of agroforestry
- Nursery and preparation of planting materials
- Demonstrate tree management practices to user group members such as planting trees and improvement felling by local FD staff and scientists
- Identification of tree vegetation in community forest area and home garden to measure the success of forest rehabilitation

Discussion at site visit

Nursery Establishment

Home garden

Work Plan for 2014

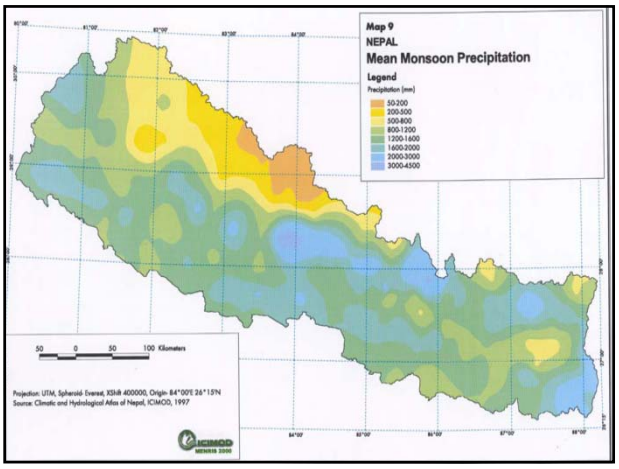
- Upland nurseries for preparing seedlings and planting materials of rare and endangered native tree species.
  - ✓ Field experimentation of site requirements and techniques to prepare and transplant seedlings and planting materials of locally preferred, rare and endangered native tree species
  - ✓ Field demonstration of site requirements and techniques to prepare seedlings and planting materials of locally preferred, rare and endangered native tree species
  - ✓ Completion of the database of locally preferred, rare and endangered native tree species (list of species, site requirements and propagation techniques, based on results of Year I and Year II in this regard
- **Techniques for soil improvement in degraded areas for tree planting**
  - ✓ Soil improvement and rehabilitation of degraded forestland
  - ✓ Field experimentation of techniques to improve soil conditions of degraded areas for tree planting
  - ✓ Field demonstration of techniques to improve soil conditions of degraded areas for tree planting
- **Agroforestry systems, including understory cultivation**
  - ✓ Upland agro-forestry based models, including understory cultivation.
  - ✓ Field experimentation of agroforestry models in line with the participatory planning of forest rehabilitation
  - ✓ Field and on-farm demonstration of agroforestry models, including indigenous practices,

Thank you for your kind attention

(6) Nepal: Rehabilitation of Degraded Forest in Nepal

Rehabilitation of degraded forest in Nepal

By- Rom Raj Lamichhane
Nepal



Introduction of Nepal

- Lies between India and China
- Total area: 147,181 sq. m (1% of total mass)
- 86% high hill , only 14% flat lands
- Altitude varies from 60 m to 8,848m (Mount Everest)
- Average rainfall is about 1600mm

Introduction…….

- Varieties of natural resources

i.e. forest land, water, biodiversity

- 118 ecosystem types
- 75 vegetation types
- Forest distribution: tropical forest (up to 1000m), sub-tropical forest (1000-2000m), temperate forest (2000-3000)
- Subalpine forest (3000m-4000m), alpine forest (4000m-5000m) above 5000m only tundra vegetation type.

Forest management modes of Nepal

- Government managed forest (51.5%)
- Community forest (30%, 18133 FUG)
- Leasehold forest (40898.36 ha , 6934 groups)
- Collaborative forest (0.37%, 54,000 ha,19 groups)
- Protected forest (20% as NP,CA.WR,HR and BZ)
- Private forest (0.02%,2360.84 ha)-(DoF,2012)
- Religious forest

Overview of deforestation/degradation

- Forest area decline from 39.4% to 29%
- Invasive species invade and replace the local flora and fauna.
- Forest area loosed by 4.8m ha to 3.6m ha area by 20yrs (1990-2010)
- Conversion of forest land into agriculture, roads and infrastructure.

Overview of deforestation/degredation……..

- Overgrazing leads habitat loss, enhance surface runoff.
- Lack of scientific forest management system
- Illicit felling leads encroachment
- Shifting cultivation

State of degradation

- Degradation is @ 1.3% in Terai, 0.2% in Hills and 0.5% in Nepal (DFRS 1999).
- Forest generated 9% of GDP(2008)

Causes of degradation

- Human Population, Agriculture and Encroachment
- Heavy and unmanaged extraction of firewood fodder, timber, overgrazing, Fire.

Impact of degradation

- Soil erosion, Landslide, Siltation, Denudation.
- Environmental degradation, loss of productivity of timber, firewood and other domestic production including agricultural production.

Constraints for Forest Restoration and Rehabilitation

- Unsustainable harvesting of natural resources
- Encroachment
- Land-use change pattern
- Overgrazing/unregulated grazing practices
- Forest fire, slash and burn practices
- Overuse of chemical fertilizers and pesticides
- Landslide/flooding/natural hazards
- Steep slope cultivation
- Pollution and solid waste.

Forest Restoration and Rehabilitation initiatives

Policy Framework

- Conservation strategy of 1988(focus on sustainable use of land and natural resources).
- The master plan for the forestry sector 1989(aim conserve ecosystem, people's participation on natural recourses management, conserve genetic resources and contribute to the national economy).
- Nepal environmental policy and action plan 1993(environmental protection).

Forest Restoration and Rehabilitation initiatives

Policy Framework

- Revised Forestry sector, 2000(Block forest management in siwaliks and inner Terai).
- Nepal biodiversity strategy of 2002(biodiversity conservation, range land, agro-forestry, wetland and mountain areas for the benefit of the local people).
- Leasehold forest policy of 2002(provision of leasehold forestry in shrub land for industrial and pro-poor people).

Forest Restoration and Rehabilitation initiatives

Policy Framework

- National wetland policy of 2003.
- Herbs and non-timber forest products development policy 2004(conservation and development of NTFPs).
- Nepal Biodiversity strategy implementation plan of 2006, 13 projects.
- Multi-stake holder forestry programme.

Forest Restoration and Rehabilitation initiatives

- Plantation on degraded forest land at 48,706.9 ha(1992-1996, success rate was very poor).
- Research
- Education and Training
- Institutional capacity(Department of forest, Department of National Parks and wildlife conservation, Department of Soil Conservation and Watershed Management, Department of Forest Research and Survey and Department of Plant resources).

Financial Aspects

- Governmental Resources
- International Cooperation(UNDP, GEF, WWF, IUCN, ICIMOD, FINNKDA , JICA , IFAD, World Bank, ADB)
- NGO's Activities
- CBOs contribution
- Local clubs initiatives

Approaches to address forest degradation

- Payment for Environmental Services(PES)

(Hydropower projects, Hotels pay royalty to the Government, National Parks revenue to the local buffer zone committees)

- Carbon sequestration and REDD
- Landscape Approaches

o Terai Arc Landscape

o Sacred Himalayan Landscape

Future way forward

- Community based forest management approach
- Extension of protected areas
- Forest plantation programme
- Effective law enforcement
- Land use policy should be implemented
- Public Awareness

Barren hill in Central Nepal indicating the process of desertification

Stream bank erosion brought about by meandering river

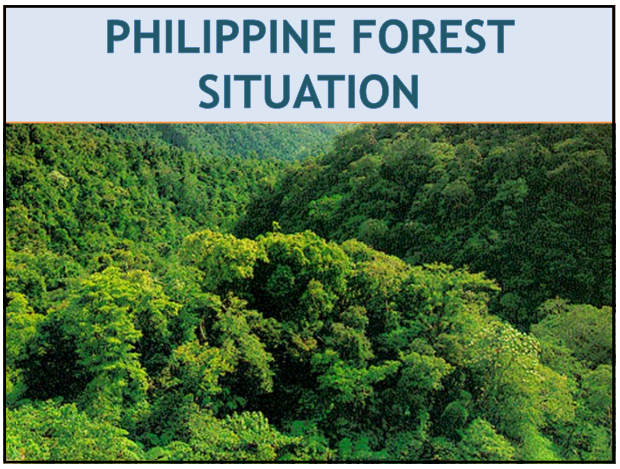
Application of Sloping Agricultural Land Technology for areas highly prone to erosion

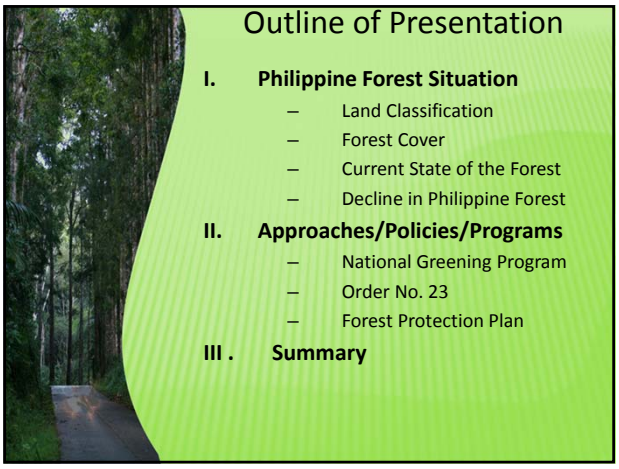
Mulching to preserve soil moisture

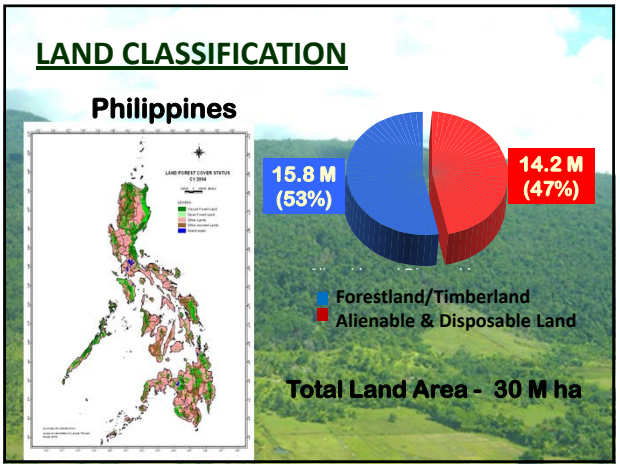
A famer in Nepal conserves the soil of his land by practicing a local method of minimum tillage (Photo S. Chakraborty)

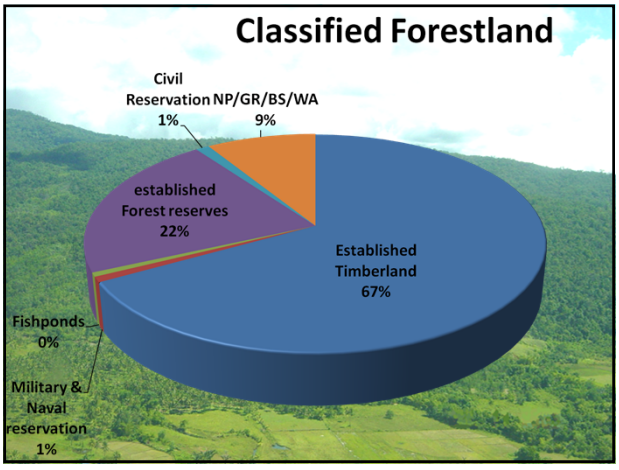
Thank you

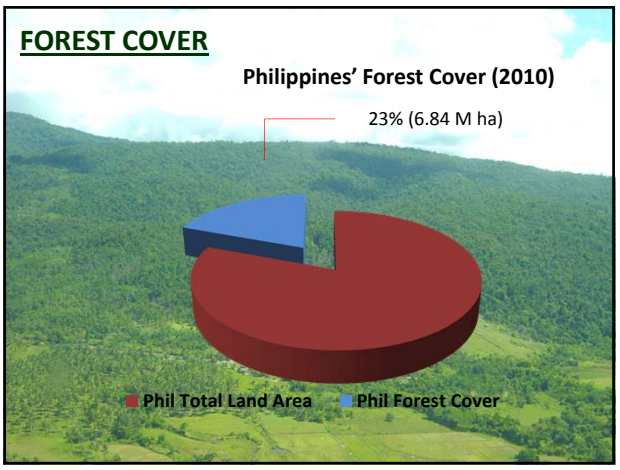
(7) Philippine: Forest Situation

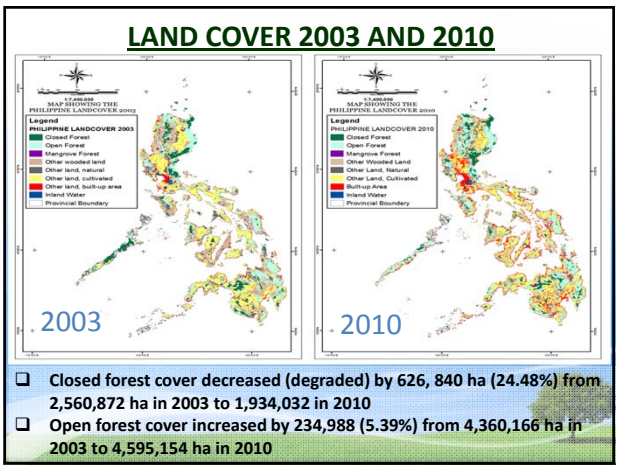






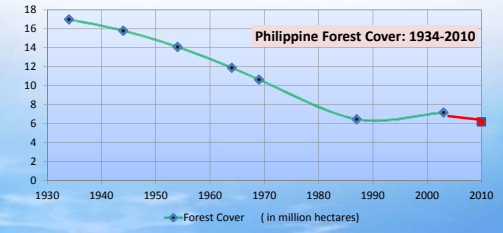






CURRENT STATE OF THE FOREST

Forest Cover change of the Philippines



- Forest cover decreased by 328,682 ha i.e. from 7,168,400 ha in 2003 to 6,839,718 ha in 2010 or an ANNUAL FOREST COVER LOSS of 46,954 ha.

Decline in the Philippine Forest cover

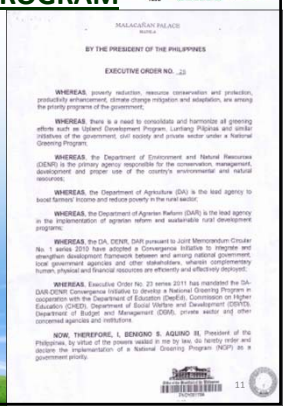
- continuous increase of the population in need of land for farming. (agricultural expansion)
- settlement due to upland migration and other land uses
- the over exploitation of timber and other non-wood forest products

Approaches/Policies/Programs towards Rehabilitation of Degraded Forest

NATIONAL GREENING PROGRAM

Background

- Executive Order No. 26 signed on February 24, 2011
- Guidelines issued on March 8, 2011
- Launched on May 13, 2011



MALACAÑAN PALACE

BY THE PRESIDENT OF THE PHILIPPINES

EXECUTIVE ORDER NO. 26

WHEREAS, poverty reduction, resource conservation and protection, productivity enhancement, climate change mitigation and adaptation, are among the priority programs of the government;

WHEREAS, there is a need to consolidate and harmonize all greening efforts such as Upland Development Program, Lumbang Pilipinas and similar initiatives of the government, civil society and private sector under a National Greening Program;

WHEREAS, the Department of Environment and Natural Resources (DENR) is the primary agency responsible for the conservation, management, development and proper use of the country's environmental and natural resources;

WHEREAS, the Department of Agriculture (DA) is the lead agency to boost farmers' income and reduce poverty in the rural sector;

WHEREAS, the Department of Agrarian Reform (DAR) is the lead agency in the implementation of agrarian reform and sustainable rural development programs;

WHEREAS, the DA, DENR, DAR pursuant to Joint Memorandum Circular No. 1 series 2010 have adopted a Convergence Initiative to integrate and strengthen development framework between and among national government, local government agencies and other stakeholders, wherein complementary human, physical and financial resources are efficiently and effectively deployed;

WHEREAS, Executive Order No. 23 series 2011 has mandated the DA-DAR-DENR Convergence Initiative to develop a National Greening Program in cooperation with the Department of Education (DepEd), Commission on Higher Education (CHED), Department of Social Welfare and Development (DSWD), Department of Budget and Management (DBM), private sector and other concerned agencies and institutions;

NOW, THEREFORE, I, BENIGNO S. AQUINO III, President of the Philippines, by virtue of the powers vested in me by law, do hereby order and declare the implementation of a National Greening Program (NGP) as a government priority.

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President Aquino Planting a Narra Tree during the NGP launching 2011 at DENR Compound in Quezon City

President Aquino Planting the 1 Millionth tree of the NGP

NATIONAL GREENING PROGRAM

Declaration of Policies

It is the policy of the State to pursue sustainable development for poverty reduction, food security, biodiversity conservation and climate change mitigation and adaptation.

NATIONAL GREENING PROGRAM

Coverage

The National Greening Program shall plant some 1.5 Billion trees covering about 1.5 Million hectares for a period of six (6) years from 2011 to 2016.

NATIONAL GREENING PROGRAM

YEAR	TARGET	
	HECTARE (ha)	SEEDLINGS
2011	100,000	100 M
2012	200,000	200M
2013	300,000	300M
2014	300,000	300M
2015	300,000	300M
2016	300,000	300M
total	1.5 Million hectares	1.5 Billion seedlings

NATIONAL GREENING PROGRAM

NGP: BEYOND REFORESTATION

OUR MISSION

- Food Security
- Poverty Reduction
- Environmental Stability
- Biodiversity Conservation
- Climate Change Mitigation & Adaptation

Bringing together agencies, efforts, people:

Convergence Works.

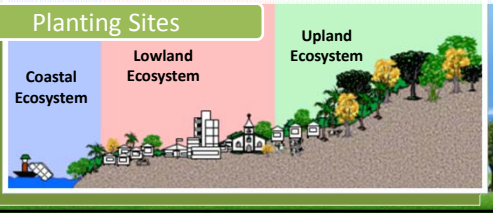
NATIONAL GREENING PROGRAM

NGP FRAMEWORK

Species

Species selection depends on objectives;
preferably indigenous/native/endemic species;
for the production zone: *Species- Site- Market Matching*
for the protection zone: *Indigenous/native/endemic species*

Planting Sites



NGP Accomplishment (2011-2013)

Year	Target Area (ha)	Area Planted (has)	Percent (%) Accomplishment of Area Planted	Number of seedling planted	Jobs Generated (No. Of POs, Extension Officers And Laborers Hired)	No. of Volunteer planters (POs, Students, NGAs , OGAs, NGOs, CSOs, Private Sector, Others)
Total	1,500,000	683,481	46%	397,769,713	1,182,764	1,574,741
2011	100,000	128,558	129%	89,624,121	335,078	715,552
2012	200,000	221,763	111%	125,596,730	380,696	387,472
2013	300,000	333,160	111%	182,548,862	466,990	471,717
2014	300,000					
2015	300,000					
2016	300,000					

NGP AREAS FOR DEVELOPMENT

- Forestlands
- Mangrove & PAs

NGP AREAS FOR DEVELOPMENT

- Ancestral domains

- Civil and military reservations

NGP AREAS FOR DEVELOPMENT

- Urban areas under the greening plan of LGUs

- Inactive and abandoned mine sites

NATIONAL GREENING PROGRAM

NGP Commodity Roadmap CY 2013 - 2016

Region	Timber	Fuelwood	Coffee	Cacao	Rubber	Bamboo	Rattan	Other Fruit Trees	Indigenous Species		Mangrove		Urban	Mixed Commodities*	Total
									Protection Forest	Protected Area	within PA	outside PA			
NCR												8			8
CAR	44,000	20,000	9,000	5,000	800	2,600	1,000	14,000	1,300	1,435					99,135
Region 1	8,000	20,000	1,000	2,000		5,000		4,000		850	510				41,360
Region 2	10,000	10,000	12,000	12,000	4,000	500	400	12,000		5,414	40	100			66,454
Region 3	10,000	15,000	5,000	5,000	4,000	10,000	5,000	10,000	10,000	18,004	75				92,079
Region 4	20,000	10,000	5,000	5,000	5,000	10,000	10,000	10,000		23,794	266	3,500			102,560
Region 4	20,000	15,000	5,000	5,000	5,000	1,000	1,000	20,000	13,000	3,399	14,119	5,000			107,518
Region 5	20,000	10,000	4,000	4,000		4,000	500	20,000	1,500	2,490	500	5,000			71,990
Region 6	20,000	5,000	1,000	1,000	800	1,000	2,000	8,000		6,000	600				45,400
Region 7	30,000	14,000	4,000	3,000	2,000	2,000	1,000	8,000	6,000	1,100	700	1,200			73,000
Region 8	15,000	15,000	5,000	5,000		4,000	5,000	15,000	4,000	50,400	500	4,000			122,900
Region 9	25,000	10,000	5,000	1,000	30,000	1,000	1,000	5,000	1,500	1,265	240	500			81,505
Region 10	20,000	5,087	2,000	2,000	8,200	2,000	1,000	5,000		5,844	31	300			51,462
Region 11	50,000	10,000	5,000	5,000	10,000			15,000		2,300	140				97,440
Region 12	25,000	20,000	10,000	2,000	25,000	10,000		15,000		3,735	189	300			111,224
Region 13	23,314	1,489	14,903	3,725	16,394	745		7,786	4,305			593			79,154
Subtotal	346,314	180,576	87,903	60,725	111,194	53,845	27,900	168,786	41,505	126,030	17,910	20,501			1,243,189
2011	47,711	1,542	2,554	1,477	5,675	571	78	9,741	7,867	2,535		1,315	1,250	46,242	128,558
2012	33,887	2,875	2,100	768	3,930	1,461	902	3,367	5,100	8,300	144	711	2,009	156,209	221,763
Total	774,226	365,569	180,460	123,695	231,993	109,722	56,780	350,680	95,977	262,895	15,964	43,028	3,259	202,451	2,836,699

Recommended by:

RICARDO C. CALDERON
Director, Forest Management Bureau
National Coordinator, NGP

ERNESTO D. ADOBO, JR.
Undersecretary
Staff Bureaus

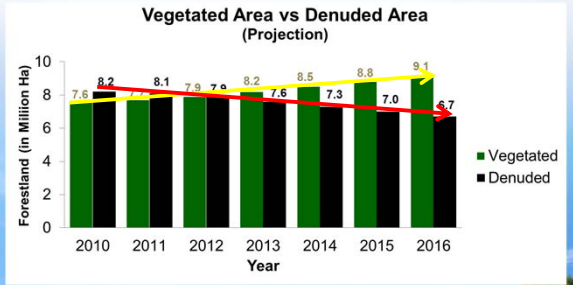
DEMETRIO J. IGNACIO
Undersecretary
Field Operations

MANUEL O. GEROCHI
Undersecretary
Policy and Planning

Approved by:

RAMON J.P. PAJE
Secretary

NATIONAL GREENING PROGRAM



- 12% increase in forest cover based on 2003 level (7.2 M hectares) with 85% survival

EXECUTIVE ORDER NO. 23

Issued on February 1, 2011

"Declaring a Moratorium on the Cutting and Harvesting of Timber in the Natural and Residual Forest and Creating the Anti- illegal Logging Task Force".

5-YEAR NATIONAL FOREST PROTECTION PLAN

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RATIONALE

- In 2011, E.O. 23 resulted in the identification of illegal logging hotspots areas covering **197 municipalities** in **51 provinces** nationwide.
- One year later, illegal logging hotspots were reduced to **31 municipalities** in **12 provinces**
- **Planted areas under NGP pursuant to E.O. 26,** to cover **1.5 M ha by 2016 shall be protected (683,481 ha as of** June 2013 NGP Report**).**
- **Some 3.717 M ha legislated protected areas under NIPAS system shall also be protected (**PAWB, 2012**).**

OBJECTIVES

1. Effective & efficient protection of the country's forests from destruction & degradation by providing full logistic & material support in the enforcement of forestry laws, rules & regulations;
2. Active involvement of various stakeholders, continued capacitate DENR field personnel & sustained undertaking of IEC campaign;
3. Effective pursuit & prosecution of criminal complaints filed in courts up to conviction; and
4. Improve forest cover to mitigate the negative impact of climate change

5-YEAR NATIONAL FOREST PROTECTION PROGRAM – A NEW APPROACH

- **new approach in preparing a forest protection and law enforcement plan described as *MENU OF OPTIONS Complete with Unit Cost* to have a clear direction for effective & efficient forest protection & forestry law enforcement.**
- **MENU OF OPTIONS ---List of Strategies with Sets of Activities for every Strategy to choose from.**
- **Provides immediate & Long Term Impacts as the ultimate goal of the National Forest Protection Program.**

MENU OF OPTIONS

MENU 1. Provision of full logistics & material support that are essential in forestry law enforcement

Use GIS & remote sensing technology in mapping & image interpretation for validation purposes

Avail the services of private companies for unmanned aerial vehicle (UAV) surveillance or DRONE, for updated, reliable and/or real time maps, data & information;

Acquire hauling trucks with boom or loading/ unloading capability, & Motorcycles.

MENU 2. Improvement of infra-structures, provision of institutional support in investigation, filing of information &/or criminal complaints & prosecution of forestry cases.

- Improve existing forest ranger stations &/or construct durable look-out towers (5mx6m) for safety & use by forest officers, that will also serve as ENR information Centers. Will be equipped with Close Circuit Televisions (CCTVs) & powered with solar panels
- effectively exchange relevant information with other CENROs & PENROs from other Regions relative to forest law enforcement & forest protection. **RADIO BASE & HANDHELD COMMUNICATIONS**

- Funds for traveling expenses of all forest officers involved in investigation & filing of information, complaints and those involved in the prosecution of forestry criminal cases in courts;
- Procure mapping equipment, surveillance software & subscription;
- Surveillance & continuous/regular foot patrol of identified hotspot areas;
- Involve forest communities in forest protection works by focusing on prevention & community organization.

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MENU 3. Active collaboration & involvement of forest communities, other stakeholders in forest protection & law enforcement undertakings

- Involve forest communities in forest protection works by focusing on prevention & community organization;
- Assist LGUs in the preparation of community forest protection plans forest fire management plan as social fencing mechanism;
- Encourage LGUs to issue ordinances/resolutions to support forest protection plan;

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MENU4. Undertake capacity building for DENR field personnel & enhance their skills & competence for effective protection of forests & plantations for biodiversity conservations

- Conduct orientation /para-legal training to DENR personnel involve in forest law enforcement
- Conduct trainings on forest fire management (prevention, detection and suppression); forest pest & disease management,
- Conduct small group & informal discussions in the upland communities.

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MENU 5. Sustained a well-planned *Information, Education & Communications (IEC) campaign* region-wide down to CENRO level

- **Advertise/publish thru print and broadcast media, even in internet;**
- **Develop video documentary featuring actual success stories of DENR & other partners in implementing forest law enforcement;**
- **Document activities in photos and similar media: writing & publicizing stories on best practices;**
- **Develop information materials i.e. motivational and instructional posters, primers, brochures, flyers;**

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MENU 6. Consistent *apprehension & mandatory administrative adjudication & confiscation of undocumented forest products including conveyances & implements*

- Apprehension of all illegally, cut, gathered, transported or possessed forest products including NTFPs, vehicles, equipment & other implements;
- Develop linkage with environmental law groups for cooperation, collaboration & possible legal assistance.
- Conduct immediate administrative & adjudication proceedings for apprehended forest products including conveyances & implements;

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MENU 7. Effective *Forest Fire, Pest and Disease Management* measures

- Monitor, assess, & undertake pest & disease control & management measure to avoid spread of forest pest & diseases.
- Train DENR personnel in detecting biological agents that cause forest destruction in both natural and forest plantations
- Identification & detection of forest pests & diseases in coordination with the research sector;

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MENU 8. Institute *Forest Certification and Timber Legality & Assurance Systems & other reforms*

- Reliable timber tracking system (*project funded by ITTO in progress*) – electronic or paperless tracking of timber using barcodes, plastic tags/labels, RFID (Radio Frequency Identifying Device)
- Forest Certification System - sustainable management of forest by following internationally accepted standards & principles in forest management.

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BUDGETARY REQUIREMENTS

YEAR	BUDGET (in Million Pesos)
1st (2015)	906.268
2nd (2016)	481.250
3rd (2017)	483.450
4th (2018)	485.871
5th (2019)	539.833
TOTAL	2,896.672

Summary

By the end of the Programs (NGP and Forest Protection), we will reverse our Forest areas from degraded areas to a more productive one. This will lead to increasing our forest cover from 24% to 30% of our land area.

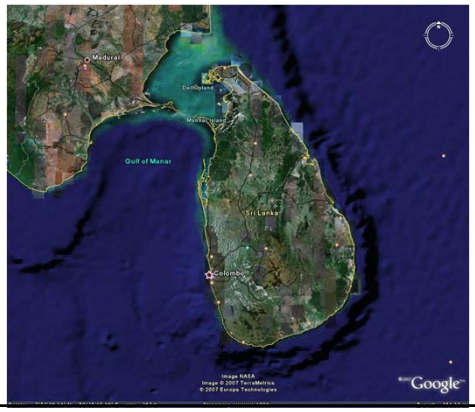
(8) Sri Lanka: Rehabilitation & Restoration of Forest in Sri Lanka

Rehabilitation & Restoration of Forests in Sri Lanka

Wasantha Dissanayake

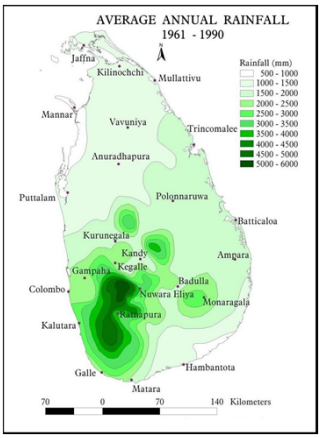
Forest Department
Sri Lanka

Sri Lanka



Sri Lanka

- Located in the Indian Ocean
  - 5^0 54" - 9^0 52" North Latitude
  - 79^0 39" - 81^0 53' East Longitude
- land area - 65,610 km^2
- Population - 20.3 million
  - Population Density - 311 people per km^2
- Literacy rate > 90%
- Per Capita Income - US$ 2400



Climate

Tropical Monsoonal

Rainfall

800 mm to over 5,000 mm

Temperature

on average 27 °C at lowlands

Climatic Zones

Average temperature

Dry zone : 28 °C
Intermediate : 24 -26 °C
Wet zone : 24 °C

Average Rainfall

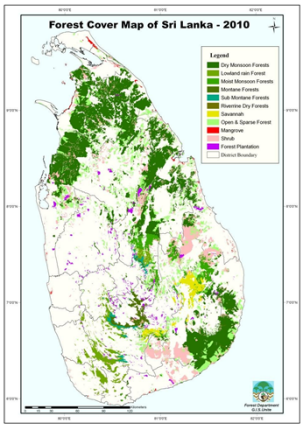
Dry zone : 1,300 - 1,750mm
Intermediate : 1,750 - 2,500mm
Wet zone : > 2,500mm
Arid zone: 900 – 1,300mm

Altitudinal Zones of Sri Lanka

Altitudinal Zone	Altitude (m)
Low country	0 – 300m
Mid country	300 – 900m
Up country	900 – 1500m
Montane zone	> 1500m

A Biodiversity Hot Spot....

- Flora (Angiosperms) – 3368 species, 875 endemic
- Fauna;
  - Land snails - 266 species, 201 endemic
  - Butterflies - 243 species, 20 endemic
  - Fresh water fish - 78 species, 32 endemic
  - Amphibians - 54 species, 35 endemic
  - Reptiles - 155 species, 81 endemic
  - Birds - 435 species, 28 endemic
  - Mammals - 90 species, 14 endemic



Forest Cover

- Dense Forest Cover – 23%
- Sparse Forest Cover – 7%
- Natural Forests - Ω 2,000,000Ha
- Forest Plantations - Ω76,000 ha
- Forest Department - 1,064,000Ha
- Wildlife Department - 782,000Ha

Forest Category	Criteria
Dry Mixed Evergreen Forests	Dense forests located below 1000m msl. with rainfall 1300 - 1850mm
Moist Mixed Evergreen Forests	Dense forests located below 1000m msl. with rainfall 1850 - 2500 mm
Lowland Wet Evergreen Forests	Dense forests located below 900m msl. with rainfall 2500 – 5000mm
Mid-elevational Evergreen Forests (Sub Montane)	Dense forests located in between 900 – 1500m msl With rainfall 1750 - 2600
Montane Evergreen Forests	Dense forests located above 1500m msl. With rainfall about 2000mm
Dry Riverine Evergreen Forests	Rich vegetation associated with river banks in dry and intermediate zones.
Sparse and Open Forests	Anthropogenic modification of dense forests
Mangrove Forests	Coastal evergreen woodlands associated with lagoons and estuaries
Dry Deciduous Thorn Scrub Forests	Climatic climax vegetation in semi-arid zone With rainfall 900 – 1300 mm
Tropical Savannah	Open savannah with scattered trees in grasslands With rainfall 1400 – 2000mm

Forest Category	Extent (ha)	Percentage of total land area
Dry Mixed Evergreen	1,121,392	17.09
Moist Mixed Evergreen	117,885	1.79
Lowland Wet Evergreen	123, 302	1.87
Mid-elevational Evergreen (Sub Montane)	28,513	0.43
Montane Evergreen	44,758	0.68
Dry Riverine Evergreen	2,425	0.04
Sparse and Open	429,485	6.55
Mangrove	15,669	0.24
Tropical Savannah	68,043	1.04

Dry mixed evergreen forests

Av. Temp. – 27 -28°C

Av. Rainfall – 1300 – 1800mm

- Seasonal with marked dry spell

Mostly Secondary forests

Emergent

- *Manilkara hexandra, Scleichera oleosa*
- *Chloroxylon swietenia, Berrya cordifolia*

Canopy (20 – 25m high)

- *Drypetes sepiaria, Diospyros ebenum*
- *Mitragyna parvifolia, Vitex altissima*

Sub Canopy

- *Diospyros ovalifolia, Pleurostylia opposita*
- *Lepisanthes tetraphylla, Cassis fistula*

Moist mixed evergreen forests

Av. Temp. – 20 -25°C
Av. Rainfall – 1800 – 2500mm

Mostly in the intermediate zone

Canopy (15 -20m high, contiguous)

Known as transitional (ecotone) forests between DMEF and LWEF
Diverse plant communities governed by mesoclimatic variations

Wet – *Artocarpus nobilis, Felicium decipiens, Mangifere indica*

Intermediate – *Vitex altissima, Chukrasia tabularis, Ficua collas*

Dry – *Schleichera oleosa, Chloroxylon swietenia, Diospyros affinis*

Lowland wet evergreen forests

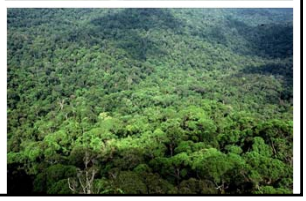
MAT. :28°C
MAR: 2300 - 5000mm
- without any dry period
Humidity : 75% - 80%

Includes undisturbed virgin forests

Emergent (up to 45m high)
- *Shorea dyeri, shores stipularis Doona congestiflora, Doona afinis*

Canopy (about 30m high)
- *Doona trapezifolia, Dipterocarpus zeylanica, Dipterocarpus hispidus, Palaquium petiolare, Mesua pulchella*

Sub Canopy
- *Cullenia zeylanica, cullenia rosayroana, Bhesa ceylanica, Callophyllum bracteatum, Callophylum thwaitesii, Mastixia tentandra*



Mid-elevational evergreen forests

MAT. : 18 - 23°C
MAR: 1750 - 2600mm
- without any dry period
Elevation: 900 – 1400m
- in the three general mountain massifs

Transitional vegetation type between LWEF and MOEF

Emergent (up to 30m high, rare)
- *Doona gardneri, Doona zeylanica*

Canopy (15 - 20m high)
- *Elaeocarpus glandulifer, Myristica dactyloids, cryptocarya wightiana, Palaquium hinmolpedde Fahrenheitia zeylanica, Syzygium gardneri Semicarpus nigro-viridis*

Sub Canopy
- *Nothopegia beddomei, Hortonia floribunda Acronychia pedunculata, Celtis cinnamomea*

Montane evergreen forests

MAT. : 15 - 16°C
MAR: about 2000mm
- without any dry period
Relative Humidity: > 80%
Elevation: above 1500m
- in the Central highlands and Knuckles
Cool conditions and abundant mist

Canopy (8 - 15m high)
- *Callophylum walkeri, Michelia nilagirica, Cinnamomum ovalifolium, Niolitsea fuscata Adinandra lasiopetala, Mastixia montana Elaeocarpus coriaceus*

Sub Canopy
- *Actinodaphne spp. Symplococ spp. Syzygium spp. Glochidion pycnocarpum Acronychia pedunculata, Eurya spp*

Mangrove forests

MAT. : 30 – 35 °C
Relative Humidity: 80 - 90%

Associated with lagoons and estuaries

Saline conditions and clay soils

True Mangroves (23 species in SL)
- *Rhizophora spp, Bruguiera spp, Avicennia marina, Excoecaria agallocha, Sonneratia caseolaria, Lumnitzera racemosa,*

Mangrove Associates
- *Acanthus illicifolia, Clerodendrum inerma, Thespesia populnea, Hibiscus tiliaceus, Cerbera odollam, Dolchandrone spathacea, Ardisia elliptica, Tamarix indica*

Tropical savannah

MAR : 1400 – 2000 mm

Generally in lowland Intermediate zone, up to an altitude of about 500m
Grassland/woodland mosaic
Subject to regular (anthropogenic) fires

Tree Species
- *Careya arborea, Terminalia chebula, Terminalia bellirica, Anogeissus latifolia, Pterocarpus marsupium, Phyllanthus emblica, Diospyros melanoxylon, Acacia chundra, Ficus arnottiana, Haldinia cordifolia*

Grass species
- *Cymbopogon polyneuros, Cymbopogon nardus, , Themeda triandra, Heteropogon triticeus, Aristida setaces, Imperata cylindrica, Panicum maximum*

Dry deciduous evergreen forests

MAR : 900 - 1300mm
- with long dry spell from Feb – Sept.

Regarded as a climatic climax ecosystem in rainfall deficit arid (semi-arid) zone

Forests are low (3-6m) open to close un-stratified woodlands dominated by thorny species

Deciduous Trees
- *Chloroxylon swietenia, Sapindus emarginata, Crateva adansonii, Cordia gharaf, Cordia monoica, Sapium insigne, Premna tomentosa,*

Evergreen Trees
- *Manilkara hexandra, Drypetes sepiaria, Strychnos potatorum, Lepisanthes tetraphylla, Limonia acidissima, Salvadora persica.*

Forest Degradation

Major Causes
- Poverty & Landlessness
- Poor Land Tenure System
- Shifting Cultivation
- Large-scale Projects
- High Demand for Forest Products
- Fire
- Other Natural Calamities

National forestry policy - 1995

Objectives;
- To conserve forests for posterity, with particular regard to biodiversity, soils, water, and historical, cultural, religious and aesthetic values.
- To increase tree cover and productivity of the forests to meet the needs of present and future generations for forest products and services.
- 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

Policy on management of state forest resources

2.1 All state forest resources will be brought under sustainable management both in terms of the continued existence of important ecosystems and the flow of forest products and services.

2.3 The natural forests will be allocated firstly for conservation, and secondly for multiple use production forestry.

2.5 The establishment and management of industrial forest plantations on the state lands will be entrusted progressively to local people, rural communities, industries and other private bodies, in pace with institutionalizing environmental safeguards.

Forest Restoration

Major Silvicultural Approaches....
- Assisted Natural Regeneration
- Enrichment Planting
- Forest Plantation Establishment
- Agro Forestry

Forest Restoration....

Implementation Mechanisms

- Block Reforestation
- Block Planting by Local Organizations
- Social Forestry Approaches
- Private Sector Leasehold Reforestation
- Forest Plantation as an Investment Scheme

Social Forestry Approaches...

- Taungya/Co-operative Reforestation/ Village Reforestation
  - State lands leased out to farmers for 3-4 years
  - Agroforestry permitted
  - Four cash payment contingents
- Farmers' Woodlots
  - State lands leased out for 25 years
  - Inter-cropping encouraged
  - Incentives provided
  - Harvesting rights ensured

Private Sector Involvement...

- Private Sector Leasehold Reforestation
- Forest Plantation as an Investment Scheme

Issues & Challenges.....

- Increasing population vs. limited forest resources
- Pressure on arable lands
- Long Planning Horizon
- Legislative and Administrative Reforms
- Changing attitudes
- Effectively Involving non-state sector

Partnership as a basic Forestry Development Strategy.....

✓The State
✓Local Resource Users
✓Local Organizations
✓Private Sector Groups
✓NGOs

Action Needed....

✓From the state side.....
- At the political level
- At the institutional level
- At the forestry officer level

✓From the non-state partners.....
- community level
- private sector level
- NGO level

Thank you

(9) Thailand: Development of an Integrated Forest Management in Thailand

Introduction

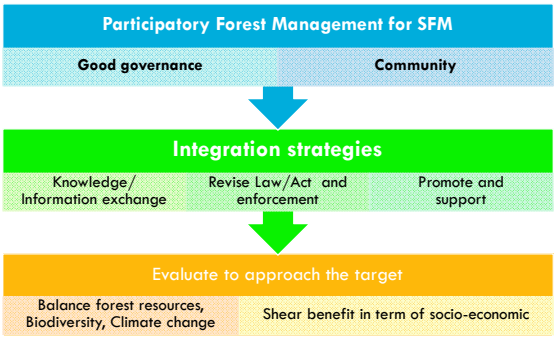
- land area at 51.3 million ha.
- Thailand's economy is predominantly agricultural and 70 percent of the populations earn their living in agricultural or related enterprises.
- In the past most timber exporter country.
- Devastating tropical depression caused flashfloods, pocket landslides and thousands of slope failures in the southern part.
- illegal timber cutting in the mountains as a partial reason for the catastrophe.

Crisis & situation

Changing of Forest Management

- In 1989,Royal Thai Government (RTG) to impose a nation wide logging ban
- Prohibited timber exploitation in nature forests.
- This was a turning point for forest management and planning.
- Timber harvesting rights were revoked.
- The remaining forests have been managed for protection and conservation.

Forest Policy



Forest Policy

- To reap social, economic, stability and environmental benefits.
- to maintain the total forest areas for at least 40% of the country area
- These forest areas were further divided into 25% for conservation forests and 15% for economic forests.

Legal Framework

The Ministry of Natural Resources and Environment (MONRE) is responsible for the natural resources and environment of the country.

1. To balance between the conservation and the utilization of the natural resources in conformity with the sustainable development approach
2. To manage the sustainable and fair utilization of biodiversity
3. To manage the water resources by integrating into watershed systems
4. To manage and develop the natural resources and environmental quality by the participation and integration at all levels.

Ministry of Natural Resources and Environment

Primary organizations

- Royal Forest Department (RFD)
- Department of National Parks, Wildlife and Plant Conservation (DNP)
- Department of Marine and Coastal Resources (DMC)
- 75 Provincial Natural Resources and Environment
- Forest Industry Organization
- Thai Plywood Company Limited

Supporting organizations

- Office of Natural Resources and Environmental Policy and Planning
- Pollution Control Department
- Department of Environment Quality Promotion
- 75 Provincial Natural Resources and Environment Offices

Responsibility for Forest Management

- RFD, DNP and DMC share responsibilities in forest resources management of the country.
- RFD is responsible for managing forest resources outside protected areas.
- DNP looks after forest resources in protected areas.
- DMC performs resource management of marine and coastal flora and fauna, including mangrove forests.

Forest laws

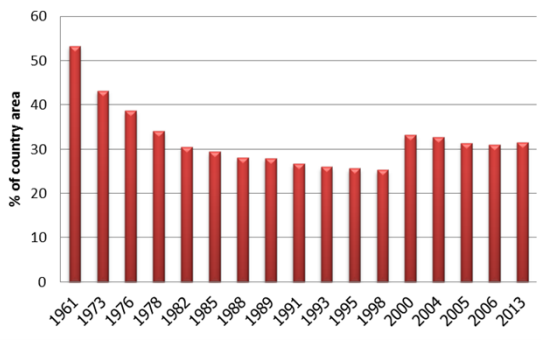
At present, there are six forest lows being employed to regulate the forest activities

- 1. Forest Act B.E. 2484 (1941) and subsequent amendment B.E. 2532 (1989)
- 2. National Park Act B.E. 2504 (1961)
- 3. National Reserve Forest Act B.E. 2507 (1964) and subsequent amendment 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)
- 6. Chainsaw Act B.E. 2545 (2002)

Forest Area

- Northern and Northeastern region: Tropical mountain evergreen forest, Coniferous forest, Mixed deciduous forest, and Dry dipterocarp forest
- Central and East region: Mixed deciduous forest and Mangrove forest
- Southern region: Tropical moist evergreen forest, Mangrove forest and Swamp forest

Forest Area



Forest Resources

- The total forest cover in Thailand (2006) was estimated at 15,865,260 hectares. representing about 30.92% of total land area.

  Forests in Thailand can be classified into two main types:

1. Evergreen forest:

   Tropical evergreen forest, Coniferous forest , Swamp forest and Beach forest

2. Deciduous forest1:

   Mixed deciduous forest , Deciduous dipterocarp forest or dry dipterocarp forest and Savanna forest

Evergreen forest

Evergreen forest consists largely of evergreen trees that retain green foliage throughout the year

Evergreen forest

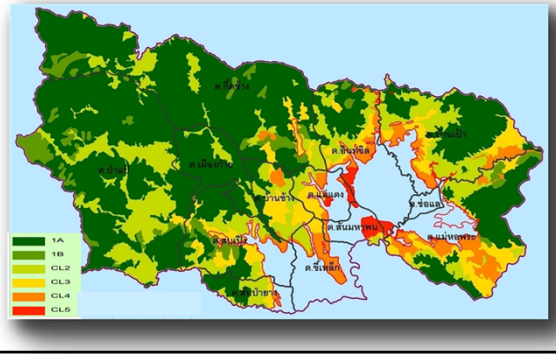
Evergreen forest

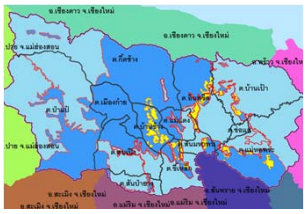
Deciduous forest

Forestry Activities

- Forest Conservation
- Forest Plantation
- Forest Production
- Watershed Management
- Forest Protection
- People's Participation

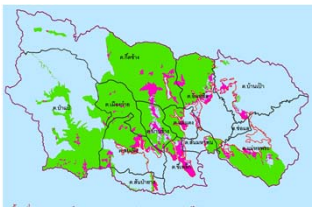
Integrated Technique Management





National Forest Reserves

Deteriorated reserve forest as resolute by the cabinet for the agricultural land reform



National Forest Reserves

Landowner right

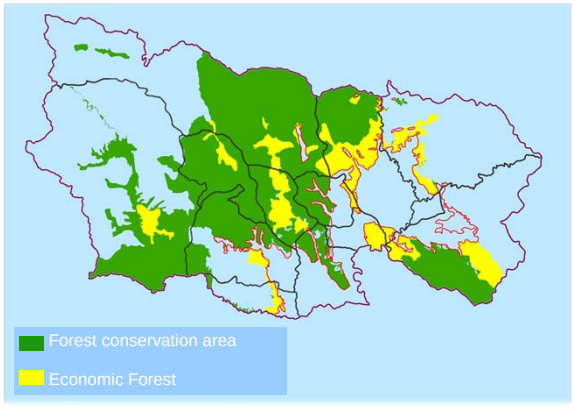
Forest Conservation

- to manage the forest resources for sustainable benefits to people and communities
- to maintain the balance of ecosystem and environment.
- forest conservation areas: national parks, wildlife sanctuaries, no hunting areas, forest parks, biosphere reserves, watershed area, botanical gardens and arboretums

Forest Plantation

RFD set up the reforestation program consist of

- Commercial plantations,
- Watershed improvement plantations,
- Restoration of degraded reserved forests,
- Plantations for environmental conservation
- Plantations for the Royal Initiative Projects.



Commercial plantation

Teak products

Commercial plantation

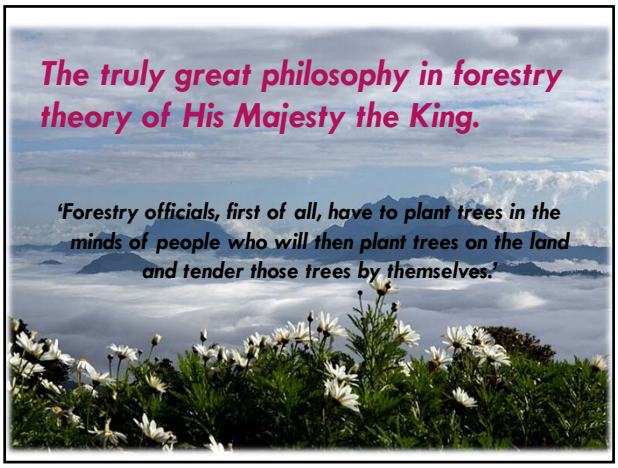
Commercial plantation

Sustainable Forest Management (SFM)

- To maintain and enhance the economic, social and environmental value of all types of forests, for the benefit of present and future generations.
- To collaborated with other countries and international organizations

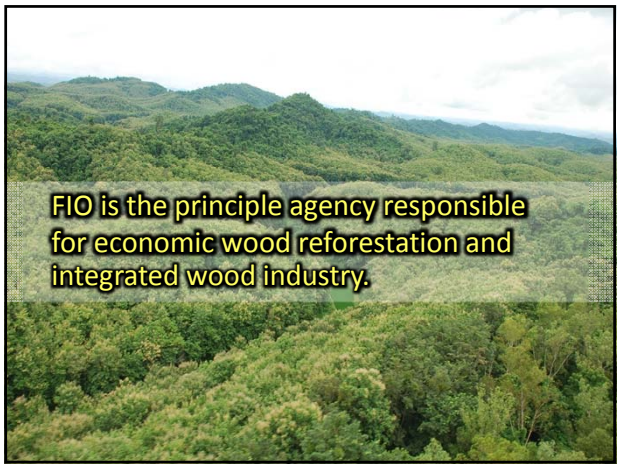
Thailand has to manage as following:

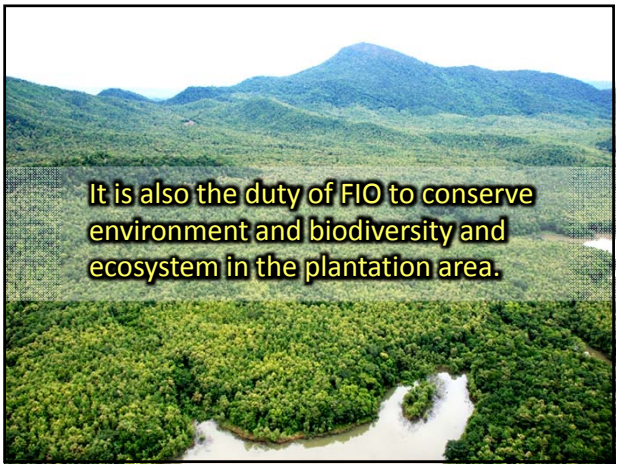
- considering ASEAN Regional Criteria and Indicator for Sustainable Management of Natural Tropical Forests to be as Thailand SFM,
- providing special RFD unit to take responsibility for the Online Monitoring, Assessment and Reporting (MAR) Systems of Sustainable Forest Management
- Carbon stocks to be collected for reporting to MAR.

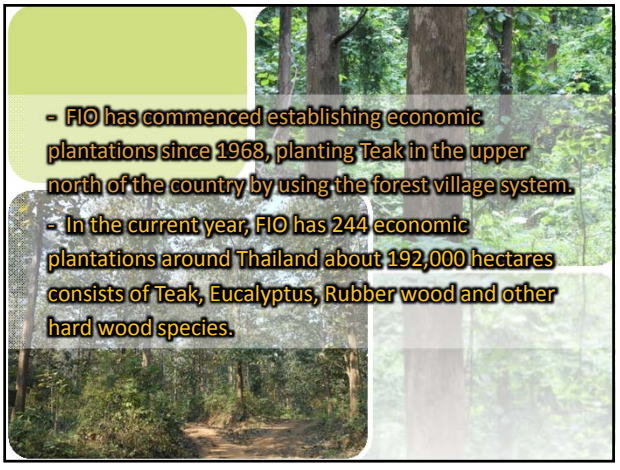

The truly great philosophy in forestry theory of His Majesty the King.
'Forestry officials, first of all, have to plant trees in the minds of people who will then plant trees on the land and tender those trees by themselves.'

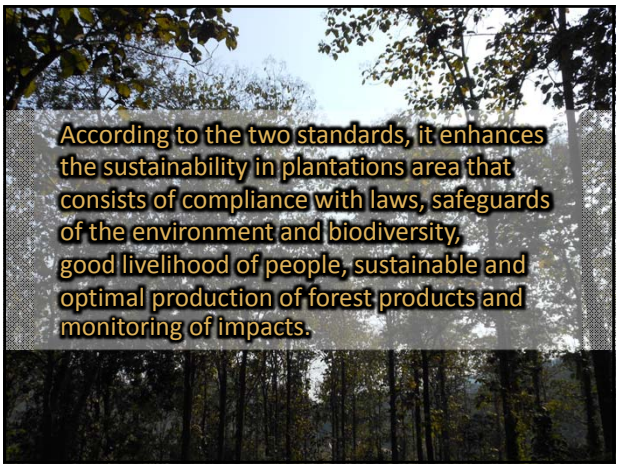

THANK YOU
Utharat Pupaiboon
Royal Forest Department
Ministry of Natural Resources and Environment
Bangkok , Thailand

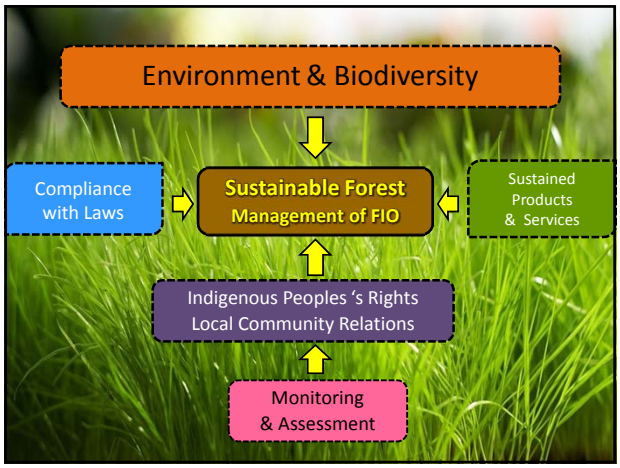
(10) Thailand:The Degraded Forest Rehabilitation and Sustainable Forest Management:SFM Activities in Forest Industry Organization in Thailand

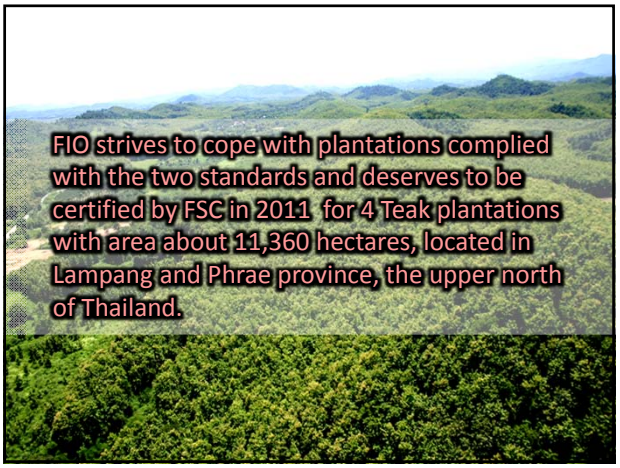






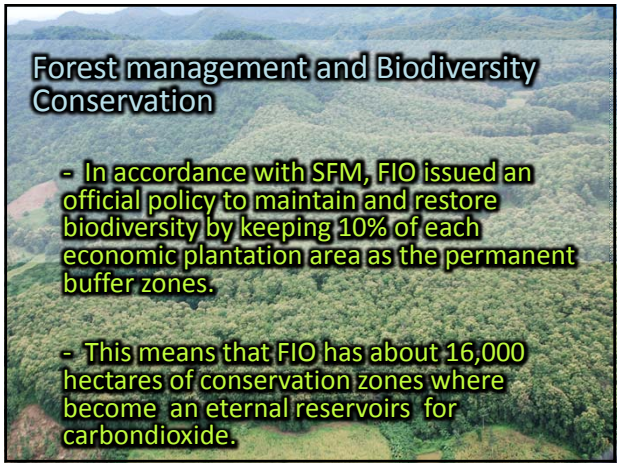

According to the two standards, it enhances the sustainability in plantations area that consists of compliance with laws, safeguards of the environment and biodiversity, good livelihood of people, sustainable and optimal production of forest products and monitoring of impacts.


Environment & Biodiversity
Compliance with Laws
Sustainable Forest Management of FIO
Sustained Products & Services
Indigenous Peoples 's Rights Local Community Relations
Monitoring & Assessment


FIO strives to cope with plantations complied with the two standards and deserves to be certified by FSC in 2011 for 4 Teak plantations with area about 11,360 hectares, located in Lampang and Phrae province, the upper north of Thailand.


FSC certified Teak Plantations under FIO Thailand

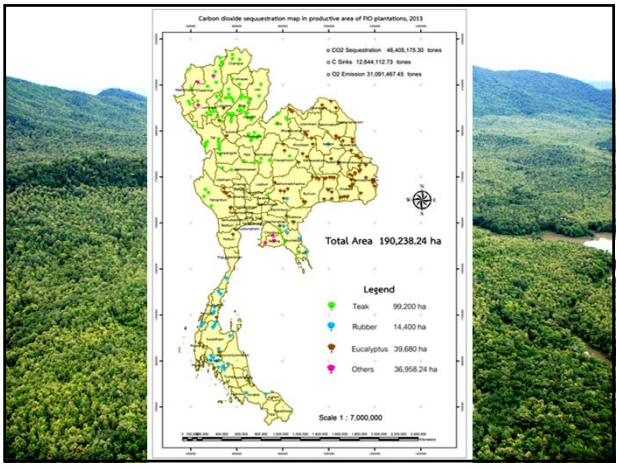

FSC Certificate for FIO 's Plantations
The Rainforest Alliance
FOREST INDUSTRY ORGANIZATION (FIO)
75 RAJ-DAMNERNNOK AVENUE, POMPARP DISTRICT
BANGKOK 10100
THAILAND
IS CERTIFIED FOR FOREST STEWARDSHIP COUNCIL FOREST MANAGEMENT AND CHAIN-OF-CUSTODY
Certificate Scope
Certificate Type: Multiple FMU Forest Management and Chain-of-Custody
Standard(s): Rainforest Alliance/SmartWood Interim Standard for Assessing Forest Management in Thailand
Product group(s): Logs
Valid from August 1, 2011 to July 31, 2016
Certificate Registration Code: SW-FM/COC-005553
FSC License Code: FSC-C103665
Certificate Issue Number: IN-2011-1
Additional details regarding the scope, including a full list of products and species, are available at info.fsc.org.
Jon Jickling, Director
SmartWood Program of the Rainforest Alliance
65 Millet Street, Suite 201, Richmond, Vermont, USA 05477
RAINFOREST ALLIANCE IS AN ACCREDITED FSC CERTIFICATION BODY
FSC

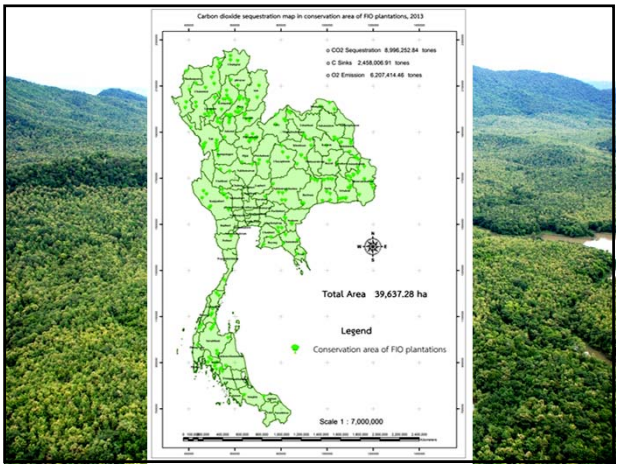

Forest management and Biodiversity Conservation
- In accordance with SFM, FIO issued an official policy to maintain and restore biodiversity by keeping 10% of each economic plantation area as the permanent buffer zones.
- This means that FIO has about 16,000 hectares of conservation zones where become an eternal reservoirs for carbondioxide.

Forest management and Biodiversity Conservation

Conservation zones in project plantations can be categorized as:

- Stream bank
- High Conservation Value forest
- Key habitat area
- Wetlands and water
- Semi-natural forest
- Edge zone
- Outer boundary zone





In addition, FIO also declared the compulsory policy to conserve ETERNITY TREE in plantation area such as:

- Rare, threatened and endangered species
- Very old trees
- Very big trees
- Fruit trees
- Wildlife sanctuary trees

Challenges

The way forward, FIO will be the for-runner of the economic wood business plantation- based which all of 244 plantations will be certified by both FIO local standard or FSC international standard of SFM within the year 2020.

Forest Policies for the Next Decade

FIO plantations have to be managed under the 5 elements of the best practice of sustainable forest management which are:

1) Compliance with laws
2) Safeguards of environment and biodiversity
3) Good livelihood of local people
4) Sustainable yield
5) Monitoring of impacts

PES Project needs for cooperation

- FIO now is seeking cooperation from abroad to establish PES project in FIO plantation called Thungkwian plantation located in Lampang province, the upper north of Thailand about 1,000 hectares.
- The conceptual idea of the project is to convert from logged forest to conservation forest for environment, biodiversity and eco system conservation and also for elephant sanctuary in the future.
- The project period is from 10-25 years.

FIO Action Plans for SFM

FIO Implementation for SFM

The productive units in each FIO regional offices should be followed up and try their best in strengthening the out-come and out-put of each regional 244 plantations for the whole country.

Focusing on:

- Document review and data collection,
- Set up of procedures and systems,
- Site inspection & field preparation,
- Participatory of environment and social impact assessment with stakeholders,
- Impacts monitoring,
- Auditing.

Economic Values Enhancement

- Sustained and optimal production of forest products
  - Management plantation,
  - Sustained yield of forest products,
  - Monitoring the effects of management,
  - Protection of the forest from illegal activities,
  - Optimizing benefits from the forest.

Economic Values Enhancement (con.)

- Extra considerations
  - Plantation planting,
  - Species selection,
  - Soil and site management,
  - Pest and disease management,
  - Conservation and restoration of natural forest cover.

Environmental Values Enhancement

- Protecting the environment
  - Environmental impact assessment,
  - Conservation of biodiversity,
  - Ecological sustainability,
  - Avoid using of chemicals,
  - Waste management.


Enhancement of Social Values
Well-being of people
Consultation and participation processes,
Social impact assessment,
Recognition of rights and culture,
Relations with employees,
Contribution to development


THANK YOU

(11) Viet Nam: Restoration and Sustainable Management of the Forest Ecosystem in the Central highlands in the Period 2013-2020, Vision 2030

MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT
VIETNAM ADMINISTRATION OF FORESTRY

PROJECT

RESTORATION AND SUSTAINABLE MANAGEMENT OF THE FOREST ECOSYSTEM IN THE CENTRAL HIGHLANDS IN THE PERIOD 2013-2020, VISION 2030

Introduction

- Western Highlands is one of the regions of Vietnam containing the provinces of Dak Lak, Dak Nong, Gia Lai, Kon Tum and Lam Dong with 5,462,666 ha of the total natural area.
- Its differences in geography, topography, climate and soil have created the typical forest ecosystems diversifying the forms of floras and faunas.
- Western Highlands has over 224 families of 1200 genera and 4.500 species.
- Western Highlands forests have been degraded due to many different causes:
  - Conversion of forestland to agriculture use (particularly to industrial perennial crops)
  - Unsustainable logging (notably illegal logging),
  - Agricultural expansion by people migrating to forested areas,
  - Infrastructure development

I. THE CURRENT STATUS, OBJECTIVES AND TASKS

1. The current status of protection and management of the forest ecosystem in the Central Highlands

The forest protection and management in the Central Highlands are shown in the following aspects:

- The protection of forests.
- Sustainable management and logging of forests, including: operating the sustainable forest management model with international standards; building plans for sustainable forest management and control; managing the processing manufactories.
- Performance of forest companies, boards of the protection forest management and boards of special-use forest management.
- Implementation of rubber tree plantation.
- Implementation of policies of payment for forest ecosystem services.

I. THE CURRENT STATUS, OBJECTIVES AND TASKS

- The total forest area in the Central Highlands was 2903803 ha, the cover of the whole area was 52.94% in 2013.
- Within 5 years (2007-2011), the forest area lost was 129,686 ha, of which 107,425 ha of natural forests and 22,261 ha of forest plantations.
- The forest quality (especially the quality of natural forests) had been significantly decreased. Forests of high quality and large volume remained unremarkable (rich forests constituted only 16%), and were special-use forests concentratively.
- Forests recently restored by natural regeneration were young forests primarily, of which the value of biodiversity, the ability of supplying forest products, and the protection function were low.

I. THE CURRENT STATUS, OBJECTIVES AND TASKS

Central Highlands is the hotspot of violating Law on forest protection and management in the whole country. From 2008-2012, there were 8643 cases of illegal deforestation discovered in here. The management of the forestry revealed many weaknesses:

- Severe deforestation taking place in many localities had caused a sharp decline of the forest quality.
- forestry companies had operated inefficient. Many of them were on the brink of bankruptcy.
- A large number of processing plants nearby forests, of which implementation were unplanned, not associated with a stable source of raw materials, and lack of efficient and regular management, had organized collections of woods and become places of illegal wood consumption.
- Boards of protection forest management and boards of special-use forest management were incompetent to protect their forests.

I. THE CURRENT STATUS, OBJECTIVES AND TASKS

2. Objectives

- Protect and restore the existing forest ecosystem; effectively and sustainably use the forest resources and the land fund for forestry planning.
- Increase the forest cover to 55% by 2020; increase the productivity, quality and overall value of forests.
- Create jobs, promote forest-based livelihoods, contribute to hunger eradication and poverty reduction; ensure security and defense.

I. THE CURRENT STATUS, OBJECTIVES AND TASKS

3. Tasks

3.1. In the period: 2013-2020

a. Protection of forests

- Protect, restore and develop sustainably 2.889 million ha of forest.
- Reduce ultimately violations of Law on forest protection and management; promote effectively protection functions, protect the ecological environment and the biodiversity of the forest ecosystem.
- Protect, regenerate unoccupied lands of regenerating trees to increase the forest area and cover.
- Strictly protect regions of genetic resources of rare and valuable plant and animal species.
- Encourage all individuals, organizations and all economic sectors in participation of protection and management contracts.
- Strengthen forest rangers, forest fire prevention, functional subdivisions of special-use forests and responsibilities of administrations of communes.

I. THE CURRENT STATUS, OBJECTIVES AND TASKS

b. Development of forests

- Increase the productivity and quality of natural production forests with 1.6 million ha of a permanent forest stand.
- Increase the productivity and quality of 302,091.6 ha of existing plantations.
- Plant 9,342 ha of protection forest.
- Plant special use forests.
- Afforesting on forestland conversed to other uses.
- Nurture forests after logging; nurture poor forests and young forests restored after hill farming; facilitate the growth and development of generating trees.
- Annually naturally regenerate 14,669 ha of special-use and protection forest on unoccupied lands of regenerating trees.
- Improve natural production forests to plant 100,000 ha of economic plantation on the poor dipterocarp forestland.
- Enhance the movement of scattered tree planting in organizations, agencies, schools, local communities and households.

I. THE CURRENT STATUS, OBJECTIVES AND TASKS

3.2. Vision 2030

- Protect, restore and sustainably develop 3,113 million ha of the existing forests area.
- Continue to protect the unoccupied land area of regenerating trees to increase the forest area and cover.
- Continue to contracts around 25-30% of the existing natural forest area on the protection and special-use forestland, and about 10% of the existing natural forest area on the production forest land.
- Continue to improve the productivity and quality of natural production forest.
- Continue on the care and cultivation of protection and production forests to increase the forest cover, and continue plant headwater forests on large river basins, critical sectors at high risk of landslides, flash floods, and the border corridor regions.
- Plant special-use forests: primarily plant native trees to renovate landscapes and to upgrade botanical gardens.
- Afforesting on forestland conversed to other uses, such as hill farming land…
- Continue to foster forests after logging; foster poor forests and young forests restored after cultivating; facilitate the growth and development of generating trees.
- Promote the movement of scattered tree planting in organizations, agencies, schools, local communities and households.

II. CONTENTS AND SOLUTIONS

1. Contents of restoration and sustainable management of the forest ecosystem in the Highlands in the period 2013-2020, vision 2030

1.1. Forest protection

- Protect, restore and sustainable develop 2.889 million ha of the existing forest area, consisting of 640,900 hectares in Dak Lak province, 285,200 ha in Dak Nong province, 719,800 ha in Gia Lai province , 665,200 ha in Kon Tum province and 578,300 ha in Lam Dong province.
- Forest protection contracts: in the period 2013-2020, contract 20% of the natural forest area equivalent to the average area of 200,274 ha per year of special-use and protection forest lands, including 94,342 ha per year of natural forests on use-special forest lands (account for 47% of total area of contracted forestland) and 105,932 ha per year of natural forests on protection forestlands (about 53% of the total area of contracted forestland).

II. CONTENTS AND SOLUTIONS

1.2. Forest Development

- Improve the productivity and quality of natural production forests with 1.6 million ha of a permanent forest stand.
- Increase the productivity and quality of 302,091.6 ha of existing plantations.
- Plant production forests.
- Plant protection forests.
- Plant special-use forests.
- Afforesting on forestland conversed to other uses.
- Nurture forests after logging; nurture poor forests and young forests restored after hill farming; facilitate the growth and development of generating trees.
- Annually naturally regenerate 14,669 ha of special-use and protection forest on unoccupied lands of regenerating trees.
- Improve natural production forests for economic plantation.
- Enhance the movement of scattered tree planting in organizations, agencies, schools, local communities and households.

II. CONTENTS AND SOLUTIONS

1.3. Synthesis of investment and labor demand:

a. Synthesis of investment

- The total expected investment demand in Central Highlands in the period 2013 - 2020 will be about 6,153.3 billion Vietnam dong, of which the state budget will be 789 billion dong, accounting for 12.8% of total investment; the remains will be around 5,364.3 billion dong, accounting for 87.2% of total capital investment.
- The average capital investment of the whole region will be about 879 billion/year, including about 1.758 billion in the period 2013-2015, accounting for 28.6% of the total projected investment needs; and about 4395.2 billion, accounting for 71.4% of the total projected investment needs in the period 2016-2020.

b. Demand for labor

- To perform the project efficiently, the demand for labor will be approximately 800,000 employees, leading the average demand for labor will be nearly 23,000 employees/year for each province.

II. CONTENTS AND SOLUTIONS

2. Solutions for restoration and sustainable management of Central Highland forest ecosystem in the period 2013-2020, vision 2030

- Solutions on forest protection
- Solutions on forest development
- Solutions on forest management and organization
  - Rearrange and reform the State forestry companies
  - Rearrange Boards of forest management
  - Enhanced the implementation of management and protection of the existing forest area under the commune people's committee
- Solutions on management of natural forest logging
- Solutions on improvement of capacity of local forest rangers
- Solution on forest management, protection and development in the Central Highlands distributed to ministries, sectors and localities

III. ASSESSMENT OF THE EFFECTIVENESS OF THE PROJECT

1. Investment efficiency

- Roles of the project
- Economic efficiency
- The effect on the environment
- The effect on society

III. ASSESSMENT OF THE EFFECTIVENESS OF THE PROJECT

2. Catalog of prior projects

- Projects of forest protection and development in the period 2011-2020 by Decision 57/QD-TTg dated January 9, 2012 of the Prime Minister; and projects of foreign investment and assistance related.
- The projects related to Payment for forest ecosystem services.
- The project of forest inventory in the Central Highlands in 2013-2014.
- The project of the large wood plantation associated with processing and exporting.
- The project of conversion of poor forests to economic plantations associated with forest management and protection.
- The project of exploitation of natural forests.
- The project of restructuring and renovating state forestry companies.

III. ASSESSMENT OF THE EFFECTIVENESS OF THE PROJECT

3. Organization of implementation

- People's Committee of provinces of the Central Highlands
- Departments of Agriculture and Rural Development of provinces
- Boards of Project Management

III. ASSESSMENT OF THE EFFECTIVENESS OF THE PROJECT

4. Recommendations

- Propose the Prime Minister and Ministry of Agriculture and Rural Development guiding People's Committees of provinces of the Central Highlands to implement the forest inventory in 2013 and 2014 associated with establishment, review, adjustment and clear determination of stable stands throughout the Central Highlands.
- Organize the implementation of the project of restoration and sustainable protection of forest ecosystems in the Central Highlands.
- Concentrate on protection, regeneration, plantation and enrichment of forest ecosystems, especially poor and degraded plantations; converse the plantations without abilities of restoration to other uses to maintain the function of environmental protection and improve livelihoods.
- Propose the Ministry of Agriculture and Rural Development evaluating the poor forest planning, particularly dipterocarp forest ecosystems for the guidance of implementing specific rehabilitation and reforestation of rubber tree plantations on the forest land.
- Propose provinces of Central Highlands collaborating with Vietnam Rubber Group for the sustainable development orientation of the rubber tree plantation in the long term.
- Propose the government considering early approving the project of natural forest exploitation for unifying implementations of forest plans.
- Propose Ministries, sectors and localities continuing to renovate and consolidate forest companies.

(12) Viet Nam: An Overview of Viet Nam Forest Rehabilitation

MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT
VIETNAM ADMINISTRATION OF FORESTRY

AN OVERVIEW OF VIET NAM FOREST REHABILITATION

PART I

CURRENT STATUS OF FOREST REHABILITAION

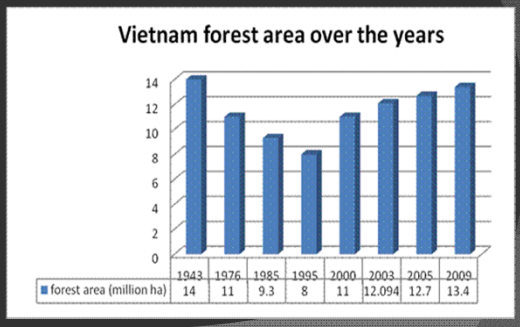
I. Current forest status resources

Vietnam has a natural area of over 33.12 million hectares, of which 12.6 million ha of forests and 6.16 million ha of barren land are targeted for agriculture and forestry production. Thus, the forestry sector has been managing and running production activities on the largest area of land, as compared with other sectors in the national economy. The forest land area is distributed mainly in the mountainous and hilly areas of the entire country, where 25 million people from different ethnic groups live. These people have low education levels, backward farming practices, slow economic development and many livelihood problems.

II. Changes in forest cover

- Due to unsustainable management and a very high need for conversion of forest land and for forest products for socio–economic development, the forest area and forest quality have been continuously decreased over the years.
- Three forest types:
  - Special-use forest: 1.93 million ha, comprising 15.2%;
  - Protection forest: 6.20 million ha, comprising 49.0%; and
  - Production forest: 4.48 million ha, comprising 35.8%.
- Government programs played a key role in this increasing coverage. Despite this increase, the forests of Viet Nam are under serious threat and various regions have high deforestation rates–including parts of the Central Highlands, the Central Coast and the Southeast region.
- With these forest resources, the present average in our country is 0.15 ha forest/person and 9.16 m3 timber/ person. Vietnam belongs to the low group of countries, in comparison with the international averages of 0.97 ha/person and 75 m3/person, respectively.
- The unused land of the entire country is 6.76 million ha, of which barren land on hilly and mountainous areas is 6.16 million ha, equivalent to 18.59% of the total national area. The gradual decreased distribution of barren land for the regions as follows: North East 28%, North West 21%, North Central Region 19%, South Central Coast 13%, Central Highlands 12%, South East 5%, etc.

Figure 1: Fluctuations in forest area of Vietnam from 1943 to 2009



Early Forest Rehabilitation Efforts

- Vietnam is known for its efforts to rehabilitate its forest cover, in addition to its drive to develop its forestry, and wood and non-wood forest product-based industries.
- Scattered Tree Planting: A significant contribution to Vietnam's forest rehabilitation is the scattered tree planting initiative. This initiative has its origin in the 1950s and was endorsed by Chairman Ho Chi Minh in 1959 as the Tet Tree Planting Festival.
- World for Food Program: A second program that had great significance for Vietnam's forest rehabilitation early on is the World Food Program. WFP implemented six forestry projects, with an allocated budget of USD 160 million.
- Rehabilitated Forests at the Beginning of the Large Programs: The three major forest rehabilitation programs of the so called Greening the Barren Hill Program (Program 327), the Five Million Hectare Restoration Project (Program 661), are shaped by this change. The first, Greening the Barren Hill Program, started and was completed during the 1990s. The Five Million Hectare Restoration Project started in 1998 and had final horizon of 2010.

III. Some causes of deforestation in Vietnam

- Land conversion for farm land.
- Devastation by war, including two anti-invasion wars, from 1945–1954 and 1961– 1975. During these wars, Vietnam lost nearly 2 million ha of forests.
- Forest fires.
- Fuelwood and timber over-harvesting by state organizations, but also illegal logging by individuals and units.
- Poor management capacity of the forestry sector and a deficient institutional and legal framework.

PART II

FOREST REHABILITATION NATIONAL STRATEGY AND PROJECTS

I. Viet Nam Forestry Development Strategy 2006-2020

The current national strategy for the forest sector is the National Forest Development Strategy (NFDS), 2006-2020. It builds on previous strategies and programs, setting out ambitious targets for policy reform, plantations, financial support for forest protection and plantations and a greater role and responsibility for the local communities. It seeks to modernize forestry, so that forestry can play its part in the industrialization and modernization of rural agriculture, in hunger eradication, in poverty reduction for people in mountainous areas, and in environmental protection. The NFDS is relatively strong on the need for clear ownership conditions for land and forest. It also discusses the enforcement of land laws, providing guidance on related responsibilities.

Objective

- Sustainably establish, manage, protect, develop and use 16.24 million ha of land planned for forestry
- Increase the ratio of land with forest up to 42 – 43% by the year 2010 and 47% by 2020; to ensure a wider participation from various economic sectors and social organizations in forest development
- Increase their contributions to socio-economic development, environmental protection, biodiversity conservation and environmental services supply
- Reduce poverty and improve the livelihoods of rural mountainous people
- Contribute to national defense and security

Solutions

- Solutions on policy and laws
  - Policies for forest and forest land management
  - Finance and credit policies
- Renovation of organizing forest production and business and encouragement of economic entities participating in forest protection and development
- Solutions on planning, plan and monitoring
- Solution on sector organization and management
- Solutions on science and technology
- Solution on training human resources
- Solutions on international cooperation

Programs

The objectives and orientations of the Forestry Development Strategy are implemented through:

- Three development programs:
  - Sustainable forest management and development program
  - Forest protection, biodiversity conservation and environmental services development program
  - Forest products processing and trade program
- Two support programs
  - Research, education, training, and forestry extension program
  - Renovation of the forestry sector institutions, policies, planning and monitoring program

II. Forest Rehabilitation Projects in Vietnam

- Protection Forest Rehabilitation Projects
- Special-use Forest Rehabilitation Projects
- Projects on Production Forest Land:
  - Raw material for paper production
  - Woodchips
  - Valuable wood from indigenous tree species
- Projects Supporting Forest Rehabilitation Projects:
  - Technical assistance projects
  - Seed production projects
  - Social forestry projects

Objectives

The objectives of the projects reviewed can be grouped into seven categories:

- Catchments protection/biodiversity conservation
- Restore forest cover/regreening
- Poverty, rural development, employment
- Promoting tourism
- Production
- Knowledge & technology creation
- Others

Executing agencies

- Department of Agriculture and Rural Development
- Forestry agency
- People's Committee
- Management Board/Project Management Unit
- State Forest Enterprise
- Donor
- Science agency
- Others

Beneficiaries

The local people were said to benefit from all the surveyed production, protection and special-use forest projects. Other beneficiaries are: companies, enterprises, non local/public, tourists/tour operators and executors.

Funding

Funding sources for forest rehabilitation projects can be divided into national and international funds:

- National Funds:
  - State budget
  - Loan
  - Direct Investment
  - Self-financed
- International Funds:
  - Technical assistance funds
  - ODA non-repayment fund
  - ODA loan
  - Joint venture funds

Method

There are 7 forest rehabilitation methods used in the projects. Some form of plantation continues to be the dominant method of forest rehabilitation. Plantation included agroforestry and intercropping methods. Forest rehabilitation through protection using natural regeneration or combined enrichment and natural regeneration, was particularly relevant in protection forest and special-use forest.

- Natural regeneration
- Natural regeneration & enrichment
- Enrichment
- Protection
- Plantation with natural regeneration
- Plantation, replanting
- Agroforestry, intercropping

Challenges

- Population growth is increasing and spontaneous migration is still happening. Inefficient land use in mountainous areas puts constant pressure on forests for expansion of agricultural land areas.
- Increasing demands for forest products have put pressures on forest resources and the environment, particularly on natural forests. The current demands for forest products exceed the sustainable supply from the forest. The suitable land areas for afforestation of high- yielding production forest are limited and scattered.
- The competitiveness of forestry production is still low. International integration not only is an opportunity, but also a great challenge, for the forest product processing industry and trade of forest products. The competition will be more critical in the future, in both international and domestic markets.
- There exist inadequacies between the requirements for fast, comprehensive and sustainable development and the restricted resources of the forest sector (e.g. human resources, infrastructure, funding, management capacity, etc).
- The importance of forestry has not been comprehensively, objectively and fairly evaluated, which has affected the formulation of investment and development policies of the sector.

III. Outcomes of Vietnam's Forest Rehabilitation Projects (up to 2005)

Forest cover - conservation achievements

- Planting forest, and improving landscape quality (1350 ha)
- Forest cover reached proposed objective
- Restoration of barren lands in special-use forest
- 43,000 ha replanted
- 3000 ha of acacia planted between 1992–2003
- Reforestation, tending and protection
- Core area of special-use forest well protected
- Selected appropriate species for dry and coastal areas
- Cutting of natural forest reduced
- Annual monitoring of biodiversity

Social achievements

- People participate in reforestation
- Resettlement and training
- Training to transfer reforestation technology in alkaline soil for local staff and farmers
- Farmers have stable prices for wood
- Improvements for education, health and culture
- Lives of local people improved
- Local people participating to formulate plan and carry out forest rehabilitation and utilize forest
- Assistance to ethnic groups to leave protected areas

Productivity achievements

- Stable supply of raw material for Vietnam Paper Corporation
- Supply of wood to VIJACHIP (Vietnam Japan Chip Corporation Ltd-an afforestation and woodchip production business company)
- Enhance productivity and improve quality of forest

Technology outcomes

- Selection of species that are appropriate and of high economic value in alkaline soil in Cuu Long delta region
- Recommended solutions to improve alkaline soil and protect water sources in the course of reforestation process
- Scientific basis for forest rehabilitation after burning and plantation of production forests in Tay Nguyen
- Technical and socio-economic solutions for developing production forests in Tay Nguyen, Son La and Dien Bien province work out steps of land use planning

Others

- Promotion of ecotourism

PART III

SUMMARY AND LESSONS LEARNT

I. The Results of 50 Years of Forest Rehabilitation

- Vietnam has a long history of forest rehabilitation, as it started to give tree planting its due importance in the mid-1950s. The country has since then spent a great deal of effort on bringing back tree vegetation where forests have disappeared.
- There are various indicators that demonstrate the success of Vietnam's forest rehabilitation. Over 85% of the projects that were surveyed as part of this report had met their main and specific objectives. The people who provided success ratings of their projects rated over 50% as successful or good, while over 80% of the projects rated between quite successful and very successful.
- Most of the forest rehabilitation projects included in the surveys had more than one objective. Project achievements fairly well matched the objectives. The objectives related to restoration of forest cover for productivity, environmental functions including biodiversity conservation, but also local and wider development objectives.
- A different indicator that reflects the success of Vietnam's forest rehabilitation is the relation between areas rehabilitated, and the existing area of rehabilitated forest at various points in history. Plantation forest area has increased markedly year by year: 1.050 million ha in 1995; 1.471 million ha in 2000; 2.218 million ha in 2004; 2.219 million ha in 2009; 3.438 million ha in 2012.
- There are positive outcomes of forest rehabilitation for local communities and the environment. There was little or no improvement in food security, health conditions, access to health care or housing.

II. Explaining Outcomes

Policy and Legislation

- The policy of forest rehabilitation has been clearly reflected through the projects carried out at the national scale. Various projects and programs in the field of forest rehabilitation have been implemented consecutively over many years. The protection function of forests, forest environment and conservation of forest biodiversity are clearly taken into account.
- The successful results of forest rehabilitation also depend greatly on sectoral and non-sectoral policies. The policies related to land ownership, support, incentives, land use planning and environmental services.
- There are also a number of decrees and decisions issued by the government regarding land allocation and forest contracting, support and credit policies for forest protection and development. Many policies have been endorsed and amended to make them consistent with the actual situation.
- National policies and legislation are being adjusted to reflect new opportunities and needs. The Environment Protection Law, for instance, was revised in 2005, as was the Forest Protection and Development Law, to better assess the role of forests in the provision of environmental services, and to open opportunities for compensation where these services are being provided.

Funding

- Vietnam has for many years invested considerable amounts of funds in forest rehabilitation, especially since the 1990s. This national investment has been complemented with significant international support.
- Under current arrangements of payments for the protection of forests, state financing of forest protection needs to continue if the forests are to be kept. There is little other funding being mobilized for forest rehabilitation, especially for the rehabilitation of production forest land that is meant to boost the forestry sector's contribution to the national economy.
- This funding situation does not translate to optimal conditions for smallholders. Some payments, such as for forest protection contracts, are perceived to be too low. Credits available for forest rehabilitation do have very favourable conditions, but even those conditions still do not convince many farmers that investing in forest rehabilitation is worth their while.

Objectives of Rehabilitation

- The objectives that are pursued in Vietnam's forest rehabilitation include environmental, economic and social objectives. The objectives are fairly compatible. Productive objectives can be carried out on production forest land, and in principle these objectives can be compatible with social objectives, like improving the well-being of the rural poor. In practice, however, the link between those objectives is difficult. Prices paid for wood and timber are limited by profit margins, and they may be too low to be attractive to small scale tree growers. Local markets for wood or other forest products may be limited. Commercially interested entrepreneurs may have little interest in dealing with many small producers. These are all constraints that diminish the compatibility of various objectives of forest rehabilitation.
- The objectives of forest rehabilitation are relatively flexible and can be adjusted if needed.

Economics, Markets and Demand

- The woodchip and derivatives sector may suffer from high production costs, in which case nationally produced products may end up being more expensive than those produced elsewhere. New product development will be an important aspect that will have to be addressed if the planned expansion is to be successful, and forest rehabilitation on production forest land economically viable. The more environmental function-oriented forest rehabilitation does not appear likely to become profitable any time soon, while some of the anticipated benefits that stimulated forest rehabilitation may not be realized because of the unclear link between forest cover and downstream flooding, or limited water volumes.
- Recently, although forest plantation has increased its contribution to covering the need for industrial materials such as paper, fibre and particle board, and woodchips, the demands remain large. In the recent years, for instance, furniture exports have increased vigorously, yet 80% of raw materials are from imports. Thus forest plantations to improve timber supplies become more and more urgent. More effort should be made to meet current and future demand for wood materials.

Technology, Extension, Technical Assistance and Training

- Various policy makers on Vietnam's forestry sector have observed technical limitations to forest rehabilitation, including inadequate seed material, poor soils in plantation sites, and inadequate plantation maintenance. It should be acknowledged that science and technology, as well as the application of advanced techniques in production, have contributed significantly to the outputs of forest rehabilitation in Vietnam. A group of tree species that have high productivity, are economically and environmentally valuable, and can grow on the degraded barren hilly land, sandy coastal and drought-stricken areas, has been available since the early 1990s. Advanced methods in terms of breed improvement, intensive afforestation, productivity increases, and planting site selection have been widely applied in the field. Good results for natural forest rehabilitation through maintenance, assisted regeneration and enrichment planting have also been achieved through the application of techniques obtained from relevant research. However, the need to improve tree productivity and the supply of high quality tree breeds remains.
- The forestry extension service has drawn attention. Agriculture and forestry extension organizations, as well as governmental extension programs, have been established from the central to the local level. A number of projects for agriculture and forestry extension have been implemented. However, the effectiveness of the service is still unsatisfactory.

III. Lessons learnt

1. Forest rehabilitation should be incorporated in projects and programs at the national level and implemented through projects at the local level with well-defined goals.
2. The procedure of project appraisal, management and monitoring of project operation is essential to ensure the success of the projects.
3. Clear and detailed benefits for households and articulated participation will vastly enhance project results.
4. Clarifying land ownership conditions for the party that will hold key responsibility for the rehabilitation, and adequately addressing technical requirements, will also enhance project results.
5. The implementation of forest rehabilitation projects should be integrated with other projects that aim to improve the socio-economic conditions of local populations.
6. Forest rehabilitation projects should be combined with other supporting activities to ensure that the major goals of the projects are met.

FOREST AND LANDSCAPE RESTORATION MECHANISM

COMMITTEE ON FORESTRYTWENTY-SECOND SESSION
Rome, Italy, 23-27 June 2014

I. BACKGROUND

1. Continued deforestation and land degradation pose serious obstacles to eliminating poverty, hunger and biodiversity loss in many parts of the world today and to reducing the impacts of climate change. Forest and land degradation also affect negatively soil protection and the water cycle, undermining agriculture and productive ecosystems and threatening the livelihoods of millions of people. In many parts of the world, however, people have started to restore their degraded forests and landscapes, creating many new opportunities. The scale of this opportunity is immense: according to the Global Partnership on Forest and Landscape Restoration (GPFLR), more than 2 billion hectares of the world's deforested and degraded landscapes have potential for restoration, a process that could help reduce poverty, improve food security, reduce climate change, conserve biodiversity, improve soil and water protection and would increase the forest area from 31 percent to 47 percent.

2. There is a growing awareness of the importance of forest and landscape restoration thanks to several international processes. The Bonn Challenge is the result of a ministerial conference held in Bonn, Germany in September 2011, which set a target of restoring at least 150 million hectares of degraded land by 2020. Additionally, Parties to the Convention on Biological Diversity have adopted the Aichi Biodiversity Targets in 2010 – Target 15 calls for countries to restore at least 15 percent of their degraded ecosystems by 2020. At the 21st session of COFO in September 2012, member states recommended that FAO “identify its role in achieving the Bonn Challenge and strengthen its capacity in rural land-use planning in an interdisciplinary way through both normative work and project support to countries”. Member states also recommended that FAO seek support for its field programme to increase assistance to member countries’ capacity development in intersectoral planning, institutional development and the application of integrated approaches, and to continue engagement with the GPFLR.

3. Responding to these challenges and recommendations, FAO has proposed the establishment of the Forest and Landscape Restoration Mechanism (FLR Mechanism), which will help countries to achieve their commitments towards the Bonn Challenge and the Aichi Targets, catalyzing

the work of the Organization in close collaboration with key partners in the context of the GPFLR.2 COFO/2014/6.4 Rev.1

II. ROLE OF THE FOREST LANDSCAPE RESTORATION MECHANISM - SUPPORT TO ACTION ON THE GROUND

4. The FLR Mechanism will support the implementation as well as monitoring and reporting of FLR at the country level. It will operate globally and its initial phase will span a seven-year period from 2014 to 2020 and will focus mainly at country level on:

- Facilitating a multi-stakeholder process in selected countries, mobilizing key actors from government, civil society, private sector and the international community, to define needs and opportunities for FLR and carry out institutional mapping of key FLR players. The process is expected to lead to a national FLR plan that includes areas targeted for restoration; the potential roles and responsibilities of all actors; capacity development needs; financial resources and technical support required and an indication of how to mobilize such support.
- Full consideration will be given to ongoing and planned FLR efforts occurring in a variety of sectors (forestry, agriculture, environment, etc.) and in the context of different processes (e.g.
- UNCCD, CBD and UNFCCC) and incorporate them to avoid overlap and duplication.
- Developing, compiling and disseminating tools and best practices related to FLR, taking into account existing related efforts (e.g. on land use planning, participation, genetic resources, biodiversity, protection from pests and disease, fire management, water and soil conservation, landscape values, etc.).
- Supporting the establishment of pilot projects and helping broker new large-scale projects and programmes with national, bilateral and multilateral donors and the private sector.Supporting adequate quality control of well-established FLR efforts, to ensure compliance with accepted guidelines, norms and standards.

5. The FLR Mechanism will also provide support at the global level in:

- Developing guidelines and standards for the establishment of baselines and the monitoring, measurement, reporting and

verification of successful restoration efforts in full collaboration with GPFLR and interested countries, contributing to national and international reporting obligations.

- Providing a financial intelligence function, identifying and making available to countries and implementing agencies information about sources of funding for FLR, as well as informing financial and donor institutions about the needs and opportunities for funding FLR. A crucial function will be to ensure that FLR becomes a more integral part of budget allocations of key international financial institutions (IFI) through closer partnership and collaboration.

- Contributing to the more effective embedding and reporting on FLR actions in global and regional commitments and processes – especially those related to (i) the United Nations Convention to Combat Desertification, (ii) the CBD with special reference to the Aichi Targets 5, 11 and 15, (iii) the United Nations Framework Convention on Climate Change, helping countries address enhancement of forest carbon stocks under the REDD+ initiative; (iv) the Great Green Wall for the Sahara and Sahel Initiative, (v) the Asian Forest Cooperation Organization, (vi) the Amazon Cooperation Treaty Organization, (vii) the Central Africa Forests Commission, (viii) the Central American Commission on Environment and Development, and (ix) the Association of South East Asian Nations.

- Helping to build and support operational partnerships on FLR, striving for increased intersectoral collaboration.

6. The FLR Mechanism will work closely and in full complementarity with other FAO-hosted arrangements and programmes that have been set up to support related objectives, such as the UNREDD programme, the Forest and Farm Facility (FFF), the Mountain Partnership Secretariat, the Globally Important Agricultural Heritage System (GIAHS) initiative, the Land Degradation Assessment in Drylands (LADA) programme, the World Overview of Conservation Approaches and Technologies (WOCAT) and others.

7. The work of the FLR Mechanism is already embedded in the new Strategic Framework, in particular the Strategic Objectives focusing on "increasing and improving the provision of goods and COFO/2014/6.4 Rev.1 3services from agriculture, forestry and fisheries in a sustainable manner" (SO2), "reducing rural poverty" (SO3), "enabling more inclusive and efficient agricultural and food systems at local, national and international levels" (SO4) and "increasing the resilience of livelihoods to threats and crises"(SO5). Under Strategic Objective 2, work of the FLR Mechanism will be linked in particular to

Output 20103, "Organizational and institutional capacities strengthened to support innovation and the transition toward more sustainable production systems". It will contribute to the delivery of the Major Area of Work on Ecosystem Services and Biodiversity, as well as to the Regional Water Scarcity Initiative in the RNE region.

III. FUNDING/SUPPORT

8. The FLR Mechanism will be funded through extra-budgetary resources and/or seconded professional staff from external donors/partners, including the Republic of Korea, building on the current cooperation with the FAO Forestry Department. It will be established as an umbrella programme under which a variety of bilateral, multilateral and other types of support could be accommodated, mainly to support action at country level.

9. The relationship of the FLR Mechanism with GPFLR partners, including the International Model Forest Network, the International Union for Conservation of Nature, Tropenbos International, the World Resources Institute, the World Bank and others, will be defined and detailed in the framework of the GPFLR Steering Committee to ensure that the FLR Mechanism is fully supportive of and synergistic with all efforts towards the achievement of the Bonn Challenge.

IV. POINTS FOR CONSIDERATION

The Committee may wish to invite countries to:consider the added value of addressing agriculture, forestry, fisheries and livestock management through a more integrated landscape approach and by strengthening inter-sectoral cooperation amongst various land management agencies;support actions towards the achievement of the Bonn Challenge, targeting the restoration of at least 150 million hectares of degraded forest lands by 2020, as well as the Aichi Biodiversity

Targets related to ecosystem restoration;consider strengthening the mobilization of innovative and enhanced levels of financing for the restoration of degraded lands, including through the GEF STAR allocations they will have available under GEF6 related to land degradation, biodiversity and climate change;provide financial and/or in-kind contributions to support the umbrella programme of the FLR Mechanism.

The Committee may wish to recommend FAO to: support country efforts to plan and implement activities related to the restoration of forests and other degraded lands, in particular through activities of the FLR Mechanism; seek further cooperation with partners to promote the restoration and rehabilitation of degraded lands, in particular through direct involvement in global partnerships and initiatives, including the GPFLR, International Model Forest

Network, and the Landscapes for People, Food and Nature initiative, as well as with the members of the Collaborative

Partnership on Forests;engage in more cross-cutting and inter-departmental work, in particular through the relevant Major Areas of Work and/or Regional Initiatives defined under the new Strategic Framework, to support landscape approaches to achieve greater food security, poverty alleviation, climate change adaptation and mitigation, as well as the conservation and sustainable use of natural resources;pursue active engagement with multilateral, bilateral and private sector resource partners, including the GEF and multilateral and regional development banks, to enable FAO to increase its support to member countries for capacity development in inter-sectoral planning, institutional development and application of landscape approaches on the ground;4 COFO/2014/6.4 Rev.1ensure that the FLR Mechanism is fully operational within 12 months of its establishment.

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Perspective

The Myths of Restoration Ecology

Robert H. Hilderbrand[1], *Adam C. Watts*[2], *and April M. Randle*[3]

Key Words: *carbon copy; command and control; cookbook; ecological restoration; fast forward; field of dreams; myths; resilience; restoration ecology; Sisyphus complex*

INTRODUCTION

Humanity's ever-increasing ability to effect environmental change on a number of spatial and temporal scales requires tough decisions about how we view, value, and manage ecosystems. For example, advances in agriculture that support vastly more people per unit area than hunting and gathering are clearly a positive outcome for society. However, many beneficial land-use practices, including agriculture, may ultimately degrade ecosystems. To function as a society, some amount of ecosystem alteration must occur to support the human population, but we are ultimately dependent on ecosystem services. Our actions both intentionally and unwittingly alter the goods and services of many ecosystems on which we rely, and by entering into this relationship of altering ecosystems, we incur responsibility to our neighbors and to future generations. However, the difficult decisions have largely been avoided by the expectations and confidence in conservation and, in particular, ecological restoration.

Given the widespread alteration of natural systems, it is clear that conservation measures alone will not suffice to protect ecosystem functions, services, and habitat for a large number of species in the future. Conservation has traditionally been a rearguard measure to prevent further degradation rather than a means for increasing resources or natural capital. As such, simple maintenance as opposed to enhancement of ecosystems may often leave ecosystems and species vulnerable. Despite conservation policies such as roadless areas and the "No Net Loss" concept for U.S. wetlands, losses continue to exceed gains (Dahl and Allord 1996), and gains are often not functionally equivalent to losses (Zedler 2000a, National Research Council 2001). Increasing human population growth and resource consumption continue to place additional stresses on systems and demands *more* capacity and services, rather than simple maintenance of current services. Thus, we must either alter consumption or rely on our ability to create, restore, and enhance ecosystems and their services.

Despite our dependence on healthy ecosystems, society has made the decision to continue life as usual until a loss of valued goods and services is realized; then, society will expect and rely on science to clean up the mess *and* make it look natural. Many government policies concerning development and extractive resource use already assume the ability to mitigate ecosystem damage through the restoration of degraded land or creation of new habitats. However, many restorations are not successful either in structure (Lockwood and Pimm 1999) or function (Kentula 1996, Zedler and Callaway 1999) when compared with reference ecosystems. Such results underscore the need to evaluate our underlying beliefs and expectations in restoration.

The incredible complexity of nature forces us to simplify the systems we study in order to develop theory and generalities by reducing them to understandable subsets. Although we cannot function without theory and conceptual models, their creation often ignores the variability that is so important to accurately describe, predict, and re-create current and future system attributes. In essence, restoration ecology strives to (re-)create complex systems from simplified guiding principles

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or myths. Failure to recognize the limitations and tacit assumptions can lead to failures because of the over-application of over-simplified concepts to complex systems (Holling 1995, Holling and Meffe 1996). We believe the same is true in ecological restoration.

We believe that many unsatisfactory restorations result from a failure to recognize and address uncertainty, and from a focus on inappropriate time scales. Ecological restoration is trying to do in a matter of years what takes decades or centuries under natural conditions. Expecting complete restoration on human time scales is unreasonable, even where full recovery may eventually occur. Nonetheless, many of our underlying beliefs tacitly assume that systems will return to a "natural" state in fairly short order if they are just nudged in the right direction through adjustments to physical attributes or by regulating species composition. Additional problems arise in defining what is "natural" and in our inability to accept that systems are dynamic and may have multiple trajectories leading to numerous possible outcomes. Finally, because we are extrapolating from oversimplified concepts, ignoring uncertainty may result in surprise and failure because we have not created a system capable of adapting or responding to future drivers or events. Therefore, restorations should not be one-time events, but are likely to require periodic attention and adaptive management to increase the chances of responsive, adaptive, and successful projects.

Based on our experiences as researchers and practitioners in conservation and restoration ecology, we propose five central myths (Table 1) under which many ecological restoration and management projects seem to be conceived and implemented. Myths have value because they help us to organize and understand complex systems and phenomena. Identifying myths can help make the tacit explicit by revealing assumptions that are otherwise hidden (Holling 1982). However, they remain simplified and potentially misguided models for understanding and application (Holling 1982, Timmerman 1986). The first Myth, the Carbon Copy, addresses the goal-setting process, and as such, it forms the basis of how restorations are evaluated. The Carbon Copy is closely tied to the remaining four myths, which involve the process of restoration and management: the Field of Dreams; Fast Forwarding; the Cookbook; and Command and Control: the Sisyphus Complex. We believe that describing these myths will be useful in understanding how some management or restoration strategies are conceived, designed, and implemented. For example, adherence to different myths may direct actions in divergent directions, as could be the case when choosing between a focus on ecosystem structure (Carbon Copy) or on key processes (Field of Dreams). Examining these myths may also help us better understand why some restoration projects do not meet our expectations. In the pages below, we briefly describe each myth and its assumptions, and give examples where the myth exists.

Our objective is not to abandon what we propose to be prevalent myths in ecological restoration—there are elements of truth in each—but to recognize that there are tacit assumptions associated with each myth. Failure to recognize these assumptions can lead to conflict and disappointing results despite large expenditures of time and effort. Our challenge is to recognize the limitations and not accept sometimes dogmatic beliefs without critical examination. We do not claim that every project is rooted in myth, but suggest that many perceived failures may be traced to over-reliance on one or more of the myths. We do not condemn restoration ecology, but rather provide a means of self-examination so readers can identify from their own experiences what worked and possible reasons for perceived failures.

THE MYTH OF THE CARBON COPY

The myth of the Carbon Copy relates to the selection of restoration goals and end points, and maintains that we can restore or create an ecosystem that is a copy of a previous or ideal state. The myth is rooted in the Clementsian (1936) idea that ecosystems develop in a predictable fashion toward a specified, static, end point or climax. Accordingly, any disturbance or degrading activity will reset the system, resulting in a phase of rebuilding and a return to the previous trajectory of ecosystem development. However, restoration sites are different from those where secondary succession occurs after disturbance (Zedler 2000*b*), and restoring or creating an ecosystem of specific composition becomes quite difficult. Most successes appear to be only transitory (Lockwood and Pimm 1999). Despite the shortcomings, the myth of a carbon copy persists in ecological

Table 1. The myths of restoration and their core issues

Restoration Myth	Core Issues
Carbon Copy	Community assembly predictable; a single endpoint exists
Field of Dreams	Sole focus on physico-chemical conditions; systems self-organize
Fast Forward	Succession and ecosystem development can be accelerated
Cookbook	Methodology overused and not sufficiently validated
Command and Control: Sisyphus Complex	Nature is controllable; Treating symptoms will fix the problem

restoration. The main reason is that the underpinnings of restoration ecology involve ecological succession and assembly rules (Young 2000), which tend to reinforce subconsciously the concept of a static, climax end point. Indeed, van der Valk (1998) described restoration as accelerated succession. Ecology is rich with examples of succession (Glenn-Lewin et al. 1992), and there is little doubt of its importance in community and ecosystem development (Odum 1969), or potential in restoration (e.g., van der Valk 1998). The main issue is the extent to which succession is equilibrial and can be predicted or controlled to arrive at a predefined state under human time scales. Most landscapes are a mosaic of different vegetation types that shift through both space and time (Bormann and Likens 1979, Pickett and White 1985), and identifying a single state as the only end point is not realistic for most systems.

The myth of the Carbon Copy has influenced resource agencies, such as the U.S. National Park Service, that have mandates to restore and manage some systems to pre-settlement conditions. At its extreme, the Carbon Copy emphasizes a natural or primeval state that existed before European settlement, and becomes the restoration or management objective. As the natural state existed before corruption by modern influences or before a need for restoration, its return is the objective. Although the purpose of restoration and management outside of legislative mandates should guide the goals and end points, a de facto end point is all too often what the system was like in an undisturbed state.

Restoration to a pre-disturbance state may be desirable when concerns are for the "naturalness" of the system, but many difficulties exist during implementation. Few would debate that a pre-disturbance state is, in most cases, preferable to a degraded one, but the ability to (re-)create a system resembling pre-disturbance may be difficult, if not impossible. Given the sheer number of non-native species that have invaded and been integrated into virtually every ecosystem, it is arguably impossible to achieve a pre-settlement target condition. Even if such a goal could be achieved, selection of the appropriate target remains in question—do we restore for the ecosystem of 1500 AD, 500 AD, or 1000 BC? Another difficulty arises when the underlying parameters and drivers have changed (e. g., Ehrenfeld 2000) or the system is too degraded to achieve pre-disturbance conditions (Hobbs and Norton 1996). Changes such as a rise in sea level, atmospheric acid deposition, and altered hydrology because of urbanization, dams, and water withdrawals may all substantially alter both structure and function as a result of changes in salinity, soil and water chemistry, and hydrography and geomorphology, respectively. Thus, we may aim at a target that is not only moving, but also at a target that is no longer attainable at a specific locale.

Tension and conflict arise when the Carbon Copy is an unrealistic or inappropriate goal. Pre-disturbance or "pristine" conditions are often in conflict with stakeholder wishes, particularly in more urbanized situations (Shore 1997). Even setting goals that recognize multiple end points can be politically and socially problematic when various stakeholders each desire a different and conflicting

result. In these cases, a pre-disturbance condition may not represent the best solution, when the objective is to maximize an ecosystem service, function, or aesthetic. Rather than focus on restoring to some primeval state, a more profitable approach would be to accept that ecosystems are dynamic and focus on repairing damaged systems to the extent possible (Hobbs and Harris 2001).

The Carbon Copy myth prevails in extractive resource industries, such as forestry and mining, and its foundations are used as arguments to justify access to resources in undisturbed environments—the belief being that these systems will return to their previous state after disturbance. Although few ecologists pretend that the more destructive forms of mining can be fully restored, the belief in this ability is promoted by those backing the extraction industries. Despite limited success, the Carbon Copy myth has resurged in the USA in the form of the "No Net Loss" paradigm of wetland protection policy and mitigation (Zedler 1996), which assumes that created or restored wetlands provide equivalent ecological services, function, and value as those destroyed. Although success stories exist, many now consider the assumptions invalid because few created or restored wetlands have achieved structure or function equivalent to existing wetlands (Zedler and Callaway 1999, National Research Council 2001, Seabloom and van der Valk 2003), and natural wetlands continue to disappear without equivalent replacement (Whigham 1999).

An alternative to creating a carbon copy of species complement is to create a system equivalent in function to the pre-disturbance state. Restored systems can be functionally superior to pre-disturbance systems, as in the case of wetlands engineered for nutrient removal (e.g., Peterson 1998). The growing field of ecological engineering is rich with examples of such enhanced systems (Ansola et al. 1995, Kadlec and Knight 1996, Knowlton et al. 2002, Kangas 2003), and will become ever more important to society as we continue to degrade natural systems. Functional replacement could be more easily accomplished than replacement of taxonomic composition because of the shared ecological function of many species (Stanturf et al. 2001). The danger in this approach is that some functions may be enhanced yet more subtle functions (e.g., species' habitats) or indirect interactions (e.g., heightened predation due to habitat differences) may suffer. Questions that remain include the resilience of functional replacements to disturbances and their acceptability to society. The heightened public awareness of invasive species modifying ecosystems and the potentially foreign look of a functional replacement may be socially unpalatable.

THE MYTH OF THE FIELD OF DREAMS

The Field of Dreams stems from the notion that all one needs is the physical structure for a particular ecosystem, and biotic composition and function will self-assemble—if you build it, they will come. Similarly, restoration of a process, such as fire or hydrologic regime, is expected to re-create pre-disturbance structure. Although re-creating the physical template and drivers are a necessary first step, it is rarely a final step and sometimes a misstep (e.g., Smith 1997). A fundamental assumption of this myth is that the community and ecosystem assembly process follow a repeatable trajectory, and uncertainty is implicitly ignored. Although there are some encouraging generalizations emerging about community assembly (Christensen and Peet 1984, Drake 1990, Keddy 1999), community assembly is in many ways reminiscent of Rudyard Kipling's (1902) *Just So Stories*: communities are historically contingent products (Parker 1997), and much uncertainty still exists given the influences of initial conditions (Grace 1987) and stochastic or neutral assembly (Hubbell 2001). Failure to accept uncertainty and the dynamic nature of community assembly can lead to the traps of the Carbon Copy myth.

The Field of Dreams approach is common in both wetland and stream restoration, where emphasis is often on re-creating physical attributes with little attention paid to biotic responses. For example, the Rosgen approach (Rosgen 1994, 1998) is probably the most widely used stream restoration method in North America, but it deals almost exclusively with geomorphic attributes of stream channels. Restoration goals in systems such as urban watersheds often involve preventing streambed erosion and destruction of buried utilities, such as sewer and water lines. Although stabilization of the stream channel is quite important, stopping at a geomorphic end point is similar to ensuring that mining excavations in terrestrial landscapes are filled after a job is completed, and then not proceeding with revegetation. Similar examples exist for wetland restorations (van der Valk 1998), where the concept of self-design (Mitsch and

Wilson 1996, Mitsch et al. 1998) is embraced after the hydrologic conditions are restored. Restoration sites do become revegetated, but may be of different species composition and degree of cover (Seabloom and van der Valk 2003), owing to dispersal limitations of many wetland species (Galatowitsch and van der Valk 1996). Thus, the effectiveness of self-design depends on the restoration goals, but adopting a concept of self-design does implicitly recognize and embrace the existence of multiple end points.

An effective restoration of the physical variables will create the template for biotic recovery, but physical structure does not always beget biotic structure, and biotic structure does not necessarily result in similar ecosystem functions across sites. The concept of self-organization, or self-design, is an intuitively appealing approach and is very attractive to resource managers who have limited time and budgets. A self-assembling ecosystem would substantially cut down on the amount of effort required to restore ecosystems, and we feel this is why the Field of Dreams is commonly employed. However, its effectiveness in restoring structure and function is still debatable (Simenstad and Thom 1996, Zedler and Callaway 1999, National Research Council 2001), and restored areas may be quite different from undisturbed sites (Seabloom and van der Valk 2003). In defense of self-assembly, composition of restored sites is expected to approach reference sites given sufficient time (Mitsch 1997). Effective restoration using this approach must overcome issues of recolonization and dispersal, stochasticity in community assembly, and assembly of energy transfer pathways. One commonly used strategy to circumvent these limitations is to jumpstart the process by adding organisms, but our understanding of accelerating ecosystem development is incomplete and may lead to the myth of Fast-Forwarding.

THE MYTH OF FAST-FORWARDING

The myth of Fast-Forwarding is based on the idea that one can accelerate ecosystem development by controlling pathways, such as dispersal, colonization, and community assembly, to reduce the time required to create a functional or desired ecosystem. This idea stems from the initial floristics model of succession (Egler 1954) in which the process of ecosystem development is accelerated by controlling initial species composition and succession to achieve the desired end point (van der Valk 1998). The major assumption is that we can reliably recreate key processes and links between the biota and physical environment. A driving force behind this approach is the need to demonstrate rapid recovery of disturbed lands in order, for example, to have insurance or mitigation performance bonds returned quickly.

Many types of restoration projects justifiably use a fast-forwarding approach to jumpstart the recovery process by using species desired in the ecosystem. As most restorations include plantings to get the ball rolling and stabilize the terrain, it is logical to try to advance the successional process, and this is why the practice is so common. However, relying on the premise that fast-forwarding will produce the desired ecosystem trajectory and speed the recovery process may result in disappointment. Little evidence exists for achieving desired trajectories or functions within the shortened time spans promised by fast-forwarding (Simenstad and Thom 1996, Zedler and Callaway 1999, Campbell et al. 2002, Wilkins et al. 2003). As with other myths, there is some element of truth, and successes using fast-forwarding have occurred (e.g., Clewell 1999). Successful projects typically require multiple plantings and a considerable amount of attention to ensure survival of plantings in systems that may be "premature" for the species' arrival. Even when successful, certain ecological processes, such as the development of tree hollows for cavity-nesting animals, soil development, mycorrhyzal associations, and hydrologic regimes, present more difficult challenges and may take years or decades. Mitsch and Wilson (1996), for example, point out that the 5-year span in which "'quick-fix' wetlands" are expected to become sufficient replacements for lost or damaged areas is improbably short, and that 15–20 years is a much more realistic expectation. Long-term monitoring (5–15 years) of restoration projects is indicating that a more likely time horizon is several decades for a restoration to resemble a pre-disturbance target (Zedler and Callaway 1999, Wilkins et al. 2003). Many ecological restoration projects—even ecological restoration itself—aim for rapid progress from a damaged state toward some more-or-less specific target. There is nothing inherently wrong with such a goal, however, we should not be so intent on attaining a specific point that the system's potential future state (i.e., after restoration efforts cease and natural processes take over) is ignored.

THE MYTH OF THE COOKBOOK

When a particular restoration experience is successful in one area or ecosystem, we naturally want to apply the same techniques in other restoration efforts; after all, science has little relevance if the results are not repeatable. We refer to the over-use or continued use of a locally unsuccessful restoration prescription because it worked somewhere else, or is in the published literature, as the myth of the Cookbook. Perpetrators of this myth assume that similar physical and ecological systems respond identically and predictably to restoration techniques. Although a reasonable starting point, systems that appear very similar may exhibit considerable differences in variables that regulate slow processes (e.g., carbon storage), and the same management prescription applied to two such systems may have vastly different results. The difficulty arises when approaches are adopted that ignore uncertainty. A non-adaptive technique forces us down a path with few alternatives to a changing world.

The myth of the cookbook arises often in stream restoration, and possibly wetland restoration and creation, where recipes for restoration exist (Rosgen 1998). Cookbook approaches seem to be most often present in engineering approaches to restorations. We are not denouncing the goal of standard methods, but we believe that there is still too much uncertainty to commit totally to one technique in a given situation. Even in chemistry, where well developed standard methods exist, a good yield from a single reaction may be 90% and a complex set of reactions may yield less than 50%, meaning that half the reactions did not go as they should. Given the complexity of many restorations, the practice is fairly successful relative to the chemistry analogy. However, incomplete chemical reactions can be precipitated, discarded, or otherwise dealt with quickly and inexpensively, but we do not have the luxury to treat degraded systems similarly, nor can we accept such a failure rate given the high financial cost. The positive side is that systems are rarely in worse condition after a restoration even if the project did not meet the stated goals.

To resource professionals plagued by a lack of information, time, and budget, cookbook approaches may be the only realistic approach. The opportunity to use a successful restoration effort as a template for a similar system is a start, and may be preferable to inaction. It may also be advisable to replicate certain elements of proven restoration techniques, because some valid generalities may be made concerning the responses of a wide range of ecosystems to the same actions (Zedler 2000*a*). However, idiosyncrasies of each system (unique ecological histories, differing assembly rules, or even differing functional roles of components of two similar ecosystems) may result in elements of surprise and crisis when a uniform, cookbook approach is used without detailed knowledge of the ecological characteristics of the ecosystem to be restored. As the community or ecosystem to be restored becomes less and less similar to the system in which a given restoration approach was successful, the potential for unforeseen responses and failure increases dramatically.

By defining the myth of the Cookbook, we do not advocate reinventing the wheel with every new project. One of the major goals of restoration ecology is to develop a suite of methods that can be used in a given situation to best effect. We believe this desire or belief in repeatable methods is why the cookbook remains. Problems arise when a method is over used or used in the wrong situation just because the method exists and is understood. A number of approaches (e.g., Kershner 1997, Clewell et al. 2000, Richter et al. 2003) provide general guidance, but allow for site-specific adjustments to deal with uncertainty. A more cautious approach, acknowledging our inability to predict the exact response of an ecosystem to manipulation, would be the application of a varied management or restoration regime across a landscape. Techniques aimed at discovering and mimicking the character of natural systems would be more likely to find successful solutions (Mitsch and Wilson 1996), while likely contributing to the resilience of the system (Holling et al. 2002).

THE MYTH OF COMMAND AND CONTROL AND THE SISYPHUS COMPLEX

The myth of Command and Control (Holling and Meffe 1996) describes the "pathology of natural resources management" where goals are achieved by active intervention and unending control, or manipulation of physical and biological components of the ecosystem. This myth, articulated by Holling and Meffe (1996), assumes we have the knowledge, abilities, and foresight to actively control ecosystem structure and function to manage for a particular ecosystem state indefinitely into the future. Exerting

command and control invariably decreases system resilience by reducing the range of natural variation and adaptive capacity for the system to respond to disturbances (Gunderson 2000). As resilience decreases, the likelihood of a disturbance shifting the system into an undesired or degraded state increases, and control is wrested from the manager.

Practice of Command and Control recalls the story of Sisyphus, one of the most unenviable characters in Greek mythology because he is compelled by the Gods to forever push a heavy boulder uphill. Just as he nears the top, Sisyphus becomes exhausted, and the boulder rolls back down to the plain below, where Sisyphus must begin again. Like Sisyphus, we can become trapped in an endless cycle of effort to compel ecosystems to remain in single, transient, or unstable states, resulting in repeated episodes of surprise and crisis that can mimic the ball-in-cup analogy of system dynamics (Lewontin 1969, Holling 1973, Beisner et al. 2003), with the ball rolling around the cup and away from the manager's desired state. The Sisyphus Complex emerges when we act through Command and Control to hold a dynamic system static or force a system to exist in a transient state. In any restoration, some amount of Command and Control is required to perform the restoration. Additional nudges to physical or biological components will likely occur in the years after the restoration as well. There is nothing wrong with some tinkering—we cannot exist without having some effect on our surroundings. Actions to be avoided are those that are long term in nature or will decrease the natural range of variability in key processes, such as fire regime or hydrology.

The Sisyphus Complex often occurs when the dominant, large-scale drivers of the system have changed and are either not noticed or conveniently ignored. When we fall into the Sisyphus Complex, we become fixated on treating symptoms rather than the root of the problem and so become susceptible to failure. Urban stream restorations often occur in response to severely eroded stream channels, and a more flashy hydrograph that results from increases in impervious surface area higher in the watershed. Many such restorations fail (sometimes multiple times) despite tremendous expense and effort, because the altered driver (the hydrograph) and the root cause (impervious surfaces) were not addressed. Other general examples include coastal beach restoration in the face of ongoing, natural erosion; rare species stocking/reintroduction programs that ignore the root causes of rarity; and attempting to direct succession to end points incompatible with environmental conditions. Sometimes the Sisyphus Complex results from social or political mandates to do something despite credible science to the contrary. In these situations, we must make every effort for science to influence decision making so that the inevitable repeated failures are not perceived as employment justification or incompetence on the part of science.

MOVING BEYOND THE MYTHS

Myths have value because they help us to organize and understand complex systems and phenomena, and provide a starting point toward the restoration and management of degraded ecosystems. We feel this is why the myths of restoration exist and persist. We hope that proposing these myths (whether the reader agrees with them or not) will begin a dialog leading to a deeper thinking about and greater understanding of natural systems and advancing the science of restoration ecology and management.

Identifying myths has several implications for restoration design. A common theme in the myths is a failure to recognize and address uncertainty. Ignoring uncertainty often results in surprise and failure, because we have not created a system capable of adapting or responding to future drivers or chance events, and we are unable to exert ultimate control over the system. An alternative approach would be designing for resilience by planning for surprise. Although we cannot anticipate all future events, we can manage and restore in ways that allow for uncertainty. Planning for resilience should allow systems a greater ability to deal with and recover from surprise and future change by focusing on a diversity of approaches, functions, and taxa.

When viewed in the context of designing for resilience, restorations become experiments in adaptive management or adaptive restoration (Zedler 2000b). Restoration projects with decision points along the way allow for critical assessment and possible intervention with contingency plans if things are not proceeding appropriately. Rapid learning can also be achieved by using a diversity of restoration techniques and approaches likely to be successful within the larger restoration. Assessing the performance of multiple approaches may increase cost, but it allows for testing multiple hypotheses and adaptive learning, and may cost less in the long run. If more than one approach is

successful, the restoration toolbox quickly expands, and much about the system is learned. If, however, no approach works, we will have quickly learned the inability of several techniques compared with the time it would take to gain the same results one restoration at a time. The challenge is to implement and design multiple approaches so that each can be assessed independently of others, as well as independently of adaptive responses that may occur along decision points after periodic evaluations. Multiple approaches within a larger restoration will also likely increase system resilience because the system created by each approach may have differential response to and recovery from disturbances. Maximizing species diversity in restorations is likely to increase response diversity (Elmqvist et al. 2003) and may increase the likelihood of a restoration containing species resistant or resilient to future conditions and disturbances. Although the concept that diversity begets ecosystem stability may itself be an emerging myth, it seems worth pursuing for other reasons as well.

Recognizing mythologies may also aid the goal-setting process. The forest primeval no longer exists and may not be attainable—exotic species, historic disturbance regimes, and changes in climatic and landscape drivers all serve to ensure that there never was, and probably never will be a single, repeatable end point. More realistically, goals should include multiple scientifically defensible end points of functional or structural equivalence. Although maintaining biotic or ecological integrity is a noble goal, invasive species are too entrenched in many systems to consider their presence a restoration failure, particularly when some may have similar roles as native species. Providing for alternative solutions to future conditions by setting multiple end points implicitly increases resilience by increasing the adaptive capacity and response diversity of the system. In addition to being more realistic and attainable, having several possible end points may also reduce tension within and among practitioners and stakeholders.

Restoration projects should expand goals and expectations beyond quantitative targets or ranges for ecological attributes, such as vegetation density, biogeochemical processes, and hydroperiods. Approaches that consider ecological capital, connectivity, and variability are likely to improve the ecological resilience of restored systems, and therefore, their ability to absorb disturbances or insults without resulting in a permanent change in fundamental system attributes. One size does not fit all, even when situations may appear very similar. Any ecological restoration or management effort involves both explicit and implicit attempts to prescribe and predict the ecological future of a site. These efforts require extrapolating far beyond our predictive abilities, and we must be aware of our limitations as scientists, as well as our tendency as humans to rely on partial truths and assumptions when implementing ecological restoration and management projects.

We conclude by suggesting a final myth of restoration ecology, but one held by society—the Bionic World. The myth of the Bionic World is a belief that science and technology will solve the pressing issues of human population growth, finite resources, and altered ecosystems. In the Bionic World, degraded landscapes will be fixed or reconstructed with the precision and surety of the "Bionic Woman" and the "Six Million Dollar Man" in the U.S. television shows of the 1970s. If we follow this logic, we have no tough choices to make about how we view and treat our surroundings, and decisions can be put off until the economic markets demand or justify a solution. Let's hope they're right, but until supporting evidence emerges, we must maintain what we have.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol10/iss1/art19/responses/

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Synthesis: Is Alcoa Successfully Restoring a Jarrah Forest Ecosystem after Bauxite Mining in Western Australia?

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Abstract

A range of reviews and technical reports have been presented in this volume that cover many components of the jarrah forest ecosystem and its restoration after bauxite mining in Western Australia. This synthesis reviews these papers and attempts to decide if the jarrah forest ecosystem has been restored. All ecosystem functions, including nutrient cycling and nutrient accumulation, appear to be successful or developing on an appropriate trajectory. Structural attributes of the restored vegetation are controlled by the floristic composition and growth of the vegetation and are developing favorably with time. Biodiversity measures show some deficiencies, which should be solved by time (e.g., lack of old rotting wood and tree hollows for fauna) or are the subject of ongoing research and development (e.g., imbalance of seeder/resprouter plant species). Various ways of measuring the success of Alcoa's restoration are discussed and a numerical scorecard is presented. The overall scores were calculated as between 90 and 92% depending on the input parameters used. Such scores seem to agree with the overall subjective impression that Alcoa's mine restoration is largely successful at restoring the jarrah forest ecosystem. A single measure of ecosystem restoration success, which acts as a surrogate for all others, does not exist, but the use of two such measures, soil organic carbon levels and floristic similarity, would adequately integrate all ecosystem components and could be used to determine the level of ecosystem restoration in this region.

Key words: Alcoa, ecosystem, restoration, success, summary, synthesis.

Introduction

Before reviewing the studies in this special issue it is worthwhile considering why Alcoa spends AU$34,000/ha to restore its mined areas (Gardner & Bell 2007) and employs over 30 environmental staff in its mining operations. Alcoa's mines in Western Australia are close to the main center of population and largely within Perth's drinking water supplies (Croton & Reed 2007). The operations are constantly under public and government scrutiny. Alcoa's environmental ethos has developed under this scrutiny. Alcoa's aim is to achieve the best mine restoration and environmental performance in the world and in this way stay ahead of any legislative requirements that exist (Gardner & Bell 2007). The stated objective "To restore a self-sustaining jarrah forest ecosystem, planned to enhance or maintain water, timber, recreation and conservation values" (Gardner 2001; Koch 2007*a*) is an ambitious one that is beyond "reclamation," "revegetation," and "rehabilitation" but which has led to high standards of environmental performance and mine restoration.

Most of the studies in this special issue show that ecosystem components have been successfully restored or are on a trajectory toward recovery. Forest tree growth and productivity is high (Koch & Samsa 2007); fauna return, nutrient cycling, soil processes, and microbial activity are mostly dependent on and respond positively to vegetation development (Grant et al. 2007*b*; Jasper 2007; Majer et al. 2007; Nichols & Grant 2007). Silvicultural characteristics of the restored forests are the same as productive forests elsewhere and in the unmined jarrah forest (Grant et al. 2007*a*; Koch & Samsa 2007) and the new ecosystem shows resilience to fire (Grant et al. 2007*a*). Plant recruitment after fire is high, confirming that pollination, seed set, and plant establishment are occurring (Grant et al. 2007*b*; Koch 2007*a*). Tree root growth is satisfactory, provided the mined areas are adequately ripped (Croton & Ainsworth 2007; Kew et al. 2007; Szota et al. 2007). There is little spread of the dieback pathogen *Phytophthora cinnamomi* due to mining (Colquhoun & Kerp 2007) and there is evidence that the restored areas are less susceptible to the disease than some areas of the unmined forest (Koch & Samsa 2007).

Some ecosystem parameters are still unrestored. Hollows in old trees, which provide specific fauna habitat, are obviously still missing from restored areas (Nichols & Grant 2007), and some fauna and fungal taxa that require

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old rotting wood have not yet returned to the restored areas (Jasper 2007; Majer et al. 2007). Plant species richness in newly restored mines is up to the values seen in the unmined forest (Koch 2007*a*); however, abundances of resprouter plant species are still lower in restored sites compared to the unmined forest. Not all taxa have been studied, including lower plants, some invertebrate groups, and some microorganisms. This is due to the difficulty of studying poorly known taxa and the shear volume of this task. Nevertheless, there is no evidence that any of these groups will not follow similar trends to those that have been studied. Streamflow from restored areas is decreased in the midterm due to vigorous early plant growth (Croton & Reed 2007); however, it is not known if this is a long-term effect.

Has the Ecosystem Been Successfully Restored?

Each area of study presented in this special issue is important on its own and contributes valuable knowledge to science. However, as restoration ecologists we also ask if we can assess this work holistically to decide if the jarrah forest ecosystem is being successfully restored after mining? In tropical rainforest, Ruiz-Jaen and Aide (2005*a*) compared four measures of vegetation structure, four measures of species diversity, and six measures of ecosystem process among pre-reforested, reforested, and reference sites to determine the best measure(s) of success. They did not recommend specific measures but suggested that by including vegetation structure, species diversity, and ecosystem process measures they had better information to determine the success of a restoration project. Ruiz-Jaen and Aide (2005*b*) also provided a comprehensive review of which measures of success have been used in 468 published restoration studies over the past 11 years in the journal *Restoration Ecology*. Only 68 studies measured restoration success. Most studies used measures that fall into the three major ecosystem attributes: vegetation structure, diversity, and ecological processes. They recommended that to measure success, ecologists should include at least two variables within each of the three ecosystem attributes described above. Restoring biodiversity is often the most difficult aspect of mine restoration. Wilkins et al. (2003) found that vegetation structure and important ecosystem functions could be restored by intensive nursery stock planting, but plant diversity measures were not significantly improved. Ross et al. (2004) also reported that even after 26 years, restored coastal sand mines were still floristically different to unmined areas despite having a similar vegetation structure. In 15 different coal mines, Holl (2002) found that there were significant floristic differences to unmined forests even after 35 years. Where the goal is restoration back to native vegetation, perhaps biodiversity (both plant and animal) should be the only measure of success because the literature indicates that restoration of vegetation structure and ecosystem function often appear to be easily achieved.

Multiple Ecosystem Attributes as a Measure of Success

The three areas of ecosystem attributes as described by Ruiz-Jaen and Aide (2005*a*) are discussed below in relation to Alcoa's bauxite mine restoration.

Vegetation Structure. Vegetation structure in Alcoa's restoration sites is assessed using the levy pole (measures vegetation touches at 30-cm vertical intervals) (Grant et al. 1997, 1998), but establishment density and growth dynamics of the tree species also provides an indirect and predictive measure of vegetation structure. The structure of restored sites is different to the unmined forest at first due to vigorous early growth but becomes more similar after time, hazard reduction burning or silvicultural thinning (Grant et al. 1998; Norman et al. 2006; Grant et al. 2007*a*). By returning a wide range of plant species of the jarrah forest, the multilayered vegetation of the jarrah forest (tall trees, subordinate trees, shrubs, subshrubs, and herbs) is also restored to post-mining areas by default.

Diversity Measures. Alcoa also routinely measures plant species richness, diversity, evenness, and similarity (Nichols & Michaelsen 1986; Norman et al. 2006; Koch 2007*a*) in restored sites as well as vertebrate fauna assemblages in a range of restoration ages (Nichols & Grant 2007). Plant species richness and diversity in restored mines now approach that of the unmined forest (Tacey & Glossop 1980; Nichols & Michaelsen 1986; Norman et al. 2006; Koch 2007*a*). However plant species similarity (measured by the Sorensen index) of restored to unmined forest is generally about 60% of the value found in unmined forest to unmined forest comparisons due to a predominance of reseeder species in the restored sites (Koch 2007*a*). Fauna species richness and diversity also approach that of the unmined forest (Nichols & Grant 2007), although some skinks (reptiles) prefer more open unmined forest to the more densely vegetated, young restored sites. The Southwestern cool skink (*Bassiana trilineata*), however, prefers the restored habitat over the unmined forest (Nichols & Nichols 2003; Nichols & Grant 2007).

Ecological Processes. Grant et al. (2007*b*) specifically addresses the question of whether jarrah forest ecosystem functions have been successfully restored. It appears however that deep ripping of the mined areas (Croton & Ainsworth 2007) is essential for the restoration of ecological processes (Szota et al. 2007). In Grant's (2006) state-and-transition model for Alcoa's bauxite mine restoration, soil compaction is the single most important abiotic threshold that must be overcome before biological processes can occur. Studies over the past 20 years have emphasized the importance of returning topsoil, application of fertilizer to offset any losses through vegetation removal, and the soil handling process, and establishing native nitrogen-fixing legume species in restored areas. The resultant vegetation growth, litter accumulation,

nutrient buildup, and decomposition rates are comparable to the unmined forest. The accumulation of biomass and nutrients in restored areas has been rapid. Although future fire and silvicultural management of restored areas will lead to losses of some nutrients, particularly nitrogen, research has shown that restored areas are resilient and nutrients will rapidly return to predisturbance levels. Topsoil seed stores rapidly accumulate in restored areas, indicating that plants are flowering and setting viable seed. Grant et al. (2007*b*) concludes that to date, all measured ecosystem function parameters indicate that restored areas have achieved or are on a trajectory toward a self-sustaining jarrah forest ecosystem.

Herbivorous, detritivorous, and nectivorous animals return quickly to restored sites (Nichols & Grant 2007; Majer et al. 2007). Insectivores and carnivores also return when food and habitat develop. Coarse woody debris is returned to restored sites (Koch 2007*b*; Nichols & Grant 2007), but old trees and tree hollows are presently missing from restored sites. These components will probably take 100 years or more to become available (Whitford 2002), which could slow down the return of organisms that require this habitat.

Within the restored mines the key hydrological process is the ability of the deep soil profile to store winter rainfall, and for the vegetation to use this water over the summer drought. Rainfall to runoff coefficients in unmined jarrah forest are approximately 15–25% (Schofield et al. 1989; Croton & Reed 2007). That means 75–85% of the annual rainfall is taken up as evapotranspiration. This is the key to having a forest growing in a Mediterranean climate. Nowhere else does this occur (Dell & Havel 1989). The removal of the lateritic caprock during the mining process will undoubtedly change the hydrological characteristics of the soil profile; however, 30 years of experience and monitoring indicates that the restored vegetation has access to this water and that vegetation productivity is not limited by water availability.

Based on these ecosystem components it would seem appropriate to conclude that the jarrah forest ecosystem has been successfully restored. The removal of the bauxitic duricrust by mining means the ecosystem will never be identical to the pre-mining state but is likely to be a modified jarrah forest ecosystem. But what does this mean in a regional context? The northern jarrah forest is not just a single homogeneous ecosystem. Different jarrah forest site vegetation types exist (Havel 1975; Koch 2007*a*), which are the result of variations in the underlying geology and consequent moisture and nutrient conditions of the soils. Parts of the native landscape, particularly the lower lying slopes near the valley floors, do not have duricrust and the friable zone that make up the "bauxite" layer, which is why they are not mined. Therefore, after mining and restoration, the regolith profile is more similar to the indigenous lower slopes in the native forest. A consequence is that the vegetation in restored areas may be more similar to a valley site vegetation type. Decreasing rainfall trends (Croton & Reed 2007), however, could counteract this effect.

Restoration of Pre-Mining Land Uses

Another measure of restoration success is essentially anthropocentric and examines the question, "are the pre-existing land uses of the jarrah forest being restored?," and if they are all being restored, then the restoration is successful. This changes the focus of restoration toward utility for humankind and in many places in the world human needs and impacts outweigh "natural needs." Lamb and Gilmour (2003) discusses this issue in detail and provides case studies over the whole spectrum. They list potential indicators of restoration success in two columns: biophysical and sociocultural (Table 1). The land uses of the jarrah forest region are water catchment, timber production, recreation, conservation, some agriculture, apiculture (bee hives), and mining. All these land uses could be described as sociocultural, although several also have biophysical components.

Completion Criteria. Alcoa has an agreed set of completion criteria for both early rehabilitated areas with nonindigenous tree species and post-1988 restored areas, which have only indigenous plants used for restoration (DoIR 2002; Gardner & Bell 2007). The most recent criteria consist of 32 measures ranging from diversity measures and fire resilience, through to access and safety considerations (DoIR 2006). These criteria specify the minimum requirements for restored sites to ensure they will fulfill pre-mining land uses and will restore important ecosystem processes. They not only cover ecosystem measures, but importantly, also ensure that the government and the community accept that the land has been restored. They are very similar to the elements listed by Lamb and Gilmour (2003; Table 1) but are quantitative because they are based on many years of research and measurement. Most criteria are assessed early in the post-mining landscaping and revegetation period and any inadequacies are corrected at this early stage. Provided the procedures are followed, the "sign-off" of these criteria is an important integrated measure that restoration has been successful. A 975-ha area of the Jarrahdale mine received a "certificate of completion" from the Western Australian government in November 2005. Using these criteria, this area can be considered successfully restored. All of Lamb and Gilmour's potential indicators are also satisfied, although some of their sociocultural indicators may not apply to the jarrah forest.

Water Catchment. For humans this may be the most important land use of the jarrah forest. It includes both water quality and quantity (Croton & Reed 2007; Gardner & Bell 2007). Water quality remains high after mining due to strict internal and legislative controls on turbidity, hydrocarbon management, and salinity (Croton & Reed

Table 1. Potential indicators of success in restoration and rehabilitation programs.*

Biophysical	*Sociocultural*
No further disturbances occur that promote degradation	Stable human populations
Adequate plant cover or vegetation across landscapes	Stable or equitable land tenure system
Vigorous plant growth (e.g., tree height, diameters)	Stable land use pattern
Appropriate community structure (e.g., overstorey and understorey)	Adequate food supply and standard of living
Appropriate plant species present (including range of life-forms or functional groups)	Appropriate balance between tree and agricultural crops
Appropriate wildlife species present (including mutualists)	Stable market prices
Declining cover or populations of weeds and pest species	Stable firewood consumption rate
Appropriate trophic diversity (producers, consumers etc.)	Stable rate of water use
Adequate regeneration or reproduction of desired species	Public involvement and participation in program
Stable soil surfaces	Income provided to community
Adequate water quality in streams draining from site (e.g., reduced sedimentation or salinity)	Increasing public ecological awareness (especially in children)
Adequate crop or timber yields	Increasing economic flexibility
Decreasing need for inputs such as fertilizers (because of nutrient cycling)	
Decreased need for weed and pest control (because these are scarce or have been excluded)	
Decreasing need for irrigation	
Increasing kinds of land use possible	

* From Lamb and Gilmour (2003).

2007). Water quantity is measured as streamflow into water reservoirs (Croton & Reed 2007). Yields from mining areas are higher than from unmined catchments for about five years before returning to pre-mining yields and then decline below these as the vigorous regrowth uses this water (Croton & Reed 2007). This was particularly evident in catchments that had been severely "deforested" by the disease *Phytophthora* dieback prior to mining and where the restored mines developed a vigorous vegetation cover. It is not known yet whether this reduced stream yield is a medium-term effect of the vigorous regrowth, which will recover as the vegetation matures, or if it is a long-term change (Schofield et al. 1989). Further research is currently under way to determine this. The declining rainfall in southwestern Australia due to global warming (IOCI 2002; Croton & Reed 2007) is a confounding factor as well.

Timber Production. Restored bauxite mines can successfully produce jarrah trees with timber potential. The Department of Conservation and Environment standard is straight single stems at a density of 300 stems/ha or more (Koch & Ward 2005; Koch & Samsa 2007). The quality of the timber and longer-term growth rates are not available due to the relatively young age of the trees, but current data suggest that jarrah trees growing on restored mines show all the same silvicultural features, including growth response to thinning (Grant et al. 2007*a*), as equivalent regrowth trees in the unmined forest (Koch & Samsa 2007).

Recreation. Completion criteria specify that restored mines must provide landforms and slopes that will allow future unimpeded access (Elliott et al. 1996; DoIR 2002). Walking trails and mountain bike trails have been reinstated in restored mined areas. A lake and picnic site have been developed in one area at Alcoa's oldest (now decommissioned) mine at Jarrahdale as well as a shooting range in another area. Restoring recreation values works on a case-by-case basis. The mining operation can provide an opportunity for alternative recreational land use in restored areas. However, surveys on desirable recreational attributes for Alcoa's mines consistently find that the favored recreational criterion reported by the general public is that the native jarrah forest is restored.

Conservation. To completely restore the conservation value of the forest ultimately means putting it back the way it was. This is not strictly possible particularly because the bauxitic duricrust layer is removed by mining. A "very similar" jarrah forest ecosystem is a realistic goal. Restoring the pre-mining plant species in the same density and composition would ensure that faunal assemblages are also returned because both vertebrate and invertebrate fauna are highly dependent on the vegetation composition and structure (Majer et al. 2007; Nichols & Grant 2007). The relative imbalance of resprouter versus reseeder plant species in restored areas (Koch 2007*a*) may reduce the conservation value of the restored mines. However, there are other positive conservation aspects, including Alcoa's commitment since 1991 to use only local provenance, indigenous plant species in seeding and planting, and to ensure the species and genetic integrity is not compromised (Krauss & Koch 2004; Koch 2007*a*). Also, Alcoa's funding of Operation Foxglove, a program aiming to

reduce the abundance of feral predators, especially foxes (*Vulpes vulpes*), has assisted conservation of native fauna throughout the forest, including restored areas (Nichols & Grant 2007). Conservation of biota arguably requires that the diversity of plants, animals, and habitats is known. Alcoa supports and carries out research on a wide range of taxa both in restored mines and in the unmined jarrah forest, which provides important knowledge on the biota. Some of the papers in this special issue are examples of this information.

There is a legacy of earlier rehabilitation that did not use indigenous jarrah forest plant species (31% of area at the end of 2006). This is a diminishing proportion and is a result of the progressive development of expectations, understanding, and capacity (see table 1 in Gardner & Bell 2007). Additionally, Alcoa is actively converting these areas to native jarrah as the nonindigenous timber is harvested.

One Key Measure of Ecosystem Restoration

A third approach to measure the success of restoration is to try and identify a single or simple ecosystem measure that acts as a surrogate for a larger number of ecosystem processes and use this as a success measure. Ludwig et al. (2004, 2005) developed a quantitative system called "landscape function analysis" (LFA) to measure the ability of a restored landscape (or a degraded landscape) to capture and retain resources. These resources include seed pools, organic matter accumulation, soil particles, and water. Accumulation of these materials accelerate the vital processes of germination, organic matter processing, nitrogen fixation, soil carbon sequestration, soil macrofaunal and microbial activities, and soil nutrient transformation. These in turn represent a myriad of largely biologically mediated processes that are the "engine room" of natural ecosystem health. The LFA system uses 11 measures to produce three indexes (stability, infiltration, and nutrient cycling). Landscapes score highly when resources are retained on site and score poorly when these components are lost from the site, usually by erosion. The score can be used as a measure of restoration success. LFA is used extensively in arid and semiarid zone mine restoration in Australia. Alcoa's restored mines at Jarrahdale have been tested using LFA and provided the restoration was carried out correctly, high scores were obtained (Tongway et al. 1997). LFA integrates most important ecosystem processes and when combined with a biodiversity component is an appropriate measure of restoration success.

Ultimately, it seems the development of a functioning soil with the associated biota in all taxonomic groups is a measure of successful ecosystem restoration. The formation of soil takes a long time, in the order of several decades at least in this ecosystem (Jasper 2007). Formation of a soil is dependent on a wide range of plant and animal contributors from all taxonomic groups. The initial development and formation of a soil is dependent on the organisms, but once functioning, the organisms are then dependent on the soil. The one key measure that indicates that a true soil is formed appears to the organic matter content, measured as organic C. Organic matter content both drives soil processes and is dependent on the soil processes and all the organisms. Higher plants drop leaves and die, making litter; the litter decomposes and feeds the population of animals, plants, and microorganisms. Jasper (2007) proposes that soil microbial biomass is a reliable indicator of ecosystem development, which in turn is largely driven by plant productivity, and hence a productive vegetation is a good indicator of restoration success. This is probably true for the main ecosystem drivers, but it does not take into account the values or contribution of biodiversity to the ecosystem. The restored ecosystem may be highly productive but will only ever be "reclaimed," "revegetated," or "rehabilitated" (Aronson et al. 1993) and not "restored" if the plant and animal diversity is not returned (see Hobbs & Norton 1996 for a discussion on terminological issues relating to restoration goals and outcomes). Alcoa's objective is restoration of a complete functional ecosystem, and so it would seem two measures of restoration success are required: one is the development of soil, as measured by organic C content, and the other is return of plant and animal diversity.

Overall Scorecard

A hypothetical restoration scorecard has been constructed based on three different systems: (1) restoring pre-mining land uses; (2) multiple ecosystem attributes (Ruiz-Jaen & Aides 2005*a*); and (3) one key measure (Table 2). This has been applied to Alcoa's jarrah forest mine restoration here. The individual scores are out of 10 with no importance weighting applied. The score out of 10 is subjective and is only less than 10 if there were some measured or perceived deficiency in a component. The plant species similarity measure (6/10) is based on actual data. All three methods of measuring ecosystem restoration success actually use similar inputs. Restoring pre-mining land use scores full points for all uses except water production, which scores 8/10 due to possible streamflow reductions by vigorous vegetation growth (Table 2). Conservation scores 8/10 due to the imbalance of resprouter and reseeder plants, and the lack of nesting hollows in old trees. The total score is 36/40 or 90.0%.

Ruiz-Jaen and Aide's (2005*a*) multiple ecosystem attributes method of at least six measures (two each from three ecosystem attributes) again gives full points for four of the six measures, 9/10 for the water cycle, and 6/10 for floristic similarity. The score for water cycle in this method is higher than for water production in the restoring pre-mining land uses method because the anthropocentric importance of the water cycle is less than water production. In this system the total score is 55/60 or 91.7%.

The one key measure of success that acts as a surrogate technique is likely to need two measures for jarrah forest

restoration as discussed previously. Soil organic carbon will score full points as the restoration ages (several decades), and the biodiversity score is again 8/10 due to the imbalance of resprouter and reseeder plants, and the lack of nesting hollows in old trees. The total score using this technique is 18/20 or 90%.

Obviously there are shortcomings to this type of "tick-the-box" scorecard. There is no weighting and hence no consideration of whether some ecosystem components are more important than others. The numbers out of 10 are also subjective. For example, a reduced score of 8/10 for biodiversity due to a lack of nesting hollows for birds could be regarded as too generous by an ornithologist but may be acceptable to a forester whose priority is growing timber. However, in support of the scorecard, Alcoa's agreed completion criteria for mine restoration are in this tick-the-box format and as such are easily understood by most stakeholders.

The numerical scores of between 90 and 92% seem to agree with the overall impression that Alcoa's mine restoration is largely successful at restoring a jarrah forest ecosystem. For instance, Grant (2006), using an approach that identified desired states and trajectories for post-mining areas at different stages of the process, suggested that, of the 6,429 ha of native species restoration undertaken between 1991 and 2002, 98% was on or above the desired trajectory. This provides another potential way of assessing restoration success, which can potentially encapsulate some of the other measures discussed above.

Future Challenges

As emphasized by Gardner and Bell (2007), Alcoa's restoration process has been evolving continuously over the more than 30-year history of Alcoa's mining in Western Australia. However, there are still some unknowns and possible shortcomings. Time is expected to solve some of these, such as the lack of rotting wood and old hollow trees for fauna habitat. Reduced stream yields may be a medium term effect due to vigorous early growth of the restored vegetation and may return to pre-mining levels as the restored forest matures. Redressing the imbalance of resprouter/reseeder understorey species in restored sites is the subject of ongoing research and is also expected to improve with age. However, more fundamental questions such as the nature of the target ecosystem may continue to produce challenges and changes to current practice. For instance, we highlighted the possibility that lower lying slopes without duricrust may represent a more realistic target system due to the removal of the duricrust in the mining process. Added to these spatial issues are ongoing temporal changes, including climate change, which may necessitate a continuous reevaluation of targets and success criteria (Harris et al. 2006).

Table 2. Three possible methods of measuring success of ecosystem restoration and scores for Alcoa's mine restoration in Western Australia.

Restoration of pre-mining land uses		
Land use	Score (maximum 10)	Comment
Water production	8	Possible reduced stream yield
Timber production	10	Tree stocking and growth meet requirements
Recreation	10	Mine restoration can accommodate any requirement
Conservation	8	Resprouter/reseeder imbalance. Old hollows absent for a century or more
Total score	36/40 (90.0%)	
Measure	**Score (maximum 10)**	**Comment**
Multiple ecosystem components (Ruin-Jaen & Aide 2005*a*)		
Water cycle	9	Higher score than that of "water production" due to less human-based requirement
Carbon cycle	10	Is on track but will take decades to reach unmined forest values
Levy pole structure	10	Controlled by correct species composition
Multilayered forest	10	Controlled by correct species composition
Plant species richness	10	Internal 100% target achieved in 2001
Plant species similarity	6	Using Sorensen similarity index
Total score	55/60 (91.7%)	
One key measure		
Soil organic carbon	10	Is on track but will take decades to reach unmined forest values
Biodiversity	8	Resprouter/reseeder imbalance. Old hollows absent for century or more
Total score	18/20 (90.0%)	

The Broader Context

In this paper, and in the special issue in general, we have presented information on what is generally regarded as a very successful restoration operation. The fact that the idea for this special issue was first raised at the SERI meeting at which Alcoa won an award from SERI indicates broad recognition of Alcoa's achievement. And yet it must be acknowledged that the type of restoration being undertaken following mining represents a truly industrial-scale operation involving large amounts of heavy equipment, technology, and underpinning science, and at a relatively high cost (AU$34,000 /ha; Gardner & Bell 2007). A debate is ongoing, particularly in North America, as to whether this type of restoration activity actually qualifies as true restoration because it seems divorced from the more community-based restoration activities, which aim to not only restore nature but also restore humanity's connection with nature (e.g., Higgs 2003; Jordan 2003). Higgs (2005) also questions whether science-driven restoration is sufficient in itself again because science does not encompass other elements of how humans interact with nature.

The scale of the Alcoa restoration program (approximately 550 ha/yr) precludes a community "hands-on" approach, but Alcoa's Environmental Improvement Plan process involves ongoing discussion with the community and ensures interested stakeholders have an influence on the restoration activities. Visitors to the mines (approximately 8,000 per year; Gardner & Bell 2007) nearly all believe that restoration back to a jarrah forest is the appropriate objective although it is likely most do not have a close connection to the ecosystem. Aboriginal use of the jarrah forest is currently minor or nonexistent. It could be argued that those involved in the restoration develop a close connection to the ecosystem even if they drive large machinery while they are restoring it. (They may also be involved in the logging and clearing of the forest prior to mining.) So is there a spiritual connection to the ecosystem? If not, does this really devalue the activity, or is there room for both types of restoration in today's world. In the case of the mines in the jarrah forest of Western Australia, the requirement for large-scale soil movement and treatment means that a mechanized approach is inevitable from the start. It could be argued that many of the restoration issues facing humanity around the world are of such a magnitude that a more corporate/industrial approach is the only approach that can work at a scale commensurate with the problem. This is true in the agricultural areas to the east of the jarrah forest in Western Australia, the many large river and wetland systems and their watersheds across the globe that need restorative action, and many city and industrial areas in need of renewal. And so, maybe the success of the Alcoa restoration operation signals the need for a pluralistic view that legitimizes different types of activity, some of which have a strong community-based spiritual element and others, which take a more mechanized and corporate approach to pressing large-scale problems. Both types of restoration focus on repairing damage to the earth, and both are vital parts of the overall portfolio of restoration activities needed for the future.

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Mapping opportunities for forest landscape restoration

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More than two billion hectares of the world's deforested and degraded landscapes offer potential for restoration – a vast opportunity to reduce poverty, improve food security, reduce climate change and protect the environment.

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The typical response to the loss of forest cover has been to plant trees, usually, but not always, on an industrial scale, and with a limited mix of species. Indeed, planted forests now make up 7 percent of the world's forest area and contribute over 40 percent of the global industrial wood and fibre supply (FAO, 2010).

However, many planted forests have limitations in that they cannot supply the broad range of forest goods and services that society often requires. Therefore, about ten years ago, building on decades of field experience and observation, the concept of *forest landscape restoration* was introduced. Forest landscape restoration is an integrating framework that can, and should, be applied across a range of land uses to ensure that key ecosystem functions and societal requirements are maintained and strengthened.

Importantly, forest landscape restoration does not seek a return to past visions of land use. Rather, it is designed to ensure that present and future generations have key ecosystem goods and services at hand and deal effectively with the uncertainties of climatic, economic and social change.

Forest landscape restoration restores functionality and productivity to degraded lands and forests. Trees in agricultural landscapes can boost food production and resilience. Restored lands can supply clean water, reduce erosion and provide wildlife habitat. Forests and trees mitigate climate change by sequestering carbon.

Source: Minnemeyer *et al.*, 2011. Visit www.wri.org/restoringforests to view a large-size version of the map.

Lands with opportunities for restoration of forests and landscapes. Forests without restoration needs and croplands on former forest lands are not shown

Opportunities for restoration

Experience shows that restoration is possible. Forests have returned to vast, formerly deforested areas in North America and Europe. Costa Rica and the Republic of Korea, among others, have embarked on successful forest restoration strategies. Restoration efforts in China, the Niger and the United Republic of Tanzania are slowing desertification and restoring woodlands with associated dramatic improvements in livelihoods and ecological health. Agroforestry systems are rapidly expanding in many parts of the world, enhancing the productivity of crop and livestock production.

Most countries that have suffered forest loss and degradation have opportunities for restoration. Yet these opportunities are often overlooked. The Global Partnership on Forest Landscape Restoration therefore asked a consortium of organizations led by the World Resources Institute to map the global opportunities for restoration (Figure; Minnemeyer *et al.*, 2011).

Method

The *potential* extent of forests and woodlands, rather than today's extent, was used as the point of departure. Apart from the obvious reason that forests can grow in these areas, potential forest extent is also a useful benchmark for assessing the historical change in forest cover.

Three categories of forests were distinguished: closed forests (canopy cover greater than 45 percent), open forests (canopy cover between 25 and 45 percent) and woodlands (canopy cover between 10 and 25 percent). Land with less tree cover was considered to be either naturally non-forested or converted to some other land use from any of the forest categories above.

Only pre-existing information was used. Definitions and data are not particular to individual countries.

We first mapped where forests and woodlands could potentially grow, if soils and climate were the only limiting conditions, i.e. where forests would grow if there were no human influence. Although trees play an important role there, dry areas such as the Sahel were not included, because of their very low potential forest density.

Next, we mapped the current extent of forests and woodlands. Forest maps were derived from global 250 m resolution satellite imagery.

We then identified restoration opportunities by comparing the maps of potential and current forest extent in light of information about current land use. Croplands on former forest land, intact forest landscapes and managed natural forests and woodlands were mapped as having no potential for restoration (although this is not always true).

Then, we considered constraints on restoration by mapping human pressure as a combination of population density and land use. Restoration opportunities in remote, unpopulated areas were also identified.

Finally, deforested and degraded forest lands were divided into four categories, resulting in a map of restoration opportunity areas and other former forest lands:

- **Wide-scale restoration** – Population density of fewer than 10 people per km^2 and potential to support closed forest.
- **Mosaic restoration** – Moderate human pressure (between 10 and 100 people per km^2). Restoration to a mix of people, trees and crops (e.g. into agroforestry parklands, small, frequent patches of woodlands, improved farm fallow and secondary forests and linear arrangements such as hedgerow, contour planting and along water courses).
- **Remote restoration opportunities** – Very low human pressure (density of less than 1 person per km^2 within a 500 km radius). Restoration may not be feasible here.
- **Agricultural and urban lands** – Converted former forest lands with intensive human pressure (density of more than 100 people per km^2), croplands and urban areas

Results

More than two billion hectares (ha) worldwide provide opportunities for restoration. Most of these lands are in tropical and temperate areas. One and a half billion ha are best suited for mosaic-type restoration, and another half a billion for wide-scale forest restoration of closed forests. However, these results must be interpreted with caution. The map is based on significant simplifications, and the underlying information is both coarse and incomplete, and sometimes also of low accuracy. Good information was available on land cover, land use, population density and other factors. Yet many important factors, such as tenure and land-use dynamics, could not be considered, for lack of data.

The map shows landscapes where restoration opportunities are more likely to be found, not the location of individual restoration sites. Many features of the landscape are not visible at the level of spatial resolution of the map (1 x 1 km), and local context could not be considered. No ground validation was conducted.

The map shows the location of land with characteristics that indicate restoration opportunities, but it does not prescribe any particular type of restoration intervention. It is intended to inform the policy-making process at the global level and should be complemented by further investigation at regional and national scales, where more detailed information is needed and available.

Conclusions

Most countries have suffered forest loss or degradation. Opportunities for restoration exist on all continents and are huge in terms of area, although the estimate of their extent is rough.

Mitigation of climate change is a major benefit of restoration, making it an important complement to avoiding additional deforestation and degradation, as well as an opportunity in which many countries can engage, including countries with little or no deforestation left to avoid.

Most areas that present restoration opportunities are located far from ongoing deforestation. The world does not need to wait for deforestation and degradation to cease before it embarks on the path of restoration.

The Bonn Challenge

A global restoration goal has recently been launched – to restore **150 million ha** of lost and degraded forests by 2020. This goal was launched in September 2011 at a ministerial roundtable at the Bonn Challenge on forests, climate change and biodiversity, which was hosted jointly by the International Union for the Conservation of Nature and the German Ministry of Environment on behalf of the Global Partnership on Forest and Landscape Restoration. The Bonn Challenge links the decisions on forests made under the United Nations Framework Convention on Climate Change with those of the Convention on Biological Diversity, which adopted the goal of restoring 15 percent of destroyed or degraded ecosystems by 2020.

The map helped quantify these targets. For more information, see: **ideastransformlandscapes.org**.

While this goal may sound ambitious, it can be achieved through a doubling of current rates of afforestation, forest regeneration and silvipastoral/agroforestry expansion. This effort would meet the Bonn Challenge and help turn the vision of no net forest loss within the next decade into reality.

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SPECIAL FEATURE: PERSPECTIVE

Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses

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"Landscape approaches" seek to provide tools and concepts for allocating and managing land to achieve social, economic, and environmental objectives in areas where agriculture, mining, and other productive land uses compete with environmental and biodiversity goals. Here we synthesize the current consensus on landscape approaches. This is based on published literature and a consensus-building process to define good practice and is validated by a survey of practitioners. We find the landscape approach has been refined in response to increasing societal concerns about environment and development tradeoffs. Notably, there has been a shift from conservation-orientated perspectives toward increasing integration of poverty alleviation goals. We provide 10 summary principles to support implementation of a landscape approach as it is currently interpreted. These principles emphasize adaptive management, stakeholder involvement, and multiple objectives. Various constraints are recognized, with institutional and governance concerns identified as the most severe obstacles to implementation. We discuss how these principles differ from more traditional sectoral and project-based approaches. Although no panacea, we see few alternatives that are likely to address landscape challenges more effectively than an approach circumscribed by the principles outlined here.

food security | integrated development approaches | social ecological systems | agriculture environment trade offs | Convention on Biological Diversity

Global demand for agricultural land is on a collision course with environmental protection goals. We face a "perfect storm" as we struggle to feed a burgeoning population on a diminishing supply of land, water, nutrients, and biodiversity (1). Despite global efforts, ambitious targets and massive expenditure, there are as yet no general and effective solutions for meeting both nature conservation goals and human needs (2, 3). The Food and Agricultural Organization estimates a 70% increase in food production is needed to feed a projected population of 9.1 billion people by 2050 (4). Food production goals have to be met in ways that alleviate poverty, improve nutrition, and conserve the environment. Interactions among these challenges require that they be addressed in a concerted way. Sectoral approaches, despite still being predominant, have long been recognized as inadequate (5). For example, agricultural expansion and intensification threatens environmental goods and services (6), which could in turn undermine efforts to meet future food demands (7), while also affecting livelihoods and health (8). There are many uncertainties: climate change threatens to reduce crop production in some regions, but will perhaps provide new opportunities elsewhere (9); competing demands on land for climate change mitigation, biodiversity conservation, and agriculture implies tradeoffs, many of which are poorly understood and not easily resolvable (10). There will be no single best answer, and societies will have to confront challenges that transcend traditional agricultural and environmental boundaries. People and societies must make decisions. We contend that the quality of decision-making is a function of the process by which the decision is reached, and achieving objectives is an ongoing process subject to negotiation, learning, adaptation, and improvement. To this end, we identify 10 principles to guide the process of decision-making in landscape contexts. These principles emphasize that the integration of agricultural and environmental priorities will require a people-centered approach applied at landscape scales. We examine the multiple ways in which this is being approached and the validity of the underlying concepts.

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"Landscape approaches" have gained prominence in the search for solutions to reconcile conservation and development tradeoffs (11), and the term has evolved to encompass a wide variety of interpretations. Early conservation theory promoted landscape-scale thinking, particularly through the principles of island biogeography (12); debates about the appropriate size, number, and distributions of reserves and connectivity between them (e.g., refs. 13, 14); and metapopulation theory for maintaining viable populations (15). "People" and "society," however, were notably absent from such considerations, and, as a result, conservation has been beset by disappointments and failures (16–18). Thus, although conservation theory provided a stimulus and foundation for landscape approaches, their further development has come from the recognition of the need to address the priorities of people who live and work within, and ultimately shape, these landscapes (19). These priorities are often not aligned, and hence challenges are often "wicked" problems with no clear definitive formulation or final solution (20). In view of this, and also considering that system behavior is not wholly predictable, continuous adaptation and even "muddling through" (21, 22) is necessary (23, 24). Landscapes provide the setting over which wicked problems unfold, and the landscape approach provides the social-ecological systems' framework by which we can grapple with them (25–29).

A variety of landscape approaches are widely applied to complex real-world situations (30). Generally, they have been viewed as a means to conceptualize and implement integrated multiple-objective projects. A rich terminology has developed with the evolution of the various approaches. "Landscapes" have been defined in various ways. Drawing on ecosystem definitions, we define a landscape as an area delineated by an actor for a specific set of objectives (31). It constitutes an arena in which entities, including humans, interact according to rules (physical, biological, and social) that determine their relationships. In many cases, the objectives, arena, entities, and rules will change: our point is that the landscape is defined in broad conceptual terms rather than simply as a physical space (32).

The implementation of people-centered landscape approaches to environmental management has been embraced widely, with many conservationists now focused on multifunctional landscapes, and not solely on protected areas (11, 33). However, although many of the biophysical concepts and principles have been relatively well summarized and shared (e.g., refs. 28, 34), the human and institutional issues lack recent synthesis in the scientific literature. Here we fill that gap and discuss 10 principles that reflect the prevailing views in recent literature. They are based on current approaches and statements of "good practice" and on an extensive multidisciplinary consultation with a range of professional institutions, four formal workshops, and 137 further consultations via an online questionnaire (*SI Text*). Representing a consensus view, these principles were discussed by the Convention on Biological Diversity (CBD) during the 15th Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (35). Following a lengthy consultative process and eventual acceptance by the CBD, we expect that these principles will have traction in guiding landscape approaches to environmental management for some time to come. The principles are targeted at those seeking development and conservation outcomes in multiple-stakeholder contexts. Although some principles may not apply to some situations, and the full set may not be sufficient, these principles have broad support as guides to best practice. We advocate the use of these principles to address the critical emerging need to increase agricultural production and conserve environmental values.

Results

Our review of the literature failed to identify a universal definition for a landscape approach. The term is used to cover a diversity of approaches, many of which are very similar to those embodied in the various manifestations of the ecosystem approach (e.g., www.cbd.int/ecosystem/principles.shtml). Many practitioners use the two terms, landscape approach and ecosystem approach, interchangeably to loosely describe any spatially explicit attempt to simultaneously address conservation and development objectives. These terms share the virtue of being constructively ambiguous—meaning that people can agree on these approaches in principle while disagreeing on many key details that remain subject to negotiation. There are, however, communities of practice who apply narrower meanings. For example, the Society for Landscape Ecology has a strong focus on modeling the biophysical elements of landscapes (36), whereas, in much of Europe, landscape approaches are still largely synonymous with spatial planning (37). The de facto use of landscape approaches by most conservation organizations has evolved from the dominant paradigm of the late 20th century of integrated conservation and development projects (5, 38). It describes an approach to reconciling conservation and development through interventions in different components of a landscape matrix—some of which are managed toward livelihood development goals and others for conservation. The evolution of integrated conservation and development projects and ecosystem approaches toward landscape approaches has been incremental. The main substantive innovations have been the recognition of the need to address the complex interactions between different spatial scales, and the need to embrace the full complexity of human institutions and behaviors (38, 39).

Biodiversity conservation has been addressed in an explicitly "landscape context" since at least 1983 (40). The early uses of landscape focused on biophysical attributes (41). In 1997, a comprehensive account of ecosystem management used the term landscape only in the context of the visual (i.e., scenic) impacts of forest management interventions (42). The Forest Stewardship Council principles for Sustainable Forest Management (43), the Pan-European Indicators for Sustainable Forest Management,* and the CBD Principles of an Ecosystem Approach (www.cbd.int/ecosystem/principles.shtml), all developed in the 1990s, make only cursory reference to landscapes. This contrasts with the most recent 2012 revisions of the Forest Stewardship Council principles in which the landscape concept is much more prominent (http://ic.fsc.org/principles-and-criteria.34.htm).

More recently, the landscape concept has been central to some major international conservation initiatives. For instance, the Congo Basin Forest Partnership articulates its programs around 12 priority landscapes (http://carpe.umd.edu/works/landscape_detail.php?lid=8). The Worldwide Fund for Nature has advocated the conservation of forests in a landscape context since at least 2003 (44), and has configured a significant part of its conservation portfolio into a series of Global Initiatives, several of which work at landscape scales and address social and institutional issues. In 2007, the International Union for Conservation of Nature launched the "Landscapes and Livelihoods" initiative (www.iucn.org/about/work/programmes/forest/fp_our_work/fp_our_

*Ministerial Conference on the Protection of Forests in Europe. *Improved Pan-European Indicators for Sustainable Forest Management*. MCPFE Expert Level Meeting, 7–8 October 2002, Vienna, Austria. Available at http://www.foresteurope.org/documentos/improved_indicators.pdf.

work_initiatives/fp_our_work_ll/), explicitly addressing the dual goals of environmental conservation and poverty alleviation. Similarly, a Center for International Forestry Research/World Agroforestry Centre initiative, the "Landscape Mosaics" project, with case studies from Cameroon, Tanzania, Madagascar, Laos, and Indonesia, focused on wider landscape approaches to integrate agriculture, conservation, and other functions (45).

Ten Principles of Landscape Approach. The 10 principles of the landscape approach have now been adopted by the Subsidiary Body on Scientific, Technical and Technological Advice of the CBD, and have been submitted for consideration by the Conference of the Parties of the CBD in Hyderabad, India, in November 2012. The 10 principles are the product of an intergovernmental and interinstitutional process, and we present them in their official form. We provide our own interpretation of the justification and conceptual underpinnings of each principle. We also give examples of lessons learned in their application. The principles represent the consensus opinion of a significant number of major actors on how agricultural production and environmental conservation can best be integrated at a landscape scale (46).

Principle 1: Continual learning and adaptive management. Landscape processes are dynamic. Despite the underlying uncertainties in causes and effects, changes in landscape attributes must inform decision-making. Learning from outcomes can improve management.

Nonlinear relationships, external shocks, and unforeseen interactions and thresholds imply neverending potential for surprise. Each surprise is an opportunity for learning, leading to the development of new understandings as a basis for revised strategies. This learning and revision requires continual adjustment in which new knowledge is derived from multiple sources. Adaptive management and, more recently, "adaptive collaborative management" have emerged as practical approaches to this process of continual learning (47–49).

Principle 2: Common concern entry point. Solutions to problems need to be built on shared negotiation processes based on trust. Trust emerges when objectives and values are shared. However, stakeholders have different values, beliefs, and objectives. Totally aligned objectives are unlikely, costly to establish, or devoid of immediate significance. Identifying immediate ways forward through addressing simpler short-term objectives can begin to build trust.

Each stakeholder will only join the process if they judge it to be in their interest. Initially achieving consensus on overarching objectives may be difficult. Launching the process by focusing on easy-to-reach intermediate targets may provide a basis for stakeholders to begin to work together. In working toward this first goal, there will be opportunities for shared learning. The process will build the confidence and the trust needed to address further issues. Forest landscape negotiations in California (29) and the Pacific Northwest of the United States (50) illustrate how incremental progress can be made toward shared goals.

Principle 3: Multiple scales. Numerous system influences and feedbacks affect management outcomes, but these impacts unfold under the influence of a diverse range of external influences and constraints.

Outcomes at any scale are shaped by processes operating at other scales. Influences include feedback, synergies, flows, interactions, and time lags, as well as external drivers and demands. An awareness of these higher and lower level processes can improve local interventions, inform higher-level policy and governance, and help coordinate administrative entities. Studies by Ostrom in various sites illustrate the importance of addressing multiple scale issues (51).

Principle 4: Multifunctionality. Landscapes and their components have multiple uses and purposes, each of which is valued in different ways by different stakeholders. Tradeoffs exist among the differing landscape uses and need to be reconciled.

Many landscapes provide a diverse range of values, goods, and services. The landscape approach acknowledges the various tradeoffs among these goods and services. It addresses them in a spatially explicit and ecosystem-driven manner that reconciles stakeholders' multiple needs, preferences, and aspirations. The difficulties of quantifying and managing the interactions among these multiple functions have been extensively studied in the European Union (37).

Principle 5: Multiple stakeholders. Multiple stakeholders frame and express objectives in different ways (principle 2). Failure to engage stakeholders in an equitable manner in decision-making processes will lead to suboptimal, and sometimes unethical, outcomes. All stakeholders should be recognized, even though efficient pursuit of negotiated solutions may involve only a subset of stakeholders. Solutions should encompass a fair distribution of benefits and incentives.

Developing a landscape approach requires a patient iterative process of identifying stakeholders and recognizing their concerns and aspirations. Progress requires communication, which needs to be developed and nurtured, and mutual respect of values is essential. There is often a need to address conflicts, and issues of trust and power. Stakeholders and their concerns are not static but will change. Although many management agencies aspire to involving all stakeholder groups in decision-making, the transaction costs of doing this comprehensively can be prohibitive and total agreement can be elusive (29).

Principle 6: Negotiated and transparent change logic. Trust among stakeholders is a basis for good management and is needed to avoid or resolve conflicts. Transparency is the basis of trust (principle 2). Transparency is achieved through a mutually understood and negotiated process of change and is helped by good governance.

The need to coordinate activities by diverse actors requires that a shared vision can be agreed upon. This requires a broad consensus on general goals, challenges, and concerns, as well as on options and opportunities. All stakeholders need to understand and accept the general logic, legitimacy, and justification for a course of action, and to be aware of the risks and uncertainties. Building and maintaining such a consensus is a fundamental goal of a landscape approach (principle 2). Numerous attempts to secure consensus around major tropical land conversion projects and the widespread use of the principle of free, prior, and informed consent illustrate the potential and the difficulties of reaching broad agreement on such issues (52).

Principle 7: Clarification of rights and responsibilities. Rules on resource access and land use shape social and conservation outcomes and need to be clear as a basis for good management. Access to a fair justice system allows for conflict resolution and recourse.

The rights and responsibilities of different actors need to be clear to, and accepted by, all stakeholders. Clarification of conflicting claims will require changes, ideally negotiated, that may be legal or informal. When conflict arises, there needs to be an accepted legitimate system for arbitration, justice, and reconciliation. Recent decades have seen major changes in the mandates and management cultures of natural resource management agencies. Clarifying rights and responsibilities is now replacing the command-and-control approach. Facilitation and negotiation are emerging as the core business of resource management agencies (53).

Principle 8: Participatory and user-friendly monitoring. Information can be derived from multiple sources. To facilitate shared learning,

information needs to be widely accessible. Systems that integrate different kinds of information need to be developed.

When stakeholders have agreed on desirable actions and outcomes, they will share an interest in assessing progress. In a landscape approach, no single stakeholder has a unique claim to relevant information, and the validity of different knowledge systems must be recognized. All stakeholders should be able to generate, gather, and integrate the information they require to interpret activities, progress, and threats (principle 1). The gathering and interpretation of information is a vital part of developing and updating the "theories of change" on which the landscape approach is based (principle 6). Participatory monitoring in the Sangha Tri-National Landscape as part of the Congo Basin Forest Partnership has demonstrated how local stakeholders and government agencies can learn and adapt together (54).

Principle 9: Resilience. Wholesale unplanned system changes are usually detrimental and undesirable. System-level resilience can be increased through an active recognition of threats and vulnerabilities. Actions need to be promoted that address threats and that allow recovery after perturbation through improving capacity to resist and respond.

Perturbations impinge on all landscapes and their social and ecological structures. Maintaining and bolstering resilience, which is the capacity to avoid or deflect such threats and to absorb and recover from their manifestations, is vital to sustain processes and benefits in the longer term. Factors that contribute to system resilience are diverse and reflect ecological, social, and institutional attributes. Resilience may not be well understood in every situation, but can be improved through local learning and through drawing lessons from elsewhere (principles 1 and 10). The challenge in agricultural landscapes is often to bring about transformational change while maintaining the attributes of the landscape that provide resilience to undesirable changes (55, 56).

Principle 10: Strengthened stakeholder capacity. People require the ability to participate effectively and to accept various roles and responsibilities. Such participation presupposes certain skills and abilities (social, cultural, financial).

Effective participation makes demands of stakeholders. The complex and changing nature of landscape processes requires competent and effective representation and institutions that are able to engage with all the issues raised by the process. The learning process of the landscape approach is one means by which stakeholders can improve their capacity to judge and respond. It also provides a platform to share experiences within and among sites. The proliferation of local nongovernmental organizations addressing rural issues is a reflection of this and is recognized by the increasing willingness of development assistance agencies to support local civil society groups.

Discussion

The main driver of rural landscape change in coming decades is likely to be the intensity and spatial extent and location of agriculture. Agricultural intensification offers opportunities to close the substantial yield gap that afflicts many production systems, but this in itself is unlikely to be sufficient to meet the demands of a growing and increasingly affluent global population. Demands for nonfood land-based commodities, including wood products, vegetable oils, and biofuels (as well as mined resources), will also compete for space with agriculture. Intensification of land use and the inevitable expansion of land that is allocated to agriculture will combine to determine environmental outcomes.

The manner in which society responds to this, and the degree to which agriculture is constrained by measures to maintain environmental values, will not be determined at global or even national scales, but rather across landscapes in which agricultural and environmental objectives interact and often compete, ecosystem processes unfold, decisions impinge on other interests, and emergent properties of aggregated land use patterns are realized. Agricultural landscapes are no longer just farmed entities: they are now recognized as providing multiple values and services to diverse interest groups (37). Management of such landscapes is increasingly being seen as an evolving outcome of ongoing negotiation, and frequent conflict, among these interest groups. The principles of the landscape approach provide a framework by which outcomes negotiated among stakeholders can be reached most effectively. The means by which conflicting objectives are resolved will be subject to changing societal desires and will vary from place to place and over time. Thus, payments for environmental services, a currently popular approach in dealing with land use conflicts, are only likely to be successful if developed with due regard to the 10 principles. Similar issues are relevant to the implementation of the Reducing Emissions from Deforestation and Forest Degradation program, the expansion of oil palm in Southeast Asia, or the development of various mining interests in the Congo Basin. Current land use and environment conflicts often exist because of a failure to address one or more of the 10 principles.

Landscape approaches have emerged as the most widely advocated means to address growing pressures on land, water, and other resources, and to accommodate the needs of present and future generations. These approaches facilitate the simultaneous framing of development and conservation goals. They provide a process to steer the evolution of landscapes toward desirable futures. However, this broad engagement also means more objectives, tradeoffs, and complexity (57). A small selection of case studies (Table 1) identifies methods and tools that can be used to address each of the 10 principles, and also highlights some of the associated challenges.

There are challenges at many levels. A questionnaire survey of practitioners revealed that governance issues and those of poor institutional capacity are judged by practitioners and other experts to be the most pervasive (*SI Text*). Many of the challenges, governance and otherwise, reflect the conceptual changes needed to implement a landscape approach (53).

Landscape approaches imply shifting from project-oriented actions to process-oriented activities (58). This requires changes at all levels of interventions, from problem definition to monitoring and funding (Table 2). It ties stakeholders to long-term, iterative processes, giving them responsibilities and empowering them. It tends away from top-down engineered solutions toward more bottom-up negotiated actions that emerge from a process akin to muddling through (11).

Strategies applied to the wicked problems that are addressed through landscape approaches are not objectively right or wrong, they are simply more or less acceptable to different stakeholders (59). Stakeholders, including conservationists, need to recognize that working at landscape levels inherently changes how we look at the outcomes of our interventions. The straightforward concepts of success and failure become ambiguous in a multiple-stakeholder context in which someone's gain is someone else's loss. (For example, in the case of conservation interventions, did we or did we not stop the conversion of forest to crops?) Changes in one component of the landscape, even if desired, can have unintended and undesirable repercussions (60). Landscape approaches therefore demand an open-minded view of outcomes and acknowledgment of the tradeoffs likely to be involved in any

Table 1. Selection of case studies, methods, and tools that might be used to address each of the 10 principles, together with associated challenges

Principle	Tools and "how-to"	Constraints	Source
1. Continual learning and adaptive management	Adaptive management: https://miradi.org/	Expensive, slow, difficult to show results, disconnect with funding cycles, risk aversion, requires analytical skills, burn out	47–49
2. Common concern entry point	Approaches, www.cifor.org/mla/_ref/home/index.htm, http://satyadi.com/wordpress/wp-content/uploads/2010/04/COAIT_Manual_Part_I_RS_Format_2.pdf; Proactive conciliation tool, ref. 68, http://treadwell.cce.cornell.edu/ecoag1a/?p=41	Lack of common entry point, entrenched position, conflict and distrust	29, 50, 69
3. Multiple scale	Participatory GIS, www.iapad.org/toolbox.htm, ref. 70; see also participatory modeling, principle 8	Lack of methods for scaling up, endless complexity, time lags, limited predictability, disconnect between levels, difficulty of linking local to macroscale drivers of change	51
4. Multifunctionality	Multiple resource assessment and management: www.cifor.org/mla/_ref/home/index.htm, ref. 71	Difficulty to manage diversity and complexity, tradeoffs, incorporate multiple intangible values	37
5. Multiple stakeholder	ELDIS participatory approach, http://community.eldis.org/.59c6ec19/; social network mapping, ref. 72	Conflicting objectives, hidden agendas, identifying appropriate stakeholders, lack of capacity, power imbalance, lack of conceptual frameworks, distrust, high transaction costs, communication breakdowns	29, 73
6. Negotiated and transparent change logic	Theories of change: www.policy-powertools.org/index.html http://yosemite.epa.gov/R10/ECOCOMM.NSF/webpage/measuring+environmental+results	Hidden agendas, conflict of interests, lack of accountability, corruption, different norms and mediation institutions	50
7. Clarification of rights and responsibilities	Games: www.cifor.org/lpf/_ref/index.htm, www.policy-powertools.org/Tools/Understanding/TFR.html, www.rightsandresources.org/tenure_trends.php,	Legitimacy, overlapping rights or claims, unequal access to justice, corruption, power imbalances, lack of awareness, knowledge and education	53
8. Participatory and user friendly monitoring	Participatory modeling: http://cormas.cirad.fr/ComMod/en/, www.cifor.org/conservation/_ref/research/research.2.htm, http://wwf.panda.org/what_we_do/how_we_work/conservation/forests/publications/?uNewsID=120980	High transaction costs, lack of capacity, no linkage to decision making and benefits, formal vs. informal monitoring, social and political structure, credibility	54
9. Resilience	Resilience assessment: www.resalliance.org/index.php/resilience_assessment, ref. 74	Complexity, difficult to operationalize, inherent uncertainty in system, insufficient information, basic concept used ambiguously	55, 56
10. Strengthened stakeholder capacity	Participatory GIS, see principle 3: approaches to capacity building, www.undp.org/content/undp/en/home/ourwork/capacitybuilding/approach/, ref. 75	Lack of basic education and skills, limited government and institutional investments, short term projects, ubiquitous situations of weak governance and institutional failures make operationalization difficult	Broad range of approaches widely used, e.g., refs. 47, 50, 54, 58, 67

system change (61). Such compromises require decision-makers to consider all stakeholders and to work toward their inclusion in the processes.

Attempts to superimpose landscape approaches onto existing institutions through short-term projects will rarely work. The time scales involved and the concomitant difficulty to define and measure progress make it hard to retain the interest of donors. This may be more so because landscape approaches rarely have a clear endpoint. They deal with processes steered by individual decisions of multiple actors (e.g., farmers, land managers, policy makers) and influenced by the extent and nature of public debate and participation. However, the development of systems and institutions

Table 2. Contrasts between sectoral and landscape approaches to environmental problems

Issue	Sectoral or project approach	Landscape approach
Problem addressed	Simple	Complex (even "wicked")
Objectives and endpoint	Precisely defined	Loosely defined
Objective setting	Fixed in advance	Regularly revisited
Planning	Linear (grand design)	Nonlinear and in frequent need of revision (muddling through)
Scale	Local: Generally one or two major land uses	Larger scale: multiple interacting land uses
Scope	Generally well defined	Fuzzy and evolving (subject of consultation and negotiation)
Emphasis	Goal-driven	Process-driven
Success and failure	Easily identified ("black and white")	Perception of positive and negative outcomes are stakeholder dependent and determined by changing contexts ("shades of gray")
Monitoring	Progress can be measured, simple, evidence-based—defined in advance	Complex, targets move and desired outcomes may require modification over time
Learning	Informal and project cycle level	Integral and continuous, social learning
Management and governance	Clear and well defined organizational roles and structures	Organizational roles evolve and often overlap; civil society has increasing significance
Authority	Largely centralized and clear	Decentralized/distributed, potentially dynamic and negotiated
Time scale	Short to medium term (a few years)	Many years to several decades
Role of other actors	Subjects of a project	Participants within a process
External factors viewed as	Constraints and contexts	Possible subjects of higher level interventions to reduce threats or enable processes or outcomes
Negotiations to achieve	Specific outcomes	Engagement and to determine what is mutually acceptable
Role of science	To lead and define	To detect patterns, inform interpretation and contribute to evaluation and learning
Funding	Carefully budgeted; fits present-day donor cycles	Indeterminate (ideally institutionalized to support a long-term vision)

to facilitate constructive debate among interest groups toward a common understanding and resolution of complex objectives is a critical but neglected field within environmental management. Public participation, information dissemination, achieving consensus through public dialogue, and, notably, elevating the importance of the reflective process over that of the technical expert, is captured in our vision of the landscape approach. Changes in the mandates and cultures of natural resource management institutions in the past few decades in some countries have shown how progress can be made. Pressures for independent certification of forest management have contributed to the emergence of new types of institutions that have succeeded in facilitating landscape approaches (53).

The quality of stakeholder engagement, the degree to which various stakeholders concerns are acknowledged, and the investment in building trust and developing a shared vision will ultimately dictate the success or failure of the process. These processes are lengthy and incur significant transactions costs (29). Success has come in advanced economies in which civil society has greater influence and governance is strong. Less developed countries often lack the capacity and resources to maintain complex multiple-stakeholder processes for the time that is necessary, and the donors that support these countries rarely stay the course. Evidence-based decision-making is a vital component of management (38), but its limitations should be recognized. Evidence needs to be transparent to engender trust (principle 6) and accessible to facilitate participation (principle 8) and learning (principles 1 and 6). Transparency and accessibility also invite critique, often with assumptions being challenged and uncertainties manipulated to suit specific agendas, unless a common agenda can be agreed upon (principle 2). Although critique is to be welcomed, ongoing public debate on many environmental issues with few realistic solutions (not least climate change) illustrates the difficulties associated with rationalizing solutions from evidence without due regard to other social processes (principle 5). Nonetheless, the societal trend in many of the world's regions toward devolution, democratic participation, increased transparency, and improved access to information (62, 63) will facilitate the acceptance and uptake of a people-centered landscape approach to solving the problems at the agriculture–environment nexus.

The landscape approach does not constrain other efforts to address, manage, or reconcile this agriculture–conservation nexus, as outlined in this special issue and elsewhere (64, 65). Thus, a "designer" landscape of spatially segregated protected and productive areas (66), often the predominant paradigm of conservation biology or environmental engineering, is not precluded by a landscape approach. This might be the agreed-upon solution emerging from a landscape process. Such planning is often a necessary but not sufficient step toward achieving appropriate outcomes, as classical spatial planning may be insufficiently flexible to accommodate multiple and changing perspectives. The conceptual and sometimes spatial segregation of protection and production functions of land will thus be an unlikely outcome unless human population density is very low: the presence of many people implies many different interests (as well as higher pressure on land and its resources) and hence increasing land use and resource conflicts. As global population continues to increase in coming decades, particularly so in the tropics, dependencies on land and natural resources will increase. Landscapes will be expected to provide an increasing number of functions. Issues of multifunctionality (principle 4), accommodation of multiple stakeholder interests (principle 5), and clarity of rights and responsibilities of these stakeholders (principle 7) will become paramount, whereas strict protected areas (with conservation as a dominant objective) may increasingly become geographically and conceptually peripheral.

A shift in thinking toward resolving tradeoffs, as well as facilitating synergies, between conservation and economic interests often proposes "optimal" solutions based on quantitative analyses of system properties. Indeed, conventional spatial land use planning relies on models developed by experts with the intention of delivering optimal solutions. Such tools and analyses are important in understanding processes, feedbacks, and interactions across scales (principle 3), and system vulnerabilities and responses to perturbations (principle 9). They are fundamental to adaptive learning (principle 1). Optimization, however, is an illusion unless constrained in its application to specific and clearly defined objectives. Multiple stakeholders (principle 5) and different interests and values (principle 2) will usually preclude the emergence of a single best solution. This underscores the landscape approach as an iterative, flexible, and ongoing process of negotiation, decision-making, and reevaluation, informed by science but shaped by human values and aspirations.

This approach does have limitations when viewed from the perspective of conventional land management. The landscapes approach framework, and the wicked problem contexts to which it frequently applies, is not amenable to simple performance assessments, priority setting, or analytical evaluation. Components of the landscape can be assessed, and tradeoffs can be measured, but securing information about the overall success of a negotiated strategy, which is itself under frequent revision and change, is a challenge.

Above all, people lie at the heart of the landscape approach, and the 10 principles reflect this. We believe the principles will provide a normative basis for the landscape approach and enable it to be applied in a more consistent way. This will allow the multiple benefits that flow from a landscape to be enjoyed by a wider range of stakeholders. The principles shift the center of gravity of decision making to local people, and from the "what" and "where" to the "how" and "why" of managing the agriculture–environment nexus.

It is important to stress that these principles should not be treated as a number of boxes to be ticked in designing landscape projects. They are principles that need to be taken into account in reforming resource management agencies. These agencies must have the multidisciplinary staff capacity and resources to perform these functions and must be able to draw on the principles in ways that meet the particular needs of the problems they are confronting (24). The principles provide options that can be deployed selectively to meet the challenges found in a universe of unique landscape situations. They should shape the culture of resource management agencies and processes and not replace or duplicate these institutions. The 10 principles of the landscape approach are an innovation that should help address the challenge of increasing agricultural production while minimizing negative impacts on the environment.

Methods

We reviewed publications concerned with landscape approaches. Our goal was to understand how the term "landscape approach" had been used, and to identify elements of best practice. We developed simple indicative principles and summary guidelines based on key issues and concepts. The results were summarized (67) and were subsequently the subject of further discussion and elaboration at workshops in Bayanga, Central African Republic, in mid-2008; Kigali, Rwanda, in late 2008; Bali, Indonesia, in May 2009; and Neuchatel, Switzerland, in December 2009. This was followed by extensive virtual consultation and the final development of the landscape principles presented. The present paper is the consolidation of these discussions and results developed during a meeting in Cairns, Australia, in May 2012.

Professionals working in conservation landscapes (within development and conservation fields and academics) were addressed via an online questionnaire to assess the utility of the 10 principles and determine perceived obstacles to their implementation. The survey was designed to determine the ways in which respondents understood the term landscape approach and the obstacles they encountered in implementing such an approach. The respondents were asked to evaluate the 10 principles and provide comments on their relevance and potential issues in their implementation. Further information on this survey is provided in the Supporting Information.

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LAND USE

Cracking Brazil's Forest Code

Brazil's controversial new Forest Code grants amnesty to illegal deforesters, but creates new mechanisms for forest conservation.

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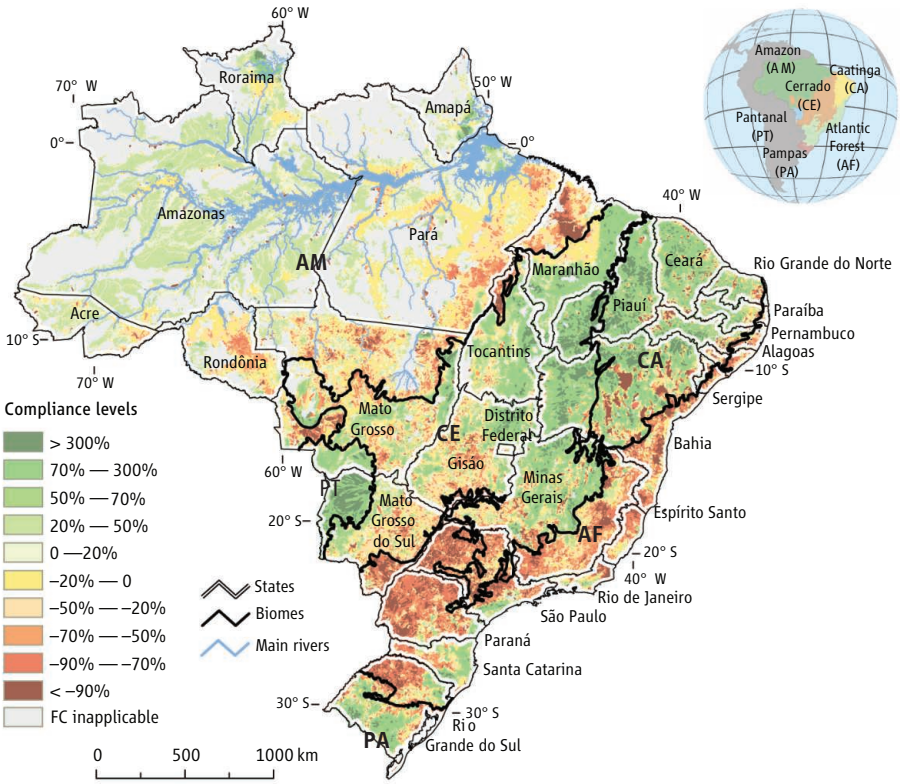
Roughly 53% of Brazil's native vegetation occurs on private properties. Native forests and savannahs on these lands store 105 ± 21 $GtCO_2e$ (billion tons of CO_2 equivalents) and play a vital role in maintaining a broad range of ecosystem services (*1*). Sound management of these private landscapes is critical if global efforts to mitigate climate change are to succeed. Recent approval of controversial revisions to Brazil's Forest Code (FC)—the central piece of legislation regulating land use and management on private properties—may therefore have global consequences. Here, we quantify changes resulting from the FC revisions in terms of environmental obligations and rights granted to land-owners. We then discuss conservation opportunities arising from new policy mechanisms in the FC and challenges for its implementation.

Created in 1965, the FC was transformed during the 1990s into a de facto environmental law via a series of presidential decrees. As of 2001, the FC required landowners to conserve native vegetation on their rural properties, setting aside a Legal Reserve (LR) that occupies 80% of the property area in the Amazon and 20% in other biomes [supplementary material (SM), fig. S1, and table S1]. The law also designated environmentally sensitive areas as Areas of Permanent Preservation (APPs), aiming to conserve water resources and prevent soil erosion. APPs include both Riparian Preservation Areas (RPAs) that protect riverside forest buffers, and Hilltop Preservation Areas (HPAs) at hilltops, high elevations, and steep slopes.

The FC severely restricted deforestation on private properties but proved challenging to enforce, particularly in the Amazon. As deforestation rates rose in the early 2000s, efforts to strengthen enforcement increased pressure on the farming sector, which triggered a backlash against the FC. The agribusiness lobby took advantage of a favorable political moment, related to a substantial drop in deforestation rates in the Brazilian Amazon, to propose creation of a new FC, which was approved in late 2012 (*2*). Some criticize the legislation for being too lenient on landowners; others maintain that it is a barrier to agricultural development. Regulations detailing key implementation mechanisms of the revised FC are still under negotiation.



Compliance levels under Brazil's 2012 FC. Percent difference between the remaining area of native vegetation and the area required to comply with the 2012 FC. Positive values indicate forest surpluses or land that may be legally deforested. Negative values indicate forest debts or land that requires restoration. See SM for details.

Amnesty for Illegal Deforestation

The 2012 FC maintains conservation requirements for LRs and RPAs—i.e., land that may not be deforested (table S1). These two requirements protect 193 ± 5 Mha of native vegetation containing 87 ± 17 $GtCO_2e$ (see the map). Changes in the definition of HPAs reduced their total area by 87% (table S8).

Because the new law differentiates between conservation and restoration requirements, the 2012 FC reduced by 58% Brazil's "environmental debt"—i.e., areas of LR and RPA deforested illegally before 2008 that, under the previous FC, would have required restoration at the landowner's expense (fig. S2). This was accomplished by forgiving the LR debt of "small" properties, ranging in size from 20 ha in southern Brazil to 440 ha in the Amazon. Under these new rules, 90% of Brazilian rural properties qualify for amnesty. Further reductions resulted from including RPAs in the calculation of the LR area, reducing the LR restoration requirement to 50% in Amazonian municipalities occupied predominantly by protected areas, and relaxing RPA restoration requirements on small properties (table S1).

Together, these measures decreased the total area to be restored from 50 ± 6 to 21 ± 1 Mha, of which 78% encompasses LRs and 22% RPAs (tables S2 and S3). Reductions in the environmental debt were uneven across states and biomes, affecting mainly the Amazon, Atlantic Forest, and Cerrado (fig. S2). These losses may have a large impact on

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biodiversity conservation (*3*) and forest restoration programs (*4*), especially in the Atlantic Forest, where only 12 to 16% of the original forest cover remains (*5*).

Furthermore, both old and new FCs allow an additional 88 ± 6 Mha of legal deforestation on private properties (table S4 and the figure). This area of native vegetation, exceeding LR and RPA conservation requirements, constitutes an "environmental surplus" with the potential to emit 18 ± 4 $GtCO_2e$ (SM, §2.1).

New Mechanisms for New Markets

Although the 2012 FC reduces restoration requirements, it introduces new mechanisms to address fire management, forest carbon, and payments for ecosystem services, which could reduce deforestation and bring environmental benefits. Perhaps the most important mechanism is the Environmental Reserve Quota (Portuguese acronym, CRA), a tradable legal title to areas with intact or regenerating native vegetation exceeding the FC requirements. The CRA (surplus) on one property may be used to offset a LR debt on another property within the same biome and, preferably, the same state. Implementating the CRA could create a trading market for forested lands, adding monetary value to native vegetation. This CRA market could potentially abate 56% of the LR debt (fig. S3). Given the high costs of forest restoration (*6*), exchange of CRAs could become a cost-effective way to facilitate compliance, meanwhile protecting forest surpluses that might otherwise be legally deforested. A balanced use of CRAs should focus on improving functional and ecological attributes of forested landscapes, e.g., habitat integrity (and thus biodiversity), carbon stocks, and water balance regulation, crucial for maintaining hydroelectric power generation in Brazil (*7*).

One of the strongest arguments of the agribusiness lobby is that forest restoration conflicts with agricultural production. Our results suggest that, with respect to land availability, this concern is unfounded. Of the 4.5 ± 1 Mha of RPAs slated for restoration, only 0.6 ± 0.35 Mha are currently occupied by crops, representing less than 1% of all croplands nationwide. Moreover, if restoration of the remaining LR debt (after compensation via CRAs) occurred exclusively in pasturelands unsuitable for agriculture, as few as ≈ 550,000 ha of required restoration would remain in arable lands (SM §§2.2 and 2.3 and figs. S3 to S5). Such a large-scale transition from cattle ranching to agriculture would require substantial increases in stocking densities to sustain current levels of meat production and allow for forest restoration. To this end, Brazil has created a national Low-Carbon Agriculture (ABC) program that provides ~U.S. $ 1.5 billion in annual subsidized loans aimed at increasing agricultural productivity while reducing associated carbon emissions and supporting forest restoration (table S5).

Key to success of the FC is the Rural Environmental Registry System (SICAR), a georeferenced Web system that will enable documentation of over 5 million rural properties, improving transparency and providing a pathway to environmental compliance. SICAR could facilitate the market for CRAs and payments for ecosystem services [for example, (*8*)], which will be critical to offset the often-prohibitive costs of forest restoration, especially for small landowners. We estimate that elimination of the FC debt via forest restoration would sequester up to 9 ± 2 $GtCO_2e$ (SM, §2.1).

Enforcement and Private Initiatives

Effective implementation of Brazil's 2012 FC will be enormously challenging. The first crucial challenge is to convince the agribusiness sector of the potential gains from the new FC. Even though law enforcement activities have intensified in recent years, the agribusiness constituency has historically taken advantage of the government's relatively weak enforcement of environmental laws. Amnesty afforded by the new FC could lead to the perception that illegal deforesters are unlikely to be prosecuted and may even be exonerated in future law reforms. To meet this challenge, Brazil must continue to invest in its monitoring and enforcement capabilities. Satellite-based deforestation monitoring systems maintained by the National Institute for Space Research (INPE) need to be expanded to other Brazilian biomes and adapted to detect subtler land-use changes, including forest degradation and deforestation in savannahs, riparian forests, and small remnants of the Atlantic Forest.

More important, there is a need to strengthen and integrate efforts across the myriad state and federal agencies responsible for implementing the FC, establishing clear land tenure, granting environmental licenses, and supporting agricultural production. This integrated system must be transparent and harnessed to economic incentives for conservation; otherwise, it might only exhort landowners to exercise rights to deforest (*9*).

Fortunately, private initiatives are aligning to assist landowners in attaining compliance. These include international certification standards, commodity roundtables, and boycotts of agricultural products grown in recently deforested or high-biodiversity areas. Increasingly, farmers and ranchers are adhering to voluntary registries that require commitments to improving social and environmental performance [for example, (*10*, *11*)]. Both certification schemes and voluntary registries may eventually enable access to special markets that provide financial incentives to participating producers. These mechanisms are particularly important in the Cerrado, the most coveted biome for agribusiness expansion, given its 40 ± 3 Mha of environmental surplus that could be legally deforested (table S4). Moreover, conservation efforts must aim at expanding protected areas outside the Amazon. Whereas these areas cover 46% of the Brazilian Amazon, the level of protection in other major biomes (7% of the Cerrado and 2.6% of the Atlantic Forest) is well below the 17% recommended by the 10th Convention on Biological Diversity. Conservation initiatives will be vital to protect large expanses of native vegetation, particularly in the Cerrado and Caatinga, where additional protection by land-use zoning is low.

Brazil has achieved an unprecedented success in reducing deforestation in the Amazon. However, this gain is not yet secured. Recently, deforestation rates ceased to decline in the Amazon and Atlantic Forest, and surged in the Cerrado (fig. S6). Our analysis suggests that the FC will allow additional deforestation, especially in the Cerrado and Caatinga. Economic incentives for conserving forests, including the Warsaw Framework for Reducing Emissions from Deforestation and Forest Degradation as (REDD+), will be essential to help implement the FC and to enable Brazil to better reconcile environmental conservation with agricultural development.

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Review

Priority setting for scaling-up tropical forest restoration projects: Early lessons from the Atlantic Forest Restoration Pact

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ABSTRACT

Ongoing conversion of tropical forests makes it urgent to invest in ecological restoration on grand scales in order to promote biodiversity conservation and ecosystem services. The 4-year old Atlantic Forest Restoration Pact (AFRP) aims to restore 15,000,000 ha of tropical forest in 40 years. The approaches and lessons learned appear transferable, and could help achieve the global restoration targets. Fundamental prerequisites for success include: effective technology undergoing continuous improvement, ongoing teaching, outreach and capacity-building efforts, presence of local intelligentsia, maintaining a clear and transparent legal environment, and presence of effective economic instruments and incentives for landowners. These prerequisites can be achieved by expanding and strengthening the network of stakeholders both in public and private forums that must be aware of macroeconomic and social/cultural shifts and trends which may provide opportunities and impose constraints to further restoration activities. Finally, environmental regulations imposing habitat protection and restoration are usually beyond individual land-owners' possibilities and level of interest. Therefore, forest restoration, even in a biodiversity hotspot, must be approached as a potentially sustainable economic activity. Otherwise, private landowners, and most other stakeholders, will not persevere.

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1. Introduction

Old-growth tropical forests continue to be converted and degraded worldwide, resulting into landscapes with impaired ecosystems yielding reduced quantity and quality of services to human society (Melo et al., 2013). Further, they harbor much less biodiversity than intact forests (Gardner et al., 2009). Sadly, this situation predominates in many or most tropical regions including the majority of the tropical biodiversity hotspots (Chazdon et al., 2009; Laurance, 2005; Peres, 2005). In this context, forest restoration has emerged as a post hoc approach to reverse the dismal situation, in order to promote biodiversity and ecosystem services simultaneously (Bullock et al., 2011). Concurrently, other initiatives are clearly required, including the extension of networks of protected area systems and facilitating new and more sustainable agricultural production activities, such as agroforestry, on already cleared lands. Finding a modus vivendi between conservation, restoration and ongoing food, fiber and fodder production is necessary to minimize further forest loss as human populations continue to grow and drive growing demand for natural resources globally (Angelsen, 2010).

The Aichi Target 15 of the Convention on Biodiversity states that we should increase ecosystem resilience and although ecological restoration is increasingly recognized as being essential and complementary to both conservation and sustainable development strategies (SCBD, 2011), it has to date been largely restricted to small-scale projects/initiatives worldwide (i.e. a few hundred hectares at most) (Menz et al., 2013). This reduces the potential of restoration to effectively contribute to long-term persistence of biodiversity and ecosystem services (Rodrigues et al., 2011). This is not surprising since large-scale initiatives face a variety of social, political, economic, juridical, and technological challenges (Aronson et al., 2011), adding complexity and uncertainty to restoration programs. In fact, the opportunity cost of land, restoration costs and the lack of a science-based, cost-effective approach have constrained the scaling-up of restoration in tropical forest biomes (Birch et al., 2010; Kettle, 2012). In this context, any large-scale initiative trying to overcome the above-mentioned barriers and constraints should be examined for insights, lessons and potential corrections. Indeed restoration is now being recognized as a global priority (Aronson and Alexander, 2013; Gonzales, 2013) and scientists and practitioners with experience are increasingly called upon to share their know-how.

Here we describe how an ambitious initiative, the Atlantic Forest Restoration Pact, has addressed and continues to address some of the major challenges for large scale forest restoration in a megadiverse, developing country like Brazil. Specifically, we address (1) articulation, consensus-building and coordination among diverse stakeholders including governmental agencies, private land owners, corporations, NGOs, and departments within academic institutions; (2) ongoing development, testing, and dissemination of science-based, cost-effective restoration technology; (3) the pressing need for training and capacity building; and (4) harmonization of legal regulations and economic opportunities for restoration on both private and public lands. We report on our experience and lessons learned thus far in order to contribute to a timely debate examining to what extent restoration projects can mitigate or even revert tropical forest degradation, provide ''green jobs'' in rural communities, and augment the provision of multiple ecosystem services to human society both medium- and long-term.

2. The Atlantic Forest Restoration Pact (AFRP)

2.1. *The origins of the AFRP*

The Brazilian Atlantic Forest region has long been recognized as a global biodiversity hotspot (Myers et al., 2000). Unfortunately, forest cover now represents less than 14% of the pre-European conquest area, it is highly fragmented, and less than 20% of surviving forest remnants are over 50 ha in size (Ribeiro et al., 2009). Additionally, more than 90% of the remaining Atlantic forest area occurs on private lands (Tabarelli et al., 2005). Consequently, a wide range of economic drivers, particularly production of primary commodities, and fluctuating markets, contribute to ongoing deforestation and fragmentation of the remaining forest fragments (Bernard et al., 2011). This situation has led conservation biologists and other scientists to advocate and test restoration initiatives able to augment forest cover, landscape connectivity and primary-type forest habitat for threatened and vulnerable species of animals and plants (see Melo et al., 2013; Silva and Tabarelli, 2000)

In April 2009, the Atlantic Forest Restoration Pact (hereafter AFRP) was launched by a large pool of stakeholders, including national and international NGOs, governmental agencies, private companies, and research institutions. The AFRP currently includes over 200 partner/stakeholders, who collectively promote, facilitate, and carry out restoration projects across eight Brazilian states (Fig. 1). In the legal context, the AFRP will soon achieve the status of a NGO, although it will continue to act as a network to mainstreaming members' projects, instead of competing with them for funding. Complementary, as a representative of many NGOs and private companies, the AFRP will have strength enough to apply for large international funding opportunities to support collective investments in restoration projects, which would not be accessible to each institution individually. At present, it already functions with a central coordination and a secretariat, both permanently funded by NGOs and private companies, plus a board of directors from academia, private and public sector and NGOs plus its pool of partners, all of whom have joined AFRP voluntarily. Partners fall into two broad overlapping categories. First, ''supporting partners'' are those directly committed to Atlantic forest restoration topic, e.g. NGOs, academic institutions and governmental agencies, but not directly involved in restoration projects/actions. They provide expertise, funding, articulation, and dissemination instruments as they are continuously challenged by scientific, technological, political, legal and economic constraints to restoration initiatives. Secondly, ''executive partners'' are those directly in charge of restoration projects, such as farmers, private companies and public agencies (Calmon et al., 2011). Executive partners are committed to plan and execute restoration projects according to a basic theoretical

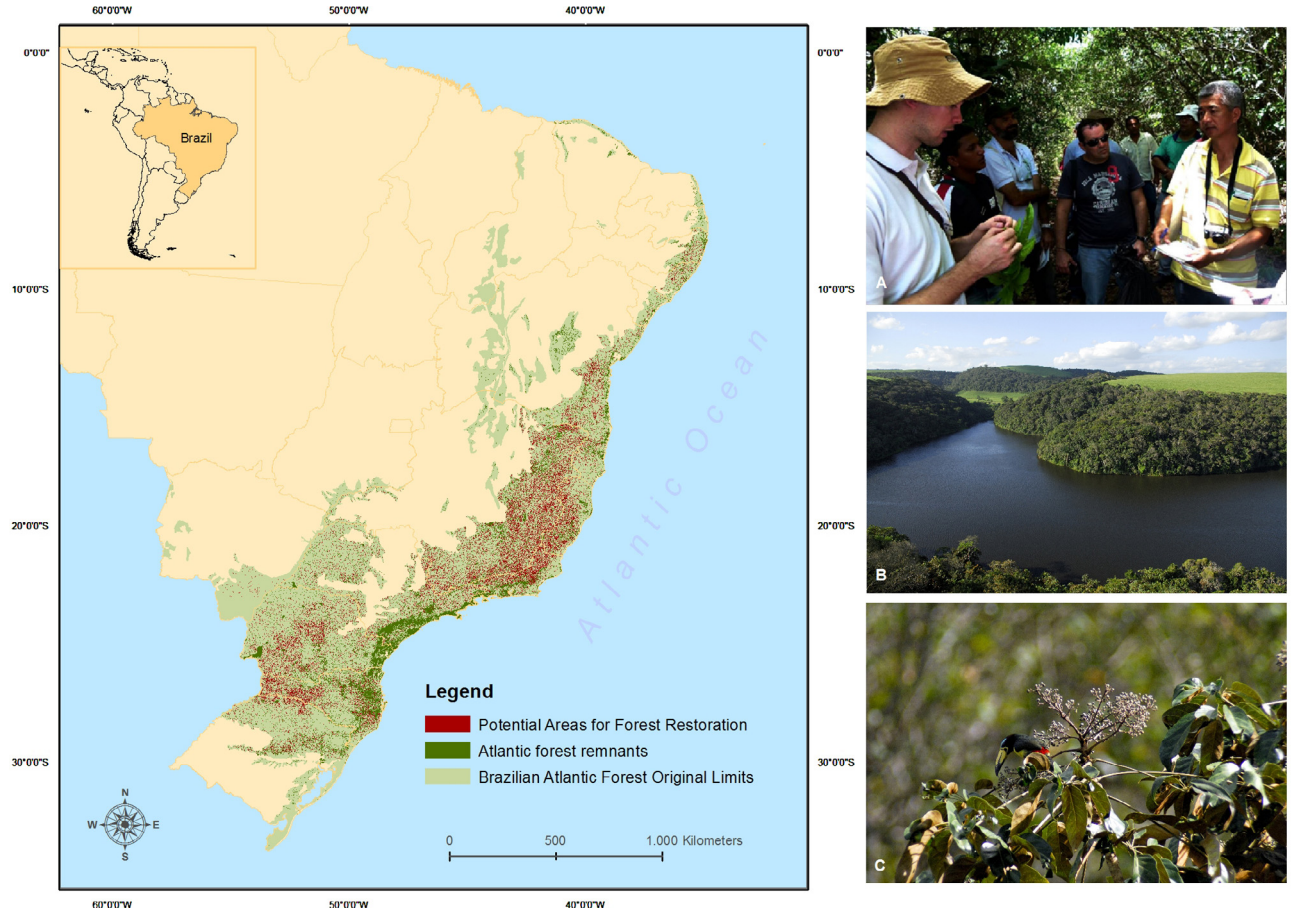

Fig. 1 – Potential areas for forest restoration according to the AFRP mapping. They refer to areas where restoration or regrowth of forest can occur without penalizing existing and viable economic activities, since restoration will not compete for agriculturally productive lands. An outreach course on forest restoration for workers of sugar-cane companies in the state of Paraiba, Northeastern Brazil (A). At the Usina Serra Grande, Alagoas state, the potential for PES (payment for ecosystem services) programs that reward forest protection and forest restoration of degraded lands (B). Biodiversity persistence on restored forests of the Atlantic forest (C).

framework, which is remarkably broad. This framework includes ongoing refinement of restoration techniques and supporting technology, overseeing attainment of socio-economic benefits for local communities (Brancalion et al., 2012a,b), and fulfillment of legal requirements, as well as furthering an ambitious scientific research agenda that will promote improved tropical forest restoration worldwide. Additionally, they help establish connections between restoration activities and biodiversity conservation programs at landscape, regional and national levels.

The AFRP has the ambitious target of restoring 15 million hectares of deforested lands to native forest by 2050; the majority of targeted lands consists of areas formerly covered by native forest, and that 'should' in future be forested, according to the Brazilian Forest Code, the main environmental law concerning forest protection and restoration (see below). Much of this land is currently degraded pasturelands and abandoned agricultural lands. The above-described outcome would increase self-sustaining forest cover from the current level (<14%) to ca. 30% of the pre-Colombian Brazilian Atlantic forest area. This goal is to be achieved without competing with, or impinging upon other, more immediately economically profitable land uses (Fig. 1). Indeed, the AFRP aims to take advantage of the third phase of forest transition, already in place in many regions of the Atlantic Forest (Baptista and Rudel, 2006), to support forest regeneration in lands with higher chances to be abandoned in the near future. Such a large-scale and long-term goal requires a wide consortium and the integration – or at least reconciliation through negotiation – of diverging interests, including those following predominantly social-economic, anthropogenic, or environmental, ecocentric, agendas. In fact, setting up the AFRP itself has only been possible thanks to its commitment to combine a large bundle of societal objectives and outcomes that may benefit – directly or indirectly – from successful forest restoration. These include: enhanced water supply and watershed protection (a target of public agencies and industries); flooding control (important to municipal, regional, and federal agencies); and commitments to comply with environmental regulations, including the Brazilian Forest Code, and green certification objectives (a large pool of industrial conglomerates such as producers of biofuel, soy bean and

Table 1 – Main challenges and opportunities for restoration initiatives according to the spatial scale at which they are planned.

Forest restoration scale	Main stakeholders	Socioeconomic constrains	Socioecological benefits
Small (up to a few hundred hectares)	Small farmers; municipalities; industrial corporations and agribusiness, but with isolated projects.	Limited funding, often in charge of landowners; high opportunity costs; diverse and at times inefficient restoration protocols.	Conservation of soil and water springs; improve connectivity among forest patches; small nurseries may respond to both local and more distant demand for seedlings, and generate extra income and jobs.
Medium (several hundred to a few thousand hectares)	Watershed committees; State governments; large agribusiness companies, with well-structured programs.	Achieve viable political arrangements; adoption of proven-to-be-efficient restoration techniques that guarantee results.	Funding is easier; association with PES (payment for ecosystem services) programs generate more social benefits; compatible with biodiversity conservation programs.
Large (several to many thousands of hectares)	Larger networks; international projects; REDD+	Establishment of common goals among differing stakeholders; disseminate successful, cost-effective restoration technology; convincing funding agencies to provide financial incentives for the restoration chain	Diverse funding sources; Stronger stakeholder's network and restoration markets; multiple benefits through restoration supply chain (social, environmental & economic).

wood pulp). Additionally, market demands for timber and non-timber forest products from native species; biodiversity protection, and poverty alleviation, especially through job creation (NGOs, social movements, small farmers, public agencies); and alternative uses for agriculturally marginal or already abandoned lands also represent direct socio-economic interests and benefits connected to ecosystem restoration projects and programs (Table 1). These multiple interests constitute a wide "basket" of opportunities and represent powerful drivers for scaling up forest restoration. Concurrently, the barriers constraining initiatives need to be addressed and mitigated, as described in the following sections.

2.2. *Restoration technology and capacity building*

Restoring tropical forest via assisted natural regeneration or plantation of native trees implies the adoption of effective protocols covering a large number of steps – from seed collection to the long-term management and monitoring of set-aside sites or newly re-planted stands. Otherwise, projects tend to achieve disappointing outcomes, what in turn discourages stakeholders and erodes both public and private support for forest restoration (Brancalion et al., 2010). In the last three decades, several restoration projects have been set up in the Atlantic forest region and generated a diverse set of guidelines that have permitted effective forest restoration resulting in biologically-viable forest patches (Rodrigues et al., 2009b). Taking advantage of this body of experience, the AFRP strives to keep abreast of all available information related to restoration technology, successes, and failures to date, and has made available a practical guide for those attempting Atlantic forest restoration (Rodrigues et al., 2009a). Thus, a comprehensive and field-tested framework for forest restoration in the Atlantic Forest is freely available on the AFRP website (http://www.pactomataatlantica.org.br). This user-friendly document provides basic guidelines relative to land-use planning, nursery, forestry techniques and legal aspects. This general framework has also been adapted to create regional restoration guides, which incorporates the particularities of each context for increasing projects effectiveness (Alves-Costa et al., 2008). To insure that any stakeholder may fully benefit from the recommendations and straightforward technology provided in the guide, and proceed with forest restoration in virtually any portion of the Atlantic Forest region, a team of AFRP 'veterans' and 'champions' provide numerous outreach training courses throughout the region on a regular basis. In 2011, the AFRP also convened a team of 80 restoration experts, stakeholders, and institutional representatives to develop and agree upon a standardized monitoring protocol, which should be applied to restoration projects. This protocol was reviewed in 2013 based on the challenges for its implementation and opportunities of improvement resulted from its wide use throughout the biome, thus resulting in a new and more robust protocol. This is now available on-line, at: http://www.pactomataatlantica.org.br/protocolo-projetos-restauracao.aspx. More specifically, all AFRP projects are now expected to be monitored with a comprehensive set of 87 indicators covering biological, economic, social, legal, environmental, and management themes (see Table 2). This protocol also makes it possible to continuously, and rigorously, examines and compares outcomes at a regional and national scale.

Finally, the AFRP has stimulated its partners to approach restoration projects as both carefully planned, and *monitored*, research experiments that also provide training and capacity-building platforms and help improve restoration technology and cost-effectiveness going forward. Project managers and researchers also document and monitor potential impacts of forest restoration relative to (1) long-term viability of forest stands, (2) conservation value and provision of ecosystems services, and (3) provide training for local restoration practitioners. For example, in northeastern Brazil, in the state of Paraiba, several practical workshops have been run recently in order to increase local interest for forest restoration in one of the poorest and degraded Atlantic forest areas (see Fig. 1). Briefly, adopting the AFRP approach, NGOs and governmental

Table 2 – Major themes, topics and indicators included in the monitoring protocol adopted by the Atlantic Forest Restoration Pact (http://www.pactomataatlantica.org.br).

Monitoring themes	Topics	Indicators
Biological	Forest structure Plant assemblage	Number of plant stems, basal area, vegetation height Number of plant species Presence of invading species Area covered by herbaceous species
Economic	Cost of restoration Revenue scores	Budget distribution among: direct sowing; fences; manpower Timber production PES
Social	Employment	Number of jobs created Wealth insurance Training programs Compliance with labor legislation
Legal	Accomplishment with Brazilian Forest Code	Presence of legal reserve, project registration on regulation agencies
Environmental	Ecosystem services (e.g. water supply)	Protection of riparian forest and water springs, water quality
Landscape management	Habitat connectivity Site selection	Connection between isolated forest patches Environmental diagnostic of sites to be restored
Project management	Technical staff	Presence of a qualified technical team

agencies have already trained hundreds of stakeholders regarding landscape planning, nursery production and protocols for ecological restoration (Fig. 1). In sum, such initiatives across the entire Atlantic forest region have resulted and benefited from a network of planned experiments (e.g. 400,000 ha of restoration area assisted by the Laboratory of Forest Ecology and Restoration of the University of São Paulo), which are under way and represent a permanent ''experiment'' addressing restoration-related topics.

2.3. *Legal instruments and economic opportunities*

Legislation has proved to be essential to (1) regulate land use in the light of environmental safeguards (Ruiz-Jaen and Aide, 2005), (2) guarantee that best practices are incorporated within restoration projects and initiatives (Aronson et al., 2011), and (3) offer a juridical environment in which stakeholders can proceed with restoration activities conscious that their efforts will be properly recognized by public agencies and those institutions in charge of certification and financial credit (Calmon et al., 2011; Rodrigues et al., 2011). Accordingly, AFRP members are permanently engaged into initiatives toward the improvement of either land-use or restoration-related regulation. One example is illustrative: in São Paulo, the richest state in Brazil, legislation covering topics from the required restoration technology to minimum levels of native plant diversity (Aronson et al., 2011) has benefited directly from the experience gained and reported in the scientific literature by AFRP restoration scientists and practitioners. Such official guidelines for restoration now proscribe a minimum of 80 native tree species per hectare in restored forests, and require the use of seedlings originating from the same vegetation type, collected asnear as possible to the actual restoration site, along with a rigourous monitoring program. The AFRP has also publicly criticized recent, pernicious proposals to change and 'water down' the Brazilian Forest Code, (Calmon et al., 2011; Tollefson, 2011) and is engaged in a successful public payment for ecosystem services program provided by small farms via forest restoration and forest protection (Brancalion et al., 2012a).

In addition to a ''clear legal environment'', forest restoration also relies on financial resources and economic support. In this context, the AFRP has been engaged in three tasks: (1) analysis, synthesis and transference to society of information relative to restoration costs and restoration-related economic opportunities as contrasted to traditional land uses; (2) development of economic instruments for supporting restoration; (3) dissemination of information relative to social benefits offered by restoration initiatives. The AFRP has estimated a minimum cost of US$5000 per hectare for forest restoration in significantly degraded sites requiring active reforestation with native tree species (Brancalion et al., 2012b). These values include direct planting and three years of post-planting site management and have been estimated based on the average cost of thousands of hectares restored in São Paulo state where decades of restoration experiences have generated practical guidelines to public policies currently adopted by both public and private sector (Brancalion et al., 2010). However, direct planting at such a cost usually responds to less than 20% of the area to be restored in most cases in the Brazilian Atlantic Forest and successful restoration can be achieved in many landscapes at lower costs just by ceasing the drivers of disturbance (especially proscribed fire and grazing) and stimulating natural regeneration through simple procedures, such as soil fertilization and weeding, which dramatically reduce the costs of restoration. This low-investment situation corresponds to approximately half of the lands currently undergoing restoration in the Atlantic forest biome with assistance from the AFRP. This low-investment situation corresponds to approximately half of the lands currently experiencing restoration in the Atlantic forest and assisted by the AFRP, which is evidenced by frequent cases of forest re-growth following land abandonment (Baptista and Rudel, 2006).

Table 3 – Simulation of economic revenues resulting from extensive cattle ranching and different income opportunities proposed for tropical forest restoration, based on overall values estimated for the Brazilian Atlantic forest. Given that the proposed values may vary dramatically according to species selection, system of production, response of the plants to specific site conditions, and the socio-economic context in which the project is included, these values provided are merely illustrative.

Source of income	Annual revenue[a] (US$/ha/year)	Timeline (years) 1 2 3 4 5 6 7 8 9 10 11–19 20 21–29 30	Total accumulated revenue (US$)
Opportunity cost of land for cattle ranching	−100.00		−3000.00
Income opportunities through restoration			
Crops produced in agri-successional schemes[b]	300.00		900.00
Payment for ecosystem services – water[c]	118.00		1180.00
Payment for ecosystem services – carbon[d]	330.00		3300.00
Non-timber forest products[e]	200.00		5000.00
Timber – fast growing species[f]	2500.00		2500.00
Timber – intermediate species[f]	4000.00		4000.00
Timber – slow-growing species[f]	6000.00		6000.00
Sum of opportunities			22880.00
Total (US$)			19880.00

Adapted from (Brancalion et al., 2012b).
Gray shading means both costs and benefits applicable to each year and/or period.
[a] For activities providing an annual income, represented in the table by income inputs in consecutive years, the annual revenue represents the average income obtained during the period proposed for the activity. In the case of timber exploitation, annual revenue is restricted to the year of harvesting, i.e. 10, 20 and 30 years for fast-, moderate- and slow-growing species, respectively.
[b] Based on the income provided by annual crops traditionally planted in small landholdings, such as beans, corn, cassava, pumpkin, etc. These crops can be cultivated between planting lines of trees for a period of three years; after three years, shading provided by trees may hamper commercial production of annual crops.
[c] Considered as the same as the opportunity costs of land for expensive cattle ranching, based on the model program of Extrema, Minas Gerais, southeastern Brazil. Although payments for ecosystem services for water may last indefinitely, we propose that they should be limited to a period of 10 years if other sources of income are included in the project.
[d] Based on the estimated stocking rate of 30 tons of carbon in 30 years and a market price of US$10 per ton of carbon. The total value to be paid in the 30 years period was concentrated in the first 10 years, in order to anticipate income generation.
[e] Although some native species may provide a much higher income than US$200/ha/year, we use this conservative value to avoid over estimation.
[f] Values based on the economic evaluation for the Brazilian Atlantic forest, in which very conservative estimates were made of both timber prices, and tree growth rate, and without considering any type of value aggregation.

Brancalion et al. (2012b) provides a detailed analysis of a ''basket of opportunities'' related to forest restoration including, for example, (1) crop production in agro-successional restoration schemes, (2) exploitation of timber as non-timber forest products in restored areas, and (3) payment for providing ecosystem services (PES), i.e. water- and carbon-related services among others (see Table 3). Briefly, annual revenue provided by cattle ranching on steep slopes achieve US$ 100/ha/yr, while revenue varies from US$ 300 (crop production via agroforestry) up to US$ 4000/ha/yr via timber production or alternatively US$ 11,800/ha/yr to protect riverbanks and natural springs via restored forests; i.e. the water-related PES supported by the Extrema municipality (Minas Gerais state). A figure of 30.5-million ha currently devoted to low-revenue cattle-ranching (IBGE, 2003; PROBIO, 2009), in addition to increasing levels of urbanization and industrialization (Baptista and Rudel, 2006), represents an opportunity for moving land use toward restoration-based activities or even a 'restoration economy', where previous valuable timber and non-timber forest products over-exploited in the past in native forests are reintroduced in the market through their production in restoration projects. For example, the recently created investment company Symbiosis (http://www.symbiosisinvestimentos.com.br) has already planted 800 ha of about 30 high valuable native timber species as long-term investments, and plans to reach 100,000 ha in the next years supported by international pension funds.

Although restoration activities are already partially/totally affordable through a combination of mechanisms, additional possibilities are welcome. The AFRP has continuously provoked many governmental agencies to incorporate forest restoration as part of their either economic, development, research or environmental agenda (Joly et al., 2010; Wuethrich, 2007), extending the possibilities to afford restoration initiatives. For instance, the Brazilian Bank of Development, which is well known for funding large infrastructure projects, recently created a program in partnership with the AFRP to make significant investments in ecological restoration projects in the Atlantic Forest biome. Dissemination of PES instruments involving public agencies is underway in the Atlantic forest region with the leadership of several AFRP members.

As Brazilian society becomes aware about social benefits from restoration-related activities and initiatives, more stakeholders are expected to become engaged, including

governments. The AFRP estimates that by 2050 the supply chain of forest restoration could generate up to 6 million jobs for rural and traditional communities via sustainable exploitation and supply of forest products in the Atlantic forest region (Brancalion et al., 2012a). Currently, in São Paulo State alone, more than 40 million seedlings of native trees and shrubs are produced each year, in more than 200 private forest nurseries managed principally by private sector and some community-based ones. This provides a cornucopia of jobs and new livelihood opportunities as more people are obtaining on-the-job training and capacity-building. The AFRP is conscious that all this social and economically-related information must be continuously updated and communicated to society in order to illustrate that restoration can in fact become an economically- and socially-attractive land use as compared to more traditional activities such as extensive cattle-raising (Rodrigues et al., 2011).

2.4. *The generality of the AFRP experience in Brazil*

The degree to what AFRP experiences in Brazil can be applied to other tropical countries will depend on how involved stakeholders perceive both bottlenecks and opportunities for forest restoration. In many tropical countries of African continent, for example, recent changes on land-tenure model creates uncertainties on the availability of lands to be restored (Njoh, 2013). Also, ecological constrains of arid environments (van der Vyver et al., 2012) and lack funding sources (Crookes et al., 2013) should be effective bottlenecks to achieve large-scale ecological restoration in South Africa, although successful initiatives have also been reported in this country (Hobbs, 2004). However, in many African countries communal land tenure still predominates and schemes of payment for ecosystem services and REDD+ mechanisms should be effective in conserve and recreate forests. The Greenbelt Movement in Kenya is an example of a promising initiative that can benefit from the AFRP case study (http://www.greenbeltmovement.org/). In Asian countries such as China and Vietnam predominates afforestation with non-native pulp species as it constitutes a good economic opportunity but has limited impact on the conservation of biodiversity and ecosystem services (de Jong, 2010; Lambin and Meyfroidt, 2010). However, these countries have probably developed good techniques of both forest planting and landscape management. Finally, in poorer regions of Latin America, the lack of a well-established legal environment for ecological restoration may limit afforestation to natural regeneration after abandonment of marginally productive lands due to rural exodus of human populations (Lambin and Meyfroidt, 2010; Parry et al., 2010), but economic rewards to remaining farmers through PES may stimulate forest re-growth (Sanchez-Azofeifa et al., 2007). However, urbanization of Latin American countries may represent more capacity building and available land to forest restoration. Probably, the main lesson of the AFRP for other tropical countries is the intense dialog among diverse stakeholders at different spatial and temporal scales. Passing the barriers of opposing interests among stakeholders is surely the ultimate outcome of the AFRP and this might be possible to be replicated in any country.

3. Partial outcomes and lessons learned

We are not yet able to report on the effectiveness of the AFRP initiative as only recently has a standardized monitoring protocol been adopted by the well-established restoration projects in the network. However, several successes listed in the AFRP First Evaluation Report (available on http://www.pactomataatlantica.org.br) should be mentioned, including the coordinated management of no less than 80 projects, which represent almost 60.000 ha under restoration. Research projects, scientific publications and calls for greater public policies and environmental regulations have also emerged via the expertize joined together in AFRP; see for example the debate on public regulation relative to a minimum number of native tree species to be adopted by restoration projects (Aronson et al., 2011). Although the AFRP only came into existence three years ago, some lessons have emerged and these can be summarized into six guidelines.

- Our concept of scaling-up restoration implies not only increasing the number of projects but also the average size of restoration projects. This is possible through restoration planning at the landscape and regional scales and is crucial to improve the prospects of achieving the ultimate restoration goals of conserving biodiversity and ameliorating ecosystem services.
- Scaling-up restoration depends upon several basic prerequisites being in place, namely appropriate technology, an infrastructure to aid in capacity-building, presence of a local intelligentsia, clear legal environment (i.e. reduced juridical uncertainties), and effective economic instruments and incentives being operational.
- Restoration prerequisites are better achieved by an expanding network of stakeholders with shared, restoration-related interests and collectivized activism in both public and private forums.
- Forest restoration initiatives, especially large-scale ones, should not be recommended or promoted unless appropriate technological prowess can be demonstrated. In other words, restoration is a professional, technical and economic activity that involves both economic and social investments and trade-offs over a long period, even for community-based initiatives. Stakeholders and potential project 'owners' should be encouraged to do 'due diligence' on existing know how and cost-effectiveness, just as investors regularly do when approached by an entrepreneur seeking new partners and investments.
- The restoration 'community' must be aware of, and remain attentive to, evolving macro-economic and socio-political and cultural scenarios as these may represent opportunities but also constraints to restoration activities.
- Environmental regulations imposing habitat protection and restoration are usually beyond individual land-owners' possibilities and level of interest. Overall, forest restoration must be approached as a sustainable economic activity and society must be continuously informed about the full range of benefits provided by restoration projects and programs, both short-term and also medium- and long-term.

4. Final remarks

Restoration ecology is flourishing worldwide and ecological restoration as a profession and an enterprise is a growing component of international environmental and corporate policy debates and economic planning and negotiations. The U.N. Convention for Biological Diversity (CBD) explicitly addresses restoration in two of its Aichi Biodiversity Targets as follow: ''*Target 14: By 2020, ecosystems that provide essential services,. . ., are restored and safeguarded; and Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification*'', making it timely to consider restoration science, policy, and practice (Benayas et al., 2009). Indeed, in October, 2012, the CBD ratified these targets in its Decision XI/16 (Convention on Biological Diversity, 2012) and over a dozen major agencies, several far-sighted governments, and two other international conventions signed on (Aronson and Alexander, 2013). The endeavor of restoring 150 million ha by 2020 is estimated to provide U.S. $84 billion per year to the international economy (Menz et al., 2013), and the existence of another 2 billion ha of deforested and degraded lands available for restoration provides a favorable scenario for long-terms investments in this emerging field of activity (http://www.wri.org/project/forest-landscape-restoration). The AFRP, with 1 million ha, with both the United States Department of Agriculture Forest Service (15 million ha) and the Government of Rwanda (2 million ha) were the first groups to officially establish, at the Rio+20 United Nations Conference on Sustainable Development, the a compromise to contribute with a share of the global goal of restoring 150 million ha. This 1 million ha of the AFRP represents the area expected to be restored collectively by its members by 2020, according to the program of goals of the movement.

Fortunately, economic development, increasing social concern with environmental issues, new economic instruments for restoration (e.g. carbon market), and land-use shifts (e.g. forest transition) represent opportunities for scaling-up forest restoration and restoration community must take advantage of this emerging scenario, via integrated and large-scale projects (Melo et al., 2013). For instance, the consolidation of Brazilian environmental regulation with increasing law enforcement, the abandonment of agriculturally marginal lands associated to urbanization/industrialization (Baptista and Rudel, 2006), and the continuous expansion of green markets (i.e. a global concern to environmentally-wealth products), represent the best scenario for restoration initiatives ever experienced by the Atlantic forest region. However, in the absence of major scaling-up of restoration, this rare opportunity, and more generally, the ambitious CBD Aichi targets will not be achieved. In that case, society will probably pay the immense 'extinction debt' already accumulated across degraded tropical – and also extratropical – landscapes elsewhere. We hope that this essay about the AFRP can help move the global restoration 'agenda' forward, stimulate new restoration initiatives and policies and provide some guidance to those embarking or small, medium or large scale programs or projects in other parts of the world.

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