Forest landscape restoration for Asia-Pacific forests

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Foreword

Forests, from whichever viewpoint we hold, are part of a nation's capital. Seeing the forest land going barren and existing forests becoming degraded is clearly a huge loss. The loss is expressed in manifold ways: loss of timber wealth, loss of livelihoods for forest-dependent people, loss of environmental services that includes climate mitigation, and a loss for all the plants and animals inhabiting them. Besides all these, there is also the loss of the scenic beauty they have always provided for mankind. This has become the reality for forests in the Asia-Pacific region – deforestation has resulted in huge tracts of wasteland, and extensive areas of standing forests are degraded to a point where their value as forests may be uncertain. Of course foresters have worked hard at rebuilding them – in fact such endeavours represent the beginning of scientific forest management in the region.

While notable successes are seen with the rebuilding of extensive monoculture plantations in the region, there still remain huge areas needing further attention. On-site efforts to restore forests are continuously being undertaken, but their results are frequently dismal. Increasingly we are beginning to realize that more holistic approaches are needed. With natural resources, the thinking these days is to examine the issues from a landscape level. This encompasses not only attention to the physical and biological aspects, but also including the affected people playing a role in the solution. And with forestry, we are looking at Forest Landscape Restoration (FLR).

The FLR approach, which is still in its nascent stages of development, is rapidly gaining attention as a more appropriate way to restore both degraded forests as well as the surrounding degraded landscape. The great value of this approach is that it integrates forest restoration actions with the desirable objectives of the landscape, and it is undertaken with the full participation of the people who will have a role in the management of the restored areas over the longer term. So, FLR brings together social, environmental and economic considerations in restoring the forests and lands, converse to just restoring an isolated patch of forest without taking into consideration the people in the area. With people having no stake in the forest, the long-term success of the restoration work is not assured.

In this last decade, global campaigns for planting trees are being announced frequently, such as the Bonn Challenge to restore 150 million hectares, and APEC's announcement to boost their forest area by 20 million hectares. These announcements have also pointed out the value in adopting the principles of FLR, particularly the value of regaining ecological integrity and enhancing human well-being in the process of restoring degraded forests and deforested lands. While FLR is being advocated as the way forward with forest restoration, unfortunately the approach is hardly known in the region. Both FAO and RECOFTC recognize the challenges Asia-Pacific forests are facing, and consider FLR to have the desirable attributes for bringing back the forests while simultaneously meeting the people's needs. With this in view, the two organizations proposed this multi-country study on forest restoration and how FLR can be implemented in the Asia-Pacific region. In this respect, we would like to first of all congratulate the authors of this study for their excellent contributions. Likewise, our thanks to all those who contributed to shepherding this work to fruition, as well the numerous reviewers and editors whose efforts have vastly improved the final product. It is hoped that FAO and RECOFTC will continue to work in jointly promoting FLR approaches in the region for a greener Asia-Pacific, where forestry will play a greater role in enhancing the livelihoods of its people, and contribute to mitigating climate change.

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Acronyms and abbreviations

5MHRP	5-Million Hectares Reforestation Programme (Viet Nam)
AAC	Annual allowable cut
ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AFoCo	ASEAN-Korea Forest Cooperation
ANR	Assisted natural regeneration
APEC	Asia-Pacific Economic Cooperation
APFNet	Asia Pacific Network for Forest Rehabilitation and Sustainable Forest Management
ARDC	Agriculture and Rural Development Corporation (Myanmar)
ASEAN	Association of Southeast Asian Nations
CADT	Certificate of ancestral domain title (Philippines)
CBD	Convention on Biological Diversity
CBFM	Community-based forest management
CBFMA	Community-based forest management agreement
CBNRM	Community-based natural resource management
CBO	Community-based organization
CDM	Clean Development Mechanism
CF	Community forest
CFI	Community Forestry Instructions (Myanmar)
CFUG	Community forest user group
CIDA	Canadian International Development Agency
CIFOR	Center for International Forestry Research
CITES	Convention on International Trade in Endangered Species
CLUP	Comprehensive land-use plan
CNFM	Close-to-Natural Forest Management
COFO	Committee on Forestry
CSO	Civil society organization
CSR	Corporate social responsibility
DA	Department of Agriculture (Philippines)
DOE	Department of Energy (Philippines)
DENR	Department of Environment and Natural Resources (Philippines)
DFRS	Department of Forest Research and Survey (Nepal)
DMCR	Department of Marine and Coastal Resources (Thailand)
DNP	Department of National Parks, Wildlife and Plant Conservation (Thailand)
DNPC	Department of National Parks and Wildlife Conservation (Nepal)
DoF	Department of Forests
DZGD	Dry Zone Greening Department (Myanmar)
ECD	Environmental Conservation Department (Myanmar)
ECTF	Experiment Centre of Tropical Forestry (China)
EIA	Environmental impact assessment
ENR	Environment and natural resources
EPAN	Energy Producers Association of Nepal
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign direct investment
FDT	Forest development type
FIO	Forest Industry Organization (Thailand)
FLR	Forest landscape restoration
FLUP	Forest land-use management
FMB	Forest Management Bureau (Philippines)
FMU	Forest management unit
FPDP	Forest Protection and Development Plan (Viet Nam)
FORDA	Forest Research and Development Agency
FORRU	Forest Restoration Research Unit (Thailand)
FSCC	Forestry Sector Coordination Committee (Nepal)
FUG	Forest User Group
GHG	Greenhouse gas
GPFLR	Global Partnership on Forest and Landscape Restoration
Gt	Giga ton
HKm	Hutan Kemasyarakatan (community forestry)
HR	Hutan Rakyat (privately-owned forest)
HTI	Industrial timber plantations (Indonesia)
HTR	Community-based forestry plantations (Indonesia)
ICRAF	World Agroforestry Centre
IEM	Integrated ecosystems management
IFAD	International Fund for Agricultural Development
IFMA	Industrial forest management agreement
IP	Indigenous people
IPRA	Indigenous Peoples' Rights Act (Philippines)

IRR	Internal rate of return
ITTO	International Tropical Timber Organization
IUCN	World Conservation Union
KPH	Kesatuan Pengelolaan Hutan (FMU)
LCMP	Life cycle management plan
LRMU	Land Resource Management Unit
LGU	Local government unit
LOI	Letter of Intent
masl	Metres above sea level
M&E	Monitoring and evaluation
MARD	Ministry of Agriculture and Rural Development (Viet Nam)
MDG	Millenium Development Goal
MFFM	Multifunctional Forest Management
MNRE	Ministry of Natural Resources and Environment (Thailand)
MOAI	Ministry of Agriculture and Irrigation (Myanmar)
MOECAF	Ministry of Environmental Conservation and Forestry (Myanmar)
MoF	Ministry of Forestry
MoFSC	Ministry of Forests and Soil Conservation (Nepal)
MWSS	Manila Waterworks and Sewerage System
MTE	Myanmar Timber Enterprise
MPTS	Multipurpose tree species
NCIP	National Commission on Indigenous Peoples (Philippines)
NAMRIA	National Mapping and Resource Information Authority (Philippines)
NECC	National Environmental Conservation Committee (Myanmar)
NESDB	National Economic and Social Development Board (Thailand)
NESDP	National Economic and Social Development Plan (Thailand)
NFCP	National Forest Conservation Program (China)
NFI	National Forest Inventory
NFMP	National Forest Master Plan (Myanmar)
NGP	National Greening Program (Philippines)
NIPAS	National Integrated Protected Area Systems (Philippines)
NSDS	National Sustainable Development Strategy (Myanmar)
NWFP	Non-wood forest product
ODA	Overseas Development Assistance
ONEP	Office of Natural Resources and Environmental Policy and Planning (Thaiand)
PAMB	Protected Area Management Board
PAWB	Protect Areas and Wildlife Bureau (Philippines)
PAS	Protected Area System(s) (Myanmar)
PES	Payments for ecosystem services
PFE	Permanent forest estate
PLA	Pasture licence agreement
PNRPS	The Philippine National REDD-plus Strategy
PPA	Programmes, plans and activities
PPF	Protected public forest
PSD	Planning and Statistics Department (Myanmar)
R&D	Research and development
RAP	Regional Office for Asia and the Pacific (FAO)
RECOFTC	Regional Community Forestry Training Center for Asia and the Pacific (also known as RECOFTC – The Center for People and Forests)
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RF	Reforestation Fund (Indonesia)
RF	Reserved forest (Myanmar)
RFD	Royal Forest Department (Thailand)
ROI	Return on investment
ROK	Republic of Korea
RRA	Responsibility, accountability and authority
RWE	Roundwood equivalent
SDC	Swiss Agency for Development and Cooperation
SFM	Sustainable forest management
SLM	Sustainable land management
SOR	Stand Operations Regime
SPT	Spatial Planning Techniques
TBI	Tropenbos Indonesia
TLA	Timber licence agreement
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
VAT	Value added tax
WPA	Water protection area
WWF	Worldwide Fund for Nature

Forest landscape restoration for Asia-Pacific forests: a synthesis

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with support from

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Executive summary

Introduction

Work on forest restoration is not new in the Asia-Pacific region. Classical achievements include the planting of teak in Java, and the 'taungya' system, first introduced in Burma for afforesting swidden areas. A variety of restoration techniques is available, ranging from natural regeneration to mixed species plantations. The need for restoring forests is increasing in the Asia-Pacific region considering the extensive areas of degraded forests and lands. In this context, a new approach, called forest landscape restoration (FLR) is currently being promoted widely. FLR is an innovative approach that integrates restoration work in the forest with other activities across the landscape for achieving optimum productivity, both in commercial and ecological terms. However, practitioners are not fully aware of the concept behind the approach. With a view to strengthening FLR approaches in the region, the FAO Regional Office for Asia-Pacific (FAO RAP) and RECOFTC – The Center for People and Forests undertook a multicountry study to review the status of forest and land degradation, restoration approaches commonly used and the policy and institutional environments which can support the introduction of FLR approaches in the region.

Deforestation and forest degradation

The Asia-Pacific region has experienced heavy deforestation and forest degradation. The region lost about 0.25 million ha of forest annually during 1990 to 2000, but since then it has reversed and has been increasing at about 1.35 million ha annually. However, among the megadiverse countries of Southeast Asia the trend has remained negative. This has resulted in 125 million ha of degraded forest land and 145 million ha of degraded forests in Asia alone (ITTO 2002). The main direct causes include opening up of forest lands for cash crops, shifting cultivation, fires and unsustainable logging practices. The underlying causes include undervaluation of forests, poor enforcement of regulations, ineffective land policies and lack of or unclear tenurial rights. The resulting landscape is a mosaic of land uses, ranging from agriculture to underutilized open areas, heavily encroached forest patches and intact forests some distance away from human activity. Besides the obvious loss of timber and biodiversity, there is a reduction in other goods and ecosystem services, including the ability to mitigate the impacts of climate change. These factors have undermined the livelihoods of people closely dependent on forests and agriculture.

Forest restoration

The region has seen some important developments in forest restoration. In the second half of the last century, China, Japan, Republic of Korea (ROK) and Viet Nam initiated massive nationwide restoration programmes, which effectively doubled or tripled their forest cover. China expanded its forest cover from 8.6 percent in 1949 to 22.1 percent in 2015, increasing its forest area by over 120 million ha. In the 1970s, almost 80 percent of ROK was denuded. The government introduced huge restoration programmes – one massive programme included planting 12 billion trees on 4.25 million ha. In the 1990s, Viet Nam started two large restoration programmes (Greening the Barren Hills Program and the 5 Million Hectares Reforestation Programme). As a result, forest cover increased from 35.6 percent in 2000 to 47.6 percent in 2015 (FAO 2010a,b).

Most of the restoration of degraded forests and lands relates to the development of plantations of fast-growing species for timber production. Analysis of the seven countries in the study brings out some pertinent issues. The technical issues are swamped by institutional, regulatory and policy issues. Most constraints relate to state control of the forest, lack of devolution, lack of clarity on tenure and lack of participation by communities and the private sector. The successes are overwhelmingly with the countries which have provided the appropriate policies for people's participation. These countries are in the early stages of shifting from timber production with management for multiple products and services, reforming tenure policies and renewing emphasis on people's livelihoods and implementation of community forestry.

Forest landscape restoration

Besides all these constraints, the traditional approach is mostly concerned with wood production, with less attention to ecological and ecosystem services; management rarely includes landscapes beyond the boundaries of the forest reserve. Based on these concerns, several researchers proposed the FLR approach. This is a planned process to integrate forest restoration actions with desirable landscape-level objectives, undertaken in a participatory manner by all stakeholders. It works at restoring a full landscape that includes forests and other lands so that they provide multiple benefits; the desired landscape objectives are undertaken through the full participation of the people who will have a crucial role in the management of the restored lands. As FLR brings together social, environmental and economic considerations in restoring forests within the landscape of other uses, the scientific community is convinced that it holds better prospects for success.

In 2000, the Worldwide Fund for Nature (WWF) and the World Conservation Union (IUCN) developed a framework and process for promoting FLR approaches that are socially and ecologically appropriate and defined FLR as "a planned process that aims to regain ecological integrity and enhance human well-being in deforested or degraded forest landscapes." It was also pointed out that the FLR approach can play an important role in supporting various international agreements such as the Convention on Biological Diversity (CBD), United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol's Clean Development Mechanism and the United Nations Convention to Combat Desertification (UNCCD).

This has led to the formation of the Global Partnership on Forest and Landscape Restoration (GPFLR), a partnership to catalyze support for FLR. Based on this, several pledges were made by governments, such as the Bonn Challenge, to restore 150 million ha of deforested and degraded lands, and Asia-Pacific Economic Cooperation leaders pledged to boost their forest area by 20 million ha by 2020. FAO launched its 'Forest and Landscape Restoration Mechanism' in 2014 to support implementation at the national level.

Based on the review of the status of restoration work in the seven countries in the region, and the understanding of the FLR approaches, FAO RAP and RECOFTC proposed the setting up of a facility to support the FLR mechanism in the region.

The review further examined the specific issues relating to FLR:

- **What is FLR?** A landscape can contain a mosaic of land uses from natural forests, secondary forests and timber plantations to agricultural and degraded lands. Depending on the stakeholders, restoration efforts vary. Individual farmers may seek economic gains, whereas government agencies may pursue ecological and environmental benefits. Restoration has to therefore meet the needs of the various stakeholders in terms of land use, species suitability and people's needs. FLR attempts to bring a balance between conservation and production issues by first paying attention to the causes of forest loss and degradation, engaging stakeholders in removing conflict over land-use planning and sharing of benefits, and negotiating trade-offs that are acceptable to all, including biodiversity conservation and a range of other benefits.
- **How much restoration?** FLR attempts to address both conservation and production issues at a landscape level. Restoration for biodiversity conservation pays attention to connectivities between forest patches, buffer areas for small forest fragments and the overall viability of the remaining species. Hydrological and soil protection are also considered at the landscape level. Restoration takes up the socio-economic concerns of participants. This depends on individual farmers, communities and the private sector, and how their specific needs can be met. While there is no easy answer to how much area can be restored, this is influenced by the local setting.
- **Where to restore?** This is addressed on the basis of what is the best way to conserve biodiversity, sites which are vulnerable to soil erosion, locations best suited for commercial tree plantations and so forth. The ideal sites for restoration are where multiple benefits can be attained, with low opportunity costs.
- **What restoration approach?** A variety of restoration approaches are possible; they range from secondary forest regrowth, monoculture plantations and mixed species plantations to ecological restoration among others. Each has different commercial and conservation potential; the choice is based on what fits an individual's needs and is determined by species-site fitness, highest benefits gained and diversification of incomes. The requirement is to ensure all result in the best overall outcomes.
- **Planning FLR.** With appropriate planning, *ad hoc* decisions by individual landowners can be minimized. The views of secondary stakeholders are also considered, which include downstream water users, urban populations and state agencies among others. In order to avoid conflict, it is necessary to find a solution that meets various objectives through negotiations. Considering the many stakeholders, a consultative planning process should be adopted. Through such an approach, the benefits of the wider community can be considered against the needs of the individual landowners, and an implementation plan can be presented to reach collective agreements.

The FLR approach has to contend with a number of issues, such as policies and laws, stakeholders, particularly the local communities, and restoring the functionality of the landscape from the perspectives of ecological integrity and human well-being. The precursors for implementing FLR approaches exist in some of the countries that were reviewed. Examples include policies that influence forest and land classification to target areas for restoration, national programmes on restoration, establishing restoration funds, transparent and participatory master plans for restoration, focus on people's involvement in forest and land restoration, and community-based forestry programmes. Overall, there is a strong need for countries to formulate supportive policies and legal frameworks for implementing FLR approaches. Minimally, these would have to cover governance issues, property, tenure and access rights, strengthening capacity of public institutions, engaging the private sector and markets, and decentralizing control and decision-making to local bodies. Considering FLR approaches are still evolving, additional research and sharing of experiences on good practices are vital.

1. Introduction – why undertake restoration?

In our effort to open up forest lands for other uses, principally for raising food and other cash crops, huge tracts of forests were cleared in the last century. In this rush, considerable areas were opened which turned out to be unsuitable for agriculture and have since been abandoned. It has been estimated that globally some 2 billion ha of forests are degraded (Minnemayer et al. 2011) with about half occurring in tropical countries (ITTO 2002). While some 350 million ha of former tropical forests have been converted to other land uses (ITTO ibid), the remaining forests, owing to poor logging practices, have become severely degraded and are not in a condition to provide timber and other ecological services anytime in the foreseeable future. These degraded forests have become open access areas for continued encroachment, especially by landless people. The end results of this process are vastly altered landscapes with islands of degraded forests surrounded by villages engaged in poor and disorganized agricultural activities.

Would it matter if such large areas of degraded forests are completely cleared and/or left in various stages of degradation? Opening forests unsuitable for agriculture has, of course impoverished large populations – they have to eke out a living from poor lands, while having lost an opportunity to earn income from the forests. Besides, deforestation and forest degradation have resulted in severe environmental damage. This includes loss of biodiversity, reduction in game for forest-dependent communities, erosion of topsoil leading to loss of soil fertility and even loss of water quality. All of these factors have severely undermined the livelihoods of people closely dependent on forests and agriculture. Added to this are ongoing considerations of climate change, which are currently placing a focus on deforestation and forest degradation as significant sources of greenhouse gas emissions into the atmosphere.

Effectively, with deforestation and forest degradation, large segments of the poor have to cope with a harsh existence in the changed landscape, without the benefits of the services and products from the forests. This is clearly a manifestation of under- or poor utilization of natural resources. International agencies, NGOs and local governments have been trying to respond to forest and environmental degradation, mainly through the promulgation of a broad set of policies. They range from intensification of agriculture in cleared lands, creation of protected areas and forest parks, implementing better harvesting practices and restoration of degraded forests and abandoned land.

Among all the activities, restoration of forests and lands looms large as a solution – it represents an opportunity to bring back green cover and biodiversity, improve the environment, mitigate climate change impacts and support livelihoods. Such restoration work has been done before. In fact, it dates back to the beginnings of scientific tropical forestry. But considering the amount of degraded forests and lands, these restoration exercises have had little impact in many places. The restoration measures, to a large extent, have remained *ad hoc*, and have not become part of regular forest management practice. Either they are complex, difficult, costly or the results are not providing social benefits, which could partly explain why large tracts of degraded forests and lands remain unproductive.

However, in the last decade or so, interest in restoring large areas of degraded forests and lands has been rekindled globally. The GPFLR was launched in 2003 by IUCN and others to coordinate global efforts on forest restoration. Since then several international campaigns on restoring forests have been announced. One prime example is the Bonn Challenge of 2011 which called for a global effort to restore 150 million ha of the world's degraded and deforested lands by 2020. The GPFLR which helps to oversee the progress of the Bonn Challenge is working with countries to develop and implement restoration plans. Countries such as Brazil, Costa Rica, El Salvador, Rwanda and China have pledged to restore over 20 million ha of their lands. In 2007, the Asia-Pacific Economic Cooperation (APEC) pledged to boost its forest area by 20 million ha by 2020. This burst of interest is however centred around the FLR approach.

The FLR approach is a planned process to integrate forest restoration actions with desirable landscape-level objectives, undertaken in a participatory manner by all stakeholders. It is not limited to just planting trees or rehabilitating a forest area. It works at restoring a full landscape that includes forests and other lands such that they provide multiple benefits and the desired landscape objectives are undertaken through the full participation of the people who will have a crucial role in the management of the restored lands. As the FLR approach brings together social, environmental and economic considerations in restoring forests, the scientific community is convinced that it holds better prospects for success. However, the concept is barely understood in the Asia-Pacific region and there is very little related work to match the enthusiasm expressed by the experts. This requires a major FLR initiative in the region, one that mirrors efforts at international levels being undertaken by organizations such as the GPFLR. This is the principal reason for FAO RAP and RECOFTC to come together and start planning for an FLR initiative for the Asia-Pacific region.

In preparation for starting the FAO-RECOFTC FLR initiative, a multicountry study to review the status of forest restoration in the region was initiated. The objective of the study was to contribute to the development of strategies, actions, and policy guidance for an FLR initiative that contributes to multiple aims, including conservation of forest biodiversity, safeguarding ecosystem services including climate change impact mitigation and equitable sharing of forest wealth. The outputs were: a synthesis paper of the country case studies and the principles of FLR; country case studies; a regional workshop for reviewing the country reports; a publication of the synthesis with the country case studies; and a concept note for developing a regional programme on FLR. Essentially, the report attempts to cover the region's wide range of forest restoration efforts, the limitations of such endeavours, and with the additional insights thus gathered, make a case on how forest restoration can be more effectively addressed through FLR approaches.

Initially, eight countries were considered for the study. They were chosen because of their spread among the different subregions, as well as the history and intensity with which their forest restoration efforts have been pursued. The country studies comprised: a historical perspective of land degradation; direct and indirect causes of land degradation and their consequences; major forest and land restoration strategies; forest policies and institutions as well as socio-economic parameters for success; and cases of successful forest restoration initiatives. The following countries were selected – China, Indonesia, Myanmar, Nepal, the Philippines, Thailand, and Viet Nam. Table 1 outlines country characteristics and brings out some salient features for comparison. All countries have undergone heavy deforestation, or are still experiencing losses, mostly under the banner of economic growth. Those countries that have embarked on people-oriented forestry programmes, with supporting policies and legislations, are beginning to reverse the losses. However, most of the gains appear to come from monoculture exotic plantations that are not providing a wide enough range of ecosystem services or biodiversity conservation. Nevertheless, some countries are beginning to explore approaches that include restoration of natural forests. These restoration initiatives could provide the basic foundations for formulating FLR approaches. However, it is obvious that such nascent efforts would need to be built further and scaled up considerably before they can be regarded as FLR initiatives and ready for implementation.

Table 1. Overview of countries chosen for review of forest restoration practices

General features	Major forestry features
China Location: Northeast Asia (tropical-temperate-alpine conditions) Population: 1 333 million Forest area: 206.8 million ha (22% of the land area); annual change: +1.4%	China has a wide range of climatic regions, and hence has a wide variety of forests, including alpine, temperate and tropical types. In the past, forests underwent heavy exploitation, which resulted in severe environmental problems. Starting in 2000, there was a major shift from timber production to achieving sustainable forest management. With a series of key initiatives, including reform of tenure policies, the country has begun to reverse forest loss. Currently, 22% of the country is under forest area, with annual growth of about 1.4%. Most of the gains have been through expansion of plantations, mainly monoculture of a few exotic species. However, the role of villages/communities in this growth has been clearly established. With these developments in place, the research community finds it appropriate to foster FLR approaches as the next steps in Chinese forestry development.
Indonesia Location: Tropical archipelago (Southeast Asia/Australasia) Population: 240 million Forest area: 94.4 million ha (52% of the land area); annual change: -0.7%	Indonesia still has high forest cover of almost 52% and remains a major producer of timber from its natural forests; it is currently losing about 0.7% of its forest area annually. While these forests represent some of the most megadiverse forests on earth, there is still heavy pressure for conversion to other land uses, especially cash crop plantations. Its forest plantation area, constituting about 4% of its forest area remains small, and is unlikely to make up for the heavy logging of natural forests. The heavily fragmented and disturbed forests are extremely vulnerable to forest fires, and large tracts of them are regularly lost. In the past people relied heavily on forests for their livelihoods but this dependence was undermined by policies centred on timber production. With the renewal of emphasis on people's livelihoods from forestry gaining momentum, and the vast areas of degraded lands, the potential for implementing FLR approaches looks good. Some new work on the ground provides pathways to forging such approaches.
Myanmar Location: Continental Southeast Asia (tropical) Population: 56 million Forest area: 31.7 million ha (48% of the land area); annual change: -0.9%	Myanmar has a wide variety of forests, dominated by tropical evergreen forests, mixed deciduous forests, dry forests and temperate evergreen forests. Myanmar has retained a high forest cover of 48% and is the world's leading source of teak from natural forests. Timber export represents over 10% of its export earnings, indicating the important role forestry plays in the country's economy. While Myanmar has a rich history of forest management, it is mainly focused on natural forests and forest plantations have remained marginal; community forestry has not been fully implemented. With over-reliance on forestry for the national economy, illegal logging, shifting cultivation and other causes, the forest area is still declining at about 0.95% annually. While the need for FLR approaches exists, the basic requirements of appropriate policies, institutional set ups and technical knowledge are non-existent.
Nepal Location: South Asia (subtropical-tropical) Population: 23 million Forest area: 3.6 million ha (29% of the land area); annual change: 0.0%	With elevations ranging from 70 to over 8 000 m, Nepal has a wide range of climatic conditions that support tropical, temperate and alpine forest types. With such mountainous conditions, the country needs to maintain high forest cover, but with over 80% of its population dependent on agriculture, the forest area has shrunk to around 29% of the land area. Loss of forest area comes from a variety of sources: illegal harvesting, occupation by landless farmers, shifting cultivation, grazing etc. This has led to rapid environmental deterioration. The country, with donor support, embarked on large-scale community and leasehold forestry programmes; currently more than 1.6 million households are engaged in community forestry, managing over 1 million ha of forests. These programmes are beginning to meet a large amount of the country's wood needs and it appears that the rate of deforestation overall has begun to halt.

	Several policy and legislation changes have been implemented to strengthen the people's role in forest ownership and management. In addition, some of these timber forests, with adequate protection from encroachment (natural and anthropogenic sources) are capable of regenerating from coppices, requiring less effort to restore them. Effective natural recovery systems and strong involvement of people in forest management provide excellent precursors for implementing FLR approaches in the country.
The Philippines Location: Tropical archipelago in Southeast Asia Population: 100 million Forest area: 7.6 million ha (26% of the land area); annual change: +0.7%	The country used to have more than 50% of its land under forest cover in the 1970s but this had declined to under 20% by the late 1990s. The loss of these megadiverse forests can be mainly traced to inequitable policies that favoured rapid exploitation of timber and conversion of forested areas to agriculture by poor farmers. The government supplanted such commercial schemes with other forms of co-production schemes that were not effective. There were attempts to increase forest cover through massive restoration of denuded lands in the 1990s, but without adequate protection and maintenance, they were not fully successful. Nevertheless, recent reports are indicating positive annual growth of 0.7%. Since the 1990s, the thrust has been for more social justice and equity in the forestry sector, which has resulted in a proliferation of 'people-oriented' forestry programmes. Besides applying new land tenure instruments, NGOs, local governments and people's organizations are being included in the restoration initiatives. Plans are being formulated to restore deforested areas and also to bring 'open-access' forest areas under community forest management. These changes provide the template for introducing FLR approaches.
Thailand Location: Continental Southeast Asia (tropical) Population: 67 million Forest area: 18.9 million ha (37% of the land area); annual change: +0.1%	Thailand is dominated by evergreen and deciduous forest. More than half of the country used to be under forest cover, but with rapid economic growth and agricultural expansion, forest cover declined to below 40%. Faced with continued encroachment, illegal logging, fire and other causes, a logging ban on natural forests was imposed in 1989. Nevertheless, the sector continues to face illegal logging and conflicts with forest dwellers. Plantations, estimated at about 1.87 million ha, especially of rubberwood, along with imports are the main source of timber for the export-oriented timber industry. Debate is still ongoing over the rights of traditional and local communities over access to and use of forests. However the Community Forestry Bill has not been passed yet to open up additional opportunities for people to manage forests. While technical knowledge in forest restoration of degraded forests and lands is sufficiently well developed, the forest policy environment precludes large-scale restoration work at present.
Viet Nam Location: Continental Southeast Asia (tropical) Population: 92 million Forest area: 13.7 million ha (43% of the land area); annual change: +1.1%	Viet Nam's southern border is close to the equator and the north touches the subtropical belt. With such diverse climatic conditions, its forest types are equally diverse. The dominant forest types include: evergreen and semideciduous broad-leaved forests, deciduous forests, coniferous forests and open broad-leaved forests. In the 1940s, almost half the country was covered with forest, but this declined rapidly and by the 1990s it was only 27%. Forest quality also suffered. The main causes for deforestation and degradation included overharvesting, shifting cultivation, conversion to agriculture, encroachment and damage from war. Economic development policies, which promoted large-scale cash crop plantations contributed heavily to the forest loss. The government thus introduced regulations to restore natural forests and afforest and reclaim degraded areas. The strategy included realigning to forest resource establishment, restructuring forestry to include people and the private sector, diversifying focus to multiple products and services, and development of plantations on a more scientific basis. The 5MHRP was implemented with strong community involvement. While this has expanded the forest area and stocking, most regeneration comes from exotic monocultures. The government is now examining approaches to increase the value of natural forests through payments for ecosystem services (PES) such as carbon sequestration, biodiversity and genetic conservation. With all these innovations, the basis for implementing FLR approaches in the country appears to be good.

FAO and RECOFTC are convinced that FLR approaches will have much value in Asia and the Pacific; it is worthwhile to invest more in the processes and persuade more countries in the region to adopt these practices. We also recognize that the FLR process remains relatively unknown in these countries and a major regional effort is required to mainstream it. This synthesis will first examine the current status of forest land, past achievements with forest restoration, various restoration approaches, the need to adopt FLR approaches that integrate social and environmental aspects in restoration work, how FLR works and a proposal for setting up a regional facility to jump-start the FLR approach in the Asia-Pacific region.

2. Forest and land degradation in the Asia-Pacific region

2.1 Forest restoration – terminology explained

Before embarking on a historical review of the causes of deforestation and the various restoration approaches, it would be best to clarify the terminology generally used for discussing the various processes. The terms have multiplied and technical experts have tended to refine them to a point where some of them are for very narrow and for specific situations. Much confusion prevails as well, even with the most commonly-used terms such as rehabilitation, reforestation, restoration and so forth; they have often been used interchangeably, making the environment for discussion rather difficult and sometimes muddling.

The terminology that is currently prevailing among technical experts is listed below (after Lamb 1994; Siyag 1998; FAO 1998, 2000, 2001, 2002; Gilmour et al. 2000; Lamb and Gilmour 2000; Chokkalingam and De Jong 2001; CBD 2001; ITTO 2002; Carle and Holmgren 2003):

- **Reforestation:** An all encompassing term that includes the development of forests using the entire range of techniques available from natural regeneration to artificial planting. It also describes situations where bare ground is being reforested and not regenerated as part of the normal silvicultural sequence following a forest harvesting operation. It therefore includes monoculture plantations, rehabilitation and ecological restoration. Contrary to afforestation, reforestation is applicable to sites that were under forest within the previous 50 years. Afforestation is used to describe reforestation in areas that have never been occupied or had trees for over 50 years.
- **Rehabilitation:** Development of new forests using some, but not necessarily all, of the original species. It may even include using some exotic species where these are needed for commercial reasons or because of their tolerance of present site conditions. Planting, seeding and natural regeneration may be employed for developing such areas. Many of the former productivity and ecological processes can be recaptured.
- **Natural regeneration:** Growth or re-emergence of native vegetation resulting from natural processes, or following destruction or degradation, through protection of the site from biotic and abiotic interference. Regeneration may come from seeds, stumps, coppices or root suckers.
- **Reclamation:** Recovering the productivity of a degraded site using mainly exotic species, without restoration of the original biodiversity, although the protective function and some of the original ecological services are re-established.
- **Monoculture plantations:** Plantings of single species, indigenous or exotic, carried out at the same time. The functions and processes of the former forest may be partially recovered.
- **Agroforestry:** A land-use system where woody perennials are raised in the same area with agricultural crops, in a spatial arrangement or temporal sequence, which results in both ecological and economic interactions between both components.
- **Forest (ecological) restoration:** A process that assists the recovery of a degraded, damaged or destroyed ecosystem. The process seeks to bring back the forest structure, ecological functions and biodiversity to levels that resemble the historical forest ecosystem. The forest restoration process employs natural regeneration or a combination of planting, seed sowing and natural regeneration.
- **Deforestation:** Conversion of forest to another land use or the long-term reduction of tree canopy cover below the 10 percent threshold.
- **Degraded forest:** Forest which has lost some of its structure, function and species composition, and delivers less of the goods and services expected of a natural forest at that site.
- **Degraded forest land:** Formerly forested lands severely damaged by intensive and/or repeated disturbances such as wood harvesting, mining, fire and grazing, which result in inhibition or delay in forest re-establishment.

More recently, Stanturf et al. (2014) reviewed forest restoration and presented more coherent terminology for restoration strategies using a functional approach. They described the various restoration approaches as:

- **Rehabilitation** – restoring desired species composition, structure or process to a degraded ecosystem;
- **Reconstruction** – restoring native plant communities on land recently used for other resource uses, such as agriculture;
- **Reclamation** – restoring severely degraded land generally devoid of vegetation, often the result of resource extraction such as mining; and
- **Replacement** – introducing new species (or new genotypes) in response to climate change impacts.

Their terminology is simpler and more readily identifiable with field techniques being used for restoration purposes. The techniques mentioned above would constitute the restoration strategies generally available for bringing back forests in denuded lands, sites under other forms of land use and degraded forests. This terminology will henceforth be used in this report, except when quoting other sources. Of course, this does not replace more specific terms such as natural

regeneration, plantation and afforestation where they clearly convey the techniques being employed. Collectively, all of these terms are referred to as restoration activities.

2.2 Extent of forest and land degradation

The rest of this chapter covers the state of degradation in the region, a brief review of causes, the global momentum for restoration work, the experiences gained with restoration and factors that create success.

The Asia-Pacific region has around 723 million ha of forest, which is about 18 percent of the global forest area (FAO 2015 a,b). However deforestation is not uniform throughout the region (Table 2, Figure 1). In aggregate, during 1990 to 2000, the region lost annually 0.7 million ha of forests. Deforestation rates began to reverse from 2000 onwards with annual gains of 1.35 million ha. This was mainly due to massive afforestation in China (and to some extent in India and Viet Nam) during the period. However, of greater concern are the forests of Southeast Asia, which host extraordinary wealth of terrestrial biodiversity (Figure 1). The Southeast Asian subregion lost about 31.3 million ha during the period 1990-2010. A better perspective is obtained when this annual loss of about 1.3 million ha is compared with the global annual loss of around 5 million ha during the same period. (FAO 2015).

Table 2. Forest area change in the Asia-Pacific region

Subregion	Area (million ha)					% change (1990-2015)
	1990	2000	2005	2010	2015	
East Asia	209.2	226.8	241.8	250.5	257.0	22.9%
South Asia	77.6	77.7	79.5	81.4	82.0	5.8%
Southeast Asia	242.0	221.0	217.1	214.6	210.8	-12.9%
Oceania	176.8	177.6	176.5	172.0	173.5	-1.9%
Asia-Pacific	705.6	703.1	714.9	718.5	723.4	2.5%
World	4,128.3	4,055.6	4,032.7	4,015.7	3,999.1	-3.1%

Source: FAO 2010a, 2015

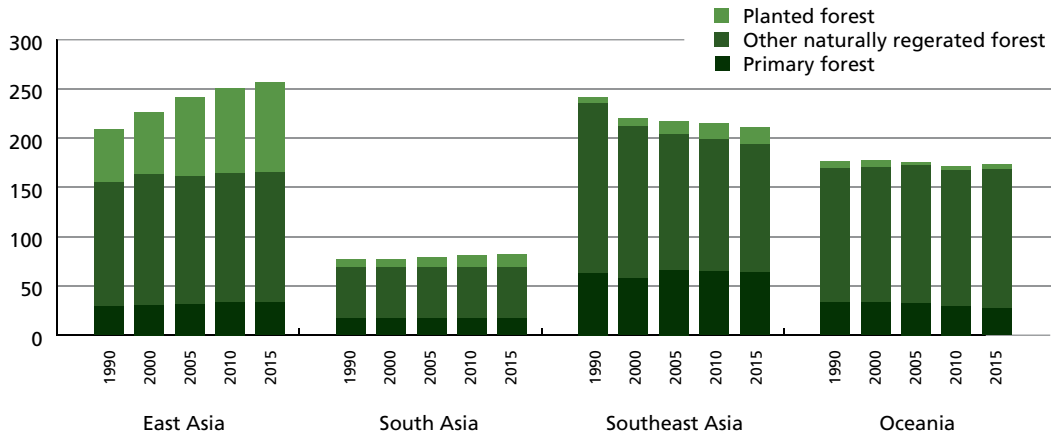

Figure 1. Breakdown of forest types in the Asia-Pacific region

Source: FAO 2010a, 2015

While deforestation is quite clearly visible, the extent of forest degradation generally remains unquantified. By adopting the 10 percent canopy cover standard for designating forest area, irrespective of whether this is primary forest or plantation monocultures, changes to the quality of the forest are not easily quantified; Miettinen et al. (2014) arrived at a similar conclusion in trying to review the situation in Southeast Asia using remote sensing. Nevertheless, some figures have been collated (Achard et al. 2002; Table 3). It appears that Southeast Asia experienced very high deforestation - it lost 2 million ha compared to the global estimation of 4.9 million ha during the 1990s (Table 3). Primary forest cover showed the steepest decline in Southeast Asia - from 34 percent in 1990 to 29 percent in 2010 (Table 4). However, the rate of loss slowed somewhat in the 2000-2010 period compared to the previous decade.

Table 3. Annual changes in forest cover in humid forests between 1990 and 1997

Activity	Southeast Asia		Global	
	Million ha	% of forest cover	Million ha	% of forest cover
Deforestation	2.5	0.91	5.8	0.52
Regrowth	0.53	0.19	1.0	0.08
Net forest loss	2.0	0.71	4.9	0.43
Degraded forest	1.1	0.42	2.3	0.20

Source: Achard et al. (2002)

Table 4. Changes in forest cover in Southeast Asia[a] between 1990 and 2010

Forest type (million ha)	1990	2000	2005	2010	2015	% change/yr 1990-2000	% change/yr 2000-2010
Total forest cover	242.0	221.0	217.1	214.6	210.8	-0.91%	-0.31%
Primary forest cover	75.4	66.6	66.1	64.8	63.7	-1.23%	-0.30%

Source: FAO (2015)

[a] *Countries include Brunei, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Thailand and Viet Nam*

Deforestation is heavily driven by conversion to agriculture, prominently for cash crop plantations and biofuels in Southeast Asia (Butler 2009; FAO 2009). Other practices such fuelwood collection, shifting cultivation and grazing are also contributing to the loss. On the other hand, forest degradation is primarily stemming from poor logging practices. Once the forests become highly degraded, they become more vulnerable to encroachment, fire and pests and diseases. In the past, fires in natural forests were rare in Southeast Asia. However, their incidences and intensity have increased, coinciding strongly with the El Niño drought events. For example, the two strongest El Niño episodes (1982-1983 and 1997-1998) were associated with huge fires in Borneo (Wooster et al. 2012). The fires were most intense in the highly degraded forest areas, suggesting the situation can only worsen as forest degradation continues. As a result, extensive areas of forests can no longer provide environmental benefits or future timber harvests.

2.3 Drivers of deforestation and land degradation

It is appropriate to review drivers of both deforestation and forest degradation before embarking on consideration of restoration work. Many reviews have been produced on this issue. Examples include Geist and Lambin (2002) and De Jong (2005).

In general, the drivers are distinguished as proximate or direct causes and underlying or indirect causes. Proximate causes are the ones carried out by human beings that directly affect forest cover. They include agricultural expansion (commercial and subsistence), infrastructure and urban expansion, and mining. Activities like logging, unmanaged fires, livestock grazing and fuelwood collection and charcoal production are linked to forest degradation.

Underlying causes are the result of complex interactions of demographic, economic, technological, institutional and socio-cultural factors (Geist and Lambin 2002). Economic growth in the region has increased demand for forest goods and agricultural products, and become an important indirect driver of deforestation and degradation in the tropics. Likewise, population growth places additional demand for agricultural land, fuelwood and other forest products, leading to deforestation and forest degradation. In addition, poor governance, corruption, tenure uncertainties, low institutional capacity for planning and enforcement of rules are just as critical underlying factors of deforestation and forest degradation. The important drivers, both proximate and underlying, are briefly examined below.

- **Agriculture:** In the region, agricultural expansion that includes establishment of permanent crops, shifting cultivation and resettlement of populations has been a major cause of deforestation.
- **Logging:** Logging alone does not result in deforestation, but bad logging practices have led to extensive forest degradation. While methodologies to ensure good logging practices are available, they are rarely implemented and rules are poorly enforced. With low stumpage fees and taxes on the concessionaires, the incentive to convert heavily-logged forests to other land uses increases. Moreover, the external cost of environmental damage is borne by the public, which makes logging even more profitable to concession holders.
- **Corruption:** Corruption, which is often endemic with logging, results in less re-investment in forest management and the community receiving a lower share of the benefits of forest management.
- **Inappropriate land-use policies:** Lands unsuitable for agriculture were opened up, often more for the purpose of extracting timber than for legitimate agricultural development, and subsequently abandoned.

- **Tenure:** Without appropriate tenure in place and improved agricultural productivity, landless farmers have continued to encroach into state forest reserves because they are perceived as 'open-access' areas.
- **Economic development and population growth:** Economic development placed increased demand on forest goods and other commodities, and led to an increase in deforestation.
- **Energy:** Expansion of land for biofuel production has placed some pressure on forests. Likewise, hydropower development has resulted in extensive loss of forests.
- **Policy and institutional factors:** Policies which provide incentives for agricultural growth, transportation, infrastructure development and timber subsidies (such as artificially-low domestic prices) encourage deforestation (Geist and Lambin 2002).

While the above drivers are described as single-factor causation, in reality they act synergistically, with many of them interacting leading to deforestation and degradation. For example, state policies aimed at economic development and land use can lead to expansion of cash crops in forested areas. The road construction that accompanies economic development of an area can open up more forests for logging and lead to new settlements.

This review is supported by seven country reviews (China, Indonesia, Myanmar, Nepal, Philippines, Thailand and Viet Nam). Some of the underlying causes for deforestation in these countries are summarized in Table 5.

Table 5. Underlying causes and agents of deforestation

China:

The country review states that deforestation and forest degradation have been the general trend for several decades and attributes this to past human activities, especially with agricultural expansion. Poor policies that have accelerated these processes are:

- Policies that prioritized timber production and the generation of rapid economic benefits over environmental and biodiversity considerations.
- Poorly developed economic development policies favouring rapid industrialization which led to heavy deforestation.
- Poor and unsuitable management prescriptions, described as a "commercial-ecological two-class management policy" (Dai et al. 2009) led to heavy degradation and poor stand constitution.
- Afforestation programmes may not have taken into consideration the heterogeneity of nature, society and the economy.
- Planning has been centralized using a top-down approach and has not included a meaningful role for local initiatives.

Indonesia:

The underlying and direct causes of deforestation cannot be separated, as they are part of the long chain of events leading to forest loss. Nevertheless, the underlying causes can be attributed to: i) market failures, ii) policy failures and iii) broader socio-economic and political causes.

- Market failures – commercialized forest products such as timber are undervalued, giving no incentive to conserve forest resources.
- Policy failures (examples):
    - 20-year logging permits – a disincentive to implement appropriate logging practices or enrichment planting,
    - Industrial timber plantation owners had rights to clear-cut trees remaining on land prior to reforestation but then failed to undertake the reforestation,
    - Premature decentralization and the inadequate capacity of local government and forestry services have increased illegal logging and forest encroachment,
    - The Community Forest Concession Permit – translated to timber utilization without the responsibilities to rehabilitate logged areas.
- Broader socio-economic and political causes – with the economic crisis of 1997, farmers ended up opening considerable areas of state-owned forest lands, including primary forest for their livelihoods.

Myanmar:

All the direct causes for deforestation and forest degradation, which include overexploitation, illegal logging, shifting cultivation, agricultural expansion, demand for woodfuel, settlements and mining, appear to prevail in Myanmar. Other underlying causes include:

- The Myanmar Forest Law (1992) and Forest Rules (1995) – these were prepared to harmonize with the revised 1995 Forest Policy. While there are principles designed to provide safeguards against deforestation and forest degradation and to foster reforestation efforts, the ground provisions for implementation are not fully established.
- People's participation – forest management policy, both under colonial and latter national governments, has extinguished the rights and privileges of local communities to their traditional use and access to forest resources, which has led to encroachment.
- Land-use policy – the absence of a clear and inclusive land-use policy and planning process has created an environment where other sectors prevail over the needs of the forestry sector.

Nepal:

A variety of underlying causes for deforestation are cited in the country review including:

- Market failure – smuggling, and distortion of prices and excessive bureaucratic controls of high value timber led to rampant illegal harvesting and trade.
- Institutional failures – the Department of Forests has inadequate management and control mechanisms. This, together with corruption, has meant it has not been able to halt illicit felling and smuggling of timber.
- Inappropriate policies – formerly, families could avoid agricultural taxes by supplying fuelwood, charcoal and other products to the government, which led to extensive deforestation.

These unfavourable policies, without consideration of communities' needs, led to heavy deforestation and forest degradation up to the 1990s.

The Philippines:

Government policies have been clearly cited as the main underlying causes for deforestation. A selection of the policies supports such a view.

- Forestry policies during the heyday of logging were geared towards centralized management and supported corporate concession holders who rarely promoted protection, conservation or rural development activities.
- A series of acts and policy changes was introduced, such as the Community-Based Forest Management (CBFM) Act in 1995 and the Indigenous Peoples' Rights Act (IPRA) in 1997, which led to overlapping land uses and tenure instruments, generating local conflicts, and resulting in more forest degradation and deforestation.
- Existing tenure provisions in CBFMs do not allow access to outside support for financing reforestation work.
- In response to several natural calamities, logging bans were enacted; the latest is the February 2011 Executive Order (EO) 23. This has been happening despite an increase in demand for wood throughout the country, leading to widespread illegal logging.

Thailand:

Government policies and the failure to update them to meet new circumstances have contributed to ongoing loss of forests.

- Economic development policies – in the 1980s, the government supported agroindustry development which resulted in extensive forest areas being converted to cash crop plantations.
- Failure of law enforcement and corruption – with problems of implementation and enforcement, a logging ban on natural forests was imposed in 1989, without taking into account the needs of the timber industry. Illegal logging still continues as a consequence.
- Land use and land rights – the government classified forest land for protection, parks and reserves, without taking heed of the needs of ethnic groups who already occupied forested areas; this insecurity over property rights led to extensive forest degradation.
- Market failure – forests were grossly undervalued, mainly benefiting the private sector, which strongly influenced the conversion of forests for other land uses.

Viet Nam:

While direct causes are frequently cited for deforestation and forest degradation, the underlying causes have exacerbated the problems significantly:

- Pressure of poverty and high population – apart from rapid population growth and limited farming land, migration policies to move people to other sites, mostly forest areas, led to rapid loss of forest lands.
- Economic development policies – economic growth based on exports of cash crops and wood products resulted in conversion of natural forests.

Institutional weakness – the quality of forest management and law enforcement at the local level remains weak, leading to shifting cultivation and conversion of forest lands to other uses.

- Forest tenure and management – in the past, forests remained as a free resource for local people to enter and collect forest products.

The conclusions emerging from these country reviews echo those made by Geist and Lambin (2002) for several Asian countries. Without exception, they regularly attribute deforestation to direct causes such as poverty, agricultural expansion (especially for cash cropping), shifting cultivation, resettlement and so forth. But as the situation unfolded (Table 5), the underlying causes, mainly as consequences of poor policies, have been far more deleterious to both the livelihoods of the people and forests, and the problems appear to persist over the long term. Many cases can be cited, and include:

- The migration/transmigration policies seen in Indonesia and Viet Nam that have resulted in opening of forests unsuitable for agriculture, sometimes following unregulated timber harvesting.
- The market failures that have been associated with commercial logging, evident in most of the countries reviewed, which have overwhelmingly benefited corporate tenure holders and have worked against forest protection and restoration.
- The short-term logging permits in Indonesia that proved to be a disincentive for enrichment planting.
- The failure in offering clear tenurial rights to rural communities which led to conflicts (that are still ongoing in Myanmar, Indonesia, Thailand and the Philippines) and to escalation of deforestation.
- The reclassification of forest areas without recognition of the rights of forest dwellers in Thailand.

These policy failures have yet to be clearly resolved and the consequences are still continuing. For example forest encroachment frequently cited as the cause of forest degradation in Indonesia, and the subsequent widespread fires. This was mainly precipitated by tenurial arrangements which favoured large corporate plantation holdings over the local populations.

2.4 Area of degraded lands and forests available for restoration

It is difficult to make an absolute estimate of degraded lands, as they are capable of reverting back to forests. Laestadius et al. (2011) indicated that worldwide, there are more than 2 billion ha of deforested and degraded landscapes which potentially can be restored. ITTO (2002) estimated that there were 850 million ha of degraded forest lands in the tropics worldwide – 350 million ha of degraded forest land and 500 million ha of degraded primary and secondary forests. For Asia, the studies estimated degraded forest land at 125 million ha and a further 145 million ha of degraded forests, with an additional 1 million ha of degraded forests and lands entering into the category annually (ITTO 2002; Mayaux et al. 2005). While there is no question that degraded forests and lands proliferate in the region, it is more important to find out if countries recognize this problem and are interested in addressing the issue. This has been collated for Southeast Asia (Table 6, from Lamb 2011 and Gilmour et al. 2000).

Table 6. Estimates of degraded land area in selected Southeast Asian countries that might be available for forest restoration

Country	Degraded land (000 ha)	Percent land area	Area for restoration (000 ha)
Cambodia	2 600	15	no report
Indonesia	56 900	30	47,000
Lao PDR	8 700	36	8,700
Malaysia	1 200	4	no report
Philippines	9 300	31	5,500
Thailand	2 300	4	2,306
Viet Nam	9 700	30	5,000

Source: Lamb (2011), Gilmour et al.(2000)

The data may be rough estimates, but they do portray how extensive the problem is with degraded land, and the need for restoration. The estimates range from 1 million ha in Malaysia (which seems to be a vast underestimation) to 57 million ha in Indonesia. The countries have also recognized the problem – for example, Viet Nam has stated that 5 million ha need restoration while Indonesia has called for restoring some 47 million ha.

2.5 Losses from deforestation and degradation

Losses from deforestation and degradation are far greater than simply the loss of timber production potential. Lamb and Gilmour (2003) outline some of the problems, such as reduction in ecosystem services (especially water regulation, nutrient cycling, wildlife habitat), reduction in range and quality of goods and services received by people, increased climate change impact, increased outbreak of pests and diseases, loss of biodiversity and problems with invasive species.

Biodiversity: The humid forests of Southeast Asia are some of the richest forests globally in terms of biological diversity. Human activities have had very adverse impacts on biodiversity and the loss is continuing. Sodhi et al. (2004) cite forest conversion, forest fires, hunting for bushmeat and wildlife trade to be the main drivers for species loss. They extrapolate that current rates of habitat destruction in Southeast Asia will result in the loss of 13–42 percent of regional populations of all species by 2100.

Ecosystem services: Forest loss and degradation have resulted in alteration of ecological processes, such as food webs, pollination and seed dispersal. This results in reduction in the supply of forest goods, non-material values and ecosystem services. They can be summarized as (after Lamb 2011):

- Goods: timber, fuelwood, food (plant and animal), medicines;
- Non-material values: existence, spiritual, cultural, historical, recreational, ecotourism;
- Ecosystem services: biogeochemical cycles (carbon, nitrogen, phosphorus) and water cycles, natural pest control, pollination, seed dispersal, decomposition, erosion prevention, improvement of soil fertility, soil formation, climate regulation.

Climate change: Tropical forests are estimated to contain about 25 percent of all carbon in the terrestrial biosphere (Bonan 2008), or about 240 tonnes of carbon per hectare are stored in vegetation and soils (IPCC 2000). Deforestation contributes significant amounts of carbon dioxide and methane emissions into the atmosphere. The estimates range from 0.5 to 2.2 petagram C per year (Ramankutty et al. 2007), which is about 15 percent of total CO_2 emitted to the atmosphere from human activities. So, in this context forest restoration can reverse the trend and capture some of the CO_2 emissions from the the atmosphere.

Watersheds: The impact of deforestation on hydrological cycles and watersheds is quite complex and not well understood. Deforestation affects water yields, both positively and otherwise (Bruijnzeel 2004; Bruijnzeel et al. 2005) as well other associated problems such as soil erosion and siltation of waterways (Wiersum 1984), and landslips (Sidle et al. 2006; Forbes and Broadhead 2011).

2.6 How to pay for forest restoration?

While the losses emanating from deforestation are well recognized, the push to reverse the loss by reducing deforestation and restoring degraded sites has not witnessed similar enthusiasm from planners and policy-makers. One of the biggest constraints is our inability to quantify the losses in economic terms that can be used to communicate effectively with politicians, policy-makers and entrepreneurs. But some improvements are foreseen, especially with the potential for earning income from forest services. Various valuation mechanisms are being developed that include carbon trading, payments for water services, biodiversity-offset schemes, income generation from ecotourism and trade in non-wood forest products (NWFPs). These could provide sufficient financial incentives to carry out restoration work. Several studies have attempted to quantify the values of tropical forests (see www.teebweb.org), but these are largely irrelevant if no one is willing to pay for these values. Two forms of valuation are used: market price for a product and substitution values, usually for a service. Hence, the cost of restoration can be directly equated to the approaches that bring back such products and services. 'Biodiversity-offset' has been proposed, whereby destruction of biodiversity resulting from development is offset by restoring equivalent biodiversity elsewhere (McVittie and Hussain 2013); this proposal may be difficult to apply as the value of biodiversity differs from site to site.

The trade in carbon however, has witnessed a faster trend. Already compliance carbon credits, under the obligations of the Kyoto Protocol, are being purchased by corporations and governments. However, forestry has not played a significant role in this market which works through the Clean Development Mechanism (CDM) channel. A voluntary credit scheme for individuals and organizations did get some attention, but interest in this has declined. Another new initiative is Reducing Emissions from Deforestation and Forest Degradation (REDD+) launched by the UNFCCC. The REDD+ concept encompasses the enhancement of carbon stocks, and if implemented, can provide significant funding for forest conservation and restoration.

Among all the potential services, the one most easily amenable for marketing is the supply of freshwater to farmers, urban dwellers and hydropower dams, which is generally dependent on the maintenance of forest cover upstream. Several

mechanisms are being developed in the region for paying forest owners to protect or restore forests upstream for foregone incomes (e.g. Huang and Upadhyaya 2007).

It is useful to look at how much forest restoration would cost (Enters and Durst 2004). This is difficult to estimate, as it depends on methods, locations and other fluctuations. The only certainty is that the costs of restoration are dependent on the stage of degradation, with the costs of protection being relatively low and complete site amelioration and planting being much greater (Table 7, after Elliott et al. 2013; Nawir et al. 2014; this volume).

Table 7. Examples of costs for various restoration approaches

Degradation stage	Method	Country	Date	Present-day (current) costs (US$/ha)
Stage 1	Protection	Thailand	-	300-350
Stage 2	Assisted natural regeneration (ANR)	Philippines	2006-2009	638-739
Stage 3	Framework species method	Thailand	2006	2,071
	Restoration ecosystem	Indonesia	2013	1,400
Stage 4	Mine site amelioration with maximum diversity	Brazil	1985	8,890

Source: after Elliott et al. (2013), Nawir et al. (2014) (this volume)

3. Forest restoration

3.1 Early work

While many countries accept the need for forest restoration and a few have achieved considerable success, overall there are still huge areas of degraded forests and lands deserving forest restoration. At this point we will take a brief look at forest restoration techniques and examine closely why some programmes have succeeded while others have failed. Forest restoration is not new. In Java, teak which was probably introduced 400 to 600 years ago, has become naturalized (Troup 1921) and has transformed tree plantations in the island. That being said, the beginnings of scientific forestry in the tropics are closely tied with the need to rehabilitate degraded forests. The taungya system for reforesting shifting cultivation areas with teak was introduced by Dietrich Brandis in Burma in 1856 (Blandford 1958). Similar approaches were introduced in India in the 1890s for rehabilitating degraded forests (see Chundamanni 1993), and in Peninsular Malaysia in the 1920s (Appanah and Weinland 1993; Sim et al. 2003). Nevertheless, deforestation and forest degradation have outpaced the restoration efforts. Restoration efforts have commonly been expensive; failures have been frequent and have often been undertaken with limited consideration of social implications. Neither have environmental issues been given a high priority. Certainly, the region has witnessed the establishment of many large plantations (e.g. China, Indonesia and Viet Nam), mainly with exotics which have been very successful in providing timber, and less so for ecosystem services. But at the same time, there are too many disappointing forest restoration initiatives, resulting in loss of interest and large areas of degraded forests and lands remaining unproductive.

The largely successful nationwide forest restoration works that Northeast Asian countries such as China, Japan and ROK undertook are good cases to highlight here. With slash-and-burn agriculture, heavy extraction of fuelwood and two wars, over 80 percent of ROK's forest was damaged. The growing stock had declined to less than 10 m^3/ha, and the country also faced massive erosion problems. In the early 1970s, the government introduced huge rehabilitation programmes. It planted 12 billion trees on 4.25 million ha and the growing stock had grown to about 126 m^3/ha by 2010 (Table 8, after Lee 2012).

Table 8. Forest area and growing stock over time in Republic of Korea

Year	Area (1,000 ha)	Growing stock (1,000 m^3)	Growing stock (m^3/ha)
1960	6 700	63 995	9.6
1970	6 611	68 772	10.4
1980	6 567	145 694	22.2
1990	6 476	248 426	38.4
2000	6 430	387 758	60.3
2010	6 369	800 025	125.6

Source: Lee (2012)

The case of China is worth emphasizing. With agricultural expansion, logging, forest fires and misplaced policies, by the early 1950s, forest cover had declined to 8.6 percent of the land area. By the late 1970s, the country had begun to witness huge environmental problems, which prompted the government to undertake large-scale forest rehabilitation programmes, mainly reforestation. As a result, China's forest cover had expanded to over 18 percent by 2000, effectively doubling its forest cover in about 40 years (Figure 2); currently forest cover stands at over 22 percent (FAO 2015). While these initiatives are not without their critics, the overall increase has been so impressive that it has impacted the reporting of forest area in the Asia-Pacific region – the downtrend from the 1950s onwards was reversed in the decades since 2000, largely owing to the increases in China.

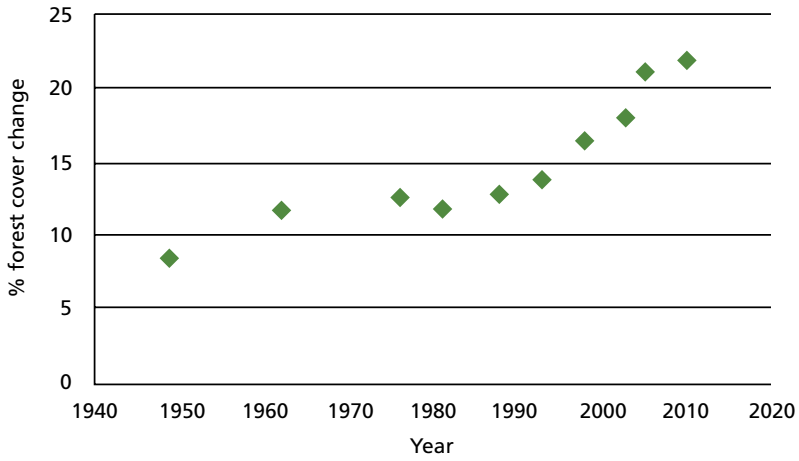

Figure 2. Total forest cover change (percentage) over 1949 to 2010 in China (compiled from Zhang and Song 2006, FAO 2005, 2009, 2010a, 2010b)

The successes in China and ROK can be attributed to several factors, including strong political will, good government institutions and international technical assistance. Of course, some would argue that this success is also partly attributable to the simpler temperate ecosystem to handle compared to the more complex tropical forests. This may be a simplistic argument, as Viet Nam has been able to prove otherwise. It started two massive restoration programmes, the greening the Barren Hills Program and the 5 Million Hectares Reforestation Programme. This has resulted in the protection and restoration of nearly 3 million ha of forests nationwide and raised forest cover from about 25 percent in the 1990s to over 40 percent currently.

Against this background, new initiatives are being declared. The Philippines recently announced a National Greening Program which calls for a massive forest restoration programme that seeks to grow 1.5 billion trees in 1.5 million ha from 2011 to 2016. Viet Nam too is building on the success of the 5MHRP with plans for restoration of an additional 1.25 million ha by 2020. These developments have captured the attention of some regional institutions – the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet) has placed forest restoration prominently in its support for APEC countries. In September 2007, APEC itself pledged to boost forest cover by 20 million ha by 2020. Another regional institution, the ASEAN-Korea Forest Cooperation (AFoCo) has made forest restoration its main agenda in its support for ASEAN countries. Donor agencies (World Bank, Asian Development Bank) and bilateral agencies have announced large forest restoration programmes for the region.

3.2. Forest restoration – techniques and end results

It is now an appropriate stage to briefly review the techniques that have evolved in forest restoration. They vary in terms of approach, costs and end results. Some of the more common restoration approaches that have been tested or are generally in use are described below.

3.2.1 Natural regeneration

When pristine forests are disturbed from logging, shifting cultivation and natural disturbances (e.g. storms, fires, landslides), natural regeneration usually results in the recovery of the forests. This process can be separated on the basis of their seed source.

Soil seed bank: When disturbance to the forest does not result in too much soil damage, pioneer species from the soil seed bank take over in the gap areas and this class of vegetation is referred to as secondary forest. In tropical parts of the Asia-Pacific region, the dominant pioneers are usually species of *Macaranga, Mallotus* and *Trema*. Such secondary forests now cover huge areas, globally estimated at from 340 to 600 million ha (De Jong et al. 2001; Chazdon 2014). With sufficient time, the pre-existing shade-tolerant seedlings on the forest floor overtake the pioneer vegetation. Ultimately they can partially resemble the original forest in terms of biodiversity, structure and ecological functions. By taking advantage of the natural regeneration, secondary forests are the easiest to reforest.

Seedlings: Disturbed forests also have many seedlings on the forest floor, and with sufficient opening of the canopy, the seedlings can bring back the forests. One approach that captures this regeneration capacity is called the Assisted Natural Regeneration (ANR) which was popularized in the Philippines in the 1980s (Dalmacio 1989). The assistance is in the form of pressing down weed species mechanically so the favoured ones can grow rapidly in the opening. FAO, with several NGOs in the Philippines, has promoted this approach that aims to enhance the establishment of secondary forest by nurturing and protecting seed trees and wildlings existing in the area (Shono et al. 2007, Durst et al. 2011).

Stumps and roots: A third source of regeneration of disturbed forests comes from stumps and old root systems which retain the capacity to propagate vegetatively. This type of regeneration manifests itself more markedly in forests in the drier zones (Murphy and Lugo 1986). It has been effectively incorporated into silvicultural tending in the Himalayan forests dominated by *Shorea robusta* and *Schima wallichii* that are regenerated using coppice growth.

Seed dispersed from outside: The last source of natural regeneration is from seeds dispersed by animals and wind from neighbouring intact forests. The Dipterocarpaceae family which dominates Southeast Asian rain forests can disperse from neighbouring intact sites and ultimately take over disturbed forests. This fortifies the view that if intact forests are close by, the potential for secondary forests to reach climax succession stages exists. In the years to come, such secondary forests are likely to be the dominant forests of the region, with most of the economic and environmental values of forests.

3.2.2 Plantations

Monocultural plantations: Under circumstances when natural regeneration is not available, tree planting to restore the area is the most practical approach. Monoculture plantations for rehabilitation have several advantages. The choice of species (with a specific product in view), location and site preparation can all be geared to making the endeavour profitable. This is the reason behind the attractiveness of plantations for forest restoration. While large industrial plantations are profit-motivated, state-owned plantations may be geared towards socio-economic considerations such as creating jobs, protecting watersheds and promoting rural development. Smallholders too are able to participate in raising plantations, as outgrowers for a company using a specific species, or in growing diverse tree species for multiple products. In tropical parts of the Asia-Pacific region, teak, rubber, eucalypts and acacia are commonly raised. The biggest constraint with plantations is time taken for return of investments, and hence the preference of fast-growing exotics such as acacias and eucalypts.

The downside is that such monocultures may not provide all the ecosystem services needed, including habitats for wildlife. There is also concern about risks from pests and diseases, wind-throws, soil suitability and so forth.

Multi-species plantations: As with monocultural plantations, multi-species plantations are also used for restoration when natural regeneration is undependable. They can be useful where a wider range of ecosystem services are required or income sources need to be diversified to minimize risks. Mixed-species plantations are not common on an industrial scale because of the management difficulties, but smallholders have often employed them to raise timber, fruit trees and other crops. This offers the smallholders a diversity of crops (different timber species for different markets, or NWFPs and timber) some of which can be traded in the near term while waiting for the final crop at a later date. This enhanced economic resilience is particularly appealing to many smallholders.

Mixed-species plantation designs include growing of cash crops beneath timber plantations, shade crops (coffee) beneath timber trees, rattan under host trees, growing shade-tolerant and shade-intolerant species and uneven-aged plantations. Various designs are available from research. The examples below illustrate just some of the options for mixed-species plantations:

- **Shade trees for growing coffee and cacao:** In general coffee is grown with overstorey trees such as *Casuarina, Erythrina, Falcataria, Gliricidia, Grevilea* and *Leucaena*. The smallholder can produce food, fuelwood and timber by varying the species (Bourke 1985).
- **Uneven-aged tree plantations:** Many of the upper canopy timber species of the moist forests of Southeast Asia will not tolerate planting in the open and require shade in their early years. Nurse trees such as *Acacia mangium* and *Acacia auriculiformis* have been used to improve site conditions. When the nurse trees reach about eight years, they can be thinned and underplanted with more desirable but less-tolerant species such as *Dipterocarpus alatus, Hopea odorata* or *Parashorea chinensis*. Some species, such as members of the Meliaceae family that are often affected by shoot borers may have damage reduced via underplanting. This practice of using nurse trees has been tested in many tropical Asia-Pacific countries (Kuusipalo et al. 1995; Anon 1999; McNamara et al. 2006; Lamb 2011).
- **Even-aged plantations with short- and long-rotation species:** There is demand for both sawlogs and poles in rural areas of Asia. In Viet Nam, a trial consisted of planting native species of *Chukrasia tabularis* and others (for sawlogs) and *Eucalyptus urophylla* (for poles). In this combination, it would be possible to harvest the eucalypt in about six years, and leave the sawlogs for future harvest about 20 years after planting (Lamb and Huynh 2006).
- **Multi-species planting:** Several variations of multi-species plantations have been tested for over a century in Asia. The planting of dipterocarp mixtures in Malaysia in former tin-mining areas (e.g. the location of the Forest Research Institute Malaysia) is a notable example.
- **Enrichment planting:** Also called line planting, enrichment planting has been commonly practiced in Malaysia (Appanah and Weinland 1993). Seedlings of commercially valuable indigenous species (mainly dipterocarps) are planted in logged-over forests. Planting lines are created at intervals, non-commercial species and undergrowth are cleared along the rows, and advanced seedlings of commercial species are planted about 3 meters apart. Their success is variable as the canopy overhead tends to close up rapidly and need to be regularly opened in order to provide sufficient light for the seedlings.
- **Planting mixtures of species for creating forests:** Trials are ongoing for the planting of a small number (20-30 species) of indigenous trees that grow fast, are fire resilient and attract wildlife, which in turn introduce seeds of other plant species to create a forest, although not necessarily the original vegetation. These plantings have been called 'novel ecosystems' (Hobbs et al. 2009) and 'framework species' (Elliott et al. 2013), a method of forest restoration that was first implemented in Australia (Goosem and Tucker 1995; Tucker and Murphy 1997).
- **Mosaic of monocultures:** Diversity of species can also be achieved by planting small monoculture patches of different species across the landscape. These are easier to establish and manage, and as a whole, can produce a greater variety of products than single species monoculture. Mosaic plantings are practised by farmers with smallholdings in the Philippines (Emtage 2004), and as 'ecoforests' in China to rehabilitate severely degraded hills (Lamb 2011).

Multi-species plantations, besides having more species, also harbour a greater diversity of wildlife (Kanowski et al. 2005), form the canopy for a huge variety of understorey plants (Kala 2010), provide soil conservation and watershed protection (Zhou et al. 2002) and store more soil carbon than monocultures (Russell et al. 2004). It may be reasonable to state that in future multi-species plantations may be a way to conserve many plant and animal species in the Asia-Pacific region.

3.2.3 Agroforestry

Agroforestry is an agrosilviculture system where trees or shrubs are grown around or among crops or pastureland in a sustainable land use system that results in maintenance of existing yields or higher yields. While it introduces the benefits of forests to farmland, the arrangement between agricultural crops and forests ensures the farmers need not forego income generation for a decade or more which is usual with tree growing. Agroforestry is gaining importance as another restoration technique that is favoured by smallholders.

Various agroforestry approaches have been developed across the region depending on the agroclimatic conditions, economic needs, and cultural practices (Nair 1993). These are labelled as agrisilvicultural system, silvopastoral system, and agrosilvopastoral system. In the agrisilvicultural system, tree crops are planted amidst agricultural crops such as cereals, fodder and others. Usually the trees perform better in this system compared to monoculture plantations. This represents

diversification of income for the farmer, and includes practices such as planting fallow areas, taungya, alley cropping, and home gardens. Next is the silvopastoral system where trees, pasture and/or animals are incorporated. They are represented by trees on rangeland or pastures and tree plantations with pastures and animals. The practice of raising cattle or goats in coconut and rubber plantations represents the latter. The final one is described as agrosilvopastoral system where trees, crops and animals are raised together. The examples include home gardens involving animals, apiculture with trees, and aquaforestry (trees lining fish ponds, with tree leaves being used to feed fish). Among the practices, the ones with highest relevance to forest restoration are the home gardens and farm forestry.

Tree home gardens: These are land-use systems that consist of multipurpose trees and shrubs with annual and perennial agricultural crops within homesteads, and managed by the family to meet domestic needs. These home gardens are common in high rainfall areas of the tropics, and have been practiced for centuries. Of course home gardens without trees do exist and they are not relevant for forestry. Forestry-related home gardens are preferably referred to as tree home gardens (Torquebiau 1992). The typical tree home gardens have high species diversity, and the vegetation is usually in 3-4 strata, with emergent timber and fruit trees in the upper layers, the second layer with food crops such as papaya and banana, and the ground floor with vegetables and spices. The choice of species varies depending on what is locally available and cultivated. According to a survey in Sri Lanka, home gardens covered 858,000 ha which is about 30 percent of the forest area of the country (Ariyadasa 2002). Some of their common timber species included *Alstonia macrophylla, Artocarpus integer, Cocos nucifera, Eucalyptus* spp., *Hevea brasiliensis, Mangifera indica, Swietenia macrophylla* and *Tectona grandis.* These home gardens produced 41 percent of the nation's sawlogs and 26 percent of the biofuel needs. In fact, trees raised in homesteads and other agroforestry systems have become the main strategy to meet domestic timber needs of Sri Lanka.

Farm forests: Farm forestry is the incorporation of commercial tree growing into farming systems, and may come in the form of woodlots, timber belts, alleys and widespread tree plantings. It differs from the classical agroforestry system which refers to production of timber and an agricultural product from the same parcel of land. Besides the commercial gain, farm forests provide substantial environmental benefits. In countries like Australia farm forests are gaining interest as their benefits include carbon sequestration, water table management, salinity hazard management, fire breaks, and enhancement of farm productivity and diversification of incomes. Farm forests are increasing in importance in Asian countries that are facing shortages in wood supply. Farmers with small holdings in Laos, Philippines and Thailand are encouraged to plant timber trees on their marginal lands. Mainly fast growing exotic species of *Acacia, Casuarina, Eucalyptus* and *Leucaena* are raised. Some native species of *Tectona* and *Pterocarpus* are being introduced as well. In India, where private companies are not allowed large land holdings, the paper industries have entered into contracts with farmers to plant clonal *Eucalyptus* species with guaranteed purchase prices. This has accelerated the growth of farm forests in the country. But there still remain many constraints for the growth of farm forests in Asia, particularly as a result of antiquated rules and regulations that limit the felling, transport and sale of farm forestry species (Appanah et al. 2012).

3.2.4 Ecological restoration

In general, ecological restoration involves assisting a destroyed or degraded ecosystem to recover and eventually reach its former historical structure and composition. While this approach represents the ultimate goal in forest restoration, it is costly and difficult to manage. Techniques include the so-called framework method in which a small number of mostly pioneer species is used to initiate successional development and more complex planting and direct seeding schemes. Some of the various techniques are described by Lamb (2011) and Elliott et al. (2013).

3.3 Comparison of restoration approaches

Section 3.2 reviewed various forest restoration approaches. Researchers have tried to assemble these approaches schematically in terms of their end results, i.e. forest structure and biodiversity. This is best captured in Figure 3 (adapted from Lamb and Gilmour 2003).

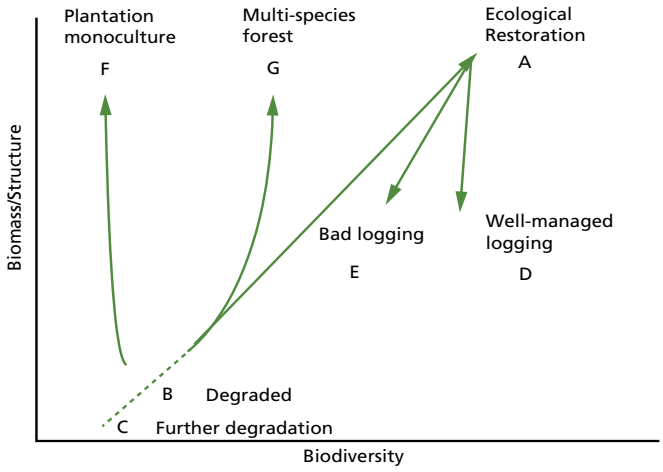

Figure 3. Impact of forest harvesting and different forms of rehabilitation on biodiversity and forest structure

A natural forest (original condition of point A) following logging may reach the state of point D. Through ecological restoration, natural recovery, the site is likely to return to its former condition (point A) in terms of forest structure and biodiversity. If the logging is poorly managed, this would lead the site to a state of point E, where more species can be lost, structure further damaged and the site may be dominated by pioneer species. Ecological restoration in the form of natural recovery is likely to occur, but may take longer and the species composition may differ somewhat, but the potential to return to condition of point A exists. Deforestation can take the forest back to point B, which can result in changes to its structure and species composition. If the site is degraded further by fire or grazing, for example, the condition may lead to point C where few of the original species are left, and the site is taken over by weeds. A number of restoration approaches are available for returning such degraded sites to productive ones. Reverting back from condition B to A through ecological restoration would occur through natural regrowth and planting seedlings of the original species. Other options exist, one being monoculture planting of a timber species. This results in a new state (point F). If the multispecies plantations approach is adopted, the forest is likely to reach the condition indicated by point G. The three approaches provide the owner with choices for a forest that can produce goods, ecosystem services or a mixture of both. The time scales differ as well, with monoculture plantations reaching their objectives fast, while ecological restoration may take much longer, perhaps a century.

3.4 Forest restoration – what is being done?

Earlier, we briefly examined the early history of forest restoration in the region, some country successes and many of the restoration techniques in common use or which are under development. At this juncture we shall examine what the countries under review are doing and what conditions are needed for success. The findings from China, Indonesia, Myanmar, Nepal, the Philippines, Thailand and Viet Nam are summarized below.

3.4.1 China

Earlier it was indicated how China recovered from forest loss through massive monoculture plantations. China conducted reforestation projects in the 1950s and promoted intercropping and shelterbelts in the 1960s (Hyde 2003). Several topical reforms were introduced which emulated the success of agricultural reforms. However, the environmental disasters of 1998 precipitated massive changes in China's forestry development – laws and regulations were revised and forest policies were given higher attention (SFA 2009). The main objectives of the policy changes are outlined in Box 1.

Box 1. Main policy objectives of China (since 1998)

- To improve biodiversity conservation and secure national ecological safety.
- To restore key ecosystems.
- To promote sustainable forest management – switching from forest expansion to forest quality.
- To clarify forest land tenure and secure farmers' rights to forest and forest land management.
- To promote forest industry, which favours a balance between production and conservation.
- To strengthen international cooperation.

Source: Chen (2008)

Authority to control forests was devolved to various management bodies of collectives and state-owned forests. Major forestry programmes were initiated; investments in forest establishment and rehabilitation were stepped up; a forest management classification was introduced; compensation funds for forest ecological services were established; and collective forest ownership systems and clear property rights were introduced. Despite the criticisms the afforestation programmes have received, some of the policy changes and management practices have clearly proven to be positive in China's restoration efforts.

Some of the more recent programmes for promoting forest expansion include the Six Major Forestry Programmes (Box 2). Among them is the Protection and Conversion of Croplands Programme which is referred to as the 'Grain-for-Green Programme' which resulted in planting trees in marginal agricultural area. Others include afforestation and greening programmes for desertification control, wildlife conservation and development of shelterbelts and plantations. As a result, forest cover increased at 1.6 percent annually during the period 2000-2010 (FAO 2010 a,b).

Box 2. Programmes promoting China's plantation expansion

In line with the national forestry strategy, major forestry programmes were initiated. These are referred to as the Six Major Forestry Programmes:

1. The Natural Forest Protection Programme (includes logging bans and afforestation with incentives to forest enterprises).
2. Conversion of Cropland for Forests and Grassland Programme (often referred to as the Grain for Green Programme).

3. Sandification Control Programme.
4. Key Shelterbelts Programme.
5. Wildlife Conservation and Nature Reserve Development Programme.
6. Fast Growing and High Yielding Forests Base Construction Programme.

Source: FAO (2010 a,b)

3.4.2 Indonesia

Indonesia has introduced some 150 official rehabilitation projects in the last 50 years; the number has increased rapidly since the 1990s in tandem with the deforestation rate (Box 3). The technical approaches were mainly the taungya system for conservation of watersheds, single- and multi-species industrial plantations and restoration (enrichment planting) of degraded lands for community and farm forestry programmes. Several policies were promulgated to support the restoration work. The main ones included steps to reclassify forests, reforestation funds, a transparent and participatory master plan and a policy focusing on people's involvement in forest rehabilitation (Box 3).

Box 3. Major forest restoration policies of Indonesia

- Forest Land Use by Consensus (1984) – targeted for improving rehabilitation in state forests.
- Reforestation Funds (1980, 2002) – supported forest plantations and state forest rehabilitation programmes.
- Master Plan for Forest and Land Rehabilitation (2000) – provided the basis for planning rehabilitation programmes that could be integrated, transparent, participatory and based on local regions' aspirations and uniqueness.
- National Movement for Forest and Land Rehabilitation (2003, 2007) – focused on people's involvement in forest and land rehabilitation.
- Forest Landscape for Revitalizing Communities (2002, 2009) – included community-based forestry plantations, community forestry, village forests and ecosystem restoration.
- New strategic priorities for 2010-2014 were announced in 2010 – they included establishment of forest area zoning units, forest rehabilitation and watershed carrying capacity improvement, fire control, biodiversity conservation, revitalization of forest use and forest industry, empowerment of local communities, climate change mitigation and adaptation, and strengthening forestry institutions.

Source: Nawir et al. (2015) (this volume)

Despite the successful establishment of industrial timber plantations by some corporate growers, efforts to restore forest cover on degraded lands in Indonesia have been much less successful. Nawir and Rumboko (2007) point out that some US$68 million were allocated for rehabilitating 5.5 million ha, but this only achieved restoring 19 percent of the area. Although the cost for rehabilitation was effective, the funds were misused. In some cases, reforestation funds were siphoned off for non-forestry purposes. Nawir and Rumboko (2007) reviewed the conditions which can strengthen forest restoration (Box 4). They relate very strongly to community participation, clarity of ownership issues and encouraging greater private sector involvement in forest restoration.

Box 4. Conditions to strengthen forest restoration in Indonesia:

- Reform the funding mechanism policy to avoid project-oriented approaches at the expense of also considering the broader context in which forest restoration is taking place.
- Address the causes of deforestation and degradation in the design of the restoration initiative.
- Increase community participation by ensuring both short- and long-term benefits.
- Strengthen institutional arrangements and ensure ownership issues are clear in order to reduce conflict and improve community participation.
- Address the factors that influence community adoption of forestry restoration initiatives (e.g. ignorance of the techniques).
- Ensure long-term management planning and sustainability for restoration initiatives.
- Use the restoration approach that best fits the local conditions – the status of the forest/land, markets and the population is going to influence the outcome of restoration work.
- Make good use of the decentralization policy by getting the local government, which knows the most about local conditions, to lead the process of designing the most appropriate restoration programmes.
- Encourage the private sector to lead restoration programmes with commercial interests, with government-

dominated agencies paying greater attention to programmes that are geared towards conservation and protection of ecosystem services.

Source: Nawir and Rumnoko (2007)

3.4.3 Myanmar

Forest cover restoration in Myanmar has mainly occurred through the establishment of plantations. Various types of plantations have been introduced including commercial plantations of native species (teak, *Xylia, Pterocarpus*, pine etc.) and industrial plantations (fast-growing species of mostly exotics) to afford watershed protection and to meet local fuelwood supply.

The taungya system is still widely used for rehabilitating degraded forests; with declining interest in intercropping, this system however, requires modification to attract communities to practise it. While teak, *Xylia* and *Pterocarpus* are commonly used for commercial plantations, more drought-resistant species such as *Azadirachta, Albizzia* and *Acacia* are employed with intensive ground preparation in the dry zone areas. While the targets for plantations have been set high, the annual averages are in the range of 20 000 to 30 000 ha. Besides plantations, rehabilitation (enrichment planting) of logged natural forests continues. While the original forest policies, based on the 1894 Indian Forest Policy, focused mainly on timber production, the Myanmar Forest Policy Act of 1995 requires managers to take a broader approach and take account of environmental and social objectives and not only production goals (Box 5).

Box 5. Focus areas of Myanmar's Forest Policy Act 1995

- Protection of soil, water, wildlife, biodiversity and the environment.
- Sustainability of forest resource use.
- Basic needs for fuel, shelter, food and recreation.
- Efficient use, in a socially and environmentally friendly manner, of the full economic potential of forest resources.
- Participation of people in the conservation and use of forests.
- Public awareness of the vital role of forests in the well-being and socio-economic development of the nation.

Based on these focuses, the National Forest Master Plan was developed to cover the period 2001-2030 with regard to, *inter alia*, conservation, harvesting of natural forests, exports, NWFPs, forest regeneration and rehabilitation, and watershed management.

Source: Ba Kaung (2015) (this volume)

Community forests (owned by communities on a long-term lease from the state) have received the highest attention in areas that are highly degraded and vulnerable to climate change such as the dry zone regions and the Shan Plateau. This led to the establishment of the Dry Zone Greening Department for supporting the establishment of "forest plantations for local supply and greening of the environs."

Despite all these restoration efforts, forests are still declining at about 1 percent annually. However, policy changes, particularly those related to community forestry and efforts to meet the local needs of people, are currently under consideration. In the mid-2000s, privately-owned teak and hardwood plantations were allowed and they are likely to increase in the future.

3.4.4 Nepal

During the 1950s, Nepal nationalized its forest estate, resulting in heavy loss of forests. The subsequent land degradation caused Nepal's foresters to look towards forest plantations as a means of reversing forest losses. Research as early as the 1950s favoured planting the exotic *Pinus roxburghii* on degraded hill sites. These early studies also suggested *Schima wallichii* and *Shorea robusta* could be useful species for forest restoration because they are capable of regeneration by coppicing and, even if damaged, can grow back if protected from fire and grazing. In the 1970s, plantations of these species were the main forms of forest restoration. Over time it became evident that plantings under the control of communities tended to be more successful than those established by the government. As a result, the role of community forestry grew into a major platform for forest restoration.

Several policy steps were involved. Following heavy deforestation and soil damage, more conservation-based policies were formulated with strategies and programmes to arrest deforestation. The 1976 National Forestry Policy Plan of Nepal addressed deforestation and gave emphasis to industrial development, but also recognized people's participation in forest management. The Master Plan for the Forestry Sector (1989) forwarded many strategies and programmes, including the community forestry and the leasehold forestry programmes as effective interventions to reverse deforestation and forest degradation. The Revised Forestry Sector Policy 2000 provided clear options for management of degraded and open

forests in the plains and mountain areas. With strong support from international donor agencies, Nepal was able to hand over 1.25 million ha of forests (approximately 25 percent of the forest area) to over 14 000 forest user groups. The main forest-related policies are highlighted in Box 6.

Box 6. The major forest-related policies in Nepal

- National Forestry Policy Plan 1976 – the plan envisaged development of forest and forest industries for self-reliance in timber and fuelwood. In order to achieve this, the plan placed a restriction on export of raw logs. The plan also provided the objectives for forest management that included restoration of natural balance, economic mobilization, development of scientific technology, promotion of public cooperation etc. These national policies form the basis for implementing the five-year national development plans.
- Fifth 5-year Plan (1975-1980) – this represented a landmark in Nepal's forestry sector following the formulation of the National Forestry Plan 1976 and the Panchayat Forest and Panchayat Forest Rules 1978.
- Sixth 5-year Plan (1980-1985) – the need for people's participation in the conservation and management of forestry was highlighted. The Hill and Terai Community Forestry Projects were launched.
- Seventh 5-year Plan (1985-1990) – emphasis was placed on meeting people's daily needs, afforestation on a large scale with people's participation, agroforestry and protection of watersheds.
- Eighth 5-year Plan (1992/1993-1996/1997) – included stable supply of people's needs, raising productivity of forests for forest-based industries and increased income and employment for underprivileged families.
- Ninth 5-year Plan (1997-2002) – the main objective was poverty alleviation by providing economic opportunities for poor people and encouraging their participation in development activities.
- Tenth 5-year Plan (2002-2007) – the role of forest resources in reducing poverty was elaborated through forest-based enterprises, income and employment generation, and the promotion of private forestry.
- Three-year Interim Plan (2007-2009) – proposed the need for legal and institutional reform, poverty reduction, and equitable distribution of forest resources, especially for Dalit (discriminated) communities and women.

Source: Tamrakar and Mohns (2015) (this volume)

It is obvious that Nepal's forests began to stabilize only following the implementation of community-based forestry regimes, which helped to restore denuded landscapes while improving livelihood opportunities for rural people. In this context, supporting forest policies, appropriate tenurial arrangements and greater emphasis on forests as a means to alleviate poverty proved to be an excellent model.

3.4.5 Philippines

There has been no lack of forest restoration initiatives and the key ones are outlined in Box 7. They have included rehabilitation, forest plantations, ANR and agroforestry. These were initially managed by the Reforestation Administration which was created in 1972. Such restoration works were strongly driven by the government, which received considerable international donor assistance. Restoration work in the 1990s focused on fast-growing species like mahogany, gmelina, acacia and eucalyptus that were thought to be able to thrive even under minimal maintenance and inhospitable conditions (Chokkalingam et al. 2006).

Box 7. Major forest restoration techniques developed in the Philippines

- Forest plantations using fast-growing hardwoods – species such as gmelina, acacia and albizzia which thrived in poor sites with minimal maintenance.
- Enrichment planting in residual forests – improving forest stand stocking with indigenous and exotic species.
- 'Rainforestation' – a term used to describe a form of multispecies planting using mainly indigenous timber and fruit tree species in open areas.
- ANR – a simple, low-cost technique based on enhancing the growth of natural regeneration in grassland areas.
- Agroforestry – using trees as hedgerow crops, intercropping with agricultural crops.
- Fuelwood plantations – planting fast-growing fuelwood species.
- Riverbank rehabilitation – planting to stabilize riverbanks with economic species such as bamboo, fuelwood varieties.
- Muyong – an indigenous system of forest management; a woodlot maintained for providing food, fuel, lumber, medicines etc.

Source: Guiang and Aragon (2015) (this volume)

Partnership arrangements with communities have evolved over time, with collaborative arrangements between forest occupants and the government for the restoration of degraded and denuded areas (e.g. the Family Approach to Reforestation, the Communal Tree Farm). The arrangements were not clear, until the 25-year certificate of stewardship tenure system was created, which was the precursor of the Community-Based Forest Management Program of 2009. The 1997 Indigenous Peoples' Rights Act had a strong influence and moved forestry towards community-based management, along with recognition of indigenous peoples' rights over ancestral lands. The principal forest policies and initiatives for influencing forest restoration are given in Box 8.

Box 8. Philippines: Major policies and initiatives for forest rehabilitation

Policies and laws which support FLR approaches in various management units or watershed ecosystem units include:

- Revised Forestry Code (Presidential Decree 705; 1975) – although dated, the law has provided the basis for the rehabilitation of open and degraded forest lands with development of industrial plantations, tree farms and agroforestry; it has promoted their implementation with an incentive package.
- National Integrated Protected Areas Systems Law (1992) – protected areas under this law are considered as 'set asides' for protection, conservation, development, regulation and management of biodiversity and ecosystem services.
- Community-Based Forest Management Program (Executive Order No.263; 1995) – this programme provides the means for restoring/rehabilitating open and degraded forest lands by communities, with usufruct rights, possessory and custodial rights, and overall management of the lands.
- Indigenous Peoples' Rights Act (1997) – these land and resource management units are to be managed using traditional knowledge, attitudes and practices.
- Master Plan for Forestry Development (2003) – one strategic policy measure is forest expansion, to be achieved through afforestation/restoration in available barren and degraded lands, deforested areas and marginal lands, and to further extend tree planting to farmlands, grazing lands, recreation areas, and to support expansion of community forestry, farm forestry etc.
- Promoting Sustainable Forest Management (Executive Order No. 318; 2004) – this decree provides the guiding principle for sustainable forest management, with priority for rehabilitation and protection. It provides incentives for the private sector's participation in forest development.
- The National Greening Program (Executive Order No. 26; 2011) – a massive forest restoration programme was announced in February 2011 to grow 1.5 billion trees over 1.5 million ha from 2011 to 2016. This programme has strategies that cover climate change mitigation, poverty reduction and timber production.

Source: Guiang and Aragon (2015) (this volume)

The evolution of forest policies clearly demonstrates that originally concerns targeted restoration of degraded forests by establishing industrial timber plantations. Although they were considered to be technically sound, these government-led initiatives were not entirely successful. Only with the implementation of community-based forestry, with appropriate ownership rights for communities, has stabilization and positive increase of forest cover resulted.

3.4.6 Thailand

Forest restoration approaches in Thailand have mainly focused on industrial plantation development although some enrichment plantings have been done in conservation areas. These industrial timber plantations were mainly established by state agencies such as the Forest Industry Organization and the private sector. In addition, the Royal Forest Department (RFD) has also promoted community forestry development by promoting the use of fast-growing trees in private farm holdings. A simplified chronology of forest restoration is given in Box 9. It demonstrates the shifts from indigenous species to fast-growing exotics, the growth of pulp wood plantations and the use of wood from old rubber trees as an important source of furniture timber.

Box 9. A chronology of forest restoration efforts in Thailand

Policies and laws which support FLR approaches in various management units or watershed ecosystem units include:

- 1906-1965 – planting indigenous commercial species (teak, *Pterocarpus*, *Dalbergia* etc.) as compensation for timber cut from natural forests.
- 1965-1975 – planting pines and acacias for protection of degraded watershed areas; similar species were used for commercial plantations in the lowlands.
- 1975-1978 – plantations of fast-growing species (eucalypts, acacias, *Peltophorum* etc.) for regreening and

reclaiming of encroached forest reserves.

- 1978-1987 – planting trees for fuelwood.
- 1987-1992 – development of eucalypt plantations for pulp production by large private companies.
- 1993-1998 – restoration work to cover watershed conservation and degraded forests.
- 1999 onwards – rubber was introduced early, but its planting was expanded through a new programme launched (by the Department of Agriculture) in 2004; timber from old rubber trees meets the needs of the furniture industry substantially.
- 1999-2005 – promotion of the role of the private sector and local communities in forest restoration; government-funded plantations (afforestation, restoration by forest concessionaires, Forest Industry Organization etc.) have reached about 1.1 million ha; restoration through social forestry was promoted in the Northeastern region with eucalypts, neem, *Pterocarpus*, acacia and teak.

Source: Wongpakattanawong et al. (2013) (this volume)

Prior to 1985, forest policy was mainly expressed through legislative acts. The first comprehensive National Forest Policy was adopted in 1985. The national tree cover objective was set at 40 percent (15 percent protection and 25 percent production) and the policy promoted the principles of sustainable forest management; measures were proposed for controlling shifting cultivation, forest fires and forest clearance by ethnic minorities. Restoration for industrial wood production was stressed. A resettlement programme was also created for forest dwellers which allowed them to engage in commercial restoration of degraded forest. However, the policy could not address deforestation, and following severe floods in 1988, a logging ban in natural forests was introduced in 1989. The 7th National Economic and Social Development Plan reversed the target forest cover of 40 percent (aimed at timber production) with one that allocated 25 percent of forests for protection and 15 percent for production. While the policy and related instruments favour protection and conservation, decentralization and public participation in policy planning and management of natural resources remain constrained. Nevertheless, in 1991 the RFD developed a Community Forestry Bill to facilitate local community involvement in forest management. The bill, despite several revisions, has never been approved, because of amendments made to it that would ultimately lead to the eviction of thousands of forest-dwelling communities. This failure has contributed to and partly explains the continued conflicts between people and authorities over forest-use rights and the lack of any increase in the country's forest cover.

3.4.7 Viet Nam

Viet Nam has built a substantial reputation for its forest restoration work. In the 1950s, it carried out scattered tree planting, and it has been claimed that between 1960 and 1985, about 3.6 billion trees were planted. In 1975, the World Food Programme, among its various programmes, also provided material for developing 450 000 ha of plantations; farmers were allowed to choose their own species for their smallholdings. In the 1990s, two major forest restoration programmes were initiated. Program 327 (also called the Greening the Barren Hills Program) rehabilitated open lands and barren hills, and protected existing forests so natural regeneration could restore the sites. This resulted in about 400 000 ha of new plantations and 300 000 ha of regenerated forests; this work was pursued in integration with rural development (Sikor and Apel 1998). In 1998, the country initiated the 5MHRP and this lasted till 2010. Close to 1.2 million ha of protection forests and special-use forests were restored, as well as about 0.5 million ha of production forest plantations. As a result, forest cover increased from 33.2 percent in 1999 to 35.8 percent in 2003, and to 44.0 percent in 2010 (FAO 2010 a,b).

The forest restoration techniques included several forms of plantations, agroforestry and rehabilitation of natural forests through natural regeneration and enrichment planting. Many reasons have been provided for the exceptional success in Viet Nam (Box 10). A key reason appears to be because of the emphasis given to ensuring participation by local people, involving them in planning and ensuring they received financial benefits from their work. Success is also likely to have been enhanced because of the strong interest and monitoring by officials in provincial and national agencies.

Box 10. Reasons for the success of forest restoration work in Viet Nam

- The social benefits included additional cash income and savings for local people, resettlement and training in restoration techniques, together with improvements in their livelihoods and stable prices for wood.
- The restoration work involved active participation of local people and the authorities, active involvement and support of households, and strong interest from national authorities.
- Close monitoring by provincial managers and Ministry of Agriculture and Rural Development officials.
- The use of appropriate techniques and adequate and timely funding.
- The investment method for afforestation was in line with prevailing natural and socio-economic conditions.

Source: De Jong et al. (2006)

Forest restoration in Viet Nam has been successful owing to well-developed forest policies, other relevant policies, legislation and effective enforcement agencies. Some of the relevant policies are highlighted in Box 11. Initially the 'forest zoning and maintenance system' which is equivalent to 'passive reforestation' (Lamb and Gilmour 2003) provided the basis for protection and natural regeneration in the 1950s. Viet Nam's forest restoration efforts have been translated into two major projects, the Program 327 and the 5MHRP. The success of the projects was preceded by re-organization of the state forest enterprises, along with the classification of forests into conservation (special-use), protection and production categories. The revisions to the land laws allowed for allocation of land to households and individuals for sustainable forest production. Revisions in investment policies, credit and tax systems are being made to improve the environment for developing forestry-based enterprises by individuals and private companies.

Overall, Viet Nam has been able to move towards greater participation of people in forestry, increasing plantation area and strengthening timber-processing industries. In the process, forestry has become an important economic sector which is contributing to higher employment, livelihood improvement and reduction in poverty. The trend for forestry in Viet Nam appears to take the following course (FSIV 2009):

- Plantations emerging as the main source of timber, while natural forests are increasingly targeted for protection;
- Forestry shifting from production of wood to a variety of value-added products and ecosystem services; and
- Shifting from state control and public forestry to people's forestry with empowerment of local bodies in forestry-related production and trade.

Box 11. Major policies and initiatives for influencing forest rehabilitation

Policy and legislation have been quite conducive for forest restoration and they can be extended to FLR approaches. They are divided into two groups: a) reclamation and reforestation/afforestation, and b) restoration of natural forests. Some of the highlights include:

- Forest zoning, equivalent to passive restoration, has been in place since the 1950s. This has latterly been called 'forest zoning and promoting regeneration' and is regulated by technical rules on promoting regeneration and enrichment planting (e.g. QPN 21-98).
- Program 327 (1993-1998) and the 5MHRP (Decree 661/Q-TTg (7/1998)) have had a major impact on forest rehabilitation, leading to increase in forest cover of 43 percent, protection of soil and water resources, and flood control.
- Forest and forest land allocation policies (Decree No. 02/1994/CP) have clearly defined the rights of land users, and have allowed allocation and lease of forest land to businesses, households and individuals with production objectives. In the process afforestation of barren land has taken place.
- When households invest in production forests, laws give them ownership and permission to decide on the plantation period and method.
- The National Forestry Development Strategy 2006-2020 was announced in 2007. It provided new guidance and programmes for sustainable forest management; forest protection, biodiversity conservation and ecosystem services; forest product processing and trade; research, education, training and extension; renovating forestry sector institutions, policy, planning and monitoring.
- Laws have been formulated to allow individuals and organizations engaged in production forest plantations access to preferential credit, and preferential tax if the work involves planting fallow land and denuded hills.
- Nationwide regulation of PES (Decree No. 99/9/2010) has opened up opportunities to benefit from REDD+ and other PES mechanisms.

Source: Phan (2015) (this volume)

In summary, the technical aspects of forest restoration, from protecting and allowing natural regeneration to proceed in natural forests, to rehabilitating denuded lands with exotics and indigenous species have been reasonably well developed across the region. In fact, in countries like the Philippines, innovative new techniques such as ANR have been developed. Likewise, the coppicing system of regrowth that is prevalent in the drier areas such as Nepal provides an easy option to regenerate degraded sites with minimal interventions. Nevertheless, there are still some drawbacks in the choice of species, their genetic quality and plantation establishment techniques.

However, the difficulties surrounding these technical issues seem marginal when compared with the problems associated with policies, institutions and social issues required for dealing with forest restoration. While the commitment to reverse forest loss and degradation might remain high among professional staff, it is not always translated into action. The crucial policy issues appear to be related to tenure and equity, especially with access to and use rights of natural forests. There is now ample evidence that participatory planning is critical for all restoration undertakings. It is clear that China, Nepal, the Philippines and Viet Nam have developed supportive policies for forest management, particularly with the various aspects of forest restoration. China and Viet Nam developed major restoration programmes to realize the benefits of policy revisions. Forest and land allocation policies provided clarity to ownership issues, which encouraged people's participation

in the programmes. The implementation of community forestry in Nepal, which basically involved denuded lands being handed over to communities, testifies to how effective the role of people is in bringing back forest cover. Here too, policy and regulations slowly evolved to shift from state-controlled forest management, to an increase in people's participation, with a strong emphasis on reducing poverty. In fact, all the reviewed countries that are beginning to enjoy stable or increased forest cover have implemented large community-based forestry programmes. Myanmar, Indonesia and Thailand have not made much progress with community forestry and this is reflected in relatively less progress in improving forest cover, forest resources and the role of forestry in poverty reduction.

State control of forests is being gradually reduced in China and Viet Nam, which has resulted in the growth of collectives, expansion of community forestry, and participation by the private sector. This has been further assisted with non-sectoral policy and legislative changes that have provided preferential credit for people engaged in forest restoration work. Indonesia has also taken steps to improve the policies relating to forest land classification. Policies have addressed reforestation funds, transparent and participatory master plans for forest and land restoration, and are giving greater focus to people's involvement in forest rehabilitation and community-based forestry.

But while the overall situation remains mixed, some countries have clearly forged ahead. The experience so far indicates that the countries that have shown progress are the ones that have addressed the issues of tenure, use rights of forest resources and community participation, and moved forestry from heavy state control to management increasingly undertaken by the private sector, individuals or corporations. There are other policy changes that are still in their infancy – Viet Nam and China are beginning to address the issues of forest values for their ecosystem services. This recognition of forest values beyond wood, and establishing a financial value for the service or product would greatly expand the contribution of forests to national GDP and give more credence to forestry as an important economic sector.

Another major obstacle remains with institutions – most of them remain inflexible and are unable to adapt to the changing environment and stakeholders' needs. Slight changes are seen in countries like China and Viet Nam, which, while not decentralized, are able to employ market mechanisms in forest restoration programmes.

In brief, most of the countries under review are beginning to develop appropriate policies, regulations and institutional changes, including activities that are focused on strengthening forest restoration. But none of them have gone far enough to examine the intersectoral policies and regulations that are required to support the implementation of FLR approaches. Nevertheless, the prospects remain positive for implementing FLR approaches. The experiences gained from implementing some of the large restoration programmes would provide the precursor for implementing more holistic FLR programmes.

4. Forest landscape restoration

4.1 Why FLR?

The preceding chapter pointed out how the countries under review possess the technical knowledge to carry out forest restoration work. The concerns to date, however, have been limited to forest areas and the issues outside forest boundaries have not been taken into consideration at all. Even more constraining is the limited appreciation of the potential role of people living in these broader landscape areas in assisting in the restoration task – this alone has led to many failures with restoration initiatives. All issues considered, the options are limited. It is possible to continuously strive to bring about the requisite changes, which from the experience shown by China, Nepal and Viet Nam, may take several decades, and involve much trial and error before seeing an acceptable measure of success.

An alternative would be to undertake forest restoration work using the far more innovative FLR approach. All the difficulties associated with traditional approaches require new methods such as looking for solutions across the landscape and not at an isolated spot, making people partners in the initiative, ensuring all other stakeholders have expressed their views on the outcomes and recognizing that restoration is not confined to wood production but encompasses a greater variety of ecosystem and environmental services. But these changes have to be encompassed within a broader landscape context that encourages making strategic choices for where forest restoration will be carried out and how policy and institutional arrangements to enable this type of planning will be implemented.

The FLR approach is new and not widely known in the Asia-Pacific region; it requires some institutional backstopping for promotion. The rest of the chapter outlines the FLR concept, how it evolved, its primary tools and how it is applied in the field.

4.2 A brief history of FLR

It is ironic that much of the deforestation and degradation discussed already could have been avoided, and along with it, the consequent economic losses and difficulties for people. With this backdrop, interest in forest restoration has been mounting for some time. Several international and national initiatives have been clamouring for 'bringing back the forests'. These days it is not uncommon to hear about forest restoration projects and announcements of campaigns to plant a million or a billion trees. The most memorable campaign appears to be the Green Belt Movement based in Kenya, begun in 1997 and championed by Nobel Laureate Wangari Maathai. It was a pioneering initiative for planting millions of trees through community empowerment.

However there was no guarantee that these campaigns would eventually result in forested areas. It was at this juncture that the ideas for FLR began to consolidate. A brief history of FLR was given in IISD (2002). It began with WWF and IUCN launching a Joint Forest Strategy in 1996, with the specific objective of restoring forests. In 1999, the "Forest Reborn" project was established with a vision to promote higher quality forest landscapes to meet human needs while conserving biological diversity and fulfilling the ecosystem functions for all life on earth. Under the project, a number of studies, dialogues and workshops on forest conservation and restoration were implemented in several regions. In 2000, WWF and IUCN held an international workshop in Segovia, Spain, to develop a framework and process for promoting forest restoration approaches that were socially and ecologically appropriate. This was when the definition of FLR was formulated as "a planned process that aims to regain ecological integrity and enhance human well-being in deforested or degraded forest landscapes." The meeting made some broad conclusions about FLR, which included the aim of restoration, the choices to be made at the landscape level and the benefits to the environment and human well-being. Going beyond, the meeting also concluded that FLR could play an important role in supporting the implementation of various international agreements, such as work relating to the CBD, emerging opportunities for afforestation and reforestation under the UNFCCC, inclusion of FLR in the definitions of afforestation and reforestation under the CDM, conservation and sustainable management of land and water resources under the UNCCD, as well as reviewing the progress of the Intergovernmental Forum on Forests' proposals for action related to rehabilitation and restoration of degraded lands.

As the FLR process began to gain traction, the GPFLR network was launched in 2003 by IUCN, WWF and the Forestry Commission of Great Britain. More than 25 governments and international and non-governmental organizations have joined the GPFLR. The partnership allows members to work together to catalyse support for FLR, learn from each other through experience and organize activities to enhance the capacities of individuals in conservation and restoration of forest landscapes. In 2005 the partnership held a Forest Landscape Restoration Implementation workshop in Petropolis, Brazil. The workshop produced the Petropolis Challenge report, which was presented to the fifth session of the United Nations Forum on Forests in May 2005. The report defines FLR as a "vehicle for delivering internationally agreed commitments on forests, biodiversity, climate change and desertification" and notes its key role in achieving the MDGs. The Challenge called upon the international community to support restoration of forest landscapes for the benefit of people and nature, and contribute to reversing forest loss and degradation. As a result, the FLR approach received considerable support from many countries worldwide.

The GPFLR partnership has since been gaining momentum. At the invitation of the German Government and IUCN, the Bonn Challenge was established at a ministerial roundtable in September 2011. It calls for restoration of 150 million ha of deforested and degraded lands by 2020. The Bonn Challenge calls on countries and other organizations to accomplish

this as a means to meet some of the existing international agreements, such as the CBD Target 15, REDD+ agreement of the UNFCCC and the MDGs. A little earlier, in September 2007, APEC called on its members to boost their forest land by 20 million ha by 2020.

FAO has been actively participating in the GPFLR and contributed to the ongoing dialogue with other organizations. FLR was also on the agenda of the 21st session of the Committee on Forestry (COFO) which was held in September 2012, when member states recommended FAO to explore ways to contribute to the Bonn Challenge. Based on this call, and following its mandate, objectives, experience and comparative advantages, FAO proposed the establishment of the Forest and Landscape Restoration Mechanism, which was launched at the COFO session in June 2014. This mechanism will contribute to operationalizing the Bonn Challenge at the country level, supporting implementation as well as monitoring and reporting of FLR at that level. The mechanism will work at facilitating development of national FLR plans, developing tools and best practices, supporting establishment of pilot schemes, helping to broker large-scale programmes, providing quality control and contributing to the monitoring and reporting on FLR actions which meet global and regional commitments and processes. In addition, at the 25th Asia-Pacific Regional Commission held in 2013, its members called upon FAO to give more attention to FLR approaches.

4.3 What is FLR?

Several comprehensive text books are available on the subject (e.g. Mansourian et al. 2005; Rietbergen-McCracken et al. 2007; Lamb 2011). A landscape can be regarded as the heterogeneous mosaic of different land uses across a large area of land or a watershed. Such a landscape may contain a mosaic of natural forests, undisturbed primary forest and secondary (successional) forest, timber plantations and agriculture (annuals and perennials). Abandoned agricultural lands and highly degraded forests occur within the landscape complex. The ownership and access to lands is equally complex, ranging from state, corporate, community and private household stakes.

With such complexity, which represents an overlap of ecological and socio-economic mosaics, restoration efforts require considerable planning. The following difficulties may be envisaged. Restoration by individual farmers would be mostly driven by economic considerations, although with some unintended ecological benefits. Government agencies may take up restoration efforts without consulting the communities or neighbouring landowners who would have substantial influence on the outcome of restoration efforts. Another difficulty would be a technical one – are the technical inputs for restoration the most appropriate regarding land use, species suitability and people's needs? This has yet to take into account the complications from landownerships. With such prevailing complications, restoration efforts have remained *ad hoc*, poorly-planned, disconnected from adjacent land-use activities, disengaged from the views and needs of the people and without appropriate technical inputs. The end result is poor use of resources and suboptimal outcomes.

The FLR approach thus brings about a balance of both the conservation and production issues in consultation with the stakeholders. In other words, the outcomes ought to meet the needs of the individual landowners while simultaneously addressing the conservation challenges at the landscape level. This requires looking into how much restoration is needed, where and what types of new forests should be set up and how this reality can be put into effect at a landscape level. Elliott et al. (2013) summarize what FLR can achieve:

- Ascertaining the root causes of forest degradation and controlling further deforestation and degradation;
- Engaging stakeholders throughout the entire process, from planning, resolution of land-use conflicts and working out benefit-sharing arrangements;
- Negotiating land-use trade-offs that are acceptable to all parties;
- Conserving biodiversity that confers values both locally and globally; and
- Delivering a range of benefits that include: environmental protection; income from ecotourism, carbon trading, ecosystem services; and a sustainable supply of NWFPs.

4.4 How much restoration?

FLR attempts to address both conservation and production issues at the landscape level. In general, restoration ought to be able to address issues of biodiversity, hydrology and soil protection. As for biodiversity, biologists argue that loss of forests results in a proportional loss of biodiversity. This implies that the more a degraded landscape area is restored, the better this would be for conservation of species. Considering that it may be difficult to restore the entire landscape, FLR approaches have to look at the biodiversity issue from another angle. Perhaps the key role of restoration is to provide additional connectivity to forest fragments and increase the buffer areas of small forest fragments to increase the viability of the remaining species populations. In the case of hydrological protection, in general, restoration should reduce runoff as a result of the increase in evapotranspiration. However, when viewed from a landscape level, the entire area may not normally be restored. Hence, the impact on water supply at the larger landscape level may not be substantial. Regarding soil erosion, any vegetation ought to provide some protection against erosion, although with the wrong species on slopes this can be deleterious. Overall, FLR would have positive impacts on biodiversity conservation, hydrology and soil protection.

It is generally assumed that with conservation, the larger the area of restoration, the greater the benefits; however the quality of restoration over a smaller area may prove more effective. It must be recognized that one of the plus points in favour of FLR is the attention given to conservation, both ecological and environmental aspects. Although this may not mean much for most stakeholders, the additional attention to conservation over a large area could add more value to

the FLR approach. So, careful attention to the landscape, topography and soils, potential trees for restoration, and the types of economic activities on the ground, would all assist in planning restoration work that generates ecosystem and environmental benefits over the longer term. This may not be so simple when restoration is undertaken to generate socio-economic benefits. But if economic benefits are linked to environmental recovery, this will certainly garner more interest and greater awareness among stakeholders.

As for industrial plantations, large areas for restoration would be preferred because economies of scale are in their favour, the capacity of sawmills can be met, production is sustained and the product is profitable. In general, availability of large areas for restoration would be favourable for industries. For smallholders, the situation is far more complicated. Several smallholders may be required to work in a cooperative to strengthen their marketing position. Another consideration is the choice of species and whether to plant short- or long-rotation trees. Fast-growing species may be preferred by big millers, but smallholders might be better off planting specialty timber with longer rotations but would have to consider the duration and discount rates. Overall, there is no easy answer to the question of how much of an area would be needed for restoration. Usually, this depends on the local situation.

4.5 Where to restore?

How to answer this question depends on the objectives and issues to be addressed. With biodiversity conservation, a good approach would be to increase the buffer zones of the remaining fragments of natural forests and to create corridors to increase the connectivity of these patches. If the interest is in conserving the remaining biota or vulnerable species, then restoring the surrounding areas would improve their protection.

The next obvious area for restoration would be sites exposed to erosion, such as barren hill tops and abandoned lands unsuitable for agriculture. Restoration would limit the export of sediments and nutrients into waterways, and improve soil infiltration, which can maintain water flow during the dry season. Although there still remains some dispute on the effect of trees on 'dry-season flow', such restoration work may benefit hydropower dams in terms of water flow and sedimentation.

Commercial tree plantations on favourable sites (gentle topography, good soils, access to markets) face competition from agriculture. Usually plantations are a last resort for economic activities, and end up with marginal areas. In such areas, the best option would be for high-value tree plantations or NWFPs. With smallholdings, marginal lands can be reforested if large mills are close by.

Ideal sites for restoration are where multiple benefits can be attained. Examples may be marginal lands where restoration provides soil protection, improves hydrological flow and acts as buffers or corridors to isolated forest fragments.

4.6 What restoration approach?

Several restoration approaches are possible and include secondary forest regrowth, monoculture plantations, mixed-species plantations and ecological restoration. Each varies in its conservation and commercial potential, and the choice is based on what best fits the objectives and needs. Several strategies can be used, such as species-site fitness, maximization of benefits and diversification of incomes. On a landscape scale and with various stakeholders, it is likely that all the approaches may be used in different parts of the landscape depending on environmental conditions, the degree of degradation and landholders' goals.

4.7 Planning FLR

With appropriate planning, FLR can avoid *ad hoc* decision-making by individual landowners or managers. Besides the decisions of landowners, the views of secondary stakeholders have to be accommodated as well. They include downstream water users, urban populations, civil society groups and state agencies. While, in theory, stakeholder consultation might seem the appropriate process to follow, reality does not match the expectation. More often, government officials and planners propose the land-use plans and stakeholders react to them. As a consequence some of the solutions may not necessarily be in agreement with the stakeholders, which ultimately affects the success of restoration efforts. The solution is to make sure the proposed plans are not adverse to any parties in the long term.

Participation and arriving at an agreement that meets various objectives is a difficult task. With the inclusion of many stakeholders with sometimes conflicting objectives, careful planning is needed. While governments traditionally use top-down approaches, as far as rural development planning goes, such approaches can result in major failures. A pragmatic planning process is the consultative approach. This helps to build consensus among stakeholders whereby the goals can be revised based on feedback received. The initial steps include mapping the present landscape and the areas for restoration. Next is to identify the key stakeholders who would be impacted by the restoration work. Through consultations, a consensus needs to be reached, and it is at this stage that one can look at the wider community benefits against losses of individual landowners. Trade-offs have to be reached between collective benefits and individual losses. With this, an implementation plan can be presented with identified indicators for monitoring purposes. This general plan can be refined as the restoration work progresses. In reality, only approximate solutions can be arrived at and only through trial and error. With such a novel approach, some training in participatory consultations for the stakeholders, especially the planners and government officials, would be needed for success with restoration work.

5. The way forward

Forest landscape restoration is a new concept for many forestry practitioners in the Asia-Pacific region. There is a large gap in the appreciation of the ecological concept of FLR, which can vastly improve forest ecosystems as well as the productivity of the forests and adjacent lands. Perhaps it is more accurate to state that this is true worldwide as well – only a small group of experts is driving this concept, and the rest of the forestry community may not be adequately equipped to implement such a complex system on the ground. FLR involves numerous stakeholders and at different levels; there are many techniques and choices can only be made after an analysis of the best fit for the environment and people; it further requires complex negotiations over use rights and access, and examination of benefits and equity issues. The entire FLR approach has the potential for forestry to contribute to rural livelihood improvement, restore lost or degraded forest functions, improve the commercial value of the forest and streamline work among various stakeholders instead of limiting it to public agencies. Considering the complexity of the arrangements needed, at best the FLR approach is one that will still rely on trial and error, and some amount of muddling through the unknown before clarity prevails. However, implementation of FLR approaches in the region can be made more effective and efficient by first addressing many of the institutional, policy, technical and socio-economic issues. With this in view, it would be useful to explore how regional institutions and national forestry agencies can endeavour to promote FLR approaches in the region.

For a start, an institution dedicated to promoting the concept of FLR would be crucial for the region. The proposal currently is for a partnership between FAO RAP and RECOFTC to set up a facility in the region to provide support for national forestry agencies, institutional arrangements, policies and regulations, along with capacity development in technical areas for implementing FLR approaches. With their comparative strengths in forestry and community forestry, FAO and RECOFTC are well placed to undertake this role. Their close links to the countries of the region further strengthens their position to undertake such a task. They can engage with them, share knowledge and garner support for implementing FLR activities throughout the region. The facility should start by articulating a vision of what the forest landscape will be like in the future, disseminate information on the practical issues of forest management, FLR and ecosystem services, and undertake pilot trials so as to be able to demonstrate and test practical aspects for implementing FLR approaches.

Many countries in the region are clearly committed to reversing deforestation and forest degradation. However, their approaches remain traditional, and there is little appreciation of the ecological concept of landscapes as a means to prioritize development, which is what FLR strives for. With this in view, it is necessary to persuade these countries to adopt FLR approaches and look at forest restoration as a landscape approach. As a starting point, these countries will need assistance in articulating a vision of what FLR will entail, and how they will bring about the political, institutional, policy and social dialogues to shift their focus from forest restoration to a thrust that is implemented at a landscape level.

For FLR to work, forestry agencies will have to adopt a more flexible and adaptive approach, move towards decentralization and devolution of authority and responsibility, work at building partnerships with a range of stakeholders and start shifting towards market economies. In some countries this may not be easily achievable, but there are already examples like Viet Nam which is beginning to forge such a change. While Viet Nam still retains a centrally-based organizational structure, it has transferred some of the work to households, communities and private enterprises. Whichever pathway is taken, there is a clear need for institutions to shift towards greater decentralization with work relating to FLR approaches.

Most of the forestry departments in the region have forest rehabilitation units. Initially, the forestry departments/ rehabilitation units will have to review their current forest restoration approaches and retool them for landscape-level approaches. The technical interventions of FLR need to consider the broader landscape, and have to be integrated with conservation and social benefits. Research should be directed for determining the criteria for selection of sites with high potential for restoration in terms of social (institutional acceptance, social compatibility, local support) and economic criteria (transaction costs, how the initiatives will translate into revenues and if existing infrastructure can be utilized for the purpose). The departments will also need to develop appropriate codes of practice for FLR in the field, and likewise the procedures for working with other stakeholders (e.g. households, communities, the private sector). In addition, there will be a need to formulate appropriate regulations regarding the types of species, their numbers, genetic quality and proportion of land to be maintained under forest cover. In this regard, the departments should also resolve the use of exotic and native species based on restoration needs, conservation issues, economic needs and stakeholder preference. Related to this are guidelines for protection of remaining forests and the appropriate restoration approaches best suited for them, in terms of management and conservation objectives. There are many ongoing projects in the region, such as Viet Nam's 5MHRP and the Philippines' Co-management of Wao Watershed, as well as others to guide the development of such technical codes and guidelines.

Policy recommendations are crucial for the successful implementation of FLR approaches. There is a clear need to develop policies that promote FLR approaches; they should result in regulations and laws allowing natural forests to remain and favour restoration programmes that will simultaneously restore the productivity of degraded forest lands, increase their value in the range of goods and services provided and employing the native species in the restoration initiatives. Likewise, the policies for restoration should fulfill traditional needs for wider acceptance by society. More than ever, these policies should empower rural people and small landholders so they will become more engaged in forest management. Another policy issue that requires attention is valuation of forests for provision of ecosystem services; also mechanisms that allow transfer of payments from the beneficiaries to the providers of such services. Extending this rationale further, for FLR to succeed, policy instruments have to be embedded in a solid economic base – several innovative financial mechanisms are

available for such consideration. Next, considering FLR approaches are going to bring about social benefits and public goods that are not accounted for in the market economy, the policies need to buffer such schemes from market failures. Policy formulation can be guided better by initiating small FLR initiatives, which will provide feedback on which approaches are cost effective, ecologically favourable and have higher social acceptance. Similarly, economic analysis of pilot FLR initiatives can guide policy formulation more effectively in the use of incentives. Overall, these pilot trials can also demonstrate the value of FLR in relation to traditional approaches. In this context, how the policies are formulated for FLR is equally important considering the involvement of various stakeholders. Hence, it is critical that stakeholders, especially those at grassroots levels and smallholders, are included in the policy formulation process.

The subject of stakeholders has already received some attention in the policy formulation process. By virtue of working at the landscape level, the number of stakeholders increases severalfold. Since the FLR approach requires some stakeholders to set aside lands which otherwise would be used for other purposes, this can be a recipe for conflicts. For this reason, there is need for agreements among all stakeholders; they should be included in the design and decision-making process from the start. Their participation has to be equitable and their critical roles have to be clarified, including their access and use rights when it comes to the sharing of benefits and costs.

The above discussions about stakeholders apply equally to communities engaged in forest restoration work. Based on the seven country reviews, it is evident that community participation holds the key to forest restoration in the region. Experiences show in many cases that local communities should be considered as the main actors and involved in the decision-making process for FLR. Community forestry involves social, economic, cultural, political and ecological dimensions. Overall, forestry departments should develop mechanisms for inclusion of communities, conflict resolution processes should be worked out and participation and co-management should be effected to result in equitable benefits for their efforts.

Forestry departments will also have to address the issue of land allocation, which can be very contentious. In implementing FLR, issues of land tenure, incentives, access to resources and management rights have to be clarified and agreements have to be arrived at which are mutually respected. There is a need to develop criteria for landholders' preference for selection of areas where restoration should be conducted using the most effective and economical methods. This can be combined with collaborative land-use planning which takes into account the diverse needs of rural populations in the implementation of FLR programmes.

The most persuasive argument for implementing FLR is economics – can it pay for itself? First there is a need to determine what incentives can be provided for the programmes to work. If these incentives are coupled with PES (that cover provision of water, carbon sequestration, climate regulation, soil protection, biodiversity, other services) the case for FLR programmes can be strengthened. Furthermore, forestry departments can compare how effective FLR programmes are in the forests and lands that can be restored compared with conventional approaches. The inclusion of the private sector with commercially-valued schemes would further expand FLR programmes. International and regional schemes can be invited to assist in broadening the programmes.

Finally, FLR has the technical features and approaches to meet the diverse needs of people and the forest/land conditions. If the stakeholders can be empowered to participate actively and contribute to its implementation, the benefits are manifold. Considering the area of degraded forests and lands in the region, FLR provides a valuable opportunity to create additional resources, improve the environment and contribute to poverty alleviation. Regional institutions should equip themselves with the appropriate information and knowledge to contribute to this endeavour.

References

Achard, F., Eva, H., Stibig, H.J., Mayaux, P., Gallego, J., Richards, T. & Malingreau, J.-P. 2002. Determination of deforestation rates of the world's humid tropical forests. ***Science,*** 297: 999-1002.

Anonymous. 1999. *Integrated report on the multi-storied forest management project in Malaysia (1991-1999).* Kuala Lumpur, Forestry Department Peninsular Malaysia. Perak State Forestry Department, Japan International Cooperation Agency.

Appanah, S., Pragtong, K., Sharma, J.K., and Leslie, R. eds. 2012. *Participation of the tree plantation farmers in sustainable forest management*. Bangkok, FAO RAP.

Appanah, S. & Weinland, G. 1993. *Planting quality timber trees in Peninsular Malaysia.* Malayan Forest Record No. 38. Kuala Lumpur, Forest Research Institute Malaysia.

Ariyadasa, K.P. 2002. *Assessment of tree resources in the home gardens of Sri Lanka*. EC-FAO Partnership Programme. Bangkok, FAO RAP.

Blandford, H.R. 1958. Highlights of one hundred years of forestry in Burma. ***Empire Forestry Review,*** 37(1): 33-42.

Bonan, G.B. 2008. Forests and climate change: forcings, feedbacks, and climate benefits of forests. ***Science,*** 320: 1444-14449.

Bourke, R.M. 1985. Food, coffee and casuarinas: an agroforestry system from the Papua New Guinea highlands. *Agroforestry Systems,* 2: 273-279.

Bruijnzeel, L.A. 2004. Hydrological functions of tropical forests: not seeing the soil for the trees? ***Agriculture, Ecosystems and Environment,*** 104: 185-228.

Bruijnzeel, L.A., Bonell, M., Gilmour, D.A. & Lamb, D. 2005. Forest, water and people in the humid tropics: an emerging view. ***In*** M. Bonell & L. Bruijnzeel, eds. ***Forest, water and people in the humid tropics***. Cambridge, United Kingdom, Cambridge University Press.

Butler, R.A. 2009. *Changing drivers of deforestation provide new opportunities for conservation (*available at news.mongaby.com/2009/1208-drivers_of_deforestation.html).

Carle, J. & Holmgren, P. 2003. *Definitions related to planted forests.* Working Paper 79. Rome, Forestry Department, FAO.

Chazdon, R.L. 2014. *Second growth: the promise of tropical forest regeneration in an age of deforestation.* Univ. of Chicago Press, 472 pp.

Chen, X. 2008. Country profile: China. Country report submitted to FAO. Unpublished.

Chokkalingam, U. & De Jong, W. 2001. Secondary forest: a working definition and typology. *International Forestry Review,* 3 (1): 19-26.

Chokkalingam, U., Pulhin, J., Carandang, A., Peras, R.J., Lasco, R.D. & Natividad, M. 2006. Outcomes and sustainability: lessons from the ground. ***In*** U. Chokkalingam, A. Carandang, J. Pulhin, R. Lasco, R.J. Peras & T. Toma, eds. ***One century of forest rehabilitation in the Philippines: approaches, outcomes, and lessons***. Bogor, Indonesia, CIFOR.

Chundamanni, M. *History of forest management in Kerala.* KFRI Research Report 89. Kerala Forest Research Institute, Peechi, Thrissur, India. 114 pp.

Convention on Biological Diversity (CBD). 2001. *Report on the ad hoc technical expert group on forest biological diversity.* Convention on Biological Diversity. UNEP/CBD/SBSTTA/7/6, 20 September 2001 (available at www.biodiv.org/programmes/areas/forest/definitions.asp).

Dai, L., Zhao, F., Shao, G., Zhou, L. & Tang, L. 2009. China's classification-based forest management: procedures, problems, and prospects. ***Environmental Management,*** June, 43(6):1162-73.

Dalmacio, M.V. 1989. Assisted natural regeneration: a strategy for cheap, fast, and effective regeneration of denuded forest lands. Philippines Department of Environment and Natural Resources Regional Office, Tacloban City, Philippines. Unpublished.

De Jong, W. 2005. Understanding forest landscape dynamics. ***In Restoring forest landscapes: an introduction to the art and science of forest landscape restoration,*** pp.53-60. ITTO Technical Series 23. Yokohama, International Tropical Timber Organization.

De Jong, W., Chockalingam, U., Smith, J. & Sabogal, C. 2001. Tropical secondary forests in Asia: introduction and synthesis. ***Journal Tropical Forest Science,*** 13: 563-576.

De Jong, W., Dam, D.D. & Hung, T.V. 2006. *Forest rehabilitation in Vietnam: histories, realities and future.* Bogor, Indonesia, CIFOR.

FAO. 2011. *Forests beneath the grass: proceedings of the regional workshop on advancing the application of assisted natural regeneration for effective low-cost regeneration*, by P.B. Durst, P. Sajise & R. Leslie (eds.) Bohol, Philippines.

Elliott, S.D., Blakesley, D. & Hardwick, K. 2013. *Restoring tropical forests: a practical guide.* Royal Botanic Gardens. 344 pp.

Emtage, N. 2004. Typologies of landholders in Leyte, Philippines and the implications for development of policies for smallholder community forestry. *In* D.M. Baumgartner, ed. *Proceedings of human dimensions of family, farm and community forestry international symposium,* pp. 81-88. Washington, DC, Washington State University.

Enters, T. & Durst, P.B. 2004. *What does it take? The role of incentives in forest plantation development in Asia and the Pacific.* Bangkok, FAO RAP.

Food and Agriculture Organization of the United Nations (FAO). 1998. *FRA 2000 terms and definitions.* FRA Working Paper No.1. Rome, FAO (available at www.fao.org/forestry/fo/fra/index.jsp).

FAO. 2000. *On definition of forest and forest change.* FRA Working Paper No. 33. Rome, FAO (available at www.fao.org/forestry/fo/fra/index.jsp).

FAO. 2001. *Global forest resources assessment 2000: main report.* FAO Forestry Paper 140.

FAO. 2002. *Proceedings of expert meeting on harmonizing forest-related definitions for use by various stakeholders.* Rome, FAO.

FAO. 2005. *Global forest resources assessment 2005.* Rome, FAO.

FAO. 2009. *State of the world's forests 2009.* Rome, FAO.

FAO. 2010a. *Global forest resources assessment 2010.* Rome, FAO.

FAO. 2010b. *Asia-Pacific forests and forestry to 2020.* Report of the Second Asia-Pacific Forestry Sector Outlook Study. Bangkok, FAO RAP.

FAO. 2011. *Southeast Asian forests and forestry to 2020.* Subregional Report of the Second Asia-Pacific Forestry Sector Outlook Study. Bangkok, FAO RAP.

FAO. 2015. *Global forest resources assessment 2015.* Rome, FAO.

Forbes, K. & Broadhead, J. 2011. *Forests and landslides: The role of trees and forests in the prevention of landslides and rehabilitation of landslide-affected areas in Asia.* Bangkok, FAO RAP.

Forest Science Institute of Vietnam (FSIV). 2009. *Viet Nam forestry outlook study.* Asia-Pacific Forestry Sector Outlook Study II. Working Paper No. APFSOS II. Bangkok, FAO.

Geist, H.J. & Lambin, E.F. 2002. Proximate causes and underlying driving forces of tropical deforestation. *Biotropica,* 52: 143-150.

Gilmour, D.A., San, N.V. & Xiong, T. 2000. *Rehabilitation of degraded forest ecosystems in Cambodia, Lao PDR, Thailand and Vietnam: an overview.* Cambridge, UK, IUCN-Asia.

Goosem, S.P. & Tucker, N.I.J. 1995. *Repairing the rainforest - theory and practice of rainforest re-establishment in North Queensland's wet tropics.* Cairns, Wet Tropics Management Authority. 71 pp.

Hobbs, R.J., Higgs, E. & Harris, J.A. 2009. Novel ecosystems: implications for conservation and restoration. *Trends in Ecology and Evolution,* 24: 599-605.

Huang, M. & Upadhyaya, S.K. 2007. *Watershed-based payment for environmental services in Asia.* SANREM CRSP Working Paper No. 06-07. Blacksburg, OIRED, Virginia Tech.

Hyde, W.F., Belcher, B. & Xu, J., eds. 2003. *China's forests: global lessons from market reforms.* Washington, DC, Resources for the Future.

Intergovernmental Panel on Climate Change (IPCC). 2000. *Land-use change and forestry*. Cambridge, Cambridge University Press.

International Institute for Sustainable Development (IISD). 2002. A summary report of the international expert meeting on forest landscape restoration – A brief history of forest landscape restoration. *International Institute for Sustainable Developmen*t, 71:1 (available at www.iisd.ca/linkages/sd/sdcfr).

Intergovernmental Panel on Climate Change (IPCC). 2000. *Land-use change and forestry.* Cambridge, Cambridge University Press.

International Tropical Timber Organization (ITTO). 2002. *ITTO guidelines for the restoration, management and rehabilitation of degraded and secondary tropical forests.* ITTO Policy Development Series No 13. Yokohama, ITTO.

Kala, C.P. 2010. Home gardens and management of key species in the Pachmarhi Biosphere Reserve of India. *J. Biodiversity,* 1(2): 111-117.

Kanowski, J., Catterall, C.P., Procter, H., Reis, T., Tucker, N. & Wardell-Johnson, G. 2005. Biodiversity values of timber plantations and restoration plantings for rainforest fauna in tropical and subtropical Australia. *In* P.D. Erskine, D. Lamb & M. Bristow, eds. *Reforestation in the tropics and subtropics of Australia using rainforest tree species,* pp. 183-205. Canberra, Rural Industries Research and Development Corporation.

Kuusipalo, J., Ådjers, G., Jafarsidik, Y., Otsamo, A., Tuomela, K. & Vuokko, R. 1995. Restoration of natural vegetation in degraded *Imperata cylindrica* grasslands: understorey development in forest plantations. *Journal of Vegetation Science,* 6: 205-210.

Laestadius, L., Maginnis, S., Minnemeyer, S., Potapov, P., Saint-Laurent, C. & Sizer, N. 2011. Mapping opportunities for forest landscape restoration. *Unasylva,* 238 (68): 47-48.

Lamb, D. 1994. Reforestation of degraded tropical forest lands in the Asia-Pacific region. *Journal of Tropical Forest Science,* 7 (1): 1-7.

Lamb, D. 2011. *Regreening the bare hills: tropical. Forest restoration in the Asia-Pacific region.* Dordrecht, Heidelberg, Springer. 547 pp.

Lamb, D. & Gilmour, D. 2000. *Rehabilitation of degraded forest ecosystems and secondary forest formations in Cambodia, Lao PDR, Thailand and Vietnam. Secondary forest in tropical Asia: reality and perspective.* Samarinda, East Kalimantan, April 10-14, 2000.

Lamb, D. & Gilmour, D. 2003. *Rehabilitation and restoration of degraded forests.* Gland, Switzerland, IUCN & WWF.

Lamb, D. & Huynh, D.N. 2006. Mixed species plantations of high-value trees for timber production and enhanced community services in Vietnam and Australia. Canberra, ACIAR. Unpublished report.

Lee, D.K. 2012. The forest sector's contribution to a "low carbon, green growth" vision in the Republic of Korea. *Unasylva,* 239(63): 9-16.

Mansourian, S., Vallauri, D. & Dudley, N., eds (in cooperation with WWF International). 2005. *Forest restoration in landscapes: beyond planting trees.* New York, Springer.

Mayaux, P., Holmgren, P., Achard, F., Eva, H.D., Stibig, H.-J. & Branthomme, A. 2005. Tropical forest cover change in the 1990's and options for future monitoring. *Philosophical Transactions of the Royal Society (B),* 360: 373-384.

McNamara, S., Duong, V.T., Erskine, P.D., Lamb, D., Yates, D. & Brown, S. 2006. Rehabilitating degraded forest land in central Vietnam with mixed native species plantings. *Forest Ecology and Management*, 233(2): 358-365.

McVittie, A. & Hussain, S.S. 2013. *The economics of ecosystems and biodiversity – valuation database manual* (available at www.teebweb.org).

Miettinen, J., Stibig, H.J. & Achard, F. 2014. Remote sensing of forest degradation in Southeast Asia – Aiming for a regional view through 5-30 m satellite data. *Global Ecology and Conservation,* 2: 24-36.

Minnemayer, S., Laestadius, L. & Sizer, N. 2011. *A world of opportunity.* Washington, DC, World Resources Institute.

Murphy, P.G. & Lugo, A.E. 1986. Ecology of tropical dry forest. *Annual Review of Ecology and Systematics,* 17: 67-88.

Nawir, A.A. & Rumboko, L. 2007. Chapter 2. History and state of deforestation and land degradation. *In* A.A. Nawir, Murniati & L. Rumboko, eds. *Forest rehabilitation in Indonesia: Where to after more than three decades?* Bogor, Indonesia, CIFOR.

Ramankutty, N., Gibbs, H.K., Achard, F., Defries, R., Foley, J.A. & Houghton, R.A. 2007. Challenges to estimating carbon emissions from tropical deforestation. *Global Change Biology,* 13: 51-66.

Rietbergen-McCracken, J., Maginnis, J.S. & Sarre, A. 2007. *The forest landscape restoration handbook.* London, Earthscan.

Russell, A.E., Cambardella, C.A., Ewell, J.J. & Parkin, T.B. 2004. Species, rotation, and life form diversity on soil carbon in experimental tropical ecosystems. *Ecological Applications,* 14: 47-60.

Shono, K., Cadaweng, E.A. & Durst, P.B. 2007. Application of assisted natural regeneration to restore degraded tropical forestlands. *Restoration Ecology,* 15(4): 620-626.

Sidle, R. C., Ziegler, A. D., Negishi, J. N., Abdul Rahim, N., Siew, R. & Turkelboom, F. 2006. Erosion processes in steep terrain – truths, myths, and uncertainties related to forest management in Southeast Asia. *Forest Ecology and Management,* 224: 199-225.

Sikor, T. & Apel, U. 1998. *The possibilities for community forestry in Vietnam.* Asia Forest Network Working Paper Series. Santa Barbara, California, USA, Asia Forest Network.

Sim, H.C., Appanah, S. & Durst, P.B., **eds.** 2003. *Bringing back the forests: Policies and practices for degraded lands and forests.* Proceedings of an international conference. Kuala Lumpur, Malaysia. Bangkok, FAO.

Siyag, P.R. 1998. *The afforestation manual: technology and management.* Jaipur, India, TreeCraft Communication.

Sodhi, N.S., Koh, L.P., Brook, B.W. & Ng, P.K.L. 2004. Southeast Asia biodiversity: an impending disaster. *Trends in Ecology and Evolution,* 19: 654-660.

Stanturf, J.A., Palik, B.J. & Dumroese, R.K. 2014. Contemporary forest restoration: A review emphasizing function. *Forest Ecology and Management,* 331: 292-323.

State Forestry Administration (SFA). 2009. *People's Republic of China forestry outlook study.* Bangkok, SFA/FAO.

Torquebiau, E. 1992. Are tropical agroforestry home gardens sustainable? *Agriculture, Ecosystems and Environment*, 41: 189-207.

Troup, R.S. 1921. *The silviculture of Indian trees.* Vol. II, pp. 697-769. Oxford, Clarendon Press.

Tucker, N.I.J. & Murphy, T.M. 1997. The effects of ecological rehabilitation on vegetation recruitment: some observation from the wet tropics of North Queensland. *Journal of Forest Ecology Management,* 99: 133-152.

Wiersum, K.F. 1984. Surface erosion under various tropical agroforestry systems. *In* C.L. O'Laughlin & A.J. Pearce, eds. *Effects of forest land use on erosion and slope stability*, pp. 231-239. Vienna, IUFRO.

Wooster, M.J., Perry, G.L.W. & Zoumas, A. 2012. Fire, drought and El Nino relationships in Borneo (Southeast Asia) in the pre-MODIS era (1980-2000). *Biogeosciences,* 9: 317-340.

Zhang, Y. & Song, C. 2006. Impacts of afforestation, deforestation, and reforestation on forest cover in China from 1949 to 2003. *Journal of Forestry,* 104(7): 383-87.

Zhou, Y.Y., Morris, J.D., Yan, J.H., Yu, Z.Y. & Peng, S.L. 2002. Hydrological impacts of reafforestation with eucalypts and indigenous species: a case study in southern China. *Forest Ecology and Management,* 167: 209-222.

Theory and practice of forest restoration at the landscape level in the People's Republic of China

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1. Forestry history – FLR and multifunctional management in China

Forest landscape restoration (FLR) 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. It not only seeks a return to past visions of land use, but also to ensure the functionality and productivity of degraded lands and forests (Laestadius et al. 2011).

China has a wealth of forest resources with over 27 000 species of higher plants (including ferns) belonging to 353 families and 3 184 genera, of which more than 7 000 species are woody plants. Forest area constitutes 195 million ha and timber volume 13 721 million m^3 (SFA 2010; Editorial Board of Vegetation of China 1980). Past agricultural practices and other human activities have affected the condition of almost all forest lands, juxtaposed by degradation, for hundreds of years. Since the beginning of the 1950s, efforts to restore forests have been ongoing and forest coverage has kept increasing, from about 8.6 percent at that juncture to reach about 20.36 percent of the land area today. This growth is expected to continue till it reaches about 26 percent according to general estimation (SFA 2009; Ren et al. 2012).

However forest degradation has been the general trend in the last few decades. Forestry has been governed by a policy that prioritized timber production and economic benefits, which forced villagers and local governments to transform natural forests into monoculture plantations. This resulted in biodiversity depletion in most productive Chinese forests, with only small patches of primeval forests in a few natural reserves (Hu 2002; Su and Yang 2012).

The causes of forest degradation are complex, the foremost being limited amounts of natural resources, unplanned human activities and unsuitable management practices. Due to uneven distribution of rainfall, forest distribution in China is also very uneven, with more than half of the forests occurring in the Northeast and Southwest territories, which represent only one-fifth of total Chinese territory. In contrast, the vast region of the Northwest, accounting for 30 percent of the total territory, only has 2.55 percent of forest land. Forests in this region comprise mostly single species with simple structure; natural regeneration is poor owing to adverse ecological conditions, increasing social disturbance and vulnerability to degradation, which makes restoration difficult. Furthermore, deforestation has also occurred following rapid industrialization. The process has continued to the point that 38 percent of China's total land area is now considered clearly degraded (Li and Lai 1994). On the other hand, there are still 63 million ha of barren land which is still classified as forest area and is suitable for afforestation. Out of it, 4.84 million ha are suitable for establishing productive timber forest (Li 2004).

As a consequence of bad management practices, forest structure has been degraded. Although China has plenty of tree species only a few of the dominant species, mainly conifers (*Pinus massoniana, Pinus yunnanensis, Cunninghamia lanceolata, Larix* spp., *Picea asperata, Abies* spp., *Cupressus* spp. and three fast growing broadleaf species *of Betula, Populus and Eucalyptus*) occupy about 56 percent of the total forest area. Plantation and secondary forests make up 94.9 percent of the forest area; natural forest with complete canopy structure and natural regeneration potential occupy only 5.1 percent. Young and middle-aged forests occupy 67.3 percent of the total with very low average tree diameter (under 13 cm). Although plantations are meant to continuously provide timber, the yearly harvests are low, and about 59 percent of the timber still comes from secondary natural forest (SFA 2010). But the conifer and fast-growing species that dominate plantations, in their young stages, are extremely vulnerable to degradation (Yang 2001).

After the 1980s, forests and plantations over the whole country were classified as either commercial production forests or forests with socio-ecological benefit as an overall forestry policy; some of the low-quality plantations were persistently transformed into ecological forests with measures to heighten their environmental and ecological roles (Chen 1992; Xu 1992). As a result, commercial plantation management is strongly oriented towards controlled farming, while ecological forests under state protection have no proper management regulations, which causes additional problems.

Such long-term simplified forest land use has resulted in severe depletion of biodiversity and a bias towards degradation. Moreover, short rotation monoculture plantations of exotic tree species such as eucalypts and rubber cause rapid land degradation, leading to decline in forest productivity and destabilized ecosystems. As a result, forest quality has deteriorated with average standing volume of 85.88 m^3/ha; for plantations the average volume is only around 45 m^3/ha, with annual increments of barely 4.5 m^3/ha. This is exacerbated by poor ecosystem resilience, loss of positive interactions among species and increase in pests and diseases, leading to further demand for land protection and restoration. After 1998, the shortcomings of the two-class management policy were realized and the search began for ecologically and environmentally friendly policies and silvicultural models. Multi-functional Forest Management (MFFM) has been promoted and adopted; this constitutes silvicultural practices to accomplish a wide range of objectives such as producing fibre, maintaining biodiversity and soil nutrients, creating wildlife habitats, and enhancing recreational opportunities (Lu et al. 2012).

FLR is defined as "a planned process to regain ecological integrity and enhance human well-being in deforested or degraded landscapes." It comprises tools and procedures to integrate site-level forest restoration activities with desirable landscape-level objectives; these are decided via various participatory mechanisms among stakeholders (Mansourian et al. 2005; Lamb 2002; Lamb et al. 2005). The policy of MFFM is therefore an identical framework to support FLR both in policy and practice. In other words, it can be stated that the MFFM policy and techniques are an expression of FLR practice in China in that they restore a range of forest functions at the landscape level.

At the Experiment Centre of Tropical Forestry (ECTF), in the coastal plantations of the tropical island province of Hainan and in the montane areas of Hunan Province, the Close-to-Natural Forest Management (CNFM) approach and techniques used are in line with the FLR approach. The ongoing work and preliminary results have persuaded the Chinese Government to set aside more land for multipurpose forests in state forests, which amount to over 40 percent of China's forest cover (Stone 2009).

2. Theory and techniques in Chinese FLR practices

These include the concept of MFFM, the Spatial Planning Techniques (SPT) planning tool that combines forest functions in management plans to ensure forest ecological integrity at the landscape level, the CNFM to strengthen the resilience and ecological integrity of forests and the Stand Operations Regime (SOR) to realize multifunctional goals at stand operation level.

Forest restoration at the landscape level attempts to manage forests with their ecosystem functions and services retained, as outlined below:

(1) A reliable supply of clean water, environmental protection such as reduced soil erosion, lower landslide risk and flood/drought mitigation;
(2) A sustainable supply of a diverse range of forest products including food, medicine, fuelwood etc;
(3) Monetary income from various sources, e.g. ecotourism, carbon trade and other cultural services; and
(4) Creating opportunities for employment or payments for ecosystem services (PES).

We define the concept of MFFM as "management of forest land in a designed way to realize at least two goals in combination out of the above desirable outcomes". Concomitantly, techniques are required in the contexts of function zoning, multispecies composition, forest development design, silvicultural model design and associated implementation to enhance forest integration and resilience as core components of FLR.

2.1 Spatial planning techniques

The first task of FLR is function zoning, supported by SPT. SPT is a GIS-based tool for disaggregating all geographical, site, biotope and conservation needs into different layers, and then integrating them with spatial-related land-use limitations into a classification map of management intensity to ensure forest landscape integrity, along with their function zoning.

Forest function zoning is an important feature of forest management planning that can be understood as "division of forest into different function types by following regulation standards of the management unit." The purpose of function regionalization is to realize the classification of MFFM by using different intensity operations for the corresponding areas of function type.

2.2 CNFM options

MFFM and CNFM are more or less an expression of the same thing from different angles, but CNFM is more concerned with technical aspects. To address forest management in China under the prevailing social conditions, we disaggregated the CNFM techniques into a three-level framework of principles, indicators and operations (Lu 2006).

2.2.1 Principles of CNFM

(1) **Principle of biorationalization:** Through the question "What is a forest?" and the corresponding answer, the first principle of biorationalization is proposed. The principle contains the consideration of biodiversity presented by tree species diversity, soil development processes and the selection of indigenous tree species as limitations in a forest management plan.
(2) **Principle of employing the force of natural automation:** Through the question "What need not be done?" and the corresponding answer, the second principle is expressed. The features of a forest as a self-organized ecosystem with self-fertilizing ability could be used in forest management to make forests more stable entities resilient to biological, physical and human disturbance.
(3) **Principle of nature response promotion:** Through the question "Why do we do it in such a way?" and the corresponding answer, the third principle of nature response promotion is proposed. This principle emphasizes that each management operation conducted in forests should aim at a certain form of improvement and result in a positive response from nature – otherwise it is not worth doing.

2.2.2 Technical indicators with quantitative options

The main factors which influence our understanding of the forest situation are summarized into four dimensions with quantitative indicators:

The first dimension – the succession process of forest development: Five stages of natural forest succession are identified according to the natural and scientific characteristics of forests in combination with the operational feasibility of CNFM. Details are given in Lu et al. (2012).

The second dimension – characteristics of forest canopy structure: No matter at which succession stage the current forest is, the canopy structure and tree species are the most important factors used for determining forest management activities. For example, for forest with clearly degraded canopy structure, the main management activity is to keep the few vital trees in the main canopy and put maximum effort into promoting regeneration as fast as possible.

The third dimension – species competition attributes: According to biological and ecological characteristics, the dominant or target tree species in a region can be sequentially classified into five types: typical pioneer tree species, long-life pioneer tree species, opportunistic tree species, subclimax tree species and climax tree species. The value of this classification is that tree species in the latter sequence can be used for planting under the former ones but the opposite sequence is not possible.

The fourth dimension – identifying individual differentiation: Variation among individuals always exist regardless of succession stages, stand structure and dominant tree species. We can make use of this variation so as to achieve the best management effects. The rationale of target tree management systems is that it takes the variation of individuals into consideration and then advances the corresponding management operation systems. According to the variation and competition among trees, individual trees can be classified into four types: target tree, obstructing tree, supporting tree and neutral tree, each with a different function and for selection in the management system.

2.2.3 The five operational tasks of CNFM

For managing a specific stand, investigation should be conducted to obtain the necessary information for evaluation of the status of the stand according to the four dimensions, with quantitative technical indicators. After estimating the situation of the forest, such as the development stage, structure type, species composition, stand quality and individual relationship, the specific silvicultural operation plan can be designed. Generally, there are five operational types to be included in the plan:

Design of the targeted forest development type (FDT): According to the forest characteristics and stand site condition, the targeted forest form is designed to describe possible succession stage, sustainable stocking level and tree species composition, harvest and regeneration procedures, the target diameter of each species, target timber class and service functions. However, the FDT is a summary of the future stand, and there are no standard methods to do this. Estimation and description of the stand parameters mentioned above are the main parts of an FDT (Lu 2006; Larsen and Nielsen 2007).

Individual classification and stand tending or harvest operation: According to the current succession stage, determine if a harvest or thinning operation should be conducted, identify/mark all target trees in the stand and remove the competing trees. Measures to accelerate the target trees are also included in the operation.

Protecting and accelerating natural regeneration: This design contains identification of and marking the potential high quality seedlings in the regeneration layer. All possible measures to protect and improve their continual growth are incorporated in the design; these can include cutting the growth around the regeneration seedlings, thinning and selecting the vital seedlings and digging a pit around their root area to accumulate water and fertilizer for them.

Enrichment planting under the canopy: When the plantation does not have enough natural regeneration, both in quality and quantity terms, enrichment planting should be undertaken. If the forest has regeneration, but it is clustered, replanting where natural regeneration is absent should be done.

Life cycle management plan (LCMP): This is a series of operations designed to inform practitioners on how to follow the plan to successfully achieve the original design of the FDT. Characteristics of the LCMP include classification of the stand growing period and the related activities required, not according to the stand age or time, but according to the stand's vertical structure, which is based on the dominant tree height.

2.3 Stand Operation Regime

The Stand Operation Regime consists of seven standardized silvicultural operation models as shown in Table 1 and Figure 1. They are operation programmes at the stand level which integrate specific harvesting, regeneration and tending treatments to achieve a predictable yield of benefits from the stand over the whole life cycle.

Table 1. Definition and description of seven operation models in the ECTF

Silvicultural models	Simple concept	Illustration	Additional remarks (species type and function zone)
1. Clear-cutting	Cut down most or all trees in an area when the stand reaches maturity (a rotation). Using artificial afforestation to cultivate the next generation.	Bulking or banding is the main form of clear-cutting here, with the largest area of clear-cutting being less than 30 m.	Fast-growing species like *Eucalyptus robusta* and *Mytilaria laoensis*. Function zone IV.

2. Mosaic clear-cutting	Cutting area is less than 5 ha, and arranged in mosaic grids. Reforestation in the cutting blocks should be finished in two years after felling.	The largest width and length of the cutting banding are 100 and 500 m when the gradient is more than 15°. The boundary of the cutting block should be selected where stands have better wind resistance.	Most species except for *Dalbergia odorifera* and *Castanopsis hystrix*. Function zones III and IV.
3. Strip intermediate cuttings	Harvest the mature woods in the banding, and use the gap effect to promote natural regeneration. Fell a banding (width = 1.5-2 times average tree height) in a stand, and use artificial assisted regeneration or natural regeneration to restore the cutting-blank.	The renewal process of the whole forest might continue for decades. The trunk forms of regeneration saplings are always better. It can be seen as a silvicultural model for high-quality timber in the ECTF.	Native broad-leaved tree species with fast or medium to fast growing features. Function zones II and III.
4. Shelter cutting	Over-storey trees are removed in a series of cuts designed to achieve a new, even-aged stand under the shelter of the remaining trees .The number and size of trees removed in this system are based on the amount of light reaching the forest floor.	Implement in even-aged or uneven-aged forest stands. It contains four steps: preparatory cuts, seed cutting, accretion cutting and cleaning.	Medium fast-growing species such as *Mytilaria laoensis*, *Castanopsis fissa* and *Betula alnoides* in the ECTF. Function zones II and III.
5. Group selection cutting	Continuous cut of the inferior individuals or mature individuals in the group. A number of 'groups' or small openings are created by the removal of several adjacent trees. Mimic larger, multitree mortality events, which in some environments may represent natural disturbance regimes.	Implemented where the gradient is less than 15°, the radius of the group is about 1.5-2 times that of the average tree height, use low-intensity operation to promote the growth of retained trees and understorey regeneration, cultivate valuable large diameter hardwoods.	Shade-tolerant tree species such as *Dalbergia odorifera*, *Castanopsis hystrix* and *Erythrophloeum fordii* Function zones I and II.
6. Single tree (target tree) selection cut	Cut the individual trees of mature and/or unhealthy species. Leave most of the trees and a variety of age classes to grow and regenerate an uneven-aged forest.	Implemented in areas that do not exhibit problems with shade-tolerant species. Under conditions with intensive management and control of undesirable trees.	Shade-tolerant tree species such as *Erythrophloeum fordii, Dalbergia odorifera* and *Castanopsis hystrix*. Function zones I and II.
7. Enclosure and protection	No felling activity in the forest; only do some tending on target trees (select and mark target trees, cut rattan etc.)	This model mainly used in places where the terrain is steep (gradient >45°) and complex.	Usually shade-tolerant tree species. Function zone I (gradient >45°).

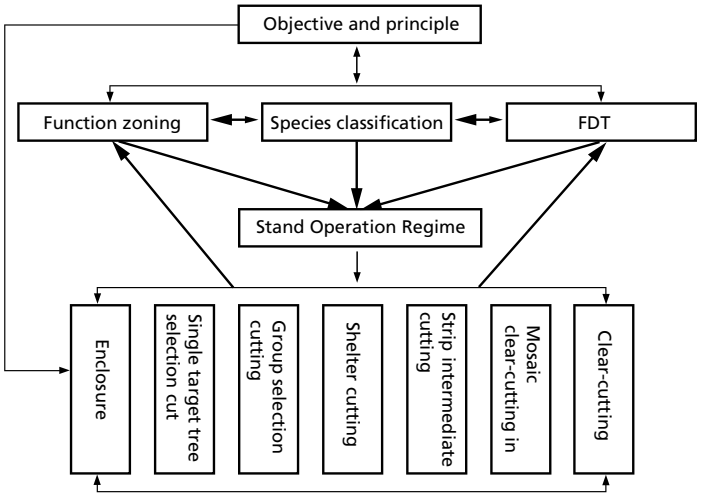

Figure 1. Systematic consideration and logical FLR framework used in China

First, an FLR planning task will be conducted according to the utilization characteristics (function zones), dominant species feature (shade tolerance and rate of growth) and the designed FDT. Subsequently, one of the seven silvicultural models to meet these preconditions to realize multifunctional goals at the stand operation level is to be undertaken.

3. Case study of FLR in the ECTF

The ECTF is situated in the Chinese tropical montane region (Figure 2). It is a state-owned forest management unit founded in 1979; it began with afforestation as the main management activity on an area of 1.92 ha. Initially the ECTF was managed for timber only, and the dominant tree species were *Pinus massoniana* and *Cunninghamia lanceolata* which occupied 81 percent of the total area. Some fast-growing species like *Eucalyptus* and *Acacia* were also part of the experiment before 2000. As the stand grew into middle age, it came under attack from pine moths which caused significant damage to the trees; severe soil degradation also occurred.

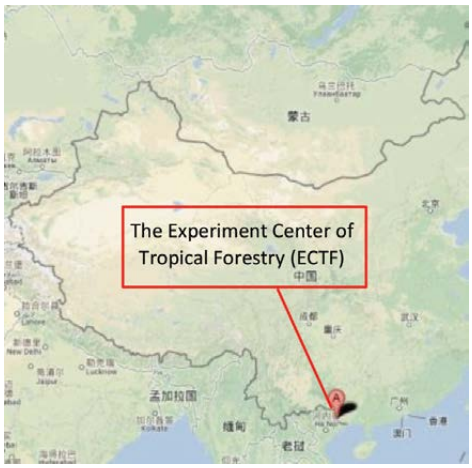

Figure 2. Location of the ECTF in the Chinese tropical montane region

Thus a need for change was deemed necessary. The first approach was a mixed afforestation experiment in the late 1990s. The second was to emulate CNFM with cultivation of high-value hardwood native species, thereby transforming most of the conifer plantations. Revised steps, beginning in 2010, addressed developing a multifunctional management plan for the whole management unit, characterized by function zoning and the setting up of long-term goals for every stand (FDT design) to realize sustainable management at the landscape level. All these steps transpired within 15 years to make the ECTF an exemplary case of FLR in China. These activities and initial results have been reported in the Chinese media and journals (Stone 2009).

3.1 Function zoning and CNFM model of the ECTF

The goal of the ECTF's MFFM is to maintain the health and vitality of forests and develop their economic and ecological service functions at the same temporal and spatial scales.

In the ECTF's function zoning, all management areas are divided into the following four types:

1. **Ecological protection forest zone** – forests that have special ecological and natural conservation values, and need to be protected; harvesting is forbidden.
2. **Ecological forest zone** – some tending optimization and low intensity harvest activities allowed.
3. **Commercial forest zone** – restricted felling, low intensity felling for timber production; clear-cutting forbidden.
4. **Commercial forest zone** – timber production with no restriction on operation intensity.

Based on the results of function zoning for ECTF forest areas, the four function zones can be regarded as the premise and precondition for arranging the different silvicultural models to ensure the necessary ecological functions for maintaining natural ecosystem integrity, and then to realize MFFM at the landscape level.

3.2 Species consideration for the MFFM plan

Tree species (or species groups) are the basic elements for MFFM. The most important aspect is to understand the species characteristics and identify optimal combinations of species in mixed stand situations or for forest transformation. Species features such as the growth environment (altitude, soil type and bedrock), economic value, growth cycle, nutrient preserving capability, water and soil conservation, drought tolerance, fire resistance, landscape aesthetics and so forth have to be considered in the design of silvicultural models.

As a new development towards productivity and biodiversity promotion at the landscape level, the silvicultural tree species in the ECTF have been enriched from four dominants (*Pinus massoniana, Cunninghamia lanceolata, Eucalyptus* spp., *Mytilaria laoensis*) to 20 species as shown in Table 2. This table was derived from the ECTF's long years of management experience and provides an important guide for the ECTF; it also serves as a reference for other tropical montane regions.

Table 2. The ecological characteristics, site type and function groups of tree species planned in silvicultural models of the ECTF's management plan

Species			Ecological characteristics									Site							Benefits			
No.	Scientific name	Code	indigenous species	broadleaf	conifer	exotic species	dominant pre-	dominant light	demanding	moderately shadow tolerant	shadow tolerant	fertility	dry	moderate fertility	barren	moist	alternating moist	wet	high-value timber	timber	ecologically important	others
1	*Pinus massoniana*	PiMa	•		•		•		•			•		•						•	•	
2	*Cunninghamia lanceolata*	CuLa	•		•		•			•		•					•			•	•	
3	*E. grandis* + *E. urophylla*	EuGr		•		•			•			•	•									
4	*Eucalyptus arophylla*	EuAr		•		•			•								•			•		
5	*Tectona grandis*	TeGr	•	•					•			•								•		•
6	*Mytilaria laoensis*	MyLa	•	•								•	•				•				•	
7	*Castanopsis fissa*	CaFi	•	•						•			•		•					•		
8	*Acacia confusa*	AcCo	•	•																•		•
9	*Betula alnoides*	BeAl	•	•	•		•				•	•								•		
10	*Pinus elliotii*	PiEl			•	•	•			•		•			•	•				•		
11	*Pinus caribaea*	PiCa	•		•	•		•	•											•		
12	*Michelia macclurei*	MiMa	•	•							•						•			•		
13	*Erythrophloeum fordii*	ErFo	•	•					•			•					•		•	•		
14	*Castanopsis hystrix*	CaHy	•	•	•		•			•		•							•			
15	*Illicium verum*	LlVe	•	•					•			•				•						•
16	*Keteleeria davidiana*	KeTe	•		•	•				•							•			•		
17	*Zenia insignis*	ZeIn	•	•					•											•		
18	*Schima superba*	ScSu	•	•					•				•			•	•			•		•
19	*Parashorea chinensis*	PaCh		•		•	•					•				•			•		•	
20	*Dalbergia odorifera*	DaOd	•	•			•				•			•					•	•		

3.2 Design of the FDT and operation models

The FDT is the basic presentation of species relationship based on tree growth and stand development characteristics, and it can be taken as a standardized tool for the design of species combination and target stand structure; therefore it is an oriented silvicultural model in the plan. Further description for design of the FDT is given by Lu et al. (2012); the 12 FDTs that have been worked out and their representative species are given in Table 3. Next, the suitable ecological scale and function zone, together with the seven operational models in the ECTF (Table 1) and the various silvicultural models for the given FDT (Table 4) consist of the main contents of the ECTF's management plan.

Table 3. Main FDT species for matching with different function zones in the ECTF

Species	Code	Succession process	Altitude	FDT in function zones			
				IV	III	II	I
Eucalyptus robusta	EuRo	1	1	FDT1EuRo-BeAl			FDT 2 EuRo-DaOd
Tectona grandis	TeGr	1-2	1		FDT 3 TeGr		
Pinus massoniana	PiMa	2	1-2	FDT 4 PiMa- MyLa	FDT 5 PiMa-CaFi		FDT 6 PiMa-CaHy
Cunninghamia lanceolata	CuLa	2-3	2-4	FDT 7 CuLa- MyLa	FDT 8 CuLa-CaFi		FDT 9CuLa-CaHy
Mytilaria laoensis	MyLa	2-3	1-3	FDT 4,FDT 7, FDT 10 Fast-BL			
Castanopsis fissa	CaFi	2-3	2-4	FDT 5, FDT 8, FDT 10			
Betula alnoides	BeAl	1-3	1-2	FDT 10			
Erythrophloeum fordii	ErFo	1-2	1-2	FDT 11 ErFo- BL			FDT 12 ErFo-CaFi-CaHy
Dalbergia odorifera	DaOd	4-5	1-2			FDT 2	
Castanopsis hystrix	CaHy	5	1-3		FDT 6, FDT 8		

Note: Succession process and shade-tolerance: 1. pioneer tree species; 2. long-life pioneer tree species; 3. opportunistic tree species; 4. subclimax tree species; 5. climax tree species.

Altitude (m): 1. <350 2. 350-750 3. 750-1 050 4. > 1 050.

A silvicultural regime is a planned programme of treatments during the life cycle of a forest stand designated to achieve specific stand structural objectives. According to the species feature (shade-tolerance and growth speed), operation and utilization characteristics (function zones) and FDT, seven silvicultural models have been designed along a series of felling intensities, as shown in Table 1.

The next step is to decide a suitable silvicultural model to realize the designed FDT for a certain forest type or forest land. Table 4 shows the match between different FDTs and silvicultural models.

Table 4. Different silvicultural models for the given FDTs

FDT	Dominant species	Associated species	Silvicultural models						
			1	2	3	4	5	6	7
FDT 1	EuRo	BeAl	*	*			*	*	
FDT 2	EuRo	DaOd							
FDT 3	TeGr	—		*					
FDT 4	PiMa	MyLa	*	*					
FDT 5	PiMa	CaFi	*	*			*	*	*
FDT 6	PiMa	CaHy							
FDT 7	CuLa	MyLa	*	*					
FDT 8	CuLa	CaFi	*	*			*	*	*
FDT 9	CuLa	CaHy			*	*			
FDT 10	MyLa	CaFi, BeAl		*	*				
FDT 11	ErFo	BL species		*			*	*	*
FDT 12	ErFo	CaFi, CaHy							

Note: 1: Clear-cutting, 2: Mosaic clear-cutting in a small area (< 5 ha), 3: Strip intermediate cutting, 4: Shelter cutting, 5: Group selection cutting, 6: Single tree (target tree) selection cutting, 7: Enclosure.

*indicates suitable FDTs.

An important task in the management plan is to recognize the appropriate management option for a subcompartment, and to select a suitable FDT, match a suitable silvicultural model for this site, and bring about its designed functions. This is made possible with a technical tool which works with optimal algorithms in a computer program to support selection decision.

3.4 Brief cases of FLR in other regions

The first example of FLR in China, besides the ECTF, is CNFM of a single-structured *Casuarina equisetifolia* plantation on Hainan Island. As shown in Figure 3, the plantation area is situated in the Northeast of the island. As the overall main development goal has shifted to international tourism in the island, there was a move to convert the *Casuarina equisetifolia* plantation with its typical pioneer species and short rotation/simple ecosystem service function, to one with natural regeneration under the canopy to form a sustainable integrative coastal forest ecosystem.

Figure 3. Case study area on Hainan Island and the *Casuarina equisetifolia* stand dynamics with enriched fast growing broadleaf species of *Melia azedarach* (second picture from right) and high-value hard wood species of *Dalbergia odorifera* (first picture from right)

The CNFM hypothesis here can be expressed as "the present canopy of *Casuarina equisetifolia* will serve as protecting layer for establishment of seedlings of other new introduced broadleaf species which do not thrive in open areas such as the tropical coastal site. A series with typical pioneer-opportunity-climax species planted under the canopy will speed the development of the stand towards a stable coastal forest ecosystem." *Melia azedarach, Beischimiedia glauca* and *Mytilartia laosensis* as the fast-growing group, and *Homalium hainanense, Dalbergia odorifera* and *Calophyllum inophyllum* as the hardwood climax group were used for enrichment planting under the canopy. The first two years of observations showed very positive results by 2013, and on this basis the transformation of the coastal protection plantation can now be expanded.

The second example is the large-scale restoration of forests damaged by the extreme ice-storm in Hunan Province. Hunan Province is a subtropical climate-controlled montane region in South Central China; its natural conditions of humid sunny climate and abundant tree species on hill and low montane areas are highly favourable for forestry. The province has a long history of conifer plantation management with *Cunninghamia lanceolata* and *Pinus massoniana*. The extreme ice-storm of early 2008 affected about 35.28 percent of the total forest area, with loss of growing stock reaching 43.19 percent of the total growing volume in the province. This represented a direct loss to forestry of about 16.5 billion yuan (US$1.00 = 6.119 yuan, October 2014), further affecting the economy of the province. Notably, damage from the ice-storm was more severe and devastating in single species coniferous forest plantations and bamboo stands than in natural, mature forests or mixed species plantations.

A few years after the event, it was clear that most of the damaged forests, in particular the plantations, would not be able to recover naturally. Therefore an FLR scheme, the Hunan Forest Restoration and Development Project, was proposed and supported by the government to prevent further degradation and restore the ecological balance in the storm-affected landscapes of 22 counties. The project started in January 2013 and will last for six years. Its objective is to develop forest restoration and management models that will both strengthen resilience and enhance carbon sequestration in forest areas severely damaged by the ice-storm.

3.5 Tentative results

Ten years ago conifer plantations were the main forest type in the ECTF and occupied 71 percent of the total forest area. Masson pine (*Pinus massoniana*, 63 percent) and Chinese fir (*Cunninghamia lanceolata*, 7 percent) were the two largest tree species there. Compared with single species rotation management models of these two conifer species, CNFM has at least three advantages: (1) forming a multilayer stand structure to increase spatial availability, (2) enhancing positive interspecies synergy between conifer and broadleaf species to increase vitality and resilience of stands, and (3) thinning to allow the target trees to be released from competition. Based on our analysis of the data from 80 plots for the two forest types over five years (2008-2013), the yearly growth of standing volume increased to 19.3 m^3/ha for *Pinus massoniana* and 15.9 m^3/ha for *Cunninghamia lanceolata*, compared to the reference stand with 4 m^3/ha and 3.9 m^3/ha, respectively (Figure 4).

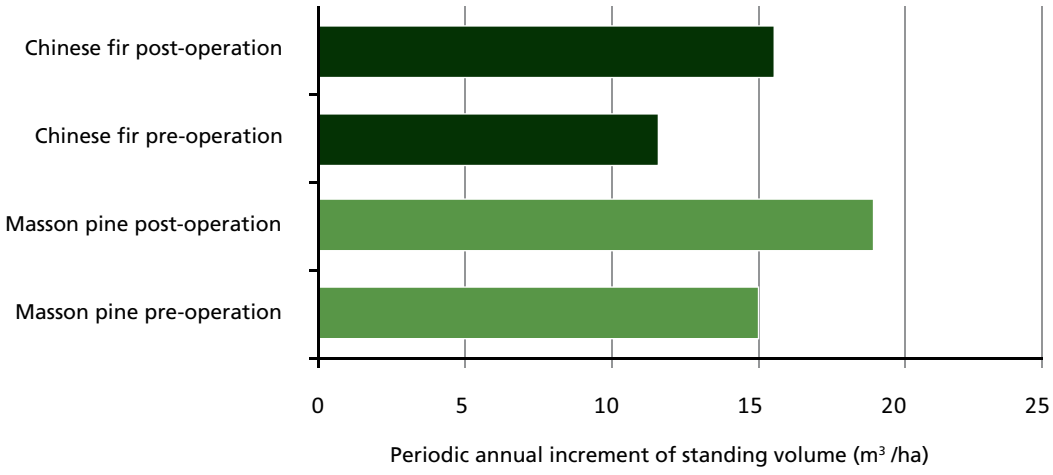

Figure 4. Volume per annual increment before and post-CNFM

The observations also show that species composition had improved after eight years' transformation from pure *Pinus massoniana* forest to mixed forest (Figure 5), and likewise with the *Cunninghamia lanceolata* forest (Figure 6). The species numbers in both types of forests are clearly higher through enrichment planting and identifying/protecting natural regeneration through the transformation process.

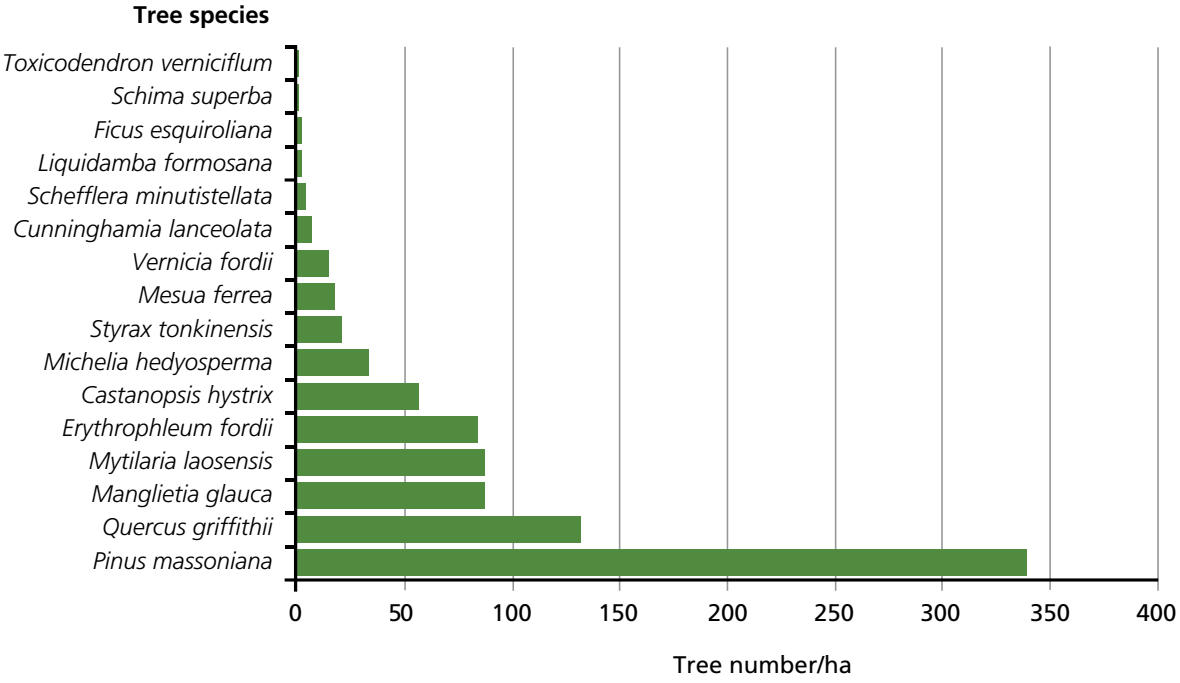

Figure 5. Species composition of a *Pinus massoniana* stand showing enrichment after eight years' transformation from pure to mixed forest through both enrichment planting (*Mytilaria laoensis, Castanopsis fissa, Castanopsis hystrix*) and identifying/protecting natural regeneration

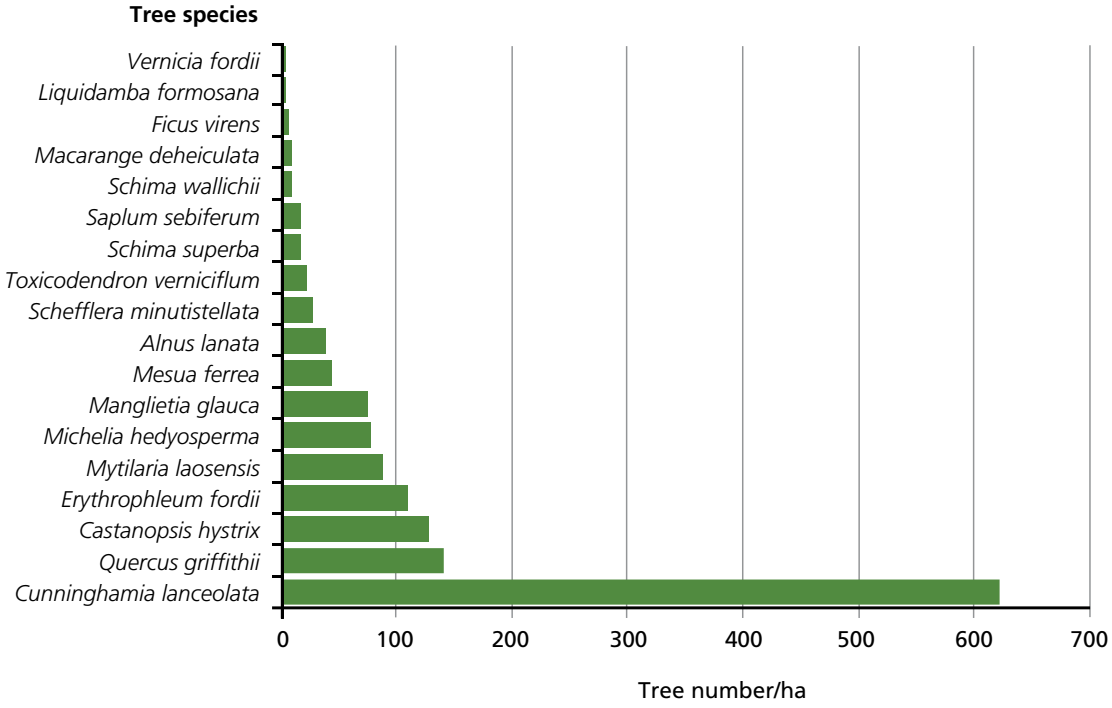

Figure 6. The species composition of a *Cunninghamia lanceolata* stand is clearly enriched after eight years' transformation from pure to mixed forest through both enrichment planting (*Mytilaria laoensis, Castanopsis fissa, Castanopsis hystrix*) and identifying/protecting natural regeneration.

Concerning all trees with diameter over 5 cm, species number reached 16 with total tree number of 902/ha for *Pinus massoniana* forest, and 18 with total tree number of 1 438/ha for *Cunninghamia lanceolata* forest.

4. Policy and participatory forestry processes in China

As a vast land with a huge population and diverse traditions, participatory processes in forestry in China are heavily dependent upon forest protection and ecological improvement while simultaneously supporting local livelihoods. The Chinese Government has formally approved and started to implement the Six Key Forestry Development Programs (the Natural Forest Conservation Program, Key Shelterbelt Construction Program, Program for Transforming Farmland into Forests, Desertification Control Program, Conservation of Biodiversity and Nature Reserve Program and Establishment of Fast-Growing Timber Plantations) since the 1990s. These six programmes encompass 97 percent of China's regions in terms of counties, and signal the end of the timber only-oriented forestry era, and the beginning of forest ecosystem restoration and multifunctional forestry in China.

In 1998, in an effort to promote forest management activities to prevent forest destruction and further deterioration, the Chinese Government established the National Forest Conservation Program (NFCP), which articulated the new forest policy. The central government invested some 17 billion yuan (US$2.125 billion) during 1998 to 2000 for the NFCP (Li 2004), and further operation in the second phase (2010-2020) aimed at increasing an additional 600 000 ha in the area, 290 000 000 m^3 stock of forests and providing 443 200 job positions in the target regions.

In 1999, another massive programme – the Key Shelterbelt Construction Program – was initiated for the restoration of forest and grassland in Northwestern arable areas where slopes exceed 25° or desertification poses a threat. This programme will cover 22 provinces, and most of them are concentrated in the western part of China. Within the next ten years, this programme is intended to convert an additional 5.33 million ha of marginal farmland to forest land for soil erosion control and to regenerate an additional 39 million ha of forest plantations and natural forests in degraded areas (SFA 2010). In this programme, the participatory cost-sharing policy is a core component that involves farmers, their families, researchers and local government officials in addressing forestry problems; scientific cooperation is designed to improve communication between government officials and farmers.

Since 2003, a programme for transforming farmland into forests or grassland (known as 'Grain for Green') has been launched in China. It covers a trial area in 17 provinces and targets control of 22.67 million ha of land affected by soil erosion and 26.67 million ha of sand-affected areas by 2010. The central government offers compensation to farmers who ceded their degraded farmlands for forest restoration; the compensation is intended to equate to the maximum quantity (2.25 tonnes food/ha/year) they would have obtained from the land, and also provides financial support to cover the cost of reforestation (750 yuan/ha/year) and maintenance (300 yuan/ha/year). The compensation in the form of grain and cash will last for eight years with the understanding that farmers will be able to generate income from forest production or service functions subsequently. The process is participatory and collaborative, with local communities providing land and being responsible for tending the seedlings. As the first stage of forest restoration, the Six Key Forestry Development Programs incorporated participatory forestry development from the outset and the efforts are still ongoing.

The second stage of forest restoration is characterized by a general forestry policy of compensation for public and ecologically beneficial forests. In 2009, with governmental support, the State Forestry Administration established the Forestry Ecological Compensation Fund, which awards compensation for public ecological service forests; the standard was 75 yuan/ha/year initially, but was raised to 225 yuan/ha/year in 2013. In this context, Chinese Government support has reached 14.9 billion yuan per year.

In 2013 the new National Forest Tending Regulation that adopted the MFFM concept was enacted; it included a training and monitoring programme nationwide. It addresses most state forests and supports all multifunction-oriented forest tending and silviculture operations in both natural forests and plantations. It has been redesigned to allow public benefits to predominate. It is partly supported by government funding at about 2 000 yuan/ha/year and more than 6.2 billion yuan was spent for tending or silvicultural activities in public welfare-oriented multifunctional forests nationwide in 2013. This policy will be slowly elevated step-wise on a yearly basis.

The FLR concept reported in this paper and its technical tools for implementation are characterized by a technical framework of multifunctional zoning, CNFM planning and stand operation regimes. This approach is likely to meet current needs with the implementation of the new National Forest Tending Regulations. The multifunctional stand operation regime would be a suitable concept for most public ecologically- and socially-oriented forests, as well as those with community or private ownership that intend to participate in the Ecological Compensation Program.

All of these FLR policies are government-oriented in character due to the relatively simplified and uniform forest ownership system in China; however farmers and forest residents are encouraged to pursue restoration and maintenance of forest ecological services nationwide.

5. Conclusion and future perspectives

The FLR thrust in the ECTF supported by the technical framework of multifunctional zoning, CNFM planning and stand operation regimes have been implemented step-wise for the last 15 years. The tentative results show that positive outputs have been obtained at stand and forest levels as discussed in this paper and reported by Stone (2009). A new task of identifying the effects of forest restoration on degraded landscapes is to look for concrete indicators and related methods to measure and present the effects at the landscape level. A systematic sampling system with 238 plots was set up covering all forest area of the ECTF in 2011 and the first remeasurement of this system was only finished in 2013. The reports will come later. A similar study is being carried out for the case studies from Hainan and Hunan provinces. However, the FLR concept and its technical tools are gradually being recognized and applied in different areas of China. Another positive step is that the concepts and techniques of multifunctional forests have been accepted and implemented in the new National Forest Tending Regulation enacted in 2013, and to be released in 2014. We can expect that with the implementation of this technical approach in most Chinese forests with governmental support, forest ecosystems will be improved and forest degradation will be mitigated in the future.

References

Chen, B. 1992. Status, causes, and improvement strategy of soil degradation in timber plantations in China. ***In*** W. Sheng, ed. ***Research on site degradation of timber plantations***. Beijing, China Science and Technology Press. (In Chinese)

Editorial Board of Vegetation of China. 1980. *Vegetation of China*. Beijing, Science Press. 1500 pp.

Hu, J.Q. 2002. A brief account of the study of China forest history. ***Journal of Zhejiang Forestry College,*** 19(3): 330-333.

Laestadius, L., Maginnis, S., Minnemeyer, S., Potapov, P., Saint-Laurent, C. & Sizer, N. 2011. Mapping opportunities for forest landscape restoration. ***Unasylva,*** 238 (68):47-48.

Lamb, D. 2002. ***From local to landscape: how to restore degraded landscapes as well as degraded lands*** (available at www.iucn.org/themes/fcp/activities/publications).

Lamb, D., Erskine, P.D. & Parrotta, J.A. 2005. Restoration of degraded tropical forest landscapes. ***Science,*** 310: 1628-1632.

Larsen, J.B. & Nielsen, A.B. 2007. Nature-based forest management—where are we going? Elaborating forest development types in and with practice. ***Forest Ecology and Management,*** 238: 107-117.

Li, W.H. 2004. Degradation and restoration of forest ecosystems in China. ***Forest Ecology and Management,*** 201: 33-41.

Li, W.H. & Lai, S.D. 1994. *Agroforestry in China.* Beijing, Science Press. (In Chinese)

Lu, Y.C. 2006. ***The theory and practice on close-to-nature forest management***. Beijing, Scientific Press. (In Chinese)

Lu, Y., Liu, X., Li, T., Le, X. & Meng, J. 2012. ***Technical framework of plantation management towards increasing carbon stocks and multi-functional forest service in China.*** Proceedings of the 2nd International Workshop on Forests in Climate Change Research and Policy: The Role of Forest Management and Conservation in a Complex International Setting. Göttingen, Cuvillier Verlag.

Mansourian, S., Vallauri, D. & Dudley, N., eds. (in cooperation with WWF International). 2005. *Forest restoration in landscapes: beyond planting trees.* New York, Springer.

Ren, H., Lu, H.F., Wang, J., Liu, N. & Guo, Q.F. 2012. Forest restoration in China: Advances, obstacles, and perspectives. ***Tree and Forestry Science and Biotechnology,*** 6 (Special Issue 1): 7-16.

State Forestry Administration (SFA). 2010. The seventh national forest resources inventory and the status of forest resources. ***Forest Resources Management,*** (2010) 1: 1-8.

Stone, R. 2009. Nursing China's ailing forest back to health a lauded effort to create mixed forest is giving villagers and loggers a chance to make a living while restoring ecosystem vitality. ***Science,*** 325: 556-558.

Su, Q.Y. & Yan L.Q. 2012. Review and introspection of China forest history. ***Journal of Anyang Normal University,*** 1:70-80.

Xu, H. 1992. Dynamic characteristic of soil fertility of forest land and problems of soil degradation in timber plantations. ***In*** W. Sheng, ed. ***Research on site degradation of timber plantations***. Beijing, China Science and Technology Press. (In Chinese)

Yang, X. 2001. Impacts and effectiveness of logging bans in natural forests: People's Republic of China. ***In*** P.B. Durst, T.R. Waggener, T. Enters & L.C. Tan, eds. ***Forests out of bounds: impacts and effectiveness of logging bans in natural forests in Asia-Pacific,*** pp. 81-102. RAP Publication 2001/08. Bangkok, FAO, Regional Office for Asia and the Pacific.

Experiences, lessons and future directions for forest landscape restoration in Indonesia[1]

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1. Introduction

Indonesia has had considerable experience in implementing more than 150 projects, in more than 400 locations, on forest rehabilitation and mining reclamation in the past four decades (Nawir et al. 2007a). However, forest landscape restoration (FLR), implemented over the past four or five years, is considered a recent initiative. The IUCN, ITTO and Tropenbos International Indonesia Programme (TBI Indonesia) led the initiative in voluntarily developing Principles and Guidelines on Landscape Restoration for Indonesia by involving different stakeholder groups, such as the government, private companies and international organizations as part of the Working Group on FLR (National GPFLR 2009).

In facilitating Indonesia as it moves forward in the direction of FLR, this paper summarizes the main issues that are useful as a basis for designing future scenarios from past and current experiences gained from implementing various forest rehabilitation projects.

The paper takes into account extensive studies and experiences of the Center for International Forestry Research (CIFOR), TBI Indonesia, WWF Indonesia and the local government of Sumbawa District. It relies strongly on the CIFOR study in Indonesia on 'Review of Forest Rehabilitation – Lessons from the Past' implemented in collaboration with the Forestry Research and Development Agency, Ministry of Forestry (Nawir et al. 2007a). TBI Indonesia has experience in facilitating the Working Group on FLR, as well as the promotion and establishment of nine learning sites uploaded to the Global Partnership on Forest Landscape Restoration website as part of FLR implementation projects. Lastly, WWF Indonesia and the local government of Sumbawa District have been involved in implementing FLR through the forest management unit (FMU) or Kesatuan Pengelolaan Hutan (KPH) and this is presented in this paper as one of the case studies.

2. Historical overview of forest and land degradation and current status

Indonesia's total terrestrial area covers 193 million ha including 130.7 million ha of state forest land and 5.5 million ha of marine national parks under management of the Ministry of Forestry; the remaining terrestrial areas are not forested (MoF 2012). The state forest area is administered and managed by the Ministry of Forestry, while the area classified as non-state forest area is administered and managed by the National Land Agency. The state forest area is estimated to be almost 68 percent of the terrestrial land mass; land allocated for non-forest purposes constitutes 32 percent.

As an archipelagic country with more than 13 466 islands (Susanto 2013), population and forest cover are unevenly distributed. Two-thirds of the estimated 240 million people (2013) live on the fertile island of Java with only 2.3 percent of primary forest land cover remaining; the rest of the population is distributed among many other islands across the archipelago that have higher forest cover (BPS 2013).

Assuming that 46.3 percent of the population lives in rural areas and directly engages with forests, the average ratio of forest area per capita is only 1.2 ha (Table 1). The assumption is that all 130 million ha of forest are distributed among the rural population.

Table 1. Population and population density in Indonesia in 2010

Island	Total area (km²)	Population	Density (people/km²)
Sumatra	482 393	46 136 521	96
Java	127 499	136 610 590	1 071
Kalimantan	547 891	9 391 848	17
Sulawesi	191 800	17 371 782	91
Papua	421 981	3 593 803	9
Indonesia	**1 937 179**	**237 641 326**	**123**

Source: BPS (2013).

The 130.7 million ha of state forest is classified based on its functions as conservation forest (20.52 percent), protection forest (24 percent), production forest and limited production forest (18.72 percent), permanent production forest (24.95 percent) and convertible production forest (13.73 percent) (Table 2). As open access areas increased, they were subject to encroachment and subsequently degraded. Highly degraded forests are caused by uncertainty of tenure, lack of ownership and/or management. The decline in forest concessions has resulted in the absence of forest management at the site level. Consequently, with no protection and site management, the forests are encroached and illegal activities have further degraded the forests left by the concessionaires.

Table 2. Forest distribution by function

Forest function	Area (000 ha)	Percentage of the total forest area
Conservation forest	26 820	**20.52**
Protection forest	28 860	**22.08**
Limited production forest	24 460	**18.72**
Production forest	32 600	**24.95**
Convertible production forest	17 940	**13.73**
Total forest area	**130 680**	**100.00**

Source: National Forestry Plan for the period 2011-2030 (MoF 2011).

State forest management rights are unevenly distributed between corporate and community allocations. In the early 1980s some 98 percent of production forest was granted to more than 580 logging concessionaires, while less than 2 percent was allocated to local communities under various schemes, such as community forestry (Hutan Kemasyarakatan – HKm) (Safitri 2006).

A study conducted by Gunarso (2013) found that Java had only 0.29 million ha (2.3 percent) of undisturbed forest cover in 2010 (Table 3) compared to 2.6 million ha of privately-owned forest (Hutan Rakyat – HR) at around 20 percent of the island (BPKH and MFP 2009; Wonodipuro 2013). Most timber for local wood industries used in Java comes from farm forestry. Gunarso (2013) also concluded that the remaining primary forest cover on the outer islands varied from the least on Sumatra with only 11 percent of the island to the highest in West Papua with 69 percent.

Table 3. Percentage of undisturbed primary forest cover in upland state forests

Island	2000	2005	2010
	Million ha (% of the total area on each island)	Million ha (% of the total area on each island)	Million ha (% of the total area of each island)
Sumatra	6.50 (14)	6.03 (13)	5.49 (11)
Kalimantan	16.92 (31)	15.57 (29)	14.07 (26)
Sulawesi	5.85 (31)	3.96 (21)	3.90 (21)
Java	0.37 (2.8)	0.29 (2.3)	0.29 (2.3)
Papua	31.56 (76)	29.87 (72)	28.64 (69)

Source: Gunarso (2013).

The rate of degradation of primary upland forest (Table 3) is alarming, particularly for Sumatra and Kalimantan. In Sumatra, the upland primary forest was 14 percent of the total land area in 2000 and declined to only 11 percent in 2010, equal to loss of 1.4 million ha or 140 000 ha per annum. In Kalimantan the upland primary forest in 2000 amounted to 16.9 million ha, while in 2010 it had been reduced by 5 percent (from 31 percent to 26 percent), equal to loss of 2.7 million ha or 270 000 ha per annum. This degradation was particularly rampant after the Reformation Era started in the late 1990s. The national annual rate of deforestation reached 2.83 million ha per year during the 1990s. This was more than triple the rate during the period 1982-1990, which was 900 000 ha per year (MoE 2007).

Illegal logging, forest encroachment and forest conversion have been identified as the three main causes of deforestation in the Reformation Era (Wibowo 2013). Forest conversion, however, was not directly from primary forest, but mostly a succession from primary to degraded areas, and then converted into agricultural and estate crops (FWI 2011). Degraded areas identified as critical lands inside forest accounted for 54.6 million ha for the whole of Indonesia (Baplan 2002). Industrial forest plantations have grown much more slowly than oil-palm plantations, although they were planted much earlier in the mid-1980s. Of the 10 million ha the Ministry of Forestry (MoF) allocated for industrial forest plantation, less than 5 million ha are currently planted (FWI 2011). There are more complex dynamics underlying the causes of deforestation.

Up to 2011, recent statistics showed that the deforestation rate had declined to 1.08 million ha per year (MoE 2007). While this appears to be good news, there has been no detailed study to assess the causes of this decline or to confirm that the deforestation rate is slowing down and forest areas and conditions are being restored.

3. Current status of forest degradation

The vast area of Indonesian forests is now of very low quality or its status is highly degraded. Deforestation and degradation have left only small areas of undisturbed primary forests. Only about 30 percent of the primary forests remains and the proportion continues to decrease due to continuing deforestation and forest degradation. Based on the latest figures, the total critical areas inside and outside forest land accounted for 77.8 million ha in 2007 or about 60 percent of the total estimated forest area of Indonesia (MoF 2007). Most is located inside forest (38 percent), which includes critical peat swamp forest covering 4.5 million ha (MoF 2007). The quality of related water supply has also been affected – around 17 000 watersheds are in a critical condition inside these forests, and another 3 000 watersheds have been destroyed (MoF 2007). This situation has affected an estimated 10-20 million people who depend on forests for their daily livelihoods (Sunderlin et al. 2000; FWI/GFW 2002).

Furthermore, large areas of forest cover remain in areas designated for non-forestry use. Due to spatial planning where terrestrial land is divided into conservation, protection and utilization zones, many areas designated for non-forestry use remain covered with forests. In contrast, many areas designated as state forests have no forest cover due to the unsustainable practices of forest concessionaires. A land swap between forested non-forestry use areas with designated deforested or degraded forest has been proposed in recent years. The proposal is mainly linked to the potential of the carbon sequestration role of these forested lands and at the same time to encourage forest rehabilitation on designated deforested or degraded areas through FLR. Recent policy to allow mining of coal in production forest has increased the areas of highly degraded forests. In East Kalimantan alone, the total land allocated for coal mines has amounted to 5 million ha released under 1 488 permits (Hidayat 2013). The potential for forest destruction from coal mining, with no proper reclamation, is huge. While companies are required to deposit funds for post-mining reclamation in the beginning, in practice only a small number of mining companies undertake reclamation activities after their permits have terminated.

With such a large area of degraded forest and associated diminishing ecological services, massive forest rehabilitation and restoration of forest landscape are needed. Despite more than three decades of implementation of forest rehabilitation and other associated programmes, this work has not been able to catch up with the rate of deforestation and forest degradation (Nawir et al. 2007c). This is due, in part, to the MoF not having adjusted the annual target area since the 1980s; it is not keeping pace with the increasing rates of deforestation and degradation (Nawir et al. 2007c). The government has provided only limited funds for the rehabilitation or restoration of degraded forests. In a more recent programme, 'Planting One Billion Trees' launched in 2011, less than 300 000 ha of degraded forest were targeted annually for inclusion in the programme. This was in addition to another annual development programme for 200 000 ha of forestry plantations (Sarinah 2013). This programme was initiated in response to Indonesia's international commitment to reducing its greenhouse gas (GHG) emissions by 26 percent for 'business as usual' and 41 percent with international support by 2020 (Bappenas 2010). With funding from the Norwegian Government, Indonesia signed a Letter of Intent (LoI) to implement a low carbon economy and Reducing Emissions from Deforestation and Forest Degradation (REDD+) as part of the country's efforts to reducing its GHG emissions. The recent Presidential Decree No. 6, 2013 aimed at improving the forest governance of primary forests and peatlands (CIFOR 2013; INPRES 2013).

While the government has limited funding available for forest landscape restoration and rehabilitation, local communities are a potential source of labour and investment for the rehabilitation of degraded forests and land. When access to forest areas is given to local communities, such as in Java, they have implemented reforestation and forest rehabilitation with a small amount of funding assistance or no support at all from the government. The demand for local timber in Java has increased the interest of small investors, mainly temporary out-migrants working in the city who invest in trees in their home villages. In 2009, community forestry from this kind of investment covered approximately 2.8 million ha, 78 percent of all private forest in Indonesia, which is an estimated 3.6 million ha (Wonodipuro 2013).

There are more dynamic and complex driving factors related to deforestation and land degradation to be resolved in order to improve forest management in Indonesia. Any forest rehabilitation, mining reclamation and restoration efforts at project sites and the landscape level should include plans and actions to address them.

3.1 Causes of forest degradation

It is important to understand the range of drivers behind deforestation, so that the interventions undertaken by programmes (rehabilitation, reclamation and restoration) can address the underlying causes of deforestation and land degradation. These may be identified by understanding the direct and underlying causes, and the agents responsible for a certain act (Contreras-Hermosilla 2000).

3.1.1 Direct causes

There are two types of direct causes: natural conditions and those resulting from human activities. As direct causes, human activities usually have more permanent and prominent roles compared to natural conditions.

Natural conditions: Indonesian geomorphology and high rainfall (1 500-4 000 mm per annum) have affected the soil so that it is vulnerable to natural catastrophes such as landslides and erosion, which lead directly to deforestation (Santoso 2005). Long drought seasons (such as those caused by El Niño) are another natural condition that can render forests

vulnerable to fire, which is often unmanageable (FWI/GFW 2002). However, there are limited statistics that can actually estimate the total area affected and deforested in Indonesia due to natural causes. This is mainly because of the difficulty in differentiating between natural causes and those resulting from human activities, such as forest fires. The greatest natural disaster was the tsunami on 26 December 2004 that hit Aceh and Nias in North Sumatra. It was initially estimated that 48 926 ha of coastal forests (other than mangroves) were severely impacted (UNEP 2005). The tsunami's impact was greater because most of the mangrove forests in Aceh had been converted to fish and shrimp ponds (EFJ 2006).

Human activities and agents of deforestation: There are at least two direct causes of deforestation: (1) logging and illegal logging and (2) forest fires caused by human activities.

Logging and illegal logging: Human activities in relation to forest extraction have been the main causes of deforestation, mainly through logging operations, illegal logging and unmanageable fires (Sunderlin and Resosudarmo 1996; FWI/GFW 2002; Tacconi et al. 2004). Logging contributes between 77 000 - 120 000 ha to deforestation annually; this is about 10 - 20 percent of the total deforested area and 10 - 15 percent of the 800 000 ha logged each year (Sunderlin and Resosudarmo 1996). Since 2001, the number of logging companies or HPH has been in decline (Tacconi et al. 2004). Subsequently, the rates of deforestation and volumes of wood logged illegally have been increasing (Tacconi et al. 2004). There are three reasons for the fall in HPH numbers: permits have expired and have not been extended (186 units, 15.69 million ha), permits have been withdrawn and the area returned to the state (10 units, 1.15 million ha) and permits have been withdrawn as a punishment for violations (67 units, 4.32 million ha) (Ministry of Forestry and Estate Crops 1998 in Kartodihardjo and Supriono 2000). To date, however, these concessions have declined to less than 150 with a total area of around 24 million ha (Suparna 2013 in Rasyida 2013). As a result of the unclear status of the forest on revoked concession areas, there are more than 43 million ha of open access production forests (Forum Reklamasi Hutan Pada Lahan Bekas Tambang 2003; Nawir et al. 2007c). Although the number of HPH companies has declined, the area deforested has continued to increase because of other problems, such as illegal logging (Nawir et al. 2007c). Tacconi et al. (2004) estimated illegally-logged areas to be about 2.5 million ha in 2001, with a total volume of 50 million m^3 based on the assumed harvesting rate of 20 m^3 per hectare. In 2006 there were 345 cases of illegal logging, conducted by 319 people in 20 provinces (MoE 2007).

Forest fires in relation to human activities: Indonesia has experienced two major outbreaks of fire in the last 30 years: in 1982/1983 fire damaged 2.7 million ha of forest, and in 1997/1998 5.4 million ha of forest were destroyed, mostly in Kalimantan and Sumatra (FWI/GFW 2002). However, it is not clear whether the areas burned in 1982/1983 had recovered before the 1997/1998 fires occurred. The total area damaged by the later fires and forests not exclusively affected was 11.7 million ha across Sumatra, Java, Kalimantan, Sulawesi and West Papua (Tacconi 2003). The causes of the fires varied, but the main source was intentional burning during land clearance prior to the development of estate crops that spread out of control, as well as smallholder activities in clearing the land for cultivation (FWI/GFW 2002). Increasingly, forest fires have become an endemic problem every year with the magnitude tending to increase from year to year. The recent peak season for forest fire was in June 2013 (Sizer et al. 2013).

3.1.2 Underlying causes and agents of deforestation

The underlying and direct causes cannot be separated, because there is often a long chain of events that leads to deforestation (Contreras-Hermosilla 2000). However, the underlying causes of deforestation are complex and cover various aspects: (1) market failures, (2) policy failures and (3) broader socio-economic and political causes.

Market failures: Market failures have been identified as one of the disincentives to managing forests sustainably. With distorted or malfunctioning markets, prices do not necessarily reflect the actual social and environmental values of the resources (Pearce et al. 1990; Perman et al. 1996; Richards and Costa 1999). In Indonesia, even the most commercialized forest products, such as timber, have been undervalued as the domestic market for roundwood has been protected; this is reflected in the stumpage fees and obligatory reforestation fund payments set by the government (Scotland 2000). With an abundant supply of illegal logs the value of timber is even further reduced; this provides no incentive to conserve forest resources and leads to deforestation.

Policy failures: Policy failures occur when the policies implemented create disincentives to sustainably manage the resource and further distort market prices (Richards and Costa 1999). There are at least five policy-related issues that can be identified as major causes of deforestation in Indonesia:

(i) *Logging policies:* Logging companies' irregular management of their concessions and the short-term investment period are due to the 20-year logging permit granted to concessionaires (Sunderlin and Resosudarmo 1996). This is a disincentive for companies to implement enrichment planting.

(ii) *Failures in rehabilitation by HTI: (see iv) companies resulting in more abandoned land:* Many companies were more interested in clear-felling of the remaining standing stock, instead of developing timber plantations under the HTI programme. This was mainly due to disenchantment, resentment and conflict with local communities over forest resources as well as competition for land during the development of oil-palm plantations. Furthermore, local governments at the district level are more supportive of private investments in oil-palm plantations because they perceive them as local government revenue sources.

(iii) *Premature decentralization and inadequate capacity of local government and District Forestry Services:* This has contributed indirectly to forests being managed unsustainably for the last ten to 15 years, resulting in an increase in degraded forest (Casson 2001; Obidzinski and Barr 2003). Continued illegal logging and forest encroachment have been a serious problem since the implementation of regional autonomy under the district governments, particularly in provinces with a high proportion of natural forest.

(iv) *Transmigration policies:* The transmigration policy, implemented intensively during the 1970s, reallocates people from high-density areas, such as Java, to other low-density islands. Transmigration has had three effects on forest cover on the outer islands: forest is converted for cultivation, new forest areas are opened up when cultivation on initially designated land is unsuccessful and transmigrants put pressure on the land and forests managed by local people (Sunderlin and Resosudarmo 1996). In 1985, the government also started the HTI Trans (Hutan Tanaman Industri Transimigrasi) programme to develop forestry plantations under partnerships between companies and transmigrants (Nawir et al. 2003). However, there is no clear indication that this programme has been successful (Potter and Lee 1998; Barr 2001).

(v) *Policies result in higher risks as logged-over areas become 'open access':* Two main policies contributed to more open access. First, the unclear status of revoked concession areas frequently left the question hanging as to who was responsible for rehabilitating these logged-over areas after the concession rights had been revoked. As often occurs in the field, this ambiguity rendered these areas common property and anyone could go in and convert them to non-forestry purposes, such as agriculture. However, as commonly perceived, the rights attached to the IUPHHK (Ijin Usaha Pemungutan Hasil Hutan Kayu) or licence to collect timber refer more to utilization (or exploitation) than to the broader area of management, which includes the responsibility to rehabilitate the former logging areas.

The second is the discontinuity of rehabilitation policies, in particular the rehabilitation programme assigned to state-owned companies. An example was the case of 5.5 million ha of degraded forest land being assigned to state-owned companies, Inhutani I to V (Nawir et al. 2007c), to be rehabilitated. This resulted in waste of government reforestation funds as no end outputs were ever produced. Further, the areas that had been allocated under the programme were abandoned and became open access lands.

3.1.3 Broader socio-economic and political causes

One example of broader socio-economic causes is economic crisis. The economic crisis that hit Indonesia in mid-1997 resulted in the loss of natural forest cover (Sunderlin et al. 2000). This finding was based on the responses of 68 percent of those interviewed, who had cleared new land during the crisis period. The category of 'land cleared' included primary forest, which ranged from 2.8 to 46.2 percent of the total areas in the provinces of Riau, Jambi, Lampung, West and East Kalimantan and Central Sulawesi. Consequently, forest encroachment has also become a serious problem, particularly in areas where the competition for land use is high. One farmer may only clear a small area of land to practise shifting agriculture, however, the net impact of many farmers can be very damaging to the natural forests (Scotland 2000). The encroachment problem is also a sensitive issue, as it often involves people who are poor and rarely have other income options. Forest encroachment is still the biggest problem in forest management, as well as forest rehabilitation and landscape restoration (Nawir et al. 2007a; Wibowo 2013). However, lack of records makes it difficult to estimate the magnitude of the areas being encroached.

4. Impacts of forest degradation

The increasing rates of deforested and degraded land have major consequences for the national economy, community livelihoods, as well as global forest biodiversity and GHG emissions. The most significant impact on the national economy has stemmed from diminishing timber production from natural forests. For example, timber production in 2012 was only 15 percent of that in 1992 and was produced by fewer concessionaires (294) on 23.90 million ha (Soeprihanto 2013). This was also reflected in productivity that declined to 0.23 m^3/ha/year in the same year from 0.61 m^3/ha/year in 1992 (Soeprihanto 2013). In addition, there have been losses due to illegal logging that accounted for about IDR30 trillion per annum as estimated in 2004 (Minister of Forestry, Kaban in Tempo newspaper, 14 November 2004 in Nawir et al. 2007b). This has affected government revenues as well as Reforestation Funds (Dana Reboisasi – DR) paid by concessionaires for each cubic metre logged. Reforestation Funds are used mostly to fund forest rehabilitation programmes. The total government budget spent on rehabilitation projects may account for as much as 85 percent of the total government forestry budget since the start of the early programme in 1976/1977 (H. Pasaribu, personal communication, 2004 in Nawir et al. 2007b). This has significantly reduced the forestry budget for other uses. For example in 2003, the total target area was 3 000 000 ha with a total allocated budget of IDR5.9 trillion (± US$670.6 million) (Ditjen RLPS 2003, 2004). In the same year, the programme focused on rehabilitating 17 catchment areas over the following five years and had an estimated total budget of US$1.6 billion (Baplan 2003).

Forests in Indonesia are home to 16 percent of the world's bird species, 11 percent of the plant species and 10 percent of mammal species (FWI/GFW 2001). It is estimated that 20-30 percent of Indonesia's biodiversity is lost every year, which also includes mammals, such as orangutan, elephant and tiger (Ministry of Environment 2008). Other ecological impacts include soil erosion, degraded watersheds, vulnerability to fires during the drought season and high probability of severe floods during the wet season. It was estimated that the economic costs of forest fires in 1997/1998 ranged from US$2.3-3.2 billion, and US$5.1-6 billion if carbon emissions are taken into account (FWI/GFW 2002; Tacconi 2003). All of these factors have caused a significant direct and indirect economic cost to society, not only in Indonesia, but also in neighbouring countries and at the global level. At the local level, forest and land degradation has directly or indirectly disrupted the livelihoods of 10-20 million forest-dependent people in Indonesia. (FWI/GFW 2002). Other estimates suggest between 6-30 million people have been affected (Sunderlin et al. 2000). Important forest products and services used by local people have been impacted due to biodiversity losses and the destruction of ecological systems including most non-wood forest products (NWFPs) important for local livelihoods.

Deforestation and land degradation in Indonesia have contributed to global GHG emissions and the country is one of the world's ten largest emitters. In 2005, Indonesia's annual GHG emissions were 2.2 giga tons (Gt), expected to rise to 3.2 Gt by 2030 under the 'do nothing' scenario (Dewan Nasional Perubahan Iklim Indonesia 2010). FWI/GFW (2002) indicated that total intact forest vegetation in Indonesia produced more than 14 billion tonnes of carbon and was estimated to store about 3.5 billion tonnes of carbon. Forest restoration in Indonesia is not important just for the country's economy and local people's livelihoods, but also for the global climate.

5. Implementation of forest restoration and rehabilitation initiatives

5.1 History of initiatives, strategies and techniques

As mentioned in the introduction, during the last 50 years there have been 150 official rehabilitation projects in 400 locations nationwide. However, the number of projects only started to increase significantly during the 1990s and by 2004 they had doubled from that of the 1980s. This is almost certainly in response to the escalating rate of deforestation since the late 1990s, and with few, if any, earlier rehabilitation projects showing positive results. The history of project initiatives can be understood by assessing the major policies driving the initiatives.

5.2 Major policies influencing rehabilitation initiatives in the New Order Era

Since the beginning of the New Order Era in 1966, 12 major forestry policies have directly and indirectly influenced different rehabilitation initiatives in Indonesia (Figure 1).The two most important policies are:

(1) The forest land classification system of the Forest Land Use by Consensus (*Tata Guna Hutan Kesepakatan-TGHK*) that aimed to better target rehabilitation in state forests, 1984

The Provincial Regional Spatial Management Plan (*Rencana Tata Ruang Wilayah Propinsi – RTRWP*), produced in 1992, complemented this policy.

(2) Reforestation Funds (RF) for implementing state forest rehabilitation programmes

The Reforestation Guarantee Deposit Fund (*Dana Jaminan Reboisasi – DJR*) was introduced in 1980 and renewed in 2002 under Dana Reboisasi or Reforestation Fund (RF) Management regulation PP No. 35/2002. In relation to the RF, two important initiatives funded by this fund as discussed here are: (a) Industrial Plantation Forest (*Hutan Tanaman Industri – HTI*) that was initiated in 1984, and then formalized in PP No. 7 published in 1990; and (b) state forest rehabilitation programmes implemented by state-owned companies. These two policies are discussed further below and the major policies in the Reformation Era and under regional autonomy are given in Section 5.4.1.

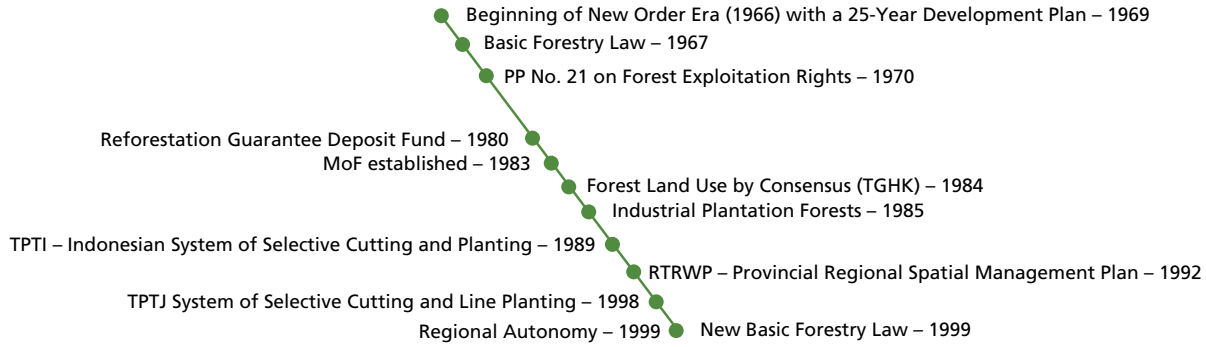


Figure 1. Timeline of major policies influencing rehabilitation initiatives during the New Order Era

Source: Adopted from Nawir et al. (2007c).

TGHK policy: The 1980s was a very important period in the development of rehabilitation programmes. Once the MoF became an independent ministry in 1983 (separated from the Ministry of Agriculture), it began to manage rehabilitation intensively. Rehabilitation programmes were mainly developed based on the forest land classification of 'state forest' for reforestation and 'outside state forest' for afforestation. It is perceived that the differences between reforestation and afforestation relate only to the status of forest, i.e. state forest as opposed to outside state forest, thereby defining the jurisdiction of the government agencies responsible. Afforestation is defined as any effort to rehabilitate critical areas on community land outside state forests through vegetative and 'civil structure' techniques, which aim to restore the functions of the land. Afforestation focuses on prioritized critical areas on community land. Since 1998 (the beginning of the Reformation Era), community involvement and participation have been important aspects of the approaches to implementing afforestation. However, since the 1990s, community participation has been promoted as part of the concept of developing rehabilitation programmes, but actual participation and roles in the implementation have been limited.

Reforestation is defined as any effort to rehabilitate degraded forest areas inside state forests that were formerly barren land, *Imperata* grassland or shrubland, with the aim of restoring the functions of the forests through replanting. Reforestation focuses on priority watersheds in protection forests and production forests where no concession rights have been granted

(Hutan Produksi yang tidak dibebani hak) with the objectives of increasing forest cover, and taking a participatory approach in providing benefits to local people. For production forests with rights granted, the responsibility for rehabilitation is in the hands of those who have the rights and pay taxes to the Reforestation Guarantee Deposit Fund (Dana Jaminan Reboisasi). The main rehabilitation activity under reforestation is replanting with forest tree species and trees that provide livelihood benefits (tanaman kehidupan), the latter mainly comprising multipurpose tree species (MPTS).

The MoF further classifies initiatives in state forests based on production forest, protection forest and conservation forest as included in the forest classification of TGHK in 1984. A fifth category inside state forest, 'conversion production forest', was adopted in the late 1980s to cover degraded forest land designated for permanent conversion to other uses (Barber 1997).

In 1990 the TGHK was overlaid with the RTRWP – the spatial management plan related to provincial land areas – to further elaborate the Spatial Management Act of 1992 (Kartodihardjo and Supriono 2000). According to the RTRWP, the spatial classifications were protection forest and forest land cultivation area. Since 1993, the two functional land classification systems have been integrated. The forest classification is useful when initiatives are being planned because it helps planners to clearly define the different objectives (single or multiple objectives) of the rehabilitation initiatives to be implemented in the different forest areas. For example, in production forests, the rehabilitation initiatives permit the felling of trees as harvestable products (but there is no access yet for communities), while in protection forest or conservation areas, it is not permitted to fell trees and harvestable products are limited to NWFPs (see Table 4).

Table 4. Government forest classification and its rehabilitation approaches

Classification of forest area	Causes of deforestation	Rehabilitation approaches and technical methods	Objectives	Institutional arrangement	Land tenure	Actors involved
Production forest (limited and permanent production forests)	Overlogging & illegal logging, land claims, forest fires	Establishment of HTI, enrichment planting, replanting of logged-over areas in the Selective Felling and Planting System (TPTI) mechanism, small-scale plantations, and assisted natural regeneration (ANR)	Commercial, increase forested areas & fire prevention	Concessionaires' rights, management rights given to tree grower cooperatives, companies and communities	State land	Private and state companies, forestry services, communities
Protection forest	Encroachment, forest fires, illegal logging, population pressures and mining	Community forestry programme and watershed management by developing agroforestry and payments for ecosystem services (water)	Improve and maintain the hydrological functions of watersheds and ecosystems	Communities given management rights and access to NWFPs, with NGO facilitation	State land	Forestry services, communities, NGOs
Conservation forest	Encroachment, illegal logging, forest fires, population pressures	Creating buffer zones and watershed management by developing agroforestry with no timber harvesting, conducting enrichment planting, preferably with endemic trees and/or fodder trees	Conserve biodiversity flora, fauna and ecosystems and ecotourism	Communities given management rights and access to NWFPs, with NGO facilitation	State land	Forestry agencies, communities, NGOs
Special purpose forest	Encroachment, illegal logging, population pressures	Enrichment planting, community forestry	Improve ecological functions, conserve biodiversity, increase forest cover for R&D, education and training, as well as religion and culture	Management rights provided for public interest i.e. universities, R&D institutes and local communities	State land	Universities, research centres and local communities
Community land	Demand for increased productivity, inappropriate land use, population and market pressures	Private forest, partnerships, traditional forestry management by developing small-scale plantations and agroforestry	Income generation, improve land productivity, conserve water resources, hydrological functions of watersheds and ecosystems	Community manages the areas individually or in a group, with or without partnerships	Private and communal	Forestry services, communities, private and state companies

Sources: Mursidin et al. (1997); Baplan (2003); Ditjen RLPS (2003); Santoso (2005); Wibowo (2006).

Reforestation Fund (RF) policy: The policy of collecting RFs from concessionaires was established in 1980 under the Reforestation Guarantee Deposit Fund (Dana Jaminan Reboisasi – DJR), with the aim of promoting better management of production forests (Otsamo 2001; Oka and William 2004). The concessionaires are required to pay certain refundable 'deposits' defined for each cubic metre logged based on timber species and the location of the logging area. Currently DJR is non-refundable and has become the highest tax in the timber industry (Barr 2001). The DJR has been used for implementing several government programmes (Iskandar et al. 2003):

1. From 1989 to 2000, the funds were used mainly for plantation development.
2. In 1995/1996, most private and state companies (Inhutani I to V), which participated in plantation development and received their funds from the government through a soft loan mechanism, were not focused on degraded forests.
3. In 1995/1996, the funds were also used to support the Farm Forestry Credit Schemes.
4. Since 2001, these funds have also been used to finance the Specific Allocated Funds, Reforestation Funds (DAK-DR) programme, and since 2003, five-year programmes such as GN-RHL/Gerhan.

The establishment of HTI areas is an activity that will continue to be supported through the RF. According to this government regulation, RFs are to be deposited into the Central Government Account (Kas Negara) under the control of the Minister of Finance. HTI developed by private companies and the State Forests Rehabilitation Programme implemented by the state-owned companies are two important programmes funded by the RF.

5.3 Industrial timber plantations (HTI)

The development of fast-growing plantations has become the main approach of rehabilitation programmes for *Imperata* grasslands since 1988 (Potter and Lee 1998; Otsamo 2000). The underlying concept was to replace forest vegetation, remaining standing stock of less than 16 m^3 per ha, scrub or *Imperata cylindrica* with forest plantations (Haeruman 1993). However, it is important to note that not all forestry plantation development programmes in production forest are aimed at rehabilitating degraded forest. A package of incentives was provided by the government to develop large-scale HTI, including interest-free loans, start-up capital for joint ventures with state forest companies, low property tax, the right to clear remaining trees in concession areas etc. (Haeruman 1993; Sudradjat and Subagyo 1993; Hasanuddin 1996; Potter 1996; Potter and Lee 1998; Otsamo 2000).

In 2000, the Directorate General of Forestry Production Management (Bina Produksi Kehutanan – BPK) produced a regulation, based on Ministerial Decree No. 10.1/Kpts-II/2000 dated 6 November 2000, to give HTI rights only on non-forested areas of production forest (Ditjen BPK 2000). Following this regulation, BPK produced the 'HTI Development as Part of the Reforestation Programme' Action Plan. Since 2002, HTI development has been prioritized on 2.6 million ha of barren, degraded production forest in ex-HPH areas, in which natural succession is not possible. The second priority is to implement reforestation inside active HPH areas covering 11.6 million ha (Departemen Kehutanan 2002). It has been pointed out that the funding for new HTI companies should come from private investment and not from the RFs. By developing plantations, the objective of rehabilitation has not focused on restoring the forest, but more on improving the productivity of the degraded forest areas, since HTI development makes intensive use of fast-growing exotic species, such as *Acacia mangium*.

5.4 State forest rehabilitation programmes implemented by state-owned companies

In 1995/1996 the MoF assigned the state companies Inhutani I, II and III and formed Inhutani IV and V to rehabilitate logged-over areas in Sumatra, Kalimantan and Sulawesi. As state-owned companies, they are intended to be profitable, and they act as government partners to support national development and forestry management, with the core business of logging and timber plantation development. However, in 1998 the MoF did not release a budget for this programme; an official decision was then made in 1999 to revoke the rehabilitation assignment by the end of 2002/2003 (date of closure varied from company to company) (Directors and staff of Inhutani, pers. comm. 2004). From 1995/1996 to 1998 there was little progress in the state companies' rehabilitation activities and social problems occurred in some of the rehabilitated areas. The transition from a centralized to a decentralized forestry management policy in 1999 created a conflict of interest and uncertainty regarding law enforcement. The assigned areas were returned to the MoF, who handed the areas over to the provincial government to manage. With no budget allocated to the provincial government in conjunction with the responsibilities, due to lack of funding and human resources to at least supervise the areas, these areas then became open access and have been subject to illegal logging. This has led to further increase in degraded forest areas.

5.4.1 Rehabilitation programmes during the Reformation Era and regional autonomy

The master plan for forest and land rehabilitation: The MP-RHL was developed in 2000 with the objective of providing the basis for planning rehabilitation programmes and activities that could be integrated, transparent, participatory and based on local regions' aspirations and uniqueness (Baplan 2003). By 2004, 28 provinces had finished their Regional Master Plans, and 16 of these had been approved by the provincial head and were referred to in the implementation of the rehabilitation programme (Baplan 2004). Consistent with the national forest rehabilitation programme, the Master Plans use watersheds as the unit of coverage.

The national movement for forest and land rehabilitation (GN RHL/Gerhan): Under direction from the three Coordinating Ministers of People's Welfare, Economics, and Politics and Security, the MoF initiated the GN RHL/Gerhan programme in 2003/2004 to 2007/2008 in response to the need to rehabilitate the increasing number of degraded areas. GN RHL/Gerhan focuses on generating people's involvement in forest and land rehabilitation by involving them in planting and maintenance. The programme is considered to be a strategic national initiative to restore and improve the function of forests and land, with the aim that eventually the carrying capacity of the forest, its productivity and roles can be maintained to provide services for people (Wibowo 2006).

The GN RHL/Gerhan programme was claimed to be a moral movement to invite people's participation in forest and land rehabilitation activities (Santoso 2005). The total target area was 3 million ha with a total planned budget of IDR5.9 trillion (± US$670.6 million) (Ditjen RLPS 2003, 2004). The target areas were located in 236 districts, in 68 priority watersheds in 27 provinces. The priority areas are critical watersheds with critical levels of degraded forest and land, vulnerable to natural disasters and with a low area of forest cover.

In December 2006, the President of Indonesia launched the Indonesian Movement for Forest and Land Rehabilitation. This national strategy includes a policy and programmes designed by the MoF to involve local communities in commercial forestry. Its aim was to enhance community involvement in commercial forestry across 1.2 million ha by 2009 and 5.4 million ha by 2016. As a result of the President's declaration, the MoF has prioritized Community Based Forest Management (CBFM) in the ministry's strategic policy for forestry development, noting that CBFM could significantly assist national efforts to reduce poverty amongst rural communities in the surrounding forest areas.

6. Recent initiatives

Taking into account past experiences (failures) a more landscape-based and integrated approach has been introduced through FLR and FMU that involves communities actively. This has been highlighted in various programmes such as HTR and HKm.

FLR: This is implemented in many different forms that encompass the tree planting movement, industrial forest plantation, conversion to agricultural crops and ecosystem restoration and reclamation of post-mining activities. Consequently, coordination and data collection regarding implementation of FLR are scattered. While actors for FLR come from various sectors and across levels of government, coordination at the central office remains a challenge because of bureaucratic governance.

Tropenbos Indonesia (TBI), a Dutch-funded NGO, has established a network for landscape restoration called MASBENI (Landscape Community of Indonesia). This network has recently developed principles and guidelines supported by the International Tropical Timber Organization (ITTO) and the World Conservation Union (IUCN). The guidelines will be widely disseminated and led by TBI to promote productive landscapes for food and water availability to primary stakeholders – those who live and depend on the land. This activity is currently globalized in a global FLR network called GPFLR - Global Partnership on Forest and Landscape Restoration (www.ideastransformlandscapes.org). Forest landscape restoration is also organized by local communities and other pilot projects on a smaller scale. NGOs and universities in Indonesia, with support from state and foreign funding, have implemented pilot projects for forest rehabilitation and post-mining reclamation.

The FMU: This is a regional-management unit of forest areas that ensures that economic, environmental and social functions are sustainably managed. Management covers four main activities: forest utilization, forest rehabilitation and reclamation, as well as community empowerment. The plan is to establish 120 FMUs by 2014 that will lead integrated management on the ground.

Community-based forestry plantations (Hutan Tanaman Rakyat – HTR): This programme and the Village Forest Scheme (Hutan Desa) were formalized in 2009 (MoF 2009). The HTR's aims are for communities to develop commercial timber plantations similar to the Industrial Timber Plantation Scheme developed by private companies under HTI. The MoF sees the potential of small-scale plantations under HTR as a means to alleviate poverty ('pro-poor'), create new employment opportunities ('pro-job') and improve the distribution of economic growth among different stakeholder groups ('pro-growth').

Community forestry (Hutan Kemasyarakatan – HKm): HKm is one of several government-initiated programmes implemented since the early 1980s to involve communities in state forest management for a certain purpose, such as forest conservation or rehabilitation (MoF 2002; Hindra 2005). Since inception, the approaches, types and levels of community participation have been evolving under the influence of the government's policy orientation, such as the decentralization policy implemented since 1999 (Colchester 2002; White and Martin 2002; Safitri 2006). Under this scheme, rights are granted to cooperatives in the form of a Community Forest Concession Permit (Ijin Usaha Pengusahaan Hutan Kemasyarakatan – IUPHKm). Any tree planting as part of forest rehabilitation is usually developed as part of intercropping practices.

Village forests (Hutan Desa – HD): As with HKm, the government also gave village forest management rights (HPHD) in protection and production forests to rural institutions (LKMD, LMD etc.), and this is stipulated in MoF Decree No. P.49/Menhut-II/2008. HD aims to allow local communities, through village institutions, to utilize forest resources sustainably as a means to improve their welfare. Permit holders in protection forests may manage the area's ecosystem services and collect NWFPs. Production forests can be utilized in the same way as protection forests, but this can be coupled with harvesting of timber and NWFPs.

Ecosystem Restoration (Restorasi Ekosistem – RE): As regulated in MoF Regulation, Permenhut No. 6/Menhut-II/2007 with regards to Regulation No. 3/Menhut-II/2008, Ecosystem Restoration is an attempt to develop and improve the quality of natural forest inside production forest while maintaining important ecosystem functions (Arlan 2013). Efforts could also include planting, enrichment planting, thinning, animal breeding, re-introduction of flora and fauna to restore biological elements and addressing non-biological elements (soil, climate and topography) so as to restore biodiversity and ecosystems to their initial condition. Rights to implement RE can be granted to cooperatives, individuals and private- and state-owned companies. Up to 2013, the MoF has allocated up to 2.70 million ha via MoF Decree No. SK.5040/Menhut-VI/BRPUK/2013 in Sumatra, Nusa Tenggara, Kalimantan, Sulawesi, Maluku and Papua (Arlan 2013).

7. Technical approaches

In understanding the historical context it is important to review soil and water conservation; tree planting, enrichment planting and ANR; and watersheds as the unit of management and focus of the rehabilitation initiatives.

Soil and water conservation: Soil and water conservation has been defined as efforts to maintain, rehabilitate and increase land-use capacity according to the land-use classification (Mursidin et al. 1997). The main objectives were to maintain the forest hydrology through soil and water conservation and forest regeneration, based on the taungya system.

Tree planting, enrichment planting and ANR: Reforestation programmes defined the forest rehabilitation approaches and technical intervention methods as: tree planting (monoculture, mixed tree planting and intercropping), enrichment planting and ANR. Afforestation (penghijauan) or land rehabilitation was carried out via a range of technical approaches such as tree planting on degraded community land, developing demonstration plots, implementing conservation farming, enhancing private forest development and expanding the roles of forest extension workers by establishing Forestry Extension Field Officers (Penyuluh Kehutanan Lapangan – PKL). Technical intervention in afforestation/land rehabilitation focuses on the application of soil and water conservation methods by combining vegetative and physical-mechanical or civil structure techniques (Table 5).

Watersheds as the unit of management and the focus in rehabilitation initiatives: Throughout the history of rehabilitation, watersheds have often been the unit of management. The use of the watershed as the unit of planning for natural resource management was formalized in 1988 as part of the national development strategy; this has increased and clarified the role of the watershed (Baplan 2003).

Table 5. Technologies and species used in different rehabilitation approaches

Rehabilitation approach	Technical method	Species used
Industrial Plantation Forest (HTI)	Planting; ANR	*Acacia mangium, Acacia auriculiformis*, teak (*Tectona grandis*), mahogany (*Swietenia macrophylla, Swietenia mahagony*), peronema (*Peronema canescens*), eucalyptus (*Eucalyptus* spp.), *Gmelina arborea*, damar (*Agathis borneensis*), pine (*Pinus merkusii*), meranti (*Shorea* spp.), perupok (*Lapopetalum* spp.) and merbau (*Intsia bijuga*)
Community forestry, reforestation programme via agroforestry	Planting; enrichment planting; terracing on sloping areas	Mahogany, teak, rubber (*Hevea brasiliensis*), candle nut (*Aleuritus moluccana*), cashew nut (*Anacardium occidentale*), falcata (*Paraserianthes falcataria*), petai (*Parkia speciosa*), breadfruit (*Artocarpus brasiliensis*), jackfruit (*Artocarpus heterophylla*), tengkawang (*Shorea* spp.), jengkol (*Pithecellobium jiringa*), pinang (*Areca catecu*) and gamal (*Gliricidia sepium*)
Farm forestry (small-scale plantation)	Planting; enrichment planting; simple terracing (guludan)	Falcata, teak, mahogany, tamarind (*Tamarindus indica*), damar (*Shorea javanica*), durian (*Durio zibethinus*), gambir (*Uncaria gambir*), cashew nut, jengkol, petai, melinjo (*Gnetum gnemon*), jackfruit, morinda (*Morinda citifolia*), breadfruit, candle nut, mango (*Mangifera indica*) and cassiavera (*Cinnamomum burmani*)
Watershed protection	Planting; terracing; planting along contours; grassing slopes; building waterfall channels, checking dams, gully head structures and gully plugs; stream-bank protection	Teak, mahogany, durian, falcata, cashew nut, mango, rambutan (*Nephelium lappaceum*), annual crops: maize (*Zea mays*), rice (*Oryza sativa*), beans (*Glycine max*) and grasses for livestock fodder

Source: Murniati et al. (2007).

8. Economic assessment of different possible forest rehabilitation strategies

A significant amount of government budget has been used for forest rehabilitation in various locations and conditions. While there has been no actual assessment of the cost effectiveness of various programmes, comparison of several government-based strategies can assess standard financial costs set by the government and paid by a private company (Table 6). The highest cost per hectare is for mining reclamation ranging from US$1 500 to US$2 000 (Sunandar 2013), and the lowest is for a community forestry scheme (HKm) at US$60 per hectare, based on implementation in Jambi, West Kalimantan, West Nusa Tenggara and Southeast Sulawesi (Arlan 2013).

Table 6. Standard costs per hectare for forest rehabilitation and restoration strategies

Strategy	Standard costs (US$/ha)	Sources
1. Industrial Timber Plantation (HTI) and Community-based Timber Plantation (HTR)	666-12 111	MOF (2009)
2. Community Forestry Scheme (HKm)	60	Arlan (2013)
3. Deposit for mining reclamation	1 500-2 000	Sunandar (2013)
4. Restoration Ecosystem	1 400	Arlan (2013)

Based on the study conducted by CIFOR and the Forest Research and Development Agency (FORDA) that analysed rehabilitation costs based on sources of funding (Nawir et al. 2007c), the cost per hectare ranged from US$43 - 15 221, which was higher than the HTI plantations' standard cost of US$550 per hectare at the time of the analysis (2007). The HTI standard costs are commonly used in calculating the costs for implementing forest rehabilitation (Prasetyo et al. 2005).

Together, the significant amount of forestry budget allocated to rehabilitation initiatives, the small number of rehabilitated areas in major government programmes and high cost per hectare are a strong indication of the high cost of ineffective implementation of rehabilitation activities and therefore wasted budget. This is reflected in the amount spent on rehabilitation compared to the actual results. For example, the total allocated budget of IDR600 billion (US$68.3 million) resulted in only 19 percent of actual planted areas in the rehabilitation programmes implemented by state-owned companies on outer islands that initially aimed to rehabilitate 5.5 million ha (Nawir et al. 2007c). There has also been an indication of the misuse of IDR1 trillion (US$109.3 million) for non-rehabilitation purposes by district governments (Anonymous 2006).

9. Case studies

The two case studies illustrate the FLR approach and forest rehabilitation projects being implemented in the field. Despite many failures, the case studies positively indicate that restoring forest condition is possible with the collaboration of different stakeholder groups.

9.1 The FMU as an FLR approach: Sumbawa, Eastern Indonesia

The FMU concept fits well with the FLR approach. The FMU is loosely interpreted as a landscape platform with a certain ecological function in which:

- Conservation, rehabilitation and economic and sociocultural activities can be complementary in addressing ecological problems, as well as socio-economic and tenurial conflicts under integrated management; and
- Interaction among key stakeholders, including local communities, can bring about the required collaboration and resolve conflicts in a participatory manner for resource management.

The landscape platform as the basis for managing watersheds has been very effective in facilitating different projects (including forest rehabilitation and projects with focus on enhancing local community livelihoods) and implementation can be complementary. Since 2000, the MoF has piloted the FMU approach in 36 sites all over Indonesia, including Sumbawa District in West Nusa Tenggara Province (Kartodihardjo et al. 2011). Problems and threats to the implementation of FMU in Sumbawa District include: (1) how to manage protected forest while enhancing livelihoods; (2) ongoing forest encroachment; (3) illegal logging in state-owned companies; and (4) implementing forest rehabilitation in degraded areas while enhancing livelihoods.

As a landscape platform, complementary project activities can be implemented concurrently. Specific project activities include:

1) Timber and Non-Timber Products in an Integrated Production and Marketing System. This is an Australian Centre for International Agricultural Research (ACIAR)-funded project and coordinated and implemented jointly by CIFOR and the World Agroforestry Centre (ICRAF). The main activities include: integration of timber and NWFP production systems to enhance local livelihoods, enhancing marketing strategies and value chains to improve timber and NWFP market links for smallholders, improving policy frameworks to facilitate smallholder production and integrated marketing of timber and NWFPs, enhancing expansion of smallholder-managed integrated timber and NWFP production systems through extension programmes.
2) Permanent sampling plots for carbon, implemented in protected forest (the secondary forest ecosystem) with tengkawang (*Dipterocarpus retusus*) as the dominant species. This is part of an integrated watershed management approach and implemented in collaboration with FMU staff and the local community.
3) Other projects include protected forest rehabilitation and improving NWFP management.

The development of a detailed plan for the FMU consists of different stages: preparing the management plan (including site preparation, planting, maintenance, harvesting and marketing); setting up baseline data and monitoring mechanisms and procedures; setting up an agreed revenue sharing system, in particular between community groups and the government if the project site is located in state forest; and ensuring enabling conditions required for the sustainability of the project are identified and prepared, such as appropriate institutions and regulations and ensuring continuous community support for conservation efforts.

The FMU approach has been implemented since 2008 in Sumbawa and some noted potential impacts include:

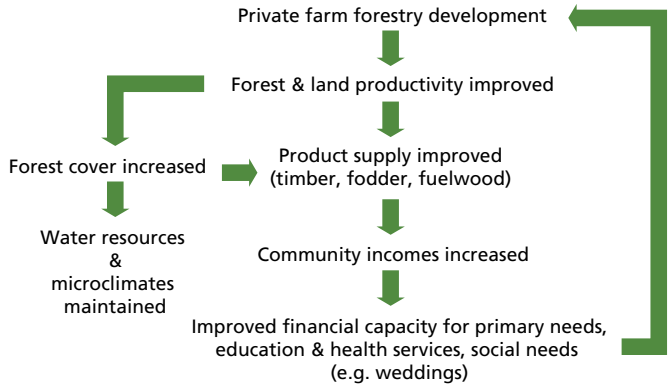
(1) Better integration of (external) intervention based on local priorities following strategic management plans developed by the FMU coordinator in consultation with wider key stakeholders, including local communities.
(2) Management of different ecosystems in different types of forest/lands (production forest and protected forest) aims to enhance/improve the carrying capacity of the watersheds (there are three rivers: the Brang Kerekeh, Ai Ngelar and Brang Pelat).
(3) Greater multiplier impacts by integrating different complementary activities from production systems to value chains to processing (e.g. forest honey is marketed through the Sumbawa Honey Forest Network or JMHS – Jaringan Madu Hutan Sumbawa in nationwide outlets such as Carrefour in Jakarta).
(4) Better understanding of different possibilities in optimizing complementary management between timber and NWFPs, as well as optimizing incomes in the household portfolio.
(5) Providing a place for other community groups to learn through cross-visits, including from other districts and provinces.

However some challenges need to be scaled up. At the local level they are: the need for delineation of production forest and community farming areas in resolving tenure conflicts; addressing the rapid increase of critical lands that affect the carrying capacity of the watershed; and the search for voluntary carbon markets and income from PES. Challenges at the national level include: (1) although supported by ministerial-level policy wider adoption of legislation is still uncertain, for example for commercial production forest, community forestry programmes and forest rehabilitation; (2) continuity of the pilot project beyond 2014 – the time frame decided by the MoF has not been discussed; and (3) implications for budget sharing between national and local government need to be discussed further.

9.2 Gunungkidul District in Yogyakarta

There are two interlinked subcases discussed here, which are complementary as they are implemented in the same district: (1) farm forestry (Hutan Rakyat) as part of the Forest Rehabilitation Project; and (2) the Learning Site at Wanagama, which is an FLR model.

Forest Rehabilitation Project – private forest (Hutan Rakyat): The most sustained rehabilitation projects are those activities that address the ecological problems that are relevant to the local people, in which significant economic impacts are subsequently generated as a result of the improved ecological conditions. One example is farm forestry in Gunungkidul, Yogyakarta, which has the highest area of forest cover and forest productivity (annual increment in tree growth). Successful farm forestry development in Gunungkidul has not only increased forest and land productivity, but also provided a supply of timber, fodder and fuelwood. Concomitantly, the increase in forest cover also has ecological benefits. This has increased water resources and likewise enhanced microclimates in the surrounding areas. As a result of improved household incomes, the community has better access to education, health facilities and even funding for social functions. On average, around 40 percent of the community's total household income comes from farm forestry. Continuous income has provided the incentives for the sustainability of local community rehabilitation initiatives. The flow of ecological and economic multiplier benefits is presented in Figure 2.



Resolving land and soil fertility problems that are important to local communities has resulted in the flow of ecological and economic multiplier benefits.

The teak here is growing successfully on stony farmland. (Inset: teak logs ready for sale.)

Figure 2. The flow of ecological and economic multiplier benefits

Understanding the flow of goods, services and the multiplier effects from the ground up has provided valuable lessons for improving the design of rehabilitation activities. Considering the overall integrated economic, ecological and social aspects, scenarios for multiplier effects can be embedded in the project design as target impacts to be achieved by the projects within a reasonable and clear time frame. These will underlie the process of defining the project strategy and approach. Applying the most suitable technical intervention that fits with the underlying problems of degraded areas is important for significant ecological impacts to be achieved. More sustainable economic and livelihood benefits can be generated from ecological improvements in the long term, beyond the project period. However, most projects tended to generate short-term cash incomes for the communities involved, mainly from project-based employment opportunities such as manual labour in the transplanting of seedlings.

An FLR model – Learning Site at Wanagama: Wanagama in Gunungkidul, Yogyakarta represents an FLR model, literally from bare land to forest. This model was established in 1964 with an initial stage of only one compartment of highly degraded forest covering an area of 10 ha. In 1983 the area was expanded under a trust given by the national government to the Faculty of Forestry, Gadjah Mada to rehabilitate a further 80 ha of highly degraded forest. To date this educational forest has grown to its current stage covering more than 535 ha.

The objectives of this forest are to provide educational forest for students from the Faculty of Forestry, Gadjah Mada University, to study and address the issue of highly degraded and critical land that exists in the southern part of Yogyakarta, and the application of research into practice. The small laboratory has grown very slowly into its current state, but the lessons learned from it have inspired the local community to follow them. Gunungkidul District in the 1970s to 1980s was known for being barren land. Now the community can enjoy the green landscape with not only the timber produced from it, but also most importantly more food and water.

The success of the establishment of Wanagama is attributable to the application of technical/biophysical and social approaches. Given the harsh conditions of the area during the initial stage of the rehabilitation process, legume species were used to improve the soil as part of the biophysical approach. As part of the social approach the community planted

medicinal plants and fodder for livestock and practised animal husbandry – sericulture, poultry raising and aquaculture. The social approach proved to be more important in determining success than technical and biophysical aspects.

Wanagama is now green and its success has inspired neighbouring villages, subdistricts and districts to follow suit. Investments are characterized by labour and informal workers such as food stall owners and side street vendors working in Jakarta and investing in trees in their hometowns. Java is now a source of domestic timber with higher production than the state-owned timber company, Perhutani.

10. Looking forward

Forest rehabilitation activities in Indonesia have a history of more than three decades. The development has been dynamic and complex due to complicated and interrelated aspects that may well influence the effectiveness and the sustainability of rehabilitation initiatives now and in the future. Conditions for success and the proposed national strategy for landscape restoration are discussed here.

10.1 Conditions for success

Reforming the funding mechanism policy to avoid project-oriented funding mechanisms: In view of the classic problems of project-oriented funding, the policy governing funding mechanisms urgently needs to be reformed. The funding for forest and land rehabilitation activities needs to be a multiyear system, less bureaucratic and adjusted to the planting seasons and local conditions. Budget approval should be given for at least five to ten years and integrated into rehabilitation planning.

A clear mechanism for the utilization of products obtained from rehabilitation programmes is also urgently needed for both the government and communities. This should provide long-term sustainable funding of the initiative's post-project activity. Equally, new funding mechanisms for forest and land rehabilitation initiatives should be explored – whether policy could be oriented to provide incentives for private sector involvement or an alternative approach such as the Collaborative Forest Management Project. Lastly, rehabilitation efforts should be viewed not so much as 'cost centres', but as 'revenue centres'. Forest and land rehabilitation activities would then involve multistakeholders based on a cost-sharing and risk analysis.

Addressing the causes of deforestation and degradation inclusive in the design of the rehabilitation initiatives: Identifying the direct and indirect underlying causes of land and forest degradation should be conducted during the preliminary planning stage. This would of course include detailed planning of how these would be addressed in the initiated projects. By understanding the flow of goods, services and the multiplier effects from the ground up, the design of rehabilitation activities could be greatly improved. In addition, applying the most suitable technical intervention that fits the underlying problems of degraded areas is important, so significant ecological impacts can be achieved.

Ensuring the economic feasibility of the rehabilitation initiatives: Short-term cash incomes for the communities involved are generated from project-based employment opportunities, mainly via manual labour for planting seedlings. To ensure long-term economic benefits, a number of economic aspects should ideally be integrated into project designs. These could include: incentive mechanisms designed to encourage community participation; the definition of a marketing strategy in the planning process; a financial analysis conducted prior to project implementation as well as designing mechanisms for re-investment; cost and benefit sharing for stakeholders; and reaching out to ensure economic impact for marginalized groups. The importance of the government's role in creating the right incentives for community initiatives cannot be emphasized enough. However, the role of the government should be that of facilitator only, e.g. it is crucial that the government (local government, and local government with support from central government) should respond to the local initiatives by providing the right policy framework. For optimal livelihood impacts, attaching rehabilitation initiatives to other ongoing project developments, as part of integrated strategic planning directed by the local government, may well be the key to this situation.

Actively involving local communities is perceived, without doubt, to be key to the most promising approach in implementing rehabilitation initiatives and can effectively build the social capital that will ultimately address the underlying causes of deforestation and degradation, e.g. preventing illegal logging and forest encroachment. In order to increase community participation in the implementation of rehabilitation initiatives inside state forest, there should be a clear mechanism, and an agreement, for the government and communities to utilize products resulting from rehabilitation activities. This would create incentives for greater community participation and provide sustainable funding after the project term. Further, a mechanism for sharing the costs and benefits among stakeholders should be formed, particularly in securing community commitment. Specific types of incentives and conditions to be considered are: subsidies and direct assistance (non-monetary), subsidies (as revolving funds), credit schemes through cooperatives, markets for NWFPs, extension programmes, revenue sharing agreements etc.

Institutional arrangements and clearer ownership are needed for greater community participation: Equally, for greater community participation it is important to have: a local (or other) organization involved in the implementation of the rehabilitation activities, or alternatively, a newly formed community organization; programme(s) aimed at empowering the community's institutional and technical capacities to support the rehabilitation programme; and multistakeholder facilitation processes at various stages of the rehabilitation programme(s). Projects implemented on community land tend to have a higher success rate than those in state forest. Clearer ownership of the land and freedom from overlapping government policies are almost certainly playing a major role in this success. Clear land status means less conflict over land, a high level of community commitment to maintain the trees planted and a guarantee to community members that they will be able to harvest anything they have planted.

Ensuring adoption – addressing the gap in knowledge by understanding the determining factors influencing a community's adoption behaviour: Although extensive technical rehabilitation projects have been implemented, at the community level, there are still gaps in technical knowledge and very few of the different technical approaches, implemented on the ground, have been adopted. A preliminary assessment must be conducted to find the best technical interventions to suit the local ecological and social conditions as well as to meet the capacity and budget of the communities involved.

Long-term management planning of the rehabilitation project is needed to ensure sustainability: The process of defining the management framework should be a participatory process and involve all stakeholders. The most important conditions to ensure the sustainability of rehabilitation activities are: the activities must be long term and self-sustaining; the activities must be implemented in accordance with the terms of the project (no premature termination); the rehabilitation programme corresponds with and is integrated into regional spatial planning (rencana tata ruang wilayah); plans are made for long-term monitoring and evaluation; a feedback mechanism exists; efforts are made to protect the rehabilitated areas from continuing local disturbances such as fires and grazing; infrastructure development is part of the rehabilitation programme; and informal land rights are recognized and formal landownership or occupation is revised.

Towards different scenarios for rehabilitating logged-over areas: It is best not to generalize rehabilitation efforts, even though they may be implemented within the same production forest or logged-over area. It must be realized that different baseline conditions would develop different rehabilitation scenarios. Baseline and external conditions may include population density, location of the area in terms of markets or economic activities and ecological or other disturbances affecting the rehabilitated area. Using baseline information, natural regeneration is an option for rehabilitating an area, which is isolated and both the population density and ecological disturbance are low. Under this scenario, no advanced technical intervention is required. However, it is essential to have good supervision and law enforcement to make sure the area is undisturbed for natural succession to occur. In the case of high continuing disturbances, ANR or enrichment planting could be undertaken if a good strategy is in place to manage the disturbances, which are often fires. Where population densities are high and a market is accessible, an integrated strategy to generate livelihood options and link up to the market should be considered. Alternatively, a small-scale plantation scheme, in collaboration with a private company, is the most promising approach to rehabilitate production forest (limited and permanent production forests).

Optimizing the decentralization policy: The decentralization policy, which also influences forestry management regimes, has been implemented since 1998. Despite the many drawbacks, the decentralization policy actually provides an opportunity for a new direction in designing a strategy for forest and land rehabilitation. Because local governments have better knowledge of their areas and their forestry management priorities, it is best if the local governments themselves (i.e. the forestry services at the provincial/district level) lead the process of designing the most appropriate local rehabilitation programmes. The central government, i.e. the MoF, would ideally act as a facilitator providing the necessary policy framework.

As an alternative to dominant government-based initiatives, it is often suggested that the government should focus on rehabilitation activities with no commercial objectives, such as inside protection forest. A community forestry reforestation programme that develops agroforestry with no timber harvesting and pays compensation for ecosystem services (e.g. water, ecotourism, reducing carbon footprints) resulting, from the community's efforts in maintaining the resources, is a possible option for protection forest. In conservation forest, efforts could be focused on creating buffer zones and watershed management by developing agroforestry with no timber harvesting, and conducting enrichment planting using endemic trees and/or animal feed plants.

Equally, state-owned and private companies need to be provided with incentives and clear supervision while implementing productive rehabilitation of logged-over areas. However, the redirection of the previous state-owned company's rehabilitation approach should be seriously and carefully considered. Of particular importance is the allocation of time for setting up institutional arrangements and conflict resolution with and among all stakeholders involved and interested in investing in areas for non-forestry purposes. Tax or DR exemption is a possible incentive that may well entice the private sector to implement direct rehabilitation activities in its concessions.

10.2 National strategy for forest and landscape restoration

The implementation of FMU, primarily using a landscape-based management approach and the inception of an FLR initiative provides a good starting point in promoting the implementation of FLR in Indonesia. Moreover, lessons learned from the Global Partnership on Forest Landscape Restoration increase the technical discussion on the importance, interests and global nature of landscape restoration.

The success of FLR requires a reform with more flexible forest regulations and governance compared to the highly regulated regime implemented over the past four decades, particularly during the authoritarian Suharto era. The reform government post-Suharto has yet to fully accept the concept of a productive landscape due to jurisdictional ownership among sectors. Implementation of agroforestry for example has been challenged by such jurisdiction rivalry, rather than synergy for improved landscape productivity.

Another condition for success is the availability of investment funds for restoration and removing negative perceptions of the forestry sector. If we use the term 'forest' in landscape restoration, participation of other sectors is limited due to the past negative perception of the forestry sector. The general perception is that the forestry sector has failed to protect the forest and to fairly distribute the benefits, yet the attitude towards maintaining forest jurisdiction above functionality remains. It is for this reason that MASBENI intentionally removed 'forest' from the title of Forest Landscape Restoration to attract more collaboration and to create a more inclusive institution.

Investment for landscape restoration is expected from the new and innovative REDD+, but the lengthy discussion of this concept has reduced the potential of addressing global climate change because of the 'low hanging fruit' expected from it.

With no global investment, the Wanagama case study suggests that local action and collaboration with local communities can successfully overcome the problem of investment. Other promising opportunities include the revitalization of the community-company partnership scheme, which the state-owned company, Perhutani, implemented in Java and private HTI companies in Sumatra and Kalimantan. Adoption of a community-company partnership scheme by other non-forestry companies offers a wider application of conservation efforts.

Synergy among sectors with strong leadership is vital for success in addressing massive forest degradation in Indonesia. Public awareness is now easily organized with numerous examples of forest-related disasters such as floods, landslides, drought and a lack of fresh water. The challenge is to organize public awareness across the country with differing degrees of deforestation and forest degradation and differing land suitability and imbalanced population distribution among the island-based community.

Global initiatives such as the Bonn Challenge will attract global investment for landscape restoration. If Indonesia participates in this global effort, not only could the image of Indonesia be improved, but also more economic activities could be generated. In the long term such initiatives could increase the services derived from forestry for the benefit of the wider community, beyond the forestry sector.

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References

Anonymous. 2006. Sekitar Rp 1 Triliun Dana Reboisasi salah sasaran (Rp 1 trillion of Reforestation Funds had been poorly targeted). ***Kompas, 8 July 2006,*** p. 17.

Arlan. 2013. ***Peran swasta dalam pembangunan Restorasi Ekosistem di Indonesia*** (Private sector role in developing Ecosystem Restoration in Indonesia). PowerPoint presentation at workshop on *'*Sistematisasi Peningkatan Produktvitas Hutan Melalui Program Restorisasi Bentang Alam Indonesia' or ' Systematisising the efforts in improving forest productivity through landscape restoration', Mataram, 5-6 December 2013. Direktorat Bina Rencana Pemanfaatan dan Usaha Kawasan, Direktorat Jenderal Bina Usaha Kehutanan (Directorate of Business Plan and Utilization, Directorate General of Forestry Enterprises), Jakarta.

Baplan. 2002. Database for MP-RHL (Master Plan - Forest and Land Rehabilitation), Baplan - Badan Planologi Kehutanan (Forest Planology Agency), Ministry of Forestry, Jakarta.

Baplan. 2003. ***Kebijakan penyusunan MP-RHL*** (Masterplan rehabilitasi hutan dan lahan). Baplan (Badan Planologi Kehutanan), Departemen Kehutanan dan JICA, Jakarta.

Baplan. 2004. ***Arah pembangunan sektor kehutanan dan butir-butir hasil ekspose MP-RHL Daerah*** (Directing the forest development and points resulted from expose on Master Plan on Forest and Land Rehabilitation). Presentasi disampaikan pada Ekspose MP-RHL Daerah, 8-9 Maret 2004 (Presentation at Master Plan on Forest and Land Rehabilitation, 8-9 March 2004, Baplan (Badan Planologi Kehutanan), Departemen Kehutanan (Planology Agency, Ministry of Forestry).

Bappenas. 2010. ***National REDD+ Strategy.*** Bappenas (Badan Perencanaan dan Pembangunan Nasional), Jakarta, Indonesia.

Barber, C. 1997. ***The case study of Indonesia, Project on Environmental Scarcities, State Capacity, and Civil Violence***. University of Toronto and the American Academy of Arts and Sciences. (Referred to in EDC News 2001-01), Toronto, (available at www.edcnews.se/Reviews/Barber1997.html).

Barr, C. 2001. ***Banking on sustainability: Structural adjustment and forestry reform in post-Suharto Indonesia.*** Washington, DC, CIFOR and WWF.

BPKH & MFP. 2009. ***Strategi pengembangan pengelolaan dan arahan kebijakan hutan rakyat di Pulau Jawa*** (Strategy for management development and policy direction for farm forestry in Java)***.*** Yogyakarta, BPKH (Balai Pemantapan Kawasan Hutan Wilayah XI Jawa-Madura - agency for resettling forest areas in Region XI Java and Madura) and MFP (Multistakeholder Forestry Programme).

BPS. 2013. ***Statistical yearbook of Indonesia 2013***. Jakarta, BPS (Biro Pusat Statistic) - Central Bureau of Statistics.

Casson, A. 2001. ***Decentralisation of policies affecting forests and estate crops in Kutawaringin Timur district, Central Kalimantan. Case Study 5. Case studies on decentralisation and forests in Indonesia.*** Bogor, Indonesia.

Center for International Forestry Research (CIFOR). 2013. Full text of President Susilo Bambang Yudhoyono's decree on Indonesia REDD+ agency. CIFOR Blog (available at blog.cifor.org/19055/full-text-of-president-susilo-bambang-yudhoyonos-decree-on-indonesia-redd-agency).

Colchester, M. 2002. Towards community forestry in Indonesia. ***WRM Bulletin No. 63,*** World Rainforest Movement (WRM).

Contreras-Hermosilla, A. 2000. ***The underlying causes of forest decline.*** Occasional Paper No. 30, Bogor, CIFOR.

Departemen Kehutanan. 2002. ***Rencana aksi pengembangan Hutan Tanaman/HTI dalam rangka reboisasi***. Jakarta.

Dewan Nasional Perubahan Iklim Indonesia. 2010. ***Indonesia's greenhouse gas abatement cost curve.*** Jakarta, Dewan Nasional Perubahan Iklim (National Council on Climate Change).

Ditjen BPK. 2000. ***Pedoman pemberian ijin usaha hutan tanaman (D/h Hak Pengusahaan Hutan Tanaman Industri)*** (Guidelines in granting permits for planted forest (D/h Concession rights for Industrial Timber Plantation). Direktorat Jenderal Bina Produksi Kehutanan, Departemen Kehutanan.

Ditjen RLPS. 2003. ***Rehabilitasi lahan dan perhutanan sosial: Dari masa ke masa*** (Land rehabilitation and social forestry: from time to time). Jakarta, Direktorat Jenderal Rehabilitasi Hutan dan Lahan dan Perhutanan Sosial), Departemen Kehutanan (Ministry of Forestry).

Ditjen RLPS. 2004. ***'Kebijakan Pembangunan Rehabilitasi dan Perhutanan Sosial' presentasi disampaikan pada Ekspose MP-RHL Daerah, 8-9 March 2004*** ('Policy for rehabilitation and social forestry development' presentation delivered at the Regional Exposure MP-RHL, 8-9 March 2004). Jakarta, Direktorat Jenderal Rehabilitasi Hutan dan Lahan dan Perhutanan Sosial), Departemen Kehutanan (Ministry of Forestry).

Environmental Justice Foundation (EFJ). 2006. ***Mangroves: nature's defence against tsunamis - a report on the impact of mangrove loss and shrimp farm development on coastal defences***. London, UK, EFJ.

Forest Watch Indonesia (FWI). 2011. ***Potret Keadaan Hutan Indonesia: Periode 2000 – 2009*** (Portrait of Indonesian forest condition: period 2000-2009). Bogor, FWI (available at fwi.or.id/wp-content/uploads/2013/02/PHKI_2000-2009_FWI_low-res.pdf).

Forum Reklamasi Hutan Pada Lahan Bekas Tambang. 2013. ***Sarasehan Nasional 'Masa Depan Pengelolaan Hutan Produksi Indonesia' 2013*** (national workshop on 'The Future of Indonesian Forest Management' in 2013), Jakarta, 4-5 September 2013, Forum Reklamasi Hutan Pada Lahan Bekas Tambang (Forum for Mining Reclamation in Forest Land).

FWI/GFW. 2001. *Keadaan hutan Indonesia* (The state of the forest Indonesia). Bogor and Washington, DC, FWI/GFW (Forest Watch Indonesia/Global Forest Watch).

FWI/GFW. 2002. *Keadaan hutan Indonesia* (The state of the forest Indonesia). Bogor and Washington, DC, FWI/GFW (Forest Watch Indonesia/Global Forest Watch).

Gunarso, P. 2013. Darurat Tutupan Hutan Indonesia! (Indonesian forest cover emergency!). *In* A. Nugraha, H. Santoso, I. Ardiansyah, M.A. Imron, R. Sanyoto, S.A. Awang, T. Yuwono & Y.E. Istoto, eds. *Darurat Hutan Indonesia (Emergency in Indonesian forests)*, pp. 235-258. Tangerang, Indonesia, Wana Aksara.

Haeruman, H. 1993. *Inter-sectoral linkages in Indonesia*. *Forestry policies of selected countries in Asia and the Pacific.* FAO Forestry Paper 115. Rome, FAO.

Hasanuddin, L. 1996. Hutan tanaman industri: blunder kedua kebijakan kehutanan di Indonesia (The industrial plantation forest: the second blunder of forest policy in Indonesia). *Tanah Air: Jurnal Lingkungan Hidup,* 1: 13-17.

Hidayat, F. 2013. Izin Tambang di Kalimantan Timur Terus Bertambah (Permits for mining in East Kalimantan keep increasing). News in Tempo.co, 28 May 2013 (available at www.tempo.co/read/news/2013/05/28/058483967/Izin-Tambang-di-Kalimantan-Timur-Terus-Bertambah).

Hindra, B. 2005. *Indonesia community forestry 2005. Community forestry status report.* First Regional Community Forestry Forum. Bangkok, RECOFTC.

INPRES. 2013. *Instruksi Presiden Republik (Inpres) Indonesia Nomor 6 Tahun 2013 tentang Penundaan Pemberian Izin Baru dan Penyempurnaan Tata Kelola Hutan Alam Primer dan Lahan Gambut* (Indonesian Presidential Instruction No. 6 of 2013 on New Permit Suspension and Improving Governance of Primary Forest and Peatland), Jakarta (available at www.kemendagri.go.id/media/documents/2013/10/08/i/n/inpres_no.06-2013.pdf).

Iskandar, U., Ngadiono, A. & Nugraha. 2003. *Hutan Tanaman Industri di persimpangan jalan*, Jakarta, Arivco Press.

Kartodihardjo, H., Nugroho, B. & Putro, H.R. 2011. *Forest Management Unit development - concept, legislation and implementation*. MIS Quarterly, Directorate of Area Management and Preparation of Forest Area Utilisation, Directorate General of Forestry Planning, Ministry of Forestry. In cooperation with Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) GmbH FORCLIME Forests and Climate Change Programme, Jakarta.

Kartodihardjo, H. & Supriono, A. 2000. *The impact of sectoral development on natural forest conversion and degradation: the case of timber and tree crop plantations in Indonesia*. Occasional Paper No. 26(E). Bogor, CIFOR.

Ministry of Environment (MoE). 2007. *Status Lingkungan Hidup* (State of environment). Jakarta, MoE.

MoE. 2008. *Status lingkungan hidup Indonesia 2007* (Indonesia environment status 2007). Jakarta, MoE (Kementerian Lingkungan Hidup).

Ministry of Forestry (MoF). 2002. *Rehabilitasi lahan dan perhutanan sosial* (Land rehabilitation and social forestry). Statistik Kehutanan Indonesia 2001 (Forestry statistics Indonesia 2001) Jakarta.

MoF. 2007. *Statistik kehutanan Indonesia* (Forestry statistics of Indonesia) 2006. Jakarta.

MoF. 2009. *Peraturan Menteri Kehutanan Republik Indonesia Nomor: P. 64/Menhut-II/2009 tentang Standard biaya pembangunan Hutan Tanaman Industri dan Hutan Tanaman Rakyat* (Government of Indonesia, Minister of Forestry Regulation Nomor: P. 64/Menhut-II/2009 on the costing standard for Industrial Timber Plantation and Community-based timber plantation).

MoF. 2012. *Forestry statistics of Indonesia 2011.* Jakarta.

Murniati, Nawir, A.A., Rumboko, L. & Gumartini, T. 2007. Chapter 4. The historical national overview and characteristics of rehabilitation initiatives. *In Forest rehabilitation in Indonesia: Where to after more than three decades?* Bogor, Indonesia, CIFOR.

Mursidin, Priyo, T., Achlil, R., Yuliarsana, N., Soewondho, Wartam, Basuki, B. & Sudarto, eds. 1997. *35 tahun pengijauan di Indonesia*. Presidium Kelompok Pelestari Sumberdaya Alam, Direktorat Jenderal Reboisasi dan Rehabilitasi Lahan Departemen Kehutanan, Direktorat Jenderal Pembangunan Daerah Departemen Dalam Negeri, Jakarta.

(National) Global Partnership on Forest Landscape Restoration (GPFLR). 2009. *Guidelines for forest landscape restoration in Indonesia.* Bogor, GPFLR, Tropenbos International, ITTO and IUCN.

Nawir, A.A., Murniati & Rumboko, L. 2007a. Chapter 6. Reorientation of the rehabilitation programme in Indonesia: Where to after more that three decades?, *In Forest rehabilitation in Indonesia: Where to after more than three decades?* Bogor, CIFOR.

Nawir, A.A., Murniati & Rumboko, L., eds. 2007b. *Forest rehabilitation in Indonesia: Where to after more than three decades?*Bogor, CIFOR.

Nawir, A.A., Murniati, Rumboko, L., Hiyama, C. & Gumartini, T. 2007c. Chapter 3. Past and present policies and programmes affecting forest and land rehabilitation initiatives. *In Forest rehabilitation in Indonesia: Where to after more than three decades?* Bogor, CIFOR.

Nawir, A.A., Santoso, L. & Mudhofar, I. 2003. *Towards mutually beneficial company-community partnerships in timber plantation: lessons learnt from Indonesia.* Working Paper 26, Bogor, CIFOR.

Obidzinski, K. & Barr, C. 2003. *The effects of decentralisation on forest and forest industries in Berau District, East Kalimantan*. Case Study 9. Case Studies on Decentralisation and Forests in Indonesia. Bogor, CIFOR.

Oka, P.N. & William, D. 2004. *The policy dilemma for balancing reforestation funds*. Decentralisation Brief, No. 1, January 2004, Forest and Governance Programme. Bogor, CIFOR.

Otsamo, R. 2000. *Integration of indigenous tree species into fast-growing forest plantations on Imperata grasslands in Indonesia - silvicultural solutions and their ecologicla and practical implications.* Tropical Forestry Reports 21. Helsinki.

Otsamo, A. 2001. *Forest plantations on Imperata grasslands in Indonesia - establishment, silviculture and utilization potential.* Tropical Forestry Reports 23. Helsinki.

Pearce, D., Markandya, A. & Barbier, E.B. 1990. *Blueprint for a green economy.* For the UK Department of the Environment. London, Earthscan Publications Ltd.

Perman, R., Ma, Y. & McGilvray, J. 1996. *Natural resources and environmental economics*, MIS Quarterly. London and New York, Longman.

Potter, L. 1996. Forestry in modern Indonesia. *In Historical foundations of a national economy in Indonesia, 1980s to 1990s*. Amsterdam, Royal Netherlands Institute of Arts and Sciences.

Potter, L. & Lee, J. 1998. *Tree planting in Indonesia: Trends, impacts and directions.* Occasional Paper No. 18. Bogor, CIFOR.

Prasetyo, L.B., Wijayanto, N., Dungio, I., Gunawan, W. & Adnan, A. 2005. *Study on the cost of the environmental plantation in Indonesia: Case study on the national movement of forest and land rehabilitation.* Cooperation project Forestry Research and Development Agency (FORDA). Bogor, MoF, Indonesia - Japan International Cooperation Agency (JICA).

Rasyida, A. 2013. *APHI: HPH Hutan Produksi Semakin Berkurang* (APHI: concessions in production forest has been decreasing) (available at www.tribunnews.com/bisnis/2013/04/05/aphi-hph-hutan-produksi-semakin-berkurang).

Richards, M. & Costa, P.M. 1999. *Can tropical forestry be made profitable by 'internalising the externalities'?* Natural Resource Perspective Number 45. Overseas Development Institute (ODI).

Safitri, M.A. 2006. *Change without reform? Community forestry in decentralizing Indonesia.* Paper presented at the 11th IASCP Conference, 19-23 June, Bali.

Santoso, H. 2005. *Arah kebijakan dan implementasi rehabilitasi hutan dan lahan.* Presentation in the 'National Workshop Review of Rehabilitation Initiatives: Lessons from the past' in CIFOR, Bogor, 22-23 February 2005, Jakarta.

Sarinah, A. 2013. *Menhut : Rehabilitasi Hutan Indonesia Tidak Sampai 100 Tahun* (Minister of Forestry: Forest Rehabilitation in Indonesia would not need 100 years), News in RRI, 9 November 2013.

Scotland, N. 2000. Indonesia country paper on illegal logging: prepared for the World Bank-WWF (World Wide Fund for Nature). Workshop on control of illegal logging in East Asia, 28 August 2000, World Bank and WWF (World Wide Fund for Nature), Jakarta.

Sizer, N., Austin, K. & Alisjahbana, A. 2013. *Data terbaru menunjukkan kebakaran hutan di Indonesia adalah kiris yang telah berlangsung sejak lama* (Latest data have shown a long term endemic forest fire incidences in Indonesia). Blog published on 26 June 2013, World Resources Institute (WRI) (available at www.wri.org/blog/data-terbaru-menunjukkan-kebakaran-hutan-di-indonesia-adalah-krisis-yang-telah-berlangsung).

Soeprihanto, P. 2013. Membangun skema perdagangan kayu global yang adil bagi penguatan industri kehutanan nasional (Developing a fair timber trade at the global level for strengthening the national forest industry). *In Darurat Hutan Indonesia* (Emergency in Indonesian forests), pp. 500-517. Wana Aksara, Tangerang, Indonesia.

Sudradjat, A. & Subagyo, S. 1993. Indonesian policies and legislation in social forestry development: perspectives and experience. *In Policy and legislation in community forestry,* pp. 169-176. Proceedings of a workshop in Bangkok, 27-29 January 2003. Bangkok, RECOFTC.

Sunandar. 2013. *Biaya Reklamasi Tambang Koba Tin US$ 16,7 Juta* (Reclamation of Koba Tin mining cost US$ 16.7 million). Date of the news bulletin: Thursday, 26 September 2013 PME Indonesia, Jakarta (available at pmeindonesia.com/berita-tambang/1234-biaya-reklamasi-tambang-koba-tin-us167-juta).

Sunderlin, W.D. & Resosudarmo, I.A.P. 1996. *Rates and causes of deforestation in Indonesia: towards a resolution of the ambiguities*. Occasional Paper No. 9. Bogor, CIFOR.

Sunderlin, W.D., Resosudarmo, I.A.P., Rianto, E. & Angelsen, A. 2000. *The effect of Indonesia's economic crisis on small farmers and natural forest cover in the outer islands*. Bogor. CIFOR.

Susanto, C.E. 2013. *Jumlah Pulau di Indonesia 'Berkurang' 4.042 Buah* (Indonesia has lost about 4,042 of its islands) News published on 18 October 2013, MetroNews.

Tacconi, L. 2003. *Fires in Indonesia: causes, costs and policy implications.* CIFOR Occasional Paper No. 38. Bogor, CIFOR.

Tacconi, L., Obidzinski, K. & Agung, F. 2004. *Learning lessons to promote forest certification and control illegal logging in Indonesia.* Bogor, CIFOR.

United Nations Environment Programme (UNEP). 2005. *After the tsunami: Rapid Environmental Assessment - Indonesia.* UNEP (available at www.unep.org/tsunami/reports/TSUNAMI_report_complete.pdf).

White, A. & Martin, A. 2002. *Who owns the world's forests? Forest tenure and public forests in transition.* Washington, DC, Forest Trends.

Wibowo, S. 2006. *Rehabilitasi hutan pasca operasi illegal logging.* Wana Aksara, Jakarta.

Wibowo, S. 2013. *Ektivitas rehabilitasi hutan dan lahan kritis berbasis gerakan moral: sebuah refleksi* (The effectiveness of forest and land rehabilitation as the moral movement: a reflection). *In Darurat Hutan Indonesia* (Emergency in Indonesian forests), pp.140-161.Wana Aksara, Tangerang, Indonesia.

Wonodipuro, D. 2013. *Menghijaukan lahan kritis: Potret keberhasilan hutan rakyat di Jawa* (Regreening the critical land: Potrait of sucessful farm forestry in Java). *In Darurat Hutan Indonesia* (Emergency in Indonesian forests), pp. 279-317. Wana Aksara, Tangerang, Indonesia.

Forest restoration at the landscape level in Myanmar

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1. Historical overview of forest and land degradation

1.1 Location, land area and population

Myanmar is the largest country in mainland Southeast Asia with a total area of 676 577 km^2. The population in 2005-2006 was estimated at 55.4 million, with more than 70 percent living in rural areas. With population growth of 2.02 percent, it is estimated that the total population in 2015 will be 62 million. Myanmar has ranked poorly on the Human Development Index – the lowest in East and Southeast Asia.

1.2 Land use

The country's economy is dominated by agriculture so greater emphasis is placed on sustainable agricultural development. Land-use status in 2009 is given in Figure 1.

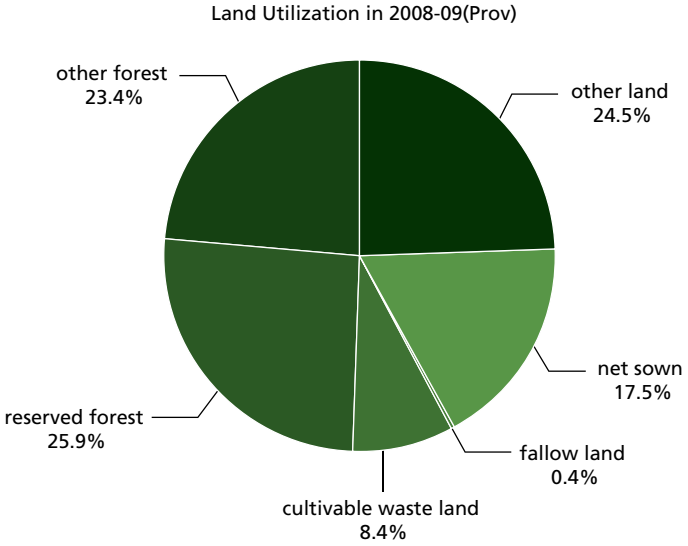

Figure 1. Land-use status of Myanmar, 2009

Source: Ministry of Agriculture and Irrigation (2009).

As of 2009, agriculture occupied 17.5 percent of the land area; forestry accounted for 49.3 percent disaggregated into 25.9 percent of reserved forest (a combination of reserved forest [RF], protected public forest [PPF] and the protected area system [PAS]). Another category of other forests (unclassed forest) constitutes 23.4 percent.

1.3 Forest cover status

The Global Forest Resource Assessment (FAO 2010b) indicates that forest still covers 48 percent of the country, one of the highest percentages in the Asia-Pacific region.

Forest cover comprises all forest lands including degraded forests and planted forests with canopy cover of more than 10 percent. Other wooded land includes all wooded lands with canopy cover of 5-10 percent which are not classified as forests. Other land means all land areas which are not classified as forest or other wooded land, but could have tree cover under agriculture or urban land use.

1.4 Forest-population ratio

According to FAO (2011), Myanmar has 0.6 ha of forest land per person. More than 70 percent of the population resides in rural areas and has to depend heavily on forests for basic needs. Moreover harvesting and utilization of non-wood forest products (NWFPs) and hunting support rural people (mostly ethnic groups and mountain tribes) for their sustenance and additional income.

1.5 Major forest types

Myanmar is rich in natural resources, with forest resources being one of the most critical and principal suppliers of livelihoods for people and the national economy. Various types of forests are found namely tidal, beach, dune and swamp; tropical

evergreen; mixed deciduous; dry; deciduous dipterocarp; and hill and temperate evergreen. Indeed, Myanmar is home to the best quality natural teak – one of the most valued and sought after tropical timbers in the world. Mixed deciduous or teak forests still occupy 38 percent of the total forest area, followed by hill and temperate evergreen forest, mostly found in Northern hilly regions (25.2 percent), and tropical evergreen forest of the southern peninsula (15.5 percent). Dry forests are common in the Central dry zone of Myanmar (10 percent). Deciduous dipterocarp forests are generally found in alluvial plains (5 percent), and tidal, beach, dune and swamp forests of delta and coastal regions (4 percent) make up the remainder.

1.6 Permanent forest estate in 2002

The 1995 Forest Policy set the target of expanding the reserve forest to 30 percent of the total land area and setting aside no less than 5 percent of the total land in a protected area system (up to 10 percent in the long term). The current status of PFE in 2002 is shown in Table 1. All PFE areas are well protected and conserved by the provisions of the 1992 Forest Law.

Table 1. Status of PFE in Myanmar in 2010

Category	Number	Area (1 000 ha)	Total land area (1 000 ha)	Percentage of total land area
Reserved forest	844	12 169	65 755	18.5
Protected public forest	296	4 454		6.7
Protected area system	36	3 789		5.7
Permanent forest estate (PFE) total	**1 176**	**20 412**		**30.9**
Unclassified forests	-	11 361		17.2
Total forest cover		**31 773**		**48.1**

Source: Forest Department (2008), Planning and Statistics Division.

The reserved forest area is still far below its goal of 30 percent. However the total area of the protected area system well exceeds its initial target of 5 percent. Unclassified forests constitute about 17 percent of the total forest area. These forests are also under state control, but legal protection over them is very weak and they are highly vulnerable to deforestation and degradation.

1.7 Forest landownership

Until recently, all types of forests were owned by the state except for some community forests (CF) which are under long-term lease agreements with the government. Up to 2012, a total 47 203 ha of CF had been established under the 1995 Community Forestry Instructions (CFI). Since 2006-2007, establishment of privately-owned teak and hardwood plantations has been allowed in forest lands under long-term leases. Up to 2012, 53 593 ha of privately-owned teak and hardwood plantations had been established. Table 2 explains the areal extent of different categories of forest ownership by different periods.

Table 2. Forest ownership by period

FRA 2010 categories	Forest area (1 000 ha)			
	1990	2000	2005	2010
Public ownership	39 218	34 868	33 280	31 676
Private ownership	0	0	41	97
… owned by individuals	0	0	0	0
… owned by private business entities and institutions	0	0	0	52
… owned by local communities	0	0	41	45
… owned by indigenous/tribal communities	0	0	0	0
Other types of ownership	0	0	0	0
Total	39 218	34 868	33 321	31 773

Sources: FAO (2010a) and Forest Department.

1.8 History of deforestation and forest degradation

Deforestation and forest degradation have been ongoing since the early British colonial period. For example, teak extraction was allowed under a laissez-faire system in the Tenassarim area. As a result, by 1856 all natural teak trees of marketable size in Tenasserim had been depleted. Although the British introduced scientific forestry (particularly the [Myanmar] Selection

System) forest degradation and deforestation gradually started with the British conquest of the whole of Burma (Myanmar) and exploitation by western timber companies (Bryant 1996).

A quantified deforestation rate has been regularly reported by Myanmar forest authorities (Table 3). It provides data on forest cover changes in terms of total land area of the country by different periods. Almost 70 percent of the nation was covered by forests in the early twentieth century. This decreased to around 60 percent in 1975 and 58 percent in 1990. Since then, the government used forest resource as a free resource for urgently-needed foreign exchange, and forest cover declined sharply to 49 percent in 2005. After 2005 the rate of decline decelerated, following severe criticism from both national and international environmental organizations and civil society groups.

1.9 Deforestation rate

As seen in Table 3, the deforestation rate has accelerated over time from only 0.15 percent between 1925 and 1975 to 0.32 percent from 1975 to 1990. The loss rate sharply increased to 1.17 percent between 1990 and 2000. For the period 2000-2010 the annual loss rate started to improve somewhat but remained alarming at around 1 percent.

Table 3. Forest area extent and annual change rate

Year	Forest cover (000) ha	Country area (000) ha	% of total land area	Forest area loss (% of country area)
1925	44 654	67 658	66	
1975	41 196	67 658	61	5
1990	39 218	67 658	58	3
2000	34 868	67 658	51	7
2005	33 321	67 658	49	2
2010	31 773	67 658	47	2
From	To	Annual change rate		
		(000) ha/year	%	
1925	1975	-69	-0.15	
1975	1990	-132	-0.32	
1990	2000	-439	-1.17	
2000	2005	-309	-0.90	
2005	2010	-310	-0.95	

Sources: FAO (2010a); UNEP (2009a); Forest Department.

1.10 Forest degradation

Forest degradation is a critical problem. Although almost half of the country is still covered by forests, their quality and value are debatable. Forest degradation continues unabated. Table 4 brings out this trend by different periods.

Table 4. Forest cover status and land use in different periods (1 000 ha)

Status	**1990**	**2000**	**2005**	**2010**
Closed forest	30 883	23 505	18 475	13 445
Open forest	8 335	11 364	14 846	18 329
Total forest	39 218	34 868	33 321	31 773
Other wooded land	19 498	19 703	19 908	20 113
Other land	7 039	11 184	12 526	13 869
Inland water bodies	1 903	1 903	1 903	1 903
Total area of country	**67 658**	**67 658**	**67 658**	**67 658**

Sources: Forest Department; FAO (2010b).

Table 4 clearly shows the decrease in closed forest area over time. This had declined to about 40 percent (13 445 000 ha) in 2010 compared to its 1990 extent of 30 883 000 ha. Open forest areas sharply increased during this period, only 8 335 000 ha in 1990 compared to 18 329 000 ha in 2010. Total forest area declined from 39 218 000 ha in 1990 to 31 773 000 ha in 2010. From these data, it can be concluded that Myanmar forests are experiencing deforestation and severe degradation.

2. Current status of forest degradation

2.1 Current status

Myanmar is regarded as one of Asia's last bastions of biodiversity. For this reason, environmentalists fear that the country's rapid liberalization risks spiraling of uncontrolled environmental degradation. With poor governance, lack of clear legal frameworks and growth objectives, the future of Myanmar's resource base could be at threat.

According to a recent national environmental performance assessment report for Myanmar, principal environmental concerns are: 1) forest resource degradation; 2) threats to biodiversity; 3) land degradation; 4) water resource and quality status; 5) inadequate solid waste management; 6) air pollution; and 7) climate change impacts (Forest Department 2012a). Given the varied terrain and geophysical context, Myanmar is also subject to multiple natural disasters on a frequent and increasing basis which affect socio-economic improvements in various sectors and for various sections of society. Furthermore, climate change is impacting biodiversity and natural ecosystems.

The net loss of 439 000 ha of forest per year reported for the period 1990-2000, has since been reduced to 310 000 ha per year for the period 2005-2010. Despite this positive trend, Myanmar remained one of the top ten countries in the world with the largest annual net loss of forest area during the period 2000-2010.

Furthermore, the government's intention to ban the export of timber in April 2014 could mean further risk of exploitation, unless better management is in place. Extractive and irresponsible investments, poor regulations and weak law enforcement have significantly hurt Myanmar's environment. Despite a tradition of sound forest management practices (through the Myanmar Selection System), Myanmar today is facing the results of extensive deforestation as a result of both increased commercial logging and illegal logging activities, particularly in border areas. This has led to soil erosion, landslides, decreased soil fertility and drought.

2.2 PFE status

The establishment of RF, PPF and PAS occurred in the late nineteenth century and they are defined legally as permanent forest estate (PFE). Despite expansion in terms of area, these areas deteriorated throughout the last century. At present, deforestation and forest degradation are clearly observed inside PFE areas. Although the Forest Law and other forestry-related laws prohibit settlement, encroachment and illegal cutting in PFE areas, such violations can easily be seen in almost every PFE area. The situation is much worse in unclassed forest areas, as there is no strong legal protection for them.

2.3 Forest under non-forest use

With over 70 percent of the population living in rural areas, the government still relies on forest resources for foreign exchange earnings; most of its forest areas are under intense pressure from timber harvesting and extraction of various other forest products. FAO (2010b) categorized as production and multiple-use forest almost 90 percent of the total forest area of the country. However, some forest areas under other categories such as soil and water protection (about 4 percent) and biodiversity conservation (about 6 percent) remain. Further, according to FAO categories, Myanmar has no forest areas functioning for social services (Table 5).

Table 5. Forest area by primary designated functions

FRA 2010 categories	Forest area (1 000 hectares)			
	1990	2000	2005	2010
Production	4 422	24 644	24 797	19 633
Protection of soil and water	312	1 499	1 499	1 352
Conservation of biodiversity	720	1 220	4 901	2 081
Social services	0	0	0	0
Multiple use	33 764	7 505	2 124	8 707
Other	0	0	0	0
None/unknown	0	0	0	0
Total	**39 218**	**34 868**	**33 321**	**31 773**

Source: FAO (2010a).

The two categories of soil and water protection and biodiversity conservation roughly coincide with the PAS areas under the Myanmar Forest Department classification. The PAS includes wildlife sanctuaries and national parks. Up to 2012 the country had established a total of 36 protected areas constituting 3 789 000 ha or about 5.7 percent of the total land area of the nation. Over the longer term the Forest Department plans to increase PAS areas by up to 10 percent.

The PAS protects the natural environment and biodiversity, and also has very attractive sites for ecotourism/social services. Associated with the promotion of PAS is the development of nature-based ecotourism. The Ministry of Environmental Conservation and Forestry (MOECAF) has identified 15 wildlife sanctuaries and parks as prime ecotourism sites, and more new sites are under preparation.

3. Causes of forest degradation

3.1 Direct causes

3.1.1 Overexploitation and illegal logging

Under the Myanmar Selection System, the annual allowable cut (AAC) is the main indicator and controlling factor for sustainable management of forests. Timber harvesting basically followed the AAC until the 1980s. However between the 1980s and 2011, the forestry sector was required to set its own annual income target to contribute to the regional as well as national GDP. This rush for income required additional harvesting of immature trees and led to weakening of the well-developed forest management system. Consequently, annual timber production by the Myanmar Timber Enterprise (MTE) exceeded the prescribed AAC of that period. Figure 2 compares annual teak production and the prescribed AAC during the period 1985-2006.

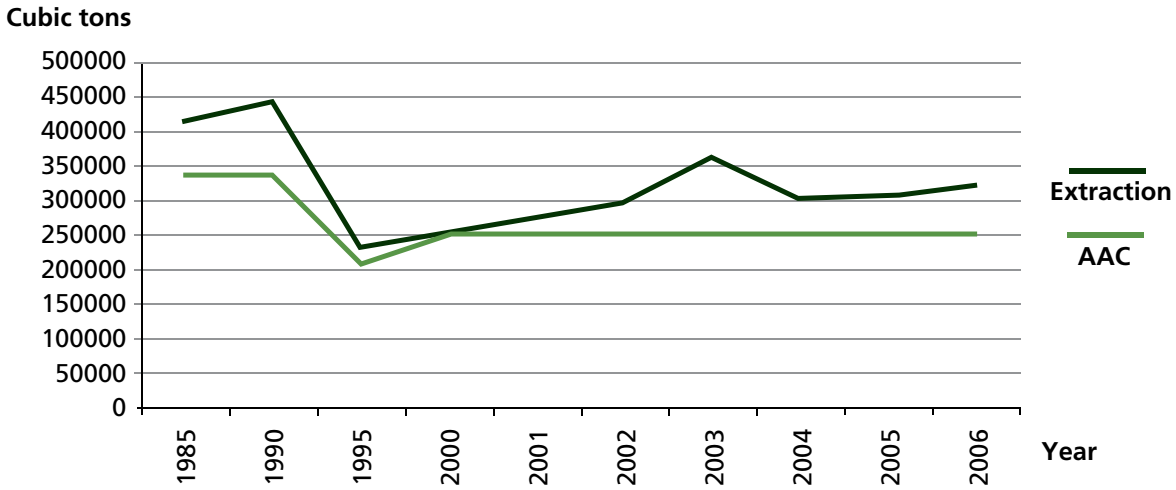

Figure 2. Teak extraction and prescribed AAC, 1985-2006

Source: UNEP (2009a).

In addition to government harvesting over the AAC, Myanmar forests have faced additional pressure from illegal logging, removal of woodfuel and harvesting of NWFPs. Illicit logging is a common problem. Usually it is carried out by forest dwellers and small local merchants who take advantage of the remoteness of forest areas and weak law enforcement. The fundamental causes of illicit logging are, inter alia, increased demand for forest products, particularly timber and fuelwood, and high timber prices due to supply-demand imbalance and corruption. Many NGOs and civil society groups have pointed out that it might be very difficult to address illegal logging by needy communities in a comprehensive manner while overexploitation above the AAC is being carried out by the MTE, the government agency and its associated timber companies.

3.1.2 Shifting cultivation

Shifting cultivation or 'taungya' has been practised by ethnic minorities for a long time in hilly areas. Up to the middle of the nineteenth century long rotations were possible as the population in hilly areas was very sparse. However as the population rose, shifting cultivation gradually increased, and with shorter fallow periods damage to the natural environment has increased. Repeated slash-and burn-practices in the same area destroys valuable timber species and hinders their regeneration, causing soil erosion and depletion of soil fertility; ultimately it leads to forest degradation and deforestation. Today, an estimated 2 million families are involved in shifting cultivation, and nearly 30 percent of the total forest land (about 9 500 000 ha) is affected; another 200 000 ha are added to this total every year (MOECAF 2012). However attempts have been made by MOAI and MOECAF to replace shifting cultivation with more stable and sustainable methods such as agroforestry, community forestry, horticulture and contour line cropping (terracing).

3.1.3 Expansion of agricultural lands and construction of dams

The country's net sown area increased rapidly from 8 910 000 ha in 1996 to 11 866 000 ha in 2009 (MOAI 2008-2009). This is the result of the national land reclamation programme, juxtaposed by the development of irrigation facilities. From 1990-1991 to 2009-2010 the Irrigation Department of the MOAI constructed 262 dams and reservoirs for irrigation and flood protection, pumping stations and associated canals. Although these activities are mandatory to ensure food security for the increasing population, they resulted in clearing and conversion of forest lands into other land uses. In the meantime, forest cover decreased at an alarming rate at -1.17 percent per annum from 1990 to 2000 and -0.95 percent annually during the 2000-2010 period. Many critics argued that the lack of an integrated and comprehensive land-use policy or plan was the main reason.

3.1.4 Demand on woodfuel

Woodfuel (fuelwood and charcoal) is still a major source of household energy, particularly for the large rural population. Although urban households have more opportunities to use electricity or gas, there are still many limitations and blackouts in urban areas. Based on the household energy consumption of different types of energy for the period 1990-2010 and the projection for 2020 (estimated by the Energy Planning Department; FAO 2009), the share percentage of fuelwood and charcoal consumption significantly decreased over time from 84 percent in 1990 to 69 percent in 2010, and is projected to be 58 percent in 2020. However, due to the growing population it is unlikely to decline in volume. MOECAF has estimated that woodfuel consumption per annum per household is about 1.4 cubic tons (t^3) for urban households and 2.5 t^3 for rural households. With this rate and in combination with the increasing population rate, MOECAF estimates that demand on woodfuel will increase from 17.5 million t^3 in 2001 to 20 million t^3 in 2020. This woodfuel demand or removal is 12 to 13 times higher than the average annual harvesting of 300 000 tons of teak and 1 200 000 tons of hardwood (total 1.5 million tons per annum) for the period 2006-2012 (MOECAF). MOECAF has estimated that 90 percent of total wood removal from forests is due to woodfuel production. People living in both rural and urban areas rely on forests to meet this huge woodfuel demand. This trend will continue unless household energy demand is substituted with other energy sources or sustainable forest management practices are implemented to meet rural wood energy needs.

3.1.5 Settlements and urbanization

As the population increased over time, demand for new homes and farming areas has also increased. For most of the rural poor who live in about 65 000 villages, the easiest option to meet this demand is encroachment on nearby forests. Some villages extend into the forests, and some even establish new subvillages (hamlets) in nearby forest areas. Every new household requires additional farmland or grazing land for livelihood needs. This has resulted in clearance of additional forest lands near their new households or hamlets. Table 6 shows the number of hamlets, households, populations and their farmlands settled in the RF and PPF of Myanmar in 2012.

Table 6. Settlements in RF and PPF

Number of hamlets	Number of households	Total population	Settlements in RF & PPF (ha)			
			Land for households	Land for farming	Other land use	Total
1 604	193 074	894 266	12 695	304 835	13 453	33 983

Source: Forest Department (2012b).

Urbanization and industrial zone developments in and around large city areas such as Yangon, Mandalay and Dawai, are also leading to deforestation and forest degradation. Along with urbanization, demand for forest products such as fuelwood, charcoal, poles/posts for households and infrastructure development has increased. These urban demands make long-term and intense negative impacts on nearby forests.

3.1.6 Mining

Mining is an important and promising sector for Myanmar's economic growth (MOM 2009-2010). Natural gas, oil, precious stones, gold and copper are the most important natural resources for local and foreign investors. The country is also well endowed with a variety of mineral resources such as tin, lead, zinc, tungsten, silver and iron. Industrial minerals such as barite, gypsum, limestone, dolomite, bentonite and fireclay are also found. Conversely, poorly managed and supported mining sites lead to environmental disturbances that extend well beyond the extent of mineralized areas. Mining activities, especially with open pit systems, usually convert green land to bare land that is often polluted with hazardous materials. They also contaminate air and water in nearby streams and rivers. In most mining sites of Myanmar, environmental considerations and operations to repair environmental damage, including forest degradation and deforestation, are lacking. Myanmar is now trying to set up environmental standards for mining activities, which are welcomed by environmental and forest conservation groups.

3.2 Underlying causes

3.2.1 Population growth

Myanmar has a relatively low population density compared with many countries in the ASEAN region. The 2005-2006 population was estimated at 55.4 million which is an increase from 40.78 million in 1990-1991. Population increase, especially the rural population, is of considerable concern, as they are highly dependent on forest resources, and directly influence fuelwood removal, illegal cutting, shifting cultivation, agricultural expansion and so forth, ultimately leading to deforestation and forest degradation.

3.2.2 Poverty

Despite its wealth of natural resources, Myanmar remains a poor country with a Human Development Index ranking of 149 out of 187 countries. Myanmar's population lives below the poverty line and the rural poor account for 87 percent of total poverty. Poverty, forest and land degradation, and human-induced climate change are associated in a vicious cycle. Heavy dependence on forests due to poverty results in deforestation, land degradation and self-destruction of the microenvironment as well as erratic climatic conditions. Again, severe environmental and climatic conditions cause greater poverty and more destruction.

3.2.3 Weak law enforcement

The new Myanmar Forest Law has been enacted since 1992 followed by the Forest Rules in 1995. Both were prepared in harmony with the Forest Policy, 1995. In addition, the Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law, 1994 was ratified in 1994. The Community Forestry Instructions (CFI) was also issued by the Forest Department in 1995.

One of the basic principles of the Forest Law is:

- To safeguard against degradation and depletion of natural forests and to conduct afforestation in areas where natural forests are depleted.

However, in reality the provisions of all forestry-related forest laws, rules and instructions cannot be fully enforced due to:

- Conflict of interests between forest sustainability and income from the forestry sector for national development;
- Policy inconsistency between the forestry sector and other economic sectors including agriculture, livestock and mining;
- Demand on forest products is still increasing and there are very few measures to replace them with alternatives (e.g. natural gas instead of woodfuel and steel, brick and cement instead of timber);
- Poverty forces local communities to defy the forest laws to make additional income from forests;
- Inadequate salaries and facilities encourage authorities to become involved in corruption.

The same phenomenon can also be observed in all other interrelated sectors, providing room for all illegal or inappropriate activities that lead to destruction of forests and the natural environment.

3.2.4 Conventional forest administration and lack of people's participation

Following the British annexation of lower Myanmar, systematic forest administration began in 1856 under police-style control and surveillance of forest areas, aiming at long-term commercial timber production from reserved forests. The forest reservation process severely constrained local communities from continuing their traditional free access to forests. Although rights and privileges for forest dependents and forest dwellers were mentioned in forest working plans, all of these management plans and regulations were conducted in a top-down fashion, without any negotiations and consensus with local communities. Police-style forest management continued after independence in 1948, and during almost half a century of authoritarian rule (1962-2011), conditions deteriorated. Government policy favoured exploitation of forests for economic growth that was not in consonance with both scientific management and local requirements. This separation of local people from the forest administration led the former to become defiant and undertake activities labeled as illegal. Misunderstanding and mistrust between authorities and communities over time led to strife and resulted in the failure of forest administration; this further exacerbated forest degradation and deforestation.

3.2.5 Insufficient budget

Myanmar's current national accounting system does not report environmental-related expenditure as a separate element. Financial resources for environment and natural resource management are allocated to sectoral ministries or agencies. According to the national budget's sectoral breakdown in 2013-2014, out of total expenditure of US$7 864.5 million, only US$519 million (about 6.6 percent) was allocated to institutions most closely linked to the management of natural resources (agriculture, forestry, livestock, fisheries). Under MOECAF, the highest expenditure (nearly 97 percent in 2012-2013) went to the MTE, which deals with timber extraction and export. However the MTE does not expend its resources for rehabilitation and conservation. The combined expenditure of the departments (FD+DZGD+ECD) which are responsible for forest conservation and reforestation efforts is only about 3 percent of the total expenditure of the whole ministry. Moreover, average Overseas Development Assistance (ODA) received by Myanmar is only about US$2.00 per capita per annum. Under the circumstances, the amount allocated to the environment, forestry etc. is practically non-existent. Under such financial limitations, MOECAF can barely fulfill its ambitious targets on forest conservation and rehabilitation through the FD, DZGD and ECD.

3.2.6 No proper all-inclusive land-use policy

One policy-related issue which apparently hinders forest conservation and rehabilitation efforts is arbitrary land use. The absence of clear land-use policy and planning has several impacts on forest management including loss of forest cover and low productivity.

Although forest policy includes statements about land use, it is a cross-cutting issue with other sectors such as agriculture, livestock, mining, settlements and urbanization. At the national level, an all-inclusive and comprehensive land-use policy has not been developed. Every sector believes that its plans and targets are very important for the livelihoods and well being of the people and the nation, and thus compete for the same plots of land. In most cases, the forestry sector is the loser, because forest conservation and rehabilitation cannot generate impressive short-term results compared to other alternative land uses such as agriculture, mining and industrial zones.

Formation of the National Environmental Conservation Committee (NECC) in 2011 has been seen as development in the right direction to resolve this longstanding land-use conflict. The committee is composed of 23 relevant ministries and mandated to achieve harmony and balance between socio-economy, natural resources and the environment through the integration of environmental considerations into the development process.

4. Impacts of forest degradation

4.1 Impact on livelihoods

The degradation of natural resources is considered a major threat to rural livelihoods, sustainable agriculture and development in general. The most vulnerable group affected by deforestation and forest degradation is the landless rural poor, who depend on forests (such as for hunting and gathering) for their livelihoods. The other rural groups, such as farmers, small merchants, livestock owners and artisans who are better-off, are also affected either directly or indirectly with the deterioration of the environment (such as soil and water quality, less productive farmlands).

The impacts of forest degradation are much more severe in the Central dry zone, delta and mountainous areas as people from these areas have fewer opportunities for alternative livelihoods with industries, services, government employment and trade. A significant indicator of environmental degradation, particularly in the Central dry zone, is mass migration. As the environment becomes highly degraded and lands become unproductive, people from these areas migrate to other parts of the country or overseas.

4.2 Impact on the environment

Due to the effects of forest degradation and deforestation, the capacity of natural ecosystems to contribute to environmental quality has decreased and a number of plant and animal species have disappeared. Land degradation as a consequence of forest depletion, particularly soil erosion in upland agricultural areas and the country's dry zones has become a serious problem. More than 30 percent of the country's total cultivated land is estimated to be vulnerable to severe soil erosion, and this is increasing at an alarming rate. Human interventions aggravate these conditions, including excessive forest harvesting, monocropping and shifting cultivation.

Soil erosion in the upland regions is primarily due to clearing of vegetative cover and farming on steep lands (10° or above). The government recognizes that immediate actions are needed to safeguard the stability and productivity of upland farms through extension support for soil conservation methods (including vegetation restoration) and provision of related technologies to farmers. However, if the decline in funding for forest conservation and rehabilitation measures is not reversed, the problem of land degradation and increasing trend of vulnerable farmland will continue.

Deforestation and degradation when unchecked over time could lead to local climate change and desertification, particularly in areas where the original natural environment is harsh (e.g. low rainfall, high temperature and poor soil fertility) such as the Central dry zone of Myanmar.

4.3 Impact on biodiversity

Various forest types of Myanmar are inhabited by a vast array of plants and wildlife species. Conservation of these biological resources has been incorporated in the broader scope of nature and wildlife conservation which is regarded as one of the national priorities. Protection of soil, water, wildlife, biodiversity and the entire environment is identified as an important imperative in the 1995 Myanmar Forest Policy. Consequently, various wild plants and animals are protected and conserved through establishment of PAS and the Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law, 1994. The total extent of PAS was approaching 6 percent of the country's total land area in 2012 and is still under expansion.

However, the Indo-Myanmar 'hotspot' is highly threatened; it is likely to lose most plants and vertebrates as a result of continued forest cover loss (Brooks et al. 2002). Throughout the hotspot, a combination of economic development and human population growth is placing increasing pressure on natural habitats and species populations.

4.4 Impact of forest management/governance

Following the loss of extensive areas of its natural forests and the impact of much more severely degraded land, the government recognized the failure of custodial forestry in the 1990s and this led to a search for alternative approaches. The state has realized the importance of people-based development to ensure sustainable forest resources for environmental, economic and social purposes. The Forest Policy 1997 provides the basic directions for public awareness raising and people's participation, and the Community Forestry Instructions 1995 provide the basis for local community participation in forest management.

In addition, in 2011, the state was apparently trying to reduce reliability on forest resources for development, including reducing logging and log exports, arranging alternative household energy for rural communities and creating non-forest-based alternative job opportunities for local communities. The last decade has seen increased commitment by the state to community-oriented forest management.

5. Implementation of forest restoration and rehabilitation initiatives

5.1 History of initiatives, strategies and techniques

5.1.1 Plantation establishment

Establishment of forest plantations has been seen as the main remedy to restore forest cover in the country. Plantations for commercial purposes, local and industrial use and watershed protection have been encouraged to fulfill domestic requirement, exports and environmental preservation. Compensatory plantations to enrich existing natural forests were initiated as early as the late 1850s. In the early 1970s, mass planting schemes were chosen due to the rapid rate of natural forest degradation and deforestation. The Myanmar Forest Policy, 1995 also encourages forest plantations in order to supply local and industrial use as well as to improve the natural environment. Four main types of plantations are classified by MOECAF – commercial, local supply, industrial and watershed. Under MOECAF, both the Forest Department and the DZGD are responsible for establishing them. The Forest Department has established all four major types of plantations but the DZGD has concentrated on establishment of local supply and watershed (environmental conservation and restoration) plantations in the Central dry zone. Forest plantation areas by types in 2000, 2005 and 2012 are shown in Table 7.

Table 7. Forest plantations in Myanmar by year and type

Classification	2000		2005		2012	
	Area (ha)	% share	Area (ha)	% share	Area (ha)	% share
Commercial	371 355	53	396 263	46	480 534	48
Local supply	197 209	29	254 460	30	250 920	25
Industrial use	50 394	7	64 581	8	72 488	7
Watershed	77 408	11	134 566	16	192 270	20
Total	**696 366**	**100**	**849 870**	**100**	**996 212**	**100**

Sources: FAO (2010a); MOECAF (2012).

Establishment of all four types of plantations has gradually increased over time. Commercial plantations (mostly teak) constitute the highest share, up to 48 percent of total plantations established in the country. Local supply plantations (mostly village fuelwood plantations) stand second at 25 percent, followed by watershed (environmental conservation and restoration) plantations and industrial plantations (such as eucalyptus plantation for pulp and paper). Currently, MOECAF has a target to establish around 10 000 ha of forest plantations annually. In addition, although no target has been set, an estimated 8 000 ha of privately-owned commercial forest plantations have been established by private companies and an average 2 400 ha of community forest are established by communities every year.

5.1.2 Expansion of PFE area

A significant indicator of the state's commitment to forest restoration and rehabilitation is the increase of PFE area following promulgation of the 1997 Forest Policy. PFE comprises RF, PPF and PAS, which were well protected and conserved under forest law in 1992. The 1995 Forest Policy set the targets of expanding RF to 30 percent of the total land area and setting aside no less than 5 percent of total land area as PAS (up to 10 percent in the long term). Figure 3 shows the percentage of PFE area to total land area between 1980 and 2015.

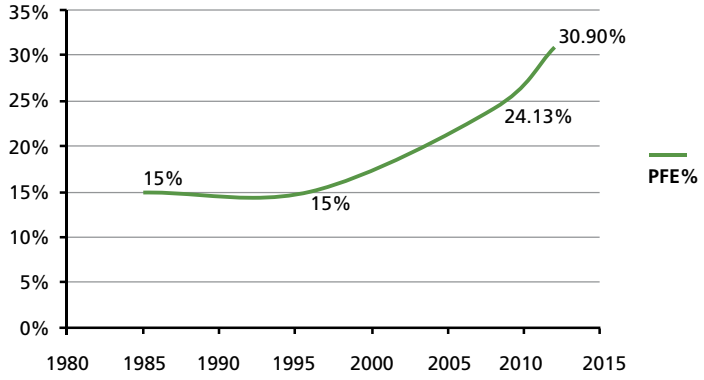

Figure 3. PFE area percent to total land area

Source: MOECAF (2012).

Before the policy target was set, the total percentage of PFE to total land area was stagnant at only about 15 percent for more than ten years (from 1985 to 1997). It had increased to 24.13 percent by 2008, just ten years after the 1997 Forest Policy. In 2012 it reached 30.9 percent of the total land area. As the long-term targets for RF and PAS have not been fulfilled yet (RF-18.5 percent and PAS 5.7 percent by 2012), further increment is still possible. Despite this positive trend, severe forest degradations and setbacks (such as land-use changes) have been observed even in PFE areas; keeping as much land as possible under PFE with full legal protection would be a significant effort towards restoration and rehabilitation.

5.1.3 Community forestry development

Deforestation and forest degradation became apparent in the late twentieth century. It is agreed that one of the main causes is lack of people's (mainly forest dwellers) participation and understanding of forest conservation, management and benefit sharing (Ba Kaung 2006).

To address this weakness, the CFI was issued by the Forest Department in 1995.
The main objectives of the CFI are:

- To achieve active participation by the rural population in tree planting on barren lands and to reforest degraded areas;
- To meet the basic needs of local communities; and
- To support the economic development of the country and regain environmental stability.

Many foresters and related professionals welcomed the CFI as a major breakthrough in the Myanmar forestry sector as it establishes the shift from centralized police-style forest management to decentralized community-based forest management. Since then, community forests (CFs) have been gradually established throughout the country and many international and national NGOs and civil society groups have encouraged and assisted their development. The total CF area reached 33 070 ha in 2005 and rose to 47 204 ha with 29 945 user group members in 2012 (MOECAF 2012). CF establishment is significantly higher in areas that are severely degraded and highly vulnerable to climate change, such as the dry zone (Sagaing, Mandalay and Magway regions), Shan Plateau and the Ayeyarwaddy Delta. Seventy-five percent of the CFs in the country is established in these regions.

The main reasons for establishing CFs in these critical areas is to rehabilitate the degraded environment, to improve local soil and water quality and to supply the basic needs (particularly fuelwood and fodder) of the rural poor, rather than for commercial exploitation of valuable timber. Establishment of CFs according to the CFI has been seen as a promising way to rehabilitate degraded landscapes and to improve farming through enhanced soil and water quality to meet the basic needs of very poor communities.

5.1.4 Development of the DZGD

The dry zone of Central Myanmar is the most critical region in terms of land degradation caused by continued deforestation (Figure 4). All possible measures have been taken to prevent and check environmental deterioration and land degradation since the 1950s. In 1954, a dry zone rehabilitation project was initiated by the Agriculture and Rural Development Corporation (ARDC) in collaboration with the Forest Department to carry out tree-planting activities in denuded lands. In 1994, the Forest Department implemented a special 'Greening Project' for the nine districts of the arid zone of Central Myanmar. During the project period, 7 280 ha of village plantations were planted on denuded lands in the vicinity of the villages for greening purposes and to supply fuelwood, poles and posts.

Figure 4. Desert-like formation in the Central dry zone of Myanmar

In 1997, a new department called the Dry Zone Greening Department (DZGD) was instituted under MOECAF in order to accelerate the implementation of greening and rehabilitation activities focusing on the Central dry zone. The four main tasks of the DZGD are:

- To establish forest plantations for local supply and greening of the environment;
- To protect and conserve the remaining natural forests;
- To promote the use of fuelwood substitutes; and
- To develop water resources in the region.

A 30-year comprehensive master plan for dry zone rehabilitation was drawn up for the period 2001-2002 to 2030-2031. The targets and achievements up to the 2013-2014 fiscal year are cited in Table 8.

Table 8. Targets and achievements of DZGD activities

Activity	Unit	Target	Accomplishment up to 2013 - 2014
Establishment of forest plantation	Million ha	0.425	0.143
Protection of remaining natural forest	Million ha	0.728	0.81
Utilization of fuelwood substitutes (a) Utilization of efficient stoves (b) Utilization of briquettes (c) Utilization of agricultural residue	 No. No. (million) Tons	 900 000 135 450 000	 8 880 95 320 000
Water resources development (a) Construction of ponds (b) Construction of check-dams (c) Drilling of tubewells	 No. No. No.	 2 100 4 300 150	 1 741 2 240 116

Source: DZGD (2013).

5.1.5 Development of the Environmental Conservation Department (ECD)

Currently, Myanmar is working at mainstreaming environmental considerations into its long-term national development activities. In this context, the ECD was formed under MOECAF in 2012 with the following objectives:

- To formulate the Myanmar National Environmental Policy;
- To set up policy and strategy, and conduct short-, medium- and long-term projects leading to systematic cooperation in environmental management activities regarding each state's/region's sustainable development;
- To manage conservation and sustainable use of natural resources;
- To set up environmental pollution control processes with the goal of improving environmental conditions including air, water and soil; and
- To mainstream environmental conservation and climate change activities with the cooperation of the cabinet, related ministries and departments, private and international organizations.

In 2012, the ECD set up pilot areas for action in the Yangon, Mandalay, Sagaing, Ayeryarwady and Tanintharri regions, where socio-economic development and environmental conservation issues are emerging rapidly.

5.2 Economic assessment of different possible forest restoration/rehabilitation strategies

Myanmar so far has used two strategies for forest restoration and rehabilitation:

- Forest plantation establishment; and
- Protection of remaining natural forests.

5.2.1 Forest plantation establishment

In general this is applied in areas where natural vegetation is severely degraded or the land is almost barren. The main expectations of forest plantations in Myanmar are:

- To address increased demand for basic needs by communities;
- To develop the wood-based industry;
- To earn more foreign exchange in the long term; and
- To combat deforestation and forest degradation.

Economically, teak plantations in Myanmar in general are expected to achieve a cost-benefit ratio of 8.4 at 8 percent discount rate after 50 years of plantation establishment. However, forest plantation establishment needs high investment. The current cost for forest plantation establishment (mostly teak) by private companies on average is about US$1 000-1 300 per hectare in the first year alone. Average government expenditure for plantations currently is about US$300 per hectare per year. It is also a labour-intensive activity and a long-term investment. Therefore, many possible risks have to be taken into consideration. These include natural disasters such as forest fire, drought, floods, pest outbreaks and human-induced problems such as fire, grazing, illegal cutting, theft and land conflict.

From environmental and ecological points of view, plantations, mostly monocultures in Myanmar cannot replace all the functions of natural forests, even though the production of plantation forests is usually higher than that of natural forests. Commercial plantations (mostly teak) can yield an average of 15-30 m^3/ha/year against 1-5m^3/ha/year in natural forests. However, forest plantations are worth establishing on productive sites as they can maintain green cover, provide basic needs and can be replanted.

Technical information on species and planting techniques: Commercial plantations, mainly established by the Forest Department and private companies, employ the following species and methods:

- **Tree species** – mostly teak (*Tectona grandis*) and other hardwood species such as pyinkado (*Xylia dolabriformis*), padauk (*Pterocarpus macrocarpus*), yemane (*Gmelina arborea*) and yinma (*Chukrasia tabularis*).
- **Planting techniques** mainly use the taungya method as these plantations are usually established in degraded forest areas with favourable climatic and edaphic conditions. The planting steps include slashing and burning bushes and stumps, preparing seedlings or stumps in a nearby nursery in advance and planting them at the beginning of the rainy season (usually the end of May or beginning of June). Spacing of 12 by 12´ is quite common with planting density of 300 trees per acre (Figure 5). Following planting, weeding, fertilization, fire protection and protection from grazing animals and human beings is essential. Mechanical and silvicultural thinnings are applied as necessary before commercial exploitation or final cutting.

Land after slash and burn

Nursery establishment

Sapling planting

Figure 5. Commercial teak planting activity in Myanmar

For dry zone plantations established by the DZGD and communities living in the Central dry zone:

- **Tree species**: Drought-resistant, life-supporting (for fodder, fuelwood, greening of sites and soil/water improvement) indigenous species such as tama (*Azadirachta indica*), kokko (*Albizzia lebbek*), sha (*Acacia catechu*), dahat (*Tectona hamiltoniana*), htanaung (*Acacia leucocephala*) and mezali (*Cassia siamea*). Drought-resistant Australian species such as *Eucalyptus camaldulensis* are also widely planted in highly degraded areas of the Central dry zone.

- **Planting techniques**: Digging, refilling and planting with preprepared seedlings are employed in most dry zone plantations (Figure 6). The main reason for digging is to collect scarce rain water. Refilling with soil from elsewhere is also necessary to provide enough nutrients for young seedlings as the physical and chemical conditions of the soil at the site are very poor. Various pit/trench sizes/designs are employed based on slope conditions. The most common trench size on sloping ground is 6 x 1.5 x 1´ (with a centre pit of 1 x 1 x 1´), and on flat land is 3 x 3 x 1´ (with a centre pit of 1 x 1 x 1´). Following planting, weeding, fertilization, patching and protection from fire, grazing animals and human beings are essential. Watering and fencing are also important for the success of dry zone plantations.

Land preparation

Preparing a pit trench

Trench digging

Nursery

Figure 6. Rejuvenating the dry zone through land rehabilitation

5.2.2 Protection of remaining natural forests

This strategy is applied to rehabilitate large areas of degraded natural forests in a cost-efficient manner. It is applied in areas where genetic resources (such as mother trees and stumps) still remain and is carried out in both highly productive and low productive (e.g. the Central dry zone or mountainous areas) sites. Only government departments such as the Forest Department and DZGD undertake this work. Government expenditure is only about US$6.00 per hectare. Major field operations include checking the forest boundary, boundary repair, building of guards' houses in protected forest areas, clearing of inspection paths, putting up warning notices, assignment of forest guards (average of one guard for 250 ha) and regular patrolling of the area to protect against fire, grazing, illegal cutting, encroachment and other disturbances. Although the budget looks low on a per hectare basis, when extensive areas of 500 or 1 000 ha are treated, it is still workable and the minimum targets can be met. However, the approach could be made more productive with bigger budgets.

The outcomes are quite slow and not very apparent in the first few years. After three to five years the results can be impressive. If such protection is continued, even heavily degraded forest can regrow to its optimum condition in 15 to 20 years.

Compared to forest plantation, the long-term results are much more attractive in terms of environmental, ecological, social and economic values. Both local communities and foresters prefer this operation over monoculture plantations. It is a promising strategy to restore degraded forests in an efficient and effective manner.

5.3 Case study: Rehabilitation of Shin-ma-taung Hill in the Central dry zone of Myanmar

5.3.1 General characteristics

This is an isolated hill in central flat land peaking at 525 masl (Figure 7). The total area of 7 687 ha is made up of 7 300 ha of reserved forest and 400 ha of unclassed forests. Severe weather and environmental conditions such as low rainfall, high temperature and frequent droughts are common. The average annual rainfall has been 450 mm for the last 20 years. Maximum day time temperature rises to 45°C in summer months (March to May); the lowest temperature is about 12°C on winter nights (December to February). The soil is poor, mostly sandy gravel and rocky, and is not productive.

Natural vegetation is dry-thorn forests, dominated by *Acacia, Ziziphus* and Neem species. The area is well known for *Limonia acidissima*, locally called Thanakha, from which facial and body cream is made.

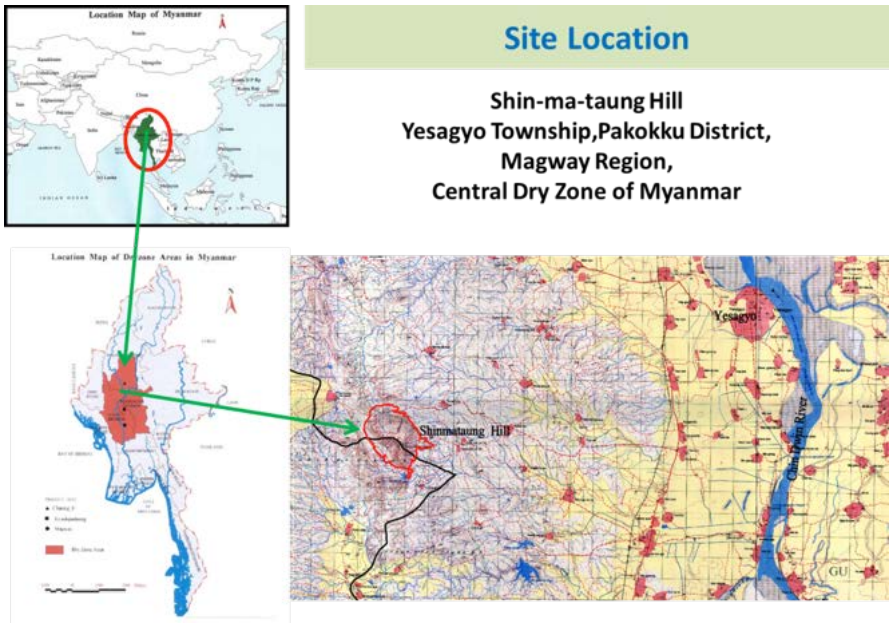

Figure 7. Location of Shin-ma-taung Hill

Source: DZGD (2013).

5.3.2 Deforestation and forest degradation in the area

Shin-ma-taung Hill used to be covered with good dry forest until the 1960s. Since the 1970s, the area faced severe pressure for logs, poles, posts, fuelwood and so forth. After 30 years of such intensive cutting and overexploitation, the once-green hill became highly degraded and partly barren. Local streams and ponds dried out, and the wild animals disappeared. Furthermore, the harsh climatic and edaphic conditions made it difficult for the degraded forests to recover naturally.

5.3.3 Rehabilitation efforts

Rehabilitation was initiated by the Forest Department in 1995. Since its formation in 1997, the DZGD took over this responsibility and has been carrying out the work to date.

The main strategy is a combination of plantation establishment and protection of remaining natural vegetation. The protection of remaining natural forests is applied where genetic resources (such as mother trees and stumps) still remain. From 1998 to 2003 a total 4 926 ha of degraded forest has been kept under continuous care and protection (Figure 8). Plantation establishment was applied in barren areas with no vegetation for natural recovery. In this case both village fuelwood plantation, community forest plantation, watershed plantation and hill regreening were established. The aim was to rehabilitate the area and also to provide basic needs for local communities. Trees used for plantation establishment are mostly local indigenous hardy species like *Acacia, Ziziphus* and Neem. From 1995 to 2001, 2 165 ha of forest plantation were established. This included 807 ha of village fuelwood plantation, 31 ha of community forest plantation, 324 ha of watershed plantation and 1 001 ha of hill regreening (plantation).

The total rehabilitated area, a combination of natural forest protection area and forest plantation, has reached up to 7 091 ha, or 92 percent of the hill area. Only 596 ha remain untouched. These untouched areas are mostly steep slopes and rocky areas that are difficult for any field operation. Authorities are expecting them to recover naturally over time.

Currently, after 18 years of continuous rehabilitation efforts, Shin-ma-taung Hill has been regreened, and provides all of its former ecological services (Figure 9). Streams and ponds have regained their sustainable water levels (even in the dry season), wildlife has returned (birds, squirrels, rabbits and deer), along with an abundance of fuelwood and fodder for local communities.

Figure 8. Shin-ma-taung Hill in 2000

Figure 9. Shin-ma-taung Hill in 2012

5.3.4 Conclusion

This case study clearly shows the success of a combination of two different forest rehabilitation strategies, i.e. forest plantation establishment and protection of remaining natural vegetation. If applied appropriately, with continuous follow up, even heavily degraded forest areas that are unproductive can be fully rehabilitated within two decades. At the moment, 17 severely degraded hills and mountains of the Central dry zone of Myanmar are being rehabilitated by the DZGD using this model.

6. Looking forward

6.1 Conditions for success

6.1.1 Reforming forest policies

The 1992 Forest Law regulates forest protection and management, establishment of forest plantations, extraction of forest products and administrative action against violations. It replaces the old Burma Forest Act of 1902. The law supports conservation, sustainable forestry and socio-economic benefits while also partially decentralizing and encouraging the private sector and community participation in forest management.

The 1995 Forest Policy was promulgated with the assistance of FAO, aiming for a more integrated approach towards forest protection. The policy provides basic fundamentals to preserve the environment and biodiversity, to promote sustainable management of natural forests and to establish forest plantations. Specifically, the law and policy advocate for a participatory approach to forest management, including community forestry for supplementing livelihoods.

The policy contains six imperatives:

1. Protection of soil, water, wildlife, biodiversity and the environment;
2. Sustainability of forest resources to ensure perpetual supply of both tangible and intangible benefits accrued from the forests for present and future generations;
3. Provide basic needs for fuel, shelter, food and recreation;
4. Efficiency to harness, in a socio-environmentally friendly manner, the full economic potential of forest resources;
5. Community participation in forest management; and
6. Public awareness about the vital role of the forests for the well-being and socio-economic development of the nation.

Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law, 1994: This law protects Myanmar's wild flora and fauna, conserves natural areas and fulfils obligations under international agreements. The law stipulates the establishment of scientific reserves, national parks, marine parks, nature reserves, wildlife sanctuaries and national heritage sites, as deemed necessary, in order to conserve wildlife, wild plants, scenic beauty and natural areas of geophysical or cultural significance. It aims to meet the requirements of international conventions agreed to by the state for the protection of wild flora and fauna and representative ecosystems in the country.

Forest Rules and Community Forestry Instructions 1995: This regulates sustainable forest management and forest plantations, and promotes community participation. Importance is given to public participation in forest management and private sector involvement is highlighted in the Forest Rules and Community Forestry Instructions issued in 1995 to fulfil this law.

In brief, forest management in Myanmar has been strengthened through the adoption of sound policy and institutional measures. The fundamental factors mentioned in the 1995 Forest Policy and related laws are to address existing situations and trends in Myanmar. However, key points are not yet fully addressed. The areas urgently in need of attention or implementation are:

- Decentralizing and encouraging the private sector to participate;
- Community participation in forest management and utilization;
- Raising public awareness about the vital role of forests;
- The sustainability of forest resources; and
- To realize the full economic potential of forest resources.

The main reason for this gap is that the Myanmar Forest Policy 1997 and related laws stand alone as a single-sector policy with no proper links or harmony with other related sectors which are also dealing with land management, rural livelihoods, energy and development. In the context of forest policy development, Myanmar needs to merge and fix other relevant policies such as those pertaining to agriculture, energy and rural development.

Myanmar's recent major developments of significance for integrated environmental and natural resource management are summarized below.

Myanmar Agenda 21, 1997: As an initial measure to integrate environmental considerations into economic policy-making and to establish a sound environmental management system, Myanmar drafted the Myanmar Agenda 21 in 1997. This aimed to achieve sustainable development and promote biodiversity conservation through the involvement of local communities in designing and planning protected area management, gathering data, consultation and decision-making. It contains programmes and activities that promote environmental protection, including social, economic, institutional and infrastructural strengthening thrusts. It aims at strengthening and encouraging systematic environmental management in the country and recognizes the need for environmental impact assessments (EIAs).

Environmental Conservation Law, 2012: Myanmar's new Environmental Conservation Law, based on a draft written in 1998 and on the inputs of four prominent local NGOS, is composed of 14 chapters that define the rights and responsibilities of MOECAF, environmental standards, environmental conservation, management in urban areas, conservation of natural and cultural resources, business application processes for an enterprise that has the potential to damage the environment, prohibitions, offences and punishment.

National Environmental Conservation Committee (NECC) (2013): The committee is composed of 23 relevant government ministries related to sustainable land management (SLM) and sustainable forest management (SFM) in order to facilitate cross-sectoral issues of SLM/SFM in a coherent and integrated approach.

6.1.2 Reconciling global and national policies

Myanmar is a signatory to various international agreements concerning the conservation and sustainable use of natural resources. In general, Myanmar's commitments to these agreements have yet to be fully translated into effective action. International and regional laws, treaties and conventions and agreements that Myanmar has participated in include: the United Nations Convention to Combat Desertification (UNCCD), the Convention on Biological Diversity (CBD), the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on International Trade in Endangered Species (CITES) and the Kyoto Protocol.

6.1.3 Strengthening institutions and markets

Institutional reforms: The success of forest management also depends on the efficiency and effectiveness of related institutions. The Ministry of Forestry became a separate entity in 1992 when the Ministry of Agriculture and Forest was restructured into two separate ministries. The name of the ministry changed to the Ministry of Environmental Conservation and Forestry (MOECAF) in 2011 as the new democratic transition government intends to put more emphasis on environmental conservation rather than conventional forestry operations. Nowadays, MOECAF is structured into the Planning and Statistics Department (PSD), the Forest Department (FD), the Myanmar Timber Enterprise (MTE), the Environmental Conservation Department (ECD), the Dry Zone Greening Department (DZGD) and the Survey Department (SD).

The PSD coordinates and facilitates the work of the remaining organizations according to directives issued by the Minister's Office. The FD is responsible for the protection, conservation and sustainable management of forest while the MTE carries out timber harvesting, milling, downstream processing and marketing of forest products. The ECD, newly formed in 2012, is the national focal point and coordinating agency for environmental matters dealing with environmental policy planning at the national level. Environmental deterioration such as forest degradation and depletion is an important concern of the department. The DZGD performs reforestation of degraded lands and environmental restoration in the Central dry zone of Myanmar. The SD re-entered into MOECAF in 2012 from the Ministry of Agriculture and Irrigation (MOAI) and is solely responsible for land survey and mapping.

Institutional structures, facilities and staff capability of existing forestry-related government agencies including training institutions such as the University of Agriculture, University of Forestry and relevant vocational training schools are considered below international standards and underfunded.

In addition, the MTE, the largest and most adequately funded body under MOECAF is actually an economic enterprise. Until 1962, timber extraction and trade were carried out by private companies under the close supervision and monitoring of the FD in accordance with the Forest Law. Under the socialist government, the MTE was formed as a government agency to control all timber harvesting and trade by the state. Under existing market-oriented economic reforms, the MTE needs to be dissolved and privatized in order to get more government funds to strengthen the institutions that include conservation in their activities, such as the FD, ECD, DZGD and the University of Forestry.

Market reforms: In June 2012, President U Thein Sein announced a 'second wave' of economic reforms aimed at developing the private sector. New laws, such as the Foreign Investment Law have been passed. New business opportunities in Myanmar are blooming in almost every sector of the economy. Myanmar has vast forestry resources but investment in capital and advanced technology within this sector is quite low. There is room to invite foreign investment in value-added product production.

6.1.4 Formulating approaches for equitable social benefits

SLM and SFM are the foundations of a green economy. Green economy is defined by the United Nations Environment Programme as an economy resulting in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities." This concept is in line with the increasing recognition that economic growth and long-term profit can and should be accompanied by environmental and social considerations for incremental benefits. This idea is gaining priority on the agenda of governments, companies and investors worldwide, which voluntarily agree to incorporate social and environmental concerns into their core business base – because it makes business sense.

Such concerns are also at the basis of the notion of corporate social responsibility (CSR), the idea that businesses should be socially and ethically responsible, and of impact investments, those that allow the capital investor to simultaneously pursue economic objectives while also generating positive social and environmental returns.

The Myanmar National Sustainable Development Strategy – NSDS (UNEP 2009b) also clearly mentioned the three perspectives of sustainable management of natural resources, integrated economic development and sustainable social development.

Action needed to improve and revise current policies, regulations and ongoing thrusts:

- The 1992 Forest Law and 1994 Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law should be reviewed and revised to be in line with current developments of national and international trends;
- The Forest Rules and Community Forestry Instructions 1995 should be upgraded to legal status or incorporated in the Forest Law, so as to assure or guarantee land allocation for CFs and boost public interest in CF establishment;
- Before rapid CF expansion, there is a need for review of existing CFs, as roughly 50 percent of them are suboptimal and may not benefit local communities.
- Formulation of rules and regulations so the Environmental Conservation Law 2012 can be adopted and implemented effectively is urgently warranted.
- The National Forest Master Plan (NFMP) 2001 should be reviewed and revised as necessary.
- Private investments in forest land restoration such as establishment of commercial plantations by private companies should be strongly promoted.
- In highly vulnerable areas such as the Central dry zone, hilly regions and the delta area, conservation of remaining natural forests should remain the priority over establishment of new plantations by clearing existing natural vegetation.
- Alternative household energy sources are needed in order to reduce high dependency on forests for daily household energy requirements (fuelwood, charcoal etc.). There is a need for a complementary energy policy for fair share and management of the nation's rich energy resources such as oil, gas and hydropower.

6.2 National strategy for forest and landscape restoration

6.2.1 Public awareness

Raising public awareness about the importance of forests and inducing public participation in forest resource management are crucial themes for achieving SFM and successful forest and landscape restoration. Two out of six imperatives of the 1997 Myanmar Forest Policy address public participation and awareness-raising:

- Community participation in forest management; and
- Public awareness about the vital role of forests for the well-being and socio-economic development of the nation.

The 1992 Forest Law also focuses on awareness and participation in the conservation and sustainable utilization of forest resources, and stresses the importance of collecting and updating resource information; planning; continuous monitoring of all forest operations; and maintaining ecological balance and environmental stability.

The major institutions striving for public awareness-raising on forestry-related issues are the Forest Department and the DZGD of MOECAF. The Forest Department has formed an extension division to take responsibility for forestry and environmental extension, information sharing and disseminating knowledge on sustainable forest and land management, forest degradation and the importance of restoration. The DZGD on the other hand is launching village-level environmental education programmes in all 54 townships of the Central dry zone of Myanmar. The main aim is to educate rural communities about the importance of trees and forests for their daily livelihoods and how they can participate in conserving and restoring the heavily degraded forest resources of the area. In addition, these two departments are encouraging and assisting communities to plant trees in degraded forests, barren lands, village tracts, farmyards and household compounds for fuelwood and other forest products.

In recent years, environmental NGOs and civil society groups in Myanmar have played an important role in promoting environmental knowledge and awareness. Their willing involvement should be highly encouraged and MOECAF should create a platform for all non-government and government organizations to share knowledge and work together on forest landscape restoration.

6.2.2 Planning, monitoring and evaluation

Planning/policy development framework: Environmental issues are now being incorporated into the national development plans. Myanmar's NSDS is the country's most recent commitment to long-term national development planning. The vision is 'Wellbeing and Happiness for Myanmar People'. Three goals, each with their own specific strategies, are specified:

- Sustainable management of natural resources;
- Integrated economic development;
- Sustainable social development.

The first goal suggests strategies for forest resource management, sustainable energy production and consumption, biodiversity conservation, sustainable freshwater resource management, sustainable management of land resources and sustainable management for mineral resource utilization.

National Forest Master Plan (NFMP), 2001: As forest resources play an important role both in socio-economic development and biodiversity conservation, the former Ministry of Forestry (now MOECAF) formulated the NFMP covering a time span of 30 years from 2001 to 2030 in order to maintain the forest biodiversity of Myanmar. The NFMP's strategic areas are: (a) management of natural forests, (b) establishment of forest plantations, (c) establishment of community forests, (d) growing trees in homesteads and non-forested areas and (e) promotion of wood-based industry value-added forest products.

The NFMP mandates an increase in PFE (constituted by reserved forests and public protected forests) to 30 percent and of PAS to 10 percent of the total country area. These targets reinforce and replace those set by the Forest Policy of 1995. Furthermore, the NFMP encourages the registration of unclassified forests into community or private forests.

Some of the NFMP's ambitious targets are to:

- Establish CF as an integral part of the strategy to achieve SFM and obtain forest products on a sustainable basis;
- Make a significant contribution towards lowering the annual deforestation rate of 220 178 ha per year;
- Achieve 919 000 ha of CF by 2030 (covering a little over 1 percent of the country's total land area) – the current CF area is about 42 000 ha; and
- Obtain 4.13 million m³ of woodfuel.

Dry Zone Greening Department Action Plan, 2001: In view of increasing reforestation and afforestation activities, particularly in the Central dry zone, the former Ministry of Forestry (now MOECAF) formed the DZGD in 1997 covering Mandalay, Sagaing and Magway. This has been outlined earlier in this paper. To provide general guidelines on effective implementation in the long run, the department has prepared a comprehensive plan for greening the dry zone as well as tackling desertification and drought. A 30-year master plan comprising five-year intermediate plans has been formulated and activities are being carried out accordingly by following the four strategic objectives cited above.

6.2.3 Monitoring and evaluation

An effective monitoring and evaluation (M&E) system is essential for every sustainable development programme. Currently the Environmental Conservation Department (ECD) under the guidance of MOECAF is responsible for overall observation and monitoring of the environment and the methodology for the elaboration of environmental impact indicators.

The Forest Department and DZGD have developed their own sets (no links with other line ministries or departments) of criteria and indicators for M&E of forestry-related programmes and projects. The Forest Department has sufficient capability to monitor land-use changes through integrated use of remote sensing and geographic information systems. The forest cover of Myanmar has been assessed four times (1955, 1975, 1989 and 1997) in order to determine the total forest cover area, to evaluate the dynamic status of forests and to analyse forest-related changes.

There is a need to develop an integrated M&E system composed of all institutions related to SLM/SFM such as the MOAI, MOECAF and Ministry of Mines. The combined team shall monitor and make continuous assessment on SLM/SFM programmes or projects, whereas evaluation is the periodic assessment of the relevance, success, cost-effectiveness and sustainability of these programmes or projects.

Staff capacity and infrastructure at all levels need to be built up in order to implement this important task in line with international standards.

6.2.4 Financing

In Myanmar, about 15 percent of the country's total land area is degraded forests which need to be rehabilitated either by natural or artificial means, or both. The current budgetary allocation for the forestry sector accounts for only 10 to 15 percent of the revenue generated by the sector. In real terms it may be well below 5 percent. This means the present budgetary allocation severely limits forest management and also efforts towards conservation and restoration.

6.2.5 National budget

Financial flows towards securing SLM and relevant cross-cutting areas (including land, forest and water; trade and markets; environment management; climate change; food security; poverty reduction; security; and so forth) need to be strengthened and monitored as an ongoing process.

Financial resources for environmental and natural resource management are allocated to sectoral ministries or agencies. Of total expenditure of US$7 864.5 million, only US$519 million (about 6.6 percent) was allocated to the institutions most closely linked to the management of natural resources (agriculture, forestry, livestock, fisheries).

The new Environmental Conservation Department of MOECAF, established in late 2012, is meant to assume a more active coordinating and integrating role for environmental matters. In this context, it is critical that its annual budget be increased for better performance and to allow for provisions for financing future M&E activities.

6.3 The private sector

Private sector involvement in SLM activities is still very rare in Myanmar. Only a few local agricultural and forest plantation companies keen to address SLM/SFM for enhancing their own activities make some indirect contribution. Large-scale investors are still waiting for a favourable business environment as the country transitions from a highly centralized to an open market economy.

References

Ba Kaung. 2006. *Proposals on modification and amendments of Community Forestry Instruction (CFI) for successful community forestry establishment in Central Dry Zone of Myanmar.* Yangon, Myanmar Academy of Agriculture, Forestry, Livestock and Fishery Sciences.

Brooks, T.M., Mittermeier, R.A., Mittermeier, C.G., DaFonseca, G.A.B., Rylands, A.B., Konstant, W.R., Flick, P., Pilgrim, J., Oldfield, S., Magin, G. & Hilton-Taylor, C. 2002. Habitat loss and extinction in the hotspots of biodiversity. *Conservation Biology,* 16(4): 909-923.

Bryant, R.L. 1996. *Romancing colonial forestry: the discourse of "forestry as progress" in British Burma*. King's College, University of London.

Dry Zone Greening Department (DZGD). 2013. *Annual evaluation report of 2012 (in Myanmar).* MOECAF.

Food and Agriculture Organization of the United Nations (FAO). 2009. *Myanmar forestry outlook study.* FAO Working Paper No. AFPSOS II/WP/2009/07. Bangkok, FAO.

FAO. 2010a. *Global forest resources assessment 2010, Country report, Myanmar*. FRA 2010/141. Rome, FAO.

FAO. 2010b. *Global forest resources assessment 2010.* Rome, FAO.

FAO. 2011. *State of the world's forest, 2011.* Rome, FAO.

Forest Department. 2008. *Myanmar forestry statistics 2008.* MOECAF.

Forest Department. 2012a. *Mitigation of climate change impacts though restoration of degraded forests and REDD-plus activities in Bago Yoma Region, Myanmar (Project Completion Report 2011-2012).* MOECAF.

Forest Department. 2012b. Myanmar forestry outlook 2020 (Draft). MOECAF, Union of Myanmar.

Ministry of Agriculture and Irrigation (MOAI). 2008-2009. *Brief description of MOAI (in Myanmar).* MOAI.

Ministry of Environmental Conservation and Forestry (MOECAF). 2012. *Brief description of MOECAF (in Myanmar).* MOECAF.

Ministry of Mines (MOM). 2009-2010. *Brief description of MOM (in Myanmar).* MOM.

United Nations Environment Programme (UNEP). 2009a. Environmental Performance Assessment (EPA), Myanmar, Final Draft. Yangon, UNEP.

UNEP. 2009b. National Sustainable Development Strategy (NSDS), Myanmar, Final Draft. Yangon, UNEP.

Forest restoration at the landscape level in Nepal

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1. Overview of forest and land degradation and current status

1.1 Location and topography

Nepal lies between the arid Tibetan highlands to the north and the Indian foothills of the Himalayas to the south. The country has five development (administrative) zones and topographically it is divided into three main physiographic zones: the foothills (Terai) occupy 15 percent of the land area, the mid-hills (Shiwaliks) 13 percent and the mountains (Middle, High, High Himal) the rest of the land. Distinct climatic conditions exist which influence the type of vegetation significantly. In fact climate, soil, altitude (ranging from 60 to 8 848 m) and terrain aspects are the major factors which determine vegetation distribution (Bajracharya 1986).

1.2 Forest area

Nepal has a land area of 14.7 million ha. Of that forest covers 3.6 million ha (25 percent) and other wooded land about 1.9 million ha (Table 1; FAO 2010).

1.3 Changes in forest cover

According to Nepal's National Forest Inventory, in the 1960s, over 45 percent of the country used to be covered with forest (Table 2). This has since declined to 25 percent currently. The annual rate of change was around -2 percent in the 1990s, it moderated somewhat during 2000-2005 to -1.4 percent, but since then it has stabilized. In the process, the other wooded land or shrubland has continued to rise, from 4.7 percent in the 1970s to 10 percent in the 1990s (DFRS 1999); it is now approximately 13 percent (FAO 2010). Overall the country has experienced rapid loss of forest cover and degradation, and only in recent years has the situation leveled out.

Table 1. Forest area, trends and annual rate of change of forest area (x 1 000 ha) (FAO 2010)

Forest area	% land area	Other wooded land	% land area	Other land	Country area
3 636	25	1 897	13	8 767	14 718

Forest trends	1990	2000	2005	2010
Area	4 817	3 900	3 636	3 636

Annual rate of change	1990-2000	2000-2005	2005-2010
	-92 (-2.09%)	-53 (-1.39%)	0 (0%)

Table 2. Forest cover identified by different national forest inventories (%)

Vegetative cover	First NFI	Second NFI	Third NFI
	1963/1964	1978/1979	1993/1994
Forest	45	38	29.0
Shrub	-	4.7	10.6
Total	45	42.7	39.6

Sources: LRMP (1986); Bajracharya (1986); DFRS (1999).

1.4 Forest to population ratio

During the 1930s, population growth was modest at 1.0 percent but increased to around 2.2 percent in the 1990s. Forest cover declined dramatically with population growth and the decrease had a multiplying effect on the per capita forest area. As of 2011, this was 0.16 ha of forest and 0.06 ha of shrubland per capita. Many independent variables such as the

economic value of the Nepalese agrarian economy, immigration from India and high growth rates led to this decline in forest to population ratio (CBS 2011).

1.5 Land classification

Land-use classifications are given in Table 3 (CBS 2012). The figures indicate that land under cultivation and 'other land uses' has increased at the expense of forest areas. About 86 percent of the total area of Nepal (Table 4) is the fragile hill ecosystems (High Mountains, High Hills, Mid-hills and Shiwaliks), which need ecosensitive planning and management.

Table 3. Land-use pattern by type, 1978/1979-2001

Types of land	(Area in ha)					
	1978/1979*		1985/1986*		2001**	
	Area	%	Area	%	Area	%
Cultivated land	2 969 400	**20.1**	3 052 000	**20.7**	3 090 780	**21.0**
Non-cultivated land	986 900	**6.7**	998 000	**6.8**	1 030 390	**7.0**
Forest	5 612 400	**38.1**	5 518 000	**37.4**	4 268 200	**29.0**
Shrubland	694 000	**4.7**	706 000	**4.8**	1 560 110	**10.6**
Grassland	1 755 900	**11.9**	1 745 000	**11.8**	1 766 160	**12.0**
Other land	2 729 800	**18.5**	2 729 000	**18.5**	2 619 800	**17.8**
Snow-capped area, rocky surfaces, others			2 729 000	**16.3**		
Total	14 748 400	**100.0**	14 748 000	**100.0**	14 718 100	**100.0**

*WESC (2010); LRMP (1986) **DFRS (1999)

Table 4. Land use by agroclimatic zone, 1986

Land use (area in %)	Agroclimatic zone (area in 000 ha)						
	High Mountains	High Hills	Mid-hills	Shiwaliks	Terai	Total	%
Agriculture	7.8 (0.3)	244.4 (8)	1 224.6 (40)	268.0 (8.7)	1 307.9 (43)	3 052.7	20.7
Forest & afforestation	154.5 (3)	1 639.0 (30)	1 806.4 (33)	1 438.4 (26)	474.4 (8)	5 512.7	37.4
Pasture/meadow	884.8 (51)	508.0 (29)	279.6 (16)	16.3 (1)	58.0 (3)	1 746.7	11.8
Shrub- & degraded land	66.7 (9)	175.7 (25)	406.6 (58)	30.8 (4)	29.2 (4)	709.0	4.8
Non-agricultural use	1.9 (0.2)	147.7 (14.8)	666.7 (66.8)	57.5 (5.8)	124.3 (12.4)	998.1	6.8
Other uses	2 233.8 (82)	244.5 (9)	59.5 (2)	74.8 (3)	116.7 (4)	2 729.3	18.5
Total	3 349.5 (23)	2 959.3 (20)	4 443.4 (30)	1 885.8 (13)	2 110.5 (14)	14 748.5	
%	23	20	30	13	14		100

Source: CBS (1998).

1.6 Forest landownership

Nepal's forests are broadly divided into two ownership categories, national and private. National forests are further categorized into government-managed forests; community forests; leasehold forests; religious forests; and protected forests. A new community approach to productive forest management is 'collaborative forests'. Community, leasehold and religious forests are managed by local communities, also called forest user groups (FUGs), while government-managed and protected forests are directly administered and protected by government institutions.

Twenty-seven percent of national forests (1 652 654.18 ha) has been handed over as community forests to 17 685 FUGs (DoF 2012). Most of the community forests are in the hills. The community forestry programme covers several forest types, categorized into nine categories/forest types, of which *Shorea robusta* accounts for about 30 percent followed by *Pinus roxburghii* (15 percent). *Schima castanopsis*, an important multiple-product yielder covers about 13 percent of the hills. Topographically and physiographically, community forests are well distributed over the country. Leasehold forest is national forest handed over on a leasehold basis to any institution established under prevailing laws, forest-based industry or community stewardship. Leasehold forestry specifically targets the poorest and most marginal households. The average area of a leasehold forest is 3 to 20 ha, and the lease period is 40 years, extendable for another 40 years. Some 9 000 ha are now registered as privately-owned forest (CBS 2011).

About 20 percent of the forest area is under national parks and conservation protection which largely excludes any public use. The protected area system includes ten national parks, three wildlife reserves, six conservation areas, one hunting reserve and 12 buffer zones (ICIMOD/MOEST 2007; DoF 2012).

1.7 History of deforestation and forest degradation

The Himalayan region is one of the most fragile mountain ranges in the world and is increasingly being threatened by large-scale human activities. Extensive deforestation and intensive farming on steep slopes and heavy population pressure on natural resources have resulted in overall environmental degradation (Shengji and Sharma 1998). Most of the deforestation and degradation took place in the Shiwaliks and Terai; during 1965-1980, the losses amounted to 15.1 and 24.4 percent, respectively. Still, virtually all the forests in Nepal have been thinned during the last ten to 30 years; much of the mountain regions was cleared earlier in history.

1.8 Current status of forest degradation and deforestation

Forests play a vital role in economic, social and environmental sectors in Nepal. They are essential resources for daily subsistence of the rural poor. More than 86 percent of the population depends on forests for livelihood and socio-economic development. Forest degradation and deforestation pose a serious problem in Nepal.

Clearing of forest land for resettlement, roads, infrastructure and other development activities as well as encroachment, illicit felling and excessive grazing are adversely affecting the extent, productivity and sustainability of forest resources (NPC 1998). Major causes of change in forest cover in Nepal appear to be expansion of subsistence agriculture and large economic development programmes involving resettlement (FAO 1997).

The pattern of forest degradation changed after national forests were handed over to communities with management responsibilities. Currently, the forests in the hills have improved, primarily due to the community forestry programme. Another factor that has eased pressure on forests is the migration of many people overseas who seek better employment. Estimates state that some 14 percent of the mid-hill population and 6 percent in the Terai have been affected by the phenomenon.

Owing to remittances, dependents have moved to urban areas, and with the reduction in labour, many farmlands, especially in the hills, have been replaced by trees via natural regrowth.

Nepal's forestry sector is characterized by its somewhat contradictory achievements and weaknesses. On the one hand Nepal has, for the last three decades, successfully implemented a large-scale and globally-recognized community forestry programme that has brought more than 27.4 percent of the country's forest area under community management and has provided livelihood benefits for more than 2.1 million people, including many poor and forest-dependent households. This participatory programme has brought more than 1.7 million ha of previously degraded forest under sustainable management resulting in better forest condition, increased availability of forest products and improved ecosystem services. These groups, through co-management, generate cash incomes which they utilize for a range of community development activities and also to create local employment (DoF 2013).

2. Current status of land/forest cover

2.1 State of forest degradation and rehabilitation needs

The forest area has declined since the 1940s but began a positive upswing with the implementation of community forestry from the 1990s onwards. In general however, large tracts of former forest are now under shrubland which has increased in size. The total forest area in the Terai zone was 1.4 million ha with an annual deforestation rate of about 1.3 percent as against the previous rate of 3.9 percent (Tables 1 and 2) for the period 1978-1979 to 1985-1986. The DoF (2005) conducted a study of 20 Terai districts between 1991 and 2001, which estimated that the rate of change of forest land was -0.06 percent. However, there was a positive change in forest cover in six districts (DoF 2005) and the protected areas of the Terai districts (WECS 2010). To plan for rehabilitation, it is safe to assume that shrubland can be targeted. According to the recent NFI, 1.56 million ha of scrubland and degraded forest need to be rehabilitated. Various techniques and efforts can be underscored here but the major issue is that degraded forest could be rejuvenated through proper application of silvicultural techniques or plantations depending on the state of degradation.

2.2 Forests under non-forest use

In the aforesaid study by the DoF for the period 1991-2001, it was found that the Terai districts experienced a minimum loss of forest land, estimated to be 0.08 percent per annum. The results were confirmed by findings of a positive change in forest cover in the protected areas of the Terai districts (WECS 2010).

According to the most recent NFI (1993/1994), 1.7 million ha (12 percent) are grassland, 3.0 million ha (21 percent) farmland and about 1.0 million ha (7 percent) uncultivated lands. In sum, of the 4.27 million ha of forest, about 51 percent (2.18 million ha) is under forest use and the rest is under non-forest use (DFRS 1999).

3. Causes of forest degradation

3.1 Direct causes

In Nepal, forest degradation is identified as a major environmental problem. Most of the forests in the mid-hills are under community management and are well managed (Kanel 2004). Forests in the Terai, Shiwaliks and High Mountains are under severe pressure from biotic interference. In general, forests under government management face a high degree of uncertainty (MoEST 2006).

Crown cover is often taken as a proxy indicator to detect forest degradation. It may, however, not be a sufficient indicator to determine forest degradation. Canopy reduction will reduce carbon sink potential, but it may enhance watershed conservation and biodiversity. The understorey may remain intact. Conversely, loss of ground vegetation or understorey, which may not be detected, could also be a key degradation element, as it affects ecosystem resilience.

Sharma and Suoheimo (1995) found that about 45 percent of trees in the Makawanpur and Rautahat districts are affected by rot diseases. Acharya et al. (2012) found degradation of existing forest stock resulting from repeated logging practices; for example the sal forest (*Shorea robusta*) used to be well stocked (> 60 percent basal area), but following repeated cuts, it became a Terai hardwood forest (sal basal area < 20 percent).

The silvicultural practice of 'selection felling' is resulting in degradation of previous sal Terai hardwood forests to Terai hardwood (Rautianien 1994). It can be inferred that the overexploitation of this species has gradually changed sal dominance. MoEST (2006) estimated that over 28 percent of the total land of the country is undergoing desertification (Table 5).

Table 5. Land area under degradation in Nepal

Land-use category	Degraded area (million ha)	Total land area (million ha)	Degraded land (%)
Poorly-managed forest	2.100	5.828	36.03
Poorly-managed sloping terraces	0.290	2.969	10.00
Degraded rangeland/open land	0.647	1.750	37.00
Area damaged by floods and landslides (1984-2003)	0.106	11.551	0.72
Forest encroachment	0.119	5.828	2.04
Total	3.262	11.551	28.24

Source: MoEST (2006).

Besides poor forest management, several other drivers have been identified. They include:

- **Increasing demand for cultivable land** – as Nepal has an overwhelmingly agrarian economy, with over 49 percent of the 29 million inhabitants living on 0.6 million ha of cultivable land in the hills, heavy encroachment on forest has continued.
- **Land acquired for development projects** – forests have been targeted for conversion to agriculture, horticulture, plantations, industrial development, roads and other infrastructure development.
- **Increasing demand for fuelwood** – of the total fuel required, 86 percent is fuelwood (CBS 2010), the rest being animal dung and agricultural residues (CBS 2011). While people are beginning to switch to other fuels, 65 percent of the population is still dependent on wood for their cooking needs (CBS 2013).
- **Increasing demand for fodder and bedding material** – the Nepalese agrarian economy is dependent on livestock rearing. According to CBS (2010) there were 7.19 million cattle, 4.83 million buffalo, 8.76 million goats, 0.79 million sheep and 1.06 million pigs. Livestock impose on forests in two ways, i.e. year-round grazing and lopping of trees for fodder. They are also responsible for overgrazing, one of the principal reasons for forest degradation. While this occurs throughout the year in the Terai, it is seasonal in high elevation pastures. About 40 percent of the high mountain forests have crown cover of less than 40 percent (Acharya et al. 2012).
- **Increasing demand for timber** – the rapidly growing population places increasing demand on timber for building houses. People exploit timber far beyond their actual needs. In the central Himalayas about 70 m^3 of valuable wood are logged per house, although less than 20 m^3 would suffice if properly and efficiently used (Mauch 1974).
- **Invasive species** – invasion of alien species has emerged as an important driver of forest degradation, particularly in the Terai and High Hills. Alien invasive species are proliferating and invading the natural environment leading to destruction and shrinkage of native flora and fauna. Many natural habitats have been degraded by species such as *Mikania macrantha, Lantana camara, Parthenium* spp. and *Eichornia crassipes* (Paudel et al. 2007). Invasion and

colonization by alien species can slowly inhibit the growth and potential of regenerating forests and infestations can ultimately affect entire forests.

- **Illegal settlements** – encroachment drives forest degradation and may lead to the permanent conversion of forests to non-forest land uses. Until the late 1970s, encroachment was never considered a factor in forest degradation. It was rather used as a cost-effective tool by the government to clear forests for resettlement programmes (COMFORTC 2007). Due to an inappropriate distribution mechanism, most of the poor and landless were excluded and consequently they continued to stay in forests. A total of 70 256 ha of forest land was found to have been encroached in 24 Terai and Shiwalik districts (Adhikari 2002).
- **Forest fire** – every year forest fires destroy many forests in Nepal. They are common during the dry spring season, when they spread over a large area destroying considerable amounts of biodiversity over hundreds of hectares of forest and croplands. High intensity crown fires in Himalayan National Parks and Conservation Areas have occurred for the first time in history (Wagle 2011).

3.2 Underlying causes

Market failure: Widespread commercialization of forest products, especially the trade in high-value timber from the Terai, has been one of the least successful aspects of Nepal's Forest Sector Master Plan (1988-2010). The open border system and sales of smuggled timber, and timber trade practices characterized by controls and distortions have resulted in considerable loss of revenue from forests.

Institutional failures: The DoF, which is understaffed and low in morale, is unable to control illicit felling, timber smuggling and other forest-related offences. Absence of proper management has further expedited degradation.

Political and socio-economic factors: There are regular media reports of deforestation and encroachment, illegal logging and corruption in forestry organizations. Recent estimates claim that some 84 000 ha of forest are being lost through illegal encroachment annually.

Inappropriate policy: Government policies have historically had the largest impact on forest degradation in Nepal. Throughout the eighteenth and nineteenth centuries, Nepal had taxes on both land and labour. Land taxes amounted to the payment of one-half of a farm's produce to the government. These taxes could be avoided if a farmer chose to convert forest into agricultural fields, wherewith she/he could enjoy a three-year tax break. The labour tax in Nepal during the eighteenth and nineteenth centuries required each family to work at least 75 days per year for the state. The tax could be avoided if the family was willing to supply a fixed quantity of fuelwood, iron, charcoal or other materials. This policy often increased the degradation of forests. One village, for example, had to supply 2.4 kg of charcoal each day, for which it had to clear 3 ha annually.

On the other hand, during the late nineteenth and early twentieth century, exploitation of forests was formalized through the legal judicial process under the rule of Janga Bahadur Rana (1847-1877). A number of rules were drawn up and reformed between 1870 and 1940 to regulate access to forests and removal of forest products, meeting the costs of the regime and timber needs of British India.

Remaining within the strategy, 'The Act of Private Forest Nationalization – 1957' was enacted (HMGN 1957). All privately-owned forests larger than 1.25 ha in hills and 3.5 ha in the Terai were nationalized. The Act also recognized the traditional practices of forestry by communities. Promulgation of the Private Forest Nationalization Act 1957 appears to have led to degradation (MoEST 2001). Forests around and in the vicinity of villages were cut recklessly.

The policy took a shift with the introduction of a people-based forest management system. The Forest Act 1978 re-introduced use rights to forest, this time through community/groups retaining the earlier rights over the national forests. The Act outlined rules and regulations to implement the use rights of the public.

4. Impact of forest degradation

The degradation of the Himalayan mountain environment not only affects the livelihoods of mountain communities but also has a significant impact on the adjacent plains (ICIMOD 1993). Degradation of natural resources and loss of biodiversity in the Nepal Himalaya have become a major concern, and the sustainable management of biological resources and conservation of biodiversity have emerged as major challenges.

It is difficult to estimate the total value of forestry to Nepal as a great deal of activity is at the subsistence level and therefore does not appear in trade statistics. The government estimates that forestry accounts for around 15 percent of the GNP. In 2008 forests generated 9 percent of the GDP but in 1988/1989 forestry accounted for only 3.2 percent of total government expenditure (Acharya et al. 2012). MoFSC (1988) estimated that the total value of the annual consumption of timber, fuelwood and fodder was NR10 500 million, NR12 700 million and NR3 150 million respectively, of which 90 percent of the timber and fuelwood and 99 percent of the fodder were consumed in Nepal without entering the market.

Other minor forest products which are important in the domestic context are pine resin, lokta and bamboo for paper-making, thatching grasses for roofing and a plethora of medicinal herbs and shrubs. No estimate appears to have been made of the total value of these products.

4.1 Environmental degradation in Nepal

About a quarter of the population of Nepal depends on the forest for employment and collection of forest products. This has resulted in heavy depletion of forests, leading to serious environmental degradation. According to Eckholm (1976) there is probably no other mountain country where the forces of escalating ecological degradation have been so rapid and visible. It is obvious that the destruction of hill and Terai forests is increasing due to demand for cultivable land, fuelwood, fodder and timber (Rieger 1976).

Denudation: Denudation is the consequence of the increasing pressure of human and ruminant populations on forest resources. It has been widespread in many hill regions of Nepal, and its pace has accelerated in recent times. Deforestation at the tops of ridges and hills in many areas has presumably lessened the moisture-retaining capacity of the soil.

Soil erosion: Closely associated with the problem of deforestation is soil erosion. Unrestricted and unscientific terraced cultivation and excessive overgrazing have been increasing the rate of erosion. Deforestation and soil erosion are inseparably linked with each other. For an agrarian economy, soil is vital for producing basic necessities. It has been estimated that 240 million m^3 of soil are lost every year in Nepal.

Landslides/natural disasters: There may be natural landslides, but human intervention (especially on forest ecosystems) has increased their frequency and gravity. A mountainous country like Nepal that experiences loss of forest cover faces severe threats from landslides. Every year landslides and floods result in human and animal mortality, generating considerable economic damage. On average 300 lives are lost, 8 600 homes are destroyed and 12 000 to 15 000 ha of arable lands are washed away annually (NPC 1991). This is partly attributable to deforestation.

Siltation: Siltation occurs because of erosion and frequent landslides. The rivers become filled with silt in the summer. Due to raised beds, during monsoon rains heavy floods occur changing the usual river course and contributing to the destruction of irrigation canals, structures and human settlements (WECS 2010).

Biodiversity: Loss of biodiversity is occurring at all levels while ecosystems are being degraded and destroyed. Various species are being driven to extinction due to deforestation and other activities, but the magnitude of such loss is not known exactly.

Cultural heritage of indigenous people: Damage induced by deforestation to the unique cultural heritage of tribal people is irreparable. The Chepang tribes in the mid-hills, formerly artisans and cereal traders, have been forced to change to farming or manual labour. In the long term, deforestation and forest degradation could also damage ecotourism such as trekking, hiking and rafting.

5. Implications of forest restoration and rehabilitation initiatives

5.1 History of initiatives, strategies and techniques

National-level degradation control – history of policy measures: Until 1951, forest resources were used as one of the main sources of government revenue. After 1951, the government gradually enacted several policies and legislations with regard to forest resource development. The most prominent policies and legislations include: the Forest Nationalization Act 1957, the Wildlife Protection Act 1958, the Forest Act 1961, the Forest Protection Act 1967, the National Parks and Wildlife Conservation Act 1973, the National Forestry Plan of 1976, the Panchayat Rules and Panchayat Forest Rules 1978, the Soil Conservation and Watershed Act 1982, the National Conservation Strategy 1988, the Master Plan for the Forestry Sector 1989, the Forest Act 1993, the Nepal Environment Policy and Action Plan 1993, the Environment Protection Act 1996, the Forestry Sector Policy 2000, the Nepal Biodiversity Strategy 2002 and the Leasehold Forestry Policy 2002.

The Master Plan for the Forestry Sector (1989) and other conservation policies have developed many strategies and programmes to cope with deforestation and forest degradation. Of these programmes the community forestry and leasehold forestry programme is an effective intervention to halt and reverse degradation and deforestation. At the moment, the government has handed over a total of about 1.7 million ha of state-owned forests to 18 133 CFUGs for development, conservation, management and sustainable use (DoF 2013). The government, with the financial assistance of the International Fund for Agricultural Development (IFAD) and technical support from FAO, has been implementing the pro-poor leasehold forestry programme that has been effective in reversing environmental degradation.

The Terai Arc Landscape (TAL) Strategic Plan (MoFSC 2006) aims to restore and conserve forest resources outside protected areas to maintain ecological integrity and support sustainable livelihoods. The plan envisages the restoration of 70 percent of degraded forests via natural regeneration and 30 percent via plantation. The restored corridors and bottlenecks will contribute to restoring degraded habitats and reducing grazing pressure in the future. MoEST (2006) has estimated that an area of about 18 000 ha was rehabilitated annually (Table 6).

Table 6. Land under rehabilitation

Land area under rehabilitation	Area (ha)	Remarks
Rehabilitation of degraded croplands	5 176	Rehabilitated annually
Rehabilitation of degraded rangelands	900	Rehabilitated annually
Rehabilitation of degraded forests	12 992	Rehabilitated annually

Adapted from MoEST (2006).

Many forestry sector programmes such as community forestry, leasehold forestry, pasture development, soil and water conservation, conservation of protected areas and development of markets for non-wood forest products (NWFPs) are being implemented in selected locations with increased people's participation. Enhanced attempts are underway to manage the buffer zone areas surrounding the protected areas for biodiversity conservation. Buffer zone management scheme areas are already underway using the participatory approach, however, the objectives are different.

Forest management and development plans were developed for a number of national forests but with limited or no implementation. This has resulted in poorer results than expected in terms of rehabilitation, production, number of forest industries, employment and overall contribution to the economy. The Ninth and Tenth Five Year Plans (1998 and 2002/2003) attributed this condition to lack of proper allocation of funds and attention to the forestry sector.

Involvement of NGOs: The forest and biodiversity resources of Nepal are scattered and it is not possible for the government to manage them alone. NGOs are therefore mobilized as necessary for sustainable forest resource management. The Nepal Trust for Nature Conservation, the Mountain Institute, WWF, IUCN and so forth are all involved in biodiversity conservation and sustainable forest resource management.

Coordination among donors and the government: Nepal has maintained relations with many countries and organizations as development partners. In order to achieve better coordination, the MoFSC has formed the Forestry Sector Coordination Committee (FSCC). The FSCC discusses problems and gives advice to the government, maintains uniformity in programme implementation and also avoids duplication of activities.

International cooperation: The forestry sector of Nepal has received technical and grant assistance from foreign aid for more than 40 years. Due to the low revenue surplus from the forestry sector, financing of development expenditures for the forestry sector is largely met by foreign aid, as the government has allocated less than 2 percent of the total national budget for the sector. A significant number of forestry sector development programmes and projects have been financed with foreign aid.

5.2 Technical approaches

Along with the policy framework to curb deforestation and forest degradation, technical backstopping has also been enhanced. The Department of Forest Research and Survey (DFRS) under the MoFSC started its research on rehabilitation of degraded land in 1963. The species elimination trial of local and exotic pines identified *Pinus roxburghii* to be suitable for degraded sites in the hills of Nepal.

The DFRS (then the Forest Resources Survey) carried out NFIs which helped to identify the extent, nature and location of forest degradation and deforestation in the country. In addition to support, it assisted policy-makers with the planning of forest resource management.

In 1976-1978, all operating donors in the forestry sector supported the need to restore and rehabilitate degraded forests. A small grant for forestry research was allocated for the DFRS to implement 'project-focused research'. For example, the Hill Community Forestry Project (World Bank), Terai Community Forestry Project (ADB), Resources Conservation and Utilisation Project (USAID), Integrated Hill Development Project (SDC) and the Integrated Bheri Carnali Rural Development Project (CIDA). In addition, Overseas Development Assistance (ODA, UK) projects had their own research activities carried out in the Pakhribas Agricultural Centre (Dhankuta in the Eastern Region) and Lumle Agricultural Centre (Kaski in the Western Region).

To identify and document techniques for successful rehabilitation through plantations, the Silvicultural Research Project (SRP) conducted all essential research and established necessary facilities to obtain and store high quality seed. Breeding seedling orchards were established, and collaboration with the Tree Improvement and Silviculture Component (TISC) was enhanced. Laboratories were established to test seed quality. Nursery techniques of all important and planted species were identified and documented. Nurseries were established in all the Silvicultural Trial Units.

Research was conducted on rehabilitation and plantation of diverse types of degraded sites in disparate topographic zones for different species and documented. Block plantations of identified species were studied and findings were documented to support future management and development of plantation forests. Species studied in block plantations were *Eucalyptus camaldulensis, Dalbergia sissoo, Pinus roxburghii* and *Pinus patula.*

In 1984, to study the techniques for regenerating degraded forests, Natural Forest Management Research was initiated. *Schima castanopsis* was targeted as it was located in the most populated area. Because of its multiple uses, it was the species of choice for rejuvenating degraded forests naturally. This study was extended to other forest types as well. The second study was carried on *Shorea robusta* (sal), which was again another highly degraded forest type in the Terai.

Research on forest recovery was carried out in degraded shrub forest and degraded/denuded sites. Silvicultural techniques were used in shrublands, while plantation techniques were the option for denuded sites. The success of reviving degraded shrublands was quite visible as shrub forests quickly responded. While the work has been of high quality, due to poor institutional links between research and end-users, the findings have not been well utilized.

5.3 Other initiatives to implement forest restoration

The Forestry Plan 1976 was the first systematic plan with provisions for afforestation. This was followed by the Master Plan for the Forestry Sector, 1989 which gave details for future supply and demand of forest products.

The 1978 position was changed when rules were promulgated whereby Panchayats (village councils) could be allocated up to 125 ha of bare or sparsely-forested government land for plantations in the hills, whereas in the Terai, this was 130 ha of such degraded forests for plantations to meet the local subsistence needs for forest products. The Decentralization Act of 1982 and the Decentralization By-laws of 1984 made forestry one of the components of the district development plan for each district. After promulgation of the Forest Act, 1993 and Forest By-laws, 1994 the responsibility of managing nearby forests was given to local users so that all degraded barren lands could be planted with the active participation of local forest dependents.

Considerable areas of plantations have been established by agencies such as the Nepal-Australian Community Forestry Project, Nepal Swiss Community Forestry Project and numerous other bodies. By 1985, about 5 000 ha were being planted annually. Not all the plantations were successful, and in some areas, there was a lack of people's participation apart from paying villagers to raise, plant and protect trees. Until the early 1980s plantation activity was mostly on government forest lands rather than private or community lands. From the mid-1980s onwards plantations were carried out in community and private lands as well.

Currently, community plantations have become the major source of forest products. The plantations are intensively managed and are technically supported by District Forest Offices. Central level/departmental plantations have been removed from the programmes. Additionally, emphasis has been put on encouraging tree planting by individual farmers. Farmers have been planting trees on their own land for many years, often using wildings from the natural forests in the hills and from nurseries in the Terai. In recent years, this activity has been increased considerably in response to the declining supply of forest products from common lands/forests.

This increase in tree planting, particularly by individuals and communities, demonstrated a positive commitment toward restoration of degraded lands and forests (Table 7) and indicates a trend towards potential long-term sustainability.

Table 7. Tree plantations on different types of land

Type of forest land	Area of plantations (ha)				
	1992	1993	1994	1995	1996
Public (government)	2 667	3 056	NA	NA	NA
Community forest	3 732	4 420	3 044.6	2 913.5	1 313.4
Private forest	6 810	3 559	6 656	8 800.2	NA
Leasehold forest	NA	298.4	436	899	NA

Source: CES (1998).

5.4 Economic assessment of different possible forest restoration/rehabilitation strategies

In Nepal, forests are major sources of rural livelihoods, income and employment. The sector generates about 9 percent of Nepal's GDP and about 87 percent of the population depends directly on it for forest products, subsistence farming and for ecosystem services. Forests fulfill 80 percent of the energy needs and 35 percent of the fodder needed for domestic animals in Nepal.

The government is well aware of this demand on forest produce and the need to prevent forests from becoming degraded. Increased level of compatibility between forestry and economic development has increased the potential for sustaining forest resources in Nepal. However, enhanced social, political and financial commitments are necessary to effectively harness this potential.

5.4.1 Forest restoration/rehabilitation strategies

The country has practised various rehabilitation, protection and management strategies for deforested and degraded land, but schemes do not contribute unilaterally to the strategy implemented. Most of the forests other than national forests within the management control of the government were either degraded forests or young plantations when they were handed over. Most forest transfers occurred in the 1990s following the promulgation of the Forest Act 1993. Forest management has begun to yield outputs in the form of poles and a few trees that are marketed.

The government strategy of encouraging greater public participation in forest management still holds. Increased areas of forest area are being handed over and an effort is being made to enhance governance of these institutions. However, in the process, national forest management has been left behind. Major chunks of forests are still under the control of the government which lacks proper forest management techniques, largely due to no enforcement of commitments.

Table 8. Financial state of the forestry programme in Nepal

Forestry programmes	Area managed (ha)	FUG or group no	Population benefited	Employment generated	Income generation (NR/year)	Comments
Community forestry	1 700 048	18 133	2 237 195 hh	Not available	NR10 096 452/yr (177 130.7/district); max. = 2 638 187 (Chitwan), min.= 2 770 (Manang)	A household (hh) is considered to have 5.44 members (CBS 2013)
Leasehold forestry	40 898.36	6 934	65 997 hh	Not available		
Collaborative forestry	54 072	19	3 321 738	482 712/yr	Royalty 916 533 850/yr Budget (159 991 649)	
Buffer zone forestry						
Private forests	2 360.84	2 458				3 329 885 trees

Adapted from DoF (2012), DoF (2013).

Community forestry programme: Nepal's community forestry programme has been successfully conducted for the last three decades. During this period, according to the Department of Forests, about 1 700 048 ha (29.2 percent) of forest area has been managed and is benefiting some 40 percent (13 423 170) of households (Table 8). These community forests (more than 18 000 FUGs) produce an average annual income of NR177 130 for each district. The Forest Act 1993 allows these groups to trade surplus forest products and use the income for a range of community development activities. In addition, the process has generated local employment and enhanced empowerment of many civil society organizations (CSOs). Above all, financially these are self-sustaining forest management institutions, which pay taxes to the government.

Leasehold forest: Participation of poorer communities in forestry is being actively promoted. The practice principally follows that of community forestry, but the groups are much smaller and manage smaller areas of degraded forests. The process is unique because a different land-use practice is allowed, other than forestry, if the group desires.

Collaborative forest management: Following the community forestry principle, to advance the technical capability of the group, highly priced timber-yielding sal forest has been handed over to the Collaborative Forest Group. There is no limitation to the area of forest this group can manage. There are 19 groups formed so far and all are in the Terai; the biggest is 5 087.43 ha (Kapilvastu Collaborative Forests) (DoF 2012).

Buffer zone forest management: In addition to the efforts carried out for national forest, Buffer Zone Community Forest Management addresses the buffer zone of the protected area. Following the principles of community forestry, silvicultural management is not practised here but ecotourism, REDD and others are being promoted.

Private forestry and its enhancing role: The government is inviting the private sector to take an active role in forest product supply. There are altogether 2 458 private forests registered; total forest area registered amounts to 2 360.84 ha. The timber supply trend over the last five years shows that 49 percent of the total requirement for timber supply comes from private forest (DoF 2012). Similarly, community forestry provided 37 percent and national forest, DoF-managed forest, supplied only 14 percent. Timber supply from national forest is decreasing, partly because of the green felling ban, and lack of governance in the management of national forests.

Compensatory payment approaches/mechanism: This has been developed with a view to discouraging conversion of forest land to other land uses. In this context the "responsible agency has to plant equal area of forests in the area specified bearing all the responsibilities for protection and management costs for up to five years when the forest has been converted to other development projects or non-profit purposes. In case of profit making purposes, responsible agencies are required to: (i) plant 25 trees for every single tree felled or harvested, and (ii) plant equal area of forests in the area specified and bear all the protection and management costs for up-to five years" (HMGN 1996).

Following this policy, the MoFSC has imposed a 5 percent environment tax on the profits of eight hydropower projects. It is necessary to obtain the permission of the MoFSC for the construction of hydropower projects, highways or other projects. The Energy Producers Association of Nepal (EPAN) is opposing the aforesaid compensatory payment policy of the government. EPAN does not see any rationale to impose an environmental tax on hydropower projects as it perceives the construction of hydropower projects as a means to stop deforestation which otherwise would happen due to the collection and burning of fuelwood.

Private investment in the forestry sector: Information on private sector investment in forestry is very scarce. Of the many forest-based industries operated by the private sector, many of them do not have their own plantations to feed the industries but use raw materials obtained from government forests. In lieu, these industries pay royalties to the DoF.

Production from mines and quarries on forest lands is considered forest produce in the forest legislation of Nepal. There are stone, gravel, slate, lime and marble quarries operating on forest land in various parts of the country. Private entrepreneurs are involved in such activities. Statistics on the production of these materials are not available.

There is very little foreign direct investment (FDI) in the private sector. Dabur Nepal, since its inception in 1992, is a private sector company engaged in promoting medicinal and aromatic plant products through direct funding. It has exported medicinal products worth US$32.19 million, thereby contributing over US$2.57 million to the Nepalese treasury in just one decade (see www.dabur.com/nepal).

In brief, revenue mainly comes from the royalties obtained from the sale of forest products such as timber, fuelwood and various NWFPs. Entities such as CFUGS have to pay the government 15 percent of their income obtained from the sale of forest products, in addition to a 13 percent VAT, which is applicable to the sale of timber and other forest products coming from private forests as well. Ecotourism is a relatively new major source of income that largely comes from protected areas in the form of fees and hunting licences. The DNPWC generates a substantial amount of revenue from ecotourism making it a major contributor followed by the community forests programme. Private forests are growing into a sector for supplementing forest products, especially timber. Trees outside the forest are another potential source of income revenue which has yet to be computed. Forestry programmes are financed by the government, however a significant portion comes from bi- and multilateral donor agencies.

5.5 Case study: Chautara pine reforestation sites

Considerable effort was made between 1980 and 1990 to study the recovery process of natural vegetation both in plantations and protected shrublands. A study was carried out in a ten-year old *Pinus roxburghii* plantation established under the Nepal-Australia Forestry Project in the Chautara forest range, Sindhu Palchok District at an elevation of about 1 450 to 1 600 masl with total rainfall of around 1 800 mm.

The study was carried out on a 35-ha site representing the following land uses prior to reforestation: (1) dry ridges covered with short grass and bushes, (2) grazing land, (3) abandoned agricultural dry terraces and (4) remnant forests. These land-use types were studied on north- and south-facing slopes (Figure 1 and Table 9). The study observed a strong natural recovery of broadleaved species in the understorey of pines established at a spacing of 2.5 x 2.5 m particularly on north-facing slopes, where in some instances the recovering broadleaf species dominated the planted pines (Mohns et al. 1988). Aboveground biomass and productivity rates of pines and broadleaved tree species plus lesser vegetation and litter were investigated. Total biomass for the pines ranged from 2.5 to 29.7 tons/ha with annual productivity rates of 0.6 and 6.7 tons/ha/year. Naturally regenerating broadleaved tree biomass ranged from 5.1 to 24.3 tons/ha with productivity rates between 1.8 and 6.7 tons/ha/year. The biomass of lesser vegetation varied between 0.71 and 2.5 tons/ha. There was a strong influence from canopy closure on annual understorey grass production which ranged from 0.14 to.0.22 tons/ha/year. Values for accumulated litter were rather uniform throughout the samples (4.3 to 5.3 tons/ha) and comprised between 9.6 and 24.8 percent of total aboveground biomass (see Table 9).

Wood and foliage biomass of regenerated coppiced stools and root suckers of the dominant species of *Myrsine capitellata* and *Quercus lanuginosa* only reached considerable values on north-facing slopes. This indicates a far stronger broadleaved succession on these sites. The two species are totally absent on exposed grazing land facing south and on former terraces.

In comparison to other studies in subtropical and tropical countries pine biomass was rather low which can be mainly attributed to the low original stocking density (wide spacing) of the original plantation design. Also standing biomass and productivity rates of the broadleaved fraction are far below the results of studies on related *Castanopsis* sp.- and *Machilus* sp.-dominated forests in warm temperate and subtropical climates. Again this can be related to the low stocking rates of the remnant broadleaved trees in the study site.

In subsequent detailed studies on the relationship between low crown canopy cover, diameter of planting pits with initial weeding and disturbance of surface soil, wind-dispersed tree seeds particularly from *Schima wallichii* and *Prunus* sp. from bird droppings were positively influenced by the establishment of pines as a nurse crop. Studies on broadleaved species revealed a strong influence of lopping intensity on stem form and annual wood biomass growth. Coppicing trials with *Schima wallichii* showed strong influences of timing of stem removal and diameter of stumps on the regrowth pattern.

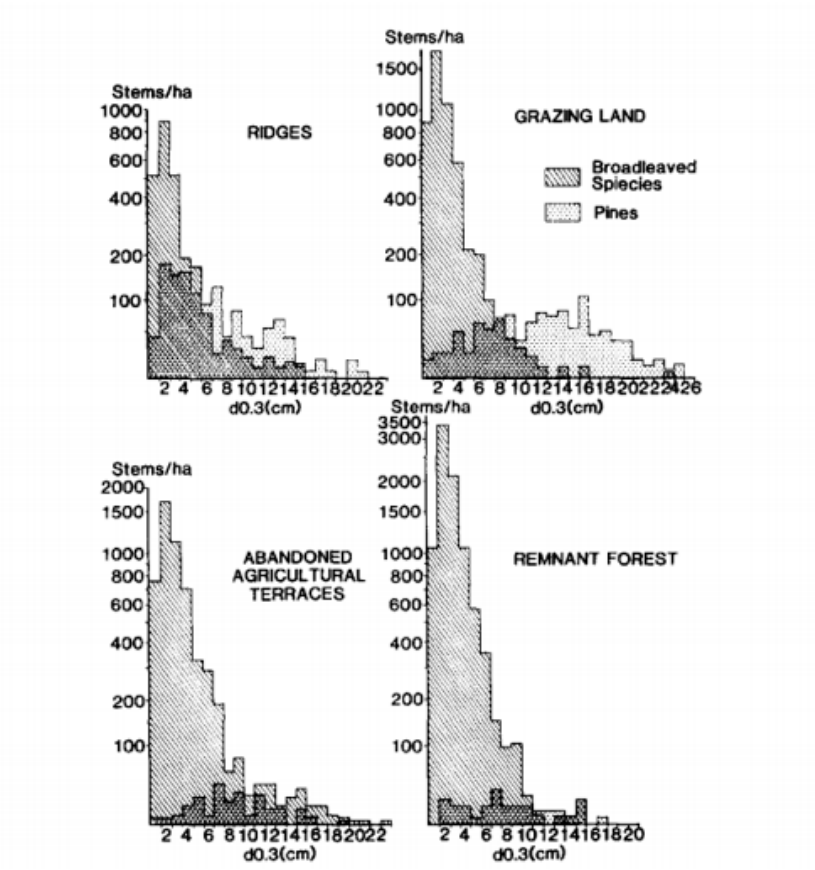

Figure 1. Diameter distributions of pines and broadleaved tree species on a north-facing slope. The trees are stratified according to former land use; d30cm is the diameter of stems at 30 cm above ground

Demonstrations for early thinning were carried out where either the pine or broadleaved components of the forests were favoured. Interviews with local communities showed that they preferred silvicultural systems which aim at increasing the yield of broadleaved species due to their better fuelwood qualities (pines are considered inferior due to indoor emission of more smoke and a faster burning process) but most of all because they provide tree fodder during the dry season and leaf litter as bedding material and fertilizer input on dry terraces.

Table 9. Annual dry matter production (tons/ha/year) for ten-year-old plantations

Aspect/former land use	Pines			Broadleaved species			Total		
	Wood (t/ha/yr)	Foliage (t/ha/yr)	Total (t/ha/yr)	Wood (t/ha/yr)	Wood (t/ha/yr)	Wood (t/ha/yr)	Wood (t/ha/yr)	Wood (t/ha/yr)	Wood (t/ha/yr)
N-slope									
Ridges	2.40	1.05	3.45	0.99	0.85	1.84	3.39	1.90	5.29
Grazing	4.89	1.85	6.74	2.24	1.84	4.08	7.13	3.69	10.82
Terraces	1.59	0.61	2.20	2.34	2.02	4.36	3.93	2.63	6.56
Old forest	0.56	0.21	0.77	2.76	2.59	5.35	3.32	2.80	6.12
S-slope									
Ridges	1.57	0.70	2.27	1.26	0.97	2.23	2.83	1.67	4.50
Grazing	2.21	0.94	3.15	2.24	1.62	3.86	4.45	2.56	7.01
Terraces	1.54	0.66	2.20	3.89	2.80	6.69	5.43	3.44	8.87
Old forest	0.43	0.18	0.61	3.35	2.32	5.67	3.78	2.50	6.28

Further studies were carried out during the same time with similar vegetation types and came to comparable conclusions regarding the importance of both regeneration from stumps and root suckers. Only some species like *Alnus nepalensis* appeared to invade larger areas through seed dispersal by wind.

6. Looking forward

6.1 Conditions for success

Land restoration is the process by which an area is returned to its original state prior to degradation of any sort. However, some have argued that it is impossible to restore degraded natural habitats. Gunn (1991) clearly argued that provided that species have not been made extinct as a result of degradation, then restoration is possible. A number of policy, institutional and market issues need to be addressed in order to bring back forests through restoration efforts.

6.1.1 Policy measures

The policies and legislations for the forestry sector listed in Box 1 have great importance. The Master Plan for the Forestry Sector (1989) has forwarded strategies and programmes to cope with deforestation and forest degradation. Heavy emphasis has been laid on the participatory approach for forest management but national forests have had a mixed approach in this regard. The community forestry, leasehold forestry and collaborative forestry programmes are recognized as effective interventions to restore and rehabilitate degradation and deforestation. Collaborative Forest Management is yet another form of the participatory approach that employs local forest users, local government and state forest authorities to manage forest jointly.

It is essential to reconcile Nepalese forest policy with global thrusts. Revising or developing a new policy that takes into consideration global commitments is warranted. Hence avoiding or reducing emissions would mean reducing deforestation and degradation. In this respect, Nepal is implementing the REDD+ and Clean Development Mechanism initiatives which can encourage local and regional governments to realize forest protection, livelihood development and climate change mitigation and adaptation. Nepal needs to reconcile its carbon policy to benefit in this respect.

Overall, there are adequate policies and legislation frameworks to equip Nepal with the appropriate measures to carry out sustainable forest management, including restoration of degraded forests and lands. However, translating these frameworks into reality is another story. Institutions need to be strengthened and renewed, requiring decentralization and devolution of control from central agencies. Forest history and experiences in Nepal show that inappropriate and top-down policies have always failed to reduce forest degradation.

Nepal owes much to the development of community-based forest management, including leasehold forestry, and the small measures for the entry of private forestry. Community forestry has been effective in landscape restoration, due to local participation, a supportive legal framework, a dynamic process of policy change, and financial as well as methodological support from donor agencies. Branney and Yadav (1998) argued that the quality of the forests is improving in nearly all forest areas under community forest management. Evidence from 60 case studies from Dolakha, Ramechap and Okhaldhunga suggests that most farmers who are FUG members feel that the forest agriculture interface has improved following the establishment of community forests in their villages (NSCFP 2003). Various studies suggest that community forestry is effective in improving the forest condition and reversing forest degradation. Forest users claim that there have been fewer forest fires and encroachment incidents in community forests in recent years compared to the adjacent national forests. The overall forest condition has also improved in community forests in terms of regeneration, number of stems per unit area, basal area, growing stock, rate of annual increment, density of forest patches, species diversity, wildlife and total biomass.

These measures appear to have stabilized forestry in the country and the production of forest goods from these sources is beginning to strengthen. Forests as a potential resource to raise the livelihoods of rural communities has also been realized through such measures.

Box 1. Policy issues for controlling deforestation and forest degradation

Over the past three decades, Nepal has seen considerable changes in institutions, policy and legislation for forests and other natural resource management. While they have become increasingly favourable, they still need to be reviewed in context with the current situation.

Policy framework

- The Nepal Conservation Strategy of 1988 – emphasized the need for sustainable use of land and natural resources.
- The Master Plan for the Forestry Sector of 1989 aims to fulfill the basic needs for forest products on a sustained basis, conserve ecosystems and genetic resources, protect land against degradation and other effects of ecological imbalance and contribute to local and national economic growth.
- The Nepal Environmental Policy and Action Plan of 1993 seeks to institutionalize environmental protection in development processes.
- The Revised Forestry Sector Policy of 2000 introduces provisions on block forest management in the Terai, Churia and Inner Terai to curb widespread deforestation and degradation.

- The Nepal Biodiversity Strategy of 2002 includes provisions on biodiversity conservation in protected areas, forests, rangelands, agroforestry, wetlands and mountain areas on a sustained basis for the benefit of the local people (HMGN/MFSC 2002).
- The Leasehold Forest Policy of 2002 includes provisions on leasehold forestry in shrublands as well as protecting restored land from encroachment and reclaimed land from natural disasters; such land must have less than 20 percent crown coverage or be vulnerable to soil erosion (DoF 2002).
- The National Wetland Policy of 2003 includes provisions that involve local people in the management of wetlands to conserve wetland biodiversity for judicious use and ecological services (HMGN 2003).
- The Agriculture Policy of 2004 emphasizes rapid agricultural growth (both production and productivity) and market development, and expresses the commitment to mitigate the negative impact of agriculture on natural ecosystems (HMGN 2004).
- The Herbs & Non-Timber Forest Products Development Policy of 2004 emphasizes the conservation and sustainable use of NWFPs, and promotes people's participation (MoFSC 2004).
- The Nepal Biodiversity Strategy Implementation Plan of 2006 includes provisions on 13 projects related to forest biodiversity conservation, integrated wetland management, agrobiodiversity conservation through community participation etc. (GON/MFSC 2006).
- The Interim Constitution of Nepal of 2007 emphasizes the protection of forest and environment through people's participation (GON 2007).

Legislative measures

The government has enacted several legislations for protection of the environment and natural resources that have both direct or indirect impacts on controlling deforestation and rehabilitating degraded forests.

- The National Parks and Wildlife Conservation Act of 1973 is a key legal instrument to protect biodiversity in Nepal (HMGN 1973).
- The Buffer Zone Management Regulation of 1996 addresses conservation and development programmes implemented through local community participation (MoFSC 1996).
- The Soil and Watershed Conservation Act of 1982 aims to manage catchment areas, including rivers and lakes, by empowering the government to declare any catchment as a protected area (HMGN 1982).
- The Forest Act of 1993 promulgated to protect and properly utilize forest resources also empowers the government to declare any part of national forests as a protected area provided the area has environmental, scientific and cultural importance (MoFSC 1993 and 1995).
- The Environmental Protection Act of 1996 emphasizes the proper use of natural resources (HMGN 1996).
- The Local Self Governance Act of 1999 provides significant autonomy to local governments, and empowers them to levy taxes on the utilization of natural resources (HMGN 1999).

Linkages to national forest and other land-use policies

There are several natural resource policies, acts and regulations that are relevant to forests, the environment and biodiversity conservation. The government recognizes four basic elements – restoration, wise use, protection and preservation of natural resources, which are crucial in long-term natural resource management. Accordingly, several policy instruments have been designed and implemented by the government. Despite all these efforts, implementation is still below expectation (NPC 2005).

6.1.2 Economic and market approaches

Improperly functioning markets can take a heavy toll on forests. A clear policy on this issue would be beneficial for safeguarding forests and their services. Ultimately, all restoration work will work if the costs can be met, or the results of such actions provide income and other benefits that can be translated in financial terms, and the providers of such products and services are compensated for such trade-offs. Government institutions, CBOs and NGOs are beginning to explore innovative programmes to expand the opportunities for payments for conservation and forest restoration (Box 2). The programmes include payments for ecosystem services, carbon sequestration (CDM, REDD+) etc. The forest landscape as a concept has been discussed with regards to conservation, transboundary issues and management of forest fires. However, forest restoration at the landscape level approach has not received similar treatment. But some of the elements, including policies, legislation, people's participation with supportive tenure or use rights, and basic financial instruments exist. There is a need to lobby for FLR approaches in the country.

Box 2. Innovation and participation for restoration, rehabilitation and conservation

The government should pay specific attention to new and innovative programmes. Some of the innovative mechanisms for Nepal include:

Payments for ecosystem services is a new voluntary contractual agreement practised between the Electricity Authority (Kulekhani) and local communities. This has influenced land-use changes in watershed areas, reduced sedimentation and increased dry season water flow to reservoirs; they are estimated to amount to US$44 570 per year (Karn 2008). Similarly, concessionaire hotels are paying conservation fees/royalties (seven hotels inside the Chitwan National Park) to the government for conservation activities. PES is also practised in Bardia National Park, Suklaphanta Wildlife Reserve (hotels) and Langtang National Park. In Langtang National Park, Himalayan Spring Water Co. Ltd. (mineral water) pays US$0.00038 per litre to the Park Authority. For the Buffer Zone Forest Management work carried out around national parks and wildlife reserves, the government pays back 30-50 percent of the park revenue to the local buffer zone committee.

Carbon sequestration is the process of storing excess CO_2 from the atmosphere. Carbon trading is an emerging global market in which developing countries like Nepal can participate through a regulatory or voluntary market framework. Forests sequester carbon at around 2.0 Mg C/ha/year (Aune et al. 2005). The CDM and REDD+ initiatives are being explored. The Nepal Biogas Project is the first greenhouse gas reduction project in Nepal under the CDM that has linked rural communities with the carbon market. The project has so far installed 150 000 biogas plants. At US$7.00 per ton of carbon dioxide, Nepal receives US$600 000 annually from the World Bank. Biogas plants have also contributed to halting further forest degradation by reducing pressure on forests for energy sources.

The Landscape Approach is an important step which Nepal has taken in the direction of environmental conservation since the 1970s. This approach is more holistic, benefiting nature and people at the landscape level. It is emerging as a promising methodology for wildlife conservation, as it realizes the fact that long-term conservation is not possible without addressing the needs of local people and protected areas which are small and isolated. The concept of the landscape-level approach was recognized as a priority programme in the Tenth Development Plan (2002-2007). This approach was legitimized after endorsement of the National Biodiversity Strategy in 2002. Consequently, the MoFSC endorsed the ten-year Terai Arc Landscape Strategic Plan in 2004 and Sacred Himalayan Landscape Strategic Plan in 2006. The Terai Arc Landscape Plan was translated into the ten-year implementation plan in 2004.

The Terai Arc Landscape (TAL) initiative is a long-term vision (50 years) and encompasses 49 500 km^2 from the Bagmati River in Nepal to the Yamuna River in India. It is a biologically diverse habitat with 86 species of mammals, 550 species of birds, 47 species of herpetofauna, 126 species of fish and over 2 100 species of flowering plants. The TAL is not only a critical habitat for biodiversity, but it is also home to 6.5 million people who are dependent on forest resources for their livelihoods.

Sacred Himalayan Landscape (SHL) is a transboundary conservation area covering 39 021 km^2 of Nepal, India (Sikkim and Darjeeling) and Bhutan; it builds links with three major transboundary conservation areas in China, India and Bhutan. The SHL supports a plethora of flora and fauna, which include several endemic species. Forestry, agriculture and tourism are dominant livelihood strategies for more than 80 percent of approximately 5 million poor people who are mainly agropastoralists (MoFSC 2006).

Monitoring of forest fires: Forest fires are common in Nepal during the dry spring season, particularly in March-May when strong winds stoke wild fires that destroy hundreds of hectares of forest and croplands. The Mountain Environment and Natural Resources' Information System division at the International Centre for Integrated Mountain Development is using the Moderate Resolution Imaging Spectroradiometer satellite and Fire Detection Algorithm to detect and report active fires.

6.2 National strategy for forest and landscape restoration: the way forward

Nepal has undergone a major shift in forest management with the introduction of the participatory forest management concept in 1976. The bottom-up planning approach adopted by participatory natural forest management programmes has yielded several positive outcomes. Local communities have initiated community stewardship for natural resource management.

Biotic pressures have already resulted in deforestation and land degradation. If the immediate and underlying causes are not identified soon and remedial actions taken, Nepal could witness severe desertification of its lands. The ecological and economic implications of land degradation are serious and the consequences will undoubtedly affect the livelihoods of the rural populace.

The government has done a commendable job in establishing a good network of protected forest areas for conservation – almost one-fifth of the total surface area. Protected areas have been effective in preserving endangered wildlife species. Nepalese army patrols in national parks and reserves effectively protect biodiversity and environmental functions.

The most important issues that Nepal should address further in the context of forest and landscape restoration include:

Awareness-raising and education: The MoFSC, its departments and field offices are trying to reach the general public via extension materials. Forestry extension is being implemented by governmental departments and partner organizations. Until and unless people understand the value of nurturing forests and biodiversity for their well-being, conservation efforts will prove difficult.

Reforming government and non-government institutions: There are five departments, five regional directorates and five training and extension centres within the MoFSC to execute forestry activities. The MoFSC is responsible for overall policy coordination, monitoring, planning and enabling activities. The departments are responsible for programme implementation. The MoFSC has over 9 000 staff for forestry sector operationalization. The government has entrusted public corporate bodies to conduct forest management activities. However, considerable restructuring of government agencies is required before these institutions can effectively support forest management, particularly reforestation efforts.

It is necessary to work more on the ground to identify not just the problems of land degradation in Nepal but also the underlying causes as well. There is a strong need to share and practise the lessons and experiences learned from different forestry development programmes.

Consolidation of all the learning and experiences gained in the past 30 years in natural forest management and equal sharing should be fed in to reform the Forest Act 1993. Initiatives towards collaboration and partnership with local, national and international organizations should be intensified. Measures are necessary to address widespread poverty and reduce the dependency of local communities on dwindling forest resources. The Shiwalik Hills and other ecologically-sensitive areas should be declared as protected forest areas to restrict environmentally-destructive activities. Forest management initiatives, inclusive of rehabilitation and reforestation with appropriate and suitable species, should be executed. Enhancing existing and developing new models of participatory forestry restoration/rehabilitation is highly recommended. Rehabilitation of sites with appropriate species is warranted. Such practices on public land would also limit encroachment.

The best models and practices should be replicated in other parts of the country. Effective law enforcement would result in land and forest protection to a greater degree. It is essential to raise awareness and educate the public at all levels on environmental issues and the consequences of degradation. Documentation of information together with research and monitoring should be underscored. Above all, proper land-use planning should be accorded utmost priority.

References

Acharya, K.P., Dangi, R.B. & Acharya, M. 2012. Understanding forest degradation in Nepal. *Unasylva*, 62.

Adhikari, B.R. 2002. *Forest encroachment: problems and solution measures (in Nepali).* Kathmandu, Hamro Ban.

Amatya, S.M. 2013. *Financing for sustainable forest management in Nepal.* New Zealand, Indufor Asia Pacific Ltd.

Aune, J.B, Alemu, A.T. & Gautam. K.P. 2005. Carbon sequestration in rural communities: is it worth the effort? *Journal of Sustainable Forestry*, 21(1).

Bajracharya, M.K. 1986. *Forestry in Nepal: An introduction.* Kathmandu.

Blaikie, P, Cameron, J. & Seddon, D. 1980. *Nepal in crisis. growth and stagnation at the periphery.* Oxford, UK, Oxford University Press.

Branney, P. & Yadav, K.P. 1998. *Changes in community forestry condition and management 1994- 98: analysis of information for the forest resource assessment study and socio-economic study of the Koshi Hills.* Project Report G/NUKCFP/32. Kathmandu, Nepal UK Community Forestry Project.

Central Bureau of Statistics (CBS). 1995. *Population monograph of Nepal.* Kathmandu, Central Bureau of Statistics.

CBS. 1998. A compendium on environment statistics, 1998. Kathmandu, Central Bureau of Statistics.

CBS. 2001/2002. *National sample census of agriculture 2001-02*. Kathmandu, Central Bureau of Statistics.

CBS. 2010. *Statistical pocket book*. Kathmandu, Central Bureau of Statistics.

CBS. 2011. *Statistical pocket book*. Kathmandu, Central Bureau of Statistics.

CBS. 2012. *Statistical pocket book.* Kathmandu, Central Bureau of Statistics.

CBS. 2013. *Environment statistics of Nepal – 2011.* Kathmandu, Central Bureau of Statistics.

COMFORTC. 2007. *Baseline assessment of the encroachment status in Western Terai landscape complex.* Western Terai Landscape Complex Project. Kathmandu, Community Forestry Research and Training Centre.

Dalit, B.K. 2007. *Carbon sequestration and trading for Nepal.* Available at, http://www.kantipuronline.com/kolnews.php?&nid=108730.

Devkota, S. 2010. *Who is responsible for deforestation and forest degradation in Nepal?* Available at, http://we.care.org/blogs/23/330

Department of Forests (DoF). 2002. *Leasehold forestry policy.* Kathmandu, DoF.

DoF. 2005. *Forest cover change analysis of the Terai Districts* (1990/91-2000/01). Kathmandu, DoF.

DoF. 2012. *Hamro Ban* (2068/069). Kathmandu, DoF.

DoF. 2013. *Community forestry database.* Kathmandu, DoF.

Department of Forest Research and Survey (DFRS). 1999. *Forest resources of Nepal (1987-1998).* FRISP Publication No. 94. Kathmandu, Department of Forest Research and Survey.

Department of National Parks and Wildlife Conservation (DNPWC). 2007. *Protected areas of Nepal.* Kathmandu, DNPWC.

Eckholm, E.P. 1976. *Losing ground.* New York, W.W. Norton and Company.

Food and Agriculture Organization of the United Nations (FAO). 1997. *Forestry statistics today for tomorrow.* FAO, Rome.

FAO. 2000. *Forest resources of Nepal (country report).* Forest Resource Assessment Working Paper No 16. Rome, FAO.

FAO. 2010. *Global forest resources assessment 2010.* Rome, FAO.

Forest Survey and Research Office (FSRO). 1969. *Timber resources and development opportunities in the lower Bheri and Karnali watersheds.* Kathmandu, FSRO.

FSRO. 1973. *Forest statistics of hill regions*. Kathmandu, FSRO.

FSRO. 1974a. *Land use report.* Kathmandu, FSRO.

FSRO. 1974b. *Nepal Forestry Technical Information Bulletin. Supplement No 1.* Kathmandu, FSRO.

Government of Nepal (GON). 2007. Interim Constitution of Nepal. Kathmandu, Law Books Management Committee.

GON/MFSC. 2006. *Nepal Biodiversity Strategy Implementation Plan.* Kathmandu, Ministry of Forests and Soil Conservation.

Gunn, A.S. 1991. The restoration of species and environments. *Environmental Ethics,* 13.

Gurung, H. 1981*. Ecological change in Nepal: a native interpretation.* Kathmandu, New Era Publications.

His Majesty's Government of Nepal (HMGN). 1957. The Act of Private Forest Nationalization – 1957. Kathmandu, HMGN.

HMGN. 1973. National Parks and Wildlife Conservation Act 1973. Kathmandu, Ministry of Forests and Soil Conservation.

HMGN. 1978. ***Forest rules.*** Kathmandu, Law Books Management Board.

HMGN. 1982. Soil and Watershed Conservation Act 1982. Kathmandu, Ministry of Forests and Soil Conservation.

HMGN. 1993. Nepal Environmental Policy and Action Plan 1993. Kathmandu, Environment Protection Council.

HMGN. 1996. Environment Protection Act 1996. Kathmandu, Ministry of Environment, Science and Technology.

HMGN. 1999. Local Self Governance Act 1999. Kathmandu, Law Books Management Committee.

HMGN. 2003. National Wetland Policy, 2003. Kathmandu, HMGN, Ministry of Forests and Soil Conservation.

HMGN. 2004. Agriculture Policy 2004. Kathmandu, HMGN, Ministry of Agriculture and Cooperatives.

HMGN/MFSC. 2002. Nepal Biodiversity Strategy. Kathmandu, HMGN, Ministry of Forests and Soil Conservation.

HMGN/MoEST. 2004. *Initial national communication report to the Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC).* Kathmandu, HMGN/Ministry of Environment, Science and Technology.

Hobley, M. 1987. *Involving the poor in forest management: can it be done?* The Nepal-Australia Project Experience. RDFN 5c. London, Overseas Development Institute.

International Centre for Integrated Mountain Development (ICIMOD). 1993. *International symposium on mountain environment and development.* Discussion Paper No. 1. Kathmandu, Mountain Population and Institution.

ICIMOD/MOEST. 2007. *Nepal biodiversity resource book: protected areas, Ramsar sites and World Heritage sites.* Kathmandu, ICIMOD/Ministry of Environment, Science and Technology.

Intergovernmental Panel on Climate Change (IPCC). 2007*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007.* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden & C.E. Hanson, eds. UK and USA, Cambridge University Press.

Joshi, A.L., Shrestha, K. & Sigdel, H. 2000. Deforestation and participatory forest management policy in Nepal. *In Underlying causes of deforestation and forest degradation in Asia.* Available at, http://www.wrm.org.uy/deforestation/Asia/Nepal.html

Joshi, L. 2010. *A community based PES scheme for forest preservation and sediment control in Kulikheni, Nepal.* ICIMOD. Available at, http://rupes.worldagroforestry.org/node/347

Kanel, K.R. 2004. *Twenty four years of community forestry: contribution to Millennium Development Goals.* K.R. Kanel, P. Matherma, B.R. Kandel, D.R. Niraula, A.R. Dharma & M. Gautam, eds. Proceedings of the Fourth National Workshop on Community Forestry, 4-6 August, 2004, Kathmandu, Nepal.

Karn, P.K. 2008. Making payment for environmental services work: a case study of Shivapuri National Park. *In* S.B. Bajracharya & N. Dahal, eds. *Shifting paradigms in protected area management,* pp. 171-185. Kathmandu, National Trust for Nature Conservation.

Land Resources Mapping Project (LRMP). 1986. *Land Resources Mapping Project*. Kathmandu, Government of Nepal/Department of Survey and Kenting Earth Sciences.

Mauch, S.P. 1974. *Long term perspective of the region's forest resources and the associated availability of firewood, cattle, fodder and construction materials for the local population.* Zurich, Integrated Hill Development Project Reproduced.

Ministry of Environment, Science and Technology (MoEST). 2008. *State of the environment (agriculture, forest and biodiversity).* Kathmandu, MoEST.

MoEST. 2001. *Nepal: state of the environment 2001.* Kathmandu, MoEST.

MoEST. 2006. *Nepal: third national report on the implementation of the UN Convention to Combat Desertification.* Kathmandu, MoEST.

Ministry of Forests and Soil Conservation (MoFSC). 1989. *The master plan for the forestry sector.* Main Volume. Kathmandu, HMGN/ADB/FINNIDA.

MoFSC. 1993. Forest Act, 1993. Kathmandu, HMGN/Law Books Management Committee.

MoFSC. 1995. Forest Regulation 1995. Kathmandu, HMGN/Law Books Management Committee

MoFSC. 1996. Buffer Zone Management Regulation 1996. Kathmandu, MoFSC/DNPWC.

MoFSC. 2000. Revised Forestry Sector Policy 2000. Kathmandu, GON, MoFSC.

MoFSC. 2002. Nepal Biodiversity Strategy. Kathmandu, Ministry of Forests and Soil Conservation, HMGN.

MoFSC. 2004. Herbs and Non-Timber Forest Products Policy 2004. Kathmandu, HMGN, MoFSC.

MoFSC. 2006. Terai Arc Landscape Nepal: Implementation Plan 2004-2014. Kathmandu, HMGN, MoFSC.

MoFSC. 2010a. *Readiness preparation proposal (RPP) for the Forest Carbon Partnership Facility (FCPF) of the World Bank*.

MoFSC. 2010b. A ban on tree felling. A directive issued for 24 districts (largely Terai) in July 2010 by MoFSC, Kathmandu.

Mohns, B., Applegate, G.B. & Gilmour, D.A. 1988. Biomass and productivity estimations for community forest management: a case study from the hills of Nepal – II. Dry matter production in mixed young stands of chir pine (*Pinus roxburghii*) and broad-leaved species. *Biomass,* 17: 165-184.

Multi-Stakeholders Forestry Programme (MSFP). 2012. *Some of the forestry facts of Nepal.* Kathmandu, MSFP.

National Planning Commission (NPC). 1991. *Approach to eighth five year plan*. Kathmandu, HMGN.

NPC. 1998. *The ninth plan*. Kathmandu, HMGN, NPC.

NPC. 2005. *Nepal Millennium Development Goals-progress report 2005.* Kathmandu, NPC, UNDP.

Nepal Swiss Community Forestry Project (NSCFP). 2003. *An assessment of the project's achievements against its objectives.* Kathmandu, NSCFP.

Oli, B.N. & Shrestha, K. 2009. Carbon status in the forests of Nepal: An overview. *Journal of Forests and Livelihoods,* 8(1).

Paudel, B.S. 2004. *The rural poor and the forest resources: socioeconomic heterogeneity, benefit sharing and participation in community forestry in Nepal.* Pokhara, Nepal, Tribhuwan University/Institute of Forestry (MSc thesis)

Paudel, K.P., Dunn, M. A., Vlosky, R.P. & Guidry, K.M. 2007. Alternative methods to analyze the rank ordered data: A case of invasive species control. *Natural Resource Modeling,* 20(3): 451-471.

Paudel, D., Khanal, D.R. & Branney P. 2011. *Transparency in Nepal's forest sector: a baseline assessment of legal indicators, provisions and practices.* Kathmandu, Livelihoods Forestry Programme.

Rautianien, O. 1994. *Natural regeneration of mixed sal forests.* FMUDP Working Papers No 10. Kathmandu, Forest Management and Utilisation Development Project/National Forest Division.

Rieger, H.C. 1976. *Himalayan ecosystems research missions Nepal report.* Heidelberg, Germany, South Asia Institute, University of Heidelberg.

Sharma, S. & Suoheimo, J. 1995. *Observation on rot in sal forest in the Terai.* Forest Management and Utilization Development Project Working Paper No. 20. Kathmandu, Ministry of Forests and Soil Conservation & Finnish International Development Agency.

Shengji, P. & Sharma, U.R. 1998. *Transboundary biodiversity conservation in the Himalayas.* Eco-regional Co-operation for Biodiversity Conservation in the Himalaya. Report on the International Meeting on Himalaya Eco-regional Co-operation. New York, UNDP.

Singh, B.K & Chapagain, D.P. 2006. *Trends in forest ownership, forest resources tenure and institutional arrangements: are they contributing to better forest management and poverty reduction?* Rome, FAO.

Subedi, B.P. 1995. Population and environment in the context of sustainable development in Nepal. *In Population monograph of Nepal*. Kathmandu, Nepal.

Valli, E. & Summers, D. 1993. Himalayan caravans. *National Geographic*, 184(6).

Wagle, S. 2011. Problem of forest fire and its prevention (available at www.forestrynepal.org/article/1725/5018).

Water and Energy Commission Secretariat (WECS). 2010. *Energy sector synopsis report, 2010.* Kathmandu, WECS.

Western Terai Landscape Complex Project (WTLCP). 2012. *Sustainable financing mechanisms for landscape conservation: existing practices and future prospects.* Kathmandu, WTLCP.

Forest restoration at the landscape level in the Philippines

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1. Introduction

During the last five years the Philippines has suffered greatly from the catastrophic results of natural disasters generated by landslides and flash floods during prolonged monsoons and stronger typhoons. This has resulted in massive loss of property and lives. The country has suffered considerably due to the 'unpreparedness' of communities and institutions, inappropriate land use extending from the uplands down to the lowlands and coastal areas, and extensive areas of agricultural production systems that have not considered the interconnectedness and interdependence of ecosystems over watershed-dominated landscapes. The prevalence of natural disasters shows the need for a multidimensional, multisectoral and intersectoral holistic approach in the governance and management of watershed-dominated landscapes. A unifying framework for individual and collective prescriptive strategies and actions seldom exists. There is definitely a need for a holistic and integrated approach for managing the highly diverse ecosystems in the Philippines that is consistent with its unique tropical location and topography.

Under the Philippines Development Plan for 2011-2016 (NEDA 2011), the Philippine policy direction on integrated ecosystems management (IEM) and its increasing adoption for river basins, watersheds, protected areas, islands, portions of key biodiversity areas, protection forests and forest lands, ancestral domains, mineral reserves and other sites appears to be consistent with the holistic forest landscape restoration (FLR) approach. FLR will definitely contribute to linking public investments in highly diverse terrestrial and mangrove forest resources that will ensure their resiliencies and those of communities, livelihoods and environment and natural resources (ENR)-dependent enterprises and industries. As described in the terms of reference it constitutes:

"… an approach to manage the dynamic and complex interactions between people, natural resources and land use within a landscape. Instead of simply restoring forest cover in a site, FLR brings people together to identify, negotiate and implement practices that restore the ecological, social and economic benefits of forests and trees within a broader pattern of land uses to an agreed optimum level. It is defined as "a planned process that aims to regain ecological integrity and enhance human wellbeing in deforested or degraded forest landscapes."

The case study captures relevant national experiences (particularly lessons learned, best policies and practices, and unique approaches) on FLR and forest rehabilitation. The study will contribute to the development of strategies, actions and policy guidance for the sustainable restoration of forest resources reflecting multiple objectives, including conservation of forest biodiversity and genetic resources, and poverty reduction.

2. Historical overview of forests and land degradation

The Philippines has lost most of its formerly abundant forests in less than a century. As a result, the remaining highly diverse terrestrial and mangrove forests, a major economic resource that provides various ecosystems goods and services, habitats for valuable species and a home for indigenous communities are now highly threatened. The Philippines, one of the world's 18 mega-diverse countries, is now considered a biodiversity hotspot. Huge financial, organizational and human resources have been and are being allocated to restore the productivity and richness of degraded forests and marginal areas, minimize the continuing deterioration and loss of biodiversity assets, and sustain the supply of various ecosystems goods and services that anchor the local and national economies.

2.1 Brief overview

At the beginning of the last century, 70 percent of the country was forested but this figure had declined rapidly to a low of about 18.3 percent in 1999 (ESSC 1999). Recent literature has examined different angles of forest loss and degradation in the Philippines to design the most strategic programmes that will lead to better policies, improved forest protection and management of the remaining natural forests, conservation of biodiversity, mobilization of a multisectoral effort for regreening the country, reduced upland and coastal poverty, improvement of existing programmes and generation of more revenue. These works include:

- Assessment of tropical forests and biodiversity conservation in the Philippines in the context of climate change issues (ADMU 2011);
- Results of the 2002-2004 national forest assessment of the Philippines that provided stock volume estimates of the different forest and land types based on international definitions (FAO 2005);
- Comprehensive review of 100 years of forest rehabilitation in the Philippines (Pulhin et al. 2006);
- Land and forest cover maps in 2003 and 2010 by the National Mapping and Resource Information Authority (NAMRIA) which are comparable because of the use of the same land and forest types and definitions;
- Assessment of community-based natural resource management (CBNRM) in the Philippines but focusing on the management of forests and forest lands in community forestry and ancestral domain lands (Braganza 2012);
- Study of the state of protected area management in the Philippines (Protected Area and Wildlife Bureau 2012);
- Analysis of the 2003 land and forest cover digitized map of the Philippines and discussion on the results in terms of future direction and strategies (Walpole 2010).

Discussions on the loss of forest in the Philippines always highlight the loss of the high-value dipterocarp forests which used to cover about 45 percent of the country's total land area, exploited to provide timber for industries (Revilla 1984). Today, the dipterocarps together with the other forest types – molave, pine, mangrove, beach and mossy – have become a scarce source of timber.

USAID (1989) and IBRD (1989) carried out a major assessment of agriculture and natural resources at the beginning of President Corazon Aquino's term after the People's Power Revolution. Indeed the agricultural expansion before and after the 1970s and early 1980s was largely brought about by bringing more land under cultivation. During these decades, the rural population increased more than three times as fast as the availability of arable land with an estimated 25 percent of the population already living on public lands (USAID 1989; IBRD 1989). During this period, the harvest volumes of timber from natural forests peaked at over 11 million m^3 per year in the late 1960s, dropped to 6 million m^3 in 1981, then 3.8 million m^3 in 1989 and about 0.588 m^3 in 2000 (USAID 1989; FMB/DENR 2000).

From 1934-1990, conversion of forest to agriculture and other uses was 10 375 000 ha or an average of 185 000 ha per annum loss of forest cover (Pulhin et al. 2006; FMB/DENR 2003). The contribution of forest cover loss from logging was estimated to be 525 000 ha for the same period at about 9 000 ha per annum (Pulhin et al. 2006). Forest degradation and eventual loss of forest cover more or less followed a predictable pattern and process: intensive logging (both legal and illegal) after the Second World War, followed by agricultural expansion and upland migration. Logging started the process by opening up the forests, creating employment opportunities and providing access roads for agricultural expansion but displacing many of the indigenous communities. The 'land for the landless' programme of President Ramon Magsaysay in the 1950s allowed the reclassification of forested areas into agricultural lands paving the way for conversion. The construction of ports and national roads facilitated the 'forest conversion' process (De Rueda 2006).

On reflection, the Philippines' version of the Regalian Doctrine has indirectly contributed to the loss of forest cover, especially in a culture where patronage, collusion, elitism, social connections and awarding privileges and entitlement rights flourish. The country's licensing system to access resource-use rights to exploit the rich natural forests fell easy prey to predators, who were partly involved in putting the system to work. In fact, even up to 1976 (FMB/DENR 2008), more than 10 million ha of forest lands were still covered by timber licence agreements (TLAs) with less than 500 holders. Most of these holders benefited from the logging boom in the 1960s and early 1970s and through the martial law years (Guiang 2001).

The 1987 Constitution after martial law provided safeguards against abusing the remaining natural forests. For one, it eliminated the licensing system for accessing natural resource assets, now joint venture, co-management or co-production

agreements. The Regalian Doctrine has been continued but now with four major types of land classification – agriculture, forest land, national parks/protected areas and mineral reserves. Succeeding legislated laws provided more substance and implementation guidelines for the allocation, governance and management of the lands of public domain. Only agricultural lands may be alienated. As of June 2013, the DENR had submitted the results of completed national forest delineation of forest lands (lands of public domain) and agricultural lands (alienable and disposable lands) to the Philippines House of Congress for approval and enactment into law. This will finally delineate the boundary between forest and agricultural lands (DENR/ENRMP/GEF 2013).

Table 1 provides a summary of the current governance configuration – composed of laws and policies –that serves as the framework for the management and regulation of the lands of public domain, ENR and ancestral lands. It should be noted that all the major types of lands may be allocated to indigenous peoples (IPs) provided that their claims are legitimate. All of the types of forest lands and ENR are under various cross-cutting laws such as those for local government, climate change, solid waste management, water, air, energy, environmental impacts, disaster risk reduction and ancestral domains.

The present allocation of the lands and domains that resulted from the current governance configuration is given in Table 2. Table 2 also includes the respective governance-designated entity or unit that has the responsibility, accountability and authority (RAA) in the management, development, and regulation of an assigned land or forest area (DENR/ENRMP/GEF 2012). This matrix of allocation and the entity or unit with RAA shows the direction and trajectory for improving conservation, forest management, regulation and development that will take shape.

Based on the 2010 statistics of population and forest cover, the forest-population ratio in the Philippines is 0.08 ha/capita (one of the poorest in 89 countries in the tropics). To increase this ratio, directly or indirectly, protection and management of the remaining natural forests combined with forest restoration will have to improve. Forest restoration and forest management have to take shape based on the current governance configuration. This has been the emerging strategy in the country's efforts to arrest continuing forest degradation.

Table 2 highlights the challenge of forest restoration in the Philippines. It is evident that the focus of protection and restoration will be in areas that are under forest reservations, community forestry and ancestral domains. This means that these efforts have to be done with the DENR for the protection and management of protected areas and watersheds, Department of Energy (DOE) and Department of Agriculture (DA) for watersheds and reservations, and the National Commission on Indigenous Peoples (NCIP) for ancestral domains. These entities with RAA in collaboration and partnership with concerned local government units (LGUs) have to plan and map out forest restoration and protection strategies.

Table 1. ENR governance and lands of public domain: the 1987 Philippine Constitution, legislated laws and administrative issuances (DENR/ENRMP/GEF 2013)

Agriculture	**Timber or forest lands**	**National parks (including initial components of the National Integrated Protected Area Systems (NIPAS)**	**Mineral reserves**
• The Public Land Act • Comprehensive Agrarian Reform Law • Agricultural and Fisheries Modernization Act • Fisheries Code	• Revised Forestry Code • Executive Order (EO) on Community-based Forestry Management • EO on Sustainable Forest Management • Forest Charges Law • Electricity Power Industry Reform Act • EO on Log Ban in Natural Forests • EO on National Greening Program	• The National Integrated Protected Area Systems Act • Specific laws covering protected areas • Wildlife Act • International commitments • Electricity Power Industry Reform Act • Joint Memo Circular between DENR-Department of Agrarian Reform NCIP • EO on National Greening Program	• Mining Act • Small Scale Mining Act
Indigenous Peoples Right Act (IPRA Law)			
Cross-cutting Laws – Executive Order on the Creation and Mandate of the DENR, Local Government Code, Climate Change Act, Environmental Impact System, Disaster Risk and Reduction Management Law, Ecological Solid Waste Management Act, Biofuels and Renewable Energy Act, Clean Water Act, Clean Air Act			

Table 2. Governance-designated entities with RAA for ENR, lands of public and ancestral domains and alienated lands (from FMB 2011)

Allocation of lands in the Philippines	Governance-designated Land and Forest Resource Management Units (LFRMUs)	Percent
1. Protected areas and reservations	DENR (PAWB and FMB) and other government agencies (DOE, DA, local water utilities)	26 (or 4+ million ha) of 15 million ha of the total land of public domain
2. Allocation to civil and military reserves	Recipients of reservations (military, state universities, export processing zones, others)	2 of 15 million ha of land of public domain
3. Allocations to LGUs	Communal forests, communal watersheds and co-managed forest lands with LGUs	Minimal
4. Allocations to community forestry and ancestral domains	Communities with community-based forest management agreements (CBFMAs), IPs with certificates of ancestral domain titles (CADTs) and recognition of ancestral domain claims	35 (more than 5.5 million) of 15 million ha of land of public domain
5. Allocations of forest lands to the private sector	Private sector tenure holders in forest lands (industrial forest management agreements, socialized industrial forest management agreements, other tenure systems)	10 (or 1.5 + million) of 15 million ha of land of public domain
6. Unallocated lands of public domain	The DENR (as the de facto agency with RAA)	19 (or more than 3 million ha) of 15 million ha of land of public domain
7. Unclassified lands of public domain	The DENR (as the de facto agency with RAA)	8 (or more than 1 million ha) of 15 million ha of land of public domain

2.2 Current status of forest degradation

For more than 20 years, the Philippines has planned and implemented various policy changes and programmes to arrest continuing degradation. Estimates underline that the Philippines has spent close to US$1 billion for the multi-agency and multidonor regional and national efforts to halt the depletion of the remaining natural forests and launch massive restoration through reforestation, tree farms, woodlots, agroforestry, assisted natural regeneration (ANR) and other technical approaches (Guiang 2008; Pulhin et al. 2006). This resulted in at least 11 percent increase in forest cover in 2003 compared with the 1988 forest cover data. Total forest area increased from 6.5 million to about 7.2 million ha (Figure 1). At the same time, the number of hotspots for illegal timber or logging activities in natural forests was reduced by 78 percent and 86 percent and in all provinces and municipalities, respectively (Calderon 2013).

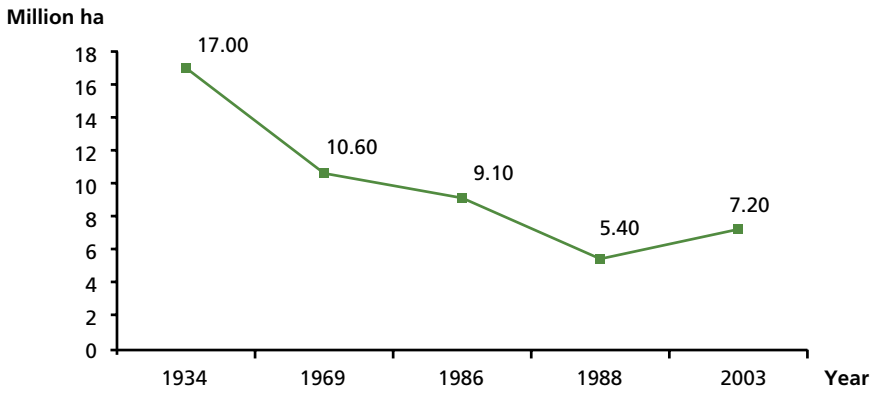

Figure 1. Forest cover changes in the Philippines, 1934-2003 (FMB 2010)

As part of the effort to improve monitoring of forest cover, adoption of the standard land and forest cover type and definition was harmonized under the Philippines National Forest Assessment (FAO 2005). The areas needing forest restoration are the open forest (for increasing stock density) and wooded lands, shrub and fallow areas, and wooded grasslands (for either reforestation, agroforestry, ANR or a combination of these technical approaches) The remaining closed canopy natural forests have to be protected from forest fires, encroachment or illegal activities to avoid falling under the open canopy category. Most of the shrub and fallow areas need reforestation and agroforestry. The wooded grasslands and wooded lands are better off with the natural process of regeneration.

A comparison of the 2003 and 2010 land and forest cover data as shown in Table 3 reveals the following:

- Continuing loss of the remaining closed canopy forests from 2003 to 2010, about 25 percent based on the closed canopy forests in 2003. This is about 3.6 percent of loss per annum.
- The increasing area of open canopy forests may have come from both the natural and planted closed canopy forests. This category increased by almost 14 percent or an average of 2 percent per annum. The additions might have come from degraded closed canopy forests or areas from the other wooded lands that were restored over the years.
- Increased area of mangrove forests which may have come from natural regeneration or mangrove planting.
- There are apparently huge opportunities for increasing forest cover in shrub- and wooded lands.
- Overall, forest cover in 2010 increased by about 22 percent or more than 3 percent per annum. This could be attributed to many factors including the increasing multisectoral approach to forest protection, rehabilitation, agroforestry and development; increasing participation of LGUs; higher level of environmental awareness at the grassroots level; improving effectiveness of forest enforcement; and increasing investments in plantations.

Table 3. Land and forest cover of the Philippines: 2003 and 2010 (ha)

Land class	**Forest**			
	Total forest	**Closed forest**	**Open forest**	**Mangrove forest**
2010	6 840 349	1 930 780	4 601 536	308 033
2003	6 838 822	2 560 872	4 030 588	247 362
Difference (2010-2003)	1 527	-630 092	570 948	60 671

Land class	**Other wooded land**				
2010	Total	Shrubland	Fallow	Wooded grassland	Total – other land
	7 247 213	3 420 217	7 381	3 819 515	14 984 629

Note: calculations based on FMB data from the NAMRIA land and forest cover maps for 2003 and 2010. The 2010 estimates of FMB from NAMRIA data are not yet official.

2.3 Causes of forest degradation

2.3.1 Direct causes

The direct causes of forest degradation have changed over time. After the Second World War and during the height of the logging days, slash-and-burn farming or kaingin, agricultural expansion by converting logged-over areas and inadequately stocked forest areas into plantations and resettlement were the largest contributors to forest degradation. Limited economic opportunities in urban areas and skewed land distribution of prime agricultural lands that were largely in the hands of a few elites, and increasing access to the forests opened opportunities for expanding agriculture in the uplands.

Poverty and limited economic opportunities drove most of the booming population into the logged-over areas and inadequately stocked forest lands. Insurgents also looked at the occupation of logged-over areas as a means to 'equalize' limited access to most of the forest lands and residual forests. As Pulhin et al. (2006) found, the estimated average annual loss of forest from 1934 to 1990 was about 185 000 ha per annum. In fact, deforestation peaked during the period 1965-1975 with a rate averaging 300 000 ha per annum. The loss of mangroves is mainly attributed to the government's decision to allocate 140 000 ha for conversion into fishponds and aquaculture areas under a 25-year fishpond lease agreement. This programme was combined with a financing package through a government financial institution.

Deforestation and loss of cover continued even after the martial law years. The sudden cancellation, non-renewal or suspension of erring TLAs/PLAs/IFMAs)[3] reduced the areas under concession from more than 10 million ha in 1976 to approximately 4 million ha in 1990 and about 1.2 million ha in 2011 (FMB/DENR 2008, FMB/DENR 2011). Without effective and functional replacement of forest management systems in forest lands that were under the concessionaires, most of these areas were rendered de facto 'open access' (Guiang 2001; de Rueda 2006). The DENR field units were simply too undermanned to enforce forest laws and protect the areas under former licence holders.

Large-scale logging activities were mostly halted, but many of the jobless people who knew the forest harvesting technology and the market dynamics continued to log, albeit illegally, as their means of livelihood. The cancellation, non-renewal and suspension of many of the TLAs/IFMAs rendered more than 400 000 people unemployed with dependents of more than 2 million (de Rueda 2006).

The construction and improvement of major national roads provided easy access to most of the protected areas, abandoned logged-over areas with remaining natural forests and plantation forests of the former licence holders. Over time, these areas were the major source of the unaccounted timber supply that was mostly coming from organized, well-financed illegal activities in most of the regions with remaining natural stands of forests.

2.3.2 Underlying causes

During the logging years, the pricing and incentives structure of resource-use rents favoured the 'mining' of forest over the practice of sustainable forest management. Extremely low resource-use rents indirectly accelerated the process of degradation. It was reported that from 1970-1982, taxes as a percentage of reported export values of logs, lumber, plywood and veneer ranged from 5.6-14.5 percent (IBRD 1989). The forest charges, licence fees, sales tax, export and realty taxes only amounted to more than 15 percent of actual rents. The forest charges were applied at an ad valorem[4] rate that ranged from 2 to 6.3 percent of the wholesale log value (Bautista 1990). The government charged more than US$1 m^{-3} while Indonesia was charging more than US$15 m^{-3} during the same period (Guiang 2001).

As a result, many timber concessionaires simply cut trees and got out quickly. After the logging boom, the government was left with very limited revenue for re-investment in forest resource rehabilitation and management (IBRD 1989). The low forest charges from 1950 to the early 1990s provided incentives to overcut until the Forest Charges Law was passed in 1992 increasing forest charges to 25 percent of FOB value of the forest products. After the passage, however, the volume of legally-harvested logs ranged from 0.5 to 1.5 million m^3 per annum, a significant reduction from the 11 million m^3 in 1974-1975 (FMB/DENR 2008).

The policies on low rents on timber and even on the use of forest lands for pasture and for aquaculture or fishponds were the products of a socio-economic structural system that has been dominated by the elite and political dynasties (Vitug 1993). The forests were simply a natural asset that could be exploited as a source of financial capital for other ventures. Over the years, this resulted in exclusive growth in agriculture and other sectors in areas with abundant forests. This further worsened inequitable access to land and assets, increased rural poverty, widened the gap between the rural and urban economies, and increased migration in the uplands for those left without a choice (Porter and Ganapin 1988; Kummer 1992; Pulhin et al. 2006).

Some forms of restructuring occurred after the martial law years with the adoption of community forestry and recognition of IPs' ancestral domains. This policy was partly meant to address social injustice and promote sustainable forestry. This partly responded to the increasing poverty and population in the uplands which contributed to the gradual but continuing degradation of the accessible forests. There were more than 20 million people in 1994 and this is predicted to double in 2015 (DENR 1996). Included are at least 5 million IPs.

The passage of the National Integrated Protected Area System Law formalized the categories of many highly diverse terrestrial and marine areas as 'protected areas'. Several key watersheds were declared as 'reservations' under state management or in partnership with the DOE or DA. These 'set asides' – protected areas and watershed and geothermal reservations – now total more than 4 million ha (Table 2).

In many of the state-managed protected areas and watershed reservations, limited capabilities and budgetary support for forest protection, enforcement and development have resulted in minimal on-site management activities (Molinyawe 2012; PAWB 2012; Guiang and Castillo 2006). Inadequate or no supervision, ineffective management due to limited resources, poor implementation of regulations and limited monitoring capability of the government, have indirectly contributed to forest degradation in these set asides. To add insult to injury, the processes in setting aside the protected areas and watershed reservations were centrally-determined. Most LGUs and communities do not have a sense of commitment and ownership of the protected areas (Guiang and Braganza 2013). In many cases, there was not enough discussion and joint adoption of the purpose of the set asides that will eventually rebound to benefit locals. Thus, with the imposition of restrictions on many forms of ENR use, communities and local vested interests found it difficult to advocate and support the protection status of the set asides.

[3] Timber, pasture and industrial forest management (licence) agreements.

[4] A tax based on the assessed value of real estate or personal property.

With more than 1.6 million ha under CBFMA in 2011 (FMB/DENR 2011) and at least 4.3 million ha with CADTs (NCIP 2012), the capacities of the communities and the IPs are tested as the governance-designated units with RAAs are required to protect, manage, develop and regulate activities in their respective areas. At this point, most community tenure and domain holders have limited resources and capabilities to protect and manage their areas, rendering major portions, to a certain extent, as open access. Most of these community organizations and IP groups do not have internal capability to manage, use or scale up modern or indigenous forest management technology, and manage or access financial resources. There has also been a highly regulated system for the communities and the IPs to access resource-use rights as initial sources of revenues for their internal forest management operations. This had led to large areas under CBFMAs or CADTs being underdeveloped and not adequately protected, and has easily opened up opportunities for encroachment and illegal extractive activities.

Many of the tenured areas were left on their own and at the mercy of market players and buyers. For instance, only 29.4 percent of the forests were found to have formal management plans during the 2002-2004 National Forest Assessment (FAO 2005). With EO 23, resource-use rights in natural forests were banned. Only seven out of the 26 IFMA holders have approved annual operations plans (Calderon 2013). Without a forest-based revenue-generating operation, only those with sufficient funds will be able to protect and conserve the remaining natural forests in their areas of responsibility. Those without adequate resources are deemed not to have self-interests to protect the remaining natural forests within their tenured areas.

Regarding harvesting rights in natural forests (such as those for IFMAs and CBFMAs) and transporting the products to the market or a processing centre, the requirements for approval and other safeguard measures are deemed to be at the whims of the government (Tesoro and Angeles 2010; Guiang et al. 2008). Over the years, a culture of lack of trust has continued to persist among the government regulators, the applicants, the processors and marketers of wood and related products. The private sector claims that the forestry sector has been overly regulated. This has indeed constrained private sector investment in the sector (Tesoro and Angeles 2010). Despite the increasing demand for roundwood and fuelwood, very few private sector and tenure holders have invested their own funds in plantation development. Existing tenure provisions in the instruments of IFMAs and CBFMAs do not simply allow them to access outside support for financing initial operations and establishment costs (Guiang and Castillo 2006; Guiang et al. 2008). The IFMA and CBFMA instruments cannot be used as 'collaterals' for accessing development loans even with government financial institutions. With the high entry cost in developing tree farms, agroforestry and forest plantations, many of the tenure holders are hesitant or simply cannot afford to get into development.

As shown in Figure 2, the demand for roundwood (in roundwood equivalent, RWE) has increased over the past years. From more than 4 million m^3 of RWE, this is expected to increase to about 10 million m^3 of RWE. More than 65 percent of the 4 million m^3 of RWE requirements in 2010 came from imported wood (Sibucao et al. 2013). The increasing demand, the limited source of domestic supply from forest plantations and limited capacities of resource management units to effectively protect and manage their areas have become indirect causes of continuing forest loss and degradation of natural forests.

Fuelwood and charcoal are also expected to increase from the present level of around 70 million m^3 per annum (Guiang 2013). Again, without adequate plantation forests and established fuelwood lots combined with weak tenure rights and limited enforcement capacities of resource management units, accessible natural forests, especially the open canopy areas, shrublands and wooded lands will be highly threatened. In fact, it has been suspected that the major supply of fuelwood and charcoal in major urban centres such as in Metro Manila, Metro Cebu, Davao and elsewhere has been sourced from accessible natural forests or existing government plantations.

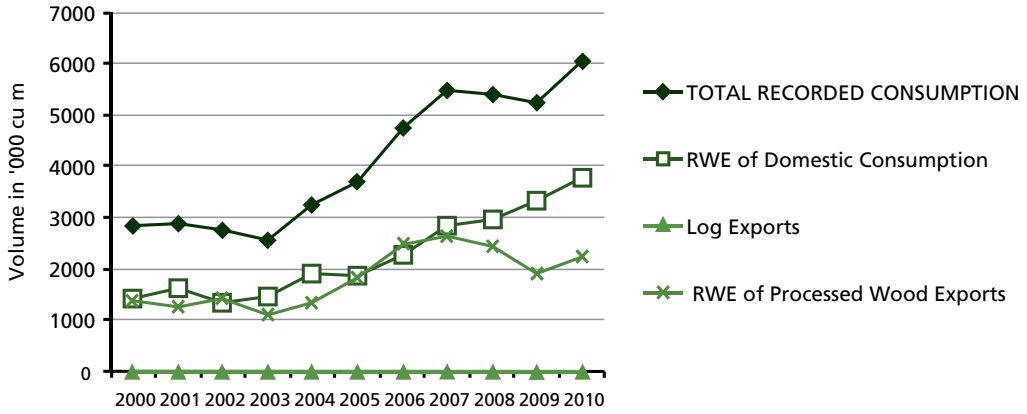

Figure 2. Wood supply and consumption in the Philippines from 2000 to 2010 (Sibucao et al. 2013)

3. Impacts of forest degradation

Forest degradation has had cumulative impacts on the economy, environment and the productivity of agriculture and fisheries. Degradation over the years, including the loss of forests, has forced the government to increase its allocation to forest restoration. But forest degradation has also opened opportunities for collaboration, a deeper understanding of the interconnectedness of various terrestrial and marine ecosystems, and improved appreciation of externalities in the environment and natural resources sector. A summary is provided below.

3.1 Economic impacts

The GDP contribution of the forestry sector has declined over the years from as high as 1.5 to 2.17 percent (based on 1972 prices) during 1975-1980 to 0.09 percent in 2006 (based on 1985 prices) (De Rueda 2006). The GDP contribution of forestry was only 0.07 percent during 2006-2010 (ADMU 2011). The forestry sector has become a 'sunset' industry. The ENR sector has become a major 'cost centre as it requires huge investments to rehabilitate and restore degraded and deforested areas. Private sector investments in forest plantations have been quite limited over the past years (Tesoro and Angeles 2010; Acosta 2002).

The immediate and local economic impact of forest degradation has been the sudden loss of employment opportunities – more than 400 000 direct employees – when most TLA holders were no longer allowed to harvest from the natural forest resulting in the phasing out of most of the wood-processing facilities. Indirectly, the loss of employment negatively affected more than 2 million people. Many of the former logging and wood-processing complexes became ghost towns.

With more than 7.2 million ha now covered with shrubs and wooded grasslands (Table 3) and an average cost of reforestation per hectare of US$1 048, total restoration will amount to US$7.5 billion. The use of ANR instead of standard reforestation will incur a total cost of US$4.2 billion with average cost of US$579/ha (Bagong Pagasa Foundation 2011). An agroforestry approach will be more expensive but will attract more labour and time from farmer-participants and thus reduce total cost by almost 30-40 percent per hectare. Estimates of previous investments in forest restoration have ranged from US$0.6 to US$1 billion, mostly from various donors in loans and in grants (Pulhin et al. 2006; Guiang et.al. 2008). By the end of 2013, the current National Greening Program (NGP) will have incurred a total accumulated cost of about US$255 million for developing more than 600 000 ha. Rough calculation indicates that the average cost per hectare of NGP reforestation is about US$425/ha.

Since 1989, the Philippines has become a net importer of wood to meet its domestic demand and processing of high-value finished products for export – the result of mismanagement of abundant and valuable natural forests in the past. In 2011, total imports of all forest-based products came to more than US$60 million (FMB/DENR 2011). Although just 1.93 percent of the total national imports, this could have been avoided if the once abundant natural forests had been properly managed. With the right incentives, the country could have also developed forest plantations as another source of raw materials.

3.2 Environmental impacts

Forest loss and degradation have also indirectly reduced the supply of water for irrigation, domestic use and energy generation. There are now 267 watersheds that are in critical condition because of their degraded forest cover. There is also a suspicion that one of the reasons for the 0.1 percent reduction of cropping intensity of irrigated rice from 1995 to 2009 could be attributed to the decreasing supply of water from watersheds during the dry months.

Early studies revealed that forest loss and degradation have contributed to the depreciation of upland soils and indirectly reduced the productivity of fishery resources. An estimated 1 billion pesos was lost in 1996-1997 (De Los Angeles and Oliva 1996).

Most of the country's watersheds have forest cover of less than 50 percent (Walpole 2005; Bautista and Tan 2000). This condition exposes at least 60 percent of the country to multiple hazards, with those in the uplands being the most economically affected and further marginalized by natural disasters (WB 2005; DENR and DA/BFAR 2010).

4. Implementation of forest restoration and rehabilitation initiatives

Deforestation converts forest to another land use or over the long term reduces tree canopy cover below the minimum 10 percent threshold. To restore deforested areas, degraded forests or previously non-forested areas, reforestation and afforestation strategies may be used. Most forest restoration processes in the tropics involve reforestation, as opposed to afforestation (Sajise 2003).

In the Philippines, strategies for forest restoration have evolved over time – with a mixture of objectives, institutional arrangements and technical approaches. This will be discussed briefly below.

4.1 History of initiatives, strategies and techniques

4.1.1 The history and emergence of various forest restoration strategies

Government initiatives: Forest restoration in the Philippines – reforestation, rehabilitation, forest plantations, and later with agroforestry and more organized ANR – started with academic efforts back in 1910 at the Forestry School (now the University of the Philippines at Los Baños College of Forestry and Natural Resources) in Los Baños (Pulhin et al. 2006).

To bolster the rehabilitation efforts, the Reforestation Administration was created in 1972 to focus on the reforestation of more areas that were degraded, denuded and rapidly undergoing various stages of degradation and becoming grasslands. By 1974, the government had reforested about 160 000 ha with the main objective of regreening, combined with testing the introduction of various indigenous and exotic species (Pulhin et al. 2006). It was not clear whether these reforested areas and plantations would eventually be the source of raw materials for the wood industry. Later the large reforestation projects became part of watershed reserve and research areas. Some have become germplasm sites for many indigenous and exotic species.

After the martial law years and the entry of the Aquino administration, the government ushered in a strong environmental campaign that focused on curbing illegal logging, pro-people allocation of the remaining natural assets and renewed reforestation efforts. The results are shown in Table 4. Reforestation reached more than 0.5 million ha during the 1986-1992 period. Most of this planting – 425 800 ha – however, was the result of massive infusion of funds through loans from the Asian Development Bank and Overseas Economic Cooperation Fund for contract reforestation by families, rural communities, LGUs and NGOs under the Forestry Sector Program (Acosta 2002).

These reforestation efforts were strongly DENR-driven and were received with mixed response of ownership by the contracted entities. These efforts were in response to external clamour to balance both production and protection. Thus, most plantations were established to rehabilitate watersheds. Tenure and long-term rights to what the families and the entities planted were not seriously considered – they appeared to be an 'after thought'. Thus, most of these areas were established after planting and initial maintenance and eventually turned over to the government for protection and management. Some communities eventually obtained tenure rights over what they had planted. These areas cannot serve as an important supply source of industrial wood (Acosta 2002; Pulhin et al. 2006).

Data from 2003 to 2007 revealed that at least 500 000 ha were 'restored forests' as a result of past reforestation, afforestation, and regeneration of degraded natural forests (ERDB 2010). Sixty-two percent of this, however, was accomplished by the government and the rest by the private sector.

Table 4. Forest planting by the government and private sector (summarized by Acosta in 2002) from FMB forestry statistics 1997-2001

Period	Government		Private sector	
	Includes contract reforestation from 1989 onwards	TLA reforestation compliance	Industrial wood planting	Planting for environmental purposes
Before 1980	184 029	67 689	6 634	15 358
1980-1985	179 389	111 300	20 681	18 653
1986-1992	425 802	132 956	28 803	6 130
1993-1998	147 609	95 138	18 901	27 048
1999-2001	69 799	8 893	3 421	4 561

The massive reforestation efforts in the 1990s and early 2000s yielded valuable lessons and approaches. In terms of species for timber (with rotations ranging from seven to 18 years) and fuelwood, the following indigenous and exotic species were deemed appropriate even under minimal maintenance and inhospitable conditions (Chokkalingam et al. 2006): Mahogany (*Swietenia macrophylla*), Gmelina (*Gmelina arborea*), *Acacia mangium*, Narra (*Pterocarpus indicus*), *Acacia auriculiformis*, *Eucalyptus deglupta*, Teak (*Tectona grandis*), Ipil-ipil (*Leucaena leucocephala*), Falcata (*Paraserianthes falcataria*), Molave (*Vitex parviflora*) and Agoho (*Casuarina equisitefolia*).

The planting materials for the above species were easily grown, available and accessible.

Private sector-driven initiatives: To a certain extent, most of the government requirements for the TLA and IFMA holders were all intended to ensure sustainable harvest for the next cycles augmented by their own reforestation, enrichment planting and forest plantations. Enrichment planting was undertaken in inadequately-stocked residual areas with Falcata and Gmelina (Natonton and Abraham 1984). Several fast-growing hardwoods appeared to be highly suitable as sources of timber from forest plantations. These were Falcata, *Gmelina, Leucaena, Acacia mangium* and Eucalypts. Several dipterocarp species responded positively when planted as seedlings or wildlings in three-to-12-year-old fertile and partly-shaded plantations of fast-growing hardwoods (Reyes 1984).

As a result of timber stand improvements, enrichment planting and planting of open areas, Nasipit Lumber Company in Agusan Del Norte, Western Mindanao Lumber Company in Basilan and Insular Lumber Company in Basilan were able to harvest second cuts of dipterocarps and other natural timber species after 15 to 30 years (Reyes 1984).

Partnership arrangements with communities in forest lands: Over time, partnership and collaborative arrangements emerged for the restoration and rehabilitation of degraded and denuded areas. This was the main rationale for the Forest Occupancy Management of Bureau of Forest Development of the Ministry of Natural Resources (now DENR) in 1971. This simple approach allows occupants to do the reforestation. This was followed by the Family Approach to Reforestation in 1974 and communal tree farms in 1979. All these initial works with the communities were simply engaging communities or family members to plant forest trees and some agricultural crops for subsistence. They were not issued long-term tenures. A more serious look at communities and occupants took place with the birth of Integrated Social Forestry in 1982. This was designed to alleviate worsening poverty in the uplands, promote social justice and protect the environment through proper stewardship. A 25-year certificate of stewardship tenure system was awarded to legitimate claimants (DENR 1996). A more vigorous programme that included community organizations was the precursor of the CBFM programme of the DENR. This was the Community Forestry Program in 1989 which included the award of 1 000 ha to organized communities for their protection and management. The provisions of the agreement included the right of the communities to utilize productive residual forests as an immediate source of income for forest protection and livelihoods (Guiang 2008). This became the foundation of the CBFM strategy and its national adoption in 1994 under EO 263. The limited harvesting rights of peoples' organizations to remaining natural residual forests and mature plantation forests within their areas were part of the overall strategy to enhance forest restoration, protection of the remaining natural forests and addressing upland poverty.

Partnerships with LGUs: Over the last 15 years, forest restoration efforts have been increasingly carried out in partnerships with cities, municipalities and the provinces. The joint forest land-use planning (FLUP) exercises have led to joint protection, development, management and oversight of various resource management units in a given locality. Most local leaders expressed their willingness to collaborate with the DENR and national government agencies to rehabilitate and restore local watersheds, address weak tenure rights, assist poor upland communities and protect the remaining natural forests (EcoGov Project 2011). Most of these efforts were initially supported by USAID, World Bank and GIZ projects. Gradually, however, FLUP and the joint implementation approaches started to flourish. This approach has significantly contributed to protecting the remaining forest cover in a given locality and increased support for the rehabilitation and restoration of community-managed forest lands and local watersheds. It has also opened up opportunities to strengthen tenure systems and link communities with the private sector for co-investments in forest lands.

Outsourcing arrangements for forest rehabilitation and technical support with NGOs: This approach originally emerged from the initial experience of the Manila Waterworks and Sewerage System (MWSS) contracting the Manila Seedling Bank Foundation for the rehabilitation and management of the La Mesa Dam that serves as the source of domestic water for Metro Manila. This approach was pilot tested by the USAID-funded Rainfed Resources Development Project with several NGOs. It is effective provided the NGO has a long-term interest in the rehabilitation, protection and management of the reforested areas.

The Manila Seedling Bank was paid for its rehabilitation, maintenance and protection efforts. The foundation was finally allowed to engage in thinning and harvesting of fuelwood and fodder from hedgerows and firebreaks to reduce the subsidy of the MWSS for its oversight. The results showed that providing long-term interest for NGOs in protecting and managing a reserve or delineated forest land with initial incentives reduced the cost of restoration. Unfortunately, the NGOs were not given long-term rights and incentives for protecting and managing their areas in collaboration and in partnership with communities and occupants in the area. Planted areas were turned over to the government instead of exploring opportunities for co-management and protection of such areas.

One area where the NGOs proved to be helpful was in assisting community organizations in improving their technical, organizational and financial capacities to protect and manage their tenured areas. This has been useful and effective in several donor-funded projects in the Philippines. The communities learned effective techniques for rehabilitation,

agroforestry and sound financial management. Some of them were even assisted by NGOs to facilitate the issuance of their long-term tenure rights.

4.1.2 Techniques

Over time under different strategies, several techniques for reforestation, rehabilitation, agroforestry development and natural restoration emerged as effective and efficient (Table 5). These are categorized based on what forest restoration and management objectives are being supported. Most of the earlier plantings were not categorized according to which resource management unit and dominant objective they would appropriately develop. Thus some of the early reforested areas used fast-growing exotic hardwoods that would provide more value if harvested and replaced with indigenous species if the main purpose was to enhance biodiversity and improve ecological stability. Communities planted fast-growing hardwoods in watershed reservations and protected areas that eventually were not allowed to be cut and sold. Some of the exotic species in the protected areas turned out to be invasive species.

Table 5. Forest restoration techniques and the objectives they support

Forest restoration technique	Short description	Target areas, resource management units and dominant objective
1. Forest plantations using fast-growing hardwoods	• Use of standard plantation or reforestation techniques and establishing tree farms or plantations with fast-growing hardwoods such as Gmelina, *Acacia* sp., Falcata and others. This was done in previously forested areas	• IFMAs, CBFMAs and ancestral domains outside PAs for producing raw materials with fast-growing, mostly exotic species of timber, rattan and bamboo for the forest industry • PAs and watersheds when using indigenous species for conserving biodiversity and providing ecosystem services
2. Enrichment planting in understocked and residual forests	• Increasing the forest stand by planting areas that are open with either indigenous or fast-growing hardwoods • 'Rainforestation' is a variant of enrichment planting	• IFMAs, CBFMAs when using fast-growing exotic hardwoods for future harvest • PAs, mangroves and watershed reservations when using indigenous species to provide PES
3. Rainforestation farming for open and grassland areas	• Forest restoration, wherein only indigenous and endemic tree species are used as planting material which include but are not limited to dipterocarp species, premium species etc. • Kind of reforestation to preserve biodiversity and expand Philippine forests and simultaneously sustain human food production	• PAs, mangroves and watershed reservations • CBFMAs and IFMAs especially in their protection forest lands • Main objective: provide ecosystem services and conserve biodiversity
4. ANR – for wooded lands and grasslands, brushlands, and mangrove areas	• Simple, low-cost forest restoration method that can effectively convert deforested lands of degraded vegetation to more productive forests • Aims to accelerate, rather than replace, natural successional processes by removing or reducing barriers to natural forest regeneration such as soil degradation, competition with weedy species, and recurring disturbances (e.g. fire, grazing and wood harvesting) (Sajise 2003; Bagong Pagasa Foundation 2011) • Enrichment planting using indigenous or endemic species is ideal if this technique is carried out in watersheds and protected areas	• PAs and watershed reservations • Degraded protection areas in IFMAs and CBFMAs • Main objective: provide ecosystem services and conserve biodiversity

5. Agroforestry	• Hedgerow cropping system using trees as hedgerows with agricultural cash crops or fruit trees • Variants of sloping agricultural land technologies: trees and livestock, forest trees and fruit trees, trees with minor forest products, grass strips in hedgerows with cash crops • Intercropping forest trees with high-value agricultural crops such as coffee, cacao and fruit trees	• CBFMAs and domain holders • Main objective: produce food and improve household income while providing ecosystem services
6. Fuelwood lots in plantations, boundary plantings, hedgerows or intercrops	• Planting of suitable species – fast growing, with coppicing characteristics, nitrogen fixing, high calorific value and suitable for highly degraded areas	• CBFMAs, IFMAs, domain holders, multiple-use zones of PAs and watersheds • Near the market for fuelwood or processing centre for charcoal
7. Riverbank rehabilitation	• Plantings on eroded riverbanks for stabilization purposes using fuelwood species, bamboos and other economic species	• Riparian zones, private lands • For slope and riverbank stabilization
8. Muyong[5]	• Muyong is deeply ingrained in the culture of the Ifugao people • Viewed as a forest conservation strategy, a watershed rehabilitation technique, a farming system or an ANR strategy • The role of culture in the development and continued maintenance of the system is pervasive (Butic and Ngidlo 2003)	• Ancestral domains and ancestral lands • Multipurpose objective – increase household incomes and support for the upland farming system

4.2 Economic assessment of different forest restoration and rehabilitation techniques and approaches

In this section, a broad array of economic and financial viability considerations will be used to discuss the viability of the different forest restoration and rehabilitation techniques. The private sector will be more interested in forest plantations that will have the lowest cost and will eventually yield a harvestable volume which can result in profit. The households and communities will be more interested in short-term increase in their household incomes and provide periodic and predictable streams of revenues over time. For restoring and rehabilitating watersheds and protected areas, the main issue will be cost per unit with the different approaches. Thus, the return on investment (ROI) and internal rate of return (IRR) will be more meaningful to the holders of CBFMAs, IFMAs and domain holders. Benefit-cost ratio and cost per unit are more applicable in protected areas and watersheds.

It should be noted, however, that whenever a hectare of degraded or deforested land is restored – reforested, rehabilitated, regenerated or developed into agroforestry – the total economic benefit (environmental and financial benefits) is twofold. The first is the public benefit share from the total economic benefit and the second is the private benefit. The public benefit from a hectare of improved or restored forests is estimated to be at least 30-50 percent. The 'investor' – tenure holder, farmer, community members or the resource management unit – is not able to get all the benefits. It gets at least between 50-70 percent of the total benefit package (Francisco 2004). Thus, the public, society in general or the individual person loses whenever a hectare of degraded or deforested area is not restored or brought back to productivity.

Table 6 provides a summary of viability and cost per unit of major forest restoration techniques and approaches that are being used in various parts of the Philippines. Forest restoration, in many ways, is a 'cost' on the part of the government or of a household. With agroforestry at the household level, labour and maintenance are normally counterparts. This reduces the cost of restoration. Private sector's investments in forest plantations under an incentivized business environment will reduce the total cost of rehabilitation by the government. Restoration in protected areas and watersheds, however, is justified on the basis of their long-term support in providing ecosystems goods and services and posterity values and, hence, the use of indigenous species.

[5] Muyong or pinugo is an indigenous system of forest management unique to the people of Ifugao. Adapted since time immemorial, the pinugo/muyung covers clan-owned woodlots or forests located above the rice terraces and is a source of food, fuel, lumber for housing and woodcarving, medicinal plants, botanical pesticides, irrigation, domestic water, and cash. In addition, it serves as the best preventive measure against soil erosion (http://www.youtube.com/watch?v=eUzOQEG9-zc).

Table 6. Economic measures of some forest restoration techniques and approaches

Restoration technique or approach	Economic or financial measure, cost per unit	Source/remark
1. Plantation or tree farm of Bagras, Falcata and *Acacia mangium*	• IRR of 41, 23, 22%, respectively	• ERDB (2012)
2. Agroforestry with Sloping Agricultural Land Technology (a combination of 40% agri-crops, 40% livestock, 20% forestry in 1 ha)	• ROI of 38.71% – agro-livestock production (fuelwood, cash crops, livestock and forage)	• IIRR (1992) • Minimizes soil erosion, improves soil fertility and generates household (HH) income
3. Agroforestry with Sloping Agricultural Land Technology (40% agri-crop, 60% forestry: food-wood intercropping in a 2-ha plot)	• ROI of 8%	• IIRR (1992) • Minimizes soil erosion, improves soil fertility and generates HH income
4. Standard reforestation and ANR for steep areas of watersheds, grasslands, strict protection zones of PAs and other restoration/ rehabilitation efforts for environmental/ecological purposes	• 3-year cost/ha of reforestation and ANR is US$1 048 and US$579 respectively • ANR is only 55% of the cost of standard reforestation	• Bagong Pagasa Foundation (2011) • ANR will enable savings for the government of at least 45% compared with the total cost of reforestation. This is huge savings for the government and will allow more areas to be restored
5. Pineapple-based agroforestry	• Highly profitable at the HH level when covered with marketing agreement and support from a private sector company • Includes technical support and guidance to farmers from LGUs and the DENR	• EcoGov 2 Project (2011)
6. Coffee-based agroforestry	• Highly profitable at the HH level when covered with a marketing agreement and support from a private sector company • Includes technical support and guidance to farmers from LGUs and the DENR	• EcoGov 2 Project (2011
7. Fruit trees with minor forest species (rattan, bamboo)	• Financial IRR of 12.6%	• Sison (1999)
8. Restoration and management of mangrove forest	• 1 ha of restored and managed mangroves in Central Visayas provides US$500 to US$1 550 per year from fisheries and wood production	• FISH (2007)

5. Case study

This section provides the details of forest restoration as a result of joint DENR-LGU assistance and support to communities and under a co-management agreement between the DENR-LGU to undertake rehabilitation activities in highly degraded areas.

5.1 Case study: Bayawan City, Negros Oriental, Philippines – co-management of forest lands to address deforestation

Bayawan City (in 2010 population approximately 100 300) was 90 percent forested in 1970, but less than 4 percent (2 397 of 60 908 ha) remained in 2004 (Baterna 2012). Massive deforestation in Bayawan began in earnest in 1979 when the government stopped all commercial logging operations in the province (Negros Oriental). When the loggers departed, they left a network of logging roads that facilitated the slash-and-burn activities of displaced forest workers and the influx of migrant settlers. By 1987 practically all of Bayawan's dipterocarp forests were gone; but displaced logging workers from neighbouring towns, including insurgency evacuees from Negros Occidental kept arriving to carve out their farms and new settlements.

As the upland settlements grew, the old and muddy logging roads were repaired by the municipal and provincial governments. By 1984, with the completion of the highway to facilitate commerce between Negros Oriental and Negros Occidental, agriculturalization of the forest lands took place. Today, 82 percent of Bayawan's forest lands are already under agricultural use.

The government through the DENR allocates forest lands to various qualified user-managers. Current policies allow five allocation categories: (1) allocation for communities, through peoples' organizations (POs) or cooperatives, (2) allocation for private individuals or business groups, (3) allocation for other government agencies, e.g. the Philippine National Oil Company, military and educational reserves, (4) allocation by the government for public goods (set asides), e.g. areas under NIPAS and (5) allocation for LGUs. The DENR issues 25-year renewable tenure instruments for the various allocation types.

Mere allocation, however, does not result in improved forest management. In Bayawan, allocated forest lands comprise only 29 percent (approximately 5 811 ha) of the 20 245 ha of forest lands. An assessment of the allocated areas made in 2003 (during preparation of the municipal forest land-use plan) found that tenured lands were not managed. Those under Certificate of Stewardship Contract, CBFMAs and CADCs were mismanaged, indicating the inability of local communities to provide the necessary resources and capacity to put their allocations under improved management. Several farmers leased their lots to other parties; others sold their land rights. All other areas (approximately 14 434 ha) which are mostly settlements and croplands were without tenure. In effect, 95 percent of Bayawan's forest lands were under open access conditions.

In 2003 the City Government did not have the capacity to perform its forest management responsibilities. The City Environment and Natural Resources Office did not have personnel to implement forest management. The DA and the City Agriculturist were concerned with maintaining agricultural productivity but they did not have programmes, personnel or expertise in soil and water conservation. The DENR, which is the primary agency concerned with forestry, has inadequate personnel. Overall, there was no systematic forest land management effort, and forest laws and enforcement had not stopped the deforestation and the ongoing encroachment of remaining stands.

But in 2004 Bayawan completed its municipal FLUP following issuance in 2003 of DENR-DILG Joint Memorandum Circular No. 2003-01. JMC 2003-01 encouraged local governments to prepare their municipal FLUP. Technical assistance was provided under the USAID-assisted Philippine Environmental Governance (EcoGov) Project in close collaboration with the DENR. Bayawan's FLUP was approved when it entered into a Co-Management Agreement with the DENR covering the municipality's untenured forest lands. It also signed a Joint FLUP Implementation Agreement with the DENR covering the entire forest lands of the municipality.

Subsequently, Bayawan created a fully-staffed Forest Management Unit and tasked it to implement the FLUP. The priority projects that were implemented included:

(1) **Bayawan Riverbank Rehabilitation and Management Project:** Started in the second half of 2004, the project aimed to stabilize around 170 km of Bayawan riverbank by establishing at least a 5-m-wide vegetative corridor through planting of forest/agroforestry tree crops along the 20-m width of strip inland.
(2) **Danapa Watershed Project:** In 2005 Bayawan spent about US$360 000 for the purchase and rehabilitation of 234 ha within the Danapa subwatershed to secure the future potable water supply of Bayawan City. To date around 220 ha are already developed using madre de cacao, mahogany and mangium. Enrichment plantings consist of banana, coffee, coconut, jatropa for agroforestry and rattan. Endemic species grow on the steep slopes.
(3) **Establishment of water production areas (WPAs):** WPAs were intended to rehabilitate traditional water springs. The identification and establishment of WPAs started in 2005 through a participatory process initiated by the forest management unit (FMU). The formulation of barangay (village) ordinance in each participating barangay to support the implementation of agreed land-use regulations was approved by the barangay councils in 2006. Since the start of implementation in 2005 around 435 ha from the 19 barangays implementing WPAs have been developed using madre

de cacao (*Gliricidia sepium*) and assorted species of fruit tree and forest tree seedlings to reforest the area. Latex rubber (*Hevea brasiliensis*) seedlings were also planted. The total budget spent for the development of water production areas including the one-year cost of maintenance in the 19 barangays was estimated at 6 500 000 pesos. The cost of development was around 14 493 pesos per hectare.

(4) **Rare/endangered species and critical habitats protected:** The 1 050-ha plantation and remnant forest (IFMA) is the habitat of the endangered Visayan spotted deer (*Rusa alfredi*). The LGUs of Bayawan City, Basay Hinobaan, Candoni and Kabankalan agreed in 2005 to establish a wildlife corridor comprising these LGUs to support conservation of both flora and fauna species in the area.

(5) **Forest law enforcement:** A total of six outposts were established to curb timber poaching. Each outpost is manned by two members of the Philippine National Police and supported by a total of 148 Barangay Police deputized as forest wardens by the DENR. The Barangay Police are provided by the City Government with a 3 000 peso monthly honorarium and free meals on duty.

(6) **Recognition of individual property rights:** The main purpose is to improve the management of forest lands by promoting responsible stewardship through legitimization of informal land claims and defining authority and privileges as well as the accountability and responsibilities of the Indigenous Peoples Rights (IPR) holder. In April 2007 Bayawan City enacted its IPR Ordinance which authorized the City Mayor, in his capacity as Chair of the Co-Management Agreement Steering Committee, to issue subagreements to forest land dwellers (forest occupants) for the implementation of agroforestry. As of 2011, subagreements had already been issued to 420 individuals occupying an aggregate of 1 092 ha. Corresponding to this, the city government collected 78 750 pesos in various user fees and charges that went into a special account as provided in the city ordinance.

Annual LGU investments in FFM (2005-2011): For the period 2005-2011, Bayawan City's cost of reforestation and rehabilitation budget ranged from 3 800 000 to 17 730 000 pesos and the total amounted to 57 135 300 pesos (about US$1 428 382.00).

Figure 3. Time sequence for FLR in Bayawan

Funds leveraged from other funding sources for FLUP implementation: The GIZ-EnRD Project supported implementation of 180 ha of agroforests by 222 IPR holders, including reforestation of around 16 ha. Also Bayawan City obtained a grant-loan package from the Reconstruction Credit Institute/CBFMMP to support agroforestry development and reforestation by IPR holders, including support for the establishment of an inland aquaculture hatchery and establishment of small water impounding projects. The total support came to 20.3 million pesos.

6. Looking forward

The conditions for success of a national FLR strategy in the Philippines must consider the dominance of highly diverse watershed landscapes, highly threatened and fragmented remaining natural forests, upland poverty, increasing demand for wood and fuelwood/charcoal products, uncontrolled population growth, high vulnerability to erratic and extreme weather conditions, and complex forest governance systems at the local, provincial, regional and national levels in order to meet international commitments.

The FLR conditions for success of the national strategy are mainly reforms in current forestry policies, especially in the areas of market orientation, social equity, decentralized support for an integrated ecosystem management and/or landscape approach; consistency with other relevant ENR-related policies; consistency with the Philippines' major international commitments; and strengthened institutions for management support and enforcing regulations. These are further discussed in the next sections.

The proposed FLR national strategy is linked to or assessed with the required conditions for success. It simply re-iterates the need to integrate prescriptive technical, governance/institutional and socio-economic strategies with efforts to make forest policies more stable, client- responsive, market-driven and decentralized in collaboration with LGUs for managing, regulating and supporting various land and resource management units (LRMUs) within priority river basins, ecosystems and landscapes. The FLR strategy also highlights the need for improving local governance in the light of relevant national forest and related policies.

The proposed strategy builds on current and ongoing efforts to update various sectoral and agency master plans such as the ongoing revision of the ENR Framework Plan of the DENR, the Revised Master Plan for Forestry Development, the National Biodiversity Action Plan (NBSAP) together with the ongoing efforts to prepare the National Protected Area Master Plan and the NCIP's Indigenous People's Master Plan. In addition to these sectoral and agency master plans, there are also cross-sectoral framework plans that directly or indirectly impinge on the implementation of the national FLR strategy. The Philippines has the Climate Change Strategy that embeds the Philippines National REDD Plus Strategy (PNRPS) and the overall Disaster Risk Reduction and Management (DRRM) Strategy that is carried out through LGUs. Over the last two years, the DENR has also started supporting the preparation and development of frameworks and master plans for the 18 major river basins in the country. All of these sectoral and cross-sectoral framework plans are, in theory, in support of the Philippines Development Plan for 2011-2016 and the succeeding development priorities and national plans after the Aquino administration in 2016.

For the Philippines' compliance to international agreements, the NBSAP and the PNRPS embody the country's commitments under the CBD especially those in the Aichi Convention and under the UNFCCC and Kyoto Protocol, respectively.

In summary, the conditions for success of the proposed national FLR strategy are anchored on the country's dominant and highly diverse watershed-ecosystem landscapes, the applicable and relevant governance and institutional systems in these landscapes and the needs of the clients and markets of forest ecosystem goods and services.

6.1 Conditions for success

Table 7 summarizes conditions for the success of the FLR national strategy in the Philippines. These are further discussed in the succeeding section. FLR, being an approach that demands a more holistic and system-based orientation in planning and implementing programmes and activities, will need new policy guidelines (but built on the strengths of the forestry sector) and stronger realization that forestry is only a component of the broader context of socio-economic development and other environmental and natural resource sector concerns. FLR has to respond to the increasing demand for evolving and expanding forest ecosystem goods and services, climate change challenges and deepening understanding of the values of forests, biodiversity and their roles and contributions to local, national and international economies.

Table 7. Conditions for success of the FLR national strategy

Conditions	Description
1. Reforms in forest policies	As conditions for sustainable FLR, the following policy areas must be modified and issued at the national level through appropriate administrative issuances: a) Implementing guidelines for the DENR's shift from a sectoral to an integrated watershed-ecosystem management approach as a unifying policy framework for FLR as a component of an intersectoral environment and natural resource management strategy in major river basins, watersheds, protected areas, large ancestral domains, islands and mineral reserve areas. Formulated in the broader context of watershed ecosystems, a policy that shall harmonize and mainstream FLR with comprehensive LGU socio-economic development plans through the joint DENR-NCIP-LGU implementation of forest land use plans, protected areas management plans, ancestral domain plans, coastal and natural resources management plans and other ENR sectoral plans (e.g. solid waste and waste water). b) DENR-NCIP Joint Administrative guidelines for areas under IFMAs, CBFMAs, SIFMAs and CADTs to be designated as the main sources of raw materials for plantation wood, fuelwood and charcoal to meet local wood-processing requirements and domestic needs. c) A national policy that will create support to capacitate, provide financing and technically assist the holders of CBFMAs, CADTs and Protected Areas Community-Based Resource Management Agreements in the multiple-use zones of protected areas. To improve their forest resource management practices, develop a national policy that will identify, determine and offer opportunities for public-private partnerships, public-community-private partnerships, co-investments and co-financing of ENR-dependent enterprises and industries.
2. Consistency with relevant and related national policies	The FLR strategy from the national level down to the LRMU must be consistent with national policies such as: a. The NIPAS Law – for any forest restoration activities in protected areas as state tenure for conserving biodiversity especially with respect to what species will be used, what zones will be covered and which strategy of the protected area management plan it supports. b. Climate Change Law and the Disaster Risk Reduction and Management Act – restoration should be consistent with the ecosystem-based LGU DRRM strategies and must be able to contribute to climate change mitigation and adaptation by communities, livelihoods, enterprises and industries. c. Indigenous Peoples Right Act (IPRA) Law – for restoration in ancestral lands, especially those in support of CADT holders as they carry out the implementation of their ancestral domain sustainable development and protection plans. d. Local Government Code – need for LGU involvement within their political jurisdiction and consistency with the LGUs' comprehensive land-use plans (CLUPs). e. Wildlife and Conservation Act – in support of critical habitat, protection of wildlife species and conservation of corridor areas that may cut across political boundaries and watershed ecosystems. f. EO 263 and EO 318 – FLR to be consistent with the community-based forest management and sustainable forest management strategies especially in forest lands of holders of CBFMAs and IFMAs. g. EO 23 – FLR to be supportive of enforcement of the moratorium on logging in the remaining closed and open canopy forests in the Philippines and of protecting them under various tenure and ancestral domain areas. h. EO 26 – FLR as support to the evolving National Greening Strategy that includes components of social mobilization, a commodity road map for reforestation, agroforestry in both tenured and non-tenured areas, partnership and collaboration, and tenure and use rights.
3. Consistency with the major Philippines international commitments	FLR should support the Philippines' commitments to the following international agreements/organizations: a) The CBD especially the Aichi Convention, b) The UNFCCC and Kyoto Protocol especially in reducing emissions from forests and forest lands, and c) The International Tropical Timber Organization (ITTO) especially in the adoption and implementation of sustainable forest management.

4. Re-oriented and strengthened national and local institutions on collaborative, integrated, client-responsive and market-oriented FLR in support of various land and forest resource management units within watershed-ecosystem landscapes	Adequate technical, institutional, financial management, organizational and leadership capacities are needed to plan, implement, monitor and evaluate programmes and projects in support of FLR at the national, regional, provincial and local levels; and of various LGUs and LRMUs for translating the FLR into their individual zoning regimes, development plans and resource management plans.

6.1.1 Reforms in major policy areas

As summarized in Table 7, reforms are needed in major forestry policy areas to support FLR approach. These should also be formulated in the ongoing shift from the sectoral to intersectoral and integrated ecosystems' approach to minimize negative environmental externalities in watershed-dominated landscapes where interconnectedness, interdependence and intergenerational impacts must be considered.

6.1.2 Consistency with current national policies

Given the need to produce forest ecosystem goods and services to meet various demands, it is imperative that FLR has to satisfy the policy provisions and requirements of various forestry and ENR-related policies. Multiple objectives must be achieved from a given watershed-dominated ecosystem or landscape. Each objective may be carried out under different policy guidance. The cross-cutting objectives will also have to satisfy the need to address climate change and disaster risk reduction, get the buy-ins and commitments of LGUs, conserve biodiversity in PAs and outside the PAs that are considered to be part of the key biodiversity areas, comply to various environmental regulations especially on mitigating negative externalities, preserve the practices of indigenous cultural communities and contribute to programmes that will reduce poverty.

Thus, as listed in Table 7, the policies that have cross-cutting concerns in FLR within each region and LGU are: a) The Climate Change Act; b) Disaster Risk Reduction and Management Act; c) The Local Government Code (LGC); and d) Executive Order 192 – Re-Organization of the Environment and Natural Resources.

There are several policies that are key for assisting or supporting various LRMUs within an LGU and watershed-ecosystem unit under the FLR approach. They include the: a) The NIPAS Law (protection and conservation of biodiversity); b) IPRA (recognition of legitimate land and ancestral domain claims of IPs); c) Presidential Decree (PD) 705 (Revised Forestry Code); d) Executive Order (EO) 318 (Sustainable Forest Management Act specifically for holders of IFMAs and CBMAs; e) EO 23 (moratorium on logging in all natural forests); and f) EO 26 (implementation of the NGP in forests and forest lands).

FLR in the Philippines is going to be effective if the approach, strategy, programmes and plans are carried out with LGUs in priority river basins or watersheds that are clearly connected with major economic investments and infrastructure and through each of the relevant LRMUs.

6.1.3 Consistency with major international commitments

The Philippines is a signatory to major international agreements which commit the country to certain forest and biodiversity conservation practices and targets. Thus, the country's FLR must contribute to achieving the commitments under these agreements. The FLR-related agreements include: the United Nations Conference on Trade and Development, the Conference for the Adoption of the Convention on Biological Diversity (CBD 2013), and the UNFCCC in 1992 and the Kyoto Protocol.

6.1.4 Re-oriented and strengthened national and local institutions

Given the dominance of watershed-ecosystem landscapes in the Philippines, the configuration of the extent and coverage of protected areas and ancestral domains as LRMUs, the governance complexity that could impinge on FLR planning and implementation would require a massive re-orientation and strengthening programme and support at the national and local levels. The following are required: a) The DENR's shift from sectoral to intersectoral and integrated ecosystems management; b) The DENR and LGUs also need orientation, training and support with the expected changes in management; and c) capacitation of CBFMAs.

6.2 National strategy for FLR

A national strategy for FLR in the Philippines has to support the Revised and Updated Forestry Master Plan for Development, the Philippines National REDD Plus Strategy, the National Biodiversity Strategy and Action Plan and the Strategic Plan

of the National Commission on Indigenous Peoples. The programmes that support these strategic plans have included approaches for forest and landscape restoration.

6.2.1 Prescriptive FLR strategies

FLR at the national, regional and watershed-ecosystem or basin levels should provide prescriptive strategies to guide the formulation of site-specific operational strategies that respond to issues, threats and opportunities. The strategies may cover mitigation and adaptation to climate change impacts; support for sustainable development needs, especially poverty and inclusive economic growth; improved local governance that supports individual and collective efforts in each basin; addressing protection and conservation-oriented land and resource uses in each LGU and LRMU to increase resiliencies; and enhancing the comparative advantage of each site in support of competitive goods and services.

Integrated management of watershed ecosystems as the main approach of FLR: The forestry sector does not exist in isolation. Thus, it has to be a part of an integrated approach to the management and regulation of an array of ecosystems in watersheds, protected areas, key biodiversity areas, islands, political units, ancestral domains and reservations. IEM has been adopted by the Philippines Government under its Philippine Development Plan for 2011-2016. This approach supports the Philippines' commitment to the CBD. It is a holistic and integrated strategy for managing land, water and living resources with humans playing a major role in the process.
The IEM prescriptive strategies at the national, regional and watershed ecosystem levels are intended to enjoin individual and collective actions to:

- Ensure ecosystem resiliencies within watershed ecosystems, mitigate the damages and risks from natural disasters that may result from erratic weather conditions.
- Facilitate the adaptation of highly vulnerable communities and their livelihoods, enterprises and industries within a given watershed ecosystem.
- Ensure that public and private investments will enhance a watershed ecosystem's comparative advantages, especially in supplying water for various purposes.
- Pinpoint opportunities for improving the value chains of competitive goods and services.

The suggested prescriptive strategies for FLR are not mutually exclusive of one another. Each may strengthen or complement and reinforce the outcome and outputs of the other strategies. Some may cut across the different strategies like governance, incentives and setting up a database system. There are at least seven prescriptive strategies that are being recommended to substantiate the FLR approach that is anchored on integrated management of watershed ecosystems in the Philippines. They are:

- Prescriptive Strategy No. 1 – The National Greening Program as the National Operational Framework of FLR – has the necessary components for FLR, but focuses on degraded and denuded areas under the 'other wooded lands' category (in Table 2).
- Prescriptive Strategy No. 2 – Governance-based Forest Restoration – restoration has to be consistent with local governance.
- Prescriptive Strategy No. 3 – Biodiversity Conservation in NIPAS and Non-NIPAS Areas – strengthening of biodiversity conservation in protected areas, and contribute to commitment to the CBD.
- Prescriptive Strategy No. 4 – Incentives and Support for Forest Restoration – defines incentives and support for the holders of CBFMAs, IFMAs and domain holders.
- Prescriptive Strategy No. 5 – Forestry Database System that Supports the Results-based Monitoring and Evaluation (RBME) Process – needed for decision-making.
- Prescriptive Strategy No. 6 – Reducing Emission from Deforestation and Degradation (REDD+) – provides an opportunity to use restoration of forests and lands to contribute to reduction of carbon emissions.
- Prescriptive Strategy No. 7 – Investments to Enhance Comparative Advantages – forest restoration programme has to be tailored in support of a region's comparative advantage.

6.2.2 Descriptive FLR strategies

Descriptive FLR strategies are going to be guided by FLR prescriptive strategies at the national, regional and watershed-ecosystem levels. These descriptive strategies are operational in nature and are translated into programmes, plans and activities (PPAs) at the DENR field unit, LGU and LRMU levels. To realize the FLR prescriptive strategies, the DENR, LGUs, NCIP (as a site may require) and other agencies and organizations are enjoined to support and assist the different LRMUs to carry out their annual plans and activities that individually and collectively will achieve the FLR goals and objectives for a given watershed ecosystem, a region and the country as a whole.

This means that in each priority watershed ecosystem, the DENR field units will prepare their annual PPAs consistent with the appropriate and applicable prescriptive strategies and leverage support of the LGUs to assist the land and forest resource management units to protect the remaining natural forests, conserve highly diverse areas, develop plantations or agroforestry farms, engage in ENR-based enterprises based on the site's comparative advantages and link with the markets.

This means that in each watershed ecosystem, the prescriptive FLR strategies are going to be used by the local governance body to guide each LGU in preparing and implementing their CLUPs with zoning regimes that have incorporated the FLUPs

and mangrove areas, the designated land and resource uses to ensure resiliencies of the ecosystems and communities, and delineated areas in lands of public domain for forest production and development, rehabilitation and restoration. This also means that each LRMU – CADT, PA, CBFMA, IFMA, holder of special-use rights, watershed reservations and the like – will develop their respective areas consistent with the FLR prescriptive strategies and LGU zoning regimes. The local governance bodies – councils, LGU executive and legislative branches, DENR, PAMBs, elders – will have to ensure that each DENR field unit, LGU, tenure and domain holder, and other units with responsibility, accountability and authority will plan and implement FLR activities consistent with the prescriptive strategies of each watershed ecosystem.

Part of FLR – at the national, regional, LGU and land and forest management unit level – is an intentional effort to ensure that the remaining natural closed canopy forests are protected and managed by each resource management unit with the guidance and oversight of the concerned DENR field unit, LGUs and local government bodies that include civil society groups and other agencies. There is no national programme along this line. This overall strategy can easily be linked with the REDD+ programmes under the PNRPS.

Lastly, the DENR, NCIP and LGUs should make sure that the ongoing and approved donor-funded projects from loans and grants in each watershed ecosystem will transition towards supporting FLR, especially in translating the prescriptive strategies into specific descriptive and operational workplans by each DENR field unit, LGU and LRMU.

References

Acosta, R.T. 2002*. Impact of incentives on the development of forest plantation resources in the Philippines.* Paper presented at the Asia-Pacific Forestry Commission meeting in Ulan Bator, Mongolia, 2002.

Ateneo de Manila University (ADMU). 2011. *Conserving tropical forests and biodiversity for human development and inclusive growth.* 2011 FAA 118/119: Philippines Environment Sector Assessment. Prepared for USAID/ Philippines by Ateneo School of Government. Ateneo de Manila University, Katipunan Avenue, Quezon City. 2011.

Bagong Pagasa Foundation. 2011. Cost comparison of assisted natural regeneration to compared to conventional reforestation. *In* P.B. Durst, P. Sajise & R.N. Leslie, eds. *Forests beneath the grass*. *Proceedings of the regional workshop on advancing the application of assisted natural regeneration for effective low-cost forest restoration*. Bangkok, Thailand, FAO.

Baterna, J.P. 2012. *Forest land use planning and implementation: experiences of Bayawan City, Negros Oriental LGU-Bayawan City.* NewCAPP Workshop Proceedings on FLUP. Quezon City, PAWB, DENR.

Bautista, G.M. 1990. The forestry crisis in the Philippines: nature, causes and issues. *Developing Economies*, Vol. XXVII, No. 1, March 1990.

Bautista, G. & Tan, R.P. 2000. *Watersheds and groundwater depletion in the Philippines: the Cagayan de Oro experience.* Quezon City, Philippines, Ateneo de Manila University, Quezon City, Philippines.

Braganza, G. 2012. *Philippines CBNRM stocktaking report.* Prepared under a DAI Contract with USAID, Washington, DC.

Butic, M. & Ngidlo, R. 2003. Muyong forest of Ifugao: assisted natural regeneration as traditional forest management*. In* P.C. Dugan, P. Durst, D. Ganz & P. Mckenzie, eds. *Advancing assisted natural regeneration in Asia and the Pacific.* RAP Publication 2003/19. Bangkok, FAO.

Calderon, R. 2013. Forest and forestry in the Philippines: 2016 and beyond. A PowerPoint presentation. FMB, Quezon City.

Chokkalingam, U., Pulhin, J., Carandang, A., Peras, R.J., Lasco, R.D. & Natividad, M. 2006. Chapter III: Outcomes and sustainability: Lessons from the ground. *In* U. Chokkalingam, A. Carandang, J. Pulhin, R. Lasco, R.J. Peras & T. Toma, eds. *One century of forest rehabilitation in the Philippines: approaches, outcomes, and lessons*. Bogor, CIFOR.

De Los Angeles, M.S. & Oliva, R. 1996. *Logging bans: economic and environmental consequences.* DAI-NRMP, Quezon City, NRMP/DAI, DENR, Visayas Avenue.

De Rueda, R. 2006. *Re-inventing the forestry agencies of the Department of Environment and Natural Resources: Philippines.* Paper presented during the Expert Consultation on Re-Inventing Forestry Agencies, Asia-Pacific Commission from 28 February to 1 March 2006 in Manila, Philippines.

Department of Agriculture (DA). 2012. *Food Staples Sufficiency Program 2011-2016: enhancing agricultural productivity and global competitiveness.* Quezon City, Department of Agriculture.

Department of Environment and Natural Resources (DENR). 1996. *Upland Development Program: a decade and a half.* Quezon City, DENR.

DENR & DA/BFAR. 2010. *Whole system in a room: workshop documentation.* Coastal and Marine Sector Multi-stakeholder Workshop, Hyatt Hotel Manila, 20-21 September 2010.

DENR/ENRMP/GEF Project. 2012. *Integrated ecosystems management: Collecting individual efforts together to overcome and achieve joint benefits in ENR management.* ENRMP Brochure. Quezon City Philippines, DENR/ FASPO.

DENR/ENRMP/GEF Project. 2013. Draft Project Completion Report of the World Bank-DENR National Program Support – Environment and Natural Resources Management Project. Quezon City, FASPO, DENR.

EcoGov Project Phase 2. 2011. *Economic benefits from investments in NRM. The Philippine Environmental Governance Project Phase 2.* Prepared for USAID/Manila by Development Alternatives, Inc. (DAI). Taipan Place, Ortigas Complex, Pasig City, Metro Manila, Philippines.

Ecosystem Research and Development Bureau (ERDB). 2010. Development and management of forest plantations: a guidebook. Los Baños, Laguna, Philippines, ERDB/DENR, College.

Environmental Science for Social Change (ESSC). *Decline of the Philippine forest.* Bookmark Inc., 1999.

Food and Agriculture Organization of the United Nations (FAO). 2001. *Global forest resources assessment 2000 main report.* FAO Forestry Paper No. 140. Rome, Italy, FAO.

FAO. 2005. *Forest resources assessment: national forest assessment working paper.* National Forest and Tree

Resources Assessment 2003-05. Working Paper 90 for the Philippines. Manila.

FAO. 2013. ***Climate change guidelines for forest managers.*** FAO Forestry Paper No. 172. Rome, Italy.

FISH Project. 2007. ***The Fisheries Improved for Sustainable Harvest Project***. Municipality of Talibon, Bohol, Philippines, the CRM Interpretive Center.

FMB/DENR. 2003. ***Revised Master Plan for Forestry Development: condensed report.*** Quezon City, Forest Management Bureau with Assistance from the FAO of UN, DENR.

FMB/DENR. 2000. ***2000 Philippine forestry statistics.*** Quezon City, FMB, DENR.

FMB/DENR. 2008. ***2008 Philippine forestry statistics.*** Quezon City, FMB, DENR.

FMB/DENR. 2010. ***2008 Philippine forestry statistics.*** Quezon City, FMB, DENR.

FMB/DENR. 2011. ***2011 Philippine forestry statistics.*** Quezon City, FMB, DENR.

Francisco, H. 2004. ***Economic analysis of allocating forest and forest lands: total economic valuation approach.*** Technical Report submitted to EcoGov 1, Quezon City, Philippines.

Guiang, E.S. 2001. Impacts and effectiveness of logging bans in natural forests: Philippines***. In*** C. Brown, P.B. Durst & T. Enters, eds. ***Forest out of bounds: impacts and effectiveness of logging bans in natural forests in Asia-Pacific.*** Bangkok, FAO.

Guiang, E.S. 2008. Resource use rights and other challenges to the sustainability of community-managed forests and forest lands in the Philippines. ***In*** K.L. Gollin &J.L. Kho, eds. ***After the romance: communities and the environmental governance in the Philippines.*** Quezon City, Ateneo de Manila Press.

Guiang, E.S. 2013. Draft technical report on updating and climate proofing the management and development of natural and plantation forests and forest-based enterprises and industries. Quezon City, FMB, DENR.

Guiang, E.S. & Braganza, G. 2013. Draft final report on the National Management Effectiveness and Capacity Assessment of Protected Areas in the Philippines. Quezon City, PAWB-GiZ, DENR.

Guiang, E.S. & Castillo, G. 2006. Trends in forest ownership, forest resources tenure and institutional arrangements in the Philippines: Are they contributing to better forest management and poverty reduction? ***In Understanding forest tenure in South and Southeast Asia. Forestry Policy and Institutions***. Working Paper. Bangkok, Thailand, FAO.

Guiang, E.S., Esguerra, F. & Bacalla, D. 2008. Devolved and decentralized forest management in the Philippines: triggers and constraints in investments. ***In*** J. Carol, P. Colfer, G. Dahal & D. Capistrano, eds. ***Lessons from forest decentralization: money, justice and the quest for good governance in Asia-Pacific.*** Bogor, CIFOR; UK, USA, Earthscan.

International Bank for Reconstruction and Development (IBRD). 1989. ***Forestry, fisheries, and agricultural resources management study.*** Report No. 7388-PH. Washington, World Bank.

International Institute of Rural Reconstruction (IIRR). 1992. Agroforestry information kit. ***In Soil and Water Conservation Conservation (SWC) Technologies and Agroforestry Systems,*** Volume 1, pp. 93-95. Silang, Cavite.

Kummer, D. 1992. ***Deforestation in the post-war Philippines.*** Quezon City, Ateneo de Manila University Press.

Molinyawe, N. 2012. ***Protected areas management in the Philippines: a situationer.*** Quezon City, PAWB, DENR.

National Commission on Indigenous Peoples (NCIP). 2012. ***Ancestral domain areas in the Philippines in hectares.*** Quezon City.

National Economic Development Authority (NEDA). ***Philippine development plan 2011-2016.*** Pasig City: National Economic and Development Authority. Manila, Philippines.

Natonton, J. & Abraham, F.B., Jr. 1984. Regenerated forest in Agusan. ***In Forest renewal in actual practice.*** Manila, Columbian Publishing.

Pinugo or Muyong System of Ifugao. Video (available at www.youtube.com/watch?v=eUzOQEG9-zc).

Porter, G. & Ganapin, D. 1988. ***Resources, population, and the Philippines' future: a case study.*** World Resources Institute Paper No. 4. Washington, DC.

Protected Areas and Wildlife Bureau (PAWB) & Ateneo de Manila University. 2012. ***Communities in nature: first state of the protected areas report.*** Quezon City, PAWB.

Pulhin, M., Chokkalingam, U. Peras, R.J., Acosta, R.T., Carandang, A., Natividad, M.Q., Lasco, R.D. & Razal. R.A. 2006. Chapter II: Historical overview. ***In*** U. Chokkalingam, A. Carandang, J. Pulhin, R. Lasco, R.J. Peras & T. Toma, eds. ***One century of forest rehabilitation in the Philippines: approaches, outcomes, and lessons***. Bogor, Indonesia, CIFOR.

Revilla, A.V., Jr. 1984. The world's dipterocarp forests***. In Forest renewal in actual practice***. Columbian Publishing Corporation, Manila. 1984.

Reyes, M. 1984. Perpetuating the dipterocarp forest in production condition***. In Forest renewal in actual practice.***

Manila, Columbian Publishing Corporation.

Sajise, P. 1989. Assisted natural regeneration as an approach to reforestation. *In Assisted natural regeneration: working with nature reforestation strategy*. Rainfed Resources Development Program, DENR and Institute of Environmental Science and Management, UPLB, College, Laguna.

Sajise, P. 2003. Working with nature: technical and social dimensions of assisted natural regeneration. *In* P.C .Dugan, P. Durst, D. Ganz & P Mckenzie, eds. *Advancing assisted natural regeneration in Asia and the Pacific.* RAP Publication 2003/19. Bangkok, FAO.

Sibucao, A.R., Jr., Maranon, L. & Agustin, **N.** 2013. Draft report on determining the supply and consumption of wood in the Philippines using roundwood equivalent (RWE) analysis. Quezon City, FMB, DENR.

Sison, R. 1999. *Financial returns of tree plantations.* NRMP 2 Technical Report. Quezon City, DENR.

Tesoro, F.O. & Angeles, L.D. 2010. Creating space for private sector financing: removing constraints to investments in the Philippines*. In* M. Pescott, P.B. Durst & R.N. Leslie, eds. *Growing green assets: removing constraints to private sector investment in forestry in Asia and the Pacific.* Bangkok, FAO.

United States Agency for International Development (USAID). 1989. *Sustainable natural resources assessment – Philippines.* Prepared by: Dames and Moore International, Louis Berger International, Inc./Institute for Development Anthropology for USAID/Manila, Philippines.

Vitug, M.D. 1993. *The politics of logging: power from the forest.* Manila, Philippine Center for Investigative Journalism.

Walpole, P. 2005. *The Aurora-Quezon-Nueva Ecija disaster.* Quezon City, ESSC.

Walpole, P. 2010. *Environmental science for social change. Figuring the forest figures: understanding forest cover data in the Philippines and where we might be proceeding.* July 2010. Available at, http://download.essc.org.ph/forest/ESSC- Walpole_Figuring%20forest%20figures_reduced_.pdf.

World Bank (WB). 2005. *Natural disaster risk management in the Philippines: enhancing poverty alleviation through disaster reduction.* Manila, World Bank.

Forest restoration at the landscape level in Thailand

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1. Historical overview

Thailand is located in the centre of the Indochina Peninsula with a total land area of 513 115 km^2. Due to variations in climate and physiographical characteristics, various types of forests can be found. The complex forest vegetation ranges from upper montane forest, coniferous forest and dry deciduous forests in the north to lowland rain forests, sphagnum bog, peat swamp and tropical mangrove forests in the south (UNEP/EAP.AP nd). More than 50 percent of the land was covered with forest in 1960 (Ongprasert nd) but this gradually decreased to 25.13 percent in 1998 (Charuppat 1998). Owing to intensive reforestation efforts forest cover was claimed to have increased to 33.4 percent of the total land area by 2008 (RFD 2011).

The history of deforestation and land degradation in Thailand dates back to the mid-1890s up to the early 1930s when the Royal Forest Department (RFD) was established to oversee forest exploitation. The first Forest Protection Act of 1913 was issued to assure benefits for the state. Rigorous forest exploitation took place from the 1930s to the 1960s, when income from logging became a driving force for other economic activities. The Forest Industries Organization (FIO) was established during this period (1947). From the 1960s to the late 1980s, forest exploitation peaked due to the shift in economic activity that replaced subsistence crops with cash crops in export-oriented agriculture. Deforestation at that time was mainly due to agricultural expansion. In the late 1980s, the country encountered several natural calamities such as severe flooding in the south and drought in the Northeast. Thus, a nationwide ban on logging concessions was enforced. The change in forest cover in Thailand can be seen in Figure 1. Table 1 summarizes major events in forest resource management in order to provide an overview of forest degradation issues.

Annual deforestation varies from year to year; however, the average between 1961 and 2004 was greater than 3 percent per year. The worst losses occurred from 1976 to 1982 when political conflicts led to more encroachment into forest land. The destruction was not limited to terrestrial forest. For example Jantakad and Gilmour (1999) estimated mangrove forest destruction to be as high as 312 000 ha in 1979 and this continued to increase at an alarming rate.

Deforestation has occurred nationwide at different intensities in each region (Table 2). The most severe deforestation occurred in the Northeastern and Eastern regions, as almost half of the forested areas were cleared between 1973 and 2008.

In terms of forest area per capita ratio, Gilmour et al. (2000) estimated the change in forest cover from 1990 to 1995 for four Southeast Asian countries: Cambodia, Lao PDR, Thailand and Viet Nam. Forest area per capita for Thailand was very low at 0.2 ha/person, and was only higher than Viet Nam, which had forest area per capita of 0.1 ha. It should be noted that the data presented in the FAO report were estimated from aerial photographs from different periods of time.

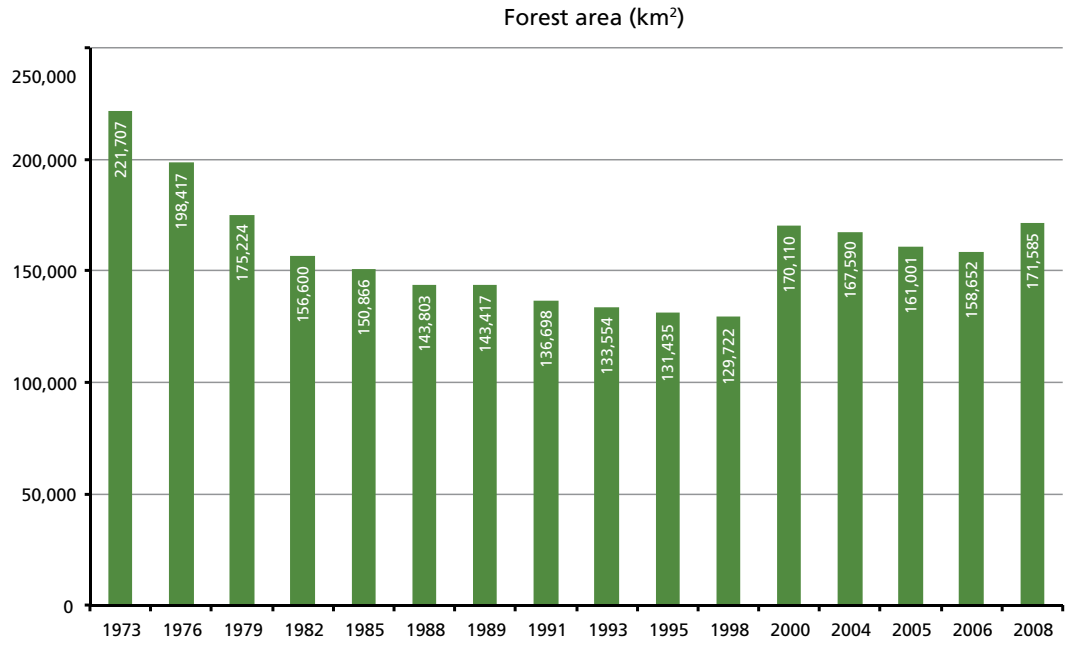

Figure 1. Forest cover in Thailand from 1961 to 2008 (RFD 2011)

2. Forest management policy

The first four National Economic and Social Development Plans (NESDPs) between 1962 and 1981 specified that at least 50 percent of the country's total land area must be kept as forest land. The target was changed to 40 percent in the fifth NESDP to reflect reality. Later in the sixth NESDP, this number had been disaggregated into two main categories: 15 percent of the forests should be managed for conservation purposes and the remaining 25 percent for production. However, the number was reversed by the seventh NESDP (1992-1996) to incorporate rising awareness into its tasks as well as to react to rapid forest degradation and the deterioration of the environment. Forest areas for conservation purposes were increased to 25 percent and 15 percent was allocated for timber production (Nalampoon nd).

The eighth NESDP strengthened this shift by developing a guideline to protect the remaining forest as well as the promotion of reforestation and rehabilitation of degraded land. In general, the current forest management approach has implemented three main intervention programmes, which are the expansion of protected areas, expansion of plantation areas and development of community forest.

Table 1. Major historical events in forest resource management

Year	Event
1874	Royal order to collect tax on the export of timber
1896	Establishment of the RFD to consolidate the exploitation of forest resources
1897	Royal order to regulate the harvest of teak forests
1913	The Forest Protection Act passed
1938	The Forest Protection and Reservation Act passed: • Categorized forest as protected forest or reserved forest
1941	The Forest Act passed: • Was amended several times • Regulated forestry-related activities, especially land under public ownership • Prohibited the felling of certain species of trees both on private and public land
1960	The Wildlife Protection and Preservation Act passed
1961	National Park Act passed: • Covered the determination of national park land • The National Park Committee • Protection and maintenance of national parks
1962	The establishment of the first national park: Khao Yai National Park
1964	National Forest Conservation Act passed: • Aimed to decelerate the rate of deforestation • Target to set aside 50 percent of the total land area as forest • About 59 percent of forest lands was declared national conserved forests to protect them from clearing, degradation and occupation as well as to conserve them for amenities, recreation, education and genetic resources (Ongprasert nd)
1975	The Enhancement and Conservation of Environmental Quality Act passed
1989	Nationwide logging ban – the adverse effects of deforestation became clear, and as a result the government decided that the remaining forest should be retained for conservation purposes
1992	The Forest Plantation Act passed: • Covered the determination of reforestation and land registration of private reforestation rights • Ownership and exemption from royalties on forest products from reforested areas
1992	In response to the seventh NESDP and the increasing challenge of resettlement, the RFD divided the national forest reserve estate into three zones: • The Conservation Forest Zone (Zone C) prohibits agriculture and covers existing protected forest areas and areas of natural forest minimally affected by human activity • The Economic Forest Zone (Zone E) was set aside from arable land suitable for commercial tree plantations for distribution to landless farmers. Some E-zone lands are in degraded forest areas • The Agricultural Zone (Zone A) portion of the national forest reserve estate was set aside expressly in deforested areas deemed suitable for agriculture
1991-present	Intention to pass the Community Forestry Act with several revisions of the draft. Conclusion has not been reached

Table 2. Distribution of forest area; unit: percentage of land area (RFD (2011)

Year	North	Northeast	East	Central	South	Total
1973	66.96	30.01	41.19	35.56	26.07	43.21
1976	60.32	24.57	34.60	32.28	28.48	38.67
1978	55.96	18.49	30.24	30.31	24.89	34.15
1982	51.73	15.33	21.92	27.47	23.25	30.52
1985	49.59	15.15	21.89	26.24	21.90	29.40
1988	47.39	14.03	21.46	25.59	20.69	28.03
1989	47.29	13.97	21.33	25.55	20.65	27.95
1991	45.47	12.91	21.07	24.65	19.02	26.64
1993	44.35	12.72	20.09	24.34	18.11	26.03
1995	43.55	12.59	20.80	24.17	17.61	25.62
1998	43.06	12.43	20.57	23.81	17.15	25.28
2000	56.75	15.71	23.12	31.84	24.62	33.15
2004	54.27	16.64	22.57	31.52	25.37	32.66
2005	47.31	15.00	21.74	30.68	24.99	31.38
2006	52.09	14.54	21.60	30.50	24.46	30.92
2008	56.04	16.32	21.01	29.81	27.03	33.44

3. Forest ownership and protected areas

Basically, all the natural forests are owned by the state and managed by three government agencies: the RFD, the Department of National Parks, Wildlife and Plant Conservation (DNP) and the Department of Marine and Coastal Resources (DMCR). All the departments are under the supervision of the Ministry of Natural Resources and Environment (MNRE). Privately-owned forests are mostly plantations and are not accounted for as part of permanent forest estate (PFE). In Thailand, conservation forests are classified based on their legal basis – areas established under laws and cabinet resolutions, and additional conservation areas where few types of land use are allowed. Types and areas of protected land are listed in Tables 3 and 4.

As of 2010, the protected area system covered 103 809.92 km^2 or approximately 20 percent of the country's land area. In this context, 25.5 percent of the protected areas is located in the Northern region. However, it should also be noted that in most protected areas, human settlements can be found. As a result the government has employed a wilderness approach in protected area management (FAO 2009) which aims to totally exclude humans from natural forest. Private sector and local people cannot have ownership rights over natural forest. The relocation of local communities residing in a protected area's boundary has been the priority of the management scheme. The relocation has generated several social conflicts and it is evident that the livelihoods of many local citizens depend on forest resources. The government, therefore, has issued various types of tenure rights for people living in forest reserves.

Table 3. Types and areas of protected land in Thailand (modified from FAO 2009)

Categories	IUCN protected areas category	Number	Total area (100 ha)	Percentage of total country area
By Royal Decrees:				
National park	II	114	6 346.4	12.37
Wildlife sanctuary	Ia & IIb	59	3 675.9	7.16
Marine national park	II	27	862.8	1.68
No-hunting area	IV	55	441.0	0.86
Total		**227**	**11 326.1**	**22.07**
By ministerial declarations:				
Forest park	III	67	87.0	0.17
Botanical garden	VI	15	5.9	0.01
Arboretum	VI	54	3.9	0.01
Total		**136**	**96.5**	**0.19**
By cabinet resolutions:				
Watershed class 1 & 2	I, II, IV & VI		9 309.0	18.41
Conservation mangrove	VI		42.8	0.08
Total			**9 351.8**	**18.22**

Table 4. Types and area of protected land in Thailand (RFD 2011)

Item	2010		2011		Expected 2012	
	No. of sites	km^2	No. of sites	km^2	No. of sites	km^2
National park	123	60 320.11	123	60 319.90	127	62 198.86
Forest park	113	1 236.08	112	1 235.18	111	1 218.99
Wildlife sanctuary	58	36 929.37	58	36 929.37	58	36 929.37
No-hunting area	53	4 060.42	57	4 164.06	60	4 306.57
Botanical garden	16	45.38	16	45.38	16	45.38
Arboretum	56	43.02	56	43.02	57	42.52

4. Deforestation and land degradation

One impact of deforestation is the degradation of land resources. Land degradation in relation to deforestation in Thailand can be found in two forms: soil erosion in mountainous and watershed areas, and desertification. A study by the Land Development Department (2004) found significant soil loss in sloping land areas compared to that of lowlands. When agricultural soil becomes degraded, farmers sometimes clear more forest area to get access to better soil quality. This leads to further deforestation and land degradation.

4.1 Current status of forest degradation

Despite the nationwide logging ban in 1989, forest cover in Thailand continued to decrease until 2000 when an intensive rehabilitation programme was implemented. As a result, by 2008, the nation's forest area was reported to be 171 535 km^2. Despite these efforts, illegal activities in forested areas have continued. They include: illegal logging, hunting, land encroachment, illegal farming, forest fires, collection of non-wood forest products (NWFPs) and so forth.

The RFD (2011) reported that illegal activities in national forest in the fiscal year of 2011 alone accounted for almost 2 500 million baht (US$1.00 = 31 baht, October 2014) in damages. There were three major offences: land encroachment (3 155 cases), illegal logging (4 520 cases) and collection of forest products (32 cases). All of these offences were responsible for the destruction of almost 80 km^2 in 2011. It should be noted that these are recorded cases. However, there were also other illegal activities conducted by unknown perpetrators that increased the amount of forested area destroyed.

Apart from the reasons mentioned above, forest fires also play an important role in the deforestation process. The area damaged by forest fires has decreased annually. In 1992, fires destroyed 19 408 km^2 of forest areas. In 2011, only 40.78 km^2 were destroyed. The top three causes of forest fire in 2011 included collection of NWFPs (1 272 cases; 19.30 km^2 destroyed), illegal hunting (391 cases; 6.44 km^2 destroyed) and burning of farmland (361 cases; 6.44 km^2 destroyed).

Almost half of the forest area destroyed by fire was caused by collection of NWFPs. FAO (2009) estimated that there are at least 5 million forest dwellers in Thailand and these people's livelihoods depend on forest products. Consequently, destroying forest habitat will critically affect this group.

Areas that were destroyed by illegal activities as well as by forest fires are the target areas for forest rehabilitation. The RFD has been implementing several programmes to improve the situation: land settlement, agroforestry, reforestation and land entitlements in reserve forest areas, for instance. These programmes are implemented in order to promote tree planting areas, increase forest plantation areas, organize forest and forest margin populations to use appropriate agricultural technology and improve the livelihoods of local citizens to decelerate the rate of deforestation.

4.2 Causes of forest degradation – direct causes

In Thailand, causes of forest degradation can be categorized as direct or indirect. Most of the direct causes are human-related. Three direct causes are described below.

Expansion of agricultural areas and changes in agricultural practices: The expansion of arable land is one of the main driving forces of forest degradation in Thailand. In 2009, the agricultural area in Thailand reached 38.7 percent of the total land area (World Bank 2011). Initially, land suitable for rice production was cleared and turned into rice paddy to provide subsistence food. Since the 1950s production of commercial crops has greatly expanded in upland areas. Undisturbed forested area, especially in the Northern region, was converted into farmland. During 1985-1993, Chiang Mai, a Northern province, lost almost 2 000 km^2 of forest land or approximately 10 percent of the total provincial area (Puri 2006).

The aim to produce more commercial agricultural products has led to changes in land use by farmers. In traditional agricultural systems, shifting cultivation was a primary mode of production in many parts of Northern Thailand. People living in the mountains used shifting cultivation on a cycle of eight to nine years, and it was the only means for food production. In the past 20 to 45 years, commercial production of, for example, vegetables, maize, fruits, soybeans and potatoes has spread widely in the uplands. Additional pressures from increased population and land-use restrictions by the government have also changed the way people farm (Rerkasem 2001). The fallow period is often shortened and many fields are permanently cropped. The shorter fallow period results in soil fertility depletion and crop yield reduction. The farmers are then forced to clear forested areas for better soils and crop yields. In the long term, changes in agricultural practices to intensive farming contribute to forest degradation and deforestation (Mansourian et al. 2005).

Forest degradation is not exclusive to Northern Thailand. In the Central, Eastern and Southern parts of Thailand mangrove forests that protect coastal areas from erosion, storm surge and tidal waves, have also been damaged by aquaculture, especially shrimp farming (Barbier and Cox 2004; Naito and Traesupap 2006). Mangrove forests steadily diminished from 3 679 km^2 in 1961 to 1 685 km^2 in 1996. The shrimp farming along the seaboard has contributed to about one-third of the destroyed mangrove area.

Forest fire: These occur annually during the dry season from December to May, peaking in February/March. They can take place in mixed deciduous forest, dry dipterocarp forest and forest plantations, and to some extent in dry evergreen forest, hill evergreen forest or even in some parts of the tropical rain forest. All fires are human-induced. The main reasons for starting the fires are: 1) gathering NWFPs such as mushrooms, fuelwood and bamboo (39 percent), 2) hunting (22 percent), 3) residue burning in agricultural areas to clear the land for the next growing season (17 percent), 4) incendiary fires (9 percent), 5) illegal logging (3 percent), 6) cattle raising (2 percent), 7) carelessness (2 percent) and other factors (10 percent) (FFCD 2013; Junpen et al. 2013).

Communist insurgency and road expansion: During the 1970s, Thai communists took refuge in the forests. The government's campaign included clearing forests and building roads to the rebel areas (Delang 2002). The road network increased from 5 000 km in 1950 to over 25 000 km in 1980, and the forests in the north alone were reduced at a rate of 3 456 km^2 annually (Phongpaichit and Baker 1996). In addition to road expansion, the government encouraged lowland farmers to settle along roads. The expansion of villages and/or farms into the forests meant less forested area for communist party members to hide in. This campaign led to significant loss of forest cover in Thailand during the late 1970s to early 1980s. A total of 65 000 km^2 of forest were destroyed for national security reasons between 1973 and 1982 (Poulsen 2001).

4.3 Underlying causes

In addition to direct causes, there are various interrelated indirect causes that influence how forests are used. The significant ones are:

Thai economic development policies: Over the past few decades, Thai policy-makers accorded high priority to economic growth over environmental protection. In 1989, the Thai Government adopted an open-door policy to attract foreign investment. Agro-industry was one of the target industries in the development plan (Panayoutou and Parasuk 1990). With support from government branches, forest clearing for agricultural crops reached its peak during this period of industrialization. Huge forested areas were turned into arable land for growing commercial crops such as rice, cassava, maize and sugar cane. The policy resulted in high economic growth rates at the expense of high rates of deforestation. Consequently, forest cover declined from 54 percent in 1961 to about 25 percent in 1995, making Thailand's deforestation rate one of the fastest in the world (Marks 2011).

Failure of law enforcement and corruption: The second underlying cause is failure to implement and enforce laws. In order to reduce deforestation rates, commercial logging in natural forests has been completely banned since 1989 (National Information Center 2013). Thailand now promotes commercial timber plantations and has to import some wood from neighbouring countries to meet industrial demand. In spite of the ban, illegal logging in the natural forests continues (Environmental Investigation Agency 2012). The actual estimates of total loss to illegal logging are difficult to obtain because there is no official record of these activities. Many cases of illegal logging in Thailand are known to have involved collusion by local authorities. From 2007 to 2012, there were nine major cases of illegal rosewood logging. Thai rosewood loggers are incentivized by extremely high prices (up to US$6 000 per cubic foot), which are offered by international traders.

Population growth and poverty: Overpopulation in Northeastern and Northern Thailand exacerbates forest degradation. Early in the nineteenth century, Thais started to migrate into Northeastern Thailand. The Northeast showed the highest population growth of all of Thailand's regions during 1970 to 1980 – the annual population increase was 3.8 percent, while the national average was 2.7 percent. The deforestation rate during this period also peaked at 7-8 percent annually (Luukkanen 2001). Deforestation was caused by rapid conversion of forested area to farmland for commercial crops, especially maize, kenaf, cassava and sugar cane. However, due to poor soils and insufficient rainfall in this region, productivity was low. When crop yields were low, farmers usually migrated and cleared forested areas higher up in the mountains.

In addition to the Northeast, Northern Thailand also faces the problem of growing population (Puri 2006). In mountainous areas, more than one-fifth of the villages in Northern Thailand are located in forest reserves. In Thailand, paddy rice is grown both for sale and for home consumption, while upland rice is primarily a subsistence crop. A study using data from 670 villages in Chiang Mai, Northern Thailand, found that a 10 percent increase in population led to an 8 percent increase in area devoted to paddy rice and a 4.4 percent increase in area devoted to upland rice (Puri 2006).

Poverty is also closely linked to forest degradation. Forest-dependent people often reside in the forests without land tenure, and rely on natural resources and crop cultivation. They are vulnerable to the interests of mining firms, commercial farmers and real estate developers, who occupy their land, and drive the people into the interior (Wunder 2001). More forests are encroached as a result.

Land use and land rights: Between 36 and 41 percent of the total land area in Thailand is classified as agricultural area, and 28-33 percent as forested land (USAID 2011). In 1961, Thailand issued The National Park Act B.E.2504 and established the first national park (Khao Yai National Park). Since then, about 16 percent of the total land area has been classified as nationally protected, including national parks and wildlife reserves. Many of the national parks were established in areas that are already occupied by some ethnic groups. Beginning in the 1970s, the government made several legislative and programmatic efforts to address high levels of tenancy, landlessness and tenure insecurity. The programme succeeded

in registering approximately 22 percent of the total land area which is privately owned (USAID 2011). In the process, an estimated 12 million people who live and work on national forest land were not eligible to participate. Without security of tenure, these people are forced to live off the forest, leading to further forest degradation.

Underestimating the value of forest ecology: market failure: Forest degradation and deforestation in Thailand are the results of decisions by private corporations, cultivators and communities (Contreras-Hermosilla 2000). An underlying cause of forest degradation is the difference between values seen by the private sector and values perceived by society (regional, national or global level). Many of the services provided by forest ecosystems and the cost of mismanaging natural resources have no market prices (Willis et al. 2000). Therefore the ecological services of forests are not included in the criteria for decision-making by the private sector. As a consequence, the landowners may make a decision to sell or clear the forested land for commercial benefits without taking into account the ecological values of the land.

5. Impacts of forest degradation

5.1 Environmental impact: extreme weather, change in soil resources

Over the past decade Thailand has faced fluctuations in weather patterns that have resulted in extreme droughts or severe floods. There is no direct link between forest degradation and deforestation and drought. However, it is believed to lead to undermining of watershed capacity to sustain and regulate water flows from rivers and streams. Without forests, soil becomes compact and incapable of absorbing rainfall. In the wet season, soils become rapidly saturated and additional water runs off, leading to downstream flooding. Many cases of flooding are severe and occur nationwide, for example the catastrophic flooding in 2013 that affected 2 million people (DDPM 2013).

Forest degradation also leads to soil erosion. Without forests, topsoils are exposed and begin to erode. A study to estimate soil loss in the Upper Chi Basin in Northeastern Thailand reported that the area lost about 6.6 million tonnes of soil in 2006 (Paiboonsak et al. 2005).

5.2 Economic loss

When forests are destroyed, all potential future revenues and employment that could be gained from the sustainable management of forest products and services disappear. Ultimately, forest degradation leads to loss of future economic benefits and to the environmental damage toll.

5.3 Social consequences

Loss of ecological services provided by forests at the local level is an obvious social impact of deforestation and forest degradation (Chakravarty et al. 2012). Forest destruction leads to loss of valuable services such as erosion prevention, flood control and carbon sequestration that affect the quality of life (especially for forest-dependent poor communities). For example, soil erosion results in siltation of water resources that impacts the health of local people who lack other potable sources (PWA 2013).

In addition, forest degradation can cause conflicts over natural resources between different groups (Delang 2005). In Northern Thailand, several ethnic groups such as the Karen, Hmong, Lahu and Akha live in upland forested areas at different altitudes and practise different agricultural practices (Srimongkontip 2000). Conflicts occur when one group expands agriculture to the land already established by another group, and similarly over water between upland and lowland agriculture communities (Buergin 2000; Thanapakpawin 2006).

6. Implementation of forest restoration and rehabilitation initiatives

6.1 A history of initiatives, strategies and techniques

The first government attempt to reforest was the reforestation policy in the 4th NESDP (1977-1981), implemented annually since then. Most of the reforestation work was conducted by the government sector. Other reforestation efforts were those of the Forest Industry Organization (FIO) and the Thai Plywood Company Limited. The private sector and local residents were promoted as part of forest restoration efforts and people as the centre of development in the 8th NESDP (1997-2001) and the 9th NESDP (2000-2006).

The first recorded reforestation effort, with satisfactory results in Thailand, was in 1906 with teak plantations in Phrae Province, Northern Thailand, using the 'taungya' system and direct seeding techniques (Table 5). In 1910, plantations were addressed more seriously in the same province. An area of 10.56 ha (66 Thai rai) was reforested, as a plantation, and an area of 31.52 ha (197 rai) was planted in another district. Both areas were planted with teak using the direct seeding technique. In 1935, the RFD tested teak planting using seedling stumps in Mae Hong Son Province (also in Northern Thailand); this was more effective than direct seeding and planting with seedlings, so it has been a preferred method since then. Other species such as mangroves were planted for the first time in 1919 in Petchaburi Province, south of Bangkok. Subsequently, more non-teak species have been planted in other provinces (MNRE 2005).

6.1.1 Forest restoration measures and methods

The forest restoration method is employed in conservation and economic (and other purposes) areas:

1. Conservation areas are national parks, wildlife sanctuaries and watershed areas administered by the DNP and the DMCR. Forest restoration schemes involve: 1) forest protection, enrichment planting and fire protection in conservation, watershed and mangrove conservation areas. They also include capacity building, surveying, database construction and forest restoration projects under Royal Initiatives to manage communities who live in the forests; 2) permanent forest restoration projects contributing to the Royal Initiatives, involving seedling distribution and seeking general public and private sector participation as well as establishing funds for this purpose.

2. Economic areas are for economic purposes. Other purpose areas are government land, religious sites, privately-owned land and public land. The aim is to increase forest areas for utilization and administration by the RFD involving: 1) community forestry development; 2) promotion of economic plantation; 3) conversion of agricultural systems to promote planting of fast-growing tree species instead of crops; 4) reforestation demonstration plots and seedling distribution; 5) permanent forest restoration projects contributing to the Royal Initiatives; 6) voluntary citizen planting and maintenance; and 7) planting in non-protected areas.

Table 5. Chronology of plantation establishment in Thailand (MNRE 2005)

Duration	
1906-1965	The emphasis was on planting native commercial species to compensate for timber extracted from natural forests. Some planted species were teak in Northern Thailand, *Pterocarpus macrocarpus, Xylia xylocarpa* and *Dalbergia cochinchinensis* in Northeastern Thailand and *Dipterocarpus alatus* and *Hopea odorata* in Southern Thailand.
1965-1975	At the beginning, the RFD was aware of the watershed degradation problem. As a result, plantations of pine species (*Pinus kesiya* and *Pinus merkusii*) and fast-growing evergreen tree species with spreading crowns (such as *Acacia* and *Prunus cerasoides*) were established to counter this problem. There were also commercial plantations in lowland areas.
1975-1978	Forest resources were degraded quickly in the lowland and highland areas due to rapid population increase and the need for more land for agriculture. This resulted in encroachment of national forest reserves. The recovery of the degraded forests was too slow. The RFD responded by establishing plantations to re-green and reclaim the encroached national forest reserves using fast-growing species (e.g. *Eucalyptus, Acacia* and *Peltophorum pterocarpum*) suitable for the lowland area. The RFD then realized how local communities could have roles in forest development, forging the establishment of forest villages. In addition, government reforestation continued.
1978-1987	There was a worldwide energy crisis. As a result, fast-growing tree plantations for energy were used. They were also grown for multiple uses. The RFD recommended planting them in community tree-planting projects nationwide. In the 1982 fiscal year, the RFD received funding for planting trees for fuelwood and other purposes. The planted trees were also for use by forest and hilltribe villages. For the RFD, there were four main types of reforestation: 1) in watershed areas, 2) projects under the Royal Initiatives, 3) for national security purposes and 4) lowland reforestation.

1987-1992	This was the boom period for eucalypt plantations (for pulp) by large private companies. Local communities and NGOs opposed this vigorously because the local communities were not paid enough attention. At this time, the RFD became interested in agroforestry and community-forestry development projects. It was also the starting point for mangrove reforestation (since 1991).
1993-1998	The RFD emphasized reforestation in forest reserve areas, not only for watershed protection, but also for broader environmental conservation (e.g. climate regulation and carbon sequestration). Commercial plantations were operated more by private companies and local communities on their own land. In 1994, the RFD revised its reforestation method from establishing plantations to: 1) watershed-ecosystem restoration by the Watershed Conservation Section of the Natural Resources Conservation Office, and 2) forest restoration in degraded areas in non-watershed conservation areas by the Government Plantation Section, Office of Reforestation Promotion. There were also reforestation projects to commemorate King Bhumipol's (Rama IX) Golden Jubilee (during 1994-1996 and 1997-2002). In 1995, the RFD determined watershed-ecosystem restoration based on natural regeneration in areas outside the areas of reforestation projects for the same reason.
1999-2005	This was the period for promoting the roles of the private sector and local communities in participating in forest restoration. People were stated to be the centre of all development according to the National Economic and Social Development Plans. The RFD, as a result, was aware of people's participation in forest resource restoration, besides regular government reforestation schemes. There were people-volunteer tree planting and maintenance projects in national forest reserves and other public areas, including roadside areas and near reservoirs. In 2000, the RFD proceeded with tree planting in non-protected areas by hiring private companies to plant the trees and maintain them for the first three years. The RFD then maintained the areas until they were ten years old.

Gilmour et al. (2000) stated that there were several policy and practical issues concerning forest rehabilitation that had to be addressed, for example, improving techniques to identify degraded land, integrating socio-economic and environmental needs (possibly via payments for ecosystem services, PES) and research on (indigenous) species/site matching. The Forest Restoration Research Unit's (FORRU) work has addressed some of these issues (assessment of degradation levels and selection of indigenous tree species for restoration).

There is no record of economic assessment done by the government on forest restoration. Elliott (2011) gathered some information on costs of different forest restoration approaches based on degradation stages (Table 6). The restoration costs were dependent on the degradation stage and the restoration method. As a rule of thumb, the higher the degradation stage, the higher the cost. The methods recommended for the higher stages of degradation are costly because they include costs for site and seedling preparation, and planting, while the methods recommended for the lower stages are mainly for site protection.

Table 6. Costs of forest restoration based on degradation stages (Elliott 2011)

Degradation stage	Restoration method	Country	Published cost (US$/ha)	Date	Reference	Present-day (2014) costs (US$/ha)*
Stage 1 (least degraded)	Protection	Thailand			Estimated	345-403
Stage 2	ANR	Philippines	579	2006-2009	Bagong Pagasa Foundation (2009)	734-850
	ANR (Castilo 1986)	Philippines	500-1 000	1983-1985	Castilo (1986)	2 044-4 508
Stage 3	Framework species method	Thailand	1 623	2006	FORRU (2006)	2 382
Stage 4	Maximum diversity with mine site amelioration	Brazil	2 500	1985	Parrotta et al. (1997)	10 224
	Miyawaki method	Thailand	9 000	2009	Mitsubishi (pers. comm.)	11 410

7. Case study on forest restoration using the Framework Species Method

The Forest Restoration Research Unit (FORRU) of the Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand was established in association with Doi Suthep-Pui National Park in 1994. FORRU adapted a forest restoration method called the Framework Species Method from Queensland, Australia (Goosem and Tucker 1995). This method is aimed at restoring structure (e.g. biodiversity) and functions (e.g. productivity) of degraded forests into their former stage using framework species (FORRU 2006). The framework species are indigenous trees, e.g. Fagaceae (*Castanopsis, Lithocarpus* and *Quercus*), Leguminosae (*Acrocarpus fraxinifolius, Afzelia xylocarpus, Archidendron clyperia, Erythina subumbran* and *Peltophorum dasyrhachis*), and Moraceae (e.g. *Ficus* spp.) that grow fast, have a spreading crown (to suppress weeds), are fire resilient and provide nectar and fruits from an early stage for wildlife (FORRU 2006). During 1994-1997, FORRU surveyed the tree species of Doi Suthep-Pui National Park and recorded their phenology and collected seeds to be germinated (for about one year to their planting sizes) in nurseries. In 1997, FORRU established trial plots for forest restoration in collaboration with Mae Sa Mai Hmong village, north of Doi Suthep Mountain. Additional trial plots have been planted with the framework tree species annually since then. A non-planted area was also established as a control. During the first few years of the establishment of the trial plots, research on site preparation and silvicultural treatments was conducted to come up with appropriate treatments for restoration. Before planting, the area was surveyed for existing plant and bird diversity (to examine recovery of biodiversity after planting). For other areas, degradation levels were assessed (five stages, Table 7) according to FORRU's protocol (FORRU 2008), so that appropriate methods (other than the Framework Species Method) could be recommended (Table 8).

For the Framework Species Method, an area is normally prepared by manual weeding or applying chemical herbicide, minimally. FORRU recommends planting 20-30 framework tree species of the indigenous species mentioned earlier that are major components of the hill evergreen forests of Northern Thailand (about 1 000 masl)). The legume trees can fix nitrogen, the oak trees provide the framework and fruits for wildlife, and so do the figs which also provide food for wildlife, especially during the dry season, as they bear fruit throughout the year. Other species can be selected from the list of framework species. The trees are planted at 3 125 seedlings/ha. They are monitored for survival after planting.

Direct seeding can be a cheap alternative restoration method as it involves no seedling production and transportation, or planting costs. FORRU has had a limited number of experiments with direct seeding. In comparison to seedlings that were raised in nurseries, trees grown from seeds grew faster and had better-developed roots. However, seeds directly sown can face some problems with dryness, seed predation by wildlife and competition with weeds.

Even though the Framework Species Method developed by FORRU has proven to be successful in restoring seasonally-dry evergreen forests, limited trials were also conducted in mixed-deciduous forests at lower elevations, and mountains, i.e. approximately 1 000 masl, of Northern Thailand, with replications in other regions of Thailand, Cambodia, China and the Philippines. There are still a number of challenges. In Northern Thailand, remaining degraded areas are now difficult to restore due to their steep slopes and inaccessibility. As a result, FORRU is trying to develop an aerial-seeding forest restoration technique. The technique will employ unmanned aerial vehicles to carry seeds to be dropped onto areas with steep slopes (Stephen Elliott, pers. comm.).

Table 7. The five stages of degradation (FORRU 2008)

Degradation level	Site factor			Landscape factor		
	Vegetation	Soil	Sources of regeneration	Forest	Seed dispersers	Fire risk
1 (Least degraded)	More trees than weeds	Mostly fertile	Viable soil seed bank, dense seedling bank, dense seed rain, tree stumps	Large remnants remain as seed sources	Common (large and small species)	Low
2	Mixed trees and herbaceous weeds	Mostly fertile, low erosion	Seed and seedling banks depleted, live tree stumps common	Remnants as seed sources	Large species becoming rare, small species still common	Medium

[3] FORRU (2006, 2008) available at http://www.forru.org; Elliott (2013).

3	Herbaceous weeds dominate	Mostly fertile, low erosion	Incoming seed rain, a few saplings and live tree stumps may remain	Remnants remain as seed sources	Mostly small species dispersing small seeds	High
4	Same as Level 3	Erosion risk increasing	Few	Absent within seed dispersal distances of the site	Mostly gone	High
5 (Most degraded)	Sparse, herbaceous weeds	Significant soil erosion	Very few	Same as Level 4	Same as Level 4	Very high

Table 8. Responses to different forest degradation levels (FORRU 2008)

Degradation level	Appropriate response for biodiversity conservation	Appropriate response for economic yield
1 (Least degraded)	Protect from further disturbance – re-introduce any plant or animal species extirpated by logging; particularly key pollinators and seed dispersers.	Replacement planting with economic tree species removed by logging. Extractive reserves with sustainable harvesting of NWFPs. Ecotourism.
2	ANR – protect forest remnants and prevent hunting of seed-dispersing animals; replant a few primary forest tree species if absent.	Enrichment planting with economic tree species particularly those logged out. Extractive reserves with sustainable harvesting of NWFPs.
3	ANR and planting 20-30 framework tree species; protect remaining forest remnants and prevent hunting of seed-dispersing animals.	Include economic species among framework trees planted. Ensure local people are well paid for tree planting and aftercare; analogue forestry; agroforestry.
4	Maximum diversity planting.	Agroforestry; mixed species plantations. Conventional plantations.
5 (Most degraded)	Improve soil conditions by planting 'nurse trees' (e.g. pioneer legumes) – followed after a few years by thinning and maximum diversity planting.	Ensure that nurse trees yield economic income to local people when they are thinned. Select tree species that also yield economic products; or establish conventional plantations of one or a few high-value tree species capable of withstanding the degraded soil conditions.

8. Looking forward: conditions for success

The RFD and DNP are the main government agencies involved in reforestation and forest restoration. They have four-year action plans. The latest action plan was formulated based on inputs and comments from various agencies of the MNRE, i.e. Departments of Forestry, Environmental Quality Promotion, Water Resources, and the Forestry Industry Organization. The action plans are formulated based on overall government policies (corresponding with the Constitution, NESDPs and Environmental Management Plans) on natural resource conservation and management. The reforestation activities involve land and seedling preparation, and planting. Another important part of reforestation is monitoring and evaluation. The involved agencies formally report achieved tree planting goals annually in terms of areas planted. Reports on tree performances and consequent ecological benefits (e.g. biodiversity recovery) are also needed as this is related to economic and social assessments of the efforts carried out. They can also be used for baseline, monitoring and evaluation reports for carbon sequestration, credits and eventually markets.

For the 2012 fiscal year, the DNP's budget was about US$280 million, an increase of about 5 percent from the previous year. A total area of approximately 8 800 ha (swamp forests, watershed forests, utilized forests, Royal Initiative forests, rattan forests, planting of Siamese rosewood [*Dalbergia cochinchinensis*] and *Aquilaria crassna*) were to be restored. *D. cochinchinensis* and *A. crassna* have been illegally logged from the forests due to their high values. However, landscape restoration has never been explicitly stated in government policies and action plans of the implementing agencies. It is unlikely that plot-level tree plantings can achieve the full ecosystem benefits, dissimilar to what landscape restoration can provide. Corridors connecting small and fragmented wildlife populations are a benefit. Reducing the impact of some natural disasters, e.g. tsunamis, can be achieved from large-scale (mangrove) forest restoration.

The National Economic and Social Development Board (NESDB) stated that a number of 'immunities' are needed in order to proceed with all the strategies in the 11th NESDP. For the Third Strategy (Sustainable Management of Natural Resources and Environment), one of the immunities concerns community strength in management of natural resources and the environment. This shows that policy-makers recognize community management roles in this regard. Also, one of the four objectives is to create fair access to and utilization of natural resources. In addition, one of the aims is to increase the effectiveness of natural resource and environmental management so communities can live harmoniously with the forests. However, whether this will be translated into actions depends on the implementing agencies. Due to recent natural disasters, for example the catastrophic 2011 flood and some severe storms, which resulted in massive damage, the general public automatically puts the blame on the mismanagement, often by rural communities, of natural resources, particularly the watershed forests in the Northern part of the country. One of the ideas proposed by the general public to reduce the impacts of such disasters is to plant more trees. This is not new to Thailand as forests have been a standing issue for a long time and are often raised whenever disasters strike. The situation is ironic as marginal communities in and near forests and forest dwellers (in or near protected areas) are poor and need land for agriculture to produce food and/or generate incomes. They often do not own the land, and as a result, they have no pronounced incentives to plant more trees.

In recent years, marginal and rural communities have been recognized for their crucial roles in conserving and protecting natural resources such as forests. Consequently, they should be compensated because they lose their opportunities to utilize the land for food production. Globally, PES mechanisms have been implemented resulting in effective management of natural resources. Thailand can implement similar mechanisms. This should lead to equitable sharing of the benefits from forests. For Thailand, there are a handful of pre-PES and PES projects, for example, the work by the DNP in four national parks and one wildlife sanctuary (http://www.unescap.org/ esd/environment/pes/ 3rd-sea-workshop/ documents/ session1/Pattanavibool.pdf), and at Doi Mae Salong (Chiang Rai) by the World Conservation Union (http://www.iucn.org/news_homepage/ news_by_date /2012/?10165/ Assessing-payments-for-ecosystem-services-PES-in-Doi-Mae-Salong-Northern-Thailand). The NESDB included a proposal on PES in the 11th NESDP as a way to generate income, by referring to ongoing global trends, for the stakeholders involved in guarding natural resources. The opportunity for generating income from carbon sequestration by trees is gaining more attention, considering its global ecological service for mitigating global warming. Local communities can add this into their rationale for planting more trees. However the transaction costs are forbidding, and as a result only a small number of projects qualify for the credits. The Thailand Greenhouse Gas Management Organization (http://www.tgo.or.th/english/) has been facilitating this. Entering voluntary carbon markets can be an option. Another interesting incentive mechanism for tree protecting and/or planting is the 'Tree Bank' of the Bank for Agriculture and Agricultural Co-operatives (http://www.baac.or.th/baac_en/index.php), in which trees can be used as collateral by people seeking loans. This has created a new culture to protect and/or plant more trees. However, this is not widely recognized, and is still fragmented. However, it can be a good starting point for more forest restoration undertakings at the landscape level.

The private sector can also play an important role in financially supporting reforestation and forest restoration. Thai industries have been known for being environmentally unfriendly. Many industries and private companies have, as a consequence, been asked by society to care more about the environment. The decentralization of the executive administration into local administrative branches has also given local communities more control over their resources. At the same time, public companies are also moving to more environmentally-friendly business approaches, directly or indirectly. One popular activity undertaken by industries and companies is to create and/or participate in tree planting via their corporate social responsibility programmes. However, these tree planting efforts have not reached their full potential (for environmental benefits). As is often the case, the planting areas are fragmented, and there have rarely been follow ups to monitor tree survival and growth. Therefore, there is huge potential for companies and industries to join forces, as well as with the government, for scaling up the efforts on tree planting and monitoring.

Forest Landscape Restoration (FLR) requires suitable techniques for different biophysical settings and stages of degradation. It also needs to be done in a participatory manner (all stakeholders) to fulfil their needs. In Thailand, most forest restoration efforts are often done sporadically in fragmented plots depending on available public and private funds and lands, which vary annually and from place to place. The restoration efforts are sometimes done without community consultation and participation. Success is unlikely as the communities do not gain a sense of ownership, and hence, they may not follow up with the requisite maintenance and protection efforts. Next, without supporting policies and legal frameworks, FLR is not going to succeed. Policy-wise, it is recommended that FLR should be highlighted and promoted among the public and private sectors as a practical method for forest restoration. It is also recommended that there should be incentives for FLR implementers. Without the appropriate tenures or usufruct rights, technical and financial support from government agencies, and incentives from the resulting ecosystem services or enhanced output of forest products, FLR will not be recognized and people may not be willing to implement it.

8.1 National strategy for forest and landscape restoration

In 2011, the Thai Government declared eight policies: 1) first-year urgent policy, 2) government stability policy, 3) economics policy, 4) social and life quality policy, 5) land, natural resources, and environment policy, 6) science, technology, research, and innovation policy, 7) foreign affairs and international economic policy and 8) good governance policy. For the fifth policy there are eight themes: 1) conserving and restoring forest and wildlife resources, 2) conserving and restoring marine and coastal resources, 3) preserving environmental quality and controlling pollution, 4) building equity and reducing gaps in utilization of land and natural resources, 5) promoting and building awareness and responsibility about natural resources and the environment, 6) promoting integrated water management, 7) building resiliency and preparing for climate change and natural disasters and 8) developing knowledge on natural resources and environmental management. The first theme emphasizes conserving and restoring forest and wildlife resources. There are many planned activities within this theme, for example, reforestation, forest protection and patrolling, promoting forest-cluster administration, community forests and protected areas, supporting the participatory approach in forest management, and so forth. It has been projected that there should be about 17.224 million ha (about 33.5 percent of the total country area) of healthy forests. Despite planned activities on reforestation and promoting forest-cluster administration, there is no clear direction on forest landscape restoration.

The first mission statement of the MNRE is to conserve, protect and restore forest and wildlife resources, which is a clear sign that the ministry is serious about forest restoration. For its six strategies, two deal with restoration – 1) to protect and restore watershed areas, and 2) to conserve and restore forest and wildlife resources (Table 9).

The NESDB issues national economic and social development plans every five years. It concluded for the first ten plans (1961-2011) that the country's performance has been overall satisfactory. Forest cover is believed to have increased from 32.7 percent of the country area in 2006 to 33.6 percent in 2010, through reforestation efforts in mangrove forests, community forests, demonstration forests, private plantations and protection of protected areas. However, the current forest cover is considered inadequate to maintain ecosystem balance. About 2.24 million ha of watershed forests are considered to be in a critical condition. The 11th NESDP covers 2012 to 2016. There are six development strategies in this plan. The last is on sustainable management of natural resources and the environment. There are four objectives: the first addresses conserving and restoring natural resources and the environment to be adequate for maintaining ecosystem balance, as the foundation for national development. The first of its goals is to maintain protected areas for at least 19 percent of the country area, to increase the forest area to 40 percent of the country area and to increase mangrove areas by at least 800 ha/year.

Another agency under the jurisdiction of the MNRE related to forest restoration is the Office of Natural Resources and Environmental Policy and Planning (ONEP). ONEP has a five-year Environmental Management Plan (2012-2016). There are six strategies within this plan, and one of them is sustainably conserving and restoring sources of natural resources. The strategy's goal targets sources of natural resources and biodiversity being effectively protected, conserved, and restored. One of the indicators for this goal is to increase the country's forest cover to 40 percent of the total land area. For this strategy, there are two action plans: 1) sustainably protecting and conserving natural resources in all ecosystems, and 2) restoring and promoting efficient utilization of natural resources. For the second action plan, there are urgent and intermediate planned activities. One of the urgent planned activities is promoting planting of trees with high economic potential and planting of similarly valuable trees in long rotations on private land. Some of the intermediate planned activities, especially in watershed areas and transition zones of protected areas, are: 1) promoting co-existence between communities and forests, 2) building incentives for tree planting in the form of tree banks, 3) planting of multipurpose trees and 4) forest restoration and reforestation through agroforestry; restoration activities for degraded ecosystems (e.g. forest ecosystems and watershed ecosystems) and ecosystem components (e.g. soils and water) are also part of the plan.

In general, Thai citizens are well aware of the advantages of forests. There are campaigns by government agencies and the private sector for reforestation for both land and coastal (mangrove) forests on different national holidays (e.g. Their Majesties' birthdays). There have also been efforts countrywide for reforestation to commemorate auspicious occasions of other members of the Royal Family. At the country level, there are strategies, objectives, aims and action plans by a number of government agencies for ecosystem (both land and coastal forests) restoration. Some of the aims are slightly different. For example, the aims for country cover range from 33 to 40 percent. While work on economic plantations and planting for watershed protection are clearly spelled out, FLR has not achieved any footing. Tree planting at the plot level is a normal practice. One of the nearest efforts for FLR is the Project on Forest and Wildlife Conservation in the Provincial

Bordered-Forests in the Five Eastern Provinces under the King's Initiative. It has an area of about 207 000 ha (consisting of two wildlife sanctuaries and three national parks). The Ministry of Agriculture and Cooperatives started the project with assistance from the RFD and Ranger Forces. The project was later adopted by the Queen as one of Her Majesty's Royal Initiative Projects in 1993. Since then, all stakeholders have taken part in protecting and reforesting land to maintain forest functions. Communities can also benefit from the land, without further encroachment.

Normally, the government (via several of the above-mentioned agencies) has annual plans and budgets for reforestation and/or forest restoration. Agencies must report their performances annually. Besides the government's effort, there are reports by private companies which support tree planting as part of their corporate social responsibility. If well organized, this can be an important source of funding for forest restoration.

It is recommended that the agencies involved in reforestation and forest restoration pool their resources and move from plot-level planting into FLR. The former can be done with MNRE agencies (e.g. the RFD and DNP) and the latter can be at the policy-making level (e.g. the NESDB and the ONEP).

Table 9. Two MNRE strategies concerning forest restoration

Strategies	**Strategy 1: To protect and restore watershed areas**	**Strategy 2: To conserve and restore forest and wildlife resources**
Objective(s)	To restore forest resources in watershed areas to prevent soil erosion and reduce flash floods in sloping areas.	To sustainably conserve, protect and restore forest and wildlife resources, with people's participation.
Performance indices and aims	1. Protected areas (1.64 million ha) in Yom-Nan watershed areas are managed. 2. Eighty percent of protected areas in Yom-Nan watershed areas are in a good condition.	1. Forest-protected areas (11.68 million ha) are protected and encroachment is prevented. 2. Twenty-five percent of the action units are developed for better efficiency.
Method	Restoring degraded forest using the King's method.	1. Protecting and maintaining forest-protected areas in good condition. 2. Restoring degraded protected areas. 3. Conserving wildlife to maintain biodiversity. 4. Developing the participatory method for forest and wildlife management. 5. Using technology and information systems in forest and wildlife management.
Responsible agencies	1. Watershed Conservation and Management Office 2. Fire Prevention, Suppression, and Control Office 3. Protected areas' restoration and development	1. Central Administrative Office. 2. Planning and Information System Office. 3. National Parks Office. 4. Wildlife Conservation Office. 5. Fire Prevention, Suppression, and Control Office. 6. Protected areas' restoration and development. 7. Watershed Conservation and Management Office. 8. Forest and Plant Conservation Research Office. 9. Wildlife and Wild Plant Protection Division 10. Law Division.

References

Bagong Pagasa Foundation. 2009. *Cost comparison analysis ANR vs. conventional reforestation.* Paper presented at the concluding seminar of FAO-assisted project TCP/PHI/3010 (A), Advancing the Application of Assisted Natural Regeneration (ANR) for Effective, Low-Cost Forest Restoration.

Barbier, E.B. & Cox, M. 2004. An economic analysis of shrimp farm expansion and mangrove conversion in Thailand. *Land Econ.,* 80(3): 389-407.

Buergin, R. 2000.*'Hill tribes' and forests: minority policies and resource conflicts in Thailand.* SEFUT Working Paper No. 7. Freiburg, Germany, Albert-Ludwigs-Universität.

Castilo, A. 1986. *An analysis of selected restoration projects in the Philippines*. Ph.D. Thesis, Los Baños, The Philippines, University of Philippines.

Chakravarty, S., Ghosh, S.K., Suresh, C.P., Dey, A.N. & Shukla, G. 2012. Deforestation: causes, effects and control strategies. *In.* C.A. Okia, ed. *Global perspectives on sustainable forest management*. Rijeka, Croatia. 312 p.

Charuppat, T. 1998. *Forest situation in the past 37 Years (1961–1998).* Bangkok, RFD. 116 p. (In Thai)

Contreras-Hermosilla, A. 2000. *The underlying causes of forest decline*. Occasional Paper No. 30. Jakarta, Center for International Forestry Research.

Delang, C. 2002. Deforestation in Northern Thailand: the result of Hmong farming practices or Thai development strategies? *Soc. Nat. Resour.,* 15:483-501.

Delang, C. 2005. The political ecology of deforestation in Thailand. *Geography,* 90(3): 225-237.

Department of Disaster Prevention and Mitigation (DDPM). 2013a. Daily report of May 31, 2013. Bangkok, Department of Disaster Prevention and Mitigation. (In Thai). Available at, http://61.19.100.58/public/group3/datagroup3/2556/dailyreportmay/ evening31.pdf).

DDPM. 2013b. *Daily Report of October 6, 2013*. Bangkok, Department of Disaster Prevention and Mitigation. (Available at: http://61.19.100.58/public/group3/datagroup3/2556 /dailyreportoct/ evening06.pdf).

Elliott, S. 2011. *Plotting a pathway towards restoring tropical forests for biodiversity recovery*. Forest Restoration Research Unit (FORRU), Chiang Mai, Thailand. Chiang Mai University.

Elliott, S., Blakesley, D. & Hardwick, K. 2013. *Restoring tropical forests: a practical guide*. Kew, UK, Royal Botanic Gardens. 344 p.

Environmental Investigation Agency (EIA). 2012. *Rosewood robbery: the case for Thailand to list rosewood on CITES*. London, Environmental Investigation Agency.

Food and Agriculture Organization of the United Nations (FAO). 2009. *Thailand forestry outlook study.* Asia-Pacific Forestry Sector Outlook Study II. Working Paper No. APFSOS II/WP 2009/22.

Forest Fire Control Division (FFCD). 2013. *Forest Fire Control Division report.* Available at, http://www.dnp.go.th/forestfire/eng/ description.htm

Forest Restoration Research Unit (FORRU). 2006. *How to plant a forest: the principles and practice of restoring tropical forests.* FORRU, Chiang Mai, Thailand, Chiang Mai University. Available at**,** http://www.forru.org/en/content.php?mid=87

FORRU. 2008. *Research for restoring tropical forest ecosystems.* FORRU, Chiang Mai, Thailand, Chiang Mai University. Available at, http://www.forru.org/extra/forru/PDF_Files/rfrtfpdf/RFRTFIQ.pdf)

Gilmour, D.A. Nguyen V.S. & Tsechalicha, X. 2000. *Rehabilitation of degraded forest ecosystems in Cambodia, Lao PDR, Thailand, and Vietnam.* IUCN, WWF and GTZ.

Goosem, S.P. & Tucker, N.I.J. 1995. *Repairing the rainforest— theory and practice of rainforest re-establishment in North Queensland's Wet Tropics.* Cairns, Wet Tropics Management Authority.

Jantakad, P. & Gilmour, D. 1999. *Forest rehabilitation policy and practice in Thailand.* 33 p.

Juárez, R.I.N., Hodnett, M.G., Fu, R., Goulden, M.L. & von Randow, C. 2007. Control of dry season evapotranspiration over the Amazonian forest as inferred from observations at a southern Amazon forest site. *J. Climate,* 20(12): 2827-2839.

Junpen, A., Garivait, S. & Bonnet, S. 2013. Estimating emissions from forest fires in Thailand using MODIS active fire product and country specific data. *Asia-Pacific J Atmos Sci.,* 49(3): 389-400**.**

Land Development Department (LDD). 2004. *National Action Programme for Combating Desertification.* Bangkok, Ministry of Agriculture and Cooperatives. 35 p.

Luukkanen, O. 2001. The vanishing and reappearing tropical forest: forest management and land use in Thailand. *In* T. Myllyntaus & M. Saikku, eds. *Encountering the past in nature: essays in environmental history*, pp. 74-93. Athens, USA, Ohio University Press. 184 p.

Marks, D. 2011. Climate change and Thailand: impact and response**.** ***Contemp. Southeast Asia***, 33(2): 229-258.

Ministry of Natural Resources and Environment (MNRE). 2005. ***Government reforestation.*** Bangkok, Royal Forest Department. (In Thai)

Nalampoon, A. Undated. National Forest Policy Review (available at ftp.fao.org/docrep/fao/005/AC921E/AC921E11.pdf).

Naito, S. & Traesupap, S. 2006. Is shrimp farming in Thailand ecologically sustainable? ***J Fac. Econ. KGU,*** (16): 55-75.

National Information Center (NIC)**.** 2013. ***Forest situation***. (in Thai). National Information Center.

Ongprasert, P. Undated. Forest Management in Thailand (available at, www.forest.go.th/foreign/images/stories/FOREST%20MANAGEMENT%20IN%20THAILAND.pdf).

Paiboonsak, S., Chanket, U., Mongkolsawat, C., Yommaraka, B. & Wattanakit, N. 2005. Spatial modeling for soil erosion risk in upper Chi basin, northeast Thailand. ***In*** Proceedings of the 26th Asian Conference on Remote Sensing. Hanoi.

Panayoutou, T. & Parasak, C. 1990. *Land and forest: projecting demand and managing encroachment.* Research Report No. 1. Thailand Development Research Institute Foundation Year-end conference: Industrializing Thailand and Its Impacts on the Environments. Chonburi, Thailand. 85pp.

Parrotta, J.A., Turnbull, J.W. & Jones, N. 1997. Catalyzing native forest regeneration on degraded tropical lands. ***For. Ecol. Manage.***, 99: 1-7.

Phongpaichit, P. & Baker, C.1996. *Thailand: economy & politics*. Oxford, UK, Oxford University Press.

Poulsen, E. 2001. *Forest in culture, culture in forest: perspectives from Northern Thailand*. Tjele, Denmark. Research Centre on Forest and People in Thailand. 246pp.

Puri, J. 2006. *Factors affecting agricultural expansion in forest reserves of Thailand: the role of population and roads.* Ph.D. thesis. College Park*,* University of Maryland. 182 p.

Provincial Waterworks Authority (PWA). 2013. Problem of turbid water. *Provincial Waterworks Authority News No. 38, 1 August 2013* (in Thai) (available at www.pwa.co.th/province/prnews/view.php?pr_id=24894).

Rerkasem, K. 2001. *Shifting cultivation in Thailand: land use changes in the context of national development*. Canberra, Australian Centre for International Agricultural Research.

Royal Forest Department (RFD). 2011. *Forestry statistical of Thailand.* Bangkok, Ministry of Natural Resources and Environment. 118pp.

Srimongkontip, S. 2000. Building the capacity of watershed networks to resolve natural resource conflicts: Field experiences from the Care-Thailand Project**.** ***Asia-Pacific Community For. Newsl***., 13(2): 46-50.

Thanapakpawin, P., Richey, J., Thomas, D., Rodda, S., Campbell, B. & Logsdon, M. 2005. Effects of landuse change on the hydrologic regime of the Mae Chaem river basin, NW Thailand. ***J. Hydrol.,*** 334: 215-230.

UNEP/EAP.AP. Undated. *Macro-scale assessment and monitoring of major land cover types in the selected countries in the Asia and the Pacific.* UNEP Environmental Assessment Programme for Asia and the Pacific (available at www.rrcap.ait.asia/lc/cd/html/thailand.html).

United States Agency for International Development (USAID)**.** 2011. *Property rights and resource governance: Thailand.* USAID land tenure and property rights portal.

Willis, K., Garrod, G., Scarpa, R., Macmillan, D. & Bateman, I. 2000. *Non-market benefits of forestry: Phase 1 Report to Forestry Commission.* Centre for Research in Environmental Appraisal and Management.

World Bank. 2011. Data: Thailand (available at data.worldbank.org/country/thailand) .

Wunder, S. 2001. Poverty alleviation and tropical forests- what scope for synergies? ***World Dev.,*** 29(11): 1817-1833.

Forest restoration at the landscape level in Viet Nam

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1. Forest status and history of deforestation and forest degradation

Viet Nam has a high proportion of mountainous areas and most of the territory is covered by forest. The climate varies from tropical humid in the south to subtropical in the high mountainous areas in the north. This variation in climatic and geographical conditions has resulted in a variety of tropical and subtropical forest types:

- Evergreen broadleaf;
- Semideciduous and deciduous;
- Mixed coniferous and broadleaf;
- Coniferous;
- Bamboo, mangrove, swamp; and
- Freshwater wetland.

These natural forests have been severely reduced or degraded over the last century.

According to the Vietnamese Forestry Strategy 2006-2020, 16.2 million ha of Viet Nam's land area have been classified for forestry purposes. Viet Nam aims to have a stable level of forest area with 14.3 million ha of forests in addition to 1.9 million ha of forest land for other uses such as agroforestry systems (MARD 2006).

According to Vietnam Administration of Forestry statistics, in 2012 the total forest area was 13.86 million ha (accounting for 41.9 percent of the total land area) divided into 10.423 million ha of natural forest and 3.428 million ha of plantations. Four types of forests were reported in 2012 forest status data: special-use forests – 2.02 million ha (equivalent to 15.7 percent of the total forest area); protection forests – 4.7 million ha (36.1 percent of the total forest area); production forests – 7 million ha (47.3 percent of the total forest area); and other forests – 200 230 ha (0.9 percent of the total forest area) (VNFOREST 2013).

Classification of forest management by managers in 2013 revealed that forest management boards are the biggest managers responsible for managing 33.2 percent of the total forest area, mainly for special-use and protection forests (Figure 1) (VNFOREST 2013).

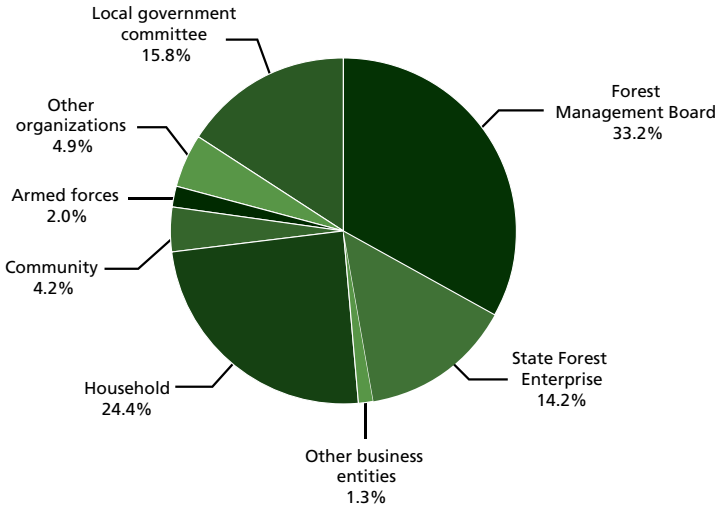

Figure 1. Forest classification by management entity

Source: VNFOREST (2013).

Farmers are managing the second largest part of the forest area (24.4 percent). Smallholder forests are mainly commercial plantations.

Forest cover has increased in recent years but it is unevenly distributed among the regions. The regions with relatively high forest cover include the Northwest, Northeast, North-central, Central-coast and the Central Highlands, accounting for 40-50 percent. Some provinces like Bac Kan and Kon Tum have very high forest cover level at 69.5 and 64.7 percent, respectively (VNFOREST 2013). The rest of the regions reported relatively low forest cover.

Although forest areas had increased from 9.2 million ha in 1990 to 13.86 million ha by 2012, deforestation and forest degradation have been continuously observed in all regions in the country, from the Central Highlands to the Central-coast and Southeast areas. Additionally, natural forests have become highly fragmented due to deforestation and forest degradation.

1.1 Forest area decline

The degradation of forest resources can be seen clearly through the decline in forest area. Originally, most of Viet Nam was forested. The forests became severely degraded over the last century, and by 1943, forest cover was estimated to be about 43 percent of the national territory. The forests declined further by some 2 million ha during almost 30 years of war (Phung and Le 1994).

The main causes for forest degradation in the post-war period from 1975 to the early 1990s included forest converted to farmland for agriculture and cash crops such as coffee, tea, rubber and ineffective and unsustainable harvesting to meet timber demand for the domestic market and export.

Table 1 indicates the trend in forest cover from 1943 to 2012. It was a continuous decline up to the early 1990s (loss of 5 million ha in 45 years; annual reduction of 0.11 million ha) and this was followed by an increase thereafter (VNFOREST 2013). From the 1990s to 2000 the forest area increased at over 1.6 percent annually (Pham et al. 2012; Phan 2014).

Table 1. Changes in Viet Nam's forest area from 1943-2012 (in ha)

Year Forest type	1943	1976	1985	1990	1995	2005	2012
Total area	14.3	11.2	9.9	9.2	9.3	12.7	13.5
Natural forest	14.3	11.1	9.3	8.4	8.3	10.2	10.3
Plantation		0.1	0.6	0.8	1.0	2.5	3.2
Forest cover (%)	43.0	33.8	30.0	27.8	28.2	38.0	41.9

Source: VNFOREST (2013).

Plantation areas have rapidly increased since 1990, from about 1 million ha in the early 1990s to 3.428 million ha in 2012 (VNFOREST 2013). This substantial increase is the result of better forest land allocation policy, market timber demand, improvement in plantation tree genetics and intensive silvicultural practices. This was further strengthened by international donor funding and improved afforestation programmes.

Forest area per capita in Viet Nam is some of the lowest in the world (Table 2). It has decreased dramatically from 0.63 ha/person in 1943 to 0.13 ha/person in 1995. In 2012, it increased to 0.15 ha/person, which is far lower than world's average of 0.93 ha.

Table 2. Average forest area per capita in the period 1945-2012 (ha/person)

1945	1976	1985	1995	1999	2005	2012
0.63	0.23	0.17	0.13	0.14	0.15	0.15

Sources: VNFOREST (2013); Phan (2014).

1.2 Decline in forest quality

Natural forests, which have the highest ecological and environmental values, have declined considerably, and have been replaced with monoculture of exotic timber in plantations and industrial cash crops such as rubber and coffee.

According to the National Forest Inventory and Monitoring Assessment Program report, Phase III, two-thirds of the natural forests in Viet Nam are considered poor (with volumes below 100 m^3/ha); rich and medium forests only account for about 4.6 percent of the total forest area and are found mainly in the high mountains and remote areas. Natural mangrove and *Melaleuca* forests in the coastal delta, which have an important role in maintaining biodiversity and environmental protection, have almost disappeared. Rehabilitated natural forests with high timber volume can only be found in small and fragmented patches. Forest quality and biodiversity are in a continuous state of decline. From 1999 to 2005, primary forest and secondary logged forest decreased by about 10.2 and 13.4 percent, respectively (FIPI 2005). Many natural forest areas in the Central Highlands, Southeast and Northwest were destroyed during the period 1991-2001 (FIPI 2005; Tran et al. 2006).

Natural forests have declined in quality and are mainly reserved as special-use and protection forests in the high mountains and remote areas. Primary forests declined from 384 000 ha in 1990 to 187 000 ha in 2000 and to 80 000 ha in 2010 (FAO 2006; FAO 2010), which is approximately 0.25 percent of the total land area (RECOFTC 2014). The total area of natural production forests was 3.145 million ha in 2006, of which 79-80 percent was poor degraded forests and young regeneration with low volume (de Jong et al. 2006; Tran 2006). Watershed natural forests and mangrove forests are severely degraded too.

Plantations have increased rapidly both in area and volume recently. This has significantly contributed to the nation's forest cover and timber for domestic consumption and export. However, significant areas of commercial plantations are dominated by exotic monocultures of *Acacia* and *Eucalyptus* with potential ecological problems (Phan et al. 2013).

2. Causes of forest degradation

2.1. Direct causes

According to the Vietnam State Environment Report 1998 on Deforestation and Forest Degradation, major causes of deforestation in Viet Nam included overlogging, shifting cultivation, conversion to agriculture, spontaneous migration, war and conversion to other land uses (Ministry of Science Technology and Environment 1998). The contributions of these factors to deforestation in each ecological region are shown in Table 3.

Table 3. Causes of forest loss by economic-ecological region (percent)

Region	Over logging	Shifting cultivation	Conversion to agricultural land	Free migration	War	Conversion to other land uses	Total (%)
Northern Basin	12		17	41	9	21	100
Northeast	27	29	11	7	8	18	100
Central north	29	27	16	9	5	23	100
Northwest	11	36	12	11	3	27	100
North central	34	21	14	6	14	11	100
South central coast	28	17	11	9	29	6	100
Central Highlands	31	24	21	5	17	2	100
Southeast	29	15	13	9	24	10	100
Mekong Delta	19	4	19	21	31	6	100

Source: Vietnam State Environment Report 1998 – Deforestation and Forest Degradation.

In general, overlogging and forest clearing for growing crops are the biggest causes of deforestation. This is especially true in the North-central, South-central coast, Central Highlands and Southeast regions. Meanwhile, land conversion and shifting cultivation are the main drivers of deforestation in the northwest (Ministry of Science Technology and Environment 1998).

In their survey on the causes of forest degradation that led to 42 forest rehabilitation projects in 2006, de Jong et al. (2006) defined the most frequent causes as logging, grazing and fire (Table 4). This is in line with reporting by the Ministry of Science, Technology and Environment (1998).

Table 4. Causes of degradation leading to forest rehabilitation projects

Cause of degradation	Prod	Prot	SpU	Total
Agricultural production	5	7	1	13
Fire	1	17	3	21
Forest exploitation	4	5	1	10
Grazing	3	15	3	21
Flood	2	14	3	19
Logging	5	20	5	30
Other	3	6	3	12
Total	**23**	**84**	**19**	**126***

*Totals exceed 42 sampled projects because single projects list different causes of degradation.

Source: de Jong et al. (2006) (Prod-Production; Prot-Protection; SpU-Special Use)

A further analysis of the major causes of deforestation and forest degradation in Viet Nam is given below (de Jong et al. 2006; Tran et al. 2006; MARD 2007; Meyfroidt and Lambin 2008).

2.1.1 Shifting cultivation and conversion of forests to agricultural crops and industrial trees

After the wars and before economic liberalization (in the late 1980s), shifting cultivation was considered a major cause of deforestation. It is estimated that shifting cultivation and conversion to crops and industrial trees accounted for 50 percent of deforestation during this period (Phan 2014). Table 5 reveals that land-use conversion is the major cause of deforestation in Viet Nam (Hoang et al. 2010).

Table 5. Change in forest area in Viet Nam, 2004-2008 (ha)

Forest category	2004	2005	2006	2007	2008	Total
Forest land with forest	**12 306 859**	**12 616 699**	**12 873 850**	**12 903 423**	**13 118 773**	**-**
1. Natural forest	**10 088 288**	**10 283 173**	**10 410 141**	**10 348 914**	**10 348 591**	**-**
a) Reasons for increase	**161 912**	**215 118**	**112 331**	**59 204**	**32 974**	**581 539**
Natural forest increase	161 912	178 596	74 328	59 204	32 974	507 014
Other forest	-	36 522	38 003	-	-	74 525
b) Reasons for decrease	**53 523**	**35 311**	**35 588**	**85 126**	**63 278**	**272 826**
Legal logging	238	530	120	376	355	1 619
Forest fire	2 141	446	259	697	109	3 652
Insects and disease	-	197	68	58	-	323
Illegal logging	3 061	7 989	6 199	1 694	3 395	22 338
Land-use conversion	24 916	15 260	18 449	11 808	23 508	93 941
Other reasons	23 167	10 889	10 493	70 493	35 911	150 953
2. Planted forest	**2 218 571**	**2 333 526**	**2 463 709**	**2 554 509**	**2 770 182**	**-**
a) Reasons for increase	**205 257**	**158 624**	**195 601**	**178 779**	**203 601**	**941 862**
Newly planted	182 699	154 787	171 444	178 799	174 918	862 627
Others	22 558	3 837	24 157	-	28 683	79 235
b) Reasons for decrease	**43566**	**35 120**	**39 231**	**45 153**	**45 334**	**208 404**
Legal logging	16 362	19 046	23 194	26 855	35 147	120 604
Fire	3 422	4 818	1 276	1 631	679	11 826
Insects and disease	-	153	71	279	18	521
Illegal logging	600	1 159	2 249	136	502	4 646
Land-use conversion	10 026	8 237	12 441	4 802	8 988	44 494
Others	13 156	1 707	-	11 450	-	26 313

Source: Hoang et al. (2010).

The economic boom in the 1990s and 2000s, including agricultural production, dramatically increased the demand for lands for industrial crops such as coffee and rubber that provide higher incomes. This caused enormous pressure to convert forest land and forests to industrial crops. The coffee area increased from 120 000 ha in 1990 to nearly 620 000 ha in 2012 while rubber plantations increased from 250 000 ha in 1990 to 910 000 ha in 2012 (GSO 2011-2013; Phan 2014). Thus, more than 1 million ha of hilly forest land were covered with coffee and rubber trees during this period.

In the coastal areas, conversion of mangroves to aquaculture farming systems was the main driver of deforestation over a large area. Approximately 5 percent of the total area of mangrove forest was lost each year to other land uses (GSO 2011-2013; Pham et al. 2012). In addition, mangrove forest was converted into paddy fields with development of irrigation systems in the Mekong Delta (Pham et al. 2012).

2.1.2 Overharvesting of forests

After the war with the United States of America, for economic recovery and development, Viet Nam conducted massive forest exploitation for domestic consumption and export. Harvesting without consideration of forest ecological characteristics contributed to rapid decline in the quality of natural forests. Unsustainable selective logging of natural forest was one of the major reasons for the severe decline in forest quality, which resulted in many rich natural forests becoming poor secondary forests with a few commercial species. Weak governance in State Forestry Enterprises which held 4.9 million ha of forests and forest land (which included the largest area of good natural forests), unsustainable forest management and a top-down approach by the central government, were the major causes of forest degradation (de Jong et al. 2006; Tran 2006; Phan 2014).

In addition, illegal logging and collection of fuelwood also had a strong impact on forest resources. According to Castrén (1999), fuelwood consumption amounted to approximately 36 million m^3 in 1992; much of this was taken from forests. Compared with timber extraction, fuelwood removes a much larger amount of biomass from forest ecosystems. Forest logging was responsible for the loss of about one-third of the forest area in the forest-rich North-central, South-central coast, Central Highlands and Southeastern regions (Ministry of Science, Technology and Environment 1998).

2.1.3 Infrastructure development

With rapid economic development, huge amounts of forest land and forest resources were lost. Irrigation and hydropower projects across the country resulted in the conversion of extensive areas of forests. According to the Ministry of Industry and Trade, 50 000 ha of forest area were lost to hydroelectric dam development (Vietnam News 2013). Thousands of hectares of forest were cut down to accommodate other infrastructure projects such as road building and establishment of electricity grids (Pham et al. 2012).

2.1.4 Armed conflicts

War is not only the direct cause but also the underlying cause of biodiversity decline in Viet Nam. From 1961 to 1975, 13 million tons of ordnance and 72 million litres of toxic chemicals, sprayed mainly in the south of Viet Nam, destroyed about 2.2 million ha of forest (Phung and Le 1994). This caused the national forest area to decline to about 9.5 million ha, of which 10 percent was primary forest. The effects of toxic chemicals sprayed by the U.S. army severely affected biodiversity as well as other forest ecosystem services (Phung and Le 1994).

2.1.5 Forest fires

Forest fire is a significant cause of forest loss and degradation of forest resources and negatively affects wildlife; it is also instrumental in exacerbating erosion and floods. According to the Department of Forest Protection, 7 380 forest fire events, which destroyed 48 837 ha of forest, occurred from 2002 to 2011 (VNFOREST 2014a). Figure 2 shows the area of forests destroyed annually from 1995 to 2010 (GSO 2014).

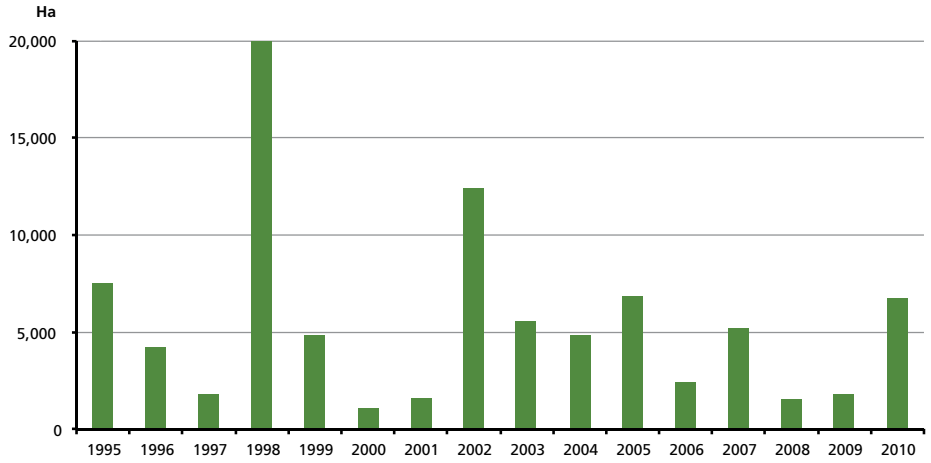

Figure 2. Forest area destroyed by fires from 1995 to 2010

Source: GSO (2014).

2.2. Underlying causes

2.2.1 Poverty and high population pressures

Viet Nam's population is estimated to reach 100 million by 2020. This is a fourfold increase from 20.9 million in 1941. Rapid population growth and limited farming land have put extremely high pressure on forest land to meet the increasing demand for food and shelter. After the American War, the government issued immigration policies to encourage people to migrate to low-population density regions with rich natural resources and fertile soil in the south. In the early 1980s, the government issued Decision 95-CP (Goverment Committee 1980) to encourage migration and establish new economic zones in remote areas where forest resources were located, especially in the Central Highlands (Phan 2014). These immigrants cleared forests for farming land (Dinh 2005; FAO 2010). In addition, many free immigrants also caused deforestation in mountainous regions (Tran 2006; Phan 2014).

2.2.2 Economic development policies

Economic growth based on exports of cash crops (coffee, rubber, cashew, pepper) and increasing demand for wood and timber resulted in conversion of natural forests. For example, the Ministry of Agriculture and Rural Development (MARD) issued circular 127/2008/TT-BNN for planting rubber on forest land (MARD 2008). This policy resulted in the conversion of regenerating natural forests into rubber plantations in the Central Highlands and other provinces (Phan 2014). Policies to promote development of timber plantations for building the export-oriented wood industry also had negative impacts on natural forests. For achieving economic growth targets, local governments of several provinces allowed conversion of natural forests into industrial plantations. Natural forest area shrank, and is continuing to do so with recent conversions to

other land uses. This is mirrored by policies that drove economic growth to exploit natural resources in an unsustainable manner; the construction of infrastructure for economic development including hydropower, mining and transportation also reduced forest area in Viet Nam (Pham et al. 2012).

2.2.3 Institutional weakness, weak law enforcement and financial deficits

The forestry management system is well structured and extends from the grassroots level to central government (de Jong et al. 2006; Tran et al. 2006; Pham et al. 2012). However, the quality of forest management in some localities is not good, especially at the commune level, where direct land management and forestry production activities are implemented (Pham et al. 2012). For many reasons, including low capacity and lack of economic incentives, the commune-level agroforestry staff often find it difficult to meet the requirements of forest management in their communes. At the same time, the local forest rangers who play essential roles in forest protection and management in the field do not fulfil their duties and have been found to be corrupt as well (Sikor and To 2011).

Failure to follow the legal instructions on forest protection and management is a serious problem leading to forest degradation. Deforestation, shifting cultivation and conversion of forest land for agricultural purposes and industrial plantations have been occurring in many localities. This is amplified by poor law enforcement, lack of awareness, corruption, overlapping regulations and mild penalties (Sikor and To 2011; Phan 2014).

Database systems for forest management, including GIS data, are not accurate, with overlaps (e.g. different mapping systems for the natural resources and environment sector and forestry sector). Moreover, the complicated history of land use including encroachment of State Forest Enterprise land, handwritten land-trading contracts and inherited land make it difficult for forest and forest land management to achieve good results (de Jong et al. 2006; Pham et al. 2012).

2.2.4 Finance

Under Decision 02-CP of the Prime Minister, millions of hectares of State Forestry Enterprise forest land and forest management boards are patrolled by local farmers under contracts with these entities. Initially, farmers received only VND50 000 per hectare per year for forest management and protection, but this has recently been increased to VND200 000. This is still too small to be an incentive for effective forest protection and management compared to the much higher economic returns from monoculture industrial plantations and other crops (de Jong et al. 2006; Pham et al. 2013; Phan 2014). The lack of resources for forest management and protection is also a major issue facing forest management boards, national parks and conservation zones. The number of personnel and the budget allocated to the forest management boards are often lower than needed, making them ineffective in protecting and managing forests (de Jong et al. 2006; Phan 2014).

3. Impacts of forest degradation

It is challenging to estimate the economic impacts of deforestation and forest degradation. The available data in Viet Nam currently cannot give reliable estimation of the direct impacts on forest timber production and non-wood forest products (NWFPs), the negative effects on forest resilience against natural disasters (floods, droughts, storms, pests and diseases) and the diminished values of forests for protection of water catchments, hydropower schemes and irrigation dams, among others. Since 1980, Viet Nam has suffered a series of major disasters of which floods and droughts have severely affected human lives and property. Statistical data showed that on average, natural disasters killed 519 people per year and caused losses of about US$256 million per year during the period 1980-2010 (PreventionWeb 2014). Soil erosion has reduced the lifetime, and increased the maintenance expenditure of irrigation systems and hydropower schemes, and decreased stable power supply capacity due to irregular water supply to reservoirs. Forest resources play an important role in regulating water supplies throughout the year, maintaining water levels at reservoirs during the dry season for irrigation and minimizing floods during rainy seasons (de Jong et al. 2006; Phan 2014).

Deforestation increased the impacts of the severe droughts in the Central Highlands in 1995 and throughout the country in 1997. Those droughts had serious impacts on agricultural crops and industrial tree plantations. Thousands of hectares of coffee plantations in the Central Highlands were destroyed due to irrigation water shortage, a direct consequence of deforestation and forest degradation (de Jong et al. 2006; PreventionWeb 2014).

Deforestation and degradation have destroyed wildlife habitats. This is one of the main reasons for population reduction and possible extinction of many wildlife species. The endangered species in the Vietnam Red Book increased to 167 in 2007 compared to the number listed in 1992. Unsustainable or illegal forest logging has led to overexploitation of many high-value timber species and NWFPs, and some have been driven to the point of extinction (Ministry of Science & Technology 2007; Phan 2014).

4. Implementation of forest restoration and rehabilitation initiatives

4.1. History of initiatives, strategies and techniques

Initial efforts at forest rehabilitation and scattered planting of trees in Viet Nam started in the late 1950s. The General Department of Forestry (later Ministry of Forestry and now MARD) implemented five major programmes, two of which were national afforestation programmes and one was a national programme for forest protection (Sikor 1998; Nguyen 2005). Policies related to forest rehabilitation in Viet Nam from the 1960s to 1999 are listed in Table 6.

Table 6. Policies relating to forest rehabilitation in Viet Nam

Number	Date	Title	Promulgation body
Decision 179/CP	12/11/1968	Policy for forestry cooperatives	Minister Council
Decision 129/CP	25/5/1974	Policy for cooperatives and expanding areas for developing agriculture and forestry in midland and mountainous areas	Government Committee
Directive 257/ TTg	16/7/1975	Promoting reforestation and forest land allocation for cooperatives	Prime Minister
Decision 272/CP	3/10/1977	Policy for cooperatives and expanding areas for developing agriculture, forestry and new economic zones and implementation of permanent farming and permanent settlement	Government Committee
Decision 682B/ QĐKT	01/8/1984	Norm for designing forest management (QPN6-84)	Ministry of Forestry
	1995	Biodiversity Action Plan	Inter-ministerial circular
Circular 01-TT/LB	06/02/1991	Instructions on forest allocation and forest land for plantation by organizations and individuals for forestry purposes	National Assembly
Law	1991	Forest Protection and Development Law	National Assembly
Law	1993	Land Law	
Decision 200/ QD/KT	31/3/1993	Norms for technical procedures when applying for production timber and bamboo forest licences (QPN 14-92)	Ministry of Forestry
Decree 22-CP	09/3/1995	Regulations on forest fire prevention and control	Government
Directive 286/ TTg	02/5/1997	Enhancing approaches for forest protection and development	Prime Minister
Decision 661/ QD-TTg	29/7/1998	Objectives, missions, policies and arrangement for implementation of the Five Million Hectares Reforestation Programme	Prime Minister
Decision 175/ QD-BNN-KHCN	04/11/1998	Norms for forest restoration by zoning and promoting natural regeneration combined with enrichment planting	MARD
Decision 245/ QD/TTg	21/12/1998	State management of forest	Prime Minister
Decision 02/1999/QD-BNN-PTLN	05/01/1999	Regulations on timber and forest product harvesting	MARD

Sources: Tran et al. (2006); Phan (2014).

Decision 47/QD/ BNN-KL	12/3/1999	Regulations on inspection of transportation, production and trade of timber and forest products	MARD
Circular 56/TT/ BNN-KL	12/3/1999	Instructions for development of village regulations on forest protection and development	MARD
Directive 24/ CT-TTg	18/8/1999	National land and land-use inventory in 2000	Prime Minister
Decree 163/ ND-CP	04/11/1999	Temporary regulations on approval of forest protection, zoning and promoting natural regeneration combined with enrichment planting, planting and tending of plantations	MARD

It is possible to divide forest rehabilitation solutions in Viet Nam into two groups: (i) reclamation and reforestation/ afforestation; and (ii) restoration of natural forests.

For forest restoration, the expression 'forest zoning and maintenance', which is similar to 'passive reforestation' (Lamb and Gilmour 2003; Lamb 2010) was introduced into government policies from the late 1950s until the 1980s. By the late 1980s, this expression was replaced by the term 'forest zoning, maintenance and promoting regeneration' (shortened to forest zoning and promoting regeneration) which is considered a change in scientific understanding of the forestry sector for forest restoration, focusing on regenerating biological resources by promoting natural succession (Tran et al. 2006). Achievements from the study of forest restoration during this period were regulated in technical rules including the 'Norm of silvicultural techniques for timber forests and bamboos' (QPN 14-92) and 'Norm of forest restoration by forest zoning, promoting regeneration and enrichment planting' (QPN 21-98) (Ministry of Forestry 1993; MARD 1998). These legal documents were breakthroughs in technical instruction and standardization for forest restoration and regeneration. However, they contained inadequacies in application with regards to the socio-economic circumstances in different regions (Tran et al. 2006; Phan 2014).

Based on these two regulations, techniques concerning reforestation and restoration of natural forests have been clearly specified for: (i) logging and regeneration; (ii) forest maintenance; (iii) forest enrichment; (iv) promoting natural regeneration; (v) forest zoning for passive restoration; and (vi) reforestation/afforestation and reclamation. Among the technical solutions for natural restoration and reforestation according to regulations QPN 14-92 and QPN 21-98, the following restoration approaches stand out:

1. Forest maintenance: This is defined as silvicultural techniques for reasonably adjusting tree density and forest structure at each succession stage. The thrust of this technical solution is to clear diseased trees, poor-quality trees or trees that block commercial tree growth in order to increase the forest's productivity and quality, and shorten the harvesting rotation. These silvicultural practices were regulated in QPN 14-92 (Ministry of Forestry 1993). However, natural forest managers often did not strictly follow introduced technical regulations due to lack of implementation funds or no enforcement on forest owners (Tran et al. 2006).
2. Forest enrichment: This technical solution is to plant native tree species in severely degraded natural forests. This approach has two important technical components: (i) species selection and (ii) silvicultural techniques for planting, tending and protection. In practice large-scale forest enrichment has not succeeded often. This is probably attributable to short tending time, only two to three years after enrichment planting. Enrichment species are mostly native timber trees with slow growth rates at the initial stage – they cannot compete with the competing regeneration in situ. Pilot forest enrichment models or research plots are often successful owing to thorough tending (Tran et al. 2006; Phan 2014).
3. Promoting natural regeneration: This can be considered as a derived solution of passive restoration (Lamb and Gilmour 2003; Lamb 2010), of which the major technique is to protect the forests from human interventions and natural incidents such as logging, fuelwood collection, grazing and forest fires. In some cases, particularly for natural production forests, it is also combined with additional silvicultural practices such as removing creepers, non-purpose trees, growing regenerating targeted trees evenly distributed in the stand, direct seeding and so forth. However, the application method resembles enrichment planting. Table 7 lists technical criteria to define degraded natural forests suitable for restoration via natural regeneration.

Table 7. Degraded natural forest criteria for restoration via natural regeneration

Current status and forest types	Available regeneration threshold
A. Timber forests 1. Degraded forest due to overharvesting 2. Abandoned forest land after crop cultivation 3. Grasslands with timber trees, soil depth > 30 cm	Degraded forests should have at least one out of the three following criteria: - Regenerating targeted saplings with height over 50 cm > 300 saplings per hectare - Base stumps for regenerating shoots with even distribution in the stand and > 150 stumps per hectare - Seed trees at the stand and even distribution with > 25 trees per hectare or neighbouring seed trees.
B. Bamboo 1. Restoration after logging or crop cultivation	Bamboo cover > 20% of the area with even distribution in the stand.
C. Critical and highly critical protection forest 1. Remote area without afforestation and enabling conditions in the next 10 years.	Vegetation cover and shrubs/grasses > 40%, height exceeding 1 m.

Sources: Ministry of Forestry (1993); Tran et al. (2006) .

Despite the highly detailed regulations, some technical norms in these legal documents still lack scientific basis, are conservative and/or do not take into account well-known best practices that have emerged from research worldwide, including Viet Nam. Therefore, some do not fit with the ecological and productive characteristics of natural forests and local socio-economic conditions. A typical example stipulates that the intensity of conventional selective logging should allow up to 45 percent of forest volume, canopy cover reduction after logging to at least 40 percent; and gap areas below 1 500 m^2. These norms exceed the ecological thresholds which can allow natural forests after logging to recover to their original status (Phan 2014). Logging norms have to be adjusted according to forest structure and density of the stand (Sist et al. 2003).

Additionally, dozens of ODA international projects are being piloted over large areas for forest restoration based on experience from other countries. However, extension of successful models has not been achieved yet, and so their positive impacts on forestry planning or forestry extension are limited (Phan 2014).

Reforestation/afforestation and reclamation are two of the greatest successes of the Vietnamese forestry sector in recent years. Before 2000, afforestation and reforestation were given first priority by the government but the success rate was low for many reasons. The causes included low investment, poor quality of seeds and seedlings, unfamiliar silvicultural techniques, low incentives for farmers for growing trees, abundant timber resources from natural forests and especially the undeveloped timber market (de Jong et al. 2006; Phan 2014). Since early 2000, the plantation area has been rapidly increased with smallholders contributing substantially to their establishment. Short rotation plantations of *Acacia* and *Eucalyptus* are the main sources for woodchip exports, for which Viet Nam has been ranked first internationally over the last two years (Phan 2014).

Policies, techniques and socio-economic solutions have had decisive effects on natural forest restoration in Viet Nam. The results from forest zoning and maintenance before 1990 are not well documented. Since 1993, two major programmes, 327 and 661, have been carried out. Over 1 million ha of natural forest have been restored under the 327 programme (Tran et al. 2006). Meanwhile, the Five Million Hectare Project (programme no. 661) has completed restoration of 803 000 ha of protective and special-use forests (MARD 2011).

4.2 Economic assessment of different possible forest restoration/rehabilitation strategies

There has been no comparative study on the economic effectiveness of different forest restoration strategies. Some studies assessing the economic values of forest types only focused on traditional forestry values (timber and NWFPs). Their estimations of forest growth, especially of natural forests, were not reliable, and thus the results have limited applicability (Phan 2014). Forest ecosystem services have been given additional attention in Viet Nam recently (Hawkins et al. 2010; Pham et al. 2012; Pham et al. 2013). Forest ecosystem service fees were calculated and many hydropower stations, irrigation companies, clean water suppliers and ecological tourism services have been charged. Total revenue from forest ecosystem service fees during 2009-2013 was approximately VND2 850 billion (US$135 million) (mainly from hydropower). The fees obtained for 2012 and 2013 were over VND1 000 billion annually (VNFOREST 2014b). Thus, in addition to traditional forest product values, it is financially valuable to invest in forest restoration, development, management and protection (VNFOREST 2014b).

However, the time gap between payments for forest ecosystem services and restoration efforts does not encourage forest managers and owners to restore natural forests with much higher ecological values other than afforestation with

monoculture of exotic species. Unless fees for other ecosystem services such as carbon sequestration, biodiversity and genetic conservation are available, natural regeneration forests and restoration approaches will not be able to compete with afforestation and commercial plantations. The low forest ecosystem service fee paid to farmers in some localities (i.e. Son La Province) makes natural forest maintenance and protection over conversion to other land uses such as cropland and industrial tree plantations much less attractive (Pham et al. 2012).

In conclusion, it is important to find a compromise to achieve the best possible results in forest restoration strategies. If the ecological and environmental values of forests are completely quantified and highly recognized in the climate change context, there may be more chances for natural forest and landscape restoration.

4.3 Case studies

The project 'Demonstration of Capacity Building of Forest Restoration and Sustainable Forest Management in Vietnam', sponsored by the Asia Pacific Network for Forest Rehabilitation and Sustainable Forest Management (APFNet) was implemented from September 2010 to December 2012. The overall objective was to contribute to improving the livelihoods of local communities through enhancing ecological services, biodiversity conservation and economic value via the restoration of secondary degraded natural forests (Phu Tho Sub-department of Forestry 2010).

The project applied best practices in natural forest restoration and sustainable forest management in Viet Nam including both technical and community development aspects. The best technical practices were species selection, planting and tending techniques. Project participants were the poorest ethnic communities in Phu Tho Province who had suboptimal cultivation techniques. It was necessary to design simple, easy and effective restoration approaches and techniques. This was the basis for the success of natural forest restoration in project areas, which can be replicated in other localities.

The highest pressure on natural forest resources in the project area was the lack of cropland and forestry plantation land; poor natural forests were mostly protection forests which were prohibited from conversion into plantations. In this environment, the forest restoration model needed to create income for people both in the short and long term. Besides enrichment planting using native timber trees, the project also selected high value NWFPs that could grow under the forest canopy and/or in forest gaps in order to create short-term income for farmers (Phu Tho Sub-department of Forestry 2010; Phan 2014).

A forest inventory conducted at pilot model sites revealed that poor secondary forests in these areas had low composition of valuable timber species, only about 15 to 35 percent in the stands (Figure 3). The survey also found that there were approximately 17 NWFP species in low population densities.

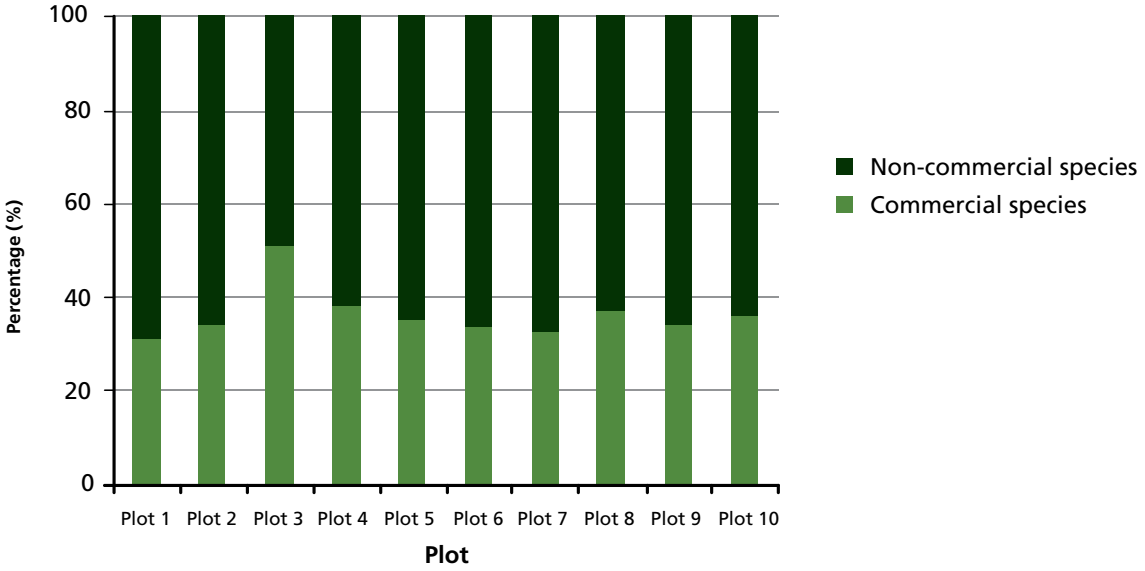

Figure 3. Commercial and non-commercial tree species in degraded natural forests in the project area

Based on the prevailing characteristics at the project site, enrichment planting was designed in strips along contour lines in the simplest possible arrangement. Saplings of native timber species and NWFP seedlings were grown in clear strips of 8-m width or in forest gaps, and the interstrip widths were kept at 12 m. Valuable regenerating species in cleared strips were carefully retained while climbers in the strips were cut for promoting targeted sapling growth.

Local community participation was essential for project success. Applying recognized community forest management techniques of successful ODA and governmental projects and a micro-institutional structure for forest protection and development in communities was carried out; village regulations for forest protection, management and benefit sharing

from forest resources were developed and a village forest management board was established to maintain long-term community forestry activities. Initially, the project's technical application was successful. The restoration approaches were simple but highly effective. Simplicity made it easy to extend the approaches to other mountainous areas where the local communities lacked technical capacity, technology and cash. The principal approach for forest restoration here was enrichment planting with native timber species in cleared strips following contour lines.

Regarding the selection of tree species for enrichment planting, all species selected for forest restoration were native and high-value species that grew well in the ecological conditions of the project area. NWFP species had high economic value and were preferred by the community. The simple growing techniques and high adaptability to site conditions of selected species were the keys to success. The selected timber species were *Parashorea, Erythrophleum fordii, Dipterocarpus retusus, Michelia mediocris* and *Manglietia conifera* and the NWFPs were *Desmodium styracifolium, Chrysopogon zizanioides, Morinda officinalis, Calamus tetradacylus* and *Erythropalum scandens*. Growing techniques for these species were developed on the basis of comprehensively studied results and pilot tested.

The participation of local people and communities was one of the decisive factors in the project's success as this is fundamental for making project models feasible and maintainable. The project applied the participatory approach in every aspect of implementation, including species selection, model establishment, tending, village regulation establishment and NWFP species harvesting.

Finally, the establishment of a local micro-institutional framework was an important factor to ensure sustainable restoration and management of natural forests. A micro-institutional framework that is fully compliant with national laws and policies is the basis for effective forest management (Phu Tho Sub-department of Forestry 2013; Phan 2014).

Local communities were fully aware of their roles in forest management and rights and restrictions regulated by state policies. Local people paid attention to improving the degraded secondary forests via planting of high-value timber trees and NWFPs. This contributed to restoring natural forests and their sustainable management. Local farmers received payments for labour at model sites and also earned some income from harvesting NWFPs. These earnings contributed to increased income and a decrease in hunger and poverty for local households (Phu Tho Sub-department of Forestry 2013; Phan 2014).

5. Looking forward

5.1 Conditions for success

With political commitment and supporting policies, Viet Nam has made significant achievements in forest restoration, increasing forests' contribution to livelihood improvement, rehabilitating and protecting the environment, and creating rural employment. While forests are important ecosystems for environmental protection in Viet Nam, most of them have become highly degraded in terms of productivity and quality. In order to ensure their sustainable development and increase their ecosystem values, the following additional measures are needed:

5.1. Policy harmonization with international commitment

First it is necessary to state precisely how the management of forests will be undertaken, in the case of Viet Nam this should be through conservation and utilization, generating benefits to all related parties, particularly the communities living in and near the forest (Tran et al. 2006).

- Accomplishment of the legal policies concerning forests, mountainous areas and mountain communities by meeting objectives through reliable assessment of all the values of forestry products and ecosystem services in order to develop solutions to promote the restoration of high-value forest ecosystems.
- Forestry and rural development policies need to pay deep attention to the rights and the participation of indigenous communities living near and in the forests. Absence of this participation brings potential risks to any forest restoration plan. Forest restoration, management and protection must bring decent income to the people in order to prevent them from encroaching on forests or supporting illegal logging (Tran et al. 2006). In any case, it is necessary to set up forest benefit-sharing policies among stakeholders, especially communities living in and near the forest. This will guarantee equity and attract them to involvement in forest restoration and management activities (Tran et al. 2006; Nguyen 2007).
- Viet Nam has participated in many international conventions that address environmental protection and conservation, and is a signatory to nearly 20 of them (Table 8); it has proceeded to convert conditions into laws and regulations concerning the forestry sector including the Law on Forest Protection and Development, Law on Biodiversity, Ordinance on Mineral Resources, Ordinance on Phytosanitation and Law on Natural Resource Tax among others. Viet Nam now needs to make its policies regarding forest management and other natural resources concord with international conventions to receive benefits from mechanisms such as the CDM, REDD/REDD+, all of which are linked to climate change mitigation processes (Phan 2014).

Table 8. International conventions related to the management and protection of forest resources signed by Viet Nam

Conventions	Signing date
Convention Concerning the Protection of World Cultural and Natural Heritage, 1972	19/10/1987
Convention on Early Notification of a Nuclear Accident (IAEA), 1985	30/10/1987
Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (RAMSAR), 1971	20/9/1989
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (IAEA), 1986	29/9/1989
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973	20/1/1994
Convention for the Protection of the Ozone Layer, 1985	26/4/1994
Montreal Protocol on Substances that Deplete the Ozone Layer, 1987	
The United Nations Declaration on Environment and Development, 1992	
The United Nations Convention to Combat Desertification (UNCCD), 1992	25/8/1998
The United Nations Framework Convention on Climate Change (UNFCCC), 1992	16/11/1994
Convention on Biological Diversity (CBD), 1992	16/11/1994
Cartagena Protocol on Biosafety	21/01/2004
Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal (Basel Convention), 1989	13/3/1995
Kyoto Protocol	3/12/1998

International Declaration on Cleaner Production	22/9/1999
Stockholm Convention on Persistent Organic Pollutants (POP), 2001	10/8/2006

5.2 Strengthening governance capacity

The Vietnamese forestry governance system is structured from the centre to the locality. However, there remains much overlap in the management of forests, forest land and biodiversity among sectors. This overlap leads to conflict of interest among related government bodies. For example, biodiversity management has been assigned to both MARD and the Ministry of Resources and Environment, and this has decreased governance effectiveness. The government needs to re-assess and clearly define these sectors and subsector roles and functions, and align the laws and regulations appropriately (Phan 2014).

In addition, forestry staff at the commune level and field forestry rangers' capacities need strengthening so they can perform their duties more effectively.

Much concern has been expressed about corruption in the forest management force, including forest management and protection bodies. Considering the low salaries and allowances in public administration it is difficult to encourage them do their jobs seriously and enthusiastically. The government needs to resolve these issues (de Jong 2006; Sikor and To 2011).

5.3 Markets

The demand for timber, especially for woodchips by China, Republic of Korea and Japan is increasing and is an important factor in the push for forest plantations in Viet Nam. In addition, the booming furniture industry is consuming much timber, some of which is currently imported from overseas. This could remain as a market for timber growers in Viet Nam for a long time.

However, plantation development contradicts the major objective of forest restoration, which is directed at ecosystems with high environmental service values. Meanwhile, natural forests in Viet Nam are mostly poor forests with low forestry product supplying capacity. Under the circumstances, it is crucial to create a developed and equitable market for forest ecosystem services to compensate for the restoration and maintenance of tropical rain forests. The domestic market-promoting factors include the government's plan for ecosystem service fees to be paid by the customers such as hydropower plants, irrigation stations, clean water suppliers and ecotourism. Viet Nam can also tap into the international market of carbon sequestration under the CDM and REDD/REDD+ schemes in order to get financial resources for sustainable forest restoration and management. However, in order to join this market, it is necessary to have an open policy and qualified executive teams in both state management and business sectors (Pham et al. 2012; Pham et al. 2013; Phan 2014).

Besides, other marketing factors could significantly influence natural forest restoration and sustainable management in the near future. They include:

- The forest ecosystem service prices are acceptable in the market (by buyers and sellers) and they are reasonably attractive to maintain and develop natural forests;
- The demand on Viet Nam's furniture exporting markets and competitive capacity compared to other countries: If Viet Nam's wood-processing industry keeps gaining strength, it will be reliant on imported wood which will increase in cost and fail to bring about added value domestically. This will add pressure to the development of natural forests in the country.
- Demands and prices of products from cash crops (rubber, coffee beans etc.): A few years ago, the demand for rubber and coffee increased and the prices soared, which resulted in opening more forest land for their cultivation, with the tacit acceptance of some local government agencies.

5.4 Formulating approaches for equitable societal benefits

At present, most of the major forest owners in Viet Nam are state-owned bodies, including state forestry companies and the forest management boards of protection and conservation forests. These entities hold the largest areas of natural forests with high standing volume, lands that are good for production plantation, with accessible infrastructure and easy to approach capital sources, including preferential capital sources. But the state-owned forestry companies are loss-making agencies, while the natural resources managed by them are still degraded (de Jong et al. 2006; Sikor and To 2011). Poor governance and restrictions by forestry management policies and forestry enterprises (for example, no permission to make a company's own forest harvesting plans, or issuance of logging quotas for companies even with approved forest management plans) prevent those companies from growing and contributing to the forestry sector.

Despite the community being recognized as a forest manager and being allocated forests and forest land for management, local communities have not been given the full legal rights of forest managers for effective management. Moreover, allocated community forests are mostly poor and severely degraded and need a long time to recover before harvesting, making it difficult to persuade them positively to join in forest restoration and management activities.

Households are often given small forestry land plots, mainly for production plantation. With income from payments for natural forest ecosystem services remaining unattractive, commercial forest plantations offer the best financial options. Moreover, it is often difficult for small households to approach preferential capital sources for forest plantation.

Furthermore, it is popular for most private forestry businesses to operate on a small scale (typically from 30-500 ha bought from other individual households whose land was assigned or leased by the state), which forces them to do business with short-term forest plantations with rapid cash flow and profit.

Therefore, development of policies to guarantee equality among forestry managers in order to ensure fair competition and rights to access available resources would contribute to the sustainable development of the forestry sector and forest restoration. State forestry companies are managing large areas of land – a precious resource in Viet Nam – and the government is cautious in privatization of these businesses. To increase the effectiveness of state-owned business governance and thus increase sustainable forest management, equitization of forestry enterprises is needed.

In addition, large areas of natural protection forests are managed by households under contracts with state companies and forest protection management boards. An appropriate payment policy would contribute to improvement of forest quality as well as reduce illegal logging and forest degradation (de Jong et al. 2006; Tran et al. 2006).

5.5 National strategy for forest and landscape restoration

After two national afforestation and forest restoration programmes, Program 327 and the Five Million Hectares Project 661, Viet Nam is still pursuing the Forest Protection and Development Plan (FPDP) for the period 2011-2020. This plan focuses on increasing forest quality and value added to the forestry sector, and also continues efforts on restoration of degraded natural forests by promoting regeneration (VNFOREST 2011; GoV 2012). The major targets of this national plan are listed below (GoV 2012):

Planning targets by 2020:

- Increasing forest coverage by up to 44-45 percent of Viet Nam's land cover;
- Restoration of 750 000 ha of forest (mainly protection and conservation natural forests);
- Afforestation and reforestation of 2 600 000 ha, of which protection and conservation forests account for 250 000 ha, production and afforestation areas account for 1 000 000 ha and reforestation after harvesting at about 1 350 000 ha;
- Reclamation of 350 000 ha of degraded natural forest;
- Forest cover increase to 15 100 000 ha;
- Planting 500 million scattered trees;
- Improving the quality of natural forests, with increase of 25 percent in the productivity of production plantations by 2020 from that of 2011.

Plan from 2011 to 2015:

- Afforestation and reforestation of 1 250 000 ha, of which 150 000 ha are protection and conservation forests (30 000 ha per year on average); 500 000 ha of afforestation of production forest (100 000 ha per year on average) and reforestation after harvesting of 600 000 ha (120 000 ha per year on average);
- Restoration of 550 000 ha;
- Reclamation of 150 000 ha of degraded natural forests (an average of 30 000 ha per year);
- Planting 250 million scattered trees (an average of 50 million trees per year);
- Improve the quality of the natural forest by increasing productivity of production plantations by 10 percent in 2015 compared to that in 2011.

The government has proposed nine solutions for successful implementation of the FPDP: (i) promotion and awareness raising; (ii) management and planning of forest land; (iii) forest protection; (iv) forest land and forest allocation and leasing; (v) science, technology and forestry extension; (vi) international cooperation; (vii) markets; (viii) development and implementation of subplan projects; and (ix) capital demand and capital-raising policy.

The government has also decided to use existing good policies and propose new ones to designate the legal framework for the FPDP from 2011 to 2020. Under the decision of the Prime Minister, with the promulgation of this programme and other related policies, MARD approved the Plan for Restructuring of Vietnam's Forestry Sector in order to reach the overall objectives of the national FPDP (GoV 2012; MARD 2013).

The forestry sector also continues to apply effective policies for conserving and developing forest resources such as: (i) the policy for investing in forest development under Project 661; (ii) the policy to provide food subsidies for mountain dwellers in order to reduce and avoid shifting cultivation and deforestation; and (iii) the policy for encouraging businesses to invest in agriculture and rural areas.

The government also plans to amend and develop policies on: (i) forest protection; (ii) forest management; (iii) forest land allocation and leasing; and (iv) credit provision.

The FPDP has also set objectives for new policy development. These are new points for more open views of the government on the protection and management of forest resources. This plan emphasizes some possible renovations in forestry sector management in the near future, including: (i) to allow all economic sectors to protect, develop and use protection forests properly; (ii) to eliminate quotas for timber logging and manage forest owners by their approved forest management plans; (iii) to implement forest co-management to share the responsibilities and benefits of forest management with local communities; and (iv) equitization of State Forest Enterprises to increase governance and business effectiveness (GoV 2012; MARD 2013).

The government's planned total capital needed for implementation of the FPDP is about VND49 trillion (US$2.4 billion), of which the state budget is about VND14 trillion (US$700 million), which is about 29 percent of the total fund. The state budget is mainly for restoration and management of protection and special-use forests.

Some comments on the FPDP:

In general, targets set in the FPDP are not ambitious, thus Viet Nam's forestry sector can easily fulfil the plan. If Viet Nam continues to maintain economic growth and the market demand for woodchips and furniture does not decline, afforestation and reforestation are feasible targets. The forest restoration objective is feasible as it is a cheap and easy technical solution. Improving plantation productivity by 10 percent in 2020 compared with that in 2011 can be achieved by improved genetic seed sources, better silvicultural practices and increasing the investment capacity of forest owners, including small-scale holders. However the target for improving the natural production forest productivity and quality seems difficult, for instance the target to increase commercial timber volume accounts to 75 percent of standing volume of the natural forest is questionable.

Monitoring and evaluating the implementation of the FPDP are not detailed in Decision No. 57/QD-TTg dated January 2012 by the Prime Minister and Decision No. 1565/QD-BNN-TCLN by MARD. However, it is recognized that reporting, monitoring and evaluation of activities and projects under the Plan of Protection and Development Forests for the period 2011-2020 will be similar to those of other government forestry programmes and projects, i.e. Project 661, the Five Million Hectares Reforestation Project. Regulations on reporting, monitoring and evaluating government programmes are often very strict. However, execution effectiveness of these regulations is still an open question.

The public media recently made a positive impact in improving people's awareness about the values of forests and the roles of good forest management and protection. Public media have kept people well informed of the consequences of upstream deforestation which has resulted in severe floods downstream. Thus, people are familiar with the negative impacts of deforestation. However, it is recognized that deforestation, slash-and-burn agriculture and conversion to short-term industrial species are a major cause, with high impact on people's livelihoods.

In general, following previous forest rehabilitation successes, the Vietnamese Government continues to pay much attention to restoring and enhancing the value of forest ecosystems via the FPDP for the time being. However, natural forest restoration and maintenance have not been given appropriate attention to bring benefits to all stakeholders. Moreover, forest landscape restoration has not been mentioned in legal documents relating to forestry and forest ecology and rarely introduced in scientific and technical documents so far. In the context of global forest values, particularly tropical rain forests, with increasing focus on ecological and environmental aspects, forest and landscape restoration and sustainable management are more important than ever. Forest and landscape restoration can create livelihoods and sustainable development for people through ecosystem services and conventional forestry products.

References

Castrén, T. 1999. *Timber trade and wood flow study, Vietnam.* Regional Environmental Technical Assistance 5771 Poverty Reduction and Environmental Management in Remote Greater Mekong Subregion (GMS) Watersheds Project (Phase I) Asian Development Bank.

de Jong, W., Do, D.S. & Trieu, V.H. 2006. *Forest rehabilitation in Vietnam: histories, realities and future.* Bogor, CIFOR.

Dinh, D.T. 2005. *Forestry, poverty reduction and rural livelihoods in Vietnam.* Ha Noi, Vietnam, MARD.

Food and Agriculture Organization of the United Nations (FAO). 2006. *State of the world's forests 2005.* Rome, FAO.

FAO. 2010. *Global forest resources assessment 2010 - Vietnam country report.* Rome, FAO.

Forest Inventory and Planning Institution (FIPI). 2005. *Vietnam forest status.* Ha Noi, Vietnam, FIPI.

Government of Vietnam (GoV). 2012. Decision 57/QD-TTg on approval of the Forest Protection and Development Plan for the period 2011 - 2020. Ha Noi, Vietnam, GoV.

Government Committee. 1980. Decision 95-CP on "Policy for development of new economic areas".

General Statistical Office (GSO). 2011-2013. *The year books (2000 - 2012).* Ha Noi, Vietnam, GSO.

GSO. 2014. *Forest area loss by fires.* Ha Noi, Vietnam, GSO.

Hawkins, S., Phuc, X.T., Pham, X.P., Pham, T.T., Nguyen, D.T., Chu, V.C., Brown, S., Robertson, S., Nguyen, V. & McNally, R. 2010. *Roots in the water: legal frameworks for mangrove PES in Vietnam.* Katoomba Group's Legal Initiative Country Study Series. Washington, DC, Forest Trends.

Hoang, M., Do, T.H., Van Noordwijk, M., Pham, T.T., Palm, M., To, X.P., Doan, D., Nguyen, T.X. & Hoang, T.V.A. 2010. *An assessment of options for reducing emissions from all land uses in Vietnam: ready for REDD*. Nairobi, ASB Partnership for the Tropical Forest Margins. 85p.

Lamb, D. 2010. *Regreening the bare hills: tropical forest restoration in the Asia-Pacific region.* Springer.

Lamb, D. & Gilmour, D. 2003. *Rehabilitation and restoration of degraded forests.* Gland, IUCN/WWF.

Ministry of Agriculture and Rural Development (MARD). 1998. Decision 175/QĐ/BNN-KHCN on promulgating "General outline of technical procedures on forest restoration by promoting natural regeneration combined with enrichment planting". Ha Noi, Vietnam, MARD.

MARD. 2006. *Vietnam forest development strategy 2006 - 2020.* Ha Noi, Vietnam, MARD.

MARD. 2007. *Project of forest allocation and lease for the period of 2007-2010.* Ha Noi, Vietnam, MARD.

MARD. 2008. *Instructions for planting rubber on forestry land.* Ha Noi, Vietnam, MARD.

MARD. 2011. *Report on summary of 5 Million Hectare Afforestation Project and Planning on forest protection and development for 2011-2012.* Ha Noi, Vietnam, MARD.

MARD. 2013. Decision 1565/QĐ-BNN-TCLN on approving the "Forestry Sector Reform Proposal". Ha Noi, Vietnam, MARD.

Meyfroidt, P. & Lambin, E.F. 2008. Forest transition in Vietnam and its environmental impacts. *Global Change Biology,* 14(6): 1319-1336.

Ministry of Forestry. 1993. Decision 200/QĐ-KT on issuing "Norm of silvicultural techniques for timber production and bamboo forests". Ha Noi, Vietnam.

Ministry of Science and Technology. 2007. *Vietnam Red Data Book.* Ha Noi, Vietnam, Natural Science and Technology Publishing House.

Ministry of Science, Technology and Environment. 1998. *Vietnam state environment report 1998 – deforestation and forest degradation.*

Nguyen, H.N. 2007. *Forest rehabilitation in Vietnam. Keep Asia Green.* D.K. Lee, IUFRO. I - Southeast Asia.

Nguyen, Q. T. 2005. *What benefits and for whom? Effects of devolution of forest management in Dak Lak*. Vietnam, Shaker Verlag GmbH.

Pham, T.T., Bennett, K., Vu, T.P., Brunner, J., Le, N.D. & Nguyen, D.T. 2013. *Payments for forest environmental services in Vietnam: from policy to practice.* Bogor, Indonesia, CIFOR**.** 78p.

Pham, T.T., Moeliono, M., Nguyen, T.H., Nguyen, H.T. & Vu, T.H. 2012. *The context of REDD+ in Vietnam: Drivers, agents and institutions.* Bogor, Indonesia, CIFOR.

Phan, M.S. 2014. *Forest restoration in Vietnam - lessons learned from APFNET project and new approaches.* Agriculture and Rural Development Publishing House.

Phan, M.S., Lamb, D., Bonner, M. & Schmidt, S. 2013. Carbon sequestration and soil fertility of tropical tree plantations and secondary forest established on degraded land. *Plant and Soil,* 362(1-2): 187-200.

Phu Tho Sub-department of Forestry. 2010. Project document: *Demonstration of capacity building of forest restoration and sustainable forest management in Vietnam.* APFNet.

Phu Tho Sub-department of Forestry. 2013. *Final report of project "Demonstration of Capacity Building of Forest Restoration and Sustainable Forest Management in Vietnam".* APFNet.

Phung, T.B. & Le, V.C. 1994. *The effects of herbicides on vegetation in forest of South Viet Nam.* The 2nd International Symposium "Herbicides in War. The Long-term Effects on Man and Nature". Ha Noi.

PreventionWeb. 2014. *Viet Nam - disaster statistics* (available at www.preventionweb.net/english/countries/statistics/?cid=190).

RECOFTC (The Center for People and Forests). 2014. *Vietnam's forestry reforms.*

Sikor, T. 1998. *Forest policy reform: from state to household forestry*. Stewards of Vietnam's upland forests. Research Network Report Number 10. M. Poffenberger, Asian Forestry Network**:** 118-138.

Sikor, T. & To, P.X. 2011. Illegal logging in Vietnam: Lam Tac (forest hijackers) in practice and talk. ***Society and Natural Resources,*** 24(7): 688-701.

Sist, P., Fimbel, R., Nasi, R., Sheil, D. & Chevallier, M-H. 2003. Towards sustainable management of mixed dipterocarp forests of South-east Asia: moving beyond minimum diameter cutting limits. ***Environmental Conservation,*** 30(04): 364-374.

Tran, V.C. 2006. Migration and tropical forests in the Central Highlands of Vietnam. ***In*** W. de Jong, T. P. Lye & K. Abe, eds. ***Migration and the social ecology of tropical forest.*** Kyoto, Kyoto University Press and Transpacific Press.

Vietnam News. 2013. *Power plants step up forest planting drive* (available at http://vietnamnews.vn/environment/252732/power-plants-step-up-forest-planting-drive.html).

VNFOREST. 2011. *Forest Protection and Development Plan for 2011 - 2020 period.* Ha Noi, Vietnam, Vietnam Administration of Forestry.

VNFOREST. 2013. *Forest status data 2012.* Ha Noi, Vietnam, Vietnam Administration of Forestry.

VNFOREST. 2014a. *Active prevention and controlling forest fires* (available at http://tongcuclamnghiep.gov.vn/default.aspx?com=AuflaNews&page=article&aid=1536&mtid=78).

VNFOREST. 2014b. *Report on payment for forest ecosystem services.* Ha Noi, Vietnam, Vietnam Administration of Forestry.

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