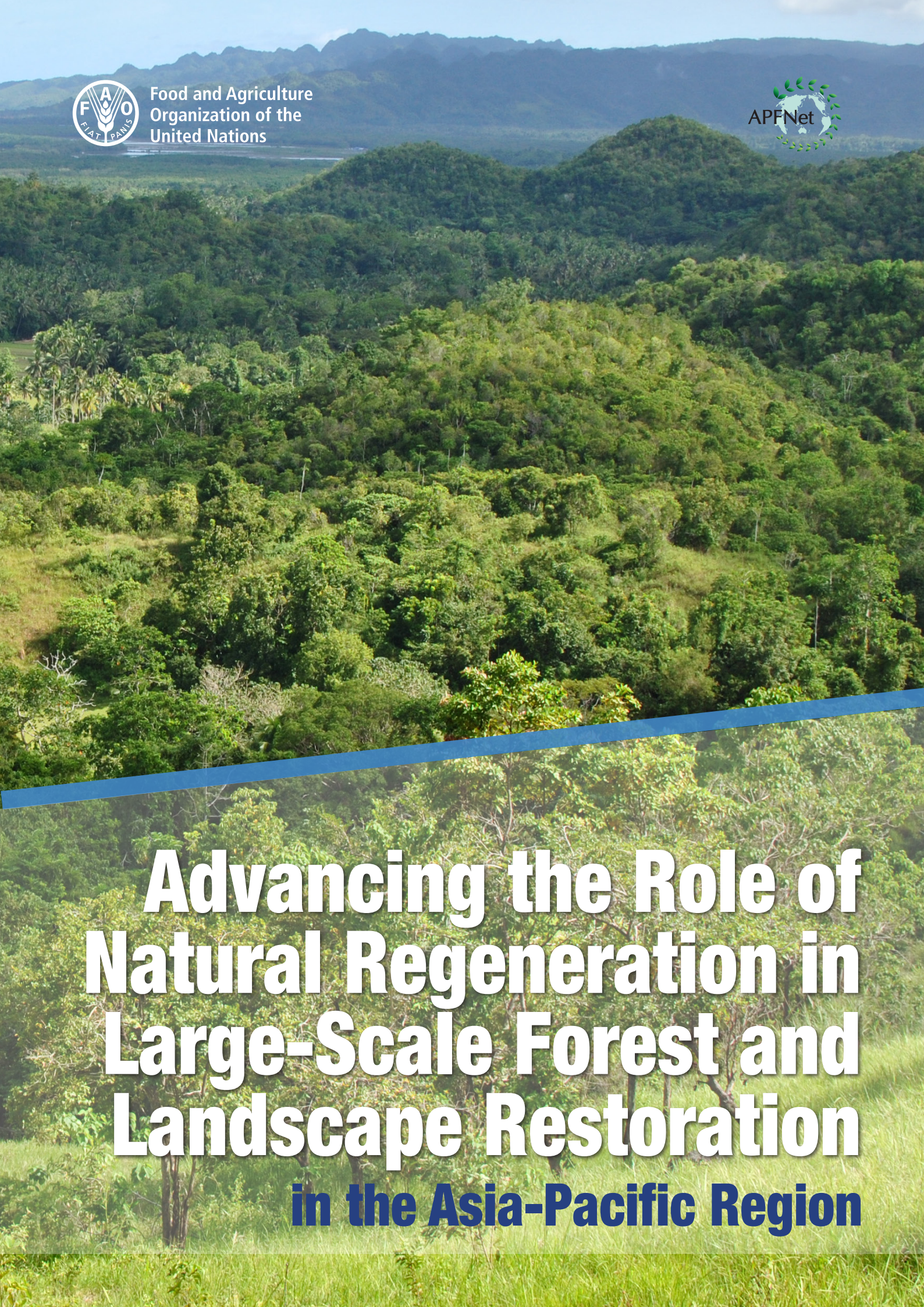

Food and Agriculture Organization of the United Nations

APFNet

Advancing the Role of Natural Regeneration in Large-Scale Forest and Landscape Restoration

in the Asia-Pacific Region

Advancing the Role of Natural Regeneration in Large-Scale Forest and Landscape Restoration in the Asia-Pacific Region

Proceedings of regional workshop
'Promoting the role of natural regeneration in large-scale forest and landscape restoration: challenges and opportunities'

19-21 June 2017, Nanning, Guangxi Province, China

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Acronyms and abbreviations

AFCC	ASEAN Multi-Sectoral Framework for Climate Change
AFoCo	ASEAN-Republic of Korea Forest Cooperation
AKECOP	ASEAN-Korea Environmental Cooperation Project
AMS	ASEAN Member States
ANR	Assisted Natural Regeneration
APAFRI	Asia Pacific Association of Forestry Research Institutions
APEC	Asia-Pacific Economic Cooperation
APFC	Asia-Pacific Forestry Commission
APFNet	Asia-Pacific Network for Sustainable Forest Management and Rehabilitation
APFORGEN	Asia Pacific Forest Genetic Resources Programme
ASEAN	Association of Southeast Asian Nations
ASFCC	ASEAN-Swiss partnership on Social Forestry and Climate Change
ASOF	ASEAN Senior Officials on Forestry
AVHRR	Advanced Very-High-Resolution Radiometer
AWG-SF	Association of Southeast Asian Nations Working Group on Social Forestry
CAF	Chinese Academy of Forestry
CBFMA	Community-Based Forest Management Agreement
CSR	Corporate Social Responsibility
DBH	Diameter at breast height
DENR	Department of Environment and Natural Resources
ECTF	Experimental Center of Tropical Forestry
FAO RAP	Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific
FLEGT	Forest Law Enforcement, Governance and Trade
FLR	Forest and Landscape Restoration (most cases), Forest Landscape Restoration (IUCN)
FLRM	Forest and Landscape Restoration Mechanism
FMB	Forest Management Bureau, DENR, Philippines
GCF	Green Climate Fund
GEF	Global Environment Facility
GPFLR	Global Partnership on Forest Landscape Restoration
ha	hectares
ICRAF	The World Agroforestry Centre
INREMP	Integrated Natural Resources and Environmental Management Program
IRR	Implementing Rules and Regulations
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
MODIS	Moderate-resolution Imaging Spectroradiometer
MSME	Micro-Small and Medium enterprises
MSS	Myanmar Selection System
NDC	Nationally Determined Contribution

NGO	Non-government organization
NWFP	Non-wood forest product
PES	Payments for ecosystem services
PFES	Payments for Forest Ecosystem Services
R&D	Research and Development
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, and fostering conservation, sustainable management of forests, and enhancement of forest carbon stocks
ROAM	Restoration Opportunities Assessment Methodology
SAP-SMED	ASEAN Strategic Action Plan on SME Development
SDG	Sustainable Development Goal
SMS	Selective Management System
VPA	Voluntary Partnership Agreement
WRI	World Resources Institute

Opening address

Patrick B. Durst

Senior Forestry Officer (retired),
FAO Regional Office for Asia and the Pacific,
Bangkok

It's a great pleasure for me to welcome you all to this workshop.

As my colleagues know well, I've been pushing for this workshop for many years. And, finally, as my last workshop to organize as an FAO staff member, it's really happening!

The reason I'm so keen on this workshop is that I believe the world's foresters have been greatly remiss in not giving adequate attention to the natural regeneration of forests. Fully 93 percent of the world's forests have come about through natural regeneration, and yet we spend almost all of our reforestation and forest regeneration attention and budget on plantations and planted trees. The fact that so many of the world's forests regenerate naturally is a testimony to the incredible resilience and potential of natural regrowth – imagine how much more success we could have if we gave more support to these processes!

Globally, the world is facing some tremendous challenges in natural resource management, not the least of which is the huge area of deforested and degraded lands that has resulted from mismanagement in the past.

On the positive side of things, there's been a surge of recognition in recent years that we can, and must do far more to address the sorry state of the world's degraded landscapes.

Internationally, the Bonn Challenge has set a global target for countries to restore 150 million hectares (ha) by 2020 and 350 million ha by 2030. Here in Asia, APEC has established an aspirational goal of increasing forest cover in the region by 20 million ha by 2020. And, as we will be discussing here in Nanning and again later this year at the 27th Session of the Asia-Pacific Forestry Commission in Sri Lanka, countries in Asia and the Pacific are looking to expand their efforts to restore forests under a regional strategy and action plan brokered by the regional forestry commission.

In addition to these international commitments, we increasingly see countries setting some very challenging targets for forest and landscape restoration. This is particularly important because this is where the real progress has to be made – at the country level and on the ground.

There are certainly plenty of degraded areas to address. The Global Partnership on Forest and Landscape Restoration estimates that there are some 2 billion hectares of degraded lands available for restoration globally. Here in the Asia-Pacific region alone, there's an estimated 400 million hectares that could be available for restoration – this is an area larger than all of India and Thailand combined.

With these kinds of scales involved, a major challenge is to identify viable cost-effective restoration approaches. Conventional reforestation and restoration can easily run to several thousand United States (US) dollars per hectare. If we take the Bonn Challenge seriously, we need to be restoring an average of at least 25 million hectares globally every year for the next 12 years. With conventional approaches, this means we'd be talking about expenditures of some US$25 billion per year up to perhaps US$100 billion or more per year. Given the current state of global finances, this is pretty unlikely. So, we need to get much smarter in our approaches and in identifying cost-effective measures to carry out large-scale restoration.

This is where natural regeneration presents us with great opportunities. I've been a huge fan of natural forest regeneration ever since my childhood. I grew up in the state of Wisconsin in the north-central part of the United States. Almost half of Wisconsin – which is about the size of Cambodia – is forested, and most of the other half is farmland. Almost all of the forest in the state is naturally regenerated with very little plantation. This is not just protected forest either; the state is a major producer of forest products, generating some US$25 billion worth of these outputs every year. One of the things that helps to sustain the forest sector is that most farmers and forest managers learned long ago the value of controlling livestock grazing and fire to enhance natural regeneration of forests and woodlots.

These are some of the same principles we're now applying in the tropics with 'assisted natural regeneration' (ANR), which emphasizes protection of naturally-occurring seedlings and root stock against fire, invasive weeds and uncontrolled livestock grazing.

The results have been highly encouraging. FAO-supported projects working with ANR in Cambodia, Indonesia, Lao PDR, the Philippines and Thailand have shown that we can reforest even highly degraded sites at roughly half the cost of conventional reforestation approaches. ANR has the added benefit of resulting in diverse forests, comprised of native species that are well adapted to the site. So, we get healthier and more biologically-rich forests, at lower costs.

So why are we not doing more of it? Part of the reason is lack of awareness. High-level policy-makers, in particular, often have little or no awareness of the potential for enhancing natural processes to regenerate forests. Too many policy-makers unfortunately have developed beliefs that the only way to reforest an area is to plant seedlings.

Beyond building awareness, we need to establish supportive policies and mechanisms and provide incentives for people to use natural regeneration. We need to develop simple and effective monitoring systems to verify regeneration progress. And perhaps most importantly, we need to engage local people in forest regeneration – not as just a source of cheap labour, but as real partners who will get a major share of the benefits resulting from their efforts.

These are some of the many things we'll be talking about in this workshop over the next couple of days. FAO is very happy to organize this workshop to advance these concepts and approaches in the region.

I would like to conclude by expressing my sincere appreciation to APFNet for working closely with FAO in co-organizing this meeting. The collaboration with APFNet has been outstanding and we're very grateful to have such an excellent partner in the region.

I would also like to acknowledge the support of several other organizations that have helped with this workshop: APAFRI, APFORGEN, Bioversity International, IUCN, RECOFTC and the WRI. We're also very grateful to the Guanxi Forestry Administration for providing excellent local support, especially for tomorrow's field trip.

Personally, I'm very much looking forward to this event. We have an impressive array of presenters and topics to address and I hope all of you find the discussions productive, enjoyable and rewarding. Thank you very much.

Opening remarks

Lu De

Executive Director,
Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet)

First of all, on behalf of APFNet, I welcome you all. You have travelled a long way to Nanning to participate in this workshop, which APFNet is honoured to jointly organize with FAO. I would also like to take this opportunity to thank the Forestry Department of Guangxi Autonomous Region and the Experimental Center of Tropical Forestry of the Chinese Academy of Forestry for their support with the local arrangements. APFNet as a regional organization set up under APEC promotes the rehabilitation of degraded forests in the Asia-Pacific region by means of demonstration projects, policy dialogue, capacity development and information sharing. Of course, natural regeneration is a very important means of rehabilitation and I fully agree with Mr Patrick Durst on the importance of natural regeneration for promoting sustainable forest management (SFM). In terms of the implementation of natural regeneration in practice, I would like emphasize three key words which are: WHEN, WHERE and WHY.

WHEN means to choose the right time to promote natural regeneration, otherwise it will not be effective. For example, it was not possible for China to apply natural regeneration in the past as the forest sector was facing two major challenges: namely low forest cover and a shortage of timber. The main priorities were therefore to increase forest cover and the production of timber by establishing plantations on a large scale.

WHERE emphasizes where the natural regeneration approach is applied. In other words, is it being applied in state-owned forest or in private forest, as the two can have very different requirements and demands.

WHY means what kinds of benefits are expected by the owners of forests from natural regeneration in the short and long term. In the Asia-Pacific region, most economies are developing and are faced with degradation of their forests. Large populations live in forested areas and depend heavily on the forests to sustain their livelihoods. Forest communities are keen to see short-term returns from the forests they manage. They cannot wait for 30 to 50 years for economic returns from natural regeneration of less-used tree species, so they strongly prioritize the planting of rare and high-value fast-growing species. This means that the application of natural regeneration should balance the returns between short- and long-term needs, especially regarding the livelihoods of local communities.

I hope that these three key words – WHEN, WHERE and WHY – can provide useful checks in your discussions over the course of this workshop. Finally, I wish this workshop success and hope that you have fruitful discussions, an enjoyable field trip and a good stay in Nanning. Thank you.

Welcome remarks

Lu Zhixing

Deputy Director-General,
Guangxi Forestry Administration

First of all, on behalf of the Guangxi Forestry Bureau, I would like to extend my warm congratulations to this workshop on natural regeneration held in the Green City Nanning, and to extend a warm welcome and heartfelt thanks to all the experts and participants!

The Guangxi Zhuang Autonomous Region is located in the southwest of China, near the northern part of South Bay, facing Southeast Asia. It occupies an important position in economic exchanges between China and Southeast Asia. Currently, Guangxi is promoting opening up and development of its economy, and is striving to build the ASEAN International Channel, to form an important gateway to the twenty-first century Maritime Silk Road and Silk Road Economic Belt.

Guangxi is located in the subtropical zone and is rich in forest resources. It is well known for its green mountains, clear water and beautiful scenery.

At present, the total forest area of Guangxi is 14.8 million hectares and forests cover 62.28 percent of the province. Guangxi is the top timber-producing province in China, with timber production reaching about 29 million cubic metres and accounting for 44 percent of the timber production in the country. In this context, forestry has made a significant contribution to maintaining China's timber security.

For a long time, in order to produce more timber, large areas of clear-cut forest land in Guangxi were burned and artificially planted with single species monocultures. Now we need to think about how to promote natural regeneration and close-to-nature forest management to balance economic and ecological benefits because promoting natural regeneration and the harmonious development of humans and nature is the common mission of foresters. Through this workshop, we hope that we can share our successful experiences so far in this context and we welcome your valuable comments on our forestry work.

Finally, I wish the workshop complete success, and wish you all good health and success in your work. If time permits, I would like to suggest that you to go sightseeing after the workshop to witness the natural scenery of Guangxi. Thank you.

1

Introduction

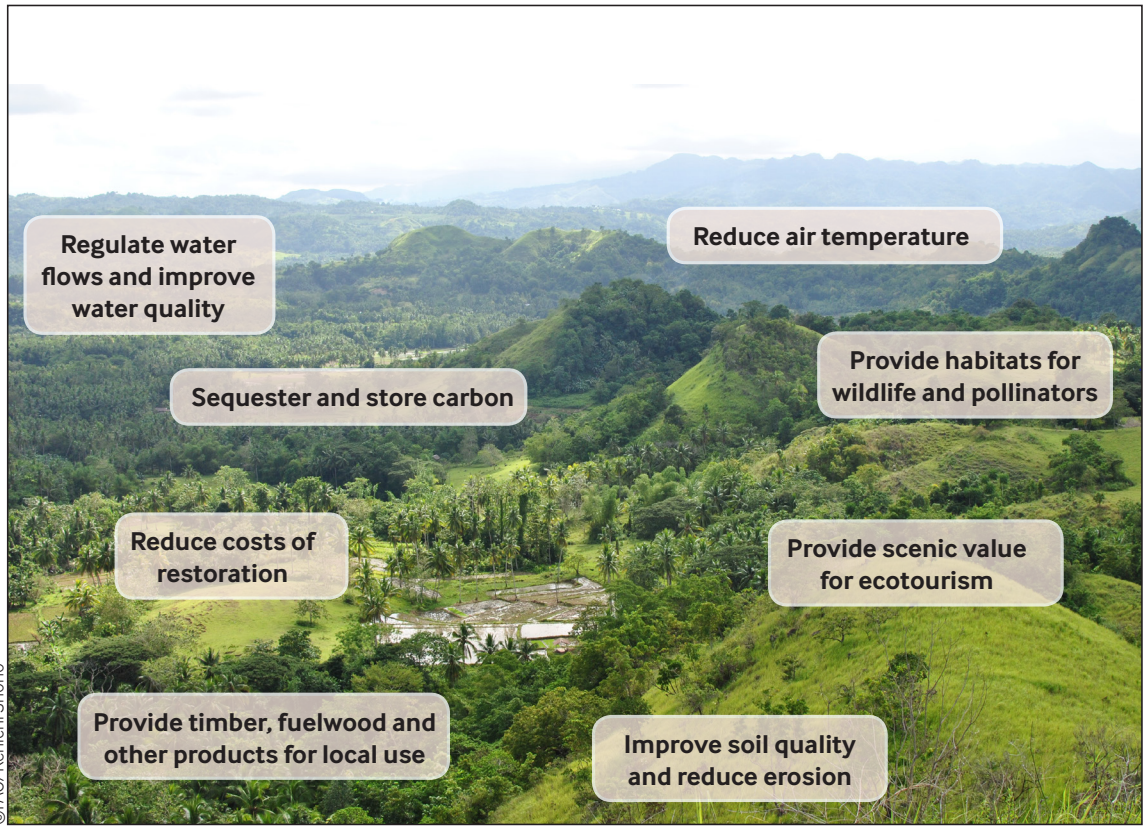
There are numerous global, regional, national and even subnational targets for increasing forest area and forest restoration. At the global level, these include the Bonn Challenge, the Aichi Target 15 of the Convention on Biological Diversity, the New York Declaration on Forests and Target 15.3 of the Sustainable Development Goals (SDGs). In the Asian region, APEC has adopted an aspirational goal of increasing forest cover in the region by at least 20 million hectares by 2020, and the Strategic Plan of Action for ASEAN Cooperation on Forestry (2016-2025) includes 'Increase of Forest Resource Base' within its Action Programme. Furthermore, nationally determined contributions (NDCs) under the Paris Agreement include increase in forest cover for many Asia-Pacific countries.

In light of these global targets and emerging ambitious national commitments, it is imperative to develop low-cost strategies and techniques for landscape restoration. The most widely used restoration strategies involving planting of tree seedlings are often costly and their application for restoring vast expanses of degraded forest lands in the region may be limited.

Case studies and experiences with natural regeneration from the region have shown that natural regeneration significantly reduces the cost of restoration in areas that meet certain conditions. Native species that are adapted to the prevailing conditions re-establish on their own with some assistance, achieving accelerated growth in accordance with natural succession, leading to the recovery of native ecosystems. Restoration strategies based on natural regeneration also provide low-cost opportunities for conserving biodiversity and enhancing ecosystem services, including carbon sequestration and watershed protection (Figure 1).

Despite these economic and environmental advantages, natural regeneration is often overlooked when restoration policies and programmes are designed for a number of reasons. These include lack of its recognition as a viable restoration option; perverse incentives favouring clearing of young secondary growth for plantation development or other land uses; lack of institutional support by government agencies and other organizations; unclear tenure and property rights; lack of incentives for local communities; and uncertainty about the restoration processes and outcomes.

Figure 1. Natural regeneration can provide a wide range of forest products and ecosystem services that provide local to global benefits



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Regional workshop

A regional workshop was organized to better understand the challenges and opportunities for natural forest regeneration and to promote its inclusion as a major component of large-scale restoration initiatives. The workshop, entitled 'Promoting the Role of Natural Regeneration in Large-scale Forest and Landscape Restoration: Challenges and Opportunities, was held in Nanning, Guangxi Province, China, from 19 to 21 June 2017.

The specific objectives of the workshop were:

1. Raise awareness among policy-makers and practitioners regarding the potential of natural generation in contributing to the achievement of forest restoration goals;
2. Share experience in and scope for using natural regeneration as a tool for forest restoration;
3. Discuss key issues related to restoring forest lands through natural regeneration, including: the ecological techniques and monitoring of regeneration; enabling policy, regulatory and institutional frameworks; and the economic and social dimensions of natural regeneration;
4. Identify barriers, gaps and opportunities for mainstreaming the application of natural regeneration as a viable and effective strategy in forest restoration; and
5. Develop recommendations on the way forward to promote the use of natural regeneration in regional and national restoration initiatives.

The workshop was organized by FAO RAP and the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet) in partnership with the Asia-Pacific Association of Forestry Research Institutions (APAFRI), the Asia Pacific Forest Genetic Resources Programme (APFORGEN), Bioversity International, the International Union for Conservation of Nature (IUCN), RECOFTC – The Center for People and Forests, and the World Resources Institute (WRI). The Experimental Center of Tropical Forestry (ECTF) in Pingxiang, Guangxi Zhuang Autonomous Region, helped to organize the field trip and make local arrangements.

Box 1. What is natural regeneration and what are its benefits?

Natural regeneration is called by many different names: fallow vegetation, secondary forest, succession, passive restoration, regrowth, scrubland and so forth. The same process underlies these terms: following deforestation, logging, non-forest land use or natural disturbances, new forest cover can emerge – spontaneously or with human assistance – from the ecological memory of the prior forest ecosystem and the surrounding landscape.

Natural regeneration is a biological process that can be assisted and managed to increase forest cover and achieve the recovery of the native ecosystem or some of its functions. Ecological restoration relies on natural regeneration processes for achieving forest ecosystem recovery. Natural regeneration can also be a component of forest and landscape restoration, among other types of interventions.

In addition to enhancing resilience and supplying multiple forest products and ecosystem services, natural regeneration can be highly effective for recovering local biodiversity, species interactions and movement within landscapes. During natural regeneration, local biodiversity is enriched by:

- Natural establishment of trees and shrubs from seeds, root sprouts, stumps, or coppices;
- Regeneration of local genetic resources adapted to local soil and climate conditions; and
- Associated pollinators, herbivores and seed dispersal agents of colonizing trees.

Many of these benefits can also be achieved using direct seeding and tree-planting approaches, but at significantly higher costs. In tropical regions, spontaneous and assisted natural regeneration are more effective than tree planting at achieving the recovery of biodiversity and forest structure. Given these advantages, prioritizing natural regeneration in suitable areas allows limited funds, labour and seed resources to be more effectively allocated for tree seeding or planting interventions in areas where they are critically needed for restoring forest cover and supporting local livelihoods.

Adapted from **Chazdon, R.L., Bodin, B., Guariguata, M., Lamb, D., Walder, B., Chokkalingam, U. & Shono, K.** 2017. *Partnering with nature: The case for natural regeneration in forest and landscape restoration.* Montreal, Canada, FERI Policy Brief. Available at www.feri-biodiversity.org/resources

Process and outcomes

A total of 56 participants from across the Asian region and beyond attended the workshop. They included forestry officials from nine Asian countries, scientific experts and practitioners, and representatives of the main agencies involved in forest and landscape restoration (FLR) in the region.

The workshop covered the entire range of topics relevant to promoting natural regeneration in FLR including key ecological aspects, economic and social aspects, planning and monitoring tools, the enabling environment and country case studies. A summary session facilitated synthesis of all the ideas discussed over the three days and outlined next steps to move forward.

The workshop provided a very enriching and valuable sharing of information and experiences across disciplines, countries and backgrounds. A one-day field trip to close-to-nature forest management sites, interactive exercises and informal discussions allowed further exchange of views.

Workshop participants

2

Opening session

The workshop was opened by Mr Patrick Durst, Senior Forestry Officer of FAO RAP; Mr Lu De, Executive Director of APFNet; and local host Mr Lu Zhixing, Deputy Director-General of the Guangxi Forestry Administration. Mr Durst stressed the need to strengthen the role of natural regeneration in national and regional forest restoration initiatives in order to meet the emerging scaled-up targets. Mr Lu De agreed on the importance of natural regeneration and highlighted the need to determine when, where and why it is most appropriate. Mr Lu Zhixing informed the audience about the importance of forestry to Guangxi as China's largest timber-producing province. He commented on the rising importance of promoting natural regeneration and close-to-nature forest management to balance economic and ecological benefits.

The opening remarks were followed by a keynote address delivered by Mr David Lamb, forest restoration expert and Honorary Professor of the University of Queensland, Australia. He spoke about the growing global interest in undertaking large-scale forest restoration at present, driven by reduction in forest cover and quality, and the large expanses of degraded lands that have resulted with associated negative environmental implications. The global restoration target based on the Bonn Challenge is to reforest 350 million hectares in the next 13 years, by 2030. To put this into perspective, in the last 100 years, 291 million hectares of forest plantations were established. Restoration through planting is resource intensive, and may not achieve desired ecological service objectives. Natural regeneration is a promising cost-effective option. Lamb discussed further how natural regeneration could play an important role in large-scale FLR and ways to accelerate its development and increase its benefits. He outlined the key issues to be addressed in this regard – the need for evaluation on the scope for natural regeneration, planning, enabling policy, appropriate institutional support and research to fill in the information gaps on assisted natural regeneration (ANR).

Following the keynote address, Mr Chetan Kumar from IUCN delivered a summary of the recently-concluded Asia Bonn Challenge High-Level Roundtable Meeting held in South Sumatra in May 2017, which aimed to mobilize political action on FLR in the region.

Restoring the targeted 350 million hectares of degraded and deforested land by 2030 will also facilitate the meeting of domestic targets for food, water and other essentials. The Roundtable Meeting recognized the enormous potential for FLR in the region, acknowledged the four new pledges to the Bonn Challenge and identified priorities for moving forward.

The opening remarks, the keynote address and the overview of the Asia Bonn Challenge meeting set the stage for the rest of the workshop discussions, exploring the ecological, socio-economic, planning, monitoring, financial, institutional and political angles of promoting the role of natural regeneration in FLR.

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Firelines established in Bohol, the Philippines, as part of the FAO-supported initiative on FLR.

3

Key ecological aspects for successful natural regeneration in FLR

There are many opportunities for ANR, including for watershed protection, restoration of wildlife habitat and carbon sequestration. Making effective use of natural regeneration instead of relying on tree planting could help save 50-95 percent of the cost of forest restoration. Some of the savings could then be channeled to livelihood development efforts and planting of ecologically and/or socio-economically desirable tree species where appropriate.

Restoring forest through natural regeneration is only possible where seeds and seedlings are naturally available in sufficient quantities. Species composition of the natural regeneration, whether it meets the specific restoration objectives, also needs to be considered. Despite the enormous potential, the application of natural regeneration as a restoration method is hampered by limited knowledge and awareness about what 'sufficient' means for different objectives and site contexts.

The objectives of the first session of the workshop were: to take stock of the current status of knowledge on the ecology and technology of accelerating natural forest recovery; discuss indicators for identifying suitable areas for restoration through natural regeneration; and identify priorities for further ecological research and technical developments to help expand the use of the method for large-scale restoration.

'Natural regeneration', as a restoration method, is used here to refer both to: (i) the protection of naturally established tree regeneration through exclusion of threats such as fire and grazing; and (ii) the assistance of natural regeneration which includes more active measures such as suppression of weeds. The term 'regenerants' is used to refer to any naturally established woody species, including seedlings, saplings and coppicing tree stumps.

The session consisted of three presentations as follows:

- The ecology and technology of accelerating forest recovery;
- Implications of species biology and landscape characteristics on regeneration success and the establishment of diverse, resilient ecosystems; and
- Sustainable management of production tropical forests through advanced regeneration: some R&D highlights from Malaysia.

Key conclusions of the session

- ***Natural regeneration, if present in sufficient density, can restore forest cover on its own within a few years.*** As a general rule, in the humid tropics, 800 well-distributed natural seedlings per hectare should be sufficient to achieve canopy cover within three years. In seasonally dry tropics, the minimum seedling density required range from 1 600 per ha (to restore basic forest structure within five years) to 3 000 per ha (to initiate canopy closure within two years) without enrichment planting (see Elliott et al., Section 3.1). Such general guidelines should be communicated to practitioners to help improve restoration success.
- ***The number of regenerants alone is not an adequate indicator of ecological success in restoration.*** Natural regeneration may be low in species diversity resulting in forest of poor species composition. Natural seedlings in the site may also lack genetic diversity, which directly affects their growth rate, resistance to pests and diseases, and future reproduction potential. The level of genetic diversity in seedlings can be assessed by studying the density of seed trees per species and pollination and seed dispersal mechanisms. Relatively simple ways to enhance genetic diversity exist, and there is a need to raise practitioners' awareness about them (see Jalonen et al., Section 3.2).
- ***When selecting restoration methods, attention should be paid to differences in species' biology and the ways they respond to their environment.*** More information is needed about the regeneration ecology of different species and vulnerability to genetic erosion, which affect the regeneration success of particular species and consequently species composition. Restoration methods need to be adapted depending on the site conditions and objectives, and the use of complementary methods such as enrichment planting should be considered where appropriate.
- ***Impacts of climate change on regeneration are commonly overlooked in restoration planning.*** Species' ecophysiological responses to environmental change should be further studied to guide the selection of restoration methods as well as the selection of species and seed sources where enrichment planting is needed to enhance the number and/or diversity of seedlings.
- Many participants shared the observation that ***tree planting is widely used for ecological restoration even when existing natural regeneration could achieve the restoration objectives.*** Awareness needs to be created among restoration practitioners, policy-makers and donors about the effectiveness of natural regeneration as a restoration method. This can help to save valuable financial, labor and seed resources for restoring other critical ecosystems where tree planting is indeed necessary.

Box 2. Discussion points for using natural regeneration as a restoration method

Workshop participants shared their experiences and knowledge on diverse technical topics related to using natural regeneration as a restoration method. Some of the topics discussed by the participants are listed below:

How to restore specific systems such as postmining sites or grasslands through natural regeneration?

Guidelines and illustrative sharing of good practices in ex-mining rehabilitation can be found on the Internet. The Centre for Mined Land Rehabilitation within the University of Queensland has some experience in mine site rehabilitation, especially in tropical areas, including Asia (www.cml.uq.edu). For natural regeneration models that target grassland ecosystems, Blakesley and Buckley (2016) and FAO (2010) may be useful.

How to deal with excessive wildlings/natural regenerants in the forest area?

Excessive wildlings/natural regenerants in the forest area can be managed by thinning to leave appropriate densities of the more desirable species, or to allow rarer shade-tolerant species to establish and enhance the diversity of the natural regeneration.

How to cope with seed predation?

Seed predation and damage to young plants by browsing can be a major constraint to restoration efforts. Burying the seeds can reduce seed predation and seed treatment to accelerate germination can reduce the amount of time when seeds are susceptible to predation. With regard to seedling predation, most herbivorous insects prefer a very limited number of plant species and scattering the seedlings would help to reduce the chances of concentrated herbivory.

How will climate change affect natural regeneration?

Climate change will affect forest ecosystems in general, including natural regeneration. Impacts could include changes in weather patterns, threats from invasive species, changes in species composition, shifts in phenology (timing of flowering and fruiting), changes in the life cycles of pollinators and seed dispersers, reduced flowering and fruiting, changes in seedling mortality, more severe/frequent fires and spread of certain weeds and pests. The exact nature of the impacts will likely be location-, ecosystem- and species-specific. The speed of climate change may be too fast for most tree species to adapt to the emerging growth conditions or to migrate to more suitable locations (Prober et al. 2015). Therefore, it may be necessary to introduce more diverse material, than what is locally available, for natural selection to work on.

How to improve capacities in restoring resilient, genetically diverse forests?

There is a set of training materials available on forest genetic resources for teachers, university lecturers and on-the-job training. The materials explain through practical case studies how genetic considerations affect issues such as conservation planning, forest management and seed sourcing. The materials are targeted at non-specialists and can also be used for self-learning. They are freely available from
http://forest-genetic-resources-training-guide.bioversityinternational.org/

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4

Tools for prioritization, decision-making and monitoring to enhance restoration success

The session was opened with brief remarks on the importance of restoration planning and monitoring. Comprehensive and inclusive planning would support effective implementation of restoration, including via natural regeneration. Meanwhile, restoration monitoring is needed for enhanced management and planning when moving forward, as well as for reporting to investors and better understanding of the potential for scaling up.

The opening remarks were followed by two presentations as detailed below:

- The Restoration Opportunities Assessment Methodology (ROAM): A planning and decision-support methodology for identifying forest landscape restoration opportunities and strategies; and
- Restoration monitoring versus deforestation monitoring.

The presentations were followed by an interactive session on ROAM's participatory mapping component to identify and prioritize FLR opportunities. Participants were divided into groups and each group was given a set of five transparencies, each showing different landscape elements (slope, land cover, forest reserves, rivers and a blank grid map with a legend). Each group worked to answer questions revolving around the priority restoration areas, objectives and approaches. In doing so, the participants were free to include physical, ecological, social and political considerations. Interestingly, most groups ended up with similar results and reasoning, especially with regard to where natural regeneration should occur.

Key conclusions of the session

- ***ROAM, a comprehensive and responsive framework, is available for FLR planning at present.*** It helps to identify restoration objectives, priority areas and appropriate strategies for these areas (including ANR) based on the conditions, objectives and resources available. The ROAM framework is adaptable, non-prescriptive, landscape-specific and manifests itself in a bottom-up approach.
- ***Stakeholder engagement and ownership is critical for sustaining any restoration effort.*** A participatory ROAM process provides the necessary local stakeholder with input and endorsement for the restoration strategies to adopt.
- ***There are important differences between monitoring deforestation and restoration that need to be taken into consideration*** to ensure that restoration monitoring is efficient and useful. The differences between the two can be summarized in brief as follows:

Deforestation	Restoration
Often a catastrophic one-time event	Mostly a slow process with subtle changes on the ground
Often measured on medium to large scale	Often dispersed in small plots
Monitoring by measuring area deforested (presence or absence of trees)	Monitoring needs to be impact-oriented, often with multiple goals (e.g. reduce soil erosion, improve biodiversity)

- ***The monitoring framework should be adapted to detect the small and slow pattern of restoration, and also contain different indicators and metrics*** to detect the achievement of specific restoration goals.
- ***High-resolution satellite data are needed*** to detect the small, slow, subtle, dispersed changes arising from restoration which significantly increase the resource requirements and costs. The situation has been ***recently alleviated by the development of Collect Earth and other crowdsourcing tools,*** which utilize high-resolution data and can be used by local people through relatively simple visual interpretation.

5

An enabling environment for natural regeneration in forest and landscape restoration

This session focused on the enabling environment for natural regeneration (and ANR) within FLR. The enabling environment includes the policy and legal frameworks and their implementation, clear tenure and rights for local communities, code(s) of practice for FLR in the field, the mandates and coordination of the government ministries and departments working directly and indirectly on issues related to FLR, and the procedures in place to facilitate effective participation of, for example, local communities, civil society organizations and the private sector.

The specific objectives of the session were:

1. Shared understanding of the necessary components of policy framework and governance for successful natural regeneration in FLR.
2. Determining a set of practical recommendations for supportive policies, regulations and institutions for FLR in the region.

The session drew on the findings and recommendations from the recently-concluded annual conference of the Association of Southeast Asian Nations Working Group on Social Forestry (AWG-SF) which focused on community forestry and FLR, as well as perspectives from the Philippines, Indonesia and Thailand.

A framework for assessing the enabling environment for effective FLR is currently being tested in Thailand. Many FLR challenges, including for promoting natural regeneration within FLR, are common to many countries in the region. The presentations and discussion echoed the findings of the AWG-SF conference, and the recommendations from the session also closely align with those from the AWG-SF conference (see Wilawan, Annex 3.3).

A panel discussion following the presentations probed for successful experiences with incentive mechanisms and livelihood options for promoting FLR and natural regeneration beyond cash. Panelists cited examples of sizeable income coming in from mushroom harvesting in community forest areas in Western Thailand; service contracts for seedling production, plantation establishment and maintenance in the Philippines; and agroforestry products as well as plantation timber in the long term in Indonesia. Non-economic incentives such as ecosystem services are also ingrained in FLR.

Restoration processes and outcomes can be quite different in different places depending on the specific circumstances. For example, Mae Chaem Province in Thailand had better results than Nan Province, due to Mae Chaem's proximity to the Chiang Mai markets for pakwan (*Sauropus androgynus*), bamboo shoots and other forest products, with communities obtaining tangible FLR benefits in two to three years. In Mae Chaem, 5 percent of the income enters a conservation fund to restore other forest areas, and the community was able to successfully negotiate for some land, which was to be designated as part of the national park, to be included in their community forestry area instead. The Nan area is at a higher elevation and protected, and people are not allowed to use it. The government is now exploring options to promote more diversified land use there through community forestry and agroforestry.

Key conclusions of the session

- In many cases, FLR implementation by the government is constrained by lack of human and financial resources, the extent of degraded state forest land and the lack of buy-in from local stakeholders. ***Strong and effective collaboration with local communities and other partners, with clear tenure and tangible benefits for local communities*** can incentivize collective action to support forest restoration efforts, including natural regeneration.
- A fundamental element for achieving sustainable land-use management, including natural regeneration within FLR is to ***place local communities at the heart of decision-making***, allowing them to understand the land-use options and decide on the restoration options, including the associated costs and benefits. Persistent problems such as expansion of agriculture, soil erosion and others stem from the non-involvement of local people.
- ***Emphasis on livelihood development is important***, including productivity of the forest and agricultural land, and connecting the communities to financial institutions at the central level. For local communities and other tenure holders, development of commercial enterprises and products is critical. This can include environmental products and services like water and carbon for naturally regenerated forests that could be valued and compensated through payments for ecosystem services (PES). Further, locally useful ecosystem services such as enhancement of local water supply, and prevention of soil erosion and landslides could also serve as useful incentives.
- ***Involvement of the private sector is significant*** in providing a stable market for local community products from restored forests. Additionally, ecotourism and other private sector enterprises that are compatible with forest conservation objectives can support natural regeneration and restoration of protected areas. The private sector's investment in such initiatives can be increased through appropriate policy support such as through tax rebates and loans.

- ***Creation of multistakeholder management bodies,*** such as the watershed management councils in the Philippines, can help address conflicting land-use interests at the landscape level and lead to more effective FLR.
- ***Adaptive planning, rather than setting binding targets, is more effective*** in responding to emerging challenges and opportunities. Having *access to information is important*, including for best restoration options (natural regeneration, ANR, plantations, agroforestry).
- ***A range of capacities is needed to ensure the success of restoration initiatives including natural regeneration.*** Lead agencies (governmental and non-governmental organizations) should have the capacity to engage with a wide range of stakeholders, facilitate the process, generate and disseminate the key data, and connect with the private sector within the landscape and beyond to bring in needed financial resources and commercialize products from the landscape.
- ***There is a need to overcome the disconnection between the policies and regulations and the realities on the ground.*** For example, laws and policies create challenges for securing tenure for local communities. Communities are reluctant to facilitate natural regeneration due to stringent laws on harvesting trees from natural forests (e.g. harvesting bans from natural forests) compared to forest plantations. This may be counterproductive in promoting the restoration of natural forests for multiple benefits over monoculture plantations. Some government agencies at the local level feel constrained to participate in such multisectoral initiatives due to the rigid working procedures of central government authorities, and limited space to partner with other sectors and stakeholders.

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Community leaders and government officials in West Sumatra Province, Indonesia, discussing ANR implementation for watershed protection and agroforestry development.

6

Synthesis of the country case studies on natural regeneration

Seven case studies from Cambodia, China, India, Indonesia, Myanmar, the Philippines and Viet Nam were presented. They covered material on natural regeneration and some reported on the use of natural regeneration in FLR programmes.

Common trends and challenges identified include: 1) a growing recognition of the significance of natural regeneration and its potential role in future national reforestation programmes; 2) considerable interest in moving from what might be referred to as passive natural regeneration towards more active forms of intervention that seek to accelerate the process of natural regeneration and enrich these new forests with economically attractive species; and 3) some negative views on natural regeneration, perceiving naturally regenerated forests as wasteland areas available for other purposes. It is evident that much still remains to be done to demonstrate the value of natural regeneration to convince land managers and decision-makers of the potential benefits.

The various country case studies reported on a number of other key challenges. One was on the ***need to devise new ways of protecting natural regeneration long enough*** for it to become fully established and capable of generating products and/or ecosystem services. Many presentations reported on approaches to excluding grazing or preventing fires, but the methods employed are often expensive and not always completely effective. Perhaps other methods of protection could be developed, such as community-based institutions to prevent uncontrolled logging, grazing and encroachment (e.g. techniques that the presentation from India referred to as 'social fencing').

A second challenge lies in ***increasing the capacity of managers to take advantage of natural regeneration where it occurs.*** Little is known about the specific conditions under which natural regeneration will be successful and how it might be assisted or enriched so that it can compete with other forms of reforestation such as planting.

A third challenge lies in finding ***ways to incorporate natural regeneration in FLR programmes.*** Natural regeneration may not always develop in the locations where restoration is most needed (e.g. sites critical to restoring ecosystem functioning) and this means that some areas will still need to be reforested by planting. Managers would need to decide where natural regeneration is of sufficient quality and spatial extent to be effective, and where enrichment planting with species of economic, functional or conservation significance is required. Many countries are researching various types of ANR but evidence concerning the long-term outcomes of these interventions is still uncertain.

A fourth challenge concerns the ***perceived costs of implementing ANR and the economic value of the resulting forests.*** As noted earlier, some people continue to view natural regeneration as being worthless and consider the opportunity cost of clearing it and replacing it with some other land use to be high. Others view natural regeneration as a cheap method of restoring forest cover over large areas to generate ecosystem services. There is very little comparable quantitative information across the region on the capacity of natural regeneration to provide economically valuable goods or ecosystem services, and on the potential to enhance such benefits.

Not surprisingly, future priorities differ in different countries. However, there appear to be several commonly recognized future tasks which include developing new policy incentives and coordination mechanisms to encourage natural regeneration, identifying areas with the potential for natural regeneration, increasing knowledge about the ecology and socio-economic benefits, establishing permanent monitoring plots, developing standards for measuring ANR progress and outcomes, and increasing the capacity of forestry agencies and land managers to manage these new forests.

7

Key economic and social aspects for successful integration of natural regeneration in FLR

The session comprised three presentations on some of the key socio-economic challenges and experiences for promoting natural regeneration in the larger landscape context. Forests are sources of wood, non-wood forest products (NWFPs) and ecosystem services that benefit society as a whole, and are especially important for rural livelihoods. FLR has been proposed as a way to counteract deforestation and reconcile the production of ecosystem services and goods with conservation and development goals. But there is limited evidence on how large-scale forest restoration could contribute to improving local livelihoods.

A review of the impacts of large-scale forest restoration on local livelihoods suggests mixed socio-economic effects on local livelihoods depending on other variables, such as availability of off-farm jobs, household characteristics, land productivity, land tenure and markets for forest products and ecosystem services. The second presentation explored the financial needs to achieve global FLR targets, as well as available data on costs and benefits of ANR. The session then heard the inspiring story of Mr Patrick Dugan's 30 years of working experience with ANR. He used examples from the Asia-Pacific region and underlined the importance of participatory planning and the need for integrating locally-suitable food crops as incentives for wider uptake of ANR among farmers.

An open discussion followed the presentations and explored the following key issues related to financing, livelihoods and choice of strategies:

At present, the main sources of financing for forest restoration are national budgets, donor funds and climate financing. Private sector investments are not substantial yet, but are growing in importance. A participant indicated that companies were generally averse to spending significant funds on ANR (e.g. weeding) and preferred to sponsor tree planting. It took him two years to convince private companies that naturally established trees were better than planted trees for their specific objectives. Another participant suggested that approaching companies with proposals to offset their carbon footprints through forest regeneration may be an effective strategy given the current focus on climate change issues. There are also substantial domestic budget allocations available for agriculture and forestry which could be directed to comprehensive landscape restoration programmes. The Green Climate Fund (GCF) and Global Environment Facility (GEF) are currently giving priority to landscape restoration and can be tapped to finance restoration efforts.

There was a discussion on farmers' needs for cash income beyond subsistence food crops that could be interplanted. Generating cash income requires the development of suitable imperishable products (such as spices) and access to these remote areas to take the products to market. Attention should be paid to three aspects: products (crop selection and product development responding to or creating demand), investments and infrastructure (provision of facilities such as storage and transportation). Species to be promoted in ANR are best decided based on discussion with local people and considering what already exists on the landscape. Economic returns, priority ecosystem services and available labour should all be considered in determining the appropriate restoration approach.

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Pressing of *Imperata cylindica* is a family affair in the Carood Watershed, the Philippines.

Key conclusions of the session

- The ***effects of large-scale restoration initiatives on local livelihoods may vary due to several factors*** and are still not clear for many situations; therefore, monitoring over time with clear indicators is needed.
- Substantial investments are required to restore the estimated 2 billion hectares of degraded landscapes across the globe. There are numerous possible funding sources for FLR at national to global levels, and different investors have different levels of risk tolerance and expect different types of returns. Beyond prevailing sources, ***private sector investments, domestic budgets for forestry and agriculture, and the GCF and GEF could be effectively tapped*** for financing forest restoration.
- Available data suggest that ***natural regeneration is a cost-effective option in multiple regions for preserving local biodiversity and for scaling up FLR efforts***, in particular in areas with a lack of both public and private investments. However, as with restoration through planting, achievement of natural regeneration requires years of sustained maintenance and protection from disturbances, and local community members are best placed to undertake such maintenance. Therefore, *enlisting the cooperation of local communities through participatory planning and implementation and providing appropriate socio-economic incentives are critical.*
- ***Evidence supporting ANR's cost-effectiveness, impacts and benefits are fragmented*** in all regions, with existing databases not being easily accessible, user-friendly or comparable. There is a strong need for harmonized cost-benefit analysis and comparable, transparent information on restoration financing to guide decision-makers in their strategic technical and financial choices at all scales.
- ***Natural regeneration is only one of the options among the range of possible FLR techniques.*** A mix of measures is generally required at the landscape level to address different restoration objectives, particularly in severely degraded landscapes with continuing anthropogenic drivers of forest degradation. It would also be important to consider the priorities of investors to fine-tune the strategy.

8

Synthesis of opportunities, constraints and next steps for advancing natural regeneration

Panel discussion

A panel discussion covered several key issues related to natural regeneration and FLR. Issues deliberated at length included generating government policy buy-in for the natural regeneration approaches, economic incentives and livelihoods for local communities to engage in ANR, and scaling up the efforts. Other issues discussed related to monitoring tools and guidance, developing viable business models to finance FLR, and better communicating and promoting awareness of the benefits of natural regeneration to investors and policy-makers.

Incentives and livelihoods for local communities

Tenure rights (at least tenure security if not outright ownership) and economic benefits for the communities need to be ensured for successful natural regeneration and long-term maintenance of the regenerated forests. It was argued that benefits for farmers should be an essential premise for promoting natural regeneration approaches, not just an ecological premise. ANR is cheap, simple and effective, farmers can implement it with little investment and training, and it can be applied over large areas without requiring huge amounts of government resources if farmers can be mobilized. A question was raised as to what incentives there were for farmers to conduct natural regeneration versus growing commercial tree species if they were given secure tenure.

Need for government policy buy-in for the natural regeneration approaches

There is a need to create incentives and mechanisms for government agencies, which are responsible for managing most forest lands in the region, to conduct and support natural regeneration as a key element of FLR. An important requirement is monitoring and tracking progress, and recognizing and incentivizing accomplishments. A participant argued that positioning natural regeneration as a 'cheap' approach could backfire as government agencies are keen on securing larger budgetary allocations, and forest plantation investments require larger budgets. Another participant called for finding ways to make government departments more accountable for preparing their budget estimates, proving the investment requirements and showing the outcomes in terms of desired products and ecosystem services. However, in ANR, the successional trajectory and resultant benefits could be difficult to predict.

Officials and other participants shared the experiences from their own countries with regard to inclusion and/or challenges for natural regeneration in their policies and programmes. The Government of Viet Nam has a specific policy to include natural regeneration in its restoration programmes, along with a complementary and supportive legal framework. Land has been allocated and incentives provided to farmers to carry out natural regeneration. There is a need to strengthen the enabling environment, including through provision of ecosystem service incentives, improving capacity for forest management, further assisting land-use planning and supporting regeneration techniques in community forest management.

In Thailand, fast-growing species are planted near national parks and once they are established and weedy species are suppressed, natural regeneration also establishes. In Cambodia's case, it is difficult for the Finance Ministry to allocate funds for natural regeneration given the lack of recognition for the same and the lack of clarity on how to monitor outcomes. A change in attitude and further data and information are required for Cambodia to encourage and integrate natural regeneration in the policy framework.

In the Philippines, there is political uncertainty as to whether the desire to restore open lands will continue beyond the current administration. There are vast areas of denuded land, and significant funds and efforts are being put into greening through conventional planting rather than natural regeneration. The Beijing Municipal Bureau of Forestry conducts mountain closure (which is one form of ANR) as well as forest health management, and a percentage of the available funds goes to local farmers for forest management activities based on the area involved. Now the Bureau is paying more attention to the promotion of natural regeneration because it is cheaper and supports restoration of a wider range of ecosystem services.

Attitudes and demands change and we need to adapt our approaches to forest restoration according to the changing circumstances. As seen during the field trip, there has been a change in the thinking of forestry officials in China, shifting from the establishment

of monoculture fir plantations for production to nurturing over 60 native tree species regenerating under the fir canopies. In this case, natural regeneration has changed from being a problem for timber producers to an opportunity to enhance the flow of ecosystem services. There is a transition towards harmonizing ecological resilience with economic returns, and from forest management for timber production to multipurpose management.

Scaling up the efforts and monitoring

Scaling up restoration efforts with a landscape perspective requires coordination, tools and capacity. The next steps should consider how to enhance coordination among the different key actors and to bring forest restoration issues up to national-level policy dialogue. A restoration movement could be created with the active participation of all key stakeholders to move towards common goals. Social network analysis could be done to identify champions who could catalyse such change. Working with youth through education programmes would help to influence the next generation.

Others pointed out that global FLR targets are very ambitious and that attention should be paid to qualitative targets based on context-specific objectives rather than purely quantitative goals. Clear criteria and indicators are required for what counts as success to facilitate planning, monitoring and adaptive management. Monitoring guidance being prepared by WRI, FAO and others will be ready shortly, which will help to address these monitoring issues.

Developing business models to pay for the complex diffuse mix of benefits from FLR

Developing business models for FLR (and ANR in particular) under which payments can be provided for the diverse mix of products and ecosystem services derived, is more complicated than developing business models for commercial forest plantations. The complex diffuse mix of FLR and ANR outputs and benefits may be difficult to measure and difficult to attribute directly to the inputs. Possible business propositions for forest restoration through ANR could be developed, for example based on carbon sequestration potential to offset the carbon footprint of companies, or watershed services for hydroelectric companies.

Communicating and promoting ANR

Foresters and restoration practitioners are not skilled at communicating their ideas to companies and other sectors. A few of the participants have had success convincing private investors to fund forest restoration activities, and these experiences could be built on. Site visits and time series of photographs or videos could potentially be used to demonstrate natural regeneration processes and potential positive outcomes to investors and policy-makers. Natural disasters in some countries have motivated governments to invest large sums in restoration efforts, and such opportunities should be harnessed to promote the role of natural regeneration wherever possible.

Opportunities, constraints and next steps

The opportunities, constraints and next steps identified from the workshop presentations and discussions for moving forward in promoting and scaling up natural regeneration efforts in the Asia-Pacific region are summarized below.

Opportunities

- There is growing recognition of the significance of natural regeneration and it has now been included in many national forest restoration programmes and strategies.
- Some excellent practical experience on natural regeneration is emerging from the region and beyond.
- ANR offers many benefits including habitat restoration, conservation of local biodiversity, climate change mitigation and provision of a range of products and services in a cost-effective manner. Forests restored through natural regeneration can also be enrichment planted with economically attractive species.
- There are relatively simple ways to enhance genetic diversity in restoration efforts, including ANR, and enhance ecological integrity and functions.
- New tools and technologies allow for more comprehensive and responsive FLR planning, including choice of restoration options, and make tracking of restoration and natural regeneration more practical.
- There is ample room for combining social forestry (in the many forms that are practised across the region) and FLR (including natural regeneration) to generate buy-in from the local people.
- Finding common ground and creating multistakeholder management bodies such as the watershed management councils in the Philippines can help to address conflicting land uses and interests at the landscape level.
- There are new financing opportunities emerging through private sector engagement and other investment partners, and governments are now allotting increased budgets for restoration – including, hopefully, for natural regeneration. Ecosystem services such as water regulation and carbon storage in naturally regenerated forests could be valued and compensated through PES schemes.
- There are good examples of private sector involvement helping to provide a stable market for local community products from enrichment planting or plantations in restored areas. The private sector could also help to naturally regenerate and manage protected areas while undertaking ecotourism and other enterprises that are compatible with forest conservation objectives.

Constraints

Perceptions and mindsets

- There is lack of awareness and recognition of the beneficial role that natural regeneration can play in large-scale forest restoration.
- Even when ANR is adopted as a tool for restoration, people very quickly shift back to planting trees, abandoning natural regeneration approaches.
- Naturally-regenerating areas tend to be viewed as unproductive wastelands without active management, and face the risk of being cleared and replaced by other land uses.

Research and information gaps

- There is a long way to go to achieve common understanding of definitions, approaches and monitoring protocols in relation to natural regeneration, even among experts and practitioners.
- There is considerable uncertainty on the successional trajectory and how to conduct ANR in different types of forests and sites to achieve the desired results.
- Information is limited on seed dispersal patterns and vulnerability to the genetic erosion of many species, which affect their regeneration success and consequently species composition of the restored forests.
- Evidence (long-term monitoring data) supporting ANR's cost-effectiveness, ecological and socio-economic impacts and benefits is limited and fragmented in all regions.
- There is a need to develop simple and effective monitoring systems to verify regeneration progress, which may be slow, subtle and dispersed.

Capacity gaps

- Lead agencies (government and non-government) involved in forest restoration tend to have inadequate capacity to make appropriate use of natural regeneration where it occurs, engage and link communities and the private sector, generate monitoring data and to facilitate the production and marketing of commercial products from restored forests.

Lack of enabling environments

- There is often poor governance and collaboration at the landscape level, local institutions are absent or ineffective in certain areas, and tenure rights of local communities tend to be unclear and weak.
- There is an unfavourable regulatory environment for natural regeneration. Planting generally implies ownership of trees while natural regeneration often does not. In many countries, there are more stringent laws and/or procedures on harvesting trees from natural forests compared to forest plantations.
- Governments, civil society organizations, farmers and other stakeholders have very different objectives related to natural regeneration, and the distribution of rights, benefits and responsibilities remains unclear.

Next steps

Creating awareness

- It is essential to communicate to and create awareness among restoration practitioners, policy-makers and donors about the effectiveness and potential of natural regeneration as a restoration method for scaling up restoration efforts, and that the effective use of natural regeneration can save valuable financial, labour and seed resources for restoring other critical ecosystems where tree planting is indeed necessary.

Filling research and information gaps

- There is a need to develop a set of guidance documents on assisting, accelerating and enriching natural regeneration to enable restoration practitioners to use the approach more widely.
- Similarly, to generate scientific evidence, data and models regarding the financial, ecological and socio-economic benefits of forest restoration through natural regeneration in different countries and scenarios to guide decision-makers and land managers in their strategic decisions.
- Permanent monitoring plots to improve scientific understanding on forest succession and for developing appropriate silvicultural management methods should be established.

Creating an enabling environment

- Develop new policy incentives, legal framework and coordination mechanisms to promote natural regeneration and equitable sharing of benefits arising from restored forests. This may include policies to strengthen tenure and harvesting rights, financial assistance and PES generated by the forests restored through natural regeneration, and coordination of different administrative units, sectors and stakeholders across the landscape.

Planning, implementing and monitoring

- Take stock of where the ROAM process has been implemented in the region, who else would be interested in applying it and who will support it.
- Build capacities of agencies and organizations involved in forest restoration to make effective use of natural regeneration as a tool for restoration, engage local communities and the private sector in such efforts, generate data and scientific knowledge, help address tenure issues and facilitate multistakeholder coordination for restoration at the landscape level.
- Identify financing opportunities for natural regeneration and help connect communities and other stakeholders to financial resources.
- Pilot forest and landscape restoration monitoring frameworks in the region, possibly integrated with the Bonn Challenge Barometer.
- Promote the use of crowdsourcing tools for restoration monitoring and use it in conjunction with capacity development of local people.

Annex 1. Keynote address

The role of natural regeneration in achieving global restoration goals – an Asia-Pacific perspective

David Lamb[1,2]

Introduction

There is growing global interest in undertaking large-scale forest restoration. This is to deal with the extensive areas of deforested and degraded lands that have now accumulated. The idea is being promoted by a number of international bodies and agencies (e.g. the United Nations Convention on Biodiversity, United Nations Convention to Combat Desertification and Asia Pacific Economic Forum). Goal 15 of the United Nations Sustainable Development Goals also aims to "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" www.un.org/sustainabledevelopment/sustainable-development-goals).

To achieve these outcomes several organizations have established the Bonn Challenge which has a goal of reforesting 350 million hectares by 2030 (www.bonnchallenge.org/). There is also growing interest in reforestation by many national governments. A number of these countries are establishing their own national reforestation goals. High-level consultations exploring how to achieve progress at a regional level have also been undertaken (APFC and FAO 2017).

Much of this interest in reforestation is being driven by the need to generate the ecosystem services once provided by natural forests such as watershed protection, carbon storage and the provision of habitats for biodiversity conservation (i.e. rather than just simply timber production). The target areas for all these reforestation proposals are large and it is mooted how they will be achieved.

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2 Tropical Forest and People Research Center, University of Sunshine Coast, Sippy Downs, Queensland.

Most previous reforestation was undertaken by planting tree seedlings. These plantings have commonly involved just a handful of exotic species and genera and have mostly involved plantation monocultures. The areas planted have been large and reached 291 million hectares by 2015 (FAO 2016). The cost of this type of reforestation is high, meaning it may be difficult to achieve the ambitious new global reforestation targets now being considered using planted forests alone. However, an alternative reforestation method is possible. Many have noted the capacity of some deforested areas to regenerate naturally (Chokkalingam et al. 2001; Chazdon 2014; Chazdon and Guariguata 2016); might this be part of the solution? Large areas of natural regeneration (or natural regrowth) are common but quantitative assessments of the extent of these are notoriously difficult to obtain. Based on satellite imagery, Achard et al. (2014) recently estimated that between 2000 and 2010 there was an annual increase in forest regrowth of 260 000 hectares in Insular Asia and 90 000 hectares in South and Continental Asia. These are significant areas and at a global level, they calculated that this regrowth removed 115 million tonnes of carbon per year from the atmosphere.

Natural regeneration has some substantial advantages for large-scale reforestation programmes. It is comparatively cheap because it avoids the cost of raising seedlings in nurseries and then planting them in the field. It offers a more feasible way for reforesting remote areas and others, such as mountainous areas, that are difficult to access. It usually involves many species and the resultant forests are therefore capable of generating a wide variety of ecosystem services. Finally, these species are likely to be matched to the environmental conditions of the sites, and the new forests are likely to be more resilient and self-sustaining than plantation monocultures. The issue now facing us, therefore, is how we might assist, enhance or even accelerate such natural regeneration to achieve the ambitious global reforestation goals now being discussed.

Natural regrowth and the landscape matrix

Part of the problem of working with natural regeneration lies in working out how it could fit into existing landscape mosaics; how these new forests will complement existing land uses and whether they will necessarily generate the required ecosystem services. Simply increasing forest cover alone will not be enough to generate many ecosystem services. Much depends on where the new forests are located and how extensive they are. For example, soil erosion is more likely to be reduced by reforesting steep slopes than flat land. Likewise, a small patch of regrowth will probably be less attractive to wildlife than a large area.

A new approach to implementing large-scale reforestation that takes these issues into consideration has become known as forest and landscape restoration (FLR). This approach seeks to improve ecological functioning at a landscape scale and, at the same time, improve the livelihoods of people living in that landscape (see www.fao.org/sustainable-forest-management/toolbox/modules/forest-and-landscape-restoration/basic-knowledge/en/). This does not mean we need to completely reforest the landscape. Rather, it involves undertaking reforestation at strategically-located sites in order to achieve functional changes. It may involve a variety of reforestation methods depending on ecological and

socio-economic circumstances within that landscape. Natural regeneration may be feasible at some locations but planted forests may be needed at others. FLR necessarily involves top-down as well as bottom-up participatory planning. It also involves negotiation among different resident and non-resident stakeholders to work out how to do this. These negotiations will decide where new forests should be located, how much should be established and what types of reforestation are possible or should be used. The task of FLR is to achieve a balance between satisfying local needs and meeting national goals.

Natural regeneration has the potential to be an important component of FLR. This means we need to understand much more about where it occurs, how we can assist in its development and how to improve its capacity to generate the ecosystem services required and provide benefits to the local communities.

Four issues for those wishing to take advantage of natural forest regeneration

(a) Evaluation and planning

We have surprisingly limited knowledge about where natural regeneration occurs, who owns it and how it might complement other land uses such as agriculture and food production. Nor do we fully understand its functional effectiveness which is something we

The origin, nature and quality of regeneration varies.

need if we are to properly undertake FLR. This means we need to map the distribution of natural regeneration and assess its quality (e.g. Is the regeneration too sparse or patchy? Is it species-rich or dominated by vines or weeds?). We also need to determine whether it is likely to generate the ecosystem services required by the community (e.g. Does the area exceed a prescribed minimum size? Is it found in the most critical landscape locations?)

(b) New policies

Natural regeneration can occur without human interventions but its use in national reforestation or FLR programmes is likely to require a deliberate and explicit new policy framework. In particular, new policies are likely to be needed to encourage the development of natural regeneration and ensure it is protected. In the past, natural regeneration areas have often been regarded as wasteland rather than as actively regenerating forest. This means these areas are at risk of been cleared and used for other purposes. But who is best equipped to assist and protect new regrowth? Are state agencies necessarily the best managers or might communities or households be sometimes more effective? Under what circumstances might this devolution be appropriate? And what policies and landownership arrangements would then be needed to encourage these non-state groups to manage natural regeneration in ways that balance public and private interests? Such changes are likely to necessitate the development of policies concerning financial arrangements to encourage the protection of natural regeneration or to provide compensation for those protecting natural regeneration at particular locations. Likewise, any schemes involving payments for the provision of ecosystem services from natural regeneration (whether state-owned or privately-owned) are also likely to need a specific new policy framework.

(c) The need for appropriate institutions to undertake this planning and implement these policies

Planning for FLR can only be done and policies implemented if there are appropriate institutions to do this. These may be existing institutions, modifications of these existing bodies or it may require the development of entirely new institutions. These institutions should include national institutions (to provide a national perspective) as well as regional and local institutions (to bring local perspectives to inform the larger-scale national viewpoint). There should be close formal links among these various levels to share information (i.e. to develop an 'institutional memory'), provide feedback and, where necessary, enable policies and financial arrangements to be modified.

(d) Research for management

There is often only limited knowledge about the location, ecology and silviculture of natural regeneration. Might some of the new remote sensing tools becoming available now be able to improve our knowledge of the location of natural regeneration? Can we find out more about the composition, the growth rate and the successional trajectory of these new forests? Can natural regeneration be assisted by weed control, especially in the early stages or enriched with commercially valuable species or species of conservation significance? Are there other ways of accelerating its development to ensure its value is more widely

recognized? What type of harvesting (e.g. of timber or non-wood forest-products) might be carried out by local communities? How can managers ensure any such harvesting is sustainable? What is the capacity of the new forests to supply ecosystem services and how might this be enhanced?

Any research answering questions such as these should also seek to develop forms of management that generate economic benefits for local communities as well as ecosystem services for the wider community. These management methods must be useable by the actual managers: in many cases local communities may be involved in the management of the new forests meaning that any silvicultural systems must be in a form that is appropriate for use by these communities.

In summary, natural regeneration has been ignored for too long even though it is widespread. It has the potential to be a powerful tool to massively increase forest cover but our ability to use it in future large-scale reforestation programmes is going to require a change in attitude by those that perceive natural regeneration as simply 'wastelands' and will need a substantial investment in planning, policy development, institution building and research.

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Annex 2. Summary of Asia Bonn Challenge meeting

Reporting back on the Asia Bonn Challenge High-Level Roundtable Meeting, May 2017

Chetan Kumar*

World leaders launched the Bonn Challenge target to bring 150 million hectares of the world's deforested and degraded lands into restoration by 2020 at a ministerial roundtable in September 2011 in Bonn, Germany. The New York Declaration on Forests issued at the United Nations Climate Summit in 2014 further extended the global target to 350 million hectares by 2030. Underlying the Bonn Challenge is the forest landscape restoration (FLR[1]) approach, which aims to restore ecological integrity at the same time as improving human well-being through multifunctional landscapes.

The 1st Asia Bonn Challenge High-Level Roundtable was held from 9 to 10 May 2017 in Palembang, South Sumatra. The event was organized by the Indonesian Ministry of Environment and the Provincial Government of South Sumatra, with the technical support of IUCN and the financial support of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

The event brought together over 100 participants from governments, civil society organizations, international organizations and the private sector. Twelve countries from the Asian region were represented at a senior level. The roundtable sought to raise the ambition of FLR in the region. The main objectives were to: (i) share regional experiences of FLR, and the challenges faced during implementation and ways of addressing these; and (ii) discuss strategies and approaches for unlocking the financial resources required for restoration.

* Global Forest and Climate Change Programme, IUCN.

1 IUCN uses the term 'forest landscape restoration', rather than 'forest and landscape restoration'.

Four new pledges to the Bonn Challenge[2] were announced during the roundtable, bringing total pledges past the 150-million-hectare milestone. New announcements were made by: (i) Bangladesh – 750 000 hectares, (ii) Mongolia – 600 000 hectares, (iii) Pakistan – 100 000 hectares and (iv) Sri Lanka – 200 000 hectares. Inspired by their participation in this meeting and positive discussions, a number of countries, including Thailand and China, indicated their interest in pledging in the near future. Sri Lanka indicated its interest in hosting the next regional roundtable.

The roundtable demonstrated that there is enormous potential for FLR in the Asia region. Some of the priorities identified during the meeting were to:

- Build on the momentum to seek further pledges to the Bonn Challenge from countries in Asia;
- Use more strategic and structured approaches to identify restoration opportunities and priorities at the national and subnational levels, by applying methodologies such as Restoration Opportunities Assessment Methodology (ROAM);
- Move from planning and pledging to implementation. There is a need to accelerate the pace of restoration on the ground, by learning from the many FLR projects across the region and elsewhere, developing new financial partnerships that harness the power of the private sector and finding innovative and creative ways to scale up existing successful initiatives; and
- Strengthen monitoring systems to ensure that Bonn Challenge commitments remain credible, for example, through the use of new tools such as the Bonn Challenge Barometer of Progress.

2 http://www.bonnchallenge.org/blog/bonn-challenge-crosses-150-million-hectare-milestone-pledges-pakistan-bangladesh-mongolia-and

Annex 3. Abstracts

3.1. Key ecological aspects for successful natural regeneration in FLR

The ecology and technology of accelerating forest ecosystem recovery

Stephen Elliott,[1]* David Blakesley,[2] Kate Hardwick[3] and Sutthathorn Chairuangsri[1]

Defining tropical forest ecosystem restoration

Tropical forest ecosystem restoration is "directing and accelerating ecological succession towards an indigenous target forest ecosystem of the maximum biomass, structural complexity, biodiversity and ecological functioning that are self-sustainable within climatic and soil limitations." The definition explicitly states four measurable indicators of restoration success. Limits imposed by climate change are implicit. Restoration involves overcoming natural and artificial barriers to succession and driving succession forward more rapidly than would occur without intervention (Elliott et al. 2013).

Barriers to succession

In the past, forest ecosystems were subjected to infrequent natural disturbances. Natural succession was sufficient to return them to their former condition within years or decades (depending on the severity of the disturbance). These days, however, human-induced disturbances are often too frequent or severe for natural succession to repair the damage within a desirable time frame. Human-induced barriers to succession require human interventions to overcome them. Such barriers include those that reduce the density of existing regenerants[4] and

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3 Millennium Seed Bank Partnership, Royal Botanic Gardens, Kew, UK.
4 Seedlings, saplings, trees and live tree stumps, capable of coppicing.

those that prevent species recruitment. In the first group are frequent burning, logging/cutting, soil degradation, livestock and competition with exotic weeds. The second group covers lack of local seed sources (within the dispersal range of the site) and/or extirpation of seed-dispersing animals that are capable of moving seeds from remnant forests to the restoration site.

Rapid site surveys and planning

Once stakeholders have decided where forest ecosystems are to be restored, participatory surveys of restoration sites are essential to: (i) determine which of the above barriers are preventing natural succession and (ii) estimate the existing density of natural regenerants.[4] The number of regenerants and the number of species in 10-metre diameter circular plots are counted (10 per hectare evenly spaced across the site). The same method can be used to survey the 'target' forest ecosystem,[5] to help quantify the goals of restoration (for the methodology, see Elliott et al. 2013). Stakeholders then use the site survey results to decide what management actions are needed to overcome the barriers identified (e.g. fire patrols, cattle exclusion and weed control); and if regenerants are present at a density high enough to meet their objectives. If not, then complementary tree planting must be considered. The density of natural regenerants should be high enough to initiate canopy closure by the end of the second year. This is the tipping point of 'site recapture', at which trees regain dominance over herbaceous weeds. As weeding is expensive, limiting the need for it to two years makes restoration more affordable and feasible. Furthermore, donors rarely fund projects for longer than two to three years, so they often require achievement of a self-sustainable system within such a time frame.

In the seasonally dry climate of Northern Thailand, regenerant density required to meet this guideline was 3 086 stems per hectare (or an average spacing of 1.8 metres between regenerants) from replicated, controlled field trials that manipulated tree-stocking density; and direct measurements of crown expansion of a wide range of tree species (Sinhaseni 2008; Elliott et al. 2003). Biodiversity recovery in plots with higher stocking densities was delayed, whilst plots with lower stocking densities remained weedy and suffered from fire intrusion. In more equatorial rain forest sites (where tree crowns expand more rapidly), canopy closure may begin in two years at lower stocking densities, whereas in drier areas, the stocking density may have to be higher, due to the slower crown expansion rates. Once the required management interventions have been identified and the need for complementary tree planting has been determined, collaborative costing of the project can be undertaken based on the survey results.

Protection

Where natural regeneration remains dense (above the previously-mentioned threshold) and regenerants are not inhibited by herbaceous weeds, protection alone may be sufficient to achieve restoration goals. This situation usually follows selective logging, where standing tree-stocking density remains high enough to shade out weeds. Preventing further degrada-

5 Usually, nearby remnants of the forest type targeted, growing under conditions similar to those of the restoration site.

tion is essential via the inhibition of additional encroachment by outsiders and by engaging local communities to avert fires, exclude livestock and attenuate the hunting of seed-dispersing animals, as required.

Inhibiting encroachment could include: (i) marking site boundaries with signs, (ii) establishing check-points on roads that enter the site, (iii) establishing a patrol system and (iv) building a strong 'sense of community stewardship' of the project.

Before every dry season, 8-metre-wide firebreaks should be cleared of combustible vegetation to arrest the spread of fire. Teams of fire watchers should be organized to alert firefighters when fires are spotted. Firefighting tools and water drums should be placed at strategic points around the planted site. The impact of livestock can be managed by tethering animals to restrict their movements or by erecting stock fences. Seed-dispersing animals should be protected by educating local people about their ecological value and by enforcing anti-hunting laws.

Assisted natural regeneration (ANR)

Where regenerants persist at stocking densities above the previously-mentioned threshold but are inhibited by weeds, protection must be complemented with 'assistance'. This may include weeding and fertilizer application around regenerants. Weeding reduces competition between trees and herbaceous vegetation, increases tree survival and accelerates growth.

Weed pressing or lodging, using a wooden board to flatten weeds, prevents the soil erosion that is often caused by using hand tools to dig out weed roots. It effectively uses the weeds' own biomass to shade out weeds and suppress germination of weed seeds. It also protects the soil surface from erosion and adds nutrients to the soil, as the lower layers begin to decompose. Herbicides should not be used, as it is very difficult to spray weeds without also spraying regenerants.

Most tree seedlings and saplings, up to about 1.5 metres tall, respond well to fertilizer application, regardless of soil fertility. Fertilizer application increases survival and accelerates growth and crown expansion, which in turn accelerate canopy closure and shading out of weeds. Although chemical fertilizers are expensive, the costs are offset by reduced long-term weeding costs. Organic fertilizers, derived from local waste materials, can also be used and are usually cost-effective.

ANR can act only on regenerants already present. Canopy closure can be achieved rapidly, but only where regenerant density remains sufficiently high. The 'assisted' trees may attract seed-dispersing animals (where such animals remain common), resulting in tree species recruitment, but most trees that re-establish on such sites are of relatively few, common, small-seeded pioneer species which represent only a small fraction of the species richness of the target forest type. Where large seed-dispersing animals have been extirpated, planting large-seeded forest tree species may be the only way to achieve a tree-species richness and composition similar to that of more mature forest.

Complementing regeneration

On tropical sites, tree planting should complement protection and ANR wherever regenerant density falls below the threshold explained above and/or fewer than 30 tree species[6] are represented. First conceived in Queensland's Wet Tropics World Heritage Area (Goosem and Tucker 2013), the framework species method is the least intensive and most effective of the tree-planting options. It involves planting the fewest trees needed to increase stocking

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The framework species method can transform landscapes. Left: Upper Mae Sa Valley (Thailand) May 1998. Right: September 2016. Restoration was initiated in 2001 (left side of track) and 2007 (right side), making the forests 15 and nine years' old respectively.

density to that required to 'recapture' the site in two years and attract seed-dispersing animals. Framework tree species are indigenous and representative of the target forest type. They also have the following characteristics: (i) high survival and growth rates when planted out in deforested sites, (ii) dense, spreading crowns that shade out herbaceous weeds and (iii) attraction for seed-dispersing wildlife due to their flowering/fruiting at a young age. Mixtures of 20-30 framework tree species (both pioneer and climax tree species) are planted. Weeding and fertilizer application around both planted trees and natural regenerants are carried out during the first two rainy seasons (usually three times/year). For the method to catalyse biodiversity recovery, remnants of the target forest type must survive within a few kilometres of the restoration site as a seed source and seed-dispersing animals must remain fairly common across the landscape.

Trials in both evergreen and deciduous forest types in the seasonally dry climate of Northern Thailand showed that canopy closure can be achieved within two to three years and biodiversity recovery is rapid. In evergreen forest sites, the species richness of the bird community increased from about 30 to 88 after six years (Toktang 2005), contributing to the recruitment of 73 species of non-planted trees within eight to nine years (Sinhaseni 2008). Most naturally-regenerated trees germinate from seeds dispersed from nearby forest by birds (particularly bulbuls), fruit bats and civets. Aboveground carbon storage, net soil-carbon inputs from litterfall and accumulation of soil carbon all return to levels typical of the target forest type in 16-17, 14-16 and 21.5 years respectively (Jantawong et al. 2017; Kavinchan 2015 a,b).

6 Or roughly 10 percent of the estimated number of tree species in the target forest, if known.

Automated restoration

Whilst the science of restoration has improved greatly over recent years, the technologies for implementing it remain primitive. Nearly all accessible land is already used for agriculture. So, most of the sites, available for restoration, tend to be remote and rugged, where delivery of planting stock and materials is impractical and where people do not want to work. To meet the UN's target of 350 million hectares restored by 2030, automation of forest restoration tasks may be necessary. Emerging technologies, such as low-cost UAV's (drones) and new imaging devices, could enable and accelerate site monitoring, weeding and aerial seeding, particularly on remote sites (Elliott 2016). Intensive collaboration among technologists and forest ecologists will be essential to ensure that such technological innovations are firmly based on sound restoration science.

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Implications of species biology and landscape characteristics on regeneration success and the establishment of diverse, resilient ecosystems

Stephen Elliott,[1]* David Blakesley,[2] Kate Hardwick[3] and Sutthathorn Chairuangsri[1]

Introduction: The unseen diversity that underscores regeneration success

Genetic diversity and origin of seed are crucial for successful restoration of functional, productive forests, but it is often difficult for restoration practitioners to assess whether available seed sources in the vicinity of the restoration sites are indeed suitable and adequately diverse for their project purposes. A high number of naturally regenerating or recruiting seedlings is not necessarily a sign of high genetic diversity because the seedlings may come from a few parent trees and all be related. This paper explains why genetic diversity and origin of seed matter in forest restoration are significant, what practitioners and other actors can do to help ensure they successfully restore that diversity and when it may be necessary to complement natural regeneration with planting or seeding.

Genetic diversity directly influences productivity, resistance to threats, regeneration potential and the adaptive capacity of restored tree populations. It is becoming more important than ever under the rapidly-changing environment that requires tree populations to quickly adapt to novel growth conditions. Yet, the changing environment also affects the species' capacity to adapt through its impacts on flowering and fruiting patterns, pollinators, seed biology, germination and seedling survival (Alfaro et al. 2014). Continued habitat loss and fragmentation add to the pressure by reducing the availability of seed sources for restoration and their genetic viability (Vranckx et al. 2012). Small or fragmented populations often produce fewer seeds and have lower germination and survival rates than seed from large continuous populations. This is the result of inbreeding (mating between related individuals) which negatively affects fitness in trees as it does in animal species.

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A recent global survey of seed-sourcing practices in 139 restoration projects worldwide showed that 65 percent of the projects had difficulties in finding suitable seed sources (Jalonen et al. 2017). According to 40 percent of the respondents, seed sources were often fragmented or degraded. Only one in three projects anticipated the impacts of climate change on the restored tree populations when selecting species and seed sources. Genetic diversity studies in restored forests show that because of lack of genetic diversity, seedling survival and growth in restored tree populations is often lower than in the remaining natural forests (Broadhurst et al. 2006; Li et al. 2012).

What to look for in terms of genetic diversity?

To help establish functional ecosystems, tree seed for FLR should come from:

1. Populations that grow under similar environmental conditions as the current conditions on the restoration site (from the same seed zone), to help ensure suitability to site conditions and early survival.
2. Populations that are genetically diverse to avoid inbreeding and ensure adaptive capacity under changing environments – typically from large, continuous forests that have at least 50 seed-producing trees per species.
3. Sufficient numbers of trees within those populations to ensure that the diversity of the source populations is captured – typically from at least 15-20 trees per species that should be widely spaced to ensure that they are not related to each other.

Rules of thumb for seed sources vary from species to species depending on their characteristics. Some species are more vulnerable to genetic erosion than others and may require more individuals or populations to obtain genetically diverse seed. Relevant information for assessing genetic diversity and vulnerability to genetic erosion includes whether the species is mainly selfing (self-fertilizing) or outcrossing, how far its pollen and seed are dispersed (extent of geneflow) and how many individual trees there are per hectare (population density).

Species that have limited pollen dispersal (e.g. by small insects) and seed dispersal (e.g. by gravity) are often vulnerable to genetic erosion because of lack of geneflow. If these species are mainly outcrossing and habitat fragmentation reduces their population sizes, the trees are likely to suffer from inbreeding depression or produce a higher proportion of inbred seedlings. Similarly, species with low population densities are typically more vulnerable than species with high population densities. Species that start producing seed only after several decades and those that flower only every few years (e.g. dipterocarp species) face higher risks than species with regular and abundant seed production from an early age.

The consequences of low genetic diversity and inbreeding are often not visible at seed or seedling stages when decisions are made about restoration methods and planting material. How and when the impacts of inbreeding are demonstrated depends on the strength of inbreeding depression which varies between species. In species that have strong inbreeding depression, inbred seed often germinates poorly and early survival of seedlings is low. In

species that have limited inbreeding depression, the negative impacts of inbreeding such as slow growth, poor productivity or susceptibility to abiotic or biotic threats, are often seen only at later growth stages. If such species are restored from closely-related parent trees, future reproduction and fruit set on the restoration site may be low. Self-incompatible species are not able to produce seeds through selfing, and isolated trees of such species usually fail to produce fruit even though they may flower intensely.

Seed originating from large, genetically diverse populations but from only few individuals will have low genetic diversity but is not necessarily inbred. Lack of genetic diversity, when not associated with inbreeding, may often become evident only when the trees are exposed to abiotic or biotic threats, such as abnormal weather patterns or pest or disease outbreaks. Such events are likely to become increasingly frequent with changing climate.

Strategies for ensuring genetic diversity in natural regeneration projects

(a) What restoration practitioners can do

- Gather information about the biology of the target species (e.g. selfing ratios, pollen and seed dispersal patterns) to assess which species are particularly vulnerable to genetic erosion.
- Characterize the seed source populations for the target species to understand the potential for geneflow (e.g. distance to restoration sites, abundance of pollinators) and identify signs of genetic erosion that can limit geneflow (e.g. number of individuals, spatial distribution, tree health, habitat quality, natural regeneration within the seed source).
- Enhance landscape connectivity as part of the restoration process to assist geneflow.
- Complement natural regeneration with tree planting or seeding for those species that have limited natural regeneration or genetic diversity of seed sources. Areas prone to climate risks or biotic threats can also benefit from planting and from increasing genetic diversity by introducing seed from more diverse origins (assisted migration; e.g. Prober et al. 2015).
- Select seed sources carefully for any artificially-introduced seed, keeping in mind the genetic diversity of seed sources, number of parent trees and the suitability of seed origin for surviving under the current and predicted future conditions on the restoration site. The scale of local adaptation in trees is broader than what is commonly believed and it is more important to use genetically diverse seed sources rather than using strictly local sources that might be degraded (McKay et al. 2005).

(b) What forestry officials and policy-makers can do

- Commission studies to assess genetic diversity of regenerating sites as a basis for developing decision-making tools.
- Develop practical guidelines for identifying species and site combinations that are likely to regenerate naturally into genetically diverse populations.

- Develop and institutionalize guidelines on seed zones and seed transfer, taking into account climate change.
- Develop information systems that provide practitioners with information on seed zones, seed sources, seed suppliers, provenance trials and other relevant projects, and studies on ecological restoration.
- Protect and manage existing seed sources, ensuring that they maintain viable populations.

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Sustainable management of tropical production forests through advanced regeneration: Some R&D highlights in Malaysia

Samsudin Musa, Abd Latif bin Mohmod and Ismail bin Parlan*

Introduction

Malaysia has relatively large areas (18.5 million hectares) of natural forest which cover 56 percent of the land area of the country (Samsudin et al. 2015). Most of this natural forest is designated production forest and the forest sector is very important economically, contributing RM22.1 billion per year (The Edge 2017). Malaysia is a major global supplier of hardwood products and the forests are expected to continue providing raw materials required by the country's forest industries. At the same time, Malaysia recognizes the many protection roles of forests such as for biodiversity conservation, watershed protection and climate regulation. The country is committed to keeping 50 percent of its land under natural forest cover and managing its forest on a sustainable basis through forest certification.

Managing natural regeneration in natural production forest

Forest restoration through natural regeneration in Malaysia is mainly focused on the production forest which constitutes the largest portion of the total forest area. Ensuring these forest landscapes are managed well is the most significant effort that could be done to ensure the forests are able to recover through natural regeneration. Once the area is degraded, silvicultural treatments to restore the sites will be very difficult and expensive. These natural production forests are currently being managed through a Selective Management System (SMS) with cutting limits imposed to protect the advanced regeneration and sustain the residual stand for a future cut, while being favourable to the forest manager as well as the logging contractor.

Managing these forests through natural regeneration under the SMS has faced many challenges. Studies on the impacts of logging under the SMS have indicated that the second-rotation forests are not as productive as predicted but are still able to produce an economic harvest in terms of total timber yield within the specified rotation cycle (Appanah and Weinland 1990). However, in some types of inland forests, the SMS did not always produce the desired residual stand capable of regenerating and recovering into a productive stand ready for the next cut (Appanah 2000).

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Specific challenges sustainable forest management in Malaysia faces include:

- Some forests are dominated by single species and have large stocking of large-sized trees that seem to aggregate in specific locations such as ridges. In such forests, there is a tendency to overcut and remove trees in patches resulting in an impoverished residual stand.
- A cutting regime involving the removal of trees above a specified size allows removal of the largest and best trees. Such a practice will result in genetic erosion which may become evident only after a few cutting cycles.
- The structure and species composition of the residual stands have been altered favouring higher dominance of less commercial non-dipterocarp species. Some of the major factors that could have contributed to this phenomenon are the slower recovery of the forest after the first cut, higher mortality due to logging damage and implementation of cutting limit prescriptions that favour high removals of dipterocarps as they are dominant in the upper diameter classes.

Malaysia is at a crossroads in terms of its timber supplies. Much of the rich undisturbed production forests is unavailable for logging. Currently almost all timber supplies from natural forests are from the second/third cut production forests which are less productive and have less commercially valuable species. The situation is exacerbated with the increasing need to protect the environment and more demanding compliance standards for forest certification.

Efforts are being undertaken to improve the current selective management system to enhance the residual stands. Efforts include imposing: (i) differential cutting limits for the commercially valuable dipterocarps compared to non-dipterocarps and (ii) a maximum removal volume of 61 cubic metres per hectare to prevent overharvesting in stands with high stocking of large trees (Thang 1997). Imposition of these limits has resulted in improvement of the residual stands but has not fully addressed all of the issues. Further improvements are needed to consider all aspects in the selection of trees to be felled including tree size, species, distribution patterns and commercial value.

A new silvicultural tree selection system has recently been developed and tested (Samsudin 2011). The new management prescription is able to ensure that trees selected for felling are proportionally spaced out thus preventing the removal of trees in clumps and creation of a large canopy opening. It is also better able to maintain the original forest structure with a more proportionate removal of trees in different diameter classes thus reflecting a true silvicultural selection system. The improved system has been tested at an operational scale and shows promise. Efforts are also being made to enhance the recovery of the sites in terms of not just timber values but also for biodiversity and other ecological services.

Table 1. Approaches used in restoration projects in Malaysia

Projects	Restoration approach
Enrichment planting in hill forest of Bukit Tapah Forest Reserve (FR) of logged forest, Peninsular Malaysia (1970-1972)	To enrich a poorly-stocked logged forest using line and group planting with selected high-quality species.
Rehabilitation of degraded peat swamp forest Raja Musa FR, Selangor, Peninsular Malaysia (1999)	To enrich degraded peat forest dominated by Imperata using line planting with selected high-quality species.
Multistoried forest management project in Chikus FR and Bukit Kinta FR, Perak, Peninsular Malaysia (1991-1999)	To enrich a poorly-stocked logged forest using line and group planting for a mixed-species multi-layered forest structure.
Rehabilitation of poor logged forest using improved planting techniques in Serting FR, Negeri Sembilan, Pen. Malaysia (1998)	To enrich a poorly-stocked logged forest using gap planting with a mix of species.
INFAPRO – Rain forest rehabilitation for carbon sequestration in Ulu Segama FR, Sabah, Malaysia (1992-2017)	To enrich a large-scale degraded forest due to fire using a combination of line and group planting of mixed species and ANR by liberation of wildings found in the lines and gaps.
INIKEA – Biodiversity improvement of degraded forest of Kalabakan FR in Sabah, Malaysia (1998-2017)	To enrich a large-scale poor forest using a combination of line planting of mixed species and ANR by liberation of wildings found in the line.
SABAL – Local community participation in agroforestry of Sabal FR, Sarawak, Malaysia (1998-2010)	To enrich a large-scale poor forest resulting from shifting cultivation using a mix of agricultural activities and planting of mixed forestry species.

Restoration of degraded sites

Much of the restoration efforts in Malaysia beyond managing advanced regeneration in natural forests is through planting. Degraded sites in forest management units of Sabah and Sarawak are being rehabilitated through row planting. Numerous projects, as listed in Table 1, also focused mainly on planting to restore degraded forests and lands, while two of them included ANR as well.

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3.2. Tools for prioritization, decision-making and monitoring to enhance restoration success

The Restoration Opportunities Assessment Methodology (ROAM): A planning and decision-support methodology for identifying forest landscape restoration opportunities and strategies

■ Li Jia*

Introduction to ROAM

The Restoration Opportunities Assessment Methodology (ROAM)[1] is a step-wise, participatory process to identify the best set of restoration opportunities and strategies for restoring an agreed optimal balance of landscape functions and human well-being benefits. The process provides analytical input to national or subnational land-use policies and planning; generates the often-missing link between landscape restoration and national priorities such as rural development, food security and energy supply; and brings people together to identify, negotiate and implement FLR activities.

Laestadius et al. (2014) provide a guide to the ROAM process which includes identification of restoration objectives and options such as ANR, plantation or others in different restoration areas; data collection and analyses on stakeholder priorities, opportunities mapping, economic viability, cost-benefit evaluation and financing among others; and discussion, feedback and validation of recommendations (Figure 1).

Case study from Quang Tri Province, Viet Nam

This case study illustrates the ROAM process, with particular reference to the planning of ANR and the way in which it forms an integral part of an overall FLR strategy.

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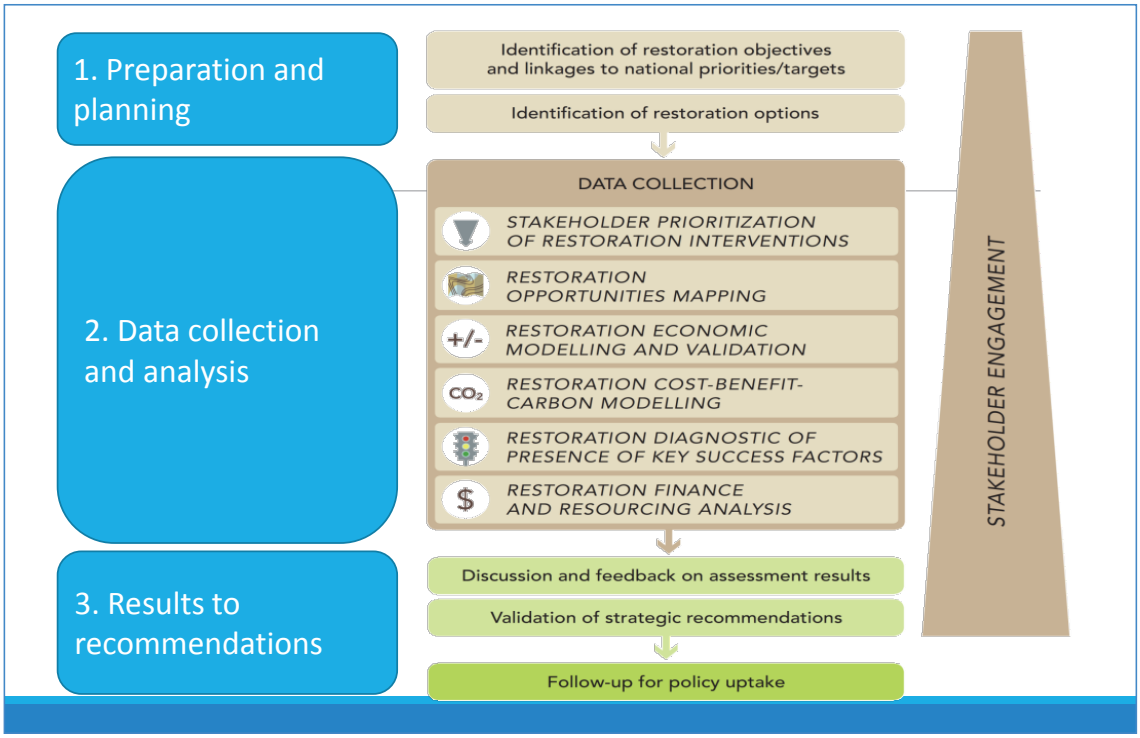
1 https://www.iucn.org/theme/forests/our-work/forest-landscape-restoration/restoration-opportunities-assessment-methodology-roam

Figure 1. Steps in the ROAM process



Quang Tri is in North-Central Viet Nam. During the American War, large areas of the province suffered deforestation as a result of bombing and the use of the defoliant Agent Orange. Although great strides have since been made in restoring forest cover, concerns remain about the quality of the forest. For example, a large proportion of the province's forest cover is composed of monoculture plantations of acacia and pine.

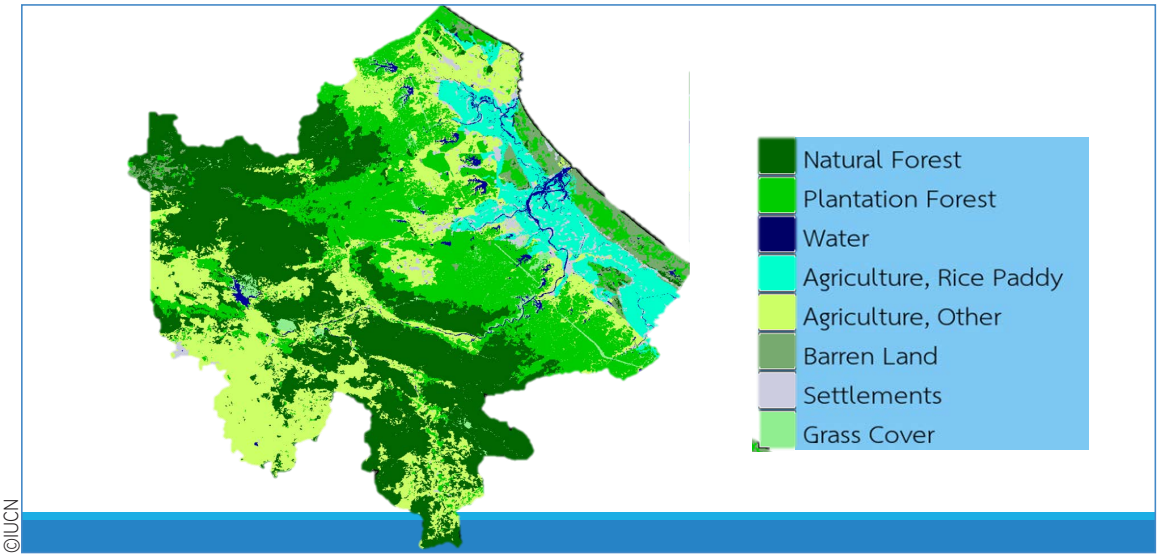
IUCN has been supporting the provincial authorities to implement a ROAM assessment, with the aim of developing a more holistic FLR strategy. As a first step, the assessment team helped local stakeholders to identify their priority restoration objectives. The consultative process revealed that the most important objectives are to:

- Increase the diversity and quality of Quang Tri's forests;
- Conserve and enhance existing ecosystem services, including watershed protection, erosion prevention and habitats that support high levels of biodiversity; and
- Improve the livelihoods of local people in order to reduce the incentives for encroaching on the forest.

With these objectives in mind, the assessment team followed a problem tree analytical framework to identify locally appropriate proxies for mapping priority restoration areas and the key restoration options for the stated objectives in those locations (Figure 2). ANR was identified as one of the key restoration options for achieving multiple ecosystem service objectives within natural forest areas.

Follow-up consultations with local stakeholders were conducted to understand the economic and institutional implications of implementing these restoration options. In addition to

Figure 2. Mapping areas for improving biodiversity and defining FLR strategies for the same



ANR, these options included: improving plantation management; payments for ecosystem services; and the introduction of agroforestry measures to improve agricultural productivity and sustainability.

Using ROAM to identify and confirm the scope for ANR

The ROAM methodology has now been used by numerous countries. Ghana used ROAM for baseline setting for its Forest Investment Program, Mexico for developing a cross-institutional national restoration strategy, Rwanda to realize its Bonn Challenge commitment and Guatemala as a foundation for its first national restoration strategy. ROAM helps to identify and validate the restoration areas and the appropriate strategies (such as ANR, silviculture, planting, agroforestry and watershed protection) for these areas based on the conditions, objectives and resources available.

ANR is an ecologically sound and potentially cost-effective restoration option for certain areas and objectives. However, a key challenge is to find a way of making it a locally appropriate and self–sustaining restoration strategy that can be embraced by local stakeholders. A participatory ROAM process provides the necessary stakeholder input and endorsement for restoration strategies to adopt. It can also help to ensure that ANR is part of the optimal balance of ecological and development benefits for targeted landscapes.

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Restoration monitoring versus deforestation monitoring

■ Fred Stolle*

Rising importance of restoration monitoring

Forest monitoring is a well-developed profession and science. The FAO Forest Resources Assessment[1] has been systematically tracking global forest resources since 1946. Recently, with the realization of the importance of forests in the global carbon cycle, forest monitoring has received a new boost in attention.

As forest-related activities can play a critical role in reducing global greenhouse gas (GHG) emissions, the UNFCCC (United Nations Framework Convention on Climate Change) developed a forest carbon mechanism in 2006 called 'Reducing Emissions from Deforestation and Forest Degradation, and fostering conservation, sustainable management of forests, and enhancement of forest carbon stocks (REDD+)'. Forest monitoring is a central part of this pay-for-performance tool. If you can prove that you have saved a tonne of carbon, you could get paid. The development of REDD+ projects and national programmes has spurred a wealth of experiences and techniques for monitoring deforestation at all scales from project to subnational, national and global scales (e.g. Global Forest Watch[2]).

Although the REDD+ mechanism has an afforestation/reforestation component (enhancement of carbon stock), this component has received much less attention. However, this is now changing. Renewed attention to FLR to regain ecological functionality and enhance human well-being across landscapes has now also increased attention paid to tracking/monitoring restoration. Tracking restoration progress effectively is vital for understanding success, taking adaptive action, planning future restoration areas and proving to investors that planned outputs are forthcoming. Monitoring restoration is thus as important for restoration as it is for deforestation.

Important differences between restoration and deforestation monitoring

One might think that organizations and countries with ample experience in deforestation monitoring are ready for restoration monitoring. And indeed, many of the same techniques that are used for deforestation monitoring such as satellite remote sensing, forest inventories and national statistics can be used for restoration monitoring. However, there

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1 http://www.fao.org/forest-resources-assessment/en/

2 http://www.globalforestwatch.org/

are important differences in monitoring deforestation and restoration that need to be taken into consideration. Below is a short inventory of the key differences that professionals should be aware off to ensure monitoring of restoration is efficient and useful.

(a) Scale of monitoring

Deforestation impact is often measured in thousands of hectares. Countries like Brazil and Indonesia have lost over 1 million hectares of tree cover per year over the last ten years. However, restoration efforts and outcomes are often dispersed in small plots of a few hectares up to a few hundred hectares. Restoration by farmers or by groups of farmers who have little to invest, may in particular, be on a small and dispersed scale. Farmers plant trees or allow natural regeneration in small patches around fields, in areas with low suitability for crops, and near houses for shade and other reasons. While deforestation driven by infrastructural and industrial development often occurs in large contiguous blocks and that driven by livelihood needs often occurs in many small adjacent plots, restoration is often small in scale resulting from innumerable individuals growing trees in different configurations. Monitoring for restoration is therefore not a large number game, but requires the ability to detect changes in small areas, small patches or even individual trees.

This need to track small area changes sets some important criteria on monitoring via satellites. High- to very high-resolution satellite images are needed to detect these small dispersed changes. Global deforestation studies with local relevance have used Advanced Very-High-Resolution Radiometer (AVHRR, 1-kilometre resolution), Moderate-Resolution Imaging Spectroradiometer (MODIS, 500- and 250-metre resolution) or Landsat (30-metre resolution) satellite data. These data can indeed also be used to monitor national progress on restoration. However, higher resolution satellite imagery at the scale of 1-10 metres is required for restoration monitoring for learning purposes, adaptive management or to attract investors to specific restoration interventions. Examples of 10-, 5- and 1-metre resolution imagery are the Sentinel satellite, Rapid Eye satellite and the Digital Globe family of satellites respectively.

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Scale of deforestation impacts versus scale of restoration efforts and outcomes.

There are two problems associated with this need for high-resolution satellite imagery. First, satellites used for deforestation monitoring are mostly free of charge (e.g. Sentinel, MODIS, Landsat), while high-resolution satellites are privately-owned and costly. Secondly, until recently, high-resolution data covered very small areas and so to monitor large areas one would need more than 10 000 images every monitoring period. Assessing large numbers of images further raises the costs significantly along with the computer and human resources required to interpret all these images.

Both the cost and sheer volume of data have been recently alleviated by a cooperation between Google and FAO in the development of the Collect Earth system[3]. Google buys high-resolution satellite data from all providers (private and government-owned) and makes them freely available in their Google Earth system. FAO developed a software package that works with this Google Earth system and allows users to develop sampling schemes and observation cards to easily interpret and develop maps and statistics with these data. This system has made it possible to detect small dispersed restoration over a large area (e.g. FAO developed 200 000 sample plots, each measuring approximately 0.5 hectares, to measure the forests in the world's 6.1 billion hectares of dry lands).

(b) Catastrophic one-time event versus slow progression

A second difference between deforestation monitoring and restoration monitoring is that deforestation is often, though not always, a one-off catastrophic event. Standing trees with canopies spanning several metres have a very different signature on the satellite imagery than the same area where the tree is removed in the next monitoring period. Restoration by contrast is mostly a slow process with growth from seed to seedling, sapling, young tree to mature tree often taking tens of years. Due to the slow growth of trees, the changes on the ground between monitoring periods can be small and subtle. It is thus important to develop clear ideas about what can be detected in what time frame and with which metrics. The presence or absence of trees, like deforestation monitoring, is not an adequate framework for restoration monitoring and more effort needs to be put into developing restoration indicators and metrics.

(c) Monitoring objectives

The third and last difference between deforestation and restoration monitoring is that restoration is always done with one or many specific purposes in mind, e.g. to increase productivity, to reclaim a degraded area, to stop erosion or to improve biodiversity. Deforestation monitoring on the other hand is conducted mainly to understand the area and patterns of change. As restoration is carried out for many different objectives, monitoring would have to track very different indicators and metrics. Currently FAO and WRI are developing a restoration monitoring framework that make it easier for restoration professionals to choose the goals they want to achieve and understand the indicators and metrics to be monitored in relation to those goals.

Conclusions

In summary, monitoring has been an invaluable and central part of tracking deforestation and REDD+ progress. Monitoring is equally important for tracking restoration. Monitoring results can show what worked where, provide valuable information for adaptive management, help attract investors, enable land-use planning and empower local users. However, restoration tends to be slow, small scale and dispersed, thereby placing heavy requirements on satellite data and on computer and human resources for monitoring over large scales. Recent developments in the form of Collect Earth and other tools have eased the situation somewhat. The monitoring framework should be adapted to the slow, pattern of restoration, and also contain different indicators and metrics to detect the achievement of the specific restoration goals.

3 http://www.openforis.org/tools/collect-earth.html

3.3. An enabling environment for natural regeneration in forest and landscape restoration

The enabling environment for FLR and natural regeneration: Sharing the findings from the 7th annual conference of the ASEAN Working Group on Social Forestry

■ Wilawan Wichiennopparat*

Introduction

Many of the ASEAN Member States (AMS) have ambitious forest cover or restoration targets (Table 1). To meet these targets in a sustainable manner many issues must be considered, especially the rights of those living in and around the areas being restored, the associated costs and benefits, and the application of appropriate restoration methods, including through natural regeneration.

Table 1. Forest area targets and restoration targets for some AMS

Country	Current forest cover (%)*	Target forest cover (%)**	Restoration target**
Cambodia	53.6	60 (by 2030)	---
Indonesia	54.0	---	2.7 million ha (2010-2015) 2.0 million ha (2016-2020)
Lao PDR	81.3	70 (by 2020)	1.5 million ha (2016-2020)
Myanmar	44.2	---	0.63 million ha (2017-2027)
Thailand	32.1	40 (by 2030)	4.16 million ha (2017-2030)
Viet Nam	47.6	47 (2020)	

* FAO 2015
** FAO and RECOFTC 2016, RECOFTC and AWG-SF 2017

* Community Forest Management Bureau, Royal Forest Department, Thailand

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AWG-SF conference, June 2017

The Association of Southeast Asian Nations Working Group on Social Forestry (AWG-SF)[1] held its seventh annual conference in Thailand in June 2017. The conference covered various key issues related to FLR under the title of 'Social forestry in forest landscape restoration: Enabling partnerships and investments for sustainable development goals (SDGs)'.

Social forestry approach for FLR

The main findings from the event were that social forestry in the many forms that it occurs in across the region, is an ideal platform for successful FLR. At its heart is ensuring adequate recognition of the value of effective participation which is also at the core of FLR. For example, one output of the process of a community getting tenure to its forest through a social forestry programme is the establishment of governance institutions at the local level. In most instances, these institutions then form networks at the landscape level and can prove to be a vital platform for facilitating, for example, participatory land(scape)-use planning which is important for FLR.

Various issues must, however, be addressed to ensure that social forestry can deliver for FLR. These issues include: (i) unclear and weak tenure and rights of local communities, (ii) an unfavourable legal and regulatory environment that actually discourages adhering to the principles of FLR, (iii) low capacity of key stakeholders to effectively conduct FLR (including facilitating participatory processes), (iv) lack of recognition of cultural knowledge and skills, (v) lack of recognition of the commercial potential of social forestry and scope for partnering with the private sector and (vi) laws and regulations that discourage natural regeneration for forest communities.

Recommendations

Based on the conference findings, the following recommendations were drafted by participants for providing an enabling environment for FLR, including for enabling the natural regeneration component of FLR.

(a) Enable multisectoral partnerships and stakeholder participation, including indigenous peoples, local communities, and forest and farm producers, to develop cross-sectoral frameworks for planning, management and implementation of FLR

Partnerships between the private sector and forest communities have significant potential, including for natural and assisted regeneration as recognized in the ASEAN Multi-Sectoral Framework for Climate Change (AFCC) and in the Vision and Strategic Plan for ASEAN Cooperation in Food, Agriculture and Forestry (2016-2025). There are a few examples from the region, including from Thailand, where the private sector adheres to the principles of FLR and forms partnerships with forest communities. We need to identify what works and what does not and learn from them to create an enabling environment for such key partnerships.

(b) Encourage equitable and mutually-beneficial investments for communities and governments

A supportive legal and regulatory framework must be further developed, recognizing its importance for FLR, whether using natural regeneration, ANR or plantations. 'Supportive' entails making it a requirement that those who conduct FLR ensure the effective and equitable participation of local communities. This framework must also support efforts to ensure that local communities have clear and strong rights to their land, a fundamental issue for achieving equitable and mutually-beneficial investments.

(c) Support communities, economies and livelihoods (including micro, small and medium enterprises, MSMEs)

Governments should enable the development of social forestry enterprises which are fundamental for local communities to tangibly benefit from their forests and for the ultimate success of social forestry. Currently in many AMS there are numerous barriers to social forestry enterprise establishment and development. However there are also many opportunities including at the ASEAN level in the ASEAN Strategic Action Plan on Micro, Small and Medium Scale Enterprise Development (SAP-SMED) for competitive and resilient community forestry-/social forestry-based enterprises. We need to build on the success stories from the AMS and the impetus provided by ASEAN to ensure that the FLR approach used includes effective social forestry enterprise development with community benefits at its heart.

(d) Undertake governance, tenure and institutional reforms

As mentioned above, clear and strong tenure is fundamental for achieving the objectives of FLR. This must be backed by renewed efforts to strengthen governance in conjunction

with reforming of institutions to address conflicting mandates and objectives. FLR should be aligned with international governance-related mechanisms such as REDD+ and the Forest Law Enforcement, Governance and Trade Voluntary Partnership Agreement (FLEGT-VPA) which provide key opportunities for reform.

(e) Conduct research and development

Capacity development programmes on the appropriate processes and tools for effective participation must be put in place for key stakeholders. Research will play an important role as part of the capacity development programme, including for local communities' views and approaches on different techniques.

(f) Promote and support enabling conditions for successful FLR programme design and implementation, including enhanced capacity development, skills and knowledge exchange

(g) Develop agroforestry guidelines for ASEAN

This will help to address the clear need to strengthen capacities on agroforestry techniques considering the different landscape objectives, including the needs of local communities.

Next steps

The next steps will see the recommendations being presented to the ASEAN Senior Officials on Forestry (ASOF) in July 2017. Additionally, the AWG-SF partners under the ASEAN-Swiss partnership on Social Forestry and Climate Change (ASFCC) project will support the AMS and AWG-SF in the implementation of the recommendations. These include a capacity development programme addressing various human capacity gaps related to FLR. For example, the World Agroforestry Centre (ICRAF) and RECOFTC are developing training manuals and providing training courses, as well as field guidelines, for different agroforestry models, including under forest restoration.

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Personal perspective on the enabling environment for natural regeneration in FLR in Indonesia: A social forestry programme in Tanah Laut, South Kalimantan Province

■ Nurhasnih*

Are there any possibilities to implement natural regeneration in Indonesia? This depends upon many factors including the effectiveness of the law enforcement and patrolling system that restrains encroachment for agriculture and small- to large-scale illegal activities, fire prevention efforts and livelihood options for local communities. In many cases, the government cannot work alone to conduct FLR through natural regeneration due to the lack of staff, financial resources and the size of the degraded state forest land.

A case study from South Kalimantan, Indonesia shows the importance of emphasizing strong and effective collaboration with local communities and other partners, including the local university, government offices, and civil society organizations. Tangible benefits and secure tenure serve to incentivize local communities to initiate collective action to support forest restoration efforts, including natural regeneration.

Large areas of the protection forest in Tanah Laut District, South Kalimantan Province were covered by *Imperata cylindrica* grassland for many years. *Imperata cylindrica* is one of the most widespread and pervasive weed species found in tropical Asia. *Imperata* grasslands cover a significant area (2.2 million hectares) of land in Kalimantan (Yassir et al. 2010). These grasslands have become a major source of annual fire in the province for years, with few effective solutions being found. Natural regeneration in such grasslands is very limited, with any regeneration efforts being hampered by illegal activities and fire.

In Tanah Laut District of South Kalimantan Province, a social forestry programme was initiated in 2011 in Tebing Siring protection forest. The local community received 35 years' rights to manage the state forest land, in this case protection forest that is covered by grassland, near their village. The Center for Social Forestry and Agroforestry, the University of Lambung Mangkurat with support from the Japan International Forestry Promotion and Cooperation Center conducted a series of dialogues leading to the establishment of a farmers' group and the development of an agroforestry system. The Bridgestone Kalimantan Plantation Company supported this initiative by providing rubber seedlings to enhance livelihood options for community members. After five years, *Imperata cylindrica* and recurrent fires have disappeared from the area due to intensive growing of rubber for income and development of an effective guarding and patrolling system for the naturally-regenerated forests. The supply of water from springs has increased substantially.

* Office for Social Forestry and Environmental Partnership for Kalimantan Region, Republic of Indonesia

© Nurhasnih

Before and after the social forestry programme in Tanah Laut, South Kalimantan Province, Indonesia.

The example from the social forestry programme in Tanah Laut District demonstrates the importance of giving clear and strong tenure and rights to local communities and clear benefits for all parties through collaboration. Communities benefited from alternative livelihood sources such as from the rubber and tree plantation linkage to clear tenure and rights, and this resulted in their commitment to protect the regenerating natural forest.

The case study suggests that natural regeneration can successfully occur where attention is paid to ensuring that:

- Local communities have alternative livelihood sources;
- Local communities have clear, strong and long-term tenure and rights;
- There is strong collaboration between the government, local communities and other stakeholders, driven by objectives of mutual benefit; and
- There is consistency in land policy to support natural regeneration.

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Personal perspective on the enabling environment for natural regeneration in FLR in the Philippines

■ Orlando A. Panganiban*

Since 2011, the Philippine Government has enforced a logging ban on natural and residual forests to retain and enhance the remaining natural forests (Executive Order No. 23, S 2011[2]). This action has placed pressure on plantation forests to meet the demands for forest goods, primarily timber products. Likewise, as timber harvesting is prohibited, benefits from natural forests are only perceived in terms of biodiversity conservation, carbon sequestration, soil and water conservation, and the like. This provides the following opportunities and challenges when we focus on natural regeneration in the context of FLR.

1. **Sustained and aggressive development of plantation forest to ease the pressure on natural forests.** Domestic and international demand for wood should be absorbed by plantation forests. The supply of timber in the Philippines does not meet the demand. Recent analysis by the FMB shows that the domestic demand for timber is around 6 million cubic metres while the available supply averages 4.6 million cubic metres (DENR 2016). The projected demand by 2019 is 7.6 million cubic metres. This has implications for sustainable plantation management and poses challenges for protecting natural forests.

2. **Sustained implementation of the logging ban on natural and residual forest.** The implementation of the logging ban facilitates forest protection activities. Today forest protection is relatively uncomplicated compared to the past. Timber sourced from natural forests is easily identified, potentially as 'illegal timber'. FMB records show a decline in illegal logging activities (from 197 illegal logging hotspots in 2010 down to 23 at present) (DENR 2015), which can be attributed to strict enforcement of anti-illegal logging laws. The effectiveness and efficiency of forest protection would definitely enhance the potential for natural regeneration.

3. **Management of protected areas by the private sector.** The government is unable to singlehandedly implement forest conservation protection activities. Protected areas, where most of the natural forests are located, may be better managed especially if this will complement, for example, ecotourism activities implemented by competent private sector actors. To some extent, government policies should allow business undertakings/projects that are compatible with forest conservation objectives.

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2 http://www.officialgazette.gov.ph/2011/02/01/executive-order-no-23-s-2011/

4. **Application of silvicultural treatments in natural forests.** Science tells us that timber harvesting is a type of reproduction method as it allows natural regeneration to occur. Other silvicultural treatments like liberation and sanitation cutting are procedures to improve the growth and yield of forests. These, of course, should be promoted with utmost prudence under the logging ban policy.

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Plantation nursery in the Philippines.

5. **Creation and/or strengthening of watershed management bodies.** At the landscape level, conflicting land uses and interests/demands can be better addressed through the creation of multistakeholder management bodies. In the Philippines, this is being promoted through watershed management councils with membership from various government agencies, the non-government sector and civil society organizations. The councils are usually chaired at the river-basin level by the governor of the local government unit which covers most of the watershed area. It is imperative that appropriate representation from peoples' organizations or Community Based Forest Management Agreement (CBFMA) holders in these councils is ensured. However, capacities of the peoples' organizations in terms of their negotiating and coordination knowledge and skills have to be enhanced for them to be meaningfully engaged in FLR, and rights of local communities should be strengthened including benefits they can gain from naturally-regenerated forests.

6. **Provision of off-site incentives.** For most local communities and other tenure holders, environmental products and services could be valued and compensated as in the case of payments for carbon, water quality and other ecosystem services. Opportunity for such incentives needs to be further explored for naturally regenerated forests.

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Requisites for enabling environmental forest and landscape restoration including natural regeneration: Example from Mae Chaem, Thailand

■ Ronnakorn Triraganon*

The top-down global, regional and national targets for restoration are a reflection of a key challenge facing FLR – ensuring that the rights of those living in and around the areas to be restored are respected, especially when the expectation is that much of the restoration is expected to come from natural regeneration.

A case study from Thailand is used here to highlight the fundamentals for achieving sustainable land-use management, including natural regeneration within FLR. It is critical to place local communities at the centre of these initiatives. Persistent problems such as expansion of agriculture, soil erosion and others stem from the non-involvement of local people.

A framework (Greijmanns et al. 2015) was applied to help understand the successes and challenges on the site, with one aim being to facilitate scaling up. The framework's principles are:

1. Accommodating multiple stakeholders' interests and needs (emphasis on local community).
2. Adaptive management and learning.
3. Availability of resources (including natural, human, tools/physical resources).
4. Developing the capacity of local communities and other key stakeholders (e.g. Forest Department officials, national NGOs).
5. Clear rights and tenure among resource users.
6. Effective governance, including effective participation.
7. Effective policy and regulatory support.

Currently, the framework is being tested on sites in Thailand. One of the first sites was in Mae Chaem, Chiang Mai, Northern Thailand. This area has experienced significant deforestation, mainly due to the lack of tenure for local communities, their consequent exclusion from local development planning and limited livelihood opportunities. Non-recognition of the rights of local communities to forest and land has prevented them from controlling deforestation, and will have significant implications for any reforestation efforts. Furthermore, the government's consideration of local communities as 'illegal' has prevented development in the area and discouraged sustainable investment, contributing to the poverty of local communities. This has forced local communities to accept whatever

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opportunities come their way irrespective of their effects on the landscape resulting in multiple other problems.

Local communities face numerous challenges in terms of their livelihoods. With increasing use of pesticides, use of fire for residue burning and cultivation on steep slopes, local communities are confronted with declining crop yields and income. Further, agricultural practices are causing environmental problems such as significant soil erosion, air pollution and haze leading to a strong backlash from the inhabitants of Chiang Mai and responses by the government.

There have been various stages in the efforts to make land use in the area more sustainable, including reforestation through plantation and natural regeneration with increasing economic, environmental and social success. The findings of the framework assessment on the site are presented in Table 1.

The example from Northern Thailand is particularly valid for many reasons, but is most interesting according to the perspective of one official that the work is not only about restoring the landscape, it is as much about restoring peoples' livelihoods. Central to this approach is placing local communities at the heart of the decision-making, allowing them to understand the land-use options and decide on the restoration options, including the associated costs and benefits.

Table 1. Testing of a framework for assessing the enabling environment for effective forest and landscape restoration at Mae Chaem, Chiang Mai, Northern Thailand

Principle	Findings on the site
(a) Accommodating multiple stakeholder interests (including meeting local needs)	Emphasis on livelihood development is important, including productivity of the forest and agricultural land. So is connecting the communities to financial institutions at the central level with actors on the landscape playing the role of intermediaries.
(b) Adaptive management and learning	Binding targets are often not the answer, but plans that can be adapted in response to emerging challenges and opportunities are more critical. Having access to information is important, including for best restoration options (natural regeneration, ANR, plantations, agroforestry). The land productivity dimension has been realized partly through ensuring that all stakeholders have access to information, including on appropriate techniques for halting soil erosion (for instance through reforestation and agroforestry).

(c) Availability of resources (including natural, human, tools/ physical resources)	Involvement of the private sector is significant in providing a stable market for local community products. However, there are still challenges for accessing financial resources.
(d) Developing the capacity of local communities and other key stakeholders (e.g. Forest Department officials and national NGOs)	A range of capacities is needed for the success of the initiative. • The leading agencies (governmental and non-governmental) should have the capacity to engage with a wide range of stakeholders. At least a few of them should have the capacity to facilitate the process, including the generation and dissemination of key data (e.g. on resource ownership, land use and land cover) which provides the basis for planning, implementation and monitoring of progress. • Capacity to connect with the private sector within the landscape and beyond to bring in needed financial resources and commercialize products from the landscape is also critical for success.
(e) Clear rights and tenure among resource users	The local government offices made significant efforts to recognize resource rights and strengthen tenure security for local communities, which was critical for the success of the initiative.
(f) Effective governance, including effective participation	The success of any initiative depends on striking a balance between top-down and bottom-up processes, in other words effective participation is the key. Engagement with local communities in land-use-related decision-making from the very beginning helped to build trust among local stakeholders and provided room for negotiating complex issues such as land tenure.
(g) Effective policy and regulatory support	There is a need to overcome the disconnect between the policy and regulatory environment and the reality on the ground. For example, the laws and policies create challenges for securing tenure for local communities. Some government agencies at the local level feel constrained to participate in such multisectoral initiatives due to the rigid working procedures of central government authorities, and limited space to partner with other sectors and stakeholders. The private sector's investment in such initiatives can be increased through appropriate policy support such as through tax rebates and loans.

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3.4. Country case studies on natural regeneration

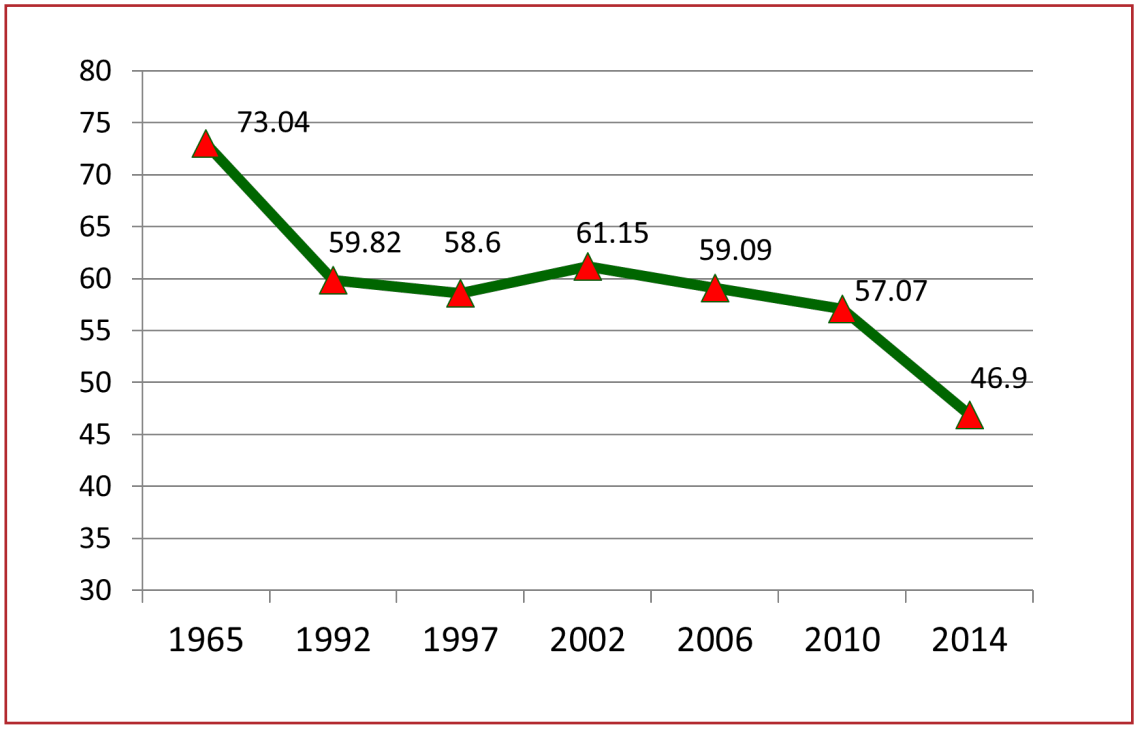
Perspective on assisted natural regeneration of forests in Cambodia

■ Hong Kimhean*

Introduction

Natural forest cover in Cambodia changed from 73 percent in 1965 to about 46.9 percent in 2014 (Figure 1, Forestry Administration 2016a). Causes of forest cover change are land conversion to agricultural crops, settlements and illegal logging, among others.

Figure 1. Percent forest cover change in Cambodia from 1965 to 2014 (Forestry Administration 2016a)



* Department of Forest Plantation Development and Private Forest

Application of ANR in Cambodia

ANR is a traditional forest management measure that has been practised in Cambodia for many years. As ANR is simple, inexpensive and applicable to many situations, and forest sites are less disturbed, ANR has been adopted by many stakeholders, such as local people, for community forestry, REDD+ implementers and forest conservators. Depending on the forest management objective, site conditions and location, ANR has been applied in different ways. This paper focuses on general application of and challenges for ANR in Cambodia based on a desktop review, and provides recommendations for future development.

(a) Community forestry

ANR has been adopted by more than 500 community forests involving more than 120 000 households and covering more than 417 000 hectares of forest (Forestry Administration 2015a). Due to financial limitations and social pressures, ANR in community forestry is mostly focused on protection of forest from fire, illegal cutting and cattle grazing through construction of firebreaks and organizing patrols. However, in some community forests, where financial support is available and there is heightened awareness, forest growth is supported through silviculture practices such as enrichment planting, weeding, thinning and pruning. In Phnom Sen Han community forest, Kampot Province, for instance, five-metre-wide firebreaks are constructed around the 54-hectare area and teams are formed to patrol and protect the forest from fire and cattle. Moreover, four plots (50 x 50 metres each) in the community forest are enriched by planting of some indigenous tree species. In some areas where forest trees are surrounded by grasses, lianas and vines, weeding is conducted to liberate the trees (Project TCP/RAS/3307 2012).

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ANR in a community forest

(b) REDD+ projects

As ANR is commonly practised and understood, this method is used to encourage the participation of local communities in REDD+. Similar to the community forest areas, REDD+ sites face social pressures such as fire, land encroachment and farming expansion. Firebreaks are constructed and patrolling activities are organized to protect the forest from fire, encroachment and other illegal activities in the REDD+ sites of Oddar Meanchey, covering approximately 64 318 hectares (Yeang and Brewster 2012); Seima, covering approximately

292 690 hectares (WCS 2010); and Prey Lang, covering approximately 400 000 hectares (Bradley and Shoch 2011). Additionally, in Oddar Meanchey where there are 4 485 hectares of degraded forest within the project site with low canopy cover, silviculture practices are applied to increase forest cover and enhance carbon stocks (Yeang and Brewster 2012).

(c) Biodiversity conservation

In the Biodiversity Conservation Corridors project launched in Koh Kong and Mondolkiri, 14 community forests have been selected for ANR implementation in approximately 1 500 hectares of forest. Similar to other areas, ANR in both provinces focuses on protecting the forest from social pressures by organizing patrols. However, enrichment planting is also applied in some degraded areas. Two nurseries have been established, and 38 500 and 13 487 seedlings have been produced and planted in Koh Kong and Mondolkiri provinces respectively (Forestry Administration 2016b).

Implementation challenges for ANR in Cambodia

Although ANR has been widely used in Cambodia for forest management, development of the practice is limited due to the following constraints: limited understanding of ecological factors, unclear outputs or outcomes of ANR and social pressures.

First, as mentioned by Sajesi (2003), ecological factors play an important role in the succession of ANR and this factor may be neglected in ANR practices in Cambodia. Species selections and site matching are considered in enrichment planting, but mortality of seedlings is relatively high. For instance, results from monitoring of enrichment planting in O Som Community Forest, Kampong Thom Province, showed that about 79 percent of the seedlings were affected by biotic and abiotic factors one year after planting. About 34 percent of the seedlings were attacked by worms and 44 percent of the seedlings were negatively affected by abiotic factors. Commercially-valuable species were prioritized for planting and young seedlings of these species may be favoured by animals or not adapted to biotic agents on the site. Moreover, the seedlings when transferred from the nursery to the site, may suffer from improper handling and planting, as well as adjustment to the new ecological conditions on the site.

Second, outputs or outcomes from ANR may be difficult to assess. As ANR is conducted mainly in natural habitats where stand composition and structure are complex, the growth rates and competition among plants within communities may be difficult to evaluate. This complexity affects planning, monitoring and evaluation of ANR in national forest restoration initiatives.

Third, social pressures affect ANR implementation in Cambodia. As a developing country with a large reliance on the agriculture sector, land is required for settlement and cropland development which has increased pressure on forest areas and ANR sites with resultant forest fires and land conflicts. Despite implementing firebreaks and organizing patrols, ANR succession is unclear and finances for continued protection are constrained.

Comparison of ANR vs non-ANR methods of forest restoration in Siem Reap Province

Two 30- x 30-metre plots were established to study the effects of ANR on restoration success (Forestry Administration 2015b). ANR treatment on one site included weeding, thinning, fertilizing, mulching and supportive sticks for seedlings. There was no significant difference in seedling survival, health and growth between the ANR and non-ANR plots. This may be because conditions for natural regeneration are already good on forest sites in Cambodia and there may not be much difference between the control and experimental sites. However, different species were found to have differential survival rates on both ANR and non-ANR sites thus indicating the importance of species selection for forest restoration (Forestry Administration 2015b).

Recommendations for further ANR development

(a) Assist succession of colonization of seedlings in natural habitats

To avoid mortality of seedlings during transplanting or enrichment planting, focus on and support colonization of seedlings in natural habitats instead of producing seedlings and planting. Study the phenology of the species including flowering and fruiting seasons, and apply silvicultural practices to the understoreys of the forests to reduce barriers for seed dispersal and seedling development. Undertake preventive measures to protect young seedlings from damaging biotic and abiotic factors.

(b) Develop standards for ANR for national planning

Although outputs or outcomes from ANR are difficult to evaluate, regionally or internationally, acceptable definitions of ANR progress should be determined to support the integration of ANR into national forest restoration plans.

(c) Manage social pressures on ANR sites

Succession of ANR is closely related to social pressures on the sites and therefore it would be important to determine whether social factors on the site are manageable before launching ANR. Land tenure should be made clear to minimize social conflicts and secure ANR on the sites. Participation of and collaboration with local partners such as local authorities and communities in forest management and ANR activities should be strengthened. Forest land-use planning should be established at national and subnational levels to ensure the land is not vulnerable to conversion to other purposes with wasted restoration efforts. Forest law enforcement should be strengthened to reduce conflicts and enhance chances of success. Livelihood options and payments for ecological service incentives could be considered to reduce pressure on the sites and support sustainable management.

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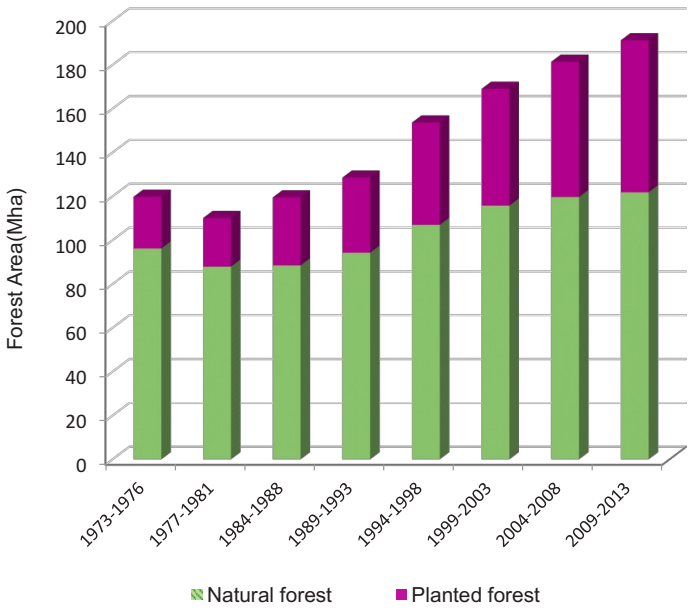
Overview of historical development and future perspective on natural regeneration in China

Liu Shirong[1], Wu Shuirong[2], Cheng Zhongqian[2], Miao Ning[3] and Cai Tijiu[4]

Introduction

Forest cover accounts for 208 million hectares or 21.63 percent of the land area of China including plantations of 69 million hectares (Liu et al. 2014). According to the national forest inventories, the area of China's planted forests increased by 212 percent, rising from 20 to 36 percent of the total forest area from 1977 to 2013 (Figure 1). Natural forests increased by 39 percent in the same period.

Figure 1. Change in China's natural and planted forest cover from 1973 to 2013 (SFA 2014).



The artificial regeneration approach involving planting and aerial seeding has played an important role in forest restoration since 1978 when China initiated the first key forestry programme. The ANR approach has also been implemented in combination with other forest restoration methods in China. However, the potential of ANR as a low-cost forest restoration method has not been well recognized and thus has not been applied to a large extent. This paper provides an overview of the historic development of forest restoration; and explores the opportunities, challenges and future perspectives for natural regeneration in China.

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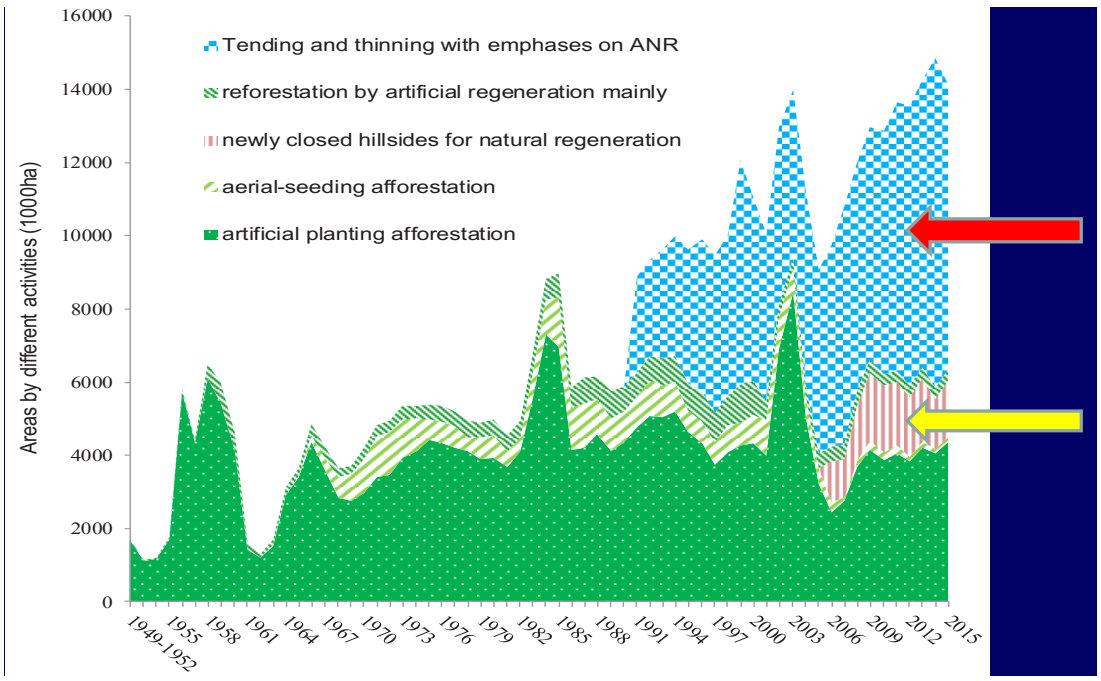
Forest restoration approaches over time in China

Historically, China has had rich forest resources and biodiversity thanks to its vast geographical area and highly diverse environmental conditions. However, natural forests in China have been greatly reduced over time as a result of agricultural development, overexploitation and years of war. Since 1949, forestry development has experienced three distinct phases with utilization, rehabilitation and development of forest resources, along with changes in the types of forest restoration approaches used (see Figure 2). In **Phase I** from the 1950s till the end of the 1970s, China's forest sector focused largely on timber utilization and artificial regeneration was emphasized after clear-cutting, with 90.39 million hectares planted, 9.13 million hectares aerially seeded and 7.08 million hectares artificial reforested in this period. In **Phase II** from the end of 1970s till the late 1990s, equal importance was given to timber production and ecological improvement; 89.65 million hectares were planted, 15.38 million hectares were aerially seeded, 11.86 million hectares were artificially reforested; and 23.69 million hectares of young and middle-age stands were tended and thinned using ANR as a major approach. In **Phase III** from the late 1990s to the present day, sustainable forestry development and ecological improvement have been targeted through the implementation of several key forestry programmes. In this period, so far China has applied planting, aerial seeding and artificial reforestation for 77.66 million hectares, 7.33 million hectares and 8.08 million hectares respectively. Additionally, 15.45 million hectares of hillside forests have been closed for natural regeneration and 110.74 million hectares of young and middle-age stands have been placed under tending and thinning.

Figure 2. Dynamics of forest regeneration and silvicultural activities from 1949 to 2015. Source: China Forestry Statistical Year Book (SFA 2016).



In China, ANR has been widely adopted as a key approach for accelerating succession, protecting forest health and vitality, and increasing biodiversity (Ouyang and Xiao 2014). ANR is mainly practised in two aspects: (i) general ANR is implemented in areas such as barren hills, wastelands, barren desert lands, cutover lands and river banks, and (ii) specific ANR is implemented on land severely affected by logging, fire and other disturbances.

Case studies

The following case studies indicate the actual potential and rationale for successful natural regeneration at the local level in China following logging, fire and other disturbances.

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Remnant old growth trees facilitated natural regeneration of shade tolerant species.

Case I: Remnant old-growth trees in support of natural regeneration after large-scale disturbance of forests in the subalpine region of southwestern China (Miao et al. 2014)

This case study indicated that remnant old-growth trees facilitated natural regeneration of Abies faxoniana, a shade-tolerant dominant species, while simultaneously hindering the regeneration of Betula albosinensis, the dominant shade-intolerant species. The remnant old-growth trees augment several different successional processes such as dispersal foci, fostering biodiversity clumps and neighbourhood effects enhancing recruitment, which act together to accelerate secondary succession of the Abies-Betula forest following logging disturbances on the eastern edge of the Qinghai-Tibetan Plateau.

Case II: Forest regeneration in the burned area of the northern Great Xing'an Mountains (Xie et al. 2007; Cai et al. 2012)

The alternatives of natural regeneration, ANR and artificial planting were applied in unburned and burned areas with different severities of burning. The postfire regeneration assessment showed that: (i) natural regeneration is well-suited for lightly-burned areas as well as broadleaved areas where many trees survived given that broadleaved species have better germination ability; (ii) ANR helps achieve restoration goals faster than pure natural regeneration in moderately-burned areas; and (iii) artificial regeneration techniques such as planting and direct seeding are suitable in heavily-burned areas, greatly shortening the successional cycle from broadleaved to climax coniferous forest communities.

Opportunities and challenges for ANR

Several laws and regulations related to forest restoration have been issued and implemented. Forest restoration has been addressed in the 13th Five-Year Plan for Forestry Development of China. With increasing recognition that landscape restoration is an effective way to

guarantee high biodiversity, productivity and stability of the rehabilitated forest assets in the long term, ANR has been well recognized and increasingly applied in China's afforestation and reforestation programmes. Compared to conventional reforestation methods, ANR can cost-effectively convert deforested and degraded lands into healthier forests by facilitating and accelerating, instead of replacing, natural successional processes. ANR techniques are flexible and allow for the integration of multiple objectives such as timber production; biodiversity recovery; and cultivation of crops, fruit trees and non-wood forest products in the restored forests (Shono et al. 2007). However, despite its practical advantages, ANR has not yet been fully applied due to lack of public awareness, supportive policies and solid scientific justification of its effectiveness. Thus, there is a need to carry out systematic application and monitoring/assessment of ANR to determine the optimal models and best practice guidance for successful implementation.

Future perspectives

In response to the increasing demand for landscape restoration and good health and quality of forests, both artificial regeneration and natural regeneration, especially ANR, will continue to play an important role in China. Natural regeneration has shifted from the passive, directionless enclosure of hillside forests in the past towards more active and deliberate application of ANR with clear objectives and better understanding of site conditions, regeneration potential and constraining factors. ANR has great potential to promote FLR while improving forest ecosystem services and enhancing the resilience of forests in adaptation to climate change.

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Natural regeneration for forest and landscape restoration: Potential, opportunities and barriers in Central India

Krishna Kumar Singh[1] and Rohini Chaturvedi[2]

Introduction

Forest and landscape restoration (FLR) is the process of revitalizing degraded and deforested lands to enhance the flow of ecosystem services and secure people's well-being, particularly that of local communities (IUCN and WRI 2014). This paper examines the potential of assisted natural regeneration (ANR) for forest and landscape restoration in Sidhi District of Madhya Pradesh in Central India. ANR is a proven, low-cost method for restoring degraded or deforested landscapes into productive forests (Shono et al. 2007). The method involves the removal or reduction of barriers to regeneration such as invasive species' proliferation, fire outbreaks, fuelwood extraction and grazing. In India, this reduction of barriers is achieved either through physical fencing of degraded areas, or social fencing involving local communities.

The findings presented in this paper have emerged from an ongoing application of the Restoration Opportunities Assessment Methodology (ROAM) developed by IUCN and WRI. The process combines scientific data, cutting-edge technology and local knowledge. While the focus of this paper is on Sidhi District, the broader findings have relevance across India. The objective of this ROAM assessment is to understand how tree-based interventions, as part of a landscape approach, can enhance the flow of ecosystem services as well as secure local livelihoods in Sidhi. This included identification of principal land-use challenges in Sidhi, the potential for different FLR interventions and the presence of enabling conditions for FLR. Consultation with stakeholders was facilitated through workshops, field visits, a participatory Mapathon using Collect Earth, Social Network Analysis and application of the Restoration Diagnostic Tool.[3]

Sidhi's forests and drivers of degradation

Sidhi District has an area of 477 214 hectares (Census of India 2011). Nearly 40 percent of this area is under forest cover (ibid) with a mix of different economically- as well as culturally-valuable species such as sal (*Shorea robusta*), mahua (*Madhuca indica*), tendu (*Diospyrous melonoxylon*), bael (*Aegle marmelos*), salai (*Boswellia serrata*), palash (*Butea monosperma*), aonla (*Amblica officinalis*), shisham (*Dalbergia sissoo*), Bamboo spp., *Terminalia* spp. and *Acacia* spp.

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3 For details on the tools used please contact Rohini Chaturvedi at rchaturvedi@wri.org

The forests of Sidhi hold tremendous significance for biodiversity. Nearly half of Sidhi's forests comprise the Sanjay National Park which is a protected area dedicated to tiger conservation. This protected area is also the source of the Gopad and Banas rivers. The remaining forests are critical for the lives and livelihoods of Sidhi's large rural population (more than 80 percent) that depends on them for fuelwood, food, fodder, small timber as well as non-wood forest products.

Over the years, Sidhi's forests have suffered depletion and degradation. Between 1996 and 2016, more than 15 000 hectares of forest were lost to development of irrigation infrastructure and expansion of agriculture; over 60 percent of the forests were degraded as a result of invasive species, fires, open grazing and unsustainable extraction of forest produce, including fuelwood (Government of Madhya Pradesh 2011). This degradation has had direct adverse impacts on the economic well-being of such marginalized groups as tribal, landless and smallholder households that are particularly dependent on forests for subsistence. FLR is, therefore, not only an environmental imperative but also a developmental one.

Potential of natural regeneration for restoring Sidhi's forests

FLR in Sidhi involves three key activities, namely:

1. Conservation of the protected area (97 000 hectares) to prevent degradation and deforestation. This conservation is also mandated by the Wildlife (Protection) Act 1972 and its rules;
2. Protection of moderately dense and dense forest areas from fragmentation and degradation; and
3. Restoration of degraded and deforested lands with canopy density of <0.4 (64 000 hectares).

Initial estimates found that more than 85 percent of Sidhi's degraded forests were suitable for ANR because these areas supported good forest cover, as recently as 1996, with species suited to natural regeneration. In the monsoon, shoots could be seen across large swathes of these forest lands.

Challenges for assisted natural regeneration

The extent of opportunities notwithstanding, there are three key challenges that constrain ANR in Sidhi:

(a) Neglect of ANR in forest plans

The areas suited for ANR overlap with those where plantations are possible. Over the years there has been an overarching neglect of ANR in forestry activities on degraded land. Instead, the focus has been on plantations, particularly of teak (*Tectona grandis*). Sidhi Forest Department statistics between 2011 and 2015 show that more than 20 million teak saplings were planted across more than 20 000 hectares of degraded forest land. This is twice as much as all other species combined. Notably, teak is not found naturally in Sidhi and, in many ways, its widespread introduction may be interpreted as an effort to change the forest composition. This change benefits the state forestry departments because teak is a hardy tree and requires minimal care; it is not used for fodder and is, therefore, naturally protected from grazing; teak is one of the most commercially valuable species that secures future flow of finances to the state.

(b) High demand for fuelwood and fodder

The principal causes of degradation of Sidhi's forests are overextraction of fuelwood and open grazing. The high demand for fodder and fuelwood also pose significant barriers to regeneration. For example, as new saplings of palash (*Butea monosperma*) emerge each year, these are lopped. The leaves are used for fodder and the wood is dried for fuel. Hence natural regeneration does not survive unless physically fenced and protected by the forest departments.

(c) Absence of community-based institutions that could support natural regeneration

India's participatory forest management policy provides opportunities for communities to be involved in the protection and management of forests. In Sidhi, Joint Forest Management Committees have been constituted across most forest areas. However, an institutional stocktaking found that most of these are 'paper' committees and not actively involved in the protection and management of forests. Even where these committees are active, the flows of benefits to communities have not been assured leading to waning interest. As a result, social protection of forests from barriers to regeneration is missing.

Conclusion

FLR is a proactive, dynamic process of restoring ecological integrity to degraded landscapes as well as ensuring flows of benefits to communities. In Sidhi, an opportunities' assessment conducted using ROAM found that ANR held immense potential for restoring forested landscapes. The absence of critical enabling conditions such as policy implementation, institutions and incentives however poses challenges for the implementation of ANR. While this case study focused on Sidhi District, it has relevance across many parts of India. Addressing the missing enabling conditions is therefore key for India to achieve its commitment to the Bonn Challenge.

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Towards successful forest and landscape restoration in South Sumatra, Indonesia: The application of the Restoration Opportunities Assessment Methodology (ROAM)

Satrio A. Wicaksono[1] and Andree Ekadinata[2]

Introduction

Indonesia has had various major forest restoration initiatives since the 1980s but has had little success to date. More than 400 rehabilitation projects from the 1990s to 2004 had little positive outcome (Nawir et al. 2007). Projects faced major technical, economic and socio-cultural problems. One of the major underlying problems was a lack of coordination in implementing restoration plans at different levels of authority.

At present, between 2015 to 2019, the Ministry of Environment and Forestry has a total restoration target of ~22.6 million hectares (Ministry of Environment and Forestry 2015) with various activities such as:

- Social forestry, with high restoration opportunities (12.7 million hectares);
- Rehabilitation of degraded forest and land (5.5 million hectares);
- Corporate social responsibility (CSR) efforts (1.6 million hectares);
- Ecosystem restoration concession (2.791 million hectares); and
- Ecosystem recovery in conservation areas (100 000 hectares).

The Peat Restoration Agency has a further restoration target of 2 million hectares by 2020.

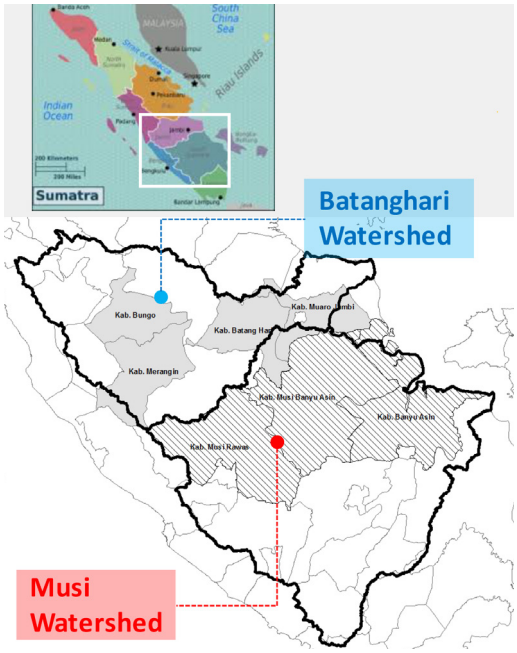
Using ROAM to determine restoration scope and goals in the Musi Watershed

Restoring degraded lands and landscapes is essential for human livelihoods and well-being, long-term food security, biodiversity conservation, water regulation and climate stability. Given the complex use and function of lands and landscapes, restoration is multifaceted and involves various stakeholders and strategies. To help guide restoration stakeholders systematically and comprehensively assess national and subnational restoration potential, WRI and IUCN developed a framework called the Restoration Opportunities Assessment Methodology (ROAM) (Laestadius et al. 2014).

1 World Resources Institute (WRI), Indonesia
2 World Agroforestry Centre (ICRAF)

ICRAF and WRI Indonesia tested and implemented ROAM within the Musi Watershed which encompasses the whole province of South Sumatra in Indonesia (Figure 1), to strengthen regional capacity in FLR planning.

Figure 1. Musi Watershed, South Sumatra. Source: ICRAF.



The ROAM-based analyses were conducted at three different levels of authority within the landscape: provincial (macro), district (meso) and forest management unit (FMU) (micro). In this context, ROAM was adapted into a technical work plan suitable for the Indonesian context.

The work plan consisted of six primary steps:

(a) Setting up the basis for a continuous multistakeholder dialogue.
(b) Determining goals and success criteria for restoration.
(c) Geospatial mapping to identify restoration potential, priority and options.
(d) At the macro- and mesolevels, identifying the drivers of degradation, measuring ex-ante impacts of restoration and designing a restoration strategy and roadmap.
(e) At the FMU level, measuring socio-economic benefits, analysing institutional readiness and value chains (i.e. market analyses), and conducting feasibility assessment.
(f) Conducting validation workshops and public consultations along with financial dialogue.

ROAM partners included the Watershed Management Forum established by the governor at the macrolevel, the District Planning Agency at the mesolevel and the FMU and Forest Conservation Park at the microlevel. Other stakeholders involved included landowners, local communities and smallholders/farmers at the microlevel; local governments, CSOs and academia at the landscape level; and the national government and international organizations.

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ROAM workshop conducted in Musi Watershed, South Sumatra, Indonesia.

Restoration potential in the Musi Watershed

More than 1.1 million hectares (approximately 16 percent) of the Musi Watershed holds potential for restoration. Of these, about 83 percent (913 000 hectares) has the potential to be restored through enrichment planting or ANR, 15 percent through natural regeneration and 2 percent through rehabilitation and mine reclamation. Carbon modeling analysis suggests that following through with these restoration options could reduce carbon emissions by 41.7 percent in 2030 compared to the business-as-usual scenario.

Restoration through natural regeneration in South Sumatra is envisioned to include tree-planting activities using local species with or without additional silviculture techniques to accelerate regeneration processes. In the Musi Watershed, natural regeneration may take place mostly within conservation and production forest areas. Due to its susceptibility to anthropogenic disturbance, this restoration option requires strong policy implementation at the local level and active participation of stakeholders to maintain natural succession. This is particularly crucial in the buffer zones of protected areas, which serve as an interface between protected areas and communities or privately-managed land.

The analyses also suggest that enrichment planting which utilizes local and/or commercial species, is best done through agroforestry and social forestry. These activities, if conducted effectively, yield high benefit-to-cost ratios and would help to ensure that local people gain the socio-economic benefits of restoration. The requirements for this approach include good quality of seeds and seedlings, a dedicated workforce and suitable agricultural practices.

Rehabilitation and mine reclamation include revegetation of heavily degraded land, and this tends to be more resource- and time-intensive. The use of suitable technology and adaptive species is crucial in this type of restoration.

Other diagnostics, action plans and financing

At the microlevel, ROAM-based collaboration with the FMUs within the Musi Watershed resulted in several restoration diagnostic and action plan documents. Many of these documents indicate the high potential for various restoration and restoration-related approaches, such as ecotourism, development of agroforestry and non-wood forest products, and private-public-community collaborative management, to be implemented in the respective FMUs. These documents also serve as business plans for attracting potential funding. Public finance is insufficient for restoration, and therefore it is important to make restoration profitable and capable of attracting private investment.

Conclusions

Past restoration-related projects in Indonesia have not been very successful for various reasons, particularly lack of coordination among different levels of authority in implementing restoration plans. ROAM was adapted and used in South Sumatra at three different levels (macro, meso and micro) within a landscape to assess restoration potential in an inclusive, comprehensive manner and to increase the capacity of stakeholders in following up on the results. Results include restoration intervention options, priority areas for restoration, cost and benefit calculation, carbon emissions' scenarios, diagnosis of the presence of key success factors, action plans and financing options for restoration. Results at each level affected ROAM results at the other levels, therefore synchronization and iteration of restoration planning at the three levels are crucial to effectively leverage restoration incentives and avoid repeating past failures. Further, the participatory ROAM framework could provide the backbone for an effective restoration monitoring system, for example through a combination of best available satellite technology and crowdsourcing.

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Promoting the role of natural regeneration in large-scale forest and landscape restoration in Myanmar

■ Soe Myint Oo*

Background and current situation

The current forest cover in Myanmar is 42.92 percent of the land area, with 21.56 percent under closed forest and 21.36 percent under open forest. Degraded forests cover 22.29 percent of the land area. Forests in Myanmar are managed through ten-year District Forest Management plans for each of the 68 districts across the country. The Myanmar Selection System (MSS) was started in 1881 to manage the forest resources on a sustainable basis and obtain a sustained timber yield. Silvicultural operations are carried out to improve forest quality and forest plantations are also established in the degraded forest areas for various purposes. Recent Forestry Sector Reforms to address ongoing deforestation and degradation issues include timber logging bans in 2016-2017, revision of the Community Forestry Instructions, submission of revised forest and wildlife laws for enactment and setting timber extraction limits for meeting domestic timber demand.

In order to maintain and increase the existing forest cover of 42.92 percent, Myanmar will implement a restoration and rehabilitation programme for a ten-year period from 2017-2018 to 2026-2027. The restoration and rehabilitation programme includes plans for ANR of 34 889 hectares in the initial year and 331 258 hectares over the ten-year period.

Implementing ANR in Myanmar

The Tactical and Operational Plan for implementing ANR in Myanmar includes:

1. Site selection – depending on the forest types.
2. Surveying and mapping.
3. Enumeration of tree species' stock.
4. Coppicing, if needed, and pruning.
5. Cleaning and cutting of vines.
6. Improvement felling, if needed.
7. Fire control.
8. Guarding/patrolling.

* Myanmar Forest School, Forest Department, Ministry of Natural Resources and Environmental Conservation

There is a good opportunity for implementing ANR in Myanmar through the conventional forest management system (MSS), a good tool for promoting forest development and sustainable forest management. There is a policy imperative to restore forest diversity, and increasing awareness and adoption of the Myanmar Reforestation and Forest Rehabilitation Programme with integrated management of both conservation and production.

However, implementation of ANR faces the following challenges:

- Limited knowledge of the ecological processes of plant succession makes it difficult to assess the natural regeneration potential of an area and to operationalize ANR;
- The labour- and knowledge-intensive nature of ANR can make it an expensive process if not conducted properly;
- The fast returns from plantations, involving more direct and simple economic planning compared to the lack of technical expertise and financial support for ANR disadvantages the latter in many areas;
- ANR does not ensure growth of the commercially-important tree species. Consequently, economic and financial viability are perceived to be low;
- Disturbances such as fire and illegal logging may become dominant limiting factors for successful implementation of ANR; and
- ANR requires constant monitoring, and thus, it is best suited to areas where it is important to conserve natural forest vegetation and in protected areas.

Conclusions

There are large areas of land available in Myanmar for conservation and restoration through simple and convenient means. ANR techniques are generally more precisely known than those for the establishment of various types of plantations, and ANR is definitely less expensive than plantation establishment. However, more information is required on ecological benefits derived from ANR versus those from plantations. Commercial products and returns may be higher in artificial restoration/plantations. ANR could be supported for nature conservation and sustaining the natural resource base for future generations.

Sustaining forest restoration through natural regeneration: Application of the assisted natural regeneration (ANR) method in the Philippines

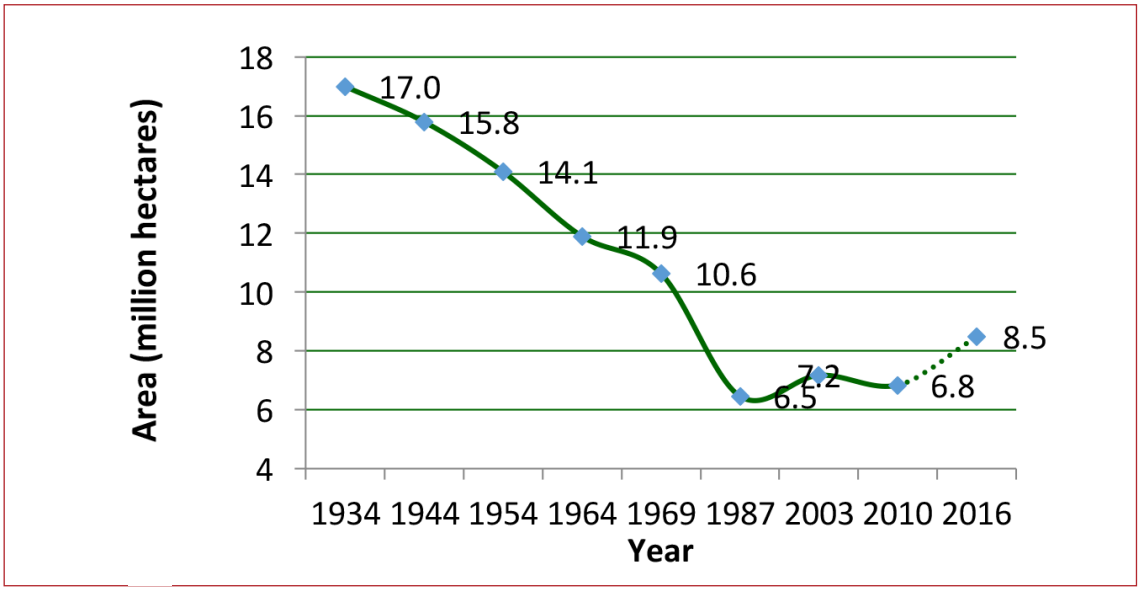
Emma N. Castillo*

Introduction

Of the total land area of 30 million hectares in the Philippines, 15.8 million hectares are classified as forest land and 14.2 million hectares as alienable and disposable land[1] (DENR-FMB 2016). Forest cover in the Philippines declined continuously from 16.9 million hectares in 1934 to 6.84 million hectares in 2010 (FMB 2015).

Since 2011, there has been a significant increase in forest cover to 8.5 million hectares in 2016, attributed to forest restoration[2] and protection activities undertaken in the country including the National Greening Program (NGP) from 2011-2015 (FMB 2017, Figure 1). The new Presidential Executive Order 193 (2015) expands the coverage of the NGP from 2016 to 2028 to cover remaining unproductive, denuded and degraded forest lands estimated at 7.1 million hectares.

Figure 1. Forest cover in the Philippines (FMB 2015)



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1 Alienable and disposable land refers to the land of public domain, which has been classified and declared as such and is available for disposition (Presidential Decree 705, 1975).

2 Forest restoration activities, as referred to here, include rehabilitation, reforestation, ecological restoration, plantations, agroforestry and other forms of enhancing tree cover.

A long history of forest restoration in the Philippines

Forest restoration initiatives in the Philippines started in the early part of the nineteenth century. Over time, several forest restoration approaches and strategies were adopted with the concerted efforts of government at different levels, peoples' organizations (POs), civil society organizations (CSOs), development partners and others. Notable initiatives have included the Osmena Reforestation Project in Cebu in 1916, the Magsaysay Reforestation Project in 1919, the Makiling Reforestation Project in the late 1930s, the Program for Forest Ecosystem Management in the 1970s, the Forestry Sector Project I (1987), which featured the Family Approach to reforestation, the Forestry Sector Project II (1995) implemented through community-based forest management, the Industrial Forest Management and Socialized Industrial Forest Management programmes in the 1990s (Chokkalingam et al. 2006) and the NGP since 2011. Forest restoration activities were applied in grasslands, communal forests, mined-out areas, protected areas, Timber License Agreement areas and private lands among others.

Experience with ANR

The Philippines thus has a long history of forest restoration, much of it through tree planting. However, in 1989, natural regeneration was formally promoted through the official introduction of the ANR method through DENR Memorandum Circular No. 17 (DENR 1989). The policy underscored the prioritization of the application of the ANR method in the development of watersheds, protection and production forests. The policy enunciated that the ANR method is economical and cost-effective, and helps to accelerate the re-establishment of vegetative cover that approximates a natural forest in terms of species diversity and composition. Further, the Revised Guidelines for Contract Reforestation (DENR Administrative Order 31, 1991) were issued, mandating the adoption of ANR in the development of protection forests in production forest lands, e.g. on riverbanks and areas with steep slopes.

However, although the method was espoused by some regional field offices, progress on ANR adoption was hindered by resistance within the government itself to changing the forest restoration strategy. There was also a lack of knowledge and skills on ANR methodology, and concrete evidence/study to prove that it was a cost-effective strategy. Communities did not know much about ANR because the method was not introduced to them.

In 2006, the Forest Management Bureau (FMB) of the Department of Environment and Natural Resources (DENR) and FAO launched a three-year project on ANR in Luzon, Visayas and Mindanao (FAO 2010). The results of the project validated that ANR implementation can expedite the restoration of mature forest and biodiversity in areas dominated by Imperata cylindrica and similar fire-prone grasses within a span of 17-18 months. Further, an analysis of costs showed that forest restoration through ANR is approximately 50 percent less expensive than conventional reforestation methods (ANR method costs US$579 while conventional reforestation costs US$1 048 per hectare). The positive results of the project attracted strong support from the DENR, other government agencies and private companies/organizations.

Further development of ANR-related policies and programmes

Several additional policies related to ANR have since been issued:

- The DENR issued a national policy on 8 October 2009 wherein ANR was one of the major activities promoted in forest restoration by different tenurial instrument holders;
- ANR was institutionalized in the mining sector (ANR was one of the selection criterion for the Annual Best Mining Forest Program Award starting in 2010);
- Private companies and NGOs were provided with financial support for the expansion, maintenance and protection of established ANR sites;
- In the Implementing Rules and Regulations (IRR) of Presidential Executive Order No. 193 (DENR Administrative Order 2016-20 [2015]) on expanding the coverage of the NGP, ANR is one of the targeted activities for the enhancement of existing forests;
- ANR is one of the recommended activities in the Philippine National Action Plan on FLR 2016-2018 (DENR-FMB and FAO 2017); and
- ANR is included as a restoration option in almost all Forest Land Use Plans in the country.

ANR is included as one of the major restoration technologies in several projects such as:

- ANR was mainstreamed in the Upland Development Program from 2009 up to 2010, wherein more than 13 000 hectares were developed through ANR (FMB unpublished results);
- The Integrated Natural Resources and Environmental Management Program (INREMP) seeks to address unsustainable management practices in four river basins in 23 watersheds, and restore around 78 800 hectares in Chico, Wahig-Inabanga, Upper Bukidnon and Lake Lanao Watersheds through ANR (INREMP 2016);
- The Forestland Management Project has targeted more than 5 000 hectares for restoration through ANR; and
- The In-Country Project supported by the ASEAN-Republic of Korea Forest Cooperation (AFoCo) has established ANR experimental and control sites (DENR-FMB 2015).

Challenges encountered in the mainstreaming of ANR

Despite the success in this round of ANR application, there are still a number of challenges for its mainstreaming:

- The ANR method is not well-recognized for large-scale restoration due to limited technical personnel with the knowledge and skills to demonstrate actual ANR application in situ;
- The scope of ANR versus other techniques such as enrichment planting and Timber Stand Improvement is unclear to many practitioners;
- Successful ANR application requires a thorough understanding of the biophysical, technological, socio-economic and cultural conditions prevailing in the area, such as drivers of forest degradation and distance to natural forests and seed sources; and
- Socio-economic incentives and benefits such as viable products and market access need to be developed for different stakeholders to engage in ANR.

Conclusions and recommendations

The Philippines has nearly 30 years of experience with ANR, making it one of the leaders in the application of ANR for forest restoration in the region. ANR has been introduced and integrated into national policies and implemented in various projects and programmes. The method's ability to accelerate restoration of natural forests as well as its cost-effectiveness have been proven in the field. However, various challenges still remain for its effective mainstreaming into forest restoration efforts in the country. Some recommendations for addressing the challenges are listed below:

- Issue a technical bulletin on ANR to guide technical personnel in its implementation;
- Conduct capacity training and transfer of technology on ANR for field technical personnel;
- Awareness needs to be raised that ANR[3] is actually a very flexible approach that can be adopted to the needs of the site and stakeholders. It can include enrichment planting and could be synonymous with *Timber Stand Improvement* if implemented with the purpose of improving degraded forest stands;
- Review the policy on the Application of ANR in watershed/protected areas to include incentives and livelihood benefits for partner POs and communities;
- Identify and develop socio-economic incentives and benefits for different stakeholders to engage in ANR; and
- Provide support to ensure the long-term sustainability of established demonstration sites in Bataan, Bohol and Davao del Norte.

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3 According to the Philippine official reference for forest-related terms and definitions (DENR-FMB and ITTO 2006), ANR is a process of rehabilitating degraded forest lands by taking advantage of trees already growing in the area. This usually involves the following activities: locating and releasing of indigenous trees, maintenance and augmentation planting and protection.

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Forest restoration by natural regeneration in Viet Nam: Experiences, challenges and opportunities

Tran Lam Dong,[1] Ha Thi Mung[1] and Quach Dai Ninh[2]

Introduction

Forest cover in Viet Nam declined from 14.3 million hectares (43 percent of the land area) in 1943 to 9.1 million hectares (27 percent of the land area) in 1990 with severe forest landscape degradation due to overlogging, shifting cultivation and war. Over the past three decades, Viet Nam has conducted considerable forest restoration efforts (de Jong et al. 2006), with a resultant rise in forest cover from 9.1 to 14.4 million hectares (covering 41.2 percent of the total land area) by 2016. Natural forest cover rose from 8.3 to 10.2 million hectares, and plantations rose from 0.8 to 3.9 million hectares from 1990 to 2015 (FSIV 2009; MARD 2017).

Government attempts to mobilize nationwide efforts towards forest protection and development began in the early 1990s with a series of policies to support forest restoration and the launching of two national reforestation programmes: the 'Greening the Barren Hills – 327 Program' from 1992 to 1997 and the 'Five Million Hectares Reforestation Program – 661 Program' from 1998 to 2010. The 327 Program contributed to the recovery and/or enhancement of about 2 million hectares of forest, in which 0.3 million hectares comprised enrichment planting, 1.6 million hectares of natural regeneration of degraded forests through contracts for forest protection issued to 466 000 households and 0.4 million hectares through planting of acacia, eucalypt and several native tree species (MARD 1998). The 661 Program contributed to the recovery of nearly 5 million hectares of forest, including 1.3 million hectares through ANR, 2.5 million hectares of new planting (1.6 million hectares of commercial acacia and eucalypt species, and 0.9 million hectares of native tree species) and 0.9 million hectares of industrial crops and fruit orchards (MARD 2011).

The natural forest area recovered from 1990 to 2015 constituted nearly 2 million hectares, largely through ANR and enrichment planting of degraded natural forests. Forest land allocation and government funding from the reforestation programmes were the key incentives for stakeholders to maintain these forests. Most of these areas were allocated to local households and communities through contracts for either: (i) protection, where the capacity for regeneration was high (i.e. high abundance of native saplings) or (ii) enrichment planting of valuable tree species, where there were gaps or a lack of saplings (MARD 2011). However, after the programmes ended, the most challenging issue for continued forest enhancement and maintenance was the lack of incentives for further planting.

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Challenges for conducting and maintaining natural regeneration

Most regenerated forests were poor in stock volume and biodiversity, and they were allocated to local ethnic households and communities who had limited financial and forest management capacity. Costs for ANR and enrichment planting were high, while income derived from forest products was negligible, with communities mainly collecting non-wood forest products (NWFPs) for local use. The nationwide policy of payments for forest ecosystem services (PFES) implemented in 2010 is currently the main incentive for forest protection by local households or communities, although the benefits are not equally distributed to all forest areas. Payments are limited to the watershed areas where hydropower plants and freshwater suppliers operate, and are based on their scale of operation. Other services derived from forests, such as tourism, carbon sequestration and aquaculture, are still being researched (Thuy et al. 2013). In addition, the perceived advantages of acacia and eucalypt plantations such as a good market, easy planting and fast-growing ability as well as the pull of cash crops (rubber, coffee, macadamia) are resulting in widespread conversion of the degraded natural forests, although it is not permitted.

There are also technical barriers for forest restoration by natural regeneration. Most of the degraded forests lack desirable species and are dominated by highly competitive vegetation such as bamboos and grasses which inhibit the regeneration of trees and other desirable species. Several studies on ANR and enrichment planting were conducted by the Vietnamese Academy of Forest Sciences, and supported by international organizations such as the Japan International Cooperation Agency (JICA), ASEAN-Korea Environmental Cooperation Project (AKECOP) and the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet). The key findings were that without silvicultural intervention, the regeneration process takes a much longer time. For enrichment planting, understanding the site requirements of the species and carrying out site-species matching are very important (Nghia 2008). Planting techniques for many native tree and NWFP species have been successfully researched and can be applied in practice, but further research on these species in the context of ANR or integrating them into degraded forest ecosystems through enrichment planting is still necessary (Nghia 2008).

Conclusions

Although there are many challenges, the ecological value of natural forests and their importance for environmental protection has been widely recognized in Viet Nam. Millions of hectares of natural forest are degraded but they have high potential for recovery. Viet Nam has a tropical climate, it is rich in biodiversity and has favourable physical conditions for the natural regeneration of forest ecosystems. In addition, the government has made much effort to restore and maintain natural forests, with many policies issued, including halting the conversion of degraded natural forests into plantation or agricultural land, logging bans in natural forest, promoting community forest management, promoting PFES and, recently, the development of a national

forest certification scheme which supports sustainable forest management. Priorities for research on forest restoration by natural regeneration need to be identified and this process could provide an information base upon which to develop a conceptual model to address the identified challenges.

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3.5. Key economic and social aspects for successful integration of natural regeneration in FLR

Impacts of large-scale forest restoration on socio-economic status and local livelihoods

Chetan Kumar*

Limited knowledge on socio-economic impacts of FLR

Forests are sources of wood, non-wood forest products and ecosystem services that benefit society as a whole, and are important to rural livelihoods. Forest and landscape restoration (FLR) has been proposed as a way to counteract deforestation and reconcile the production of ecosystem services and goods with conservation and development goals. But there is limited evidence on how large-scale forest restoration could contribute to improving local livelihoods. This paper examined the results of a systematic review of scientific literature to reduce this knowledge gap (Adams et al. 2016). The main goal was to consolidate and analyse existing knowledge on socio-economic benefits from FLR initiatives on local livelihoods. The paper does not intend to provide an exhaustive coverage of the literature, but to investigate patterns and identify socio-economic aspects that can contribute to shaping future FLR initiatives.

Literature review to fill the knowledge gap

The literature review used the Thomson-Reuter Web of Science database from 2000–2015, using the following key words as topics: reforestation* livelihoods, reforestation* governance, forest restoration* livelihoods and forest restoration* governance. Additionally, reports and other types of grey literature were accessed, but not checked systematically. References cited on the reviewed literature were also checked and new papers were included if relevant. The initial search on the Web of Science yielded 263 articles that were checked and filtered according to the availability of information on socio-economic impacts (positive, negative) of forest restoration/reforestation initiatives, independent of the scale of the study (local, landscape, national, global), resulting in 67 articles. Papers not related to the topics under review were eliminated, as well as local case studies with no information on livelihood impacts. Papers discussing reforestation and restoration governance were selected for further analysis. Relevant grey literature and references cited in the reviewed

* Global Forest and Climate Change Programme, International Union for Conservation of Nature (IUCN)

literature were added, resulting in a database with 123 references. All the papers were read and reclassified according to the availability of explicit information on livelihoods, resulting in a final database of 46 articles.

Findings

Most (89 percent) of the literature referred to case studies, the bulk being concentrated in China (49 percent), followed by Ghana, Niger, Ethiopia (9 percent each), and Mozambique and Viet Nam (4 percent each). The main theme explored was income (evaluated in 58 percent of the papers); followed by livelihood diversification; off-farm employment opportunities; poverty reduction; equity; and the provision of timber, fuelwood and fodder as ecosystem services. Nearly 60 percent of the papers discussed the importance of governance systems for socio-economic outcomes.

The reforestation/restoration programmes and policies investigated in the studies had mixed socio-economic effects on local livelihoods depending on other variables, such as availability of off-farm jobs, household characteristics, land productivity, land tenure and markets for forest products and ecosystem services. Availability of off-farm jobs, for example those created by governments and donors, was one of the key factors leading to the full or partial success of some reforestation/natural regeneration efforts, which also raises concerns about the sustainability of the approach.

Reported benefits included provisioning services, for example timber, fuelwood and fodder, as well as decrease in time for collecting these items and/or the money saved from buying them for contributing to increased household income. Agroforestry and Farmer Managed Natural Regeneration initiatives from Africa also reported an increase in food production and availability of food from the forest during lean seasons.

The main reported impact of large-scale forest restoration on local livelihoods was diversification of livelihoods caused by the freeing up of labour due to land-use change, and increases in cash income from off-farm jobs (when available), government payments and selling of household surplus produce. But some papers reported an adverse impact on livestock grazers and other forest product-dependent communities due to the ban on logging and grazing, and lack of compensation.

The main observed change in agricultural strategies was agricultural system intensification due to abandonment of shifting cultivation or changing property rights from collective to private property, for example. In the Sahel, agriculture has intensified with positive impacts on the local economy, in spite of population growth. However, in Viet Nam, intensification has resulted in numerous unintended consequences such as nutrient depletion, the disruption of collective land-use systems and conflicts over non-wood forest products and grazing land.

Conclusions

The effects of large-scale restoration initiatives on local livelihoods may vary due to several factors and are still unclear for many situations; therefore, monitoring over time with clear indicators is needed. Although the restoration initiatives can bring an array of positive socio-economic benefits, there are negative impacts as well, which should be considered in future planning.

Bottom-up participatory initiatives in Africa seemed to have more positive socio-economic impacts than top-down initiatives put in place by governments. Household heterogeneity, for example how households differ in their assets, access to productive land, labour, land tenure and livelihoods need to be better understood before planning natural regeneration/ restoration interventions. Multiple and mixed-use systems reported greater contribution to socio-economic benefits but they need to be planned through local consultation. Although not explicit in the case studies, the benefits to people are mediated through adaptable institutional and governance systems.

More empirical evidence is needed on how livelihoods are affected by and can be enhanced by natural regeneration. This includes the kind of institutional and governance arrangements that can help to achieve both ecological and human well-being through natural regeneration, as well as the impacts of markets, commercial crops and labour shortages on natural regeneration.

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Assisted natural regeneration: A cost-efficient option for achieving global FLR targets?

Christophe Besacier*

According to the Global Partnership on Forest Landscape Restoration (GPFLR), there are about 2 billion hectares of degraded land across the globe that would benefit from FLR (Liagre et al. 2015). Substantial amounts of investment are required to restore these vast areas of degraded landscapes. Estimated costs for restoring the 150 million-hectare target from 2011-2020 under the Bonn Challenge are US$36 billion per year, the 350 million-hectare target from 2014-2030 under the New York Declaration on forests is US$49 billion per year and the 2 billion-hectare land degradation neutrality target (SDG 15.3) is US$318 billion per year (Liagre et al. 2015). Does ANR provide a cost-effective option for addressing national and global FLR targets?

This paper addresses the financial aspects of ANR, starting with available financing options and expectations, available data on costs and benefits of ANR versus other options, and recommendations to address the data gaps.

Financing options to meet national and global FLR targets and investors' expectations

There are numerous possible funding sources for FLR at national to global levels. Available sources include:

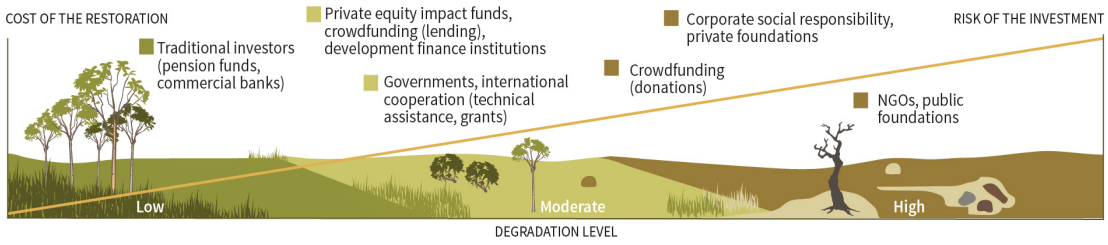
- Climate finance – voluntary carbon markets, REDD+, corporate social responsibility (CSR), small grants, adaptation funds, the Green Climate Fund, national climate funds;
- The private sector – CSR, private impact funds, institutional investors;
- Development cooperation – development finance institutions, technical cooperation agencies;
- Non-governmental funding – international, national and local NGOs and foundations;
- Environmental funds – extrabudgetary funding;[1] private, public, national and international sources;
- State budgets and resources – FLR integrated into the budgeting system, public incentives for FLR (e.g. payments for ecosystem services); and
- Non-traditional funding – crowdfunding.

* Food and Agriculture Organization of the United Nations (FAO)

1 Extrabudgetary funds refer to general government funds, often with separate banking and institutional arrangements that are not included in the annual state budget law and the budgets of subnational levels of government (Allen and Radev 2010).

However, these different investors have different expectations in terms of acceptable risks of investment. Costs and risks vary with the type of ecosystem and level of degradation of the land. The more degraded the landscape, the higher the cost of restoration and the higher the risk of investment. Traditional investors such as pension funds and commercial banks are willing to accept only low costs and low levels of risk, while private foundations, companies investing for CSR purposes, NGOs and public foundations are willing to accept higher costs and levels of risk (Liagre et al. 2015). Private equity impact funds, crowdfunding, governments and international cooperation are willing to accept moderate levels of risk (Figure 1).

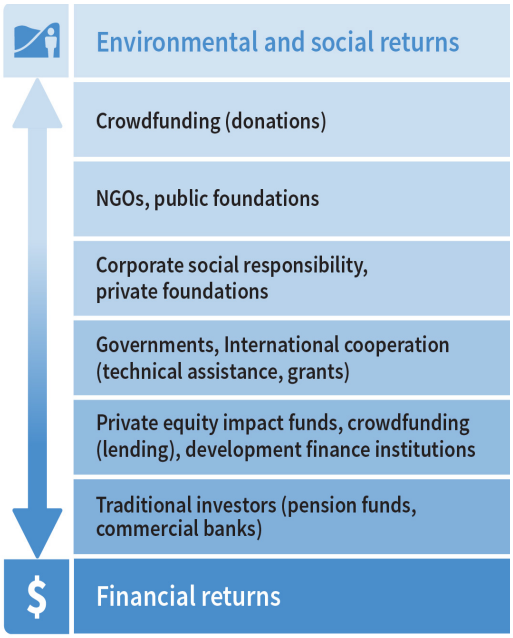
Figure 1. Cost and risks of FLR, and different investors' levels of risk acceptability (Liagre et al. 2015)



Beyond costs and investment risks, different types of investors expect different types of returns or benefits (Figure 2). The benefits of FLR investment include various socio-economic as well as environmental benefits. Types of socio-economic benefits include job and income creation, wood and non-wood forest products, enhanced crop yields and food security, resilience of community livelihoods, and cultural and recreational benefits. Environmental benefits range from restored degraded land/ecosystems to soil conservation, climate change mitigation and adaptation, disaster risk reduction, improved habitats and biodiversity, and enhanced freshwater supplies.

Traditional investors, private equity impact funds and development finance institutions require adequate financial returns; while crowdfunding (donations), NGOs and public foundations focus more on environmental and social returns. CSR, private foundations, governments and international cooperation expect moderate financial returns and environmental and social returns. Both socio-economic and environmental benefits should be included in any FLR cost-benefit assessment (Liagre et al. 2015).

Figure 2. Different investors expect different types of returns



Costs and benefits of ANR versus other options

There are limited data in the literature comparing the costs of natural regeneration versus those of conventional restoration options, and even fewer on returns on investments. Some available literature (Table 1) suggests that ANR is definitely a less-expensive option, but it would be important to also compare the returns on investments and the multiple benefits of different FLR options. IUCN's ROAM analyses in Uganda (Ministry of Water and Environment – Uganda 2016) and Rwanda (Ministry of Natural Resources – Rwanda 2014) indicate less than half the cost for ANR versus conventional agroforestry options but also a lower return of investment compared to several agroforestry options.

Table 1. Forest area targets and restoration targets for some AMS

Region	Country	Estimated costs of assisted natural regeneration	Estimated costs of conventional options
Africa/Sahel East Africa	Niger[1] Uganda[2] Rwanda[3]	US$50-100/ha US$15-25/ha US$465/ha but low return on investment compared to several agroforestry options	US$150-300/ha US$925-1 500/ha > US$1 100/ha for several agroforestry options
Mediterranean (Maghreb)	Morocco	US$25/ha/year (incentive to local cooperatives for surface >300 ha)[4]	> US$1 500/ha[5]
Asia-Pacific[6]	Philippines Cambodia Indonesia	US$500-600/ha (US$579) ~ US$250/ha < US$300/ha	> US$750/ha > US$750/ha US$750-1 000/ha

1 Secrétariat du Fonds Français pour l'Environnement Mondial (2016)
2 Ministry of Water and Environment – Uganda (2016)
3 Ministry of Natural Resources – Rwanda (2014)
4 El Mokaddem et al. (2014)
5 Bouyer and Le Crom (2013)
6 Shono et al. (2007)

ANR is, sometimes, not the best FLR option but one option in the range of possible FLR techniques. A mix of measures is generally required at the landscape level to address all restoration issues, particularly in very degraded landscapes with strong anthropogenic drivers. Depending on the key drivers and on the level of degradation, ANR can integrate a mix of solutions such as fire prevention measures (firebreaks), overgrazing protection measures or simple management plans for fuelwood collection for example. It would also be important to look at the priority of investors (e.g. carbon) to fine-tune the strategy.

The main well-recognized benefits of ANR[2] to scale up FLR initiatives include:

- A cost-efficient way of regenerating degraded forests;
- Job opportunities for communities;
- An excellent option to contribute to strengthening biodiversity;
- An opportunity to maintain habitats that are providing multifunctional landscapes and multiple goods and services (such as hunting, recreation, freshwater and non-wood forest products); and
- A cost-effective climate change mitigation option.

Conclusions and recommendations to address existing data gaps on ANR costs and benefits

ANR is a cost-effective option in multiple regions for preserving local biodiversity and avoiding the replacement of a native ecosystem by a non-native ecosystem. It is a good option for scaling up FLR efforts, in particular in areas with a lack of both public/private investments (e.g. in the Sahel region in Africa). However, implementing ANR requires: (i) adequate governance at the landscape level (effective contracts), (ii) strong involvement/ownership of local stakeholders (multistakeholder dialogue is needed through the planning, implementing and monitoring phases) and (iii) relevant local financial instruments/incentive packages (e.g. incentives for grazing exclusions paid since 2002 with domestic financial resources in Morocco (El Mokaddem et al. 2014).

Available data on the costs and multiple benefits are fragmented in all regions, with existing databases not being easily accessible, user-friendly or comparable. There is a strong need for harmonized FLR/ANR cost-benefit analyses to guide decision-makers in their strategic technical and financial choices at all scales. It would be important to generate and share further comparable, transparent data and information on ANR/FLR financing issues on global/regional knowledge platforms and hubs; and to promote a global/regional community of practices on key issues in current regional FLR initiatives (e.g. in the Asia-Pacific FLR Strategy and Action Plan in preparation with the APFC).

2 http://www.fao.org/forestry/anr/en/

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Creating incentives for rural communities to enhance natural forest regeneration

Patrick Dugan*

Introduction

Within the Asian region, forest restoration and improvement are needed on millions of hectares of denuded and degraded lands. For decades, many forest agency personnel, policy-makers, NGOs and the general public have perceived conventional tree-planting as the primary way to regenerate forests. The costs of conventional tree planting to cover such large areas will be tremendous, and it may also not be the most appropriate method for certain objectives such as biodiversity conservation and watershed protection. Assisted natural regeneration (ANR) offers a cost-effective option for enhancing the capability of financially-constrained Asian countries to accomplish key forest restoration and improvement objectives. By avoiding or minimizing seedling production and planting costs, ANR reduces regeneration expenses by 30 to 60 percent when compared to conventional reforestation techniques. Moreover, species-to-site matching mistakes are avoided.

However, achievement of natural regeneration goals requires years of sustained effort. It takes time for small seedlings in place today to evolve into the envisioned and desired forests through sustained maintenance and protection from fire and other disturbances. Thus, in addition to increasing technical knowledge and capability for implementing natural regeneration, it is crucial to identify reliable, 'hands-on' providers for constant maintenance and protection. Fundamental to that reliability is their steady, uninterrupted physical presence. The parties most able to respond to this prerequisite are members of communities residing adjacent to and within natural regeneration sites. Enlisting the cooperation of these communities through discussions and participatory planning and implementation is therefore an essential component of ANR. However, most of these communities face widespread poverty. Given their difficult struggle for subsistence, creation of socio-economic incentives to undertake the natural regeneration option, and maintain and protect the regenerated forest is a vital component of any programme to help bring about natural regeneration.

Some successful examples of incentives for communities

Some successful examples of incentives for poor rural families to invest effort and time on natural regeneration of forests are listed below:

- Community residents were paid to establish five-metre firebreaks within and surrounding sites infested by *Imperata cylindrica* in Solok Watershed, Singkarak West Sumatra; Bohol Province in the Philippines; Naxeng Village in Feuang District, Vientiane, Lao PDR; and Dambhok Khpos, Kampot Province, Cambodia (Ganz and Durst 2002).

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Once firebreaks were in place, the residents in the above-mentioned cases were provided with seeds and other planting material for food and non-timber crops they could grow in the firebreaks. Planting of shade-tolerant food crops that can help to satisfy domestic consumption needs and/or market demand is a practical way to provide incentives for local community participation.


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Peanuts planted on a firebreak

- In Ifugao Province, the Philippines, a local forest agency officer sourced modest savings from his office budget to purchase basketballs and notebooks that were donated to villagers in his district who prevented fire: i.e. he established a 'no-fire-bonus' incentive (Butic and Ngidlo 2002).
- While a mixed-species forest is usually ideal for watershed management purposes, interplanting of fruit tree, premium non-timber or timber species may be desired for socio-economic reasons. Under these conditions, ANR establishes a foundation for the development of either agroforestry farms, non-wood forest product or timber production areas that would create incentives for sustained maintenance and fire prevention, as well as preventing timber poaching and unregulated grazing.
- There are ongoing projects in several Asian countries working on the development of payments for ecosystem services (PES). These PES projects can provide funds for starting up natural regeneration (e.g. firebreaks, seeds for food crops and tools for creating firebreaks).[1]
- Availability of training and demonstration initiatives on ANR, such as in FAO-supported training sites, providing hands-on training on how to apply the method, establishing firebreaks, tending of the natural regenerants, inhibiting competing vegetation and protecting against poachers or grazing animals (UNDP-SGT 2007).

Development of incentives for community participation will almost always have site-specific factors to consider. For instance, what shade-tolerant food and non-timber crops would local communities prefer to interplant among trees, given domestic consumption needs and prospective sources of income (e.g. medicinal plants, handicrafts). Careful consideration of all relevant factors and adoption of a combination of approaches in response to the site conditions, objectives and community needs can help to increase chances for expanding natural regeneration initiatives.


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Interplanting with rattan

Potential enabling conditions for creation of incentives

Some enabling conditions are required for the development and creation of appropriate incentives for communities to engage in natural regeneration of forests. Some potential enabling conditions which could have positive impacts for moving forward are listed below:

- Broad sectors of the general public have severely limited perspectives of forest management and conservation. Oversimplified, these perspectives may be described as a belief or view that forestry consists of only two elements: Tree planters –the 'good guys' and tree cutters – the 'bad guys'. Enlarging these perspectives to recognize the enormous challenges posed by issues of poverty, tenure security, and peace and order that impinge on forestry, may help to lead to crafting of policies, programmes and budgets that make it feasible to put incentives in place.
- Media can and should play a major role in broadening perspectives. But enlarging of general public perspectives needs to be accompanied and driven by investments in time and effort to concurrently expand the perspectives of media practitioners as well.
- Policies and budgets that govern operations of government forestry agencies almost invariably prioritize seedling propagation and planting, and expenditure for these activities. There is a need to enlarge the perspectives of policy-makers and forestry agencies to understand the scope and potential for natural regeneration as an appropriate strategy to restore forests in many locations. Long-term funding for natural regeneration, protection and maintenance should be considered a high priority.
- Government agencies, donors, NGOs and other relevant agencies should incorporate long, and generally unrestricted time frames for the implementation of processes essential for establishing credibility and mobilizing community participation (Walpole 2002). The 'rush-rush' mindsets prevalent in urban office settings are not appropriate in the countryside.

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Annex 4. Field visit to Pingxiang

Workshop participants went on a one-day field trip to the Experimental Center of Tropical Forestry (ECTF), Pingxiang in Guangxi Zhuang Autonomous Region, and visited a number of experimental sites as well as the Chinese Academy of Forestry (CAF). The ECTF comprises four forest farms covering about 19 000 hectares, of which 13 000 hectares are forested, almost entirely with plantations. The ECTF has over three decades of forest research experience focusing on the intensive management of tropical and subtropical plantations, as well as the domestication and cultivation of broad-leaved tree species that are native to the region.

Since 2008, the ECTF has embarked on an experimental programme to test close-to-nature forestry, with the aim of developing sustainable approaches to the management of China's subtropical forest plantations and the rehabilitation of degraded natural forests. Close-to-nature forestry uses natural processes as much as possible to obtain healthy, functioning, productive forests that are resilient to environmental change and economically profitable. The ECTF's experiments on transforming declining monocultural plantations into diverse, multistoried, seminatural forests that are both highly productive and resilient in the face of environmental change are now beginning to produce results.

1. Fubo Forest Farm: Close-to-nature transformation applied in conifer plantations

Large areas of monoculture conifer plantations in China face problems with single stand structures, poor stand stability, low species diversity, high vulnerability to pests and diseases, and low productivity. To address these issues, the ECTF adopted a close-to-nature approach, introducing broad-leaved species into conifer plantations. The project aims to shift monoculture conifer plantations towards close-to-nature forests through thinning and interplanting, to create a multispecies, multistorey, biodiverse and sustainable forest with a stable structure and high productivity.

The ECTF selected 90-120 pine crop trees per hectare 14 years after planting, conducted a second thinning and left 375-450 trees/hm2 in the stand. They then planted valuable local species in the following spring at a planting density of 750 seedlings/hm2. They tend the young forest to manage valuable local species. They select 90-120/hm2 crop trees 15 years

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Visit to Fubo Forest Farm.

after enrichment planting, and focus on the crop individuals in subsequent management. An optimal environment is created for crop trees as well as understorey natural regeneration. Crop trees with diameter at breast height (DBH) of ≥60 cm can be harvested selectively.

Floral biodiversity has increased substantially in both Cunninghamia lanceolata and Pinus massoniana plantations. The standing volume, and the physical and chemical structure of the soil were greatly enhanced from 2007 to 2016.

2. Large-diameter Castanopsis hystrix plantation based on the close-to-nature approach

Castanopsis hystrix occurs naturally in Guangxi Autonomous Region. Stands of Castanopsis hystrix generate large amounts of litter, contributing to water and soil conservation and therefore have great potential for natural regeneration.

The project site was established to sustainably produce high-quality timber (DBH 40-60 cm) and promote the development of multistorey and uneven-aged stands. Natural regeneration is used to enrich biodiversity and achieve high economic returns at a low cost. The ECTF uses a crop tree individual management system, selecting and marking crop trees and felling competitors. Crop trees are harvested as soon as they reach the target diameter. Natural regeneration in the understorey is promoted and protected.

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Visit to the *Castanopsis hystrix* plantation managed on a close-to-nature approach.

Currently, the surface soil contains 53 tonnes of carbon per hectare and 3.2 tonnes of nitrogen per hectare, 14.3 percent and 23.1 percent more, respectively, than in a Pinus massoniana plantation of the same age and at the same location. Soil physical properties such as texture, water retention and permeability have all improved on the experimental site.

3. The Rocky Arboretum: Rehabilitation of degraded subtropical karst ecosystems

Southern China has many karst areas which are rocky outcrops with thin soils that provide a harsh environment for growing vegetation. Despite this, karst areas have a variety of ecological niches such as cracks in the rocks and areas with some soil that allow for the establishment of diverse species.

The initiative aimed to restore the degraded karst ecosystem on the experimental restoration site by planting suitable species. The ECTF has been collecting karst species since 1980, and has successfully introduced 334 species. Restoration has been achieved by closing areas to human pressure and facilitating seedling establishment, taking advantage of the natural regeneration of native tree species to accelerate the restoration process.

After 30 years, the severely degraded site has recovered into a stable, healthy, close-to-nature forest with a complex structure and abundant plant species. Carbon storage in the vegetation increased from almost zero in 1980 to about 80 tonnes per hectare in 2012.

4. Chinese Academy of Forestry (CAF)

Participants had the opportunity to visit the CAF and interact with the scientists and management there. Restoration initiatives at the ECTF were discussed, and CAF staff responded to participants' questions and shared information on forest restoration approaches and outcomes in China.

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Rehabilitated karst ecosystem.

5. Baiyun Forest Farm

Much of the land in southern China was once dense primary forest with rich biodiversity, large mature trees and little human interference. Over time, most of this primary forest was encroached and became highly degraded. The ECTF supports restoration of degraded subtropical forests through research in demonstration sites. It is a two-phase research programme: (i) to establish forest plant communities (1979-1986); and (ii) to promote close-to-nature restoration (since 2002).

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Visit to the Chinese Academy of Forestry.

Aiming to change the practice of planting large areas of monocultures, a demonstration forest was established with multiple native species that could regenerate naturally, being planted in patches. Up to now, more than 40 tree species have been planted in the demonstration area with each species/patch covering 1-2 hectares. As of now, after 30 years of implementation, a multi-age and biodiverse forest has been established on the experimental site. The forest is now in a natural successional state with forest trees regenerating naturally.

Annex 5. List of participants

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9	Quach Dai Ninh	Deputy Head, of Forest Development Department, Viet Nam Administration of Forestry of (VNFOREST), Viet Nam
10	Stephen Elliott	Co-Founder and Research Director, Forest Restoration Research Unit, Chiang Mai University, Thailand
11	David Lamb	Honorary Professor, University of Queensland, Australia
12	Liu Shirong	Chinese Academy of Forestry and International Center for Bamboo and Rattan
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