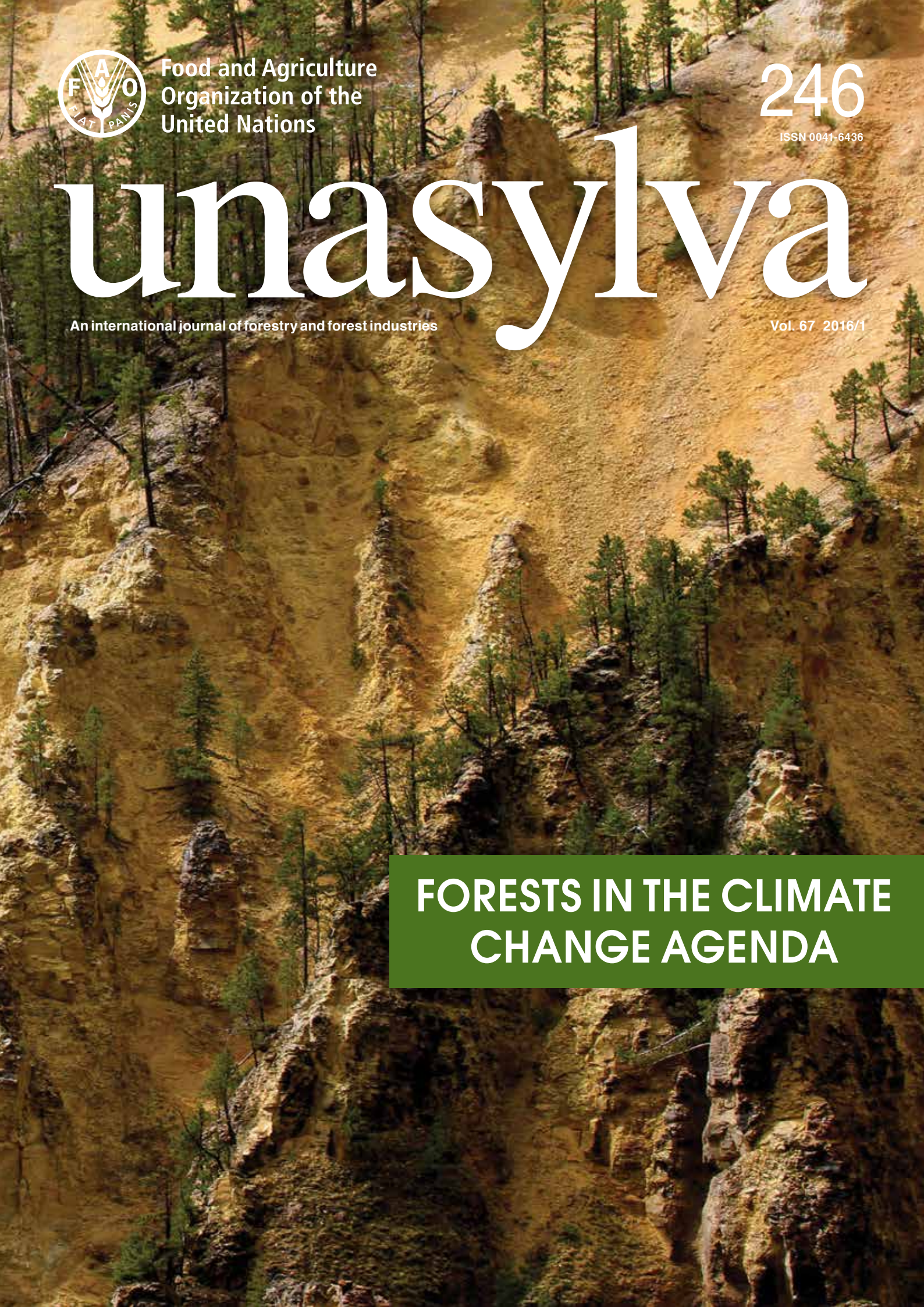

Food and Agriculture Organization of the United Nations

246

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An international journal of forestry and forest industries

Vol. 67 2016/1

FORESTS IN THE CLIMATE CHANGE AGENDA

Joining forces to achieve SDG15: Delivering on the global agenda for forests, climate and development

UN system side event

UNFCCC COP22
Marrakech, Morocco
Blue Zone, Arabian Room

16 November 2016
18.30–20.00

Interactive town hall discussion on REDD+ (reducing deforestation and forest degradation) and other land-use-related initiatives as powerful catalysts for delivering on SDG15 and achieving countries' Nationally Determined Contributions

Moderated by Matt Frei (Channel 4 News)

Speakers will include José Graziano da Silva (FAO Director-General) and Erik Solheim (UNEP Executive Director), with an international panel of ministers and high-level representatives from Chad, Costa Rica, Fiji, Ghana, Indonesia, the United Kingdom and other agencies (UNDP and World Bank).

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The FAO publications reviewed in *Unasylva* are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org.

Contents

Cover: Trees cling to the slopes of the Grand Canyon of the Yellowstone, United States of America
© Roy Luck

EDITORIAL

Almost one year has passed since the parties to the United Nations Framework Convention on Climate Change (UNFCCC) met in Paris and agreed to make a collective endeavour to limit temperature increases to below 2 °C. But between the intention and its realization lies a great deal of uncharted territory, and it is useful to map out what has already been accomplished. This issue of *Unasylva* comes just a few days after the Paris Agreement entered into force on 4 November 2016 and coincides with the 22nd Conference of the Parties of UNFCCC (COP 22), which will be decisive for the effective implementation of the agreement.

The articles cover a range of aspects relating to the role of forests in the climate change agenda. Together they provide a comprehensive overview, both for those already versed in the complexities of the issues and those who would like to gain a better grasp of them. Readers will be able to gain better insight into the background and status of ongoing climate negotiations, the functioning of mechanisms and initiatives such as Reducing emissions from deforestation and forest degradation (REDD+), and where these stand in the international architecture. They will also discover several interesting and innovative success stories that point the way to some avenues for further exploration.

The introductory article, by Iversen, provides a snapshot of the main international agreements relating to climate change, the place of forests within these agreements, and the obstacles that remain to be overcome. Although the UNFCCC has long recognized forests' key role in climate regulation, accurate and comparable monitoring and reporting are still a challenge. The second article, by Cattaneo and Lipper, identifies further challenges. Arguing that the drivers of deforestation and forest degradation are often situated outside the forest sector, it highlights the need to look at land use through a broad lens and build the synergies between forestry and agriculture.

Sanz and Penman give a detailed account of REDD+, arguably the most important mitigation initiative involving forests, and explain its role in providing a framework and guidance for countries to develop concrete action plans. Sanz then looks specifically at UN-REDD, a multilateral programme that supports over 60 partner countries in meeting their REDD+ commitments.

Muir, Murray, Sartoretto, Hewitt, Simpson and Fox explore REDD+ from another angle, making a convincing case for strengthening its interlinkages with the European Union's Forest Law Enforcement, Governance and Trade (FLEGT) initiative. Whereas REDD+ provides incentives to keep forests standing, FLEGT improves the functioning of the market for forest products by eliminating illegal timber. Viet Nam, Honduras and Côte d'Ivoire are examples of countries that are successfully developing synergies between the two.

Silori, Wisyet, Poudyal and Wu also share noteworthy examples of the application of REDD+ on the ground, looking at several Asian countries where efforts are being made to strengthen the capacities and the involvement of grassroots stakeholders, thereby improving implementation.

In turn, Bervoets, Boerstler, Dumas-Johansen, Thulstrup and Xia shed light on an important concern for many African countries, namely woodfuel. They stress the importance of factoring woodfuel into the climate change equation, including both the extent to which it is contributing to emissions and the role that it can play as a substitute for fossil fuels.

The article by Kurz, Smyth and Lemprière provides a different perspective on wood, looking specifically at the role of harvested wood products to maximize the displacement of emissions from other sectors, and the accounting principles involved.

Strategies to deal with climate change must take a range of areas into account in order to be successful. Loo's article highlights the adaptation potential of forest genetic resources, as well as their importance in the tree-planting efforts needed for climate change mitigation.

The final article describes some effective adaptation measures for coping with the tangible effects of climate change, presenting the case of mountain areas in Peru that are already witnessing significant glacial retreat and glacial lake outburst floods.

These and other types of climate-change-related phenomena will spread and increase as temperatures rise, and the many effects of climate change are only just beginning to be felt globally. This issue of *Unasylva* cautions that we will have to work faster, more collaboratively and in a more integrated way if we are to successfully tackle the enormous challenge that is facing us today. ◆

Forests' role in the climate change agenda

P. Iversen

Where and how forests fit into the main international agreements on climate change.

Peter Iversen is an independent consultant who has represented Denmark in the UNFCCC negotiations on land-use topics, and co-chaired negotiations on land use, land-use change and forestry (LULUCF) under the Kyoto Protocol.

Forest ecosystems are affected by climate change, e.g. changes in temperature, changes in precipitation patterns and an increasing frequency of extreme weather events. At the same time, forest ecosystems remove significant amounts of greenhouse gases, mostly CO_2, from the atmosphere through forest growth, afforestation and reforestation, and add to them through deforestation and forest degradation.

The United Nations Framework Convention on Climate Change (UNFCCC)[1] was established in 1992 with the objective of stabilizing greenhouse gas concentration levels in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, to be achieved within a timeframe sufficient to allow ecosystems to adapt naturally to climate change. Exactly what this means in practice is not explained, but the 197 countries that have ratified and become Parties to the Convention have nevertheless agreed to work towards this objective, with differing responsibilities for developed and developing countries.

[1] http://unfccc.int/essential_background/convention/items/6036.php

Above: Desertification and land degradation are serious challenges, Niger

In 1997 Parties established the Kyoto Protocol[2] under the Convention in order to strengthen efforts to meet the Convention's objective. Unlike the Convention, the Kyoto Protocol assigned internationally binding emission reduction commitments for developed countries. To achieve these commitments, Parties to the Protocol agreed on accounting rules and a number of flexible mechanisms were established, such as the Clean Development Mechanism (CDM). In accordance with the CDM, a developed and a developing country can jointly reduce emissions or enhance removals, such as through an afforestation project in the developing country, thereby helping to fulfil the commitment of the developed country. Such achievements, which are counted in tonnes CO_{2eq}, are sometimes called carbon credits.

The Kyoto Protocol assigns an annual emission allowance for each developed country with a commitment under the Protocol. Developing countries do not have a reduction commitment under the Protocol. The first commitment period, agreed in 1997, included the five years from 2008 to 2012, whereas the second period, agreed with the Doha amendment to the Kyoto Protocol in 2012, covers the eight years from 2013 to 2020.

Not all developed countries have commitments under the Protocol. The United States of America decided not to be part of the Kyoto Protocol and was later followed by Canada. For the second commitment period, Japan, New Zealand and the Russian Federation decided not to make any reduction commitments under the Protocol.

Following a decision taken at UNFCCC's 16th Conference of the Parties (COP 16) in 2010, all developed countries have national reduction targets under the Convention. These are not annual or binding commitments but are quantified commitments that should be met by 2020. Similar to those under the Kyoto Protocol, these commitments are economy-wide, which means that all emissions and removals are included with the exception of emissions from international shipping and aviation. By the same decision, it was agreed that developing countries should voluntarily undertake Nationally Appropriate Mitigation Actions (NAMAs). These are intended mitigation actions that, in the context of appropriate support, aim to achieve a deviation in emissions relative to "business-as-usual" emissions in 2020. Whereas the Kyoto Protocol has drawn up accounting rules, e.g. for the inclusion of emissions and removals from forests, this is not the case under the Convention. Under the Convention, countries can define their own approach although they must be transparent about the assumptions and conditions that they have used.

In December 2015, Parties to the Convention met in Paris and reached the landmark Paris Agreement.[3] In advance of the conference, they had submitted Intended Nationally Determined Contributions (INDCs), indicating their mitigation contribution and, for a large number of countries, providing information also on adaptation to climate change. Almost 190 countries submitted INDCs, which, after the Paris Agreement and potentially with some modifications, become Nationally Determined Contributions (NDCs).

Countries explained their assumptions and conditions in their INDCs. There is broad variation and INDCs may use 1990, 2005, 2010 or a business-as-usual scenario as the reference point for their emission reduction efforts. In addition, some countries aim to achieve their targets by 2025 and others by 2030. Assumptions regarding accounting rules for the inclusion of emissions and removals from forests and other land uses are also different. While a majority of countries have included economy-wide contributions, some include specific sectors only. This makes the comparison of efforts difficult and estimating the cumulative effect of all the INDCs is challenging.

Following the Paris Agreement, Parties opened negotiations on how to ensure sufficient transparency about achieving the NDCs, including negotiations on accounting rules and different approaches to collaboration between countries, including market- and non-market-based approaches.

The Paris Agreement entered into force on 4 November 2016. The meetings of the Parties to the Paris Agreement will be known as the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA). The first meeting will be held in Marrakech, Morocco, this year, in conjunction with the meeting of the Parties to the UNFCCC (COP 22) and the meeting of the Parties to the Kyoto Protocol (CMP12). All three bodies meet annually (Figure 1) usually over two weeks in November or December.

TABLE 1. Overview of different emission reduction commitments/actions before and after 2020

Before 2020	Developing countries	Developed countries
Convention	Nationally Appropriate Mitigation Actions (NAMAs)	National reduction targets to be achieved by 2020
	Deviation in emissions compared to business as usual in 2020	Economy-wide targets
Kyoto Protocol		A subset of the developed countries have binding reduction commitments for the period 2013–2020
After 2020 Convention	Countries that submit a Nationally Determined Contribution (NDC) with a mitigation contribution	

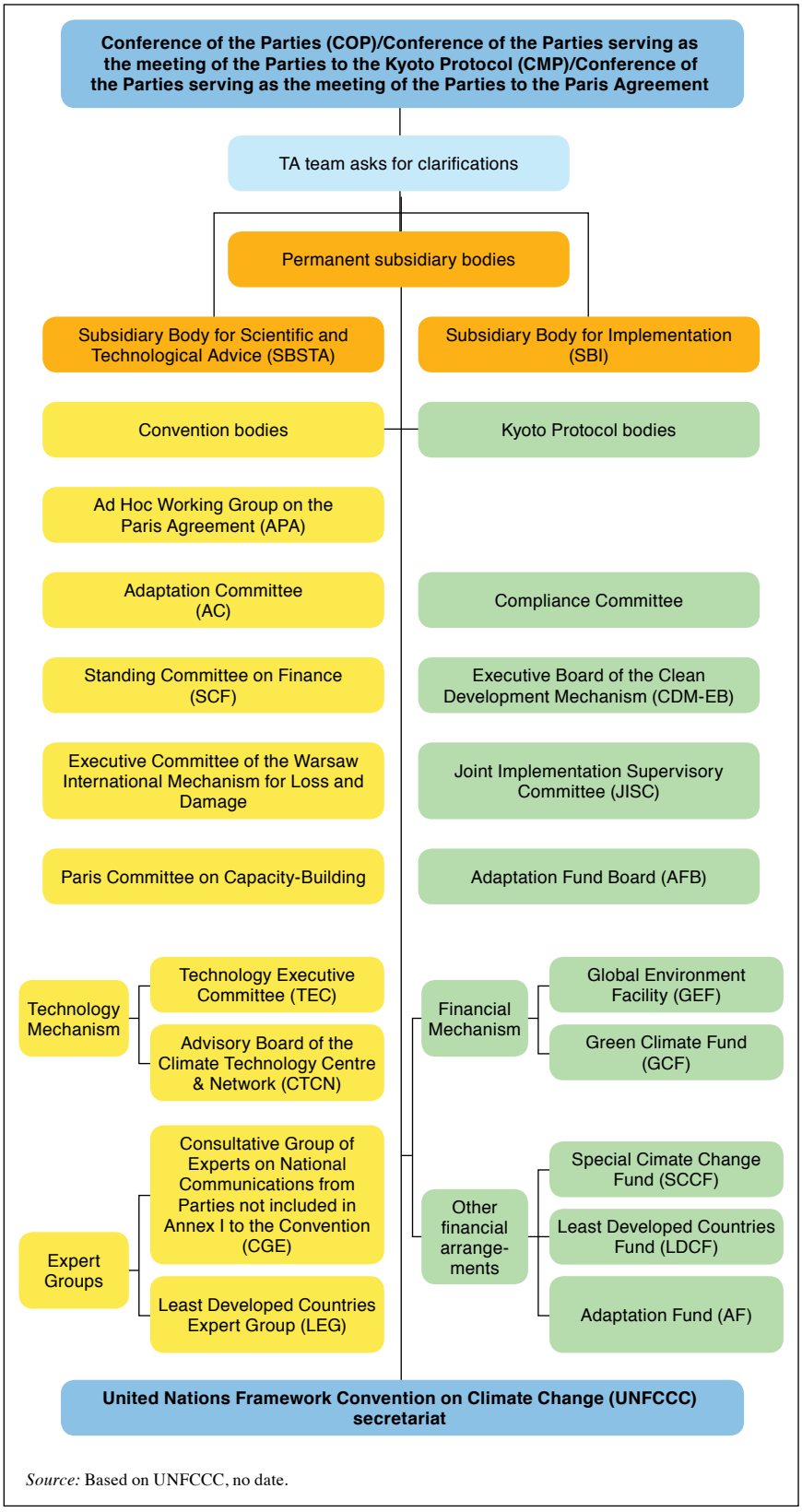
FORESTS' ROLE

Forests are important for the Convention, the Kyoto Protocol and the Paris

[2] http://unfccc.int/kyoto_protocol/items/2830.php

[3] http://unfccc.int/paris_agreement/items/9485.php

1
UNFCCC bodies



Source: Based on UNFCCC, no date.

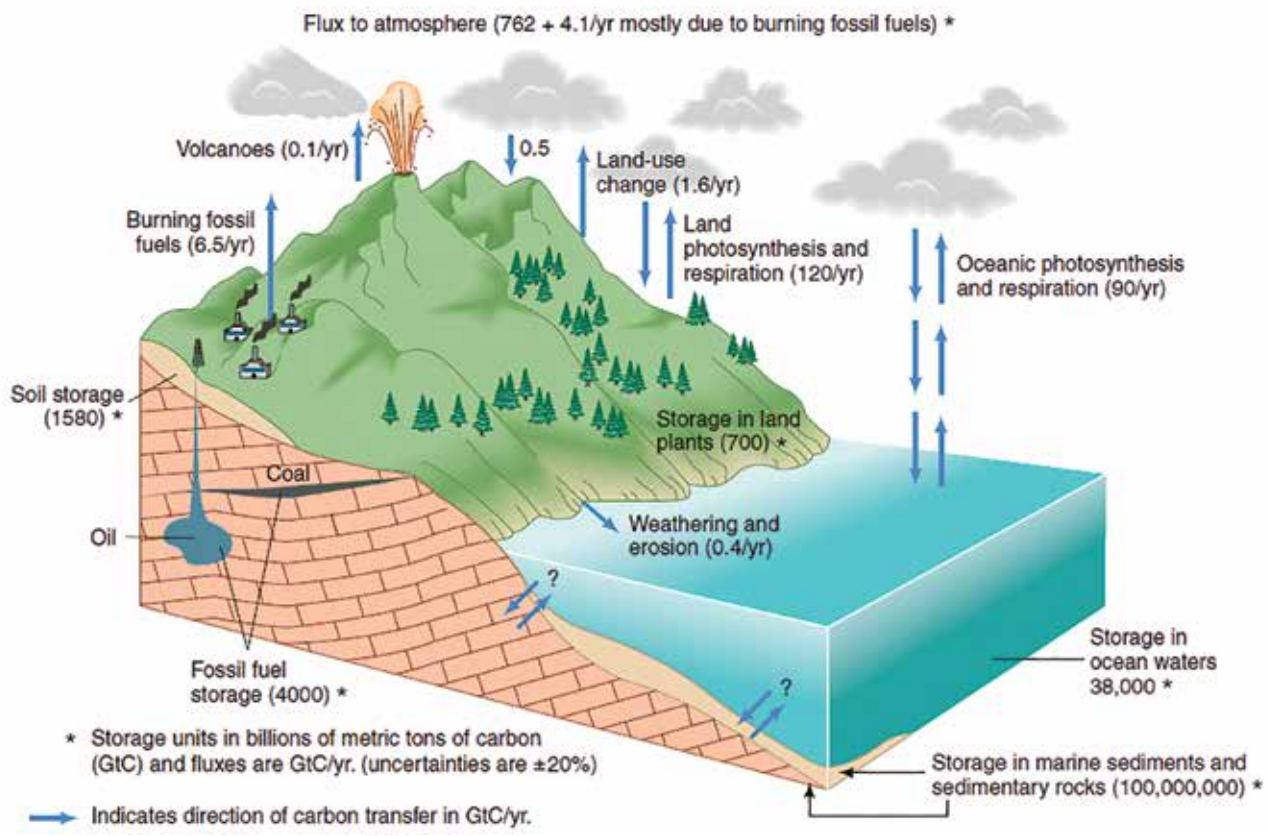
Agreement. In the context of climate change, forests and other land uses are often referred to as reservoirs of greenhouse gases. They are referred to as a sink if greenhouse gases are being removed from the atmosphere through photosynthesis, and as a source if greenhouse gases are being released into the atmosphere by the oxidation of carbon caused by, for example, decay of wood or forest fire (see Figure 2 for an overview of the carbon cycle).

The importance of these concepts was highlighted by the Global Carbon Project 2015, which pointed out that 30 percent of global CO_2 emissions in the period 2005–2014 were absorbed by the terrestrial biosphere, 26 percent were absorbed by oceans and 44 percent ended up in the atmosphere.[4] The Global Carbon Project also concluded that land-use change, which in this case is mostly comprised of deforestation, contributed on average 9 percent of all global anthropogenic emissions during the period 2005–2014. Land-use activities can thus play both a positive and a negative role in terms of stabilizing greenhouse gas concentration in the atmosphere.

As set out in the Convention, Parties have committed to: 1) developing and periodically updating national inventories of anthropogenic emissions by sources, and removals by sinks, using comparable methodologies; 2) implementing measures to mitigate climate change by addressing anthropogenic emissions by sources, and removals by sinks, of greenhouse gases; and 3) implementing measures to facilitate adequate adaptation to climate change.

To make reporting easier, the Parties use guidelines developed by the Intergovernmental Panel on Climate Change (IPCC).[5] IPCC was established in 1988 to provide a clear scientific review of the current state of knowledge on climate

[4] http://www.globalcarbonproject.org/carbonbudget/15/hl-compact.htmphp



Source: FAO, no date.

2
Simplified carbon cycle diagram

change and its potential environmental and socioeconomic impacts. IPCC counts 195 member countries and thousands of scientists contribute to its work. The panel prepares assessment reports, as well as reports on specific topics, in many cases upon invitation from the UNFCCC COP. These include guidelines for reporting emissions and removals.

The latest comprehensive guidelines for reporting are the 2006 Guidelines for National Greenhouse Gas Inventories, where land use, including forests, is dealt with in a volume entitled *Agriculture, Forestry and Other Land Use (AFOLU)*. The land-use sector faces some inherent challenges in estimating emissions and removals as compared to point sources in the energy sector. Whereas a point source is a single localized source, usually industrial, e.g. a fossil fuel power plant or cement factory, emissions and removals from land use occur all over the land. Another important characteristic of the land-use sector is the relatively slow sink process of photosynthesis as compared to the swift loss of carbon in the form of CO_2 through, for example, forest fires.

Since the objective of the Convention is to avoid dangerous anthropogenic interference with the climate system, the focus on anthropogenic emissions and removals is important. However, "anthropogenic" is a concept that is difficult to define when dealing with ecosystems that can be affected by a combination of natural processes and management decisions. Following recommendations from the IPCC, Parties have decided to distinguish "anthropogenic" from "non-anthropogenic" by using managed land as a proxy for the anthropogenic and non-managed land as a proxy for the non-anthropogenic. Managed land is defined as land where human interventions and practices have been applied to perform production, ecological or social functions. It is up to countries to define what this implies within their national context and to include all emissions and removals taking place on this land, regardless of whether the emissions and removals are caused by deliberate actions.

[5] http://www.ipcc.ch/index.htm

REPORTING

Parties to the Convention and to the Kyoto Protocol must submit national reports on greenhouse gas emissions and removals, as well as on other aspects.

This enables the COP to assess progress and take decisions in order to meet the objective of the Convention.

Developed and developing countries have different obligations and guidelines for reporting. Types of reports and frequency of reporting are shown in Table 2.

In order to ensure comparable information, the COP and CMP have developed common tabular formats and guidelines for both submission and review of the information. Parties are also encouraged to use comparable methodologies for the estimation of emissions and removals, namely by adhering to the IPCC guidelines. Developed countries must use the IPCC 2006 Guidelines for National Greenhouse Gas Inventories.[6]

TABLE 2. Overview of different reporting requirements to the UNFCCC

	Developing countries	Developed countries
National Communications	Every four years	Every four years
Biennial Reports		Every two years
Biennial Update Reports	Every two years starting from December 2015, with additional flexibility for least developed countries and small island states	
Annual Greenhouse Gas Inventory		Every year. This includes a National Inventory Report and a set of reporting tables for all years from 1990 to the latest year Parties with reduction commitments under the Kyoto Protocol also submit additional information requested under the Protocol

In accordance with these guidelines, emissions and removals of greenhouse gases are reported for six sectors: energy, industrial processes, solvents, agriculture, land use, land-use change and forestry (LULUCF) and waste. Developing countries are encouraged to follow the same guidelines, but may use an earlier version of the guidelines that structures the reporting somewhat differently.

To facilitate reporting, IPCC guidelines divide land into six categories: forest land, cropland, grassland, wetland, settlements, and other lands. This allows all land to be

[6] http://www.ipcc-nggip.iges.or.jp/public/2006gl

Swidden farming, also known as shifting cultivation, Malaysia

© FAO/PAH SZE MING

included in the reporting. Each category is then subdivided into six subcategories, e.g. forest land remaining forest land, forest land converted to cropland, forest land converted to grassland, etc., thereby giving a total of 36 subcategories.

IPCC has further established three levels of detail, called tiers, for estimating emissions and removals. These are ranked from 1 to 3 according to quality of information, complexity and accuracy. The IPCC guidelines provide the general information needed for any country to implement tier 1, but encourage countries to use higher tiers for key categories in the inventory. A key category is one that is prioritized within the national inventory system because its estimation has a significant influence on the country's total greenhouse gas inventory.

Emissions and removals of CO_2 from land can be estimated through a stock change approach, in which total carbon stocks in year 1 are subtracted from total carbon stocks in year 2. According to this approach, the difference represents either an increase or a decrease in carbon, which can be converted into CO_2. The other main approach is a gain–loss approach, in which gains are estimated as the annual increment and losses are estimated as the annual harvest plus natural decay. The difference between the gain and the loss is then translated into emissions or removals, depending on which value is larger. The value can show significant inter-annual variation, such as when harvest levels or the amount of forest biomass burned in forest fires increase or decrease compared to an average year.

For reporting purposes, carbon stocks can be divided into five different carbon pools: above-ground and below-ground living biomass, dead wood, litter, and soil carbon. For some forest ecosystems, the majority of carbon stocks are found in the living biomass, but for some growing on organic soils, including peat soils, the majority of the carbon may be soil carbon.

In addition to the emissions and removals that take place on the land, Parties also report on emissions from wood products. Wood products contain carbon and constitute another reservoir, in addition to the five carbon pools mentioned above. In the context of climate change, this is referred to as harvested wood products (HWPs). HWPs will always be in a process of decay, with long-lived wood products such as sawn wood for construction having longer time in use than short-lived products such as paper. If the annual addition of new HWPs is larger than the annual decay, then this is reported as removals since the reservoir is increasing. If the annual decay is larger, then we can report this as an emission. The IPCC provides different methodologies for making these calculations depending on the assumptions made regarding the inclusion or exclusion of imported and exported HWPs.

An important consequence of the sector-by-sector reporting is that emissions from the loss of biomass are reported in the LULUCF sector while the benefit of the substitution effect is not visible in this sector. The substitution effect occurs when HWP or other biomass is used to replace another product with a higher carbon footprint, such as steel, plastic, etc. The substitution effect becomes visible in the sector that would otherwise have to report on the emission if the product with the higher carbon footprint was produced. The effect can be significant depending on the products that are being substituted. The same is true for biomass used for energy. Emissions from the loss of biomass are reported as part of the LULUCF sector, not in the energy sector where the biomass is used. The substitution has important implications for biomass demand, since switching from fossil fuel to biomass can reduce emissions in the energy sector, and thereby help countries meet the emission reduction targets they have agreed to. If the biomass is produced domestically, then all emissions will correspond to the same country. However, if the biomass is imported, then emissions will not be attributed to the importing country where the biomass is used but instead to the exporting country.

ACCOUNTING

Reporting and accounting are two different concepts.[7] The purpose of reporting greenhouse gas emissions and removals is to enable the international community to take the most appropriate action to mitigate climate change. The purpose of accounting is to enable assessment of progress towards achieving an agreed target, such as an emission reduction target under the Kyoto Protocol. As mentioned earlier, there is no common accounting framework for emission reduction targets under the Convention.

The national data used for reporting are to some extent also used for accounting, although the Kyoto Protocol is organized somewhat differently when it comes to land use. Under the Kyoto Protocol, Parties divide land according to the activities taking place, such as afforestation, reforestation, deforestation, forest management, cropland management and grazing land management. This is also known as an activity-based system. Since some activities are mandatory and others are voluntary under the Kyoto Protocol, this means that only a subset of the land-based emissions and removals is included. Also, the definitions of these activities are not necessarily equivalent to the land-use categories employed under the Convention. This makes it different from the reporting system used under the Convention. Land-use activities are listed in Articles 3.3 and 3.4 of the Kyoto Protocol (see Table 3).

ACCOUNTING RULES FOR LAND-USE EMISSIONS AND REMOVALS UNDER THE KYOTO PROTOCOL

The emission reduction targets under the Kyoto Protocol are quantified emission reductions as compared to total emissions in a base year, in most cases 1990. The emissions in the base year include emissions from all sectors except the LULUCF sector. LULUCF is instead included as an

[7] A thorough review of land use in the UNFCCC is provided by Iversen, Lee and Rocha (2014).

TABLE 3. LULUCF activities included under Articles 3.3 and 3.4 of the Kyoto Protocol

Article	Activity	Accounting approach	Additional information
3.3	Afforestation, reforestation and deforestation	Emissions and removals in each year of the commitment period for all areas subject to one of the three activities since 1990	Mandatory activities. This includes forests established on or after 1 January 1990
3.4	Forest management	Emissions and removals in each year of the commitment period minus a forest management reference level (FMRL) The FMRL could be set as average annual emissions and removals for the period 2013–2020 with business as usual, as emissions and removals in 1990 from the same area, or as zero	Mandatory activity Guidance for establishing the FMRL was agreed, as well as a review process, before the COP approved them Forest management includes only areas with forest that were also with forest before 1 January 1990
	Cropland management, grazing land management, revegetation, wetland rewetting and drainage	Emissions and removals in each year of the commitment period minus emissions and removals in 1990 for the same activity	Voluntary activities Wetland rewetting and drainage was introduced as a new activity for the second commitment period

additional means for Parties to achieve the target and the accounting results are expressed as debits or credits, measured in tonnes CO_{2eq}, which can complement efforts in other sectors.

Emissions are given as a positive number because CO_2 is added to the atmosphere, and removals as a negative number because CO_2 is removed from the atmosphere. If the result of the calculation is a positive number, it represents debits and if it is a negative number it represents credits.

A number of additional rules were agreed for the second commitment period. HWPs were included in the accounting for afforestation, reforestation and forest management activities. Countries use three wood product categories: sawn wood, panels and paper, with the default half-lives considered to be 35 years, 25 years and 2 years respectively. Based on new and historical production data, annual decay (outflow) and annual production (inflow) of the three products can be calculated. If the inflow is larger than the outflow, then the pool is increasing. Only HWP from domestic forests can be included in the accounting. This is so that countries will not benefit from HWP from countries where the corresponding removal of biomass is not included in the accounting. Including HWP in the accounting provides a more comprehensive assessment of the climate effect of forestry, and counteracts the incentive to increase net removals by reducing harvesting. In fact, storing carbon in long-lived wood products can be an important complement to storing carbon in forest ecosystems. This should, however, not be confused with the substitution effect of using wood instead of more carbon-intensive products such as steel and plastic.

Another new rule is that Parties can exclude from the accounting emissions natural disturbances, which are defined as events or circumstances that cause significant emissions in forests and are beyond the control of, and not materially influenced by, the country. These may include wildfires, insect and disease infestations, extreme weather events and/or geological disturbances. In this context, "significant" means well above the normal level for the country. This is determined through a statistical approach.

Another new concept, carbon equivalent forest conversion (CEFC), was introduced for the second commitment period. This covers the conversion of a forest plantation to non-forest land while establishing a "carbon equivalent forest" on non-forest land elsewhere. This rule allows countries to keep forest plantations that are subject to deforestation under forest management if a number of requirements are met. This includes the establishment of a new forest that has a similar carbon stock potential, which will then be included under the forest management activity instead of afforestation. The aim of this provision is to enable more flexible land use for forest plantations.

To accommodate the new accounting rules agreed under the Kyoto Protocol, the IPCC has developed the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP Supplement)[8] to provide guidance consistent with decisions on LULUCF accounting for the second commitment period of the Kyoto Protocol.

Besides accounting for emissions and removals from domestic land use, the CDM under the Kyoto Protocol enables accounting for afforestation and reforestation projects in developing countries. These projects must follow approved methodologies, and allow a country with an emission reduction target under the Protocol to meet part of the target by including net removals from an afforestation project in a developing country. Under the CDM, land-use activities can result in temporary credits, which means that they have to be replaced at some point in time. This is because there is a risk that sequestered CO_2 may be lost again, e.g. due to a forest fire, and this makes them less attractive than permanent credits from CDM projects in the energy, agriculture or waste sectors, which do not need to be replaced.

[8] http://www.ipcc-nggip.iges.or.jp/public/kpsg/index.html

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Aerial view of cultivated fields, Betroka Region, southern Madagascar

Negotiations are still ongoing regarding alternative approaches to the risk of non-permanence, and whether to include additional LULUCF activities under the CDM for the second commitment period.

REDD+

REDD+ (Reducing emissions from deforestation and forest degradation in developing countries, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks) has been discussed under the Convention since 2005 (see also the article on REDD+ in this issue of *Unasylva*). A comprehensive set of decisions, agreed at COP 19 in Warsaw and known as the Warsaw Framework for REDD+, provides the basic framework for the implementation of REDD+ by developing countries. This includes a decision on how to measure, report and verify (MRV) results, which, similar to forest management under the Kyoto Protocol, are calculated as the difference between a forest reference emission level (FREL) measured in tonnes CO_{2eq}/year and actual emissions during the year concerned.

Countries participate in REDD+ on a voluntary basis. Sixteen countries had by mid-2016 submitted a proposed FREL to the UNFCCC for a technical assessment and many more are progressing towards submission.[9] A prerequisite for participating is to have a national forest monitoring system that can provide data on forest carbon stocks, forest area change, and emissions and removals of greenhouse gases. The Warsaw Framework for REDD+ lists the requirements for obtaining results-based payments for REDD+, and the Green Climate Fund has been asked to provide such funding.

The Green Climate Fund (GCF) is a financial mechanism for the Convention established at UNFCCC COP 16 in 2010. The mandate of the Fund is to promote a paradigm shift towards low-emission and climate-resilient development pathways by providing support to developing

[9] http://redd.unfccc.int/fact-sheets/forest-reference-emission-levels.html

countries so that they can limit or reduce their greenhouse gas emissions and adapt to the impacts of climate change.

ADAPTATION

Both adaptation to climate change and the mitigation of climate change are important. And for the land-use sector there are many linkages. Many adaptation activities that will improve resilience to climate change will also mean more resilient carbon reservoirs, which can be considered a mitigation activity. Through the National Communications listed in Table 2 above, Parties also report on measures to facilitate adequate adaptation to climate change.

Adaptation actions tend to be context-specific, and a changing climate makes this an ongoing process. Adaptation to climate change for forests is both about making the forest ecosystem more resilient to climate change and thereby reducing vulnerability, and about the continued ability of forests to provide goods and services, notably to forest-dependent communities. In years with poor agricultural harvests, forests have traditionally functioned as a buffer for food products and income, a role that could become even more important in the future.

In conclusion, there is no doubt that forests and other land uses will continue to play a significant role for both adaptation to and mitigation of climate change. The Paris Agreement article 4.1 mentions that "Parties aim … to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century".[10] This underlines the importance of the sink effect delivered through photosynthesis from forests and other land uses as a part of global efforts to stabilize greenhouse gas concentration in the atmosphere. An analysis made in late 2015 before COP 21 in Paris, based on 74 INDCs, showed that the expected mitigation contribution from the land-use sector up to 2030 could be between 20 and 25 percent of the total mitigation of all sectors.[11] The relevant activities and potential contribution will vary among countries, from the reduction of deforestation and forest degradation to the sustainable management of forests, establishment of new forests and production of forest products to substitute more carbon-intensive products – including fossil fuels. It will be up to countries to define how they realize this potential. ◆

[10] https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

[11] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC98451/jrc%20lulucf-indc%20report.pdf

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Incorporating forest landscapes into climate-smart agricultural strategies

A. Cattaneo and L. Lipper

Forest landscapes need to be an integral part of any climate-smart agriculture development strategy if it is to be coherent and effective.

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Climate-smart agriculture (CSA) is an approach that strives to increase food security while incorporating measures for adaptation to climate change and the mitigation of greenhouse gas (GHG) emissions. Forests are an important part of such measures. However, the drivers of deforestation and forest degradation are often situated outside the forestry sector. It is therefore important that national CSA strategies look at the agricultural system – including forestry – as a whole. This means weighing up the role of different landscapes in providing food security and GHG mitigation, interactions across landscapes, and improvements that can be made within a landscape.

Drawing upon recent analytical work carried out by FAO, this article argues that CSA strategies need to take into consideration the order of magnitude of the effects of across- and within-landscape interventions, their costs, and barriers to their adoption. In this respect, a CSA strategy that ignores forests would exclude an important segment of the vulnerable population and disregard forests' special role in mitigating both GHG emissions and the detrimental effects of climate change on agriculture.

Farmers control soil erosion, Southern Lempira, Honduras

EVOLUTION OF THE CONCEPT AND DEFINITION OF CLIMATE-SMART AGRICULTURE AND IMPLICATIONS FOR THE FOREST SECTOR

FAO designed climate-smart agriculture as an approach to help countries integrate the effects of climate change into their agricultural planning and investment decision-making.[1] The CSA approach incorporates both the need for adaptation and the possibility of mitigation actions in agricultural strategies, while considering possible trade-offs between food security and GHG mitigation. It is based on the development of an evidence base together with policy and stakeholder dialogues. The broad objective of the approach is to support countries in securing the necessary policy, technical and financial conditions to enable them to:

- sustainably increase agricultural productivity and incomes;
- build resilience and capacity of agricultural and food systems to adapt to climate change; and
- reduce and remove GHGs compatibly with national food security and development goals.

Innovative financing mechanisms that link and blend climate and agricultural finance from the public and private sector are a key means for implementing CSA, as are the integration and coordination of relevant policy instruments. The adoption of CSA practices at scale will require appropriate institutional and governance mechanisms to facilitate the dissemination of information and ensure broad participation.

Forestry is something of a special case in CSA, since the sector plays a major role in global climate-change-mitigation strategies. An entire body of work and political processes specific to forestry and climate change has thus been established, in contrast to the crops, livestock and fisheries sectors. In addition, the role of the forestry sector in food security is often overlooked or poorly understood, and the potential trade-offs between food security, adaptation and mitigation are not well articulated. CSA therefore takes on a different connotation in the forestry context, introducing the food security and adaptation elements within the existing forest-related mitigation efforts, while recognizing the important GHG mitigation potential. In this article, we consider forestry to include lands that meet criteria for formal classification as forests,[2] and consider agroforestry as land-use systems where woody perennials are deliberately used on the same land-management units as agricultural crops and/or animals.

Forestry and food security

Forests play an important role across all four dimensions of food security. For example, it is estimated that approximately 60 million indigenous people are almost wholly dependent on forests, 350 million people depend on forests to a high degree for subsistence and income, and about 1.2 billion people rely on agroforestry farming systems (World Bank, 2004). FAO estimates that 2.4 billion people use woodfuel to cook their food, and that 1.3 billion rely on forest products to provide shelter (FAO, 2014).

Historically, the main impact of forests on poverty alleviation in developing countries has been in their role as safety nets for food security or as sources of rent to be reinvested elsewhere (Wunder, 2001). Recent evidence from Asia and the Pacific region indicates that forests also contribute to more proactive forms of poverty reduction and food security, through activities such as community forestry, small and medium-sized forest enterprise development or payments for environmental services, but that this contribution is limited (FAO, 2012).

Deforestation and forest degradation are taking place at an alarming speed in many developing countries where forests are accessible to logging and to farmers (both large- and small-scale). This is a reflection of the income-generation potential of forest "mining" and agricultural activities after land conversion, despite the potential negative impacts on food security in the long term.

Any national agricultural strategy must take into account both the positive and negative impacts on poverty and on the environment of clearing new areas for production of crops or livestock, and weigh these against alternative development options that maintain forests. In fact, there is not a simple alternative between unmanaged natural forest and clearing for agricultural purposes, but rather a broad spectrum of potential intermediate landscapes (Figure 1). The innovation of a climate-smart approach here is the need to consider the role of forestry in food security and adaptation, as well as mitigation, across a range of landscapes.

Forestry and adaptation

The fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC) noted a medium level of confidence that several regions will suffer from increased tree mortality and forest dieback in the 21st century under medium to high emissions scenarios (IPCC, 2014). However, specific forestry practices can strengthen resilience of natural and planted forests to climate change. Examples include reduced impact logging to maintain ecosystem integrity, fire prevention and management, and silvicultural options aimed at facilitating genetic adaptation (Guariguata *et al*., 2008). Approaches outlining how forest management can adapt to climate change have been proposed (for example, Spittlehouse and Stewart, 2004; Millar *et al*., 2007), and the importance of such adaptation should not be underestimated (Dale *et al*., 2001; Kirilenko and Sedjo, 2007; Allen *et al*., 2010).

Forests also play an important role in facilitating adaptation by mitigating the

[1] Here agriculture refers to crops, livestock, fisheries and forestry sectors.

[2] FAO defines a forest as at least 1 ha in size with at least 10 percent crown cover and mature trees of at least 2 metres in height (see http://www.fao.org/docrep/014/i2011e/i2011e00.pdf).

impacts of climate change. Tropical forests have high rates of transpiration that contribute to cloud formation, considerably reducing both surface temperature and the amount of sunlight reaching the Earth's surface (Anderson *et al*., 2011). Land-use change alters albedo and evapotranspiration, which influence climate directly (Bonan, 2008). At local scales, direct climate effects from land-use change may have a much greater impact than the marginal indirect effects of the emitted greenhouse gases (Georgescu *et al*., 2011; Loarie *et al*., 2011). Forests and agroforestry can potentially play an important role in adaptation in crop and livestock systems (Verchot *et al*., 2007) and in disaster risk reduction (Wahlström, 2015).

Forestry and mitigation

The forestry sector can make a major contribution to global mitigation, but realizing this potential requires coordinated actions across crop, livestock and forestry production systems. Forests are a special case within agriculture, recognized in recent international efforts to support and coordinate countries' efforts to reduce emissions from deforestation and forest degradation (REDD+). This effort is a reflection of the large GHG mitigation potential related to forestry, and agroforestry, relative to other agriculture-related mitigation options.

Forest degradation and deforestation are the outcomes of two types of land-use decisions that have different drivers, with the former often being a result of excessive harvesting of forest products, such as timber or firewood, whereas the latter is typically linked to agricultural returns and the comparative advantage of clearing forests for crop and livestock uses (Cattaneo, 2008). There is an extensive literature highlighting indirect, or underlying, drivers of deforestation (Geist and Lambin, 2002; Hosonuma *et al*., 2012; Pacheco *et al*., 2011). These studies highlight the fact that developments in agriculture outside forested areas – whether related to pasture, soybeans, or biofuels from agricultural crops – can have a large impact on proximate drivers of deforestation (Cattaneo, 2005; Barona *et al*., 2010; Lapola *et al*., 2010; Cohn *et al*., 2014). The need to take account of the indirect effects of developments outside the formal forestry sector in order to manage deforestation and degradation within it implies a need for landscape-level coordination of management strategies.

Whereas reducing deforestation requires addressing issues across landscapes, there are a number of sustainable forest management (SFM) practices that have clear benefits in reducing forest degradation within forest landscapes (see Boscolo *et al*., 2009). These within-landscape management approaches have important implications for mitigation. However, large-scale adoption of many of these practices can face multiple financial, institutional, or policy-related barriers.

ILLUSTRATING THE CSA APPROACH ACROSS AND WITHIN LANDSCAPES: THE ROLE OF FORESTS

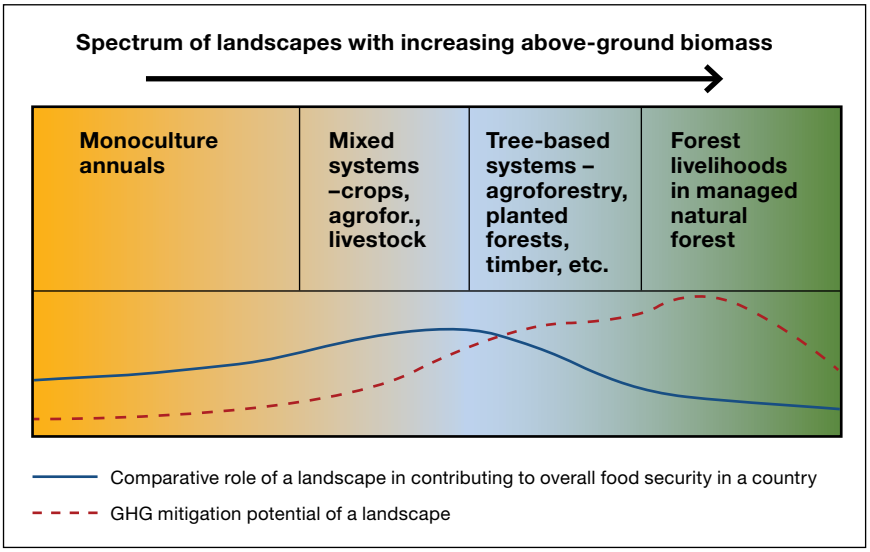
Given the objective of CSA to explicitly integrate the challenges and opportunities of climate change into agricultural development planning, it is essential to build national CSA strategies into existing agricultural development strategies, forest policies, and climate change policies. Usually, both national agricultural development and climate change policies already contain elements that support the development and implementation of CSA. However, efforts are needed to: (i) ensure a coordinated vision that articulates priorities; (ii) identify activities, institutions and policies to support such a vision; and (iii) define the overall investment strategy.

Balancing food security, adaptation and mitigation benefits across landscapes

CSA activities, and the role of forestry within them, can range over a broad spectrum, depending on the relative importance of CSA's three pillars – food security, adaptation to climate change, and GHG mitigation – in a given country. Understanding the role of forestry in a national CSA strategy requires a broad assessment of available forest-related options and their potential impacts on the three pillars. These can include reducing the expansion of agriculture onto forest lands, reducing forest degradation, improving the efficiency of charcoal use, agroforestry, and the increased use of trees in agricultural landscapes.

In Figure 1 we provide, for a hypothetical case, a schematic overview of the relative

1
A spectrum of landscapes: a hypothetical food security and mitigation potential profile



contribution to food security versus mitigation potential of a range of potential landscapes. The figure demonstrates the need for an overview of the types of food security, adaptation and mitigation benefits that can be generated across the types of landscape found within a country. The comparative role of a landscape in contributing to food security is context-dependent and depends on the size of a landscape, its population, and the relevance of specific aspects of food security (availability, access, utilization, and stability).

The hypothetical profile shown in Figure 1 represents a country where the food security benefits of monoculture annuals vary broadly depending on the crops, the farmers planting them, and the practices used. In this hypothetical case, mixed systems and tree-based systems may provide a higher contribution to food security relative to managed natural forests. The mitigation potential in this example increases steadily as more trees are included in the landscape, up to a point where naturally managed forests are remote enough to be at a lower risk of deforestation, hence with a lower likelihood of emitting the carbon stored in them than forests in more accessible areas.

The profiles illustrated in Figure 1 indicate the types of trade-offs a CSA strategy should consider when identifying the interventions needed within each landscape (for example, Pacheco *et al*., 2011). This top-down approach should then be reconciled with bottom-up approaches based on stakeholder consultation (van Noordwijk *et al*., 2015).

Within-landscape interventions: building coherent policies and institutions and overcoming barriers to CSA adoption

An important part of developing a CSA strategy is understanding the barriers to adoption of CSA management practices in a given landscape. Studies of farm-level adaptation in crop production that draw upon household datasets confirm that farmers make decisions in response to climate stimuli, household socioeconomic conditions, and institutional settings, as well as other factors (Arslan *et al*., 2013; Asfaw *et al*., 2014; Maddison, 2007; Nhemachena and Hassan, 2007).

Scaling up the adoption of agroforestry practices is a key part of national agricultural development and adaptation strategies for many countries. Adoption rates have generally been lower than expected, due to barriers such as delayed returns on investment, weak and missing input supply systems, limited property rights, and farmers' lack of information about the system and how to apply it (McCarthy *et al*., 2011; Mercer, 2004; Valdivia *et al*., 2012). Mercer (2004) provides a review of the role of preferences, resource endowments, market incentives, biophysical factors, and risk and uncertainty as determinants for the adoption of agroforestry, highlighting the fact that risk and uncertainty appear to be particularly important factors in decisions.

As mentioned earlier, the adoption of sustainable forestry management practices can contribute to the resilience of forests, as well as of local crop and livestock production systems to climate change, while also reducing emissions from forest degradation. However, the literature indicates that in managed forest landscapes adoption of SFM has been lagging. Barriers to adoption include limited profitability and the opportunity costs of maintaining forest land, inadequate legal and institutional environments and limited enforcement, and limited know-how for producing marketable tree products (Pearce *et al*., 2003; Boscolo *et al*., 2009; van Noordwijk *et al*., 2008; Nasi *et al*., 2011). Nasi *et al*. in the context of REDD+, and van Noordwijk *et al*. in the context of agroforestry, outline possible approaches for overcoming barriers to the adoption of SFM practices and tree planting. Their guidance centres on legal and institutional frameworks, regulatory enforcement, economic incentives, and extension and information diffusion. The appropriate combination of these ingredients will depend on the specific context of a forest landscape.

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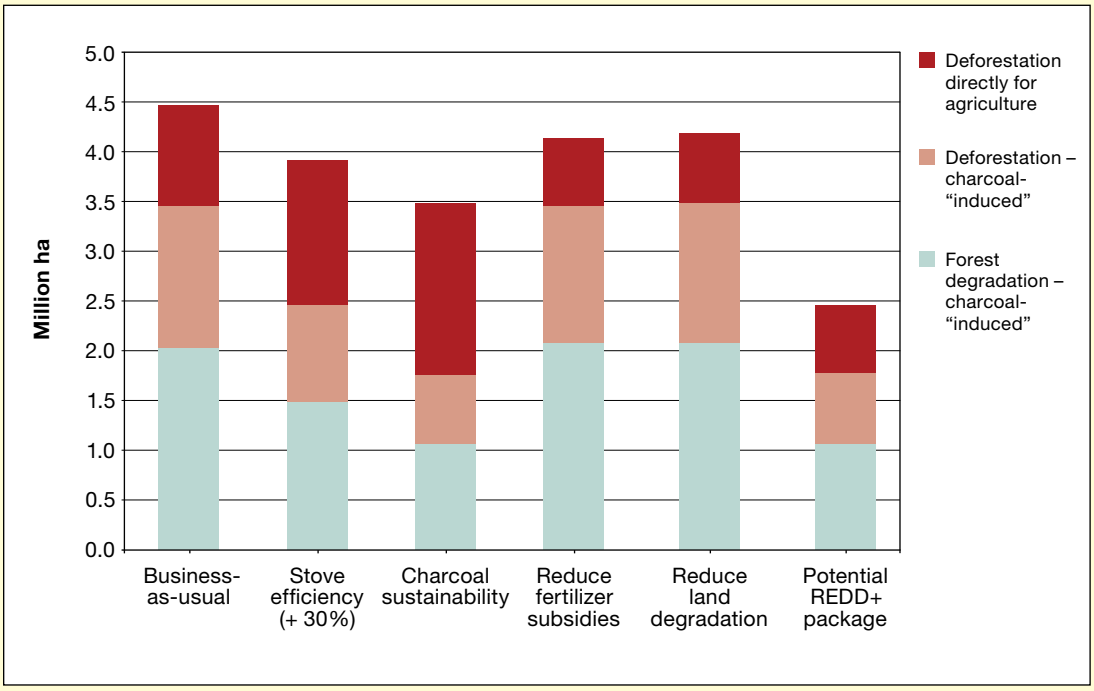
Farmers plant young pine trees to help control erosion in areas of rice cultivation in the Himalayan foothills, Nepal

Box 1
Across- and within-landscape interventions: the case of agriculture–charcoal interactions as determinants of deforestation and forest degradation in Zambia

FAO, in partnership with the Zambian Forest Department, has begun simulating the relative contribution to deforestation and forest degradation of the two largest proximate drivers of deforestation in Zambia, namely charcoal production and agriculture, under different scenarios for the period 2015–2022 (FAO, 2015a). Different options to reduce land-use change are examined, using a computable general equilibrium model that captures economic processes across Zambia's different agroecological zones. The model includes assumptions that forests used for unsustainable charcoal production are degraded, and may be converted in part to land for agricultural use. However, land can also be deforested directly for agricultural use without going through a phase of charcoal production and associated degradation.

Results highlight the important interplay between charcoal, crop, and livestock production in determining deforestation rates and forest degradation in Zambia. For example, measures that exclusively address charcoal drivers, such as decreasing charcoal demand through improved stove efficiency or improving the sustainability of production, do reduce forest degradation but are ineffective in reducing deforestation rates as land continues to be cleared due to demand for agricultural land. Conversely, measures addressing agricultural drivers, such as reducing fertilizer subsidies in a targeted manner, or reducing land degradation through the increased adoption of sustainable land management measures, contribute to reducing deforestation rates, but have little impact on forest degradation (see Figure 2).



2 Predicted cumulative impact on forests in Zambia under different scenarios for the period 2015–2022: area deforested directly for agriculture, attributable to charcoal, and forest degradation (million ha)

Simulations indicate that approximately 1 million ha of deforestation could be avoided in the period 2015–2022, and forest degradation reduced across an area of 1.06 million ha, with a potential REDD+ package proposing: a) a reduction of fertilizer subsidies in selected agroecological zones (across-landscape because it is not targeted towards improving welfare in agricultural areas, but rather to decrease pressure on forests), b) reducing land degradation through sustainable land management practices (within-landscape, with spillover effects on demand for agricultural land), combined with c) making charcoal production more sustainable and improving stove efficiency (both within the forest landscape).

We also report on effects of the proposed REDD+ package on incomes of farm households in different agroecological areas, which has a bearing on food security. Impacts differ by region, indicating that the financial resources available under REDD+ may need to be allocated so as to counteract income losses. A concerted effort that provides coherent policies and investments both across and within landscapes can therefore achieve better welfare while reducing GHG emissions, assuming that alternative livelihood options can be found for the communities most affected by the GHG mitigation strategy.

Integrating diverse financing streams: a key tenet of CSA

The necessity of adapting to and mitigating climate change in agriculture (including forestry), and building the enabling conditions to overcome barriers to adopting systems that will effectively deliver these objectives, requires a reconsideration of the strategies and investment priorities for achieving sustainable agricultural growth and food security. This will involve additional investment costs, although actual estimates vary and are context-dependent (FAO, 2013). A key tenet of the CSA approach is to respond to the additional investment requirements implied by integrating emerging sources of climate finance for adaptation and mitigation into traditional sources of agricultural finance. In this context, national forest funds (NFFs) are an important financing source to consider for an integrated CSA strategy across forest, crop and livestock productive landscapes. In 2014 there were 70 NFFs operating globally (FAO, 2015b). These funds are dedicated to supporting the conservation and sustainable use of forests and can finance a range of ecosystem goods and services from forests – including adaptation and mitigation. Such funds are notably being used to support activities for reducing deforestation and forest degradation, and improving community forest management and disaster risk reduction (FAO, 2015b).

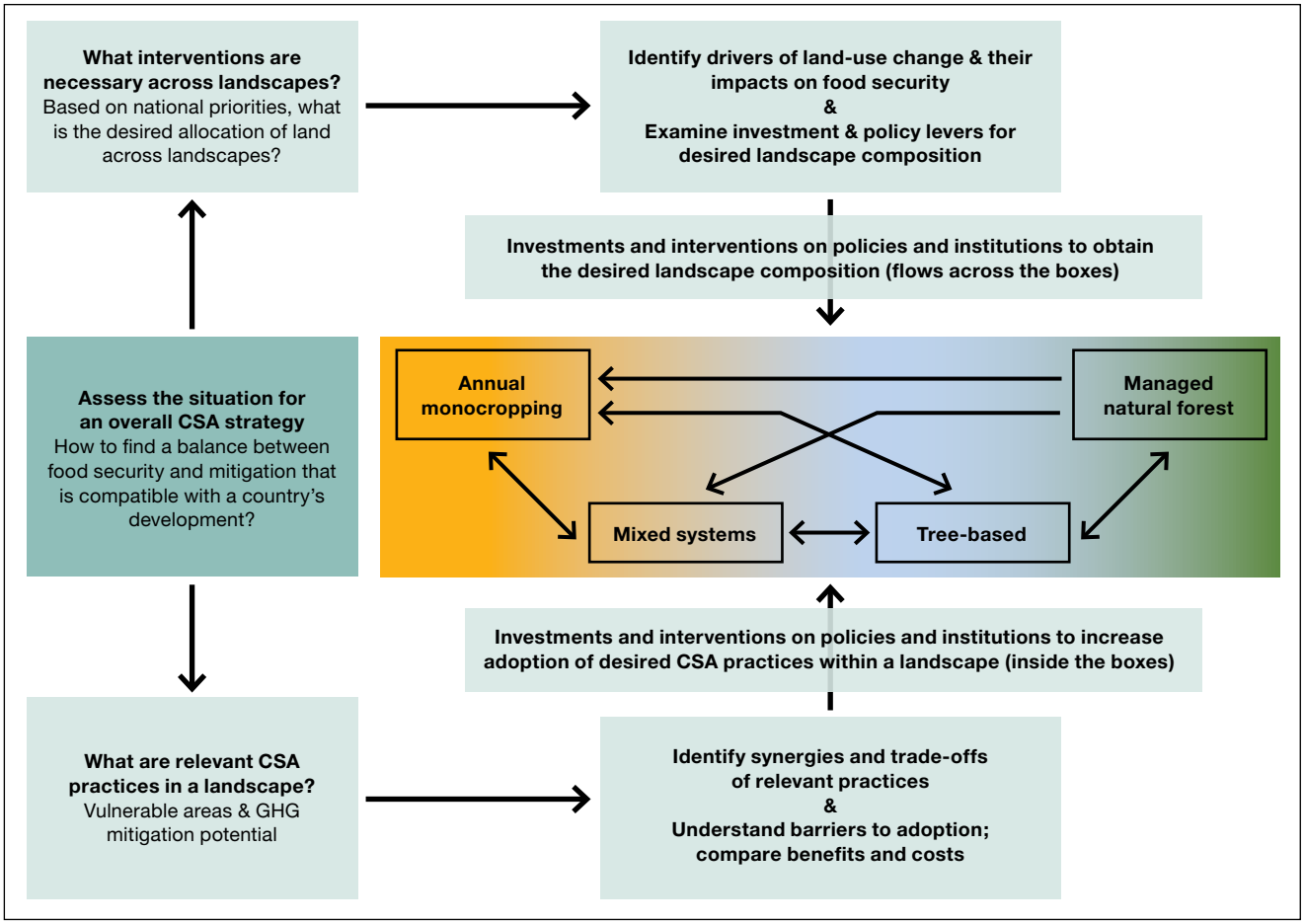
Better coordination of financing from national forest funds with national agricultural investment financing and new forms of climate finance are needed to overcome the financing gap for achieving the transition to CSA, and to improve the effectiveness of these financing sources.

Bringing it all together: developing a CSA strategy that is inclusive of forests

The framework presented in Figure 3 illustrates that when it comes to forestry it is important to distinguish between interventions aimed at affecting the balance between different types of landscapes and interventions targeted within existing landscapes. The former will be of a more systemic nature, affecting the comparative advantage of different landscapes in producing goods and services, whereas the latter will typically be more targeted to the adoption of specific practices within a landscape.

The first step in the process in Figure 2 is to assess the relative contribution (or potential) of different landscapes to food

3
A framework for developing a CSA strategy across and within landscapes



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Men carry fruit and vegetables to market, Kiroka, United Republic of Tanzania

security, climate change adaptation, and GHG mitigation goals. This should then lead to concerted action through investments and policy interventions in terms of addressing perceived imbalances across landscapes, and working within existing landscapes by improving management practices so as to increase food security and generate GHG mitigation co-benefits.

To implement this approach and find the right entry point, it is crucial to better understand the drivers of land-use change and their impacts on food security. It is also important to understand the synergies and trade-offs, i.e. benefits and costs, of relevant practices within each landscape, so as to overcome barriers to their adoption.

CONCLUSIONS

Forests have an important role to play in adapting to climate change, supporting food security and reducing emissions from the agriculture and land-use sectors – within and across agroecosystem landscapes. Until now, the mitigation role of forests has been most prominent in the climate change policy arena – as the REDD+ debate has already made clear. However, forest communities should leverage their potential role in GHG emission reductions to make sure that their food security and adaptation needs are not compromised. We argue that a CSA strategy that ignores the role of forests will undermine policies to reduce deforestation.

Both across-landscape and within-landscape actions are needed. Agricultural productivity improvements in areas far from the forest provide an example of an across-landscape consideration. Such improvements would reduce pressure on the forest while increasing food availability. A diverse set of within-landscape management practices are known, which can improve food security or mitigate GHG emissions or both. However, the adoption of such practices is often limited by information, financial, and institutional constraints, which need to be addressed in CSA policies and investment strategies.

A coherent and effective CSA strategy must acknowledge that most countries already have agricultural development plans, forest policies and national climate change policies and that efforts are therefore needed to ensure a coordinated vision across these in an integrated investment strategy. In this light, the development of a national CSA strategy is a unique opportunity to promote coordination between key stakeholders working in agricultural development, forestry, and climate change, and to bring them together to articulate a unified vision of agricultural development under climate change. ◆

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An overview of REDD+

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Reserve in Puntarenas province, Costa Rica

A look at the history and role of efforts to reduce emissions from deforestation and forest degradation.

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REDD+ is a process for reducing emissions from deforestation and forest degradation, sustainably managing forests, and conserving and enhancing carbon stocks. It aims to contribute to mitigating climate change in developing countries by reducing the release of carbon stored in forests. Payments for results can translate into incentives for mitigation that can in turn contribute to better land-use planning, better stewardship of forest resources, and investment in low-carbon paths to sustainable development.

As far back as 2000, the United Nations Framework Convention on Climate Change (UNFCCC) had, at its 6th Conference of the Parties (COP 6), already begun to look at the role of deforestation in developing countries. REDD[1] was made a formal part of the climate change agenda in 2005, at UNFCCC COP 11, held in Montreal.

REDD+, born of the discussions at COP 13, held in Bali in 2007, took this one step further, with the "plus" including the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. REDD+ has since become an important part of the climate negotiations. It made substantial progress as part

[1] Reducing emissions from deforestation and forest degradation.

of the framework agreed at the UNFCCC's Warsaw Conference of the Parties in 2013, and is part of the agreement concluded at the Paris Conference of the Parties at the end of 2015.

REDD+ processes in countries are benefiting from extensive bilateral and multilateral programmes which, although presenting a complex landscape, are becoming better coordinated. The experience gained under REDD+ is likely to be useful in land-use monitoring and management in general, and provides a basis for recognizing other environmental values.

AGREED INDICATIVE GUIDANCE

COP 13 set out and encouraged the use of agreed indicative guidance – that is, a suggested rule-set – for REDD demonstration activities. The Bali REDD+ decision contains many of the elements developed subsequently in more detail, including:

- voluntary participation;
- consistent, results-based estimation of emissions reductions;
- use of the Guidelines of the Intergovernmental Panel on Climate Change (IPCC) for estimating greenhouse gas (GHG) emissions and removals;
- national coverage with the possibility of subnational approaches as an interim step;
- safeguard provisions; and
- encouragement of independent review.

One of the main outcomes of COP 13 was the Bali Action Plan, which recognized REDD+ as an important area for future implementation of the UNFCCC, requiring greater national and international action. REDD+ was at that point the only aspect of the future treaty where an agreed rule-set had been at least sketched out, and it has since remained one of the most advanced areas.

The Bali Action Plan anticipated work on a future climate agreement (post-Kyoto) to be completed by COP 15 in Copenhagen in 2009. Although COP 15 results at Copenhagen fell short on achieving the comprehensive agreement that had been hoped for, REDD+ was one of the areas that saw significant progress. A COP decision on methodological guidance notably provided more substantial indications on requirements for REDD+. Amongst other things, the decision requested Parties to:

- identify drivers of deforestation and forest degradation, and actions that lead to stabilization of forest carbon stocks;
- use IPCC guidance;
- establish national forest monitoring systems;
- make joint use of remotely sensed and ground-based data;
- be transparent, consistent, and as far as possible accurate;
- engage indigenous communities and local communities;
- build and enhance capacity (for Parties in a position to do so and international organizations); and
- for Parties establishing reference levels, to do so transparently with the possibility of adjustment for national circumstances.

COP 16 in Cancun subsequently set out the definitive list of activities eligible to be qualified as REDD+ (also shown in Box 1), namely: (a) reducing emissions from deforestation, (b) reducing emissions from forest degradation, (c) conservation

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Field trip to Reserva Natural El Hatico, Colombia, to take carbon measurements as part of a workshop on REDD+ hosted by the International Center for Tropical Agriculture (CIAT)

Box 1
Definitive list of activities eligible to be qualified as REDD+, as set out at COP 16 in Cancun

(a) Reducing emissions from deforestation
(b) Reducing emissions from forest degradation
(c) Conservation of forest carbon stocks
(d) Sustainable management of forests
(e) Enhancement of forest carbon stocks

of forest carbon stocks, (d) sustainable management of forests, and (e) enhancement of forest carbon stocks.

The Cancun decision makes clear that these are voluntary activities to be undertaken by developing countries in the context of the provision of adequate and predictable support, including financial resources and technical and technological support in accordance with national circumstances.

The Cancun Agreements consolidate progress by requesting developing country Parties aiming to undertake these REDD+ activities to develop:

- a national strategy or action plan (NS/AP);
- a national forest reference emission level (FREL), or national forest reference level (FRL),[2] with subnational FREL/FRLs possible as an interim step;
- a robust and transparent national forest monitoring system; and
- a system for providing information on safeguards,[3] which are listed in an annex.

Parties are also asked to address drivers of deforestation and forest degradation, land tenure issues, forest governance and gender issues, and to ensure full and effective participation of stakeholders, including indigenous peoples and local communities.

The Cancun Agreements anticipate a three-phase approach, starting with capacity building and policy implementation and leading to full-scale implementation of results-based actions with measurement, reporting and verification (MRV). The Agreements also request exploration of the financing options for rewarding results, known in this context as results-based actions.

COP 17 (Durban, 2011) established that the information provided by Parties on safeguards should be transparent, consistent and regularly updated, allow for improvements over time, and be accessible to all relevant stakeholders. It should be country-driven and build on appropriate existing systems. Provision of information should respect national sovereignty and legislation, international obligations and agreements, and gender considerations. Information would be provided via National Communications (NCs), and any other channels agreed by the COP.

The same COP 17 decision established that FREL/FRLs, expressed as tonnes of CO_2 equivalent, would be used as benchmarks for assessing performance across all of the REDD+ activities. They should be established on the basis of historical data, be consistent with national GHG inventories, with the possibility of adjustments for national circumstances and updating to take into account new knowledge and methodologies. It also established that FREL/FRLs should include all significant carbon pools and activities, although "significant" is not defined. Parties are invited to submit FREL/FRLs on a voluntary basis and a process for their technical assessment (TA) is established. In a separate decision, the Durban COP recalled the agreement in Cancun on the need for results-based payments (RBPs) to take place in the context of full measurement, reporting and verification, and agreed on the possibility of both market-based[4] and non-market based approaches,[5] consistent with environmental integrity, including the safeguards identified.

COP 18 (Doha, 2012) established a work programme on results-based finance to explore means to transfer payments for results-based actions, incentivization of non-carbon benefits, and ways to improve the coordination of results-based finance. The most prominent outcome was the inclusion of REDD+ as one of the topics to be supported by the Green Climate Fund.

At Warsaw in 2013, COP 19 agreed on seven decisions concerning REDD+, collectively referred to as the Warsaw Framework for REDD+, which brings together the results of all the negotiations regarding REDD+ since Montreal in 2005. As discussed below, it is a framework that leaves a degree of flexibility in interpretation. An increasingly common understanding may be expected as experience accumulates.

THE REDD+ RULE BOOK

Four of the seven decisions in the Warsaw Framework represent rules and modalities to guide REDD+ implementation as laid out in the Cancun Agreements. The remaining three decisions relate to coordination of support, results-based financing, and addressing the drivers of deforestation and forest degradation.

The rules and modalities included in the decisions refer to the four main elements (outlined in the Cancun Agreements) that developing countries will need to have in place to access REDD+ RBPs. These are summarized in Figure 2.

In the case of National Strategy/Action Plan (NS/AP) and National Forest Monitoring System (NFMS), general guidance is provided that allows for flexibility to tailor them to national needs and circumstances.

[2] FREL and FRL together cover the full range of activities, FRELs being for (a) and (b), and FRLs for (c), (d) and (e).

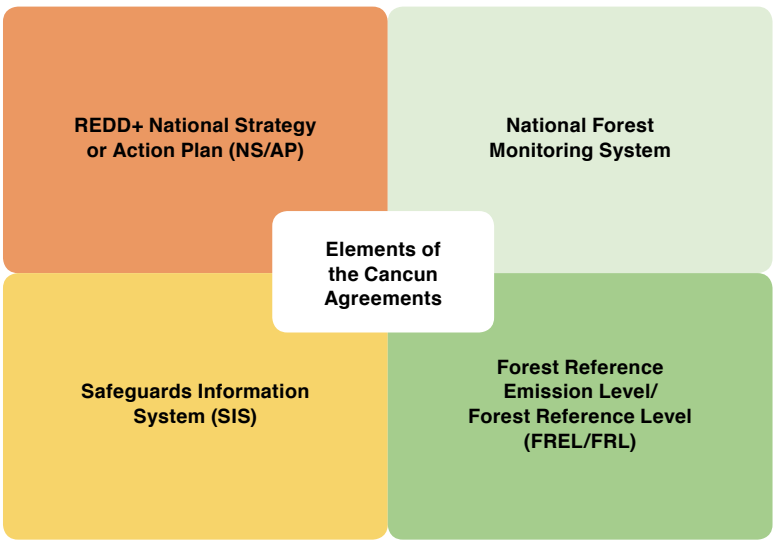
[3] Decision 1/CP.16 Annex I paragraph 2 indicates that when undertaking REDD+ activities the list of safeguards in the paragraph should be promoted and supported.

[4] Approaches where payments are provided through a carbon market transaction.

[5] Approaches where payments are not related to carbon market transactions. These approaches are being supported by countries such as the Plurinational State of Bolivia, whose Joint Mitigation and Adaptation Mechanism is an alternative to REDD+.

Decision 15/CP.19	Addressing the drivers of deforestation and forest degradation	Non-methodological provisions
Decision 14/CP.19	Modalities for measuring, reporting and verifying	Methodological provisions – rules and modalities
Decision 13/CP.19	Guidelines and procedures for the technical assessment of submissions from Parties on proposed forest reference emission levels (FRELs) and/or forest reference levels (FRLs)	
Decision 12/CP.19	The timing and frequency of presentations of the summary of information on how all the safeguards referred to in Decision 1/CP.16, appendix 1, are being addressed and respected	
Decision 11/CP.19	Modalities for national forest monitoring systems	
Decision 10/CP.19	Coordination of support for the implementation of activities in relation to mitigation actions in the forest sector by developing countries, including institutional arrangements	Non-methodological provisions
Decision 9/CP.19	Work programme on results-based finance to progress the full implementation of the activities referred to in Decision 1/CP.16, paragraph 70	
Decision 1/CP.18	Paragraphs 25–40: agreed outcome pursuant to the Bali Action Plan, laying the basis for the decisions reached in COP 19	
Decision 12/CP.17	Guidance on systems for providing information on how all the safeguards are being addressed and respected and modalities relating to FRELs and/or FRLs	Methodological provisions – rules and modalities
Decision 2/CP.17	Paragraphs 63–73: outcome of the work under the Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA) on financing options for the full implementation of the results-based actions referred to in Decision 1/CP.16, paragraph 73	Non-methodological provisions
Decision 1/CP.16	The Cancun Agreements: outcome of the Ad Hoc Working Group on Long-Term Cooperative Action under the UNFCCC	The framework decision
Decision 4/CP.15	Decision 4/CP.15 provides guidance to developing country Parties when implementing activities relating to Decision 2/CP.13	Initial methodological provisions
Decision 2/CP.13	Reducing emissions from deforestation in developing countries: approaches to stimulate action	Indicative methodological provisions & Non-methodological provisions

1
The REDD+ decisions up to COP 19, Warsaw. Decisions highlighted in green refer to technical methodological provisions; decisions highlighted in red refer to non-methodological provisions (such as drivers of deforestation, coordination of support, work programmes on issues of results-based finance/payments etc.); the decision highlighted in blue refers to the Cancun Agreements that represent the framework for REDD+. The REDD+ decisions taken at COP 19 are known as the Warsaw Framework for REDD+



2
Warsaw Framework and related decisions on the four methodological elements of the Cancun Agreements: National Strategies or Action Plans; Forest Reference Emission Levels and/or Forest Reference Levels (FREL/FRLs); National Forest Monitoring Systems (NFMS); and Systems to provide information on how safeguards are being respected and addressed (SIS)

NFMS (Decision 11/CP.19) should be informed by the most recent IPCC guidance and guidelines, as adopted or encouraged by the COP, and should provide data and information that are transparent, consistent over time and suitable for MRV, and build upon existing systems while being flexible and allowing for improvement.

In the case of the NS/AP, the Cancun Agreements already indicated that drivers of deforestation and forest degradation, land tenure, forest governance, gender issues and safeguards should be addressed, and Warsaw Framework Decision 15/CP.19 recalls the importance of addressing drivers.

As already identified, FREL/FRLs, expressed in tonnes of CO_2 equivalent, are benchmarks for assessing each country's performance in implementing the REDD+ activities. Warsaw Framework Decision 13/CP.19 represents a major step by providing detailed guidance for the TA of FREL/FRLs submitted by countries, and setting out the generic timetable for the assessment process.

The TA process is coordinated by the UNFCCC Secretariat. The assessment team (AT) is to be composed of land use, land-use change and forestry (LULUCF) experts selected from the UNFCCC Roster of Experts.[6]

Box 2 summarizes the scope of the TA and Figure 3 shows the steps and timeline as agreed in Decision 13/CP.19. The assessment sessions are scheduled once a year, and any submissions received by the UNFCCC Secretariat no later than ten weeks ahead of a session will be assessed at that session.

Each AT conducts a thorough and comprehensive assessment of the submitted FREL/FRLs, and as the main output of the process, the AT prepares a report that is made publicly available, under its collective responsibility.

The UNFCCC TA process is intended to support countries in improving their FREL/FRLs, which may initially be simple, but can be improved over time. TAs may identify areas for technical improvement, but are not to make judgements on

[6] Information on the UNFCCC Roster of Experts can be found at http://unfccc.int/parties_and_observers/roster_of_experts/items/534.php.

High-level Segment of the UN Climate Change Conference in Warsaw, 2013

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Box 2
Scope of the Technical Assessment of FREL/FRLs (summarizes the list of matters to be assessed as set out in Decision 13/CP.19)

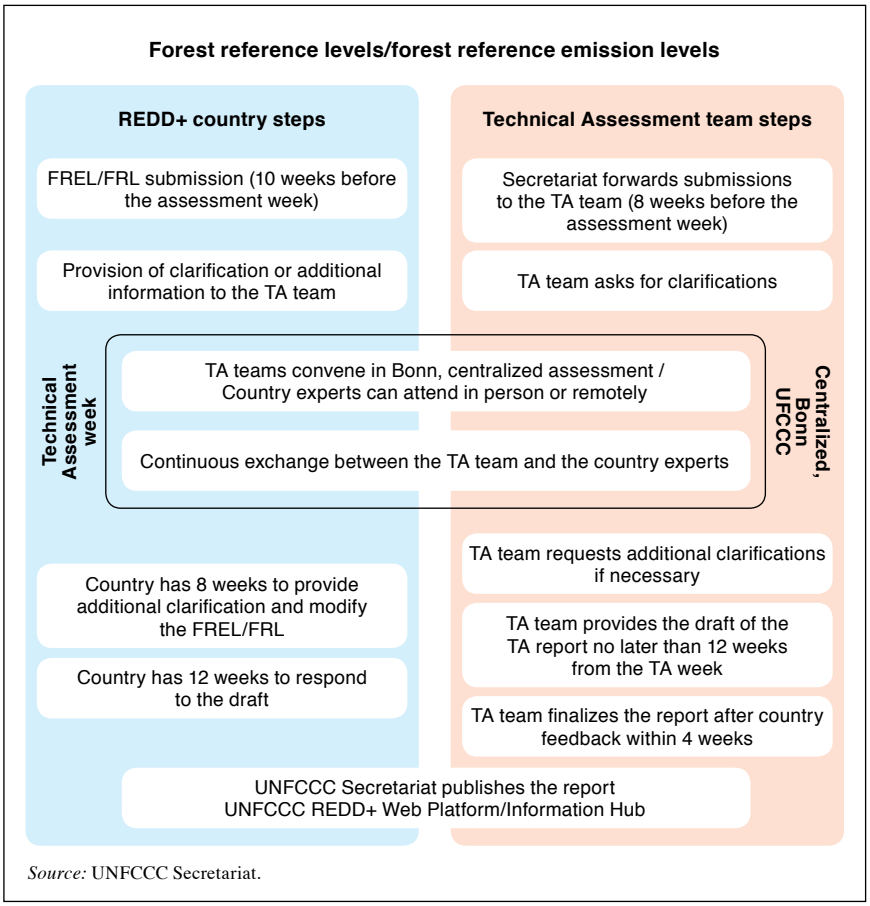
(a) Consistency between the FREL/FRL and anthropogenic forest-related GHG emissions by sources and removals by sinks in the national GHG inventory (GHGI).
(b) How historical data have been taken into account in the establishment of the FREL/FRL.
(c) Transparency, completeness,* consistency and accuracy of the information provided, including on methodologies, information, data sets, approaches, methods, models, if applicable, and assumptions used. Whether the FREL/FRLs are national or subnational.
(d) Whether an appropriate description of relevant policies and plans has been provided.
(e) If applicable, whether descriptions of changes to previously submitted FREL/FRLs have been provided, taking into account the stepwise approach.
(f) Pools and gases, activities included in the FREL/FRL, and justification of why omitted pools and/or activities were deemed not significant.
(g) Whether the definition of "forest" used in the construction of the FREL/FRL level has been provided and, if it differs from the one used in the national GHGI or from the one reported to other international organizations, why and how the definition used was chosen.
(h) Whether assumptions about future changes to domestic policies have been included in the construction of the FREL/FRL.
(i) The extent to which the FREL/FRL value is consistent with the information and descriptions provided by the Party.

* "Complete" in this context means the provision of information that allows for the reconstruction of the FREL/FRL.

domestic policies taken into account in the construction of FREL/FRLs.

Once their FREL/FRLs are assessed, countries can report the results of REDD+ implementation through a specific REDD+ annex in their Biennial Update Reports (BURs). Guidance for reporting the emission reductions and removals resulting from the REDD+ activities that will be compared with the FREL/FRLs are provided in Decision 14/CP.19 and can be summarized as follows:

- The estimation of anthropogenic forest-related GHG emissions and removals, carbon stocks and forest area changes should be consistent with UNFCCC methodological guidance, and data and information should be transparent and consistent over time, and consistent with FREL/FRLs.
- Results should be provided via BURs on a voluntary basis. When developing countries want to obtain payments for



Source: UNFCCC Secretariat.

3
Steps for the FREL/FRL Technical Assessment (TA). Ten weeks for logistical preparation and 43 weeks for the TA

Box 3
Summary of information requirements under the Warsaw Framework to be able to access results-based payments

Information on the Cancun safeguards is to be reported through the country National Communication (NC). Results of REDD+ activities in tonnes of CO_2 equivalent will be reported through a technical annex of the BUR. Submission of a national forest reference emissions level/national forest reference level (FREL/FRL) is done through its own communication channel to the UNFCCC, rather than via a NC or Biennial Update Report (BUR).

What countries need to have or provide	How to communicate to UNFCCC	Process associated under UNFCCC	Timing	Information Hub on the UNFCCC REDD+ Platform	Decision
REDD+ National Strategy or Action Plan	No need	None	In place when seeking results-based payments (RPB)	As appropriate, link to the documents	1/CP.16 para 71(a), 9/CP.19 paras 3 & 11
National Forest Monitoring System	No need	None	In place when seeking RPBs	As appropriate, link to the documents	1/CP.16 para 71(c), 4/CP.15, 11/CP.19 & Annex
National FREL/FRL	FREL/FRL submission	Technical Assessment in the context of RBPs	When ready (especially when seeking RBPs)	FREL/FRL submission and Technical Assessment Report	1/CP.16 para 71(b), 12/CP.17 (II), Annex 13/CP.19
Results in tonnes of CO_2 equivalent per year	Technical REDD+ Annex to the BUR	Technical Assessment of the Annex	After the FREL/FRL is assessed, same regularity of the BUR (2 yrs)	Technical Assessment Report of the Annex	9/CP.19 paras 3 & 11(a), (e) 14/CP.19 & Annex
Safeguards Information System (SGI)	National Communication UNFCCC Web Platform	None	Summary of safeguards available when seeking RBPs	When available or updated	1/CP.16 para 71(d), 12/CP.17 (I), 12/CP.19, 17/CP.21

Source: Adapted from P. Iversen, 2015.

results-based actions, an additional technical annex should be provided through the BURs.

- Results should be expressed in tonnes of CO_2 equivalent per year.

The reported results included in the BUR REDD+ annex will be subject to the international consultation and analysis[7] that, for the purpose of the REDD+ annex, will include two experts on the LULUCF sector from the Roster of Experts.

REDD+ rules require a summary of information on how the Cancun safeguards are addressed and respected. Timing and frequency of submission for the summary are to be provided through the National Communication (NC) after the start of the REDD+ implementation. The decision recognizes that it could also be provided on a voluntary basis via the REDD Web Platform. Once the first summary is provided, the frequency will be consistent with subsequent NC submissions. COP 21 (Paris, 2015) provided further guidance on the contents of the summary in Decision 17/CP.21.

The UNFCCC Secretariat will, via its REDD+ Web Platform, provide information on the results of the five REDD+ activities and corresponding RBPs. It thereby aims to increase transparency of information concerning results-based actions and corresponding payments, as well as on the REDD+ elements of the four Cancun Agreements (see Box 3 above and Decision 1/CP.16, paragraph 71), without creating additional requirements for developing countries. The Information Hub will contain the following (including information on the four Cancun Agreements' REDD+ elements, Figure 2):

[7] International consultation and analysis is described at: http://unfccc.int/national_reports/non-annex_i_natcom/cge/items/8621.php.

- a link to the NS/AP as referred to in Decision 1/CP.16, paragraph 71(a);
- the assessed FREL/FRLs and a link to the final report of the AT (Decision 13/CP.19, paragraph 18);
- information on the NFMS;
- a summary of information on how the REDD+ safeguards are being addressed and respected;
- the results for each reporting period and a link to the MRV report; and
- information on the quantity of results for which payments were received, expressed in tonnes of CO_2 equivalent per year, and the entity paying for results.

In addition to the rules and modalities for implementation, Decision 9/CP.19 of the Warsaw Framework launched a work programme on results-based finance. It recognized that the means of rewarding countries for reducing their emissions according to the REDD+ criteria may come from a wide variety of sources, public and private, bilateral and multilateral. It also encouraged financing entities, including the Green Climate Fund, to channel adequate and predictable results-based finance in a fair and balanced manner. Decision 9/CP.19 establishes the Information Hub on the REDD Web Platform, and publication of the information on the results and corresponding RBPs when available. There are two issues that require further work: incentivizing non-carbon benefits, and clarifying how carbon markets can support REDD+ implementation. Decision 10/CP.19 establishes a process to improve coordination of support, including matters regarding reception of RBPs, by inviting countries to designate a national entity or focal point to serve as liaison with the Secretariat and bodies under the Convention. The focal points will meet once a year, and the outcomes of these annual meetings will be reviewed by the Subsidiary Body on Implementation by the end of 2017.

SUPPORTING PROCESSES

Support to countries in their REDD+ implementation through the initial readiness phases has been ongoing since COP 13 in Bali and was substantially scaled up after COP 16 in Cancun. There are multiple initiatives being carried out by numerous actors, multilateral and bilateral, and at different scales, from regional to local. Overall types of needs and funding sources are summarized in Figure 4. So far, these are being bridged by different types of financial arrangements in the three different phases.

Donor countries and institutions are supporting readiness in various ways, from early capacity building to demonstration activities, with RBPs to be made once emission reductions or removals are demonstrated (Table 1). The voluntary REDD+ Database[9] provides an overview of the funding status and is updated by donors and recipients on a voluntary basis.

REDD+ finance is provided by several different institutions. The World Bank's Forest Carbon Partnership Facility (FCPF) Readiness and Carbon Funds, the Forest Investment Program (FIP) of the Climate Investment Funds, and the UN-REDD Programme are the funds for REDD+ that have provided most of the multilateral funding across all regions, supporting a large number of countries. The Amazon Fund and the African Development Bank-administered Congo Basin Forest Fund (CBFF), which focus on financing REDD+ in their respective regions, have also contributed to REDD+ support.

The UN-REDD Programme is an example of multilateral efforts being made to accompany countries in the readiness process following progress under the UNFCCC, and is described in more detail in the article on UN-REDD.

Other multilateral initiatives, such as the FCPF, are also supporting readiness processes (through their Readiness Fund) while providing follow-up support of results-based demonstration activities through their Carbon Fund. Forty-seven developing countries located in subtropical or tropical areas are participating in the Readiness Fund (18 in Africa, 18 in Latin America, and 11 in the Asia-Pacific region). Countries that have made significant progress in their REDD+ readiness endeavours (18 countries so far) are sending proposals through the pipeline of the Carbon Fund, through which the FCPF will pilot incentive payments.

There are other types of support, not always directly in the form of finance, such as methodological guidance and access to

[9] http://www.fao.org/forestry/vrd.

4
Needs and types of support for REDD+

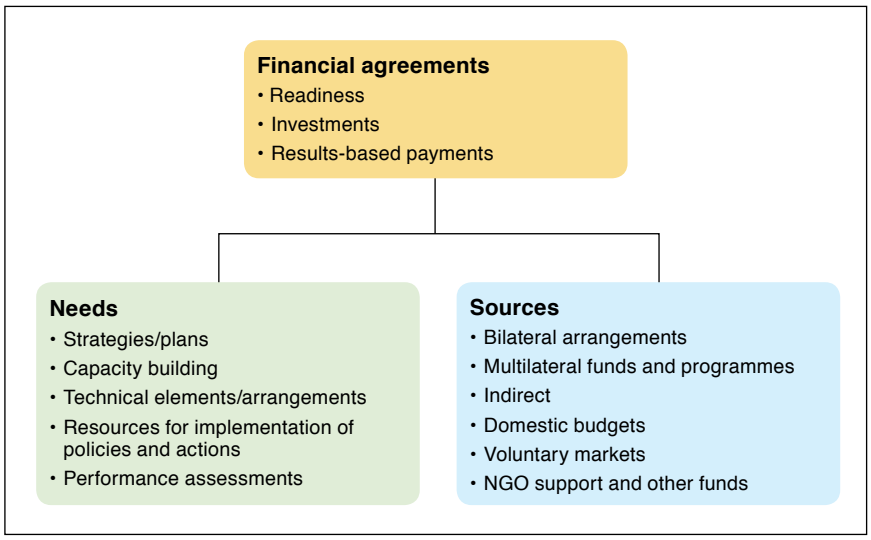


TABLE 1. Assessment of the state of REDD+ support

Type of funding/ donor	Scope of data	Data-tracking instutution/ source	Total financial pledge/ investment reported in million US$
Bilateral	21 donor countries[a]	Detailed assessment and compilation using: ODI FSF data 2010–2012, Voluntary REDD+ Database (VRD) of the REDD+ Partnership (2006–2013)	4035
Multilateral	6 multilateral REDD+/forest-focused funds[b]	ODI HBI CFU tracking (2008–March 2014)	3142
Multiple channels	21 donors and 6 multilateral REDD+/forest-focused funds	Detailed assessment and compilation using: ODI FSF data 2010–2012, Voluntary REDD+ Database (VRD) of the REDD+ Partnership (2006–2013)	23
Unknown	21 donors and 6 multilateral REDD+/forest-focused funds	Detailed assessment and compilation using: ODI FSF data 2010–2012, Voluntary REDD+ Database (VRD) of the REDD+ Partnership (2006–2013)	465
Private foundations	10 REDD+ countries[c]	Forest Trends' REDD+ (March 2014)	101
Private sector	162 projects	Ecosystem Marketplace (2013)	900
Total			**8666**

[a] Australia, Austria, Belgium, Canada, Denmark, the European Union, Finland, France, Germany, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Slovakia, Spain, Sweden, Switzerland, United Kingdom and United States of America.

[b] Multilateral funds include: the Forest Investment Program (FIP), Forest Carbon Partnership Facility (FCPF) Readiness Fund, FCPF Carbon Fund, the BioCarbon Initiative for Sustainable Forest Landscapes, the Amazon Fund and the Congo Basin Forest Fund.

[c] Including Brazil, Colombia, Democratic Republic of the Congo, Ecuador, Ghana, Indonesia, Liberia, Mexico, Peru and Tanzania..

Source: Norman and Nakhooda, 2014.

data. The Global Forest Observations Initiative (GFOI), for example, was established under the Group on Earth Observations (GEO). GFOI is led by FAO, Committee on Earth Observation Satellites (CEOS), Australia, Norway and the United States of America, and has an Advisory Committee that includes IPCC and UNFCCC representation. GFOI (2014) published version 1 of its Methods and Guidance Document (MGD), which provides operational advice on how to estimate GHG emissions and removals associated with REDD+ activities, using IPCC guidance as required by the Warsaw Framework. This is an important bridge, as the IPCC guidance does not explicitly identify the five REDD+ activities (listed in Box 1). GFOI publishes updates to the MGD on current issues such as the use of global data sets. A web-based MGD portal is in preparation and MGD version 2 is expected in 2016. On capacity building, GFOI coordinates with UN-REDD, the US SilvaCarbon programme and the Norwegian International Climate and Forest Initiative. The MGD is also used in some cases directly by countries for developing their national forest monitoring systems. GFOI also coordinates with the civil space agencies via CEOS to make freely available the core data sets identified in the MGD to support the estimation methods it describes. It produces an R&D Plan (GFOI, 2015) to identify international priorities for research. Currently these include forest degradation, mapping of specific forest types (mangrove, peat forests, etc.), interoperability, comparison of uncertainties associated with forest biomass and allometric estimation methodologies, and data model integration.

FUTURE PROSPECTS

Even before the signature of the landmark Paris Agreement in 2015 where it was included in the Agreement's Article 5, significant progress had been made in REDD+ in many countries, especially in the capacity-building phases identified in the Cancun decision. In the case of Brazil, large reductions in deforestation emissions have already been achieved in the Amazon biome, thanks to both effective use of national resources and the support of donors (such as the Norwegian International Climate and Forest Initiative) via the Amazon Fund. This did not mean that REDD+ was somehow a stand-alone process, or that it is not seen as an important part of the Paris Agreement. On the contrary, they are intrinsically linked, as evidenced in a number of ways:

1. REDD+ was conceived as part of the UNFCCC negotiating process.
2. The internationally agreed conceptual and methodological underpinning for REDD+ contained in the Warsaw Framework is a product of the UNFCCC which provides the basis for its future development.
3. The use of FREL/FRLs as a benchmark for assessing performance in implementing REDD+ activities, and the credibility of subsequent measuring, reporting and verification, are linked respectively to the TA process and Technical Analysis processes set up under the UNFCCC. These provide the basis for RBPs.
4. Possible access for REDD+ to international carbon markets may require negotiation of additional modalities, as recognized by the Warsaw Framework – the UNFCCC provides a framework for this.
5. International support for GHG mitigation, of which REDD+ is a part, has increased significantly with the new climate agreement and results-based finance for REDD+ needs to be part of that so as to benefit from it.

It follows that the prospects for REDD+ are best served as part of the

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World leaders at the Climate Change Conference in Paris, 2015

implementation of the Paris Agreement. Possible access to carbon markets is likely to require differentiation between domestic and internationally assisted action, and this may increasingly be the case with international finance in general. This may require a separation of FREL/FRLs into domestic and internationally assisted components.

In terms of capacity development, REDD+ is proving an important basis for building international capabilities in combining data from remote-sensing with ground-based data in land-use monitoring.

It is clear today that a holistic approach to mitigation and adaptation is needed, notably in order to ensure secure food supplies. Given these needs, coupled with the current pace of technical development, it seems likely that REDD+ will evolve over the coming years from its current focus on forests to a broader land-use approach. It is also likely to become increasingly relevant in valuing other crucial environmental services, notably those relating to biological diversity and water supply. ◆

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UN-REDD, the United Nations programme to reduce emissions from deforestation and forest degradation (2008–2015)

M.J. Sanz

What is UN-REDD and how does it work?

The UN-REDD Programme, launched in 2008, is the United Nations (UN) collaborative initiative on Reducing emissions from deforestation and forest degradation (REDD) in developing countries. It builds on the convening role and technical expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). UN-REDD supports nationally led REDD+ processes (see article on REDD+) and promotes the informed and meaningful involvement of all stakeholders, including indigenous peoples and other forest-dependent communities, in national implementation and international REDD+ processes and knowledge sharing.

The first five-year strategy for the programme (2011–2015) stressed the importance of "supporting governments

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Above: Forest in Arusha National Park, United Republic of Tanzania

to prepare national REDD+ strategies, build monitoring systems, engage stakeholders and assess multiple benefits" (UN-REDD, 2010). A new strategic framework for 2016–2020 was adopted in 2015 (UN-REDD, 2015a), taking into consideration the progress made by the United Nations Framework Convention on Climate Change (UNFCCC) negotiations and Sustainable Development Goals (SDGs) debate, leading to a broader overall development goal to reduce forest emissions and enhance carbon stocks in forests while contributing to national sustainable development. This reflected the progressively more complex national and international settings for providing REDD+ support to countries as well as the emerging gaps that UN-REDD could help to address.

In its first phase, UN-REDD supported national REDD+ readiness efforts across Africa, Asia and the Pacific, and Latin America in three ways: (i) direct support to the design and implementation of national strategies; (ii) ad hoc tailored support to national REDD+ action; and (iii) technical capacity-building support through sharing of expertise, common approaches, analyses, methodologies, tools, data, best practices and facilitated South–South knowledge sharing.

The UN-REDD Programme has grown significantly from 9 partner countries in 2009 to 64 partner countries by December 2015 (Figure 1). Countries have received assistance tailored to their national circumstances and specific support requirements for REDD+. UN-REDD has used the following support mechanisms:

- National Programmes, where countries define a programme of work, typically over a three-year period, and work across a range of focal areas.
- Country-specific assistance through targeted support (through formal requests from countries) and technical backstopping.
- Country/regional needs assessments: countries are supported to undertake a participatory readiness assessment, covering the principal areas defined under the UNFCCC Warsaw Framework.
- Community-based REDD+ (CBR+) which provides small grants to indigenous peoples and communities for REDD+ readiness activities in the field.
- Knowledge management and communications support.

This range of delivery mechanisms has provided flexibility to match countries' needs in advancing from readiness to implementation with the required support,

1
UN-REDD Programme partner countries by end 2015

In addition, support to Cook Islands, Gambia, Kiribati, Marshall Islands, Niger, Palau, Senegal, Sierra Leone, Tonga and Tuvalu. ★ New partner country in 2015

Source: UN-REDD, 2015b.

and to complement the contributions of other initiatives in ways that maximize efficiency and effectiveness.

In accordance with the outcomes specified in the 2011–2015 strategy, UN-REDD has achieved results in a series of thematic work areas:

- measurement, reporting and verification (MRV) and forest monitoring;
- inclusive, transparent and accountable national governance systems for REDD+, forests and finance;
- stakeholder participation in national and international REDD+ decision making;
- social and environmental safeguards and multiple benefits for REDD+;
- transformation towards the green economy; and
- development, management and sharing of REDD+ knowledge.[1]

Several assessments of the UN-REDD Programme have been undertaken since 2012, including an independent external evaluation in 2013–2014. According to one assessment:

> The UN-REDD programme has helped draw global and national attention to the importance of forests. It has given previously marginalized populations a strong voice in relevant decision-making arenas; it is leading countries to engage in policy reforms, increase transparency and reduce the risk of corruption; it has triggered the search for viable solutions to the problems associated with deforestation; it is supporting the valuation of forests and the services they provide; and it has allowed a broad range of stakeholders to gain experience with an innovative construct that now makes it possible to better articulate the conditions for sustainability and how such an agenda should be pursued (Frechette *et al.*, 2014, p. 78).

[1] Results are reviewed in UN-REDD (2014a). A list of key references is given in Annex A of this publication. Annex B includes a summary of the main achievements, based on an analysis of progress reporting since 2009.

ACHIEVEMENTS 2008–2015

In its seventh year of operation, the programme serves 64 countries (Figure 2). Partner countries stand at varying degrees of REDD+ readiness, with some now set to start implementing REDD+. Over time, the growing number of partner countries and the rapidly evolving regulatory environment shaped by UNFCCC decisions have required the programme to provide swift and targeted support to countries to complement domestic efforts or other bilateral and multilateral support.

As indicated above, the programme provides support through different modalities. As of 31 December 2015, the UN-REDD Programme had supported a total of 23 countries through National Programmes (Figure 2). In addition, funding requests for three additional National Programmes (Chile, Myanmar and Peru) were approved on a provisional basis. In 2015, 5 countries (Argentina, Bangladesh, Honduras, Mongolia and Uganda) marked the start of their National Programmes with the signature of their National Programme Documents. Up to 45 countries received targeted support across the different thematic areas indicated above, and 46 received technical backstopping. While the number of National Programmes has been relatively stable in recent years, the demand for targeted support has increased substantially and it is being seen by recipient countries as a flexible and efficient way to complement ongoing efforts in a timely and efficient manner.

All 64 partner countries benefited from the knowledge-management activities of the programme. And some specific programmes were developed in the later years to target specific stakeholders' needs, such as the Community-Based REDD+ Programme, or the Country and Regional Needs Assessment grants. Thus, 7 countries (Guatemala, Madagascar, Malawi, Peru, South Sudan, Tunisia and Zimbabwe) and 2 regions (Mesoamerica and West Africa) were granted support for needs assessments. Among the 6 pilot countries (Cambodia, Democratic Republic of the Congo [DRC], Nigeria, Panama, Paraguay and Sri Lanka) for CBR+, over 200 proposals had been received by December 2015 from communities. Out of these, 56 CBR+ projects were approved, representing over US$1.65 million in grant funding.

Thanks to the continuous support of Denmark, the European Union, Japan, Luxembourg, Norway and Spain, the total funding allocated to the programme was US$269.7 million as at December 2015. Of this, a net amount of US$238.7 million, or 89 per cent, was received by the implementing agencies (FAO, UNDP and UNEP) and US$180.2 million (or 76 per cent of the net funded amount) was spent.

LESSONS LEARNED

The UN-REDD Programme and its partners identified challenges affecting implementation of REDD+ activities during the deployment of its first phase. Lessons learned from these challenges are reflected below and were taken into account while designing the second phase.

Drawing from the programme's experience since 2008, the ingredients required for success include the following:

- Participating countries have to take the lead in the development of REDD+. This means that capacity development for a wide range of stakeholders, covering critical topics from MRV and governance to safeguards and benefits, is of utmost importance.
- Tailoring external assistance to the needs of each country is fundamental. Developing appropriate and effective policies and measures at national or subnational level is a slow and complex process.
- Effective, transparent forest monitoring systems are needed to provide data on increases in carbon stocks and reductions in greenhouse gas emissions, thereby demonstrating the "performance" for which REDD+ payments would ultimately flow.
- Capturing carbon value alone may not always be sufficient to alter land use, budgetary and natural resource

Source: UN-REDD, 2015b.

2
Yearly evolution of the UN-REDD Programme under its different implementation modalities

management decisions and practices. Linking REDD+ processes to national sustainable development agendas can contribute to supporting the shift towards building a low-carbon society while also prioritizing conservation and offering opportunities for improved livelihoods.

- REDD+ requires extensive cross-sectoral efforts – beyond forestry services and ministries of environment – to address the large drivers of deforestation and degradation in the context of economic development and climate change. Numerous interest groups are implicated in and affected by policy reform. Addressing the drivers takes time and progress to date has been slow.
- Early participation and inclusion of all stakeholders (women and men, rich and poor, rural and urban) is essential in national and international decision making on REDD+ and can contribute to reinforcing credible and legitimate policy-making and implementation. The private sector has a key role to play in these processes, but has not been sufficiently engaged so far. Conflicts may arise and conflict- or grievance-resolution mechanisms need to be in place.
- Clarity on tenure is needed to address equitable benefit-distribution systems, recognizing and protecting customary rights of local communities and indigenous peoples, and contributing to a better understanding of multiple and overlapping tenure rights.

Field trip to Sarapiquí, Costa Rica

- Strategies require thorough analysis of the generation and distribution of forest ecosystem goods and services. The costs and benefits of different REDD+ actions also need to be assessed. The role of forests in adaptation to climate change is also important.
- Development of REDD+ safeguards early in the REDD+ process is critical in mitigating the potential negative impacts of REDD+, for instance in terms of access to forest ecosystem goods and services for local communities and indigenous peoples, and foreseeing measures to ensure fair allocation of the benefits associated with REDD+.
- Alignment between the various international initiatives on REDD+ is important in order to map out the support needed and determine how countries can fully implement REDD+ policies and measures that will qualify for results-based payments.
- With three distinct UN agencies involved, the coordination and management required for the delivery of effective and efficient support to countries has been difficult. Joint country support and single interface modalities are vital to streamline operations. The implementing agencies with a strong presence in the field have made efforts to align and streamline their delivery operations and procedures, which has contributed to improving their "UN delivery as one".
- Through the development of tools, guidelines and knowledge, an important REDD+ "community of practice" is emerging, which can play an instrumental role in ensuring that appropriate and effective policies and measures are devised and implemented to tackle all aspects of REDD+.
- Supporting South–South cooperation efforts has resulted in efficient ways to increase capacity across countries and regions.

LOOKING AHEAD

The UN-REDD Programme showed in its first phase that it can support countries in meeting UNFCCC REDD+ requirements as well as countries' ambitious climate-change and sustainable development action plans, in which REDD+ is often a major element. The programme also showed that it can tailor its support while adjusting to the changing REDD+ landscape at the country level.

The UNFCCC requirements for REDD+ were framed at the Conference of the Parties in Warsaw in 2013 (COP 19), laying out the process that developing countries must follow if the results of their REDD+ activities are to be recognized under the UNFCCC. In 2015, the adoption of the post-2015 development agenda for meeting the SDGs and the global community's commitment shown at COP 21 in Paris paved the way for the consolidation of "all" countries' progressively more ambitious commitments in mitigating and adapting to climate change. In this context, the UN-REDD Programme can accompany countries along the increasingly well-defined road to REDD+, as set out in, for example, Article 5 of the Paris Agreement and prior decisions on REDD+ in the UNFCCC. Its role is also underpinned by the continued consolidation of the Green Climate Fund and the importance given to actions on agriculture, forestry and other land uses identified in countries' Nationally Determined Contributions (NDCs) submitted to the UNFCCC.

It is increasingly clear that REDD+ can make significant contributions to sustainable development in the context of climate change and poverty reduction. The UN-REDD Programme is performing a valuable role in delivering REDD+ readiness and implementation support to countries. ◆

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Coordinating climate action: experiences from REDD+ and FLEGT

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Together, REDD+ and FLEGT mechanisms provide stakeholders with the justification and tools to frame their resource use.

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Many policy-makers and experts have pointed out the potential for greater linkages between Reducing emissions from deforestation and forest degradation (REDD+) and the European Union's Forest Law Enforcement, Governance and Trade (FLEGT) initiative. However, limited evidence is available on how this has translated into practice. This article provides practical examples of how different countries are coordinating climate action on the ground through REDD+ and FLEGT. A brief review of the literature is followed by practical examples of synergies from FAO's work on FLEGT and REDD+ in Asia, Africa and Latin America, and recommendations for coordinating the roles of FLEGT and REDD+ in the climate and development agenda.

INTRODUCTION

Various international initiatives have emerged in the past few decades that contribute to the forest sector's mitigation potential, addressing both deforestation and forest degradation. Mechanisms such as REDD+ and FLEGT – and related

Workers gluing wood pieces together at a factory in Long An Province, Viet Nam

Voluntary Partnership Agreements (VPAs)[1] – are among the most notable. REDD+ provides economic incentives via emission reductions to keep forests standing, while FLEGT provides incentives in the form of market access by levelling the playing field and eliminating illegal timber. Other related initiatives also exist. It has become increasingly clear that no single initiative can achieve the global impact needed to reduce forest loss and mitigate climate change, but what is less clear is the extent to which the existing initiatives interact at the country level.

The combination of REDD+ incentives (results-based payments) and FLEGT trade incentives (improvement or maintenance of market access) could provide a unique opportunity to promote sustainable forest management (SFM) in producer countries. A recent assessment of the Intended Nationally Determined Contributions (INDCs) submitted to the UN Framework Convention on Climate Change (UNFCCC) shows that all 15 VPA partner countries have included forests in their climate mitigation plans. More specifically, the INDCs of Guyana and the Lao People's Democratic Republic, for example, make reference to both FLEGT and the VPAs, while the INDC for Côte d'Ivoire refers to FLEGT. More generally, increased cooperation between REDD+ and FLEGT at the national level could advance forest governance reforms, clarify land tenure, strengthen stakeholder engagement and balance competing interests, all of which will increase benefits for forests, people and the environment.

BRIEF LITERATURE REVIEW

The conceptual linkages between FLEGT and REDD+ have been amply covered by the literature in recent years (Broekhoven & Marieke, 2014; Tegegne *et al*., 2016; Tegegne *et al*., 2014; Marfo *et al*., 2013; and Ochieng, *et al*. 2013). Table 1 provides

[1] VPAs are binding bilateral trade agreements between the EU and timber-producing partner countries to ensure that timber and timber products imported into the EU are of legal origin.

TABLE 1. Conceptual synergies between REDD+ and FLEGT

Key synergies	Related interactions	Sources
Content		
Thematic focus	(1) *REDD+ and FLEGT both work to tackle the key drivers of forest degradation and deforestation.* While REDD+ has a more cross-sectoral approach, FLEGT focuses specifically on illegal forest activities, including illegal logging and illegal forest conversion, two important causes of forest degradation and greenhouse gas emissions. Both initiatives are working to address the structural causes of weak forest governance and promote SFM.	Broekhoven and Marieke, 2014; Luttrell and Fripp, 2015; Marfo *et al*., 2013
Process		
Stakeholder engagement	*(2) FLEGT can act as a model for REDD+.* Participatory and consensus-based forest governance is widely acknowledged as the foundation of SFM, which is the common goal of both FLEGT and REDD+. Multiple authors point to the multi-stakeholder processes that are a cornerstone of FLEGT as a model for REDD+, particularly with regard to benefit-sharing mechanisms. It should be noted that a criticism of both is that stakeholder engagement takes place primarily at the planning/readiness phases and is not as active during the implementation phase.	Broekhoven and Marieke, 2014; Luttrell and Fripp, 2015; Marfo *et al*., 2013
Legal reform	*(3) Sharing information among processes.* Both FLEGT and REDD+ processes require similar information at the planning and "readiness" phases regarding legislation (in forestry and related sectors) that could impact the sector, as well as on forest cover and condition (see *Monitoring*). Information-gathering could be performed in coordination to avoid redundancy.	Luttrell and Fripp, 2015
Traceability	*(4) The FLEGT multi-stakeholder model for monitoring timber can assist in the design of REDD+ benefit-sharing mechanisms.* FLEGT Timber Legality Assurance Systems,* which aim to track timber through multiple state and non-state actors, are viewed by some as a model that could provide insights into designing REDD+ benefit-sharing mechanisms based on the "roles and constellations of state and non-state structures and actors".	Luttrell and Fripp, 2015
Transparency and accountability	*(5) Transparency and accountability are important conditions for successful VPA and REDD+ implementation.* Reliable, accurate and verified information is at the core of FLEGT and REDD+ processes that ensure transparency and build trust, providing the foundations for investment (EFI & Proforest, 2014). In the Democratic Republic of the Congo, for example, a searchable repository of documents related to FLEGT and REDD+ has already been developed under the FLEGT VPA to make information relating to legal questions, forest management, data on annual timber production and revenues and exports to the EU publicly available.	Broekhoven and Marieke, 2014; EFI, 2014

* Countries with a VPA are setting up systems that verify that their timber is legal by tracking it throughout the supply chain. These are known as Timber Legality Assurance Systems (TLAS).

Table 1 continues on next page

Table 1 continued

Key synergies	Related interactions	Sources
Process		
Monitoring	*(6) Sharing monitoring and reporting information.* REDD+ includes mechanisms for monitoring, measuring, reporting and verification (e.g. on forest cover and condition). The institutional and technical capacity to monitor deforestation and forest degradation developed for REDD+ can be useful for FLEGT if it provides information on forest management, forest cover and illegal activities, and may also contribute to stronger national capacity and introduce a culture of effective monitoring and verification in the forest sector. *(7) Use of civil society in monitoring modelled on VPAs.* Civil society monitors are mentioned in all VPAs. Some authors consider this important for REDD+ benefit-sharing to create oversight and ensure credibility (see *Traceability*).	FERN, 2010; Brack and Léger, 2013; EFI and PROFOR, 2014; Saunders *et al.*, 2008
Community and smallholder forestry and tenure	*(8) Mutual concern over land tenure.* REDD+ focuses more explicitly on land and tree tenure, while FLEGT deals more with aspects of timber legality, thus targeting governance reforms related to helping community-based forest enterprises "go legal". Both aspects (upstream and downstream) are needed for sustainable impacts on timber production and forests.	Reem, 2015
Safeguards	*(9) REDD+ can serve as a model for FLEGT with regard to safeguards.* It is widely acknowledged that both FLEGT and REDD+ processes could have unintended negative social and environmental consequences. REDD+ explicitly mentions safeguards, in the form of seven social and environmental safeguards. FLEGT principles and guidance are generally vague (Honduras is an exception), despite FLEGT work on legality definitions; legal frameworks provide an obvious entry point for addressing social and environmental safeguards	Korwin in Broekhoven, and Marieke, 2014
Financing	*(10) FLEGT can function as a risk-reducing measure for REDD+ investments by supporting the creation of an enabling environment through stronger governance and institutions.* It has been argued that public and/or private entities may not invest in REDD+ in high-risk countries if governance and legal frameworks are weak, so investing in countries where FLEGT processes are present is a potential advantage for REDD+.	Bucki, 2012; Broekhoven and Marieke, 2014; EFI and PROFOR, 2014

a non-exhaustive list of the conceptual synergies identified. Most of the literature also suggests that while the linkages are clear, putting these synergies into practice is less so.

CASE STUDIES FROM FAO'S JOINT WORK ON FLEGT AND REDD+

Of the countries actively involved in negotiating or finalizing VPAs and those forming REDD+ readiness plans, three key countries have shown successful approaches to synergies between the two initiatives. Important advances – showcased below – have been made regarding legal frameworks and definitions, joint programmatic strategies, joint planning and stakeholder participation.

Viet Nam: FLEGT capitalizes on the national REDD+ architecture

Viet Nam is in the final stages of its VPA negotiation and in its REDD+ piloting phase. There have been mutually beneficial opportunities for FLEGT and REDD+ to link both processes, including on issues related to illegal production and trading of conversion timber – a leading cause of deforestation in the Mekong Region (a source of transboundary leakage) – and through the promotion and strengthening of SFM via voluntary forest certification. In Asia, and more specifically Viet Nam, the FAO FLEGT Programme encourages FLEGT progress within the REDD+ framework via inclusion in the REDD+ Strategy.

Conversion timber and transboundary leakage: A logging ban has been imposed on Viet Nam's natural forests since 1993; imported timber – largely sawn wood and logs – is an important source of wood and these have largely been sourced from the neighbouring Lao People's Democratic Republic and Cambodia (Lawson, 2014). While forest governance issues have lain at the core of both REDD+ and FLEGT processes in Viet Nam, recent concern over leakage into neighbouring countries indicates strong potential synergies between FLEGT and REDD+. VPAs were not designed to tackle the problem of illegal forest conversion – they can, however, contribute to mitigating the risk of illegal forest conversion by clarifying legal frameworks, strengthening legality verification and forest governance, providing platforms for dialogue among governments, civil society and industry, and promoting transparency and independent monitoring in the forest sector. Under Outcome 6 for the UN-REDD Viet Nam Phase II Programme Extension Proposal 2016–18, and as part of its regional leakage component, REDD+ strategies have been developed to ensure reduced risks of displacement through the import of illegal timber. The programme will also work on the design of a risk-assessment or due diligence system to ensure the legality of timber imports, another important element of the VPA TLAS.

Forest certification, a tool for FLEGT and REDD+: FAO FLEGT, in partnership with the Research Institute for Sustainable

Forest Management (SFMI), is preparing smallholder producers and SMEs for the Viet Nam TLAS implementation by testing voluntary group certification of integrated chain-of-custody (CoC) and due diligence systems. While waiting for the VPA negotiations to conclude, SFMI is preparing smallholder producers and SMEs for the Viet Nam TLAS implementation by piloting the use of PEFC and FSC CoC certification standards combined with other due diligence systems or risk-based sourcing. The FAO FLEGT Programme will continue to promote voluntary certification as a tool for FLEGT and SFM in its five-year strategy; further, it will also support the development of a National Certification Scheme. This will be rolled out via the funding of three projects that are working closely with national wood industry associations (e.g. Handicraft & Wood Industry Association of HCM City – HAWA). In Viet Nam, the REDD+ Programme (Phase 2) (UNREDD, 2013b) supports the use of voluntary certification of smallholders and state forest enterprises in Viet Nam as part of the Provincial REDD+ Action Plan (PRAP) pilots funded by the Forest Carbon Partnership Facility (FCPF). The REDD Programme is also supporting the design of certain elements of the Viet Nam VPA TLAS such as the Forest Crime or Violation Database, which will inform the company risk classification system that in turn defines the verification intensity prior to FLEGT licensing. The UN-REDD Programme will ensure that a National Certification System is appropriately incorporated into the revised National REDD+ Action Programme (NRAP), which would reinforce the case for future investments in developing the system under REDD+-related initiatives.

Honduras: FLEGT and REDD+ jointly address the drivers of weak forest governance, forest degradation and deforestation

Approximately 2.5 million ha of land in Honduras is considered "indigenous territory"; of this land, at least 50 percent is forested. The issue of "who owns the forest" and associated land rights challenges is said to be the most critical issue facing indigenous peoples in the country, and a core driver of weak governance and forest loss in Honduras. Land ownership is also the most important challenge for identifying timber legality (Forest Trends, 2013). To some extent, the clarification of community tenure rights (or lack thereof) is expected to make or break both FLEGT-VPA and REDD+ processes in the country because access to, use and benefits from forests are so inherent to how forest resources are governed that efforts to address timber legality and CO_2 emissions would be futile without addressing tenure. In turn, tenure has taken centre stage in both the VPA and REDD+ processes.

Unlike REDD+, however, which *in content* places emphasis on social safeguards and land and tree tenure by requiring that partners develop a benefit-sharing mechanism from the outset, FLEGT legality definition discussions have until recently focused primarily on the timber industry. Although the action plan does state that FLEGT and related VPAs should operate under a "do no harm" approach, tenure is largely beyond the scope of a VPA, as that is not its original intent. The *process* adopted in FLEGT VPA negotiations with regards to stakeholder engagement, however, has been widely acknowledged as extremely effective in terms of participation, so much so that it is widely perceived as a model for REDD+.

Moreover, in Honduras, where timber trade with the EU is limited, and increasingly in many other countries, although the VPAs began as trade agreements, the discussion has broadened to include land tenure, corruption and extra-sectoral deforestation drivers. In many ways, Honduras is an example of content (REDD+) and process (FLEGT) meeting and evolving into a strong coordinated movement to address tenure, sustainable forest management and, ultimately, climate change.

These "synergies" are unfolding in practice in several ways:

Common platform: Mesa Indígena y Afro hondureña de Cambio Climático (MIACC): The participation of indigenous and African-Honduran representatives in climate-related discussions is taking place through the MIACC platform, created by indigenous peoples in 2012 to coordinate indigenous peoples' activities on climate change, including REDD+, and now also being used for VPA negotiations. The members of the Confederación de Pueblos Autóctonos de Honduras (CONPAH) – which represents the Tawahka, Miskitu, Lenca, Garífuna, Negro de Habla Inglés, Pech, Tolupan, Maya-Chortí and Nahoa peoples – lead the work of MIACC.

Common methodology: Free, Prior and Informed Consent (FPIC): Stakeholders view FPIC as crucial for effective and sustainable VPA and REDD+ processes in the country, and to address climate action more broadly, because historically, mechanisms for effective participation of indigenous peoples and forest-dependent communities in Honduras regarding land-use decisions have been scant. Today, FLEGT, through the FAO FLEGT Programme, and REDD+, through UN-REDD and FCPF support mechanisms, are aligning efforts to support the development of a national mechanism of FPIC encompassing all nine indigenous groups with an agreed methodology. In addition, indigenous peoples are preparing new draft legislation to formalize FPIC in the legal framework, which is anticipated to be presented to the Assembly in 2016. CONPAH and local NGO Alianza Verde are the main partners working to generate consensus on the national FPIC mechanism and the draft legislation, together with FAO FLEGT and REDD+ funds. These entities not only represent indigenous peoples' rights, but are helping to develop mechanisms for implementing FPIC, thereby facilitating active participation in the VPA and REDD+ processes.

Joint planning: A common approach to forest governance and climate change mitigation by addressing tenure challenges and the participation of indigenous peoples is being applied in Honduras thanks

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Wood processing enterprise in Côte d'Ivoire

to commonalities identified during the early stages of both processes. These are explicitly mentioned in the country's REDD+ Readiness Preparation Proposal (R-PP) through a table on linkages (Del Gatto and Pokorny, 2014) that makes reference to safeguards and rights for indigenous and local communities. This collaboration, which materialized roughly one year after the Government of Honduras began negotiating VPAs with the EU (2013), is now also forming the basis of the VPA. REDD+/FLEGT alignment paved the way for a VPA legality definition which includes a specific principle on respect for community and indigenous peoples' tenure and use rights, which is unusual for a VPA.

The case of Honduras is fairly unique to FLEGT in that it is the first VPA country where indigenous peoples are playing a key role in the process, where the discussion has broadened beyond legality to include other key drivers of forest degradation and deforestation, and where efforts are now underway to identify potential livelihood impacts of the VPA from the outset to enable social and environmental monitoring. The joint action between FLEGT and REDD+ moreover demonstrates that when thematic commonalities between the two processes are addressed at an early stage, joint action is not only useful, but also optimizes the chances of success and stakeholder buy-in for both initiatives. Finally, it shows not only how both FLEGT and REDD+ can contribute to secure community and tenure rights, but how such international forest regimes can adapt to local contexts to contribute to both climate change mitigation and development objectives.

Côte d'Ivoire: FLEGT/REDD+ legal working group jointly reviews forestry legislation

Despite the different foundations and different lead ministries running FLEGT and REDD+ in Côte d'Ivoire, which have in the past resulted in the two processes running independently from each other, both are currently jointly addressing the legal, regulatory and institutional measures necessary to achieve their objectives. The development of the FLEGT VPA legality definition is a clear opportunity for potential synergies regarding process. A multi-stakeholder approach is being used to develop the legality definition and, during this process, gaps, inconsistencies and overlaps in legislation are often identified that warrant legislative reform.

From the perspective of process, efficiencies could be gained by addressing the requirements of both REDD+ and FLEGT in multi-stakeholder processes. From a substantive legal perspective, coordination of work under the two initiatives would add value to the development of new laws, ensuring consideration of multi-dimensional and cross-sectoral aspects. Laws and regulations reviewed and developed under FLEGT address many issues of relevance to REDD+ and vice versa. New legislation and regulations could, therefore, be developed with the objectives of both initiatives in mind.

Recognizing these common information needs, and at the request of the Ministry of Water and Forestry of Côte d'Ivoire, FAO's Legal department (LEGN), together with the FAO FLEGT Programme and UN-REDD team, supported the creation of a multi-stakeholder national Legal Working Group (LWG). This includes civil society representatives from the FLEGT/REDD+ Civil Society Platform – initially developed for the FLEGT process and now also used by UN-REDD to avoid parallel structures – and legal experts from the lead ministries for the two initiatives. This LWG will serve as a think tank, supporting the ongoing drafting of implementing decrees for the Côte d'Ivoire Forest Code being undertaken by a private law firm, and addressing key challenges arising under both FLEGT and REDD+, such as tenure and user rights, benefit sharing, and procedural rights.

The collaboration entails various levels of coordination and support from LEGN, including: collecting and consolidating existing legislation related to the forestry sector for the LWG – to date this includes some 250 pieces of legislation. Next steps include: i) cross-analysing the coherence of existing sector-specific legislation (e.g. forestry law, environmental law, etc.), with corresponding recommendations for reform; ii) identifying a list of priority forest code regulations that could impact on the definition of legality and related REDD+ work; iii) conducting a field consultation to gauge local communities' concerns regarding logging and REDD+-related activities; and iv) consolidating the concerns into a draft on implementing forest code regulations aimed at helping to fill some of the existing legal gaps on key aspects for both VPAs and REDD+.

CONCLUDING REMARKS

The level of synergy between FLEGT and REDD+ will depend on the phase that each process has reached. Honduras is a good example of the effectiveness of coordination at an early stage. Other promising linkages between FLEGT and REDD+ can be expected during the implementation phase where VPAs (or other FLEGT instruments) could become a tool or measure for REDD+, which in turn is supported by results-based payments. To effectively reach this stage, FLEGT has to be reflected or included in the REDD+ national strategies and piloted whenever the different stages of the two initiatives offer this opportunity, as demonstrated by Viet Nam in its national planning.

Moreover, all of the case studies suggest that FLEGT and REDD+ have the potential to deliver impacts beyond the timber industry when a multi- and extra-sectoral lens is applied to planning processes. The forest sector is considered "one of the most advanced arenas for finding examples of new types of governance with several non-State market-driven governance systems already in place and consolidated (e.g. certification or PES schemes)" (Pettenella, 2011). Adopting a legality and governance lens for areas such as agricultural commodities(e.g. "FLEGT for agriculture"), particularly with regard to an identification system for sustainable and legal products, could bring gains to other land uses and sectors. The UK's procurement policy for sustainable palm oil in food and catering, for example, is one measure very much based on experiences of the timber sector (Broekhaven and Marieke, 2014).

Our main message is that in order to effect significant change in the forest sector, large-scale initiatives need to be taken on board together as policy tools, and jointly implemented by governments and stakeholders to multiply their effect. At the end of the day, climate change mitigation, and responsible, legal forest management is implemented by people on the ground. Our audience – forest users – and the governments who shape the legal and policy framework for guiding action on the ground and mobilizing resources, are the ones who can translate objectives into common, practical actions.

With this in mind, countries can take immediate action to integrate the two initiatives, both in the preparation of National Strategies for REDD+ and in the negotiation of VPAs where applicable. In countries where a VPA is not being pursued, integration of REDD+ objectives in national strategies to combat illegal logging and national forest planning processes are equally important. Immediate actions can include:

- Clearly linking the two initiatives in policy documents such as country programming frameworks (CPFs), national forest strategies, legal reform processes and resource mobilization documents to help countries communicate how the initiatives will work on the ground for greater stakeholder buy-in.
- Greater emphasis on the weight of policy and legal frameworks and processes as this is where the country is able to conceptualize the integration/implementation of the two initiatives and "make it stick".
- More concerted efforts to coordinate action during the planning phases, and subsequently during implementation, through common platforms, methodologies and task forces as evidenced in the above case studies.
- More research on how to coordinate actions to better link both initiatives to the Paris Agreement and the Sustainable Development Goals, to enhance the forest sector's mitigation potential.

- Initiating "FLEGT and REDD+ for agriculture" to extend governance lessons from the timber industry to other commodities.

REDD+ and FLEGT initiatives have created new languages and helped re-frame common challenges by focusing on specific approaches to addressing deforestation and forest resource use. The old needs remain at the heart of the issue – how to generate true value from standing forests and ensure that the people who live in them gain tangible benefits from their use, thereby enabling them to generate income, improve their wellbeing and maintain the forests they depend on. As we have seen through climate change dialogue, we all depend on standing forests for their carbon retention services. REDD+ and FLEGT mechanisms provide stakeholders with the justification and tools with which to frame their resource use and guide future national development. REDD+, with its scientific basis in carbon monitoring, provides the "why" for maintaining forest cover. FLEGT, with its foundation in national legal frameworks, decision-making structures and participation, provides the "how". While the mechanisms may seem complex and technical, at the level of national policy-making and practical action on the ground, the two are inseparable. ◆

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Grassroots facilitators as agents of change for promoting sustainable forest management: lessons learned from REDD+ capacity development in Asia[1]

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Local resource person shares issues and concerns related to REDD+, Nepal

The opportunities and challenges involved in strengthening communication between policy-makers and local stakeholders.

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INTRODUCTION

This article aims to provide policy-makers and other key stakeholders with insights into the issues and concerns of grassroots stakeholders with regards to REDD+[2] policy and programme development. The lessons shared spring from experiences in REDD+ capacity development in South and South-East Asia, covering Indonesia, Lao People's Democratic Republic, Myanmar, Nepal and Viet Nam. Extensive participatory and contextualized discussions and a series of training events contributed to building a cadre of hundreds of REDD+ trainers and facilitators at different levels and reached out to thousands of grassroots communities in project countries.

[1] This article is based on the paper of the same title that was submitted to the XIV World Forestry Congress, Durban, South Africa, September 2015.

[2] Reducing emissions from deforestation and forest degradation, including conservation and sustainable management of forests and enhancement of forest carbon stocks. See also the article on REDD+ in this issue of *Unasylva*.

Subsequent to REDD+ capacity development, grassroots communities have taken a number of initiatives to reduce deforestation and forest degradation. Examples include the revision of forest management plans, the introduction of alternative energy devices, plantation activities and advocacy for women's participation in decision-making.

However, at the macro level, unclear land tenure, poor governance and conflicting land policies continue to pose challenges for the design and implementation of REDD+ and the sharing of its potential benefits. To address these challenges, inform the future global climate regime, and reduce poverty among forest-dependent communities, multi-pronged and multi-scale sustained interventions are needed, supported by partnership-building, collaboration and synergies among stakeholders.

Deforestation and forest degradation, along with agriculture and other land-use practices, collectively known as AFOLU (Agriculture, Forestry and Other Land Use), are the second-largest contributor to total global greenhouse gas (GHG) emissions after the energy sector and represent a share ranging from 20 to 24 percent of total GHG emissions (IPCC, 2013; Tubiello, 2014). In some countries, such as Brazil and Indonesia, deforestation and forest degradation are together by far the main source of national GHG emissions. Eighty percent of the Earth's above-ground terrestrial carbon and 40 percent of below-ground terrestrial carbon is stored in forests. REDD+ has been proposed as a means for developed and developing countries to work together under the United Nations Framework Convention on Climate Change (UNFCCC) on mitigating climate change impacts globally. It attributes a financial value to the carbon stored in the forests of tropical developing countries, offering incentives to forest managers/owners for their efforts in reducing GHG emissions from forest lands and in increasing the absorption of atmospheric carbon by managing/conserving forests sustainably.

Given that millions of rural communities depend on forests for their livelihoods and have been sustainably managing forest resources for decades, their meaningful engagement and effective participation in REDD+ is essential to formulate national policies and local institutional processes. Furthermore, as the concept of REDD+ has evolved over the years, it has become necessary to enhance the capacity of grassroots communities in order for them to contribute effectively to REDD+ policy processes and play an active role in implementation mechanisms at the local level.

Although REDD+ capacity development is already underway through multilateral, bilateral and civil society initiatives, most of these focus on technical aspects, are

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Discussion among members of a women's group, Bao Thuan commune, Viet Nam

delivered in English and remain limited to key personnel in REDD+ planning and implementation. Yet the most pressing need is to raise local stakeholders' awareness to enable them to participate meaningfully. Suitable tools, including information, education, and communication (IEC) campaigns, are required to provide neutral, balanced information that does not raise unrealistic expectations. Recognizing this need, the Center for People and Forests (RECOFTC) has been implementing a project (referred to in this article as the REDD+ Grassroots Project) with support from the Norwegian Agency for Development Cooperation (Norad) since late 2009. At present, the project covers five countries – Indonesia, the Lao People's Democratic Republic, Myanmar, Nepal and Viet Nam – and its main goal is to develop the capacity of grassroots stakeholders, enabling them to effectively contribute to REDD+ processes in the project countries by meaningfully participating in the debate, raising their concerns and aspirations and sharing their experiences in managing and using forest resources sustainably. This article summarizes the project implementation experience and lessons learned.

METHODOLOGY OF REDD+ CAPACITY DEVELOPMENT

The REDD+ Grassroots Project followed a systematic approach and used a number of simple tools to develop and deliver REDD+ capacity development in five project countries, as described below.

Capacity Development Needs Assessment

A Capacity Development Needs Assessment (CDNA) for REDD+ was the fundamental step taken by the project in order to develop a comprehensive and contextualized grassroots capacity-development programme for REDD+. The CDNA for REDD+ used a set of six competency standards (Table 1), with corresponding knowledge, skills, attitude and context for each standard, to assess the status of current capacities and capacity-development needs among target stakeholders. Since the grassroots communities were the primary target stakeholders, the CDNA process assessed the capacity-development needs among forest-dependent communities, women, ethnic groups and indigenous people, as well as frontline staff and extension workers of the forest department, non-governmental organizations (NGOs) and civil society organizations (CSOs) directly working with local communities, federations of forestry user groups, youth groups, women's groups, teachers, students, and local-level journalists (RECOFTC, 2011).

TABLE 1. Competency standards used for CDNA for REDD+

	REDD+ competency standard
1	Fundamental knowledge and understanding of climate change science and mitigation strategies
2	Understanding of REDD+ in the context of climate change
3	Integration of the REDD+ mechanism into community forest management, i.e. focusing on environmental and social safeguards for monitoring, reporting and verification (MRV)
4	Forest carbon market and trading (may be forest carbon financing)
5	Benefit sharing from forest carbon trade
6	(Opportunity) costs of REDD+

Besides identifying gaps, the CDNA results were also used to identify various methods/approaches, and to develop a range of IEC materials and tools, to deliver the capacity development among grassroots stakeholders.

Cascade approach for capacity-development delivery

The project used a cascade approach for delivering the REDD+ capacity-development activities. This included the design and delivery of training of trainers (ToT) programmes at national and sub-national levels (province/state/district) and a series of training and awareness-raising events at the local level. Using this approach, the project engaged ToT alumni to deliver training, thereby also enhancing knowledge retention among trained alumni. Since the project is implemented through a network of nearly 20 partner organizations, including government, NGOs, CSOs, local universities, and community-based organizations, developing their capacity was the first step. Using the ToT approach, trainees were then engaged for delivering training programmes at the next level. Moreover, besides enhancing technical knowledge on climate change and REDD+, the ToT also built the facilitation skills of participants. In addition, it developed stakeholders' capacity to promote social REDD+ safeguards through materials and training programmes on topics such as Free, Prior and Informed Consent (FPIC) (RECOFTC and GIZ, 2011; Edwards *et al.*, 2012), gender mainstreaming (RECOFTC, 2013), social equity (RECOFTC, 2014a), and stakeholder participation in REDD+.

Channelling grassroots stakeholders' concerns and issues

The results of the CDNA also revealed that while on the one hand the global discourse on REDD+ has been evolving rapidly, the capacity of grassroots organizations to distil the concerns and aspirations of their communities and communicate them to policy-makers is still very limited. To address this gap, the project has used a cascade-up approach to communicate grassroots concerns and issues to policy-makers. This has been done by identifying the communities' key issues and concerns in each project country, followed by multi-stakeholder discussions at the grassroots level. These are then communicated to sub-national and national-level policy-makers and other key stakeholders to influence ongoing REDD+ policy and planning processes in each project country.

Monitoring and evaluation

Participatory monitoring and evaluation (PM&E) has remained an integral part of the project implementation approach. The PM&E focused on key aspects of project delivery – use and effectiveness of training materials, tools and approaches; effectiveness of delivery of training programmes; and retention and use of knowledge by participants. To do so, the project notably used Kirkpatrick's model of training evaluation (Bates, 2004).

RESULTS

Improving accessibility of information on REDD+

A general observation based on the CDNA revealed that while a preliminary understanding of climate change and REDD+ existed at national and sub-national level, albeit limited to a few individuals, at the grassroots level such an understanding was almost non-existent across all the countries. Although such a finding may not be surprising, it was nevertheless helpful in assessing current levels of knowledge among grassroots stakeholders, who had some familiarity with the concept of climate change but not with REDD+. Further, because the grassroots stakeholders are the primary target of the project, the results of the CDNA were helpful in exploring innovative approaches to develop the most appropriate IEC materials and tailor them to different country contexts (Table 2). Such IEC materials, besides being produced in English, were also produced in the national language of the target countries via consortia of key organizations in order to contextualize the material (Luintel *et al*., 2013).

TABLE 2. Information, education and communication materials for REDD+ capacity development

IEC material	Objective	Primary target audience
Facilitators' manual on REDD+ in English and national languages of the project countries	• To enhance the understanding of climate change and REDD+ in the context of sustainable forest management • To build facilitation and participatory skills	• National and sub-national level stakeholders • Trainers and facilitators working in the forestry sector at national and sub-national level • Media persons • Project partner organizations
Facilitators' manual and guidebook on Free, Prior and Informed Consent (FPIC) in REDD+ in English and national languages of the project countries	• To respond to the capacity development needs on REDD+ safeguards, particularly on FPIC	• National and sub-national level stakeholders • Trainers and facilitators working in forestry sector at national and sub-national level • Project partner organizations
Question and answer booklets on various REDD+ topics, including safeguards	• To provide simple and concise information on climate change and REDD+ • To respond to capacity development needs on various REDD+ topics, including safeguards	• Grassroots-level facilitators, including women • Local community members • Project partner organizations • Students
Posters on climate change and REDD+	• To raise awareness on climate change and REDD+	• Grassroots communities, women, ethnic groups • Grassroots-level facilitators
Series of radio programmes on climate change and REDD+	• To raise awareness on climate change and REDD+	• Grassroots communities, women, ethnic groups • Local media persons, citizen journalists
Puppet shows, street plays, drama, songs, competitions, information fair	• To raise awareness on climate change and REDD+	• Grassroots communities, women, ethnic groups, students, youth groups

REDD+ capacity development delivery

Using the cascade approach for REDD+ capacity development, the project was able not only to reach a large number of stakeholders in a cost-effective manner, but also to link the knowledge-sharing process at different levels (Roy *et al*., 2014). This also helped to create a local-level network of trainers and facilitators equipped with training materials and tools and able to sustain the REDD+ knowledge-building process in their countries. By the end of 2013, the project had delivered more than 500 events, including ToT, refresher workshops, grassroots consultations and various awareness-raising events for REDD+ in the project countries (RECOFTC, 2014b). Over 70 percent of such events concentrated on the grassroots level. Through the events, the project was able to create a cadre of nearly 700 national- and sub-national-level trainers and facilitators, while at the grassroots level it reached nearly 40 000 stakeholders through awareness-raising events in all project countries. Gender mainstreaming in REDD+ capacity development has been one of the project's key focuses. Of all the trained participants at national and sub-national levels, an average of nearly one-third are women, while at the grassroots level nearly 40 percent of participants in awareness-raising events in the project countries are women. To keep project stakeholders updated about REDD+ developments at the global level and promote continuous learning and exchange of knowledge, refreshers and reflection workshops at the national and regional levels have proven helpful. In particular, annual regional reflection workshops have been effectively used by project countries as a platform for learning from each other and adopting best practices, thereby building a strong learning network and community of practice.

Retention and use of REDD+ knowledge

The retention and use of REDD+ knowledge varied across different project countries. In countries such as Indonesia and Viet Nam where REDD+ has made good progress thanks to various bilateral and multilateral projects, and in Nepal which has a strong foundation of community forestry, the retention of knowledge on climate change and REDD+ ranged between 60 and 80 percent among grassroots stakeholders. On the other hand, in countries like Lao PDR and Myanmar knowledge retention ranged from 30 to 60 percent. Low rates of literacy coupled with a lack of well-defined criteria for selecting training participants, as well as the diversity of ethnic groups with different languages and customs, were identified as key challenges for the retention of climate change and REDD+ knowledge in these countries. Also, despite varying levels of knowledge retention, only a few examples of use of the new knowledge were reported by project countries. These included revising local-level forest management planning in order to incorporate climate change and REDD+, initiating plantation activities, advocating for FPIC safeguards in new forestry projects, advocating for the active participation of women in local-level forest management decision-making and a number of success stories of project alumni serving as resource persons at local-level REDD+ capacity-building events.

Using the story-telling method to raise awareness among local communities, Myanmar

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Concerns and aspirations of grassroots communities relating to REDD+

The REDD+ Grassroots Project has been able to identify some key issues, concerns and aspirations of grassroots communities, which need to be addressed in order to ensure smooth and effective implementation on the ground. Some of the most recurrent issues are briefly described below:

Complexity of REDD+ language: With its complex language, the concept of REDD+ remains abstract for both stakeholders and grassroots communities alike. Most REDD+ concepts and terms are highly technical and do not exist in the native languages of indigenous people and other local communities, hindering their effective participation in national REDD+ programmes (RECOFTC and UNEP, 2011).

Sharing knowledge with school students, Lao People's Democratic Republic

Expectations from REDD+: Complex, confusing, and at times contradictory, REDD+ messages risk raising expectations or exacerbating misunderstandings among stakeholders. At the same time, the growing need for specialized knowledge and technical skills, especially related to the participatory assessment of carbon storage and monitoring, reporting and verification (MRV) of REDD+ implementation, risks disempowering local forest stakeholders, who have adeptly managed forests for decades, in favour of the outside expertise required by REDD+.

Unclear land tenure: There is widespread anxiety that a poorly designed and implemented REDD+ mechanism may lead to a backlash against community forestry. Concerns abound that REDD+ will serve as a catalyst for the escalation of conflicts, especially between communities and government – including that the state might reconsolidate forest management over previously devolved forests. This apprehension is primarily based on the fact that in many situations the land-use rights of local communities are not protected by safeguards and communities are not actively engaged in REDD+ design and preparedness processes.

DISCUSSION

REDD+ capacity development at the grassroots level in the five project countries has provided a number of useful experiences and lessons. The establishment of a knowledge base is central to REDD+ readiness as well as in progressing through the stages of REDD+. As mentioned above, as REDD+ discourse at the global level continues to evolve, it has been challenging to keep updated information available, comprehensible and relevant for grassroots stakeholders (RECOFTC and UNEP, 2011). Considering the large amount of information available in the public domain, including in the media, some of which may not be verified or may be subject

to different interpretations, expectations among grassroots communities could escalate. It is therefore necessary to filter the information in order to clearly communicate the scope and goals of REDD+ to a wide audience through awareness-raising and capacity-building. While REDD+ requires the development of new elements, such as MRV systems, a benefit-distribution system, and an effective safeguard system, all captured by the National REDD+ Strategies developed to date in the project countries, most policies and measures required for REDD+ are not substantively different from those developed over many years in the context of sustainable forest management. It is therefore important to build on existing experiences of participatory models of forest management and on local people's knowledge for an effective implementation of REDD+, thereby also responding to the Cancun Safeguards (Kant *et al*., 2011). Further, recognizing that knowledge related to REDD+ comes in many forms, from forest data to economic statistics, and covers topics from MRV to the valuation of ecosystem services to forest laws and policies, it needs to be captured, organized, clearly explained and shared broadly in different contexts, ranging from local to national.

Addressing the issue of unclear land tenure is also fundamental to the effective implementation and distribution of the benefits of REDD+. Unclear land tenure will have negative implications for local communities' rights, livelihoods and practices, and the potential recentralization of forest management through REDD+, as viewed by local stakeholders in the project countries, could undermine the viability of the "+" in REDD+ (sustainable management of forests, conservation, and enhancement of forest carbon stocks) by marginalizing these stakeholders who have a crucial role to play in its success. The persistent ambiguity around the real costs and benefits of REDD+ to local communities, national governments, and other stakeholders further increases the risk of conflict (Patel *et al*., 2013).

CONCLUSIONS

REDD+ capacity-development interventions in the project countries were delivered through an institutionalized process, by partnering with local organizations and using a collaborative learning process among a wide range of stakeholders. This boosted local institutions' competency in forest management, REDD+ and climate change by bringing their ideas, competencies and resources together, and was instrumental for the legitimacy, credibility, effectiveness, and efficiency (through synergy) of the intervention. However, there is no "one size fits all" formula for capacity-development interventions – they should always be target-driven, addressing the specific needs and conditions of stakeholders and reflecting their sustainable development strategies, priorities and initiatives. For REDD+ grassroots stakeholders, a multi-pronged and multi-scale capacity strengthening strategy that draws on the strengths of various learning methods and addresses the unique needs of targeted stakeholders is needed in order to be effective. Facilitators, advocates and IEC materials are all necessary elements in expanding and sustaining capacity building beyond the temporal and spatial limits of the project. However, it has also been observed that due to the complex and changing nature of the subject, repeated capacity-development efforts are needed at the grassroots level in order to ensure that local stakeholders clearly understand the concept and the roles of various actors in implementing REDD+ mechanisms. The more clearly climate change and REDD+ are linked with sustainable forest management, community development and the local livelihoods of grassroots stakeholders, the stronger the support is likely to be for preparing climate-friendly development packages. The crucial elements for this – capacity development, partnership and collaboration – can be fostered through both promoting local initiatives and mobilizing externally-sponsored development resources.

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Forests and access to energy in the context of climate change: the role of the woodfuel sector in selected INDCs in sub-Saharan Africa

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Woodfuel use is part of both the problem and the solution in the climate change equation, and needs to be understood and addressed.

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INTRODUCTION

This article examines the importance of the wood energy sector in selected countries in sub-Saharan Africa (SSA) and the degree to which the sustainability of the sector is prioritized in the formulation of climate change policies. In these countries, as with many others in SSA, per capita consumption of woodfuels is higher than the global average. The article analyses the extent to which the wood energy sector is reflected in selected countries' Intended Nationally Determined Contributions (INDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) under the specific adaptation and mitigation priorities and targets. The INDCs are in the process of becoming Nationally Determined Contributions (NDCs), with some already having done so. However, since the analysis was carried out during the INDC phase, the term INDC will be used throughout this article. The article opens the way for developing a roadmap to support SSA countries in addressing the climate change–energy nexus, and identifies specific entry points.

Above: Bags of charcoal being sold on the road from Lodwar to Turkana, Kenya

THE ROLE OF WOODFUELS IN SUB-SAHARAN AFRICA

Wood energy is often the only energy source available in poor rural areas and is used as a cooking fuel by one third of all households worldwide (FAO, 2014). In Africa, two thirds of all households rely on woodfuel for cooking and wood energy accounts for 27 percent of the total primary energy supply in the continent (FAO, 2014). Sub-Saharan Africa (SSA) has the highest per capita woodfuel consumption in the world and wood demand in the region is projected to increase by 2.8 and 1.4 times for charcoal and fuelwood, respectively, by 2050 (Iiyama *et al*., 2014). The majority of fuelwood and charcoal comes from unauthorized and uncontrolled sources (Dieng *et al*., 2009), with fuelwood mainly used locally in rural areas, and charcoal transported to urban centres (World Bank, 2011). It has been estimated that emissions from the combustion of unsustainably harvested woodfuel alone account for roughly 2 percent of global greenhouse gas (GHG) emissions (GACC, 2014). Overall, woodfuels are estimated to contribute 7 percent of GHG emissions worldwide and 34 percent in Africa (Whiteman, 2015). The weight of household use of fuelwood for cooking in overall emissions is estimated at about 75 percent per household.

Fuelwood users usually collect small amounts of wood on a regular basis (FAO, 2010a). Owing to the dispersed nature and lower impact of this usage, the regeneration potential of an ecosystem can in many cases offset the fuelwood extracted, thus avoiding a permanent decline in forest stocks (World Bank, 2011).

Conversely, charcoal production often targets selected species and concentrates on heavy exploitation over short periods (FAO, 2010a). Charcoal is produced using wood primarily from natural forests, and is often harvested illegally, leading to significant forest degradation (World Bank, 2011). Africa accounts for approximately 80 percent of deforestation caused by charcoal production across tropical regions of the world (Chidumayo and Gumbo, 2013). Of all the tropical regions, Africa also accounts for almost two thirds of world GHG emissions from charcoal production (Chidumayo and Gumbo, 2013).

According to the Global Alliance for Clean Cookstoves (GACC), 3 billion people in the world rely on open fires and inefficient stoves for cooking, burning solid fuels such as wood, animal waste and coal (GACC, 2014). As a result of incomplete combustion and the sourcing of biomass from non-renewable stocks, this type of use contributes nearly 25 percent of all emissions of black carbon (Practical Action, 2014; GACC, 2014), which influences climate by absorbing light and reducing the reflectivity of snow and ice, as well as through interaction with clouds.

Cooking in a rural household near Hargeisa, Somalia, using a rudimentary metal tripod

However, given that black carbon has a short atmospheric lifetime, targeted strategies to reduce black carbon emissions can provide climate benefits in the coming decades (Environmental Protection Agency, 2016). Woodfuels can also play an important role as a substitute for fossil fuels, as they account for lower levels of GHG emissions over their life cycle than fossil fuels and many other non-renewable energy sources (FAO, 2010a). Given the environmental implications and importance of woodfuels, particularly charcoal, for livelihoods in sub-Saharan Africa (SSA), it is important that the means of improving the sustainability of woodfuel production and use are reflected in international agreements and prioritized by countries with sizeable woodfuel-dependent populations. The countries' INDCs provide such an entry point.

At the 19th session of its Conference of the Parties (COP 19), the parties to the UNFCCC were invited to begin the formulation of country-specific INDCs (UNFCCC, 2016a), which were submitted to COP 21 in Paris in December 2015. The INDCs outline countries' specific intended contributions to the goal of keeping the increase in average global temperature below 2 °C (Levin *et al*., 2015), in accordance with the historic Paris Agreement reached at COP 21.

The INDCs have been crucial tools for governments to identify and formulate the best approaches to reduce national GHG emissions sustainably, and to improve coordination with bilateral and multilateral agencies to support identified climate-related needs and goals. The agreement also requests countries to update their climate plans, or NDCs, on a five-year basis (UNFCCCb, 2016b).

METHODS

A comprehensive analysis of the wood energy sector in all of SSA is beyond the scope of this article. Instead, the focus is to identify key woodfuel-dependent countries and to examine the extent to which the INDCs for those countries prioritize specific adaptation and mitigation actions that address the issue of woodfuel. First, the INDCs of the 22 countries in SSA with the highest woodfuel consumption – according to a recent study by Bailis *et al*. (2015)[1] – were reviewed. A subset of these countries includes those with the highest rates of non-renewable biomass utilization, i.e. in which the harvesting of woodfuel is unsustainable, according to Bailis *et al*. (2015). Second, the review assessed the degree to which wood energy, as described by the countries, was reflected in either adaptation or mitigation options presented in the INDC documents.

This was followed by an in-depth study of the specific INDC priorities and status of the national woodfuel sector for three selected countries with different climatic zones, forest cover and ecosystems – Zambia, Kenya and Ghana. The study was based on a literature review and the INDC priorities identified.

OVERALL INDC PRIORITIES IN HIGH WOODFUEL-CONSUMING COUNTRIES IN SSA

The sample of 22 countries identified in Bailis *et al*. (2015) range from countries with very high forest cover (the Congo, the Democratic Republic of the Congo, Guinea-Bissau and Zambia) – of 66–72 percent – to countries with the lowest forest cover in Africa (Chad, Kenya, Lesotho, Somalia, South Africa and Togo) – of 1–11 percent. Woodfuel is the main source of energy across all of the selected countries. While the INDC priorities in most of these countries do not mention wood energy specifically, they do highlight the need for improved management of natural resources, particularly forests.

A review of the INDCs of the 22 target countries found that the main adaptation goals and objectives relate to reducing vulnerability to climate change and building resilience. The main mitigation goals focus on combating deforestation and forest degradation, and promoting sustainable forest management and agroforestry. However, the need to promote the use of renewable energy (which includes sustainable wood energy) is highlighted.

Despite the well-documented reliance on wood energy for the chosen 22 countries, the issue is not well reflected in the INDCs. Zambia, Kenya and Ghana were therefore selected for an in-depth review of their respective INDC documents.

These countries were considered representative of their respective sub-regions: coastal West Africa, East Africa and Southern Africa. They also represent three levels of forest cover – medium, low and high – and three distinctive forest types, representative of their sub-regions: coastal rainforest (Ghana); dryland forests (Kenya), which are forests in arid zones that are crucial for environmental goods, services and functions; and *Miombo* woodlands (Zambia), a biome dominated by trees of the genera *Brachystegia*, *Julbernardia* and *Isoberlinia*. Furthermore, charcoal production is simultaneously a major business venture, a livelihood activity and a significant environmental issue across the three countries. Other sustainability factors were also considered in the selection of these three case studies. While all three countries have high rates of woodfuel consumption, Zambia is one of the countries in SSA with the highest burden of disease from indoor air pollution caused by the burning of solid fuels, and Kenya has one of the highest rates of non-renewable biomass utilization in the region (Bailis *et al*., 2015).

Zambia

Zambia is a landlocked country in southern Africa, home to approximately 15 million people, most of whom reside in rural areas. Forests provide a buffer for rural

[1] The 22 countries identified by Bailis *et al*. (2015) were: Chad, the Congo, Côte d'Ivoire, the Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Mozambique, Sierra Leone, Somalia, South Africa, Swaziland, Togo, Uganda, the United Republic of Tanzania, Zambia and Zimbabwe.

communities with limited or no access to sources of subsistence income or employment (Vinya *et al*., 2012). In particular, the Miombo woodlands, which cover 60 percent of the country, provide millions of rural communities with timber, fuelwood, and non-wood forest products (NWFPs) (NAPA, 2007).

Approximately 90 percent of rural Zambian households depend on forests to meet their daily energy requirements (Bwalya, 2013). Annual biofuel consumption in Zambia is among the highest in SSA, constituting the 12th largest consumer out of 55 countries in Africa (Bertschi *et al*., 2003).

Charcoal demand in Zambia mainly concerns urban centres (Chidumayo and Gumbo, 2013), with 85 percent of urban populations heavily dependent on charcoal for domestic use (Kalinda *et al*., 2008). Charcoal production and the continuous degradation of natural resources in Zambia is clearly unsustainable. Chidumayo and Gumbo (2013) studied the charcoal industry in Zambia and identified five priorities for establishing a sustainable sector, both environmentally and economically: (1) restoration of charcoal-degraded areas; (2) sustainable charcoal production; (3) support to female charcoal producers; (4) close collaboration with chiefs and district councils to ensure communities develop rules and guidelines for forest management and sale of timber to charcoal producers for set fees; and (5) encouragement of collaboration between local authorities and charcoal consumers to adopt energy-saving technologies.

A willingness to address woodfuel-related challenges is clearly reflected in both the adaptation and mitigation goals of Zambia's INDC. With regards to mitigation actions, Zambia is prioritizing sustainable charcoal production, improved technologies for cooking, and increased reliance on biogas and other forms of renewable energy. With regards to adaptation actions, Zambia is prioritizing integrated land-use planning compatible with sustainable management of natural resources, climate-smart agriculture and the promotion of renewable energy technologies. Hence, the cross-cutting nature of energy access and the links between forests and energy are aspects well-recognized by the Zambian Government. Zambia recently developed and adopted its new Forests Act No. 4 of 2015, the objectives of which include the participation of local communities and stakeholders in the sustainable management of forest ecosystems and biological diversity (Government of Zambia, 2015). It does not mention the INDC, however, and nor does the INDC mention the 2015 Forests Act. This gap indicates a need to align processes at the national level, as the Act offers unique opportunities to address the wood energy issue and tackle it sustainably from a policy and management point of view.

Kenya

Kenya has a population of around 45 million people. Biomass fuels are its largest source of primary energy, with woody biomass (fuelwood and charcoal) comprising 69 percent of all energy used in the country, both by households and institutions. In rural areas, 90 percent of the population is dependent on the use of woodfuels (Government of Kenya [GoK], 2015; UNEP, 2009). Charcoal is used by 34 percent of rural households and 82 percent of urban households (GoK, 2013). The greater reliance on charcoal in urban areas is partly due to its easier availability, as compared to fuelwood, in marketplaces (FAO, 2015b). The production and use of woodfuels are responsible for most of Kenya's household energy-related GHG emissions, and therefore contribute significantly to climate change (Iiyama *et al*., 2015). Furthermore, in Kenya, around 55 percent of biomass fuels are derived from farmlands in the form of woody biomass, crop residues or animal waste. The remaining 45 percent is derived from forests (montane rainforests, savannah woodlands, dry forests and coastal forests), which cover approximately 6.99 percent of the country's land area (GoK, 2014). As Kenya's population grows, energy supplies will need to keep pace. However, the supply of fuelwood and charcoal cannot sustainably meet demand, and forest resources are rapidly shrinking (GoK, 2014). Approximately 35–41 percent of annual woodfuel consumption in Kenya is unsustainable, corresponding to 9.5 to 11.2 million tonnes of woody biomass (Drigo *et al*., 2015).

The commitment to address woodfuel challenges in Kenya's INDC is mainly reflected in its mitigation priorities. These include a target to reach a forest cover of at least 10 percent of land area by 2030 and the promotion of clean energy technologies to reduce overreliance on woodfuels. Adaptation goals mainly concern enhanced resilience and focus on mainstreaming adaptation as part of Kenya's Vision 2030. The INDC recognizes the problem of unsustainable production and consumption of woodfuels. Both the target of 10 percent forest cover and the promotion of clean energy technologies will address key wood energy issues. However, additional measures and specifications could be beneficial. For example, more attention could be paid to ways of making the production and use of forest resources more sustainable. Another important issue is the efficiency of fuelwood conversion to charcoal. Lastly, a point can be made for addressing the situation of protracted crises and conflict, which negatively influences the sustainability of and access to woodfuels.

Ghana

Ghana is a West African country with a population of 26.3 million people and an area of 238 540 km^2 (FAO, 2016a). It is estimated that more than 20 million Ghanaians rely heavily on forests as a source of fuelwood, as well as for wood for construction and furniture (Appiah *et al*., 2009). Fifty percent of energy is consumed by the household and residential sector (Arthur *et al*., 2011). With population growth, the demand for woodfuels will continue to rise, putting increased pressure on forest resources. The commitment to addressing woodfuel issues in Ghana's INDCs is explicitly reflected in

its adaptation goals. These include a focus on governance reforms regarding the use of forest resources for sustainable energy use and biodiversity. Mitigation goals pertain mainly to ambitious reforestation targets such as doubling the 10 000 ha annual reforestation/afforestation of degraded lands, which would translate to the reforestation of 20 000 ha annually. The INDC for Ghana also mentions policy actions that address the woodfuel issue but fall outside the wood energy sector as such. These include scaling up renewable energy penetration, which may include wood energy, by 10 percent by 2030, and expanding the adoption of market-based cleaner cooking solutions to reduce woodfuel use. The co-benefits of these policy actions are projected to include an avoided degradation of 39 500 hectares of woodland, a reduction in indoor pollution from woodfuel usage, a reduction in smoke-related respiratory and eye diseases, a reduction in household cooking fuel expenditure, and job creation through the manufacture and sale of more efficient stoves.

STRENGTHENING THE CLIMATE CHANGE–ENERGY NEXUS

One of the key challenges that countries in SSA currently face is how to strengthen the climate change–energy nexus. Solutions will need to be identified to respond to a growing demand for charcoal and fuelwood while simultaneously reducing poverty in ways that are not damaging to the environment (Zulu and Richardson, 2013).

Most charcoal production is characterized by the unsustainable over-exploitation of natural forests. Iiyama *et al*. (2014) projected that SSA would need an area of about 1.6 million ha, not taking specific tree species or forest categories into account, to meet its charcoal demand for the year 2015. This is a need that will likely only increase with time given that urban populations, who are the main users of charcoal, will grow significantly in coming decades (FAO, 2009b), and that the use of solid fuels for cooking is rising in SSA (Roth, 2013).

Another key factor is the role of unclear and weak tenure systems. Unclear land tenure encourages local people to exploit woodlands for short-term benefits instead of investing in the planting of trees and more sustainable management schemes (World Bank, 2011). An important step is therefore to tackle tenure issues, which are not well addressed in the INDCs.

The INDCs from the 22 SSA countries selected do not focus substantially on the woodfuel issue, even though they are amongst the countries most vulnerable to future climate–energy crises. Only a few of the countries (e.g. Guinea, Liberia and Somalia) clearly mention a high dependency on woodfuels. Somalia's INDC, for example, states that the lack of alternative sources of energy, the inefficient production of charcoal and a huge dependency on exports of charcoal to the Gulf states, have resulted in massive deforestation in the country (Federal Government of Somalia, 2015). Hence, the proposed actions to address deforestation caused by domestic and export-oriented woodfuel demand include sustainable land management, sustainable charcoal production and promotion of alternative energy sources such as wind and solar energy (Federal Government of Somalia, 2015).

The reasons for the lack of focus on the wood energy sector are many. One is the fact that information on the woodfuel sector at country level (e.g. data on status and trends of production, collection and use of woody biomass resources) is sometimes not adequately reflected in national statistical systems. Consequently, climate-change-related strategies and policies often fail to take into consideration the important role of

Women carrying bags of charcoal in Samburu County, Kenya

woodfuels. There is therefore a need for further awareness raising and a greater understanding of the complexity of the sector. Chidumayo and Gumbo (2013) found from the analysis of the charcoal sector in Zambia that charcoal and timber resources are often regarded as informal activities, with charcoal production seen as an income-generating activity for the poor, and the sector receiving poor visibility at the national level.

Another reason is that INDCs reflect the national priorities of the countries. Wood energy may often be regarded as unimportant, and there may simply be other priorities that countries prefer to focus on.

However, the INDCs offer several entry points for integrating woodfuels in the longer term. A recent analysis of all submitted INDCs found that 14 percent of submissions indicated that fuelwood harvesting is a driver of deforestation and forest degradation, and 30 countries highlighted the need to promote the use of fuel-efficient cookstoves in order to mitigate climate change (FAO, 2016b). Furthermore, the study notes that one third of countries emphasize that biomass as a source of renewable energy is of great importance for mitigation. Another recent study found that 56 parties indicated a need to shift resources towards sustainable bioenergy (Richards *et al*., 2015). WWF analysed the 75 INDCs corresponding mainly to developing countries and economies in transition with significant forest cover or an important forest sector, and found that most countries highlighted afforestation, reforestation and restoration efforts as a main target (Petersen and Verela, 2015).

There is a need for an integrated landscape approach in order to address the multitude of climate- and natural resource-related challenges countries are facing and to better integrate sustainable wood-energy production within the broader landscape. Including sustainable fuelwood and charcoal production in these integrated approaches could be an important way of meeting the targets mentioned above.

The current INDCs provide countries and global development actors with concrete actions and strategies for embarking on a sustainable development path. The NDCs will go even further as they will be of a more binding nature. Hence, there is a need to ensure not only that integrated approaches are promoted, but that the crucial and multi-faceted issue of woodfuel is firmly embedded in the strategies, policies and actions that promote these approaches.

A platform is needed to support the implementation and execution of INDC priority actions and to make explicit reference to key sectors such as wood energy. Such a platform can help to ensure that countries move from drafting wish lists to actual policy implementation and tangible actions on the ground.

A concrete step in this direction would be to map the promises and targets listed in the INDCs against their contributions to the SDGs, and the degree to which they are linked to national and regional policies and strategies. FAO is contributing to efforts to develop such a support mechanism in order to ensure improved alignment of planned activities and the financial programmes to support them.

CONCLUSION

The INDC documents of the 22 countries included in this study share a number of challenges and proposed solutions. They therefore provide an opportunity to develop regional initiatives and actions, and open opportunities for multilateral organizations to work on developing more sustainable regimes for woodfuel production and use in SSA.

However, only a few of these INDCs explicitly mention woodfuels. Rather, they focus on measures such as reforestation, forest protection and sustainable forest management. The impact of such interventions will probably remain limited if the woodfuel issue, in terms of increasing demand and unsustainable production and supply, is not addressed in a holistic and integrated manner, e.g. through a value chain approach.

One possible reason for the omission of a more explicit mention of woodfuel could be the lack of a more targeted, multi-level process of data collection and analysis with greater focus on the source (harvest area, species, production) and the markets (including the various links in the woodfuel value chain). A gap also exists in making sure that existing data is collated, translated and packaged for a multi-sectoral audience in order to further the decision-making process and the implementation of corresponding interventions. To better support countries in addressing the woodfuel issue, there is therefore a need to (a) ensure that data is presentable and accessible to decision-makers, including stakeholders beyond the forestry sector, (b) ensure that this data is reflected in national statistics and, in turn, captured in the NDCs, and (c) support INDC implementation by ensuring that vital aspects of sustainable woodfuel and charcoal value chains are incorporated in policies and actions. ◆

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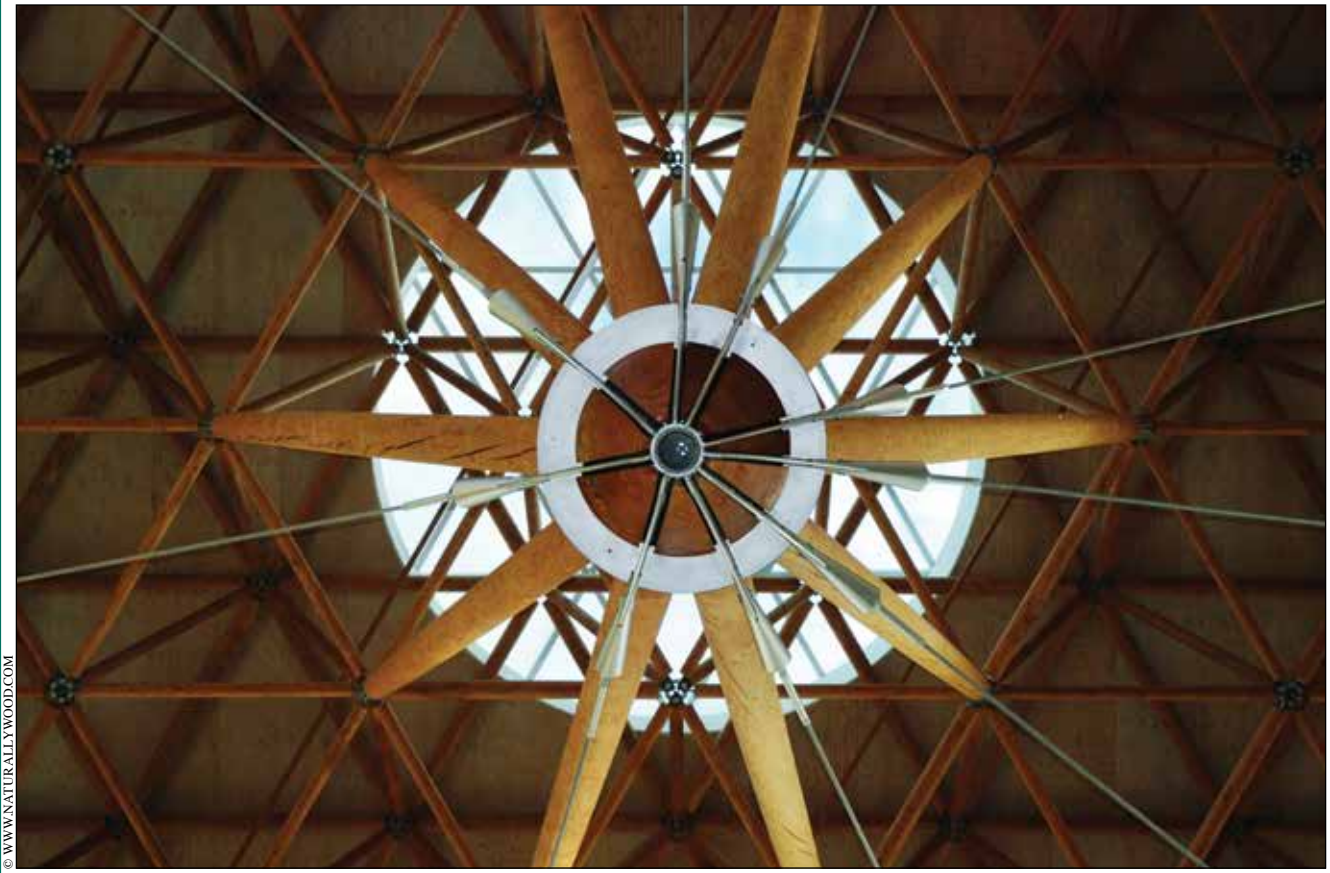

Climate change mitigation through forest sector activities: principles, potential and priorities[1]

W. A. Kurz, C. Smyth and T. Lemprière

Applying three principles will help develop effective climate change mitigation strategies, including the role of harvested wood products and avoided emissions.

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Globally, forests remove from the atmosphere a significant fraction of the annual anthropogenic CO_2 emissions. It is of considerable scientific and policy interest to understand if, and how, it may be possible to enhance the contribution of the forest sector to climate change mitigation. Simplifying accounting assumptions or assumptions about carbon neutrality of biomass burning may not result in the best choices to improve management of forests, harvested wood products (HWPs), and landfills to achieve climate change mitigation objectives.

Drawing on research carried out in Canada, Sweden and Switzerland, this article looks into the importance of sustainable forest management, maintaining or enhancing carbon stocks, increasing carbon retention in long-lived HWPs, and the use of HWPs to maximize the displacement of emissions from other sectors. It identifies priorities for early action if changes in forest sector activities are expected to contribute to emission reduction targets.

[1] This article is a slightly revised version of the paper with the same title submitted to the XIV World Forestry Congress, held in Durban, South Africa, in September 2015.

Above: Modern engineering can help increase carbon retention in wood products and achieve significant avoided emissions through the substitution of emissions-intensive materials

INTRODUCTION, SCOPE AND MAIN OBJECTIVES

Between 2004 and 2013, global forests removed 10.6 ± 2.9 $GtCO_2$ yr^{-1} from the atmosphere or about 29 percent of the annual anthropogenic CO_2 emissions from fossil fuel burning, cement manufacturing, and deforestation (Global Carbon Project, Le Quéré *et al*., 2014). Combined with the CO_2 uptake by oceans, forests have helped to reduce the airborne fraction of the emitted CO_2 to 44 percent by removing the remaining 56 percent of emissions from the atmosphere. It is therefore of considerable scientific and policy interest to understand if, and how, it may be possible to sustain or enhance the contribution of the forest sector to climate change mitigation.

This interest in potential forest sector contributions to climate change mitigation is reflected in an increase in research and publications on the subject and in the attention the land sector received in the 2015 climate agreement that was reached in Paris. Here we emphasize three principles that should be maintained when conducting analyses of forest sector mitigation options and present results from national-scale analyses in Canada conducted to demonstrate these principles and to evaluate the climate change mitigation potential in Canada's forest sector.

METHODOLOGY/APPROACH

The three key principles of forest carbon accounting for mitigation are to: (1) quantify changes in the net greenhouse gas (GHG) balance that result from changes in human activities, relative to a baseline; (2) estimate emissions, when and where they occur and the type of GHG that is emitted; and (3) quantify changes in carbon stocks and GHG emissions in forest ecosystems, from HWPs, and from substitution of emissions-intensive products such as steel, concrete, plastics and fossil fuels with wood-based products (Lemprière *et al*., 2013). Simplifying accounting assumptions, such as instant oxidation of HWPs removed from the forest or transferred into landfills, or carbon neutrality of biomass burning, result in differences between reported and actual emissions, and may not result in the best choices to improve management of forests, HWPs and landfills to achieve climate change mitigation objectives.

PRINCIPLE #1: BASELINES

Mitigation objectives are achieved when, through changes in human behaviour or technology, GHG emissions are reduced or GHG sinks are enhanced, relative to a baseline (Lemprière *et al*., 2013). The use

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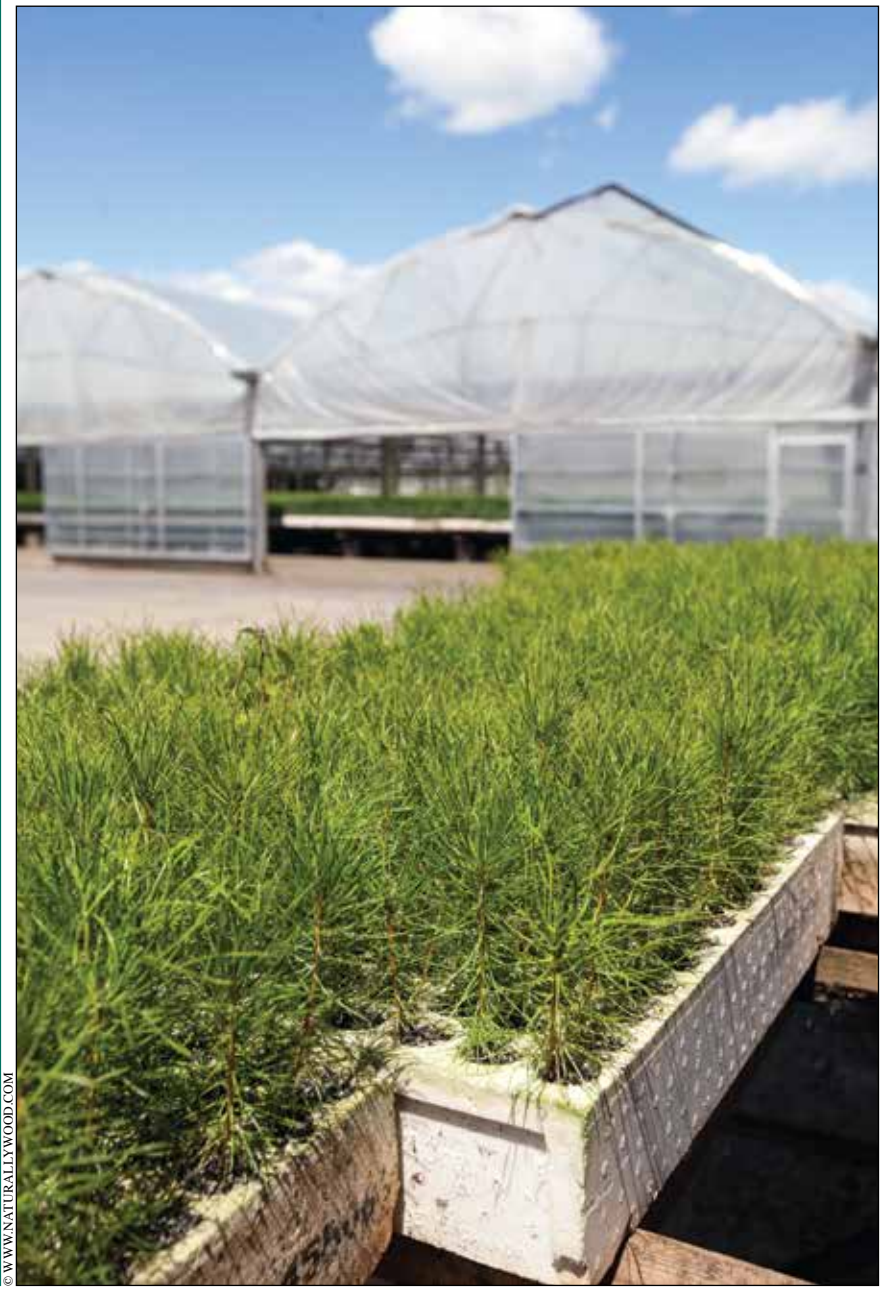
Sustainable management of the forest includes assisted migration of indigenous tree species to better match trees with future climates

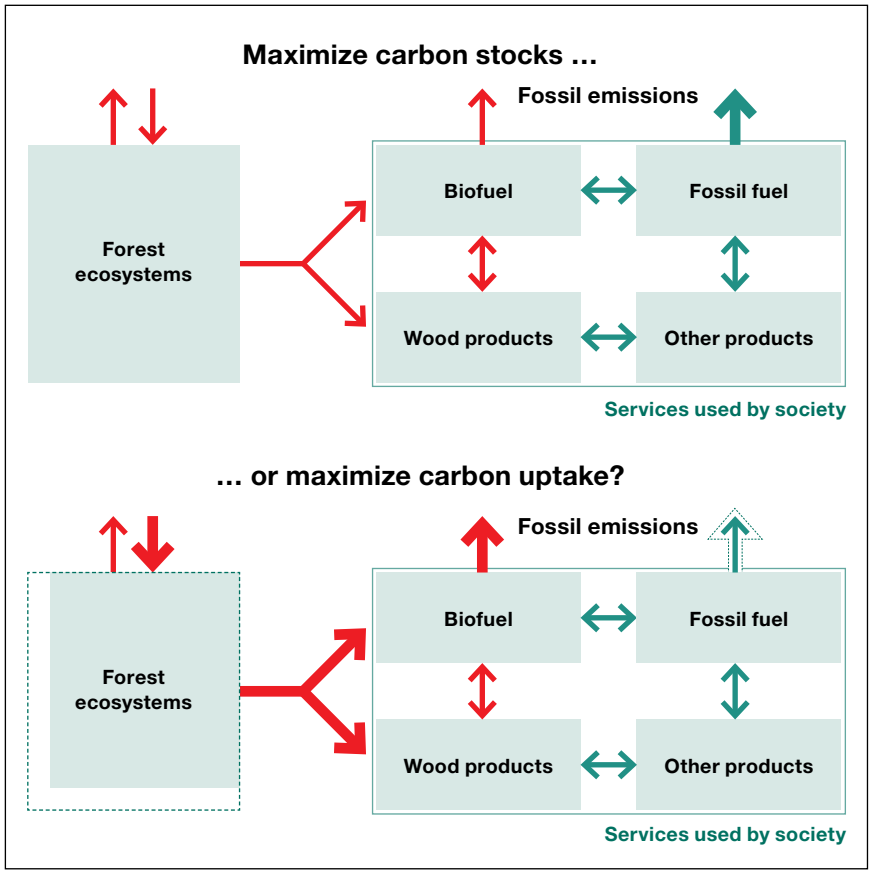
of a "business-as-usual" baseline removes the effects of age–class legacies in forests (Böttcher *et al*., 2008; Kurz, 2010), and ensures that estimated mitigation benefits are the result of changes in behaviour and not merely the result of ecosystem processes that would have occurred in any case. Baselines are essential in analysis of mitigation to ensure that existing forest carbon sinks are not incorrectly claimed as resulting from climate change mitigation efforts.

PRINCIPLE #2: ESTIMATE EMISSIONS, WHEN AND WHERE THEY OCCUR AND BY TYPE OF GHG

Mitigation actions have different time lines regarding GHG costs and benefits (Nabuurs *et al*., 2007). The simplifying accounting assumptions that have been introduced to facilitate GHG estimation and life-cycle analyses can result in policies that will not benefit atmospheric mitigation goals. For example, the revised 1996 Guidelines of the Intergovernmental Panel on Climate Change (IPCC, 1997) made a simplifying assumption that new carbon additions to HWPs merely replace a similar amount of carbon losses from existing HWP pools and that, therefore, all transfers of carbon from forest ecosystems can be considered as instantaneously oxidized to the atmosphere. This simplification resulted in an incorrect perception of the impacts of forest management on GHG balances and, more importantly, removed incentives to prolong carbon retention in HWPs. Similarly, life-cycle analyses of bioenergy or forest products have sometimes employed a simplifying assumption that all carbon obtained from the forest is carbon neutral, i.e., has no impact on changes in forest ecosystem carbon stocks. This assumption can also lead to incorrect policy conclusions that may not result in the most effective mitigation strategies, because it fails to recognize the impacts of wood harvests on ecosystem carbon stocks, and fails to make clear that the choice of biomass feedstock for bioenergy can have a significant influence on the magnitude and timing of mitigation impacts. Under the internationally agreed rules of the "production approach" used for the reporting of emissions from HWPs, the emissions from biomass used for energy are reported by the country that harvests the biomass. If the biomass is exported and used for energy, then the biomass-importing country can claim that the imported biomass is carbon neutral. So while globally the total emissions are fully reported, this accounting could lead to policy decisions that do not result in the most effective climate change mitigation strategies.



Sustainable management of the forest includes taking advantage of tree improvement programmes to increase sequestration



1
Conceptual model of alternative approaches to managing forest sector carbon stocks and flows. The evaluation of a mitigation strategy should be based on an assessment of net emissions to the atmosphere associated with changes in forest ecosystems, HWPs and substitution effects associated with the use of wood products. Conservation-focused approaches increase forest ecosystem carbon stocks but reduce carbon storage in HWPs and reduce HWPs available to substitute other products (top panel). Wood-use focused approaches can reduce forest ecosystem carbon stocks (relative to conservation-based approaches) but manage forests for higher carbon uptake rates, increased production of HWPs, and larger substitution benefits. (Figure modified from Nabuurs* et al., *2007.)

PRINCIPLE #3: ESTIMATE GHG EMISSIONS IN FORESTS, HWPs AND THE AVOIDED EMISSIONS (SUBSTITUTION) THROUGH THE USE OF HWPs

Analyses of mitigation options should be based on an integrated systems approach that considers carbon and GHG effects in three components: forest ecosystems; HWPs; and other sectors, as a result of the atmospheric effects of substitution of emissions-intensive products such as concrete, steel, plastics (Sathre and O'Connor, 2010) or fossil fuels (Ter-Mikaelian *et al*., 2015) (Figure 1). The assessment of substitution effects should include the emissions associated with the manufacture and transport of both the HWPs and the products they substitute. Mitigation efforts aimed at increasing carbon in one of the three components usually result in decreases in carbon in one or both of the other two components. For example, conservation measures aimed at reducing harvest rates may result in increased forest ecosystem carbon stocks, but at the expense of carbon in HWP or substitution benefits and associated higher emissions from fossil fuels and cement (Figure 1, top panel). Conversely, increasing harvest rates to generate more forest products will decrease forest ecosystem carbon stocks but increase carbon in HWPs and, depending on their use, can lead to increased substitution benefits (Figure 1, bottom panel).

RESULTS

The potential forest sector contributions to climate change mitigation have been assessed in recent national-scale studies. The three principles outlined above have been implemented in studies for Canada, Sweden and Switzerland (Lundmark *et al*., 2014; Smyth *et al*., 2014; Werner *et al*., 2010). All three studies demonstrate that in the long term, the greatest global mitigation benefits are achieved through substitution effects, and that these are higher than the impacts on stock changes under sustainable forest management.

Here we summarize the use of Canada's National Forest Carbon Monitoring, Accounting and Reporting System (Kurz and Apps, 2006) and associated models (Kurz *et al*., 2009) to estimate the mitigation potential in Canada's forest sector to 2050 (Smyth *et al*., 2014). Seven scenarios of changes in forest management and two scenarios of changes in wood use were implemented starting in 2015, compared to a baseline of no mitigation activity.

The results show that cumulative mitigation benefits increase over time, with relatively small benefits in the near term (to 2020) but increasingly larger benefits by 2030 and 2050 (Figure 2). Relative to the baseline management of HWPs, a small shift from pulp and paper products towards increased production of long-lived

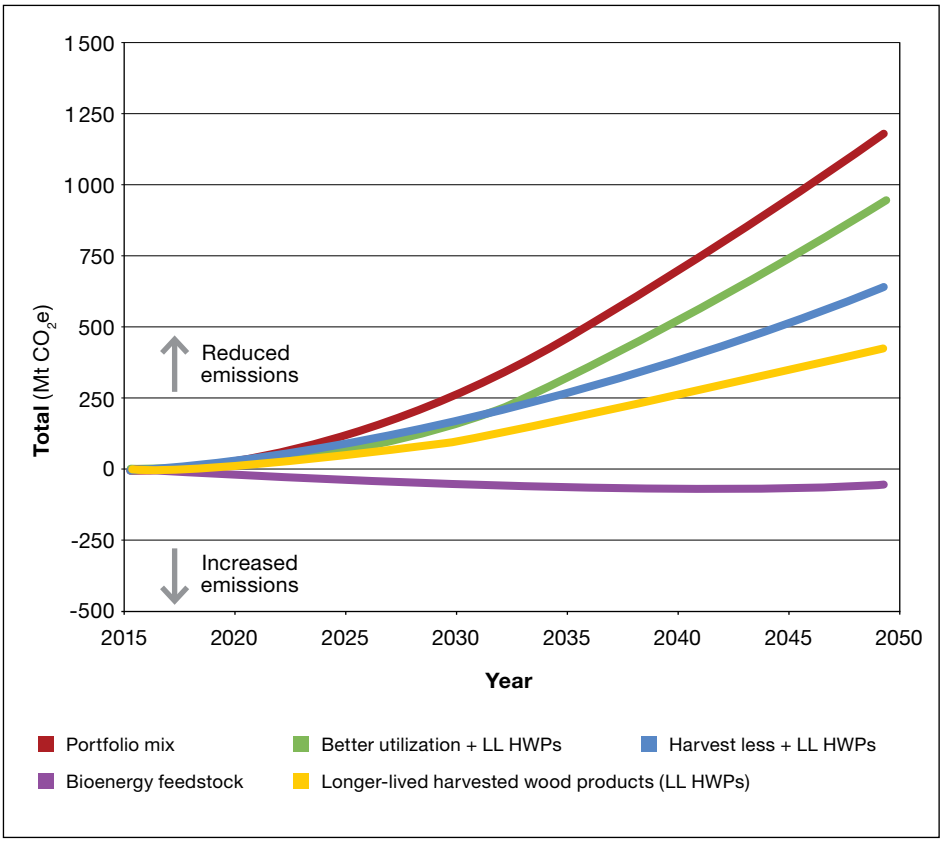
products yielded cumulative mitigation benefits by 2050 of 435 $MtCO_2e$, while shifting HWP use towards bioenergy increased overall emissions. Combining a "harvest less" forest management scenario with the increased long-lived HWP scenario yielded cumulative mitigation benefits of 600 $MtCO_2e$. The "better utilization" forest management scenario combined with increased long-lived HWPs yielded 944 $MtCO_2e$ cumulative mitigation benefits. Creating a portfolio mix by combining regionally differentiated mitigation strategies across Canada yielded cumulative mitigation benefits by 2050 of 1 178 $MtCO_2e$. Preliminary estimates of abatement costs indicate that these large mitigation benefits are also cost-effective compared to mitigation options in other sectors. The analyses also demonstrate that the sooner the mitigation activities are implemented, the larger the mitigation benefits will be in the mid term (2030) and long term (2050).

DISCUSSION

The results of studies in Canada, Sweden and Switzerland all demonstrate that the national forest sector can make meaningful contributions to climate change mitigation efforts, and that these are derived to a large extent through the use of HWPs to achieve emissions reductions in other sectors. The studies also showed that conservation strategies aimed at increasing forest ecosystem carbon stocks did not achieve the largest possible mitigation benefits. In the Canadian study, the assumptions about changes in forest management and changes in HWP use were conservative and informed by the views of provincial resource management experts on the feasibility of implementation of the mitigation strategies.

The results also show that the mitigation benefits increase over time and that the forest sector's potential to contribute to short-term GHG emission reduction goals (2020) is limited. This conclusion is specific to the countries examined because their emissions from deforestation (conversion of forest to non-forest land uses) are small. In countries with high deforestation rates, emission reductions in the short term (2020) can be achieved through strategies aimed at reducing emissions from deforestation and degradation (REDD+).

For countries such as Canada and Sweden, which export much of their HWPs, some of the climate change mitigation benefits of the HWP use strategies are achieved outside the country, as exported HWPs are used to substitute for more emissions-intensive products abroad. Under current carbon accounting rules, the mitigation benefit resulting from substitution abroad does not contribute to the domestic GHG emission reduction targets of the wood-exporting country, and in fact it may adversely affect domestic emissions because reduction in forest carbon stocks (where these occur), and



2
Cumulative mitigation benefits to 2050 of five forest sector mitigation strategies in Canada. Two strategies explore the mitigation benefits (relative to the baseline) of shifting more wood towards longer-lived harvested wood products (LL HWPs) or towards bioenergy feedstock. Two strategies compare changes in forest management (better utilization, increased conservation by harvesting less), each combined with the LL HWP strategy. The mitigation benefits are shown if each of these strategies is implemented across Canada. A final strategy (portfolio mix) is based on choosing the best strategy in each region (Smyth* et al., *2014).

emissions associated with HWP manufacturing, transport and export are counted in the country where they occur. However, the use of long-lived HWPs to substitute for emissions-intensive products such as concrete, steel and plastics does contribute to global reductions in atmospheric CO_2 concentrations and thus serves climate change mitigation objectives.

The harvest of live trees for the production and export of pellets for bioenergy is a special case with strong negative impacts on the GHG balance of the exporting country, which has to account for carbon stock reductions in the forest and the immediate oxidation of the exported biomass carbon, while the importing country that uses these pellets rarely, if ever, achieves a net reduction in actual emissions because fossil fuels are more energy-intensive than biomass. The reduction in reported national emissions associated with the use of imported biomass for energy production therefore is achieved because the biogenic emissions are reported by the exporting country.

Lastly, mitigation benefits in the forest sector do not depend on forest management alone: mitigation benefits can be increased through coordination with the users of wood products to reduce wood waste, increase the use of long-lived HWPs, and maximize the displacement benefits through substitution of emissions-intensive building products. This suggests that building codes (e.g. increasing the number of storeys permissible in wooden buildings), planners (e.g. "Wood First" building strategy), architects, builders, and home buyers can all contribute to achieving mitigation benefits in the forest sector.

Construction of the Wood Innovation Design Centre in Prince George, Canada, the tallest contemporary wood building in North America, standing at 29.5 metres high. Increased use of wood in non-traditional buildings holds great potential for avoiding emissions through less use of materials like steel and concrete that are more emissions-intensive on a life-cycle basis

CONCLUSIONS

Analyses that apply sound forest carbon accounting principles to quantify the potential of the forest sector to contribute to climate change mitigation in Canada demonstrate the importance of sustainable forest management, maintaining or enhancing carbon stocks, increasing carbon retention in long-lived HWPs, and the use of HWPs to maximize the displacement of emissions from other sectors. The analyses also identify priorities for early actions if changes in forest sector activities are expected to contribute to near-term emission reduction targets.

The results of this and other national-scale analyses that follow the three principles outlined above support the conclusion of the IPCC Working Group III Forestry chapter on climate change mitigation options that: "In the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit" (Nabuurs *et al*., 2007).

ACKNOWLEDGEMENTS

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The views expressed in this article are those of the authors and do not necessarily reflect the views or policies of FAO or the Government of Canada. ◆

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Forest genetic resources and adaptation to climate change

J. Loo

A desert tree that shows both the extent of soil erosion and an ability to tolerate such changes

Genetic resources determine the adaptive potential of trees and influence the long-term value of tree-planting efforts for climate change mitigation.

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Trees are essential components of adaptation and mitigation strategies to counter impacts of climate change. On the one hand, trees play a vital role in adaptation of landscapes and human communities to tolerate climatic changes, including hotter and drier conditions; and, on the other, expanding forest cover increases the carbon sequestration capacity of landscapes, mitigating the negative impacts of emissions. Genetic resources determine the adaptive potential of trees as well as influencing the long-term value of tree-planting efforts for mitigation purposes. Thus genetic resources of trees are critical for effective adaptation and mitigation responses to climate change. In spite of this, among natural resource managers, restoration practitioners and conservation agents, little attention is paid to the importance of forest tree genetic resources and their vulnerability to impacts of climate change if not properly managed.

Genetic diversity comprises the heritable differences among individuals within a species, and forest genetic resources refers

to the genetic diversity in trees that is of current or potential importance to people. From a biological perspective, adaptation is a genetic response to changes in environmental conditions (in a broad sense) through natural or human-mediated selection. The term has taken on a much broader meaning in climate change discourse, but in this article, the focus is on the biological definition: the process by which tree populations or species change to become better suited to their environment.

Rapid adaptation may occur as a response to strong selection pressure (i.e. high mortality as a result of an environmental shift) that favours survival and reproduction of individuals having particular adaptive trait values, combined with high phenotypic variability and high heritability. This means that the values or forms of traits necessary for survival are present in the population and are passed on from parent to offspring (Alberto *et al*., 2013). The key question is whether genetic variation in adaptive traits is sufficient to equip populations of tree species to survive in the face of climate change. The answer, of course, is "It depends": it depends on how rapidly change is occurring and whether it is directional; the amount of both plasticity (the ability of an individual organism to change its phenotype in response to environmental changes) and genetic diversity within populations; the pollination mechanisms and dispersal patterns of the tree species in question; and the degree to which populations are isolated and fragmented across landscapes. Scientists' opinions vary; for example, Yanchuk and Allard (2009) were pessimistic in their assessment of the potential of classical tree improvement programmes to respond to climate change quickly enough; Hamrick (2004) was more optimistic regarding the potential for rapid adaptation within natural populations of trees.

Several reviews (Loo *et al*., 2015; Alfaro *et al*., 2014; Koskela, Buck and du Cros, 2007) have dealt with this subject during the past decade; this article provides additional information and examples of the role of forest genetic resources in adapting to climate change.

VULNERABILITY OF FOREST TREE GENETIC RESOURCES TO CLIMATE CHANGE

Climate change threatens forest genetic resources through the potential loss of unique genetic diversity when populations of trees are extirpated or severely diminished. In the most obvious and dramatic instance, trees of all ages, including mature ones, may exhibit high mortality after extreme events such as drought or flooding or the invasion of previously unknown or sporadically occurring insects or diseases. Alternatively populations may fail to regenerate and climate-sensitive

Residual patch of forest, Sri Lanka

tree species may be replaced gradually by others that are more suited to the changed conditions (Walck *et al*., 2011). Regeneration failure may result from factors such as loss of pollinators or loss of synchrony in the timing of flowering and pollinator activity (Broadhurst *et al*., 2016). Climate change can affect wind patterns so even wind-pollinated trees may exhibit reduced reproduction as a result (Kremer *et al*., 2012). In northern climates mid-winter warming followed by sub-zero temperatures can destroy flower buds and, in extreme cases, cause tree mortality. In fact, large-scale tree die-off has already been reported in North America and Eurasia, and counter-intuitively, tree damage or death from cold stress as well as heat stress is expected by some to increase as a result of climate change in coming decades (Harfouche, Meilan and Altman, 2014). In either case, trees' reproductive capacity is compromised. Among other factors, the severity of the impacts of climate change depends on topography, recognizing that climate changes more rapidly over a given distance in mountainous topography than on flat land. Populations at or near mountaintops are likely to be highly vulnerable (Aitken and Bemmels, 2016).

When seed production is successful, seed still may not germinate or seedlings may not survive under changed temperature and moisture conditions (Walck *et al*., 2011). The seedling stage is the most vulnerable in the survival and growth of tree species (Gaspar *et al*., 2013). In the absence of successful regeneration, a population of trees may be doomed, in spite of apparently healthy mature trees that may live on for decades. Reported incidences of tree dieback are increasing, even though Walck *et al*. (2011) hypothesized that populations of many species could be buffered from the effects of climate change thanks to generally high local intraspecific genetic variation and phenotypic plasticity in seed dormancy and germination traits, occurring over small distances (both elevational and latitudinal). The examples from around the world, provided by Allen (2009) when *Unasylva* last undertook the task of summarizing adaptation to climate change in the forest sector, can be supplemented now by numerous additional ones. See, for example, Hartmann *et al*. (2015); however, the authors caution that much uncertainty remains regarding global trends in tree mortality and potential ecological effects.

Hartmann *et al*. (2015) stated that we still do not have answers to basic questions like: (1) whether tree mortality is increasing globally; (2) why some trees survive and others die under similar drought conditions; (3) which physiological characteristics of trees are critical for understanding and modelling tree mortality; and (4) which features of droughts are the most important in predicting tree mortality. The second question can be answered, at least in part, by knowledge of genetic variation in adaptive traits, which influences the differential survival of trees when faced with drought and other serious environmental challenges (Alberto *et al*., 2013). Finding an answer to the third question, as well as better understanding the genetic control of physiological traits involved in drought resistance, could lead to better management responses to counter the underlying causes of tree mortality.

In general, when environmental conditions change, tree populations have two possible alternatives to avoid extirpation: (1) adapt in place through a combination of phenotypic plasticity and genetic variation in relevant traits; or (2) migrate via seed and/or pollen to more suitable habitats (Aitken *et al*., 2008). Franks, Weber and Aitken (2014) summarized evidence of evolutionary and/or plastic responses to climate change for a number of tree species. Although many of the temperate and boreal species included in their review exhibited apparent adaptation or plastic responses, less than half of them were judged to have sufficient response to keep pace with climate change. However, Kremer *et al*. (2012) pointed out that rarely would adaptation or migration occur independently of each other and concluded, based on evaluation of the role of long-distance gene flow, that migration itself could be sufficient in many cases. The authors summarized results of mainly European tree species but it should be noted that tropical or subtropical species may have shorter gene flow distances (animal-mediated instead of wind pollination) and tropical and sub-tropical tree populations are often subject to greater landscape fragmentation than temperate ones.

As noted by Alberto *et al*. (2013), more data are available for trees than for many other plant species with respect to effects of climate change; field trials established decades ago are extremely useful now for assessing and predicting responses of tree populations to climate change. However, with a few notable exceptions, this information is limited to northern temperate and boreal species and much less is known about tropical or subtropical species.

Epigenetic effects can influence how some tree species respond to environmental change. Although not well studied or understood for many species, it is known that a handful of temperate and boreal conifer tree species exhibit these effects through permanent changes in regulation of phenological traits, such as timing of bud burst, that are triggered during the zygotic or embryo phase (Yakovlev *et al*., 2014). The "epigenetic memory" is maintained throughout the lifespan of the affected trees, via modified protein transcription at particular gene loci, and is passed to offspring, although there is no change in primary DNA sequence (Yakovlev *et al*., 2014). This complicates the interpretation of the clinal patterns of adaptation that are frequently observed across the range of tree species. However, as noted by Aitken and Bemmels (2016), the size of the epigenetic effects is itself subject to genetic variation among families.

Tree populations must be large (at least several hundred reproductively mature trees) to maintain inherent adaptive potential and ideally they should have uninhibited gene flow with other populations to facilitate adaptive responses to

Naturally drought-resistant trees in the mountainous landscape of Tajikistan

environmental stimuli or stress. Most tree species are both highly diverse and have high fecundity; millions of seeds may be produced over the lifetime of one single tree and only one offspring has to survive to replace each parent tree to maintain the population. Thus nature offers a huge potential for selection. In order for such directional selection to be successful, however, a second condition is that changes in climatic conditions must be directional and consistent. It is much less likely that trees can adapt to survive extreme events than to accommodate gradual directional change.

Modelling approaches to predicting impacts of climate change focus on range expansion and migration of species to fill climatic niches created by changing conditions. They assume homogeneity within species, i.e. all individuals within a species are treated as if they were adapted to the same climatic envelope (Alberto *et al*., 2013). In fact, tree populations may be specifically adapted to local climatic conditions and their tolerance is typically much narrower than for the species as a whole (Kremer *et al*., 2012). For tree species which have been studied in provenance trials or along climatic clines, approaches that take into account complex trait interactions such as that described by Liepe *et al*. (2016) may be used. Also commonly overlooked is the fact that other factors besides climate determine suitability of habitat and that species may not be able to migrate across highly modified landscapes to a suitable habitat, even if it exists.

Considering what is currently known, there is no clear answer for most species with regard to their ability to adapt sufficiently or migrate rapidly enough to survive and regenerate in climates of the future.

HOW CAN FOREST GENETIC RESOURCES BE HARNESSED TO RESPOND TO CLIMATE CHANGE?

Understanding diversity in adaptive traits

Where they exist, provenance trials can provide very useful information about the degree of local adaptation to environmental conditions as well as the amount of plasticity within species. Provenance trials are common garden field tests that are established using samples of planting stock that originate from (usually) a large number of populations across all or a substantial portion of a species' natural distribution. They are established following an experimental design that allows

separation of population-level genetic from environmental effects by statistical analysis. Kremer *et al*. (2012) summarized some provenance trial results that are relevant to climate change responses. Results from large numbers of provenance trials indicate that: (1) populations of tree species contain high levels of genetic variation that are maintained by gene flow; (2) in spite of high rates of gene flow, adaptive traits are strongly differentiated between populations; (3) different species exhibit similar population-level clinal patterns, especially for phenological traits along climatic or geographical variables, suggesting that many species have similar adaptive responses to directional selection; and (4) the current distribution of between vs. within population differentiation for fitness-related traits (at least for several temperate broad-leafed species) developed rapidly with the process of post-glacial recolonization. The term "fitness" is used here to mean the number of surviving offspring left by an individual.

The mechanisms by which tree populations are known to cope with rapidly changing environmental conditions can be harnessed to speed up the process of adaptation and migration in species that are under active management. Genetic improvement of trees increasingly focuses on adaptive traits in addition to production (see e.g. Harfouche, Meilan and Altman, 2014). Yanchuk and Allard (2009) reviewed the potential for tree improvement to keep pace with climate change from the perspective of forest health and concluded that the standard approach of breeding trees for resistance to individual pests when they begin to pose a threat has significant limitations. The time required for results from classical tree breeding is prohibitive considering the surge in the pace of appearance and degree of damage caused by new insect pests and diseases. Our inability to predict the next big insect or disease challenge adds to the difficulty. The authors recommended seeking general or generic resistance that could be deployed as a pre-emptive strategy. They pointed out that ensuring tree vigour and productivity is the first line of defence, but breeding for tougher, less palatable foliage, for example, could develop a form of general resistance. Numerous studies have shown genetic variation in adaptive traits, holding out the promise of breeding trees to match new environmental conditions. For example, Kreyling *et al*. (2014) described evidence for local adaptations to winter and spring frosts in seedlings of European beech (*Fagus sylvatica*) and they reported that adaptation was stronger in marginal than central populations. Identifying populations with the greatest variation in the traits of interest or which have the desired "preadapted" variants is feasible for some species. However, improvement in adaptive traits may come with a cost. As Harfouche, Meilan and Altman (2014) noted, some tree species exhibit great variation in tolerance to environmental stresses, and in some cases, the metabolic cost of stress tolerance has negative impacts on tree growth.

Montwé, Spiecker and Hamann (2015) studied Douglas-fir (*Pseudotsuga menziesii*) provenances in western Canada, using dendrochronology to evaluate the productivity response to climate change. They studied how mature Douglas-fir provenances differ in their tolerance to drought conditions and examined trade-offs with long-term productivity. Their study showed that it is possible to select planting stock that shows drought tolerance, but there would be an associated reduction in productivity. The generality of such trade-offs between productive and adaptive traits is not known.

Planting to restore forest ecosystems: the challenge of climate change

Tree-planting efforts are increasingly urgent as natural forest cover recedes under a battery of human-mediated impacts, including changing climatic conditions. Forest and landscape restoration through natural regeneration is highly successful in some areas, but planting is necessary where natural regeneration is not sufficient. However, success rates of forest restoration based on planting trees have been patchy, partly because of lack of attention to the source of planting material. As explained by Thomas *et al*. (2014), the successful establishment of self-sustaining restored forest depends on using sources of planting material that is already adapted to the often tough conditions of the planting sites and that has sufficient genetic diversity to continue to respond to changing conditions. Genetic considerations are obviously not the only determinants of success but without appropriate genetic material, failure is a foregone conclusion.

Commercial forestry plantations often consist of exotic, short-lived species and they are not intended to be self-sustaining over generations. Thus matching adapted planting material to the planting site needs to consider only the current or near future conditions and as such, is not likely to be as challenging as matching planting stock to site in landscape restoration. Restoration approaches that involve planting trees, and that are intended to restore ecosystem services as well as livelihood benefits, are likely to have a longer timeframe than commercial plantation forestry. The planting material must be adapted to planting sites that are often harsh, and capable of adapting to changing conditions in the future. To ensure adaptive potential in future generations, genetic diversity is essential. Breed *et al*. (2013) suggested that creating mixtures of seed from different sources (provenances) might maximize the adaptive potential, although it introduces the danger of outbreeding depression. "Outbreeding depression" is said to occur when breeding between individuals from different populations produces offspring that have lower fitness than progeny from crosses between individuals within either population.

Importance of marginal populations

Marginal populations of trees, meaning populations that are at the edges of a species' range, may hold particular importance in the context of adaptation to climate change. Kreyling *et al*. (2014) noted that

local adaptations are sometimes especially strong in marginal populations. This implies that the asymmetrical gene flow from the higher-density centre of species ranges to the relatively sparse periphery (as discussed by Aitken and Whitlock, 2013) does not prevent the occurrence of local adaptation in these populations. Although rapid climate change may pose threats to locally adapted marginal populations, high selection intensity (high level of climate-induced mortality) combined with isolation may have the opposite effect, resulting in rapid adaptation (Jump *et al*., 2006). Where adaptation to extreme conditions at distribution range edges occurs, these populations may have high value for planting both in other parts of the species range and in new habitats. Such populations may be subject to greater threat levels than populations in other parts of species' ranges, however, because of the likelihood of weather events that are stressful to edge populations and often a high degree of fragmentation with respect to the target species. Thus there is an urgent need to characterize and conserve marginal populations of useful tree species for their importance in countering impacts of climate change.

CONCLUSIONS

Although genetic resources of trees often receive relatively little attention in forest management, restoration and conservation, they are essential for a successful response to the impacts of climate change. This is true whether the concern is for continued adaptation of forest tree species to changing climatic conditions or mitigation of the negative effects of climate change through expansion of carbon-sequestering forest cover. The two are linked because as conditions change over time, the evolutionary potential of tree species must be maintained to allow for their continued adaptation; where trees are not well-adapted to local conditions, they do not sequester carbon efficiently. Evidence for the ability of tree species to withstand and adapt to changing environmental conditions is growing, but it is also clear that there are limits. Understanding the limits to adaptation of tree populations *in situ* and the potential for moving planting material to new suitable habitats is increasingly important. Population size is one of the most important factors in maintaining evolutionary potential but tree populations continue to be subject to loss and fragmentation. ◆

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Climate change, mountain people and water resources – the experiences of the Mountain Institute, Peru

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The impacts of climate change on mountain areas have far-reaching consequences.

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INTRODUCTION

Despite the importance of mountains, a lack of highland-focused consciousness has left mountain areas chronically neglected. Political marginalization leads to and reinforces economic marginalization, leaving mountain people and ecosystems increasingly vulnerable as the planet warms. Climate change has already accelerated the melting of glaciers while unsustainable natural resource use has compromised the ability of natural systems to buffer against the effects of warming. Glacier retreat and land use change in the Peruvian Andes are contributing to increased risk of glacial lake outburst floods (GLOFs), degraded wetland and grassland habitat, and highly acidified glacial streams. Solutions enacted in upland watersheds can safeguard valuable mountain ecosystems, secure water resources, and build resilience throughout the entire watershed. The Mountain Institute[1] recognizes that mountains are complex systems and that their people

Above: Community investigators identify seasonal lakes in Canchayllo, Peru

[1] Founded in 1972, the Mountain Institute works to conserve mountain environments, preserve mountain cultures and sustainably develop mountain economies. Its work focuses on the world's highest, longest and oldest mountain ranges — the Himalayas, Andes and Appalachians (see www.mountain.org).

possess a profound understanding of local conditions. Climate change adaptation activities conducted by the Mountain Institute in Peru emphasize processes and tools that incorporate diverse perspectives and local knowledge and empower mountain communities to make informed decisions towards climate resilience.

CLIMATE CHANGE IMPACTS AND VULNERABILITY OF MOUNTAIN PEOPLE AND ECOSYSTEMS IN PERU

Sixty-five percent of the world's population is estimated to be served by water from mountain ecosystems (Millennium Ecosystem Assessment, 2005). In humid areas, mountains generate 60 percent of the available freshwater in the watershed, and in arid and semi-arid areas they are responsible for 90 percent (Liniger *et al*., 1998). Nearly a quarter of terrestrial biodiversity and half of all biodiversity hotspots[2] are located in mountains. Despite their importance, mountain regions have been chronically neglected by societies around the world. Decision-makers are often based in lowland areas, where they have little information, awareness or understanding of mountain issues. As a consequence, many mountain people remain underserved and mountain natural resources are frequently unmanaged and overexploited. Political marginalization leads to and reinforces economic marginalization, leaving mountain people and ecosystems increasingly vulnerable as climate change advances. Accelerating glacier retreat, combined with various drivers of land-use change, are compromising the ability of natural systems to buffer the effects of global warming. There is a gap in understanding of how these changes are impacting highland resources and peoples. Melting in the Peruvian Andes has already transformed downstream ecosystems and is compromising the water security of millions, including the 10 million inhabitants of Peru's capital, Lima.

In response to these challenges, solutions enacted in headwater regions can safeguard valuable mountain ecosystems, secure water resources, and build resilience throughout entire watersheds. In the experience of the Mountain Institute, effective climate change adaptation in such regions must build on local assets, emphasizing processes and developing tools that build upon local knowledge as a basis towards greater resilience.

CLIMATE CHANGE IMPACTS ON WATER

Growing risk of floods

Mountain landscapes are recognized as highly vulnerable to climate change. Models suggest that they experience disproportionate warming compared to corresponding lowland regions (Brodnig and Prasad, 2010). Glaciers are losing mass at an accelerating rate which will continue to have major consequences for local water availability and regional hydrological cycles. In the tropical Andes, the mass balance of glaciers increases during rainy months, enabling glaciers to act as natural water reservoirs during dry season. However, Andean glaciers have shrunk by 30–50 percent in the last 30 years (Brown, 2013).

The impacts of glacier recession vary greatly depending on the scale and area considered. For example, the Cordillera Blanca has lost nearly 30 percent of its glacier coverage in the last 30 years; the smaller Cordillera of Huallanca, just south of the Blanca, has lost closer to 60 percent; and the even smaller Cordillera of Chonta, further to the south, has lost over 90 percent. Thus, the corresponding imminent risks vary greatly depending on location. Baraer *et al*. (2012) note that seven out of nine valleys with glaciers in the Cordillera Blanca have a negative hydrological balance, yet conditions and challenges are very different from one valley to the next, depending on the area of remaining glacier. Many smaller glaciers have already followed the fate of the Chacaltaya glacier, in Bolivia, which disappeared completely in 2010. The dozens of glaciers that have already vanished have seriously compromised the water security for many local villages. The consequences of this loss are great for both downstream and mountain communities. Those that have historically relied upon glaciers to store precipitation, feed rivers and recharge ground aquifers, now face greater risks from both reduced dry season water availability and increased rainy-season floods.

At the base of many glaciers, meltwater pools form behind these natural terminal moraine dams. These lakes are responsible for recharging ground aquifers and form the headwaters for many rivers and streams. The sediments carried in these waters form soils which are ideal for growing potato and other staple crops. As the peaks of the Andes experience warmer temperatures and changes in precipitation patterns, glacial lakes grow with increasing pressure on natural dams. The dams can burst without warning under the additional pressure, releasing thousands of cubic litres of water at once. Such risks are aggravated by the seismic activity of these regions. This looming threat presents an enormous risk to downstream communities. Glacial lake outburst floods (GLOFs) have the potential to wipe out entire cities. In 1941, the dam of the Palcacocha Lake in the Quillcay basin burst, killing 5 000 people in the down-stream city of Huaraz. Two more GLOFs occurred between 1941 and 1950 and were responsible for 5 000 additional deaths (Byers and Recharte, 2015). In 2010, a large piece of the Hualcán glacier above Lake 513 broke off, sending a 23-metre wave through the settlements of Hualcán, Pariacaca, Acopampa and Carhuaz, and caused the destruction of the area's potable water plant (La República, 2010). Today, the Palcacocha Lake, which had completely drained in 1941, has grown again to a volume larger than its original size and represents a high risk to the city of Huaraz, where tens of thousands of people live in the potential flood zone.

[2] Biodiversity hotspots are areas that: "a) are characterized by exceptional concentrations of species with high levels of endemism and b) are experiencing unusually rapid rates of depletion" (Myers, 1988).

The Peruvian Government has historically responded to this threat by draining or containing 34 of the country's most dangerous glacial lakes. While the risks continue to grow, the country has gained considerable knowledge and experience in addressing GLOF threats. Recognizing this Peruvian expertise, in 2012 the Mountain Institute formed the High Mountains Adaptation Partnership (HiMAP), with funding from USAID, to build partnerships with specialists and communities across Peru, Nepal and 15 other countries. The aim is to strengthen scientific, societal, and institutional capacity for climate change adaptation and resilient development, as well as disaster risk mitigation and management for high-threat glacial lakes and other climate-related disasters. The HiMAP partnership has worked with local scientists and community members to monitor glacial lakes, model downstream flooding impacts, build a community of practice for information sharing, and develop climate change adaptation mechanisms for local communities based on project research. In Peru, the Institute has supported community consultations and technical studies and designed public investment projects to install an early warning system (EWS) so that the residents of Huaraz would have time to prepare in the event of a GLOF. Consultation and studies demonstrated that GLOF control must consider local development objectives and, therefore, should address risk reduction as well as water retention for city and rural consumption. Local governments are taking action to finance the EWS; however, this is being undertaken within the normative framework of a public funding system that is not prepared to deal quickly with these kinds of growing hazards.

Shrinking wetlands

Wetlands are widely regarded as natural purifiers of water – a role which earns them the moniker "Earth's kidneys". Wetlands, too, are essential in flood and drought prevention. In the face of glacier loss, high altitude wetlands are increasingly important for regulating seasonal water shortages. Alpine wetlands may form over sloped valleys, in basins, or across flat plains.

They are primarily fed through surface and groundwater snow and glacier melt, and secondarily through rainwater (Squeo *et al*., 2006). As water dynamics change and glaciers retreat, the initial increase in water flow may overwhelm high altitude wetland floodplains, causing deep channeling and erosion. Subsequent decreases in water flow, coupled with deeper channels and less absorptive topsoil, results in reduced water storage capacity and greater runoff. This ultimately results in a reduction in wetland area.

The importance of alpine wetlands goes beyond water storage and purification. They provide a critical habitat for a range of wildlife species and endemic plants. Rich wetland vegetation is often the preferred grazing fodder for cattle in the Cordillera Blanca and for cattle and alpaca

As part of the HiMAP project, field workshops allow scientists and local participants to exchange knowledge for reducing the risk of glacial lake outburst floods

in southern Peru. However, livestock grazing can quickly change vegetation cover and composition, which in turn impacts water storage capacity. Overgrazing has been a principal cause of degradation in alpine wetlands. Pollution, drainage ditches and peat harvesting also constitute significant threats to healthy wetland ecosystems.

In addition, peat in mountain wetlands can be metres deep and thousands of years old. Peatlands provide an anaerobic, low-pH environment which prevents bacteria from breaking down vegetation. This results in huge stores of carbon which remain carbon neutral under permanent wetland conditions. However, once dried, bacteria break down organic material and high altitude wetlands can quickly emit large amounts of atmospheric carbon. Thus, from a climate change mitigation perspective, it is extremely important to maintain the integrity of high altitude wetlands.

Since 2014 the Mountain Institute, in partnership with the Huascarán National Park Authority and Michigan Technical University, has implemented a wetlands restoration initiative funded by the US Forest Service, which is restoring high altitude wetlands in two glacial valleys to improve ecosystem functioning and downstream water regulation. It is hoped that the project's successes will catalyse action by the park authority to replicate wetland restoration techniques in other glacial valleys and reverse the trends in alpine wetland shrinkage and loss.

Mineral contamination and acidification

The rapid recession of glaciers is also causing unexpected alterations in the quality of water as mineralized rock is exposed. As the glaciers melt and recede, water flows over newly exposed rock which contains pyrite and other minerals. These minerals acidify the water. As it flows downstream towards wetlands, lakes and rivers, acidified water erodes more rock, releasing more minerals (Michelutti *et al*., 2015). Hundreds of rural Andean families in this high-poverty region who depend on surface water for irrigation and personal consumption are experiencing declining crop yields and are falling ill. The Mountain Institute has sought out low-cost methods for rapidly assessing and improving the quality of water from glacially sourced streams. In partnership with national and international research centres, the Mountain Institute is aiding in the development of a smartphone application which uses macro-invertebrates as indicators of water quality. App users simply lift a rock from the stream bed, and select from a series of pictures which species they see. Because certain macro-invertebrates occur only in conditions of high acidity, and others only in drinking-quality water, the composition of macro-invertebrates can be a simple yet powerful tool for water users. The Mountain Institute has also promoted participatory action research approaches to identify low-cost, appropriate bio-remediation technologies to remove minerals from water.

Drying grasslands

Alpine tundra, or *páramo*, and montane grasslands, or *puna*, are recognized as having significant roles in carbon cycling and storage. These grasslands can be as productive[3] as cloud forests (Oliveras *et al*., 2014). The effects of climate change on high altitude grasslands are still unclear; however, one study of Andean grasslands shows that several soil properties, including resistance to runoff generation and erosion, will likely change with future climate warming (Zehetner and Miller, 2006).

In the Andes, grassland condition and upper watershed management are critical factors for sustainable pastoralism livelihoods. The Mountain Institute cooperated with the International Union for Conservation of Nature (IUCN), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) in the launching of the Mountain Ecosystem based Adaptation (EbA) project in 2010, funded by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety of the German Government (BMUB). The project worked with communities in Nor Yauyos Cochas Landscape Reserve to sustainably manage water resources and grassland condition in order to buffer against climate extremes such as drought. The project uses pre-Incan technologies to capture and repurpose otherwise lost glacier melt and rainwater to irrigate drying grasslands.

IMPACTS ON LIVELIHOODS

Since the early Holocene, people in the Andes have modified and sustainably managed *puna* landscapes (Young, 2009). Ancient livelihoods were based on camelid grazing and agriculture of native species sustained through technologies such as water reservoirs, silt dams, wetland expansion for alpaca, "irrigation" of upland alpine areas to charge groundwater aquifers and, in lower areas, terraces, water, terracing, water retention walls, and irrigation canals (Herrera, 2015; Lane, 2009). Many of these traditional practices have been lost, and today's land-use practices require outside inputs to sustain livelihood activities.

Cattle and sheep grazing in Peru began with the Spanish colonization in the 16th century. Cattle and sheep have largely replaced camelids in central and northern Peru. Cattle grazing dominates even within the boundaries of Peru's national parks and protected areas, where wild vicuña must compete for grazing resources. Cattle and sheep selectively graze and compact soils, which rapidly converts healthy wetlands and grasslands into degraded and eroded landscapes.

Introduced eucalyptus species have also put undue pressure on Andes ecosystems. These trees were propagated as a fast-growing wood source in valley areas, while the native queñual (*Polylepis* spp.) in

[3] Productivity refers to the accumulation of biomass in an ecosystem. Net primary productivity is the rate of carbon dioxide taken in by vegetation minus the amount of carbon dioxide released during respiration per unit time.

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The communities of Nor Yauyos Cochas participate in the restoration of pre-Incan technologies to improve grassland condition and underground water storage

higher altitude areas was nearly harvested to extinction for firewood fuel. In the lower areas, eucalyptus has replaced other native tree species growing at equivalent altitudes. The eucalyptus is water-intensive and places further demand on dry-season groundwater resources.

Andean communities and ecosystems are known for their resilience to climate extremes, but land degradation and the shifting climate are pushing these extremes beyond their historical variation, jeopardizing traditional livelihoods and changing how ecosystems function. Furthermore, perceived risk of disaster hinders development. Without sufficient safeguards in place, people are less likely to invest in long-term sustainable solutions. A study by Romeo *et al*. (2015) revealed that, of the 800 million people who live in mountains, 39 percent experience food insecurity. Chronic hunger and malnutrition have increased in mountain populations by 30 percent since 2000. This trend will likely continue unless development and environment efforts are made to reduce widespread poverty; political, social and economic marginalization; limited access to education; poor health and sanitation services; and risk to climate extremes.

In a survey of 400 Peruvian households in the Cordillera Blanca as part of the Securing Water and Livelihoods project in partnership with USAID, the Mountain Institute asked participants to identify and characterize various perceived risks. Those surveyed attributed reduced water availability to climate change and linked decreases in wild flora and fauna to pollution, lack of precipitation, frosts and disease. The survey also revealed that people were aware of the role of drought as well as of wind and rain erosion in landslides, impacting agro-livestock production systems and ultimately increasing the risk of malnutrition. The Securing Water and Livelihoods project promotes adaptation strategies grounded in local knowledge of territories and the improvement of local institutional and policy systems. The foundations of this community-based approach include increasing the capacities of Peruvian extension agencies to identify local community goals for development, recovering communities' deep knowledge of their climate and lands, and engaging people in meaningful discussions of the ways in which their development goals may be impacted by climate change and what actions need to be taken in order to reduce livelihood vulnerability. Gaining this detailed "on-the-ground perspective" on climate change effects is invaluable for building climate resilience in mountain geographies, given their great diversity of cultures and species. With a better understanding of how local jurisdictions are affected by climate impacts, state agencies can influence how public funds are invested in better targeted adaptation strategies at district, provincial or municipal levels.

REDUCING RISK AND VULNERABILITY IN MOUNTAINS

Mountain regions in the Andes are complex social and ecological systems shaped by steep slopes and harsh climate extremes and are vulnerable to erosion and changes in temperature and hydrology. Successful strategies that respond to climate change and other stressors must rely on local knowledge and the perspectives of mountain peoples. They must promote

direct representation of local interests in different levels of government, foster information systems that capture detailed local knowledge of territories, and enact better targeted and more effective interventions through cooperation between government at national and local levels.

Adaptation responses, such as early warning systems or engineering interventions, to GLOFs and other threats should be integrated with management objectives for other water uses, such as irrigation for agriculture, household use and energy production. Understanding the historical and present role that high altitude grasslands and pastoralism play in the regulation of water for lowlands takes on a critical importance given the context of glacier recession. Restoration of pre-Hispanic technologies adapted to contemporary socio-demographic conditions has been shown to be an effective response to the loss of glaciers, as demonstrated by the Mountain EbA Flagship Programme (Nyman, Rossing and Abidoye, 2015).

The restoration of wetland sites in Peru is a promising example of how conservation of "green infrastructure" by mountain community empowerment and improved local livelihoods. The Government of Peru has recently produced legislation and provisions, such as the "Ley de Mecanismos de Retribuciones por Servicios" (law on compensation mechanisms for ecosystem services) and guidelines to facilitate public investment in restoration and conservation of ecosystems that provide water and soil erosion control services. These mechanisms create opportunities to economically compensate mountain populations or jurisdictions that improve management, and restore and secure the services provided by their ecosystems.

Future adaptation strategies must continue to give voice to mountain peoples so that both highland and lowland communities may benefit from local knowledge and perspectives for securing mountain resources. ◆

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International Day of Forests 2016 – Forests and Water

Celebrated on 21 March, the International Day of Forests highlights a different theme each year. In 2016, FAO engaged with its forestry constituencies to promote the forests and water theme throughout the world, and celebrated the day at its headquarters in Rome, Italy, with a high-level event. Speakers from FAO included Director-General José Graziano da Silva and René Castro, Assistant Director-General, Forestry Department. Guest speakers included Abdeladim Lhafi, High Commissioner for Water, Forests and Desertification Control, Kingdom of Morocco; and Ivan Valentik, Deputy Minister for Natural Resources and Environment and Head of the Federal Forestry Agency, Russian Federation.

At the event, FAO announced its new programme on forests and water, and has followed up with a survey on the forest–water nexus which closed in July. The survey takes stock of the many variables, indicators and methods associated with measuring forest–water interactions, and was designed to engage researchers, technicians and practitioners involved in measuring and monitoring water quantity and quality in forest–water relationships, as well as socioeconomic and management considerations.

Read more about FAO's Forests and Water programme here: *http://www.fao.org/in-action/forest-and-water-programme/en/*

Committee on Forestry 2016

The 23rd Session of the Committee on Forestry (COFO) was held at FAO headquarters in Rome, Italy, from 18 to 22 July 2016, as the main event of the 5th World Forest Week. The session was attended by delegates from 125 countries and one Member Organization, and representatives of 15 United Nations agencies and programmes. Observers from 19 intergovernmental organizations and international non-governmental organizations also attended.

The session highlighted the need for a more coherent and integrated approach to the sustainability of agriculture, forestry and fisheries in the context of the SDGs. It discussed five interconnected principles, which also featured in discussions at the meetings of the Committee on Agriculture (COAG) and the Committee on Fisheries (COFI): i) conserve, protect and enhance natural resources; ii) enhance the efficiency of resource use; iii) improve and protect livelihoods and human well-being; iv) enhance the resilience of people, communities and ecosystems; and v) promote and improve effective governance.

The Committee highlighted the importance of monitoring progress towards sustainable forest management and the achievement of the

Árbol del Amor, Brazil. Two trees have become inseparably intertwined in the face of strong winds and seas. Photo shortlisted for the Committee on Forestry "Champion trees" photo competition

© SERGIO PALADINO

Marked logs, Indonesia

© FAO FLEGT

SDGs, and discussed in detail FAO's draft Climate Change Strategy. It also reviewed the follow-up to the Second International Conference on Nutrition (ICN2) and highlighted the potential for forests to play a stronger role in ensuring food security and nutrition.

Read more about the Committee on Forestry and World Forest Week here: *http://www.fao.org/about/meetings/cofo/en/*

World Food Day and Committee on Food Security

The Director-General of FAO was joined by the Prime Minister of Italy Matteo Renzi, HRH Princess Lalla Hasnaa of Morocco, and Macharia Kamau, United Nations Special Envoy on El Niño and Climate for the official World Food Day ceremony at FAO Headquarters on 14 October.

This year was marked by a strong focus on climate change and the Sustainable Development Goals, which also set the tone for the week-long Committee on World Food Security (CFS) which took place at FAO from 17 to 21 October. The opening plenary, the 43rd, set a record with more than 1 400 registered participants.

The Committee on World Food Security (CFS) is the foremost inclusive international and intergovernmental platform for food security and nutrition for all. The Committee reports to the UN General Assembly through the Economic and Social Council (ECOSOC) and to the FAO Conference. Using a multi-stakeholder, inclusive approach, CFS develops and endorses policy recommendations and guidance on a wide range of food security and nutrition topics.

Read more about CFS: *http://www.fao.org/cfs/en/*

First Forest Law Enforcement, Governance and Trade (FLEGT) timber license to combat illegal logging

On 15 September 2016, FAO announced the landmark agreement between Indonesia and the European Union to issue a license that will ensure that only legal timber from Indonesia is allowed access to the EU market.

As of 15 November, the FLEGT license can accompany shipments of timber exported from Indonesia to EU member states to certify that the timber has been harvested, transported, processed and traded according to Indonesian law. The licensing scheme is part of the EU's FLEGT Action Plan, adopted in 2003 to promote concrete measures to stem the illegal timber trade and contribute to sustainable forest management, now one of the 2030 Sustainable Development Goals.

FAO is working with the EU, its member states and other international and local partners to help tropical timber-producing countries make legally binding trade agreements with the EU. These agreements, known as Voluntary Partnership Agreements (VPAs), establish mechanisms to demonstrate the legality of timber produced in the country.

The cornerstone of the VPA is a timber legality assurance system that defines legal timber and how it should be verified. Once fully operational, FLEGT licensing can begin for consignments of timber exported to Europe. The system is audited on a regular basis to guarantee its credibility.

In Indonesia, FAO continues to support the process by providing financial and technical assistance for projects to strengthen the development and implementation of the national timber legality assurance system. This includes supporting the certification of community forests in East Kalimantan, and promoting group certification of furniture makers in Java and Bali.

Asia-Pacific Rainforest Summit

Rainforests in the Asia-Pacific represent 26 percent of the region's land area, and support the livelihoods of around 450 million people. The 2016 Asia-Pacific Rainforest Summit, held from 3 to 5 August in Bandar Seri Begawan, Brunei Darussalam, brought together key actors from government, business, civil society and the research community. Its aim was to catalyze practical action on reducing emissions from deforestation and forest degradation, and contribute towards sustainable development in the region.

The meeting promoted sustainable management of forests and landscapes as key elements to meet global commitments made under the Paris Agreement and United Nations Sustainable Development Goals, as well as regional commitments made at the inaugural Asia-Pacific Rainforest Summit held in Sydney in 2014.

The 2016 Asia-Pacific Rainforest Summit was hosted by the Government of Brunei Darussalam and supported by the Australian Government.

Read more here: *http://www.cifor.org/asia-pacific-rainforest-summit/*

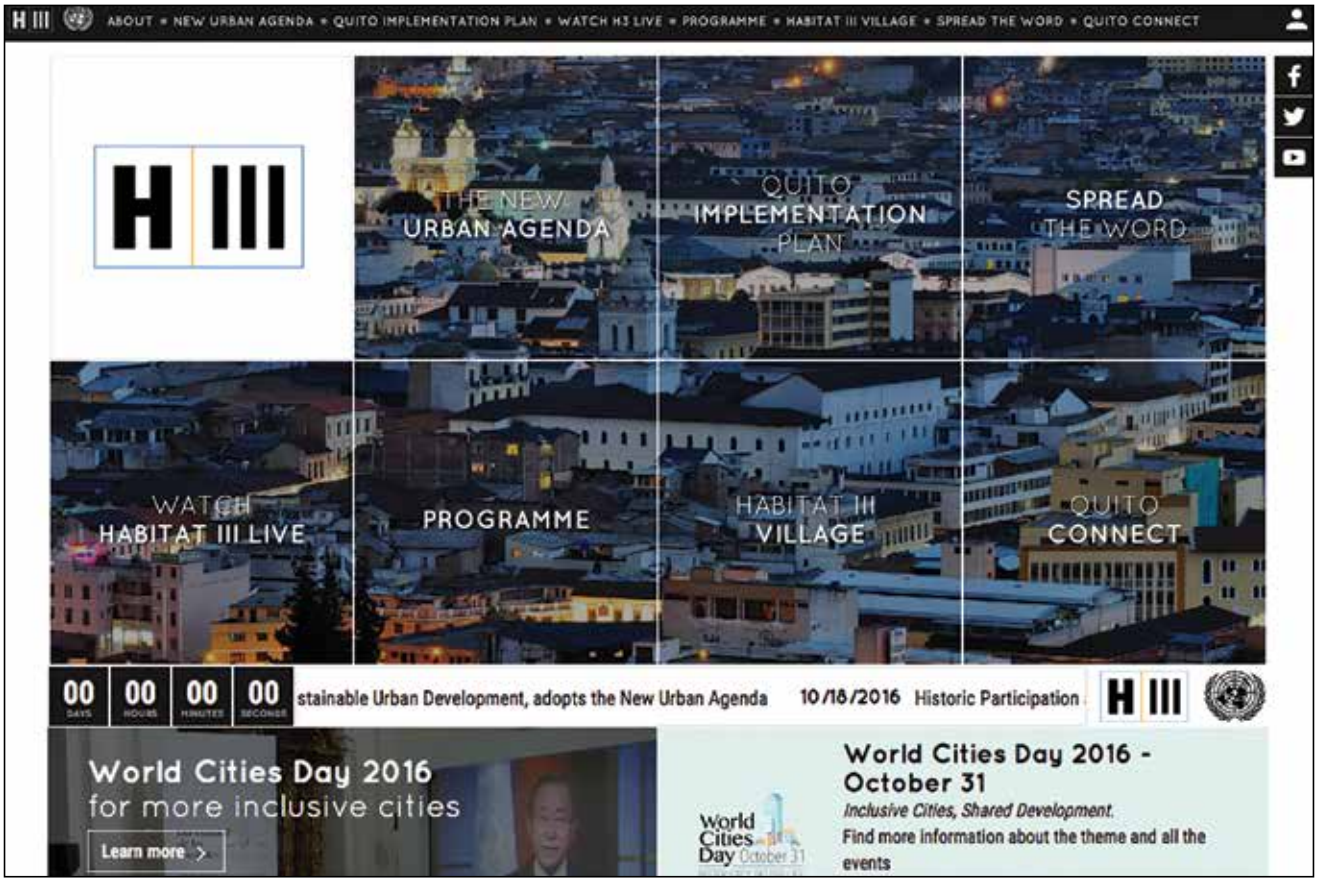
Meeting of the Convention on International Trade in Endangered Species of Wild Fauna and Flora

The 17th meeting of the Conference of the Parties (COP 17) to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) convened in Johannesburg, South Africa from 24 September to 4 October 2016. COP 17 was the largest CITES meeting to date, with more than 3 500 participants representing 152 governments, international organizations, non-governmental organizations and media. Delegates considered 90 agenda items and 62 species-listing proposals submitted by 64 countries.

In addition to resolutions and decisions regarding wildlife trafficking, demand reduction strategies to combat illegal trade in CITES-listed species, and international trade provisions regarding products generated from hunting, there was a strong focus on ensuring the sustainable and legal trade of woods such as rosewood, palisander and ebonies.

Read more here: *https://cites.org/cop17*

Fishing in the lake using a traditional net, West Java, Indonesia



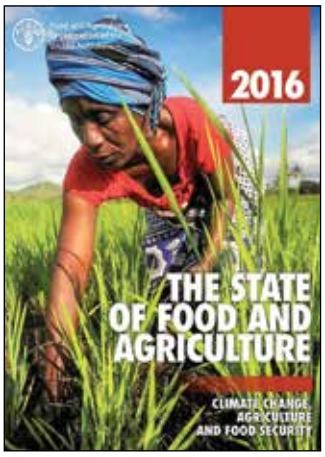
Habitat website

Habitat III

Habitat is the United Nations Conference on Housing and Sustainable Urban Development. Habitat III took place in Quito, Ecuador, from 17 to 20 October 2016. It engaged dialogue on important urban challenges such as how to plan and manage cities, towns and villages for sustainable development.

A key theme concerned *Nature in Cities: Quality of Life and Urban Ecosystem-based Adaptation*. This session focused on the value of nature for urban quality of life and the concept of urban ecosystem-based adaptation (EbA). Rapid and expansive urbanization, coupled with limited urban planning, has led to the degradation of ecosystems which provide critical resources and services to citizens (such as green infrastructure and protected areas, wetlands and rivers, and forests). This has threatened the lives and livelihoods of those in urban communities, and increased their vulnerability to non-communicable diseases, natural disasters, and climate change. Through a discussion with experts, the session explored the role of nature for cities, and cost-effective ways to reduce climate change vulnerability in urban and peri-urban settings while providing co-benefits to these communities and the environment through the protection, maintenance, and rehabilitation of the ecosystem.

Read more here: *https://habitat3.org/*



Transforming agriculture to tackle climate change

The State of Food and Agriculture 2016 – Climate change, agriculture and food security. 2016. Rome, FAO. ISBN 978-92-5-109374-0.

Climate change has alarming implications for the availability, access and use of food, particularly in countries and regions that are highly food-insecure.

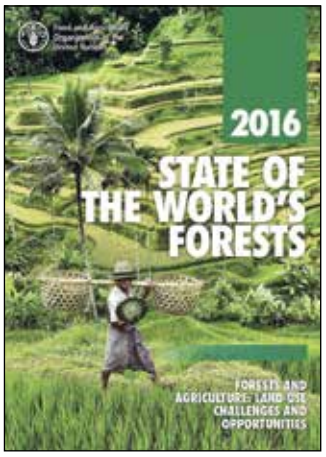
Sustainably transforming agriculture and food systems to mitigate or adapt to climate change will come at a cost and involve trade-offs. However, governments, farmers and food producers have a range of options to build resilience against the impacts of a changing global climate.

The 2016 edition of *The State of Food and Agriculture* considers the current and future impacts of climate change on agriculture and food security, making it clear that tough choices will have to be made in order to adapt to climate change and contribute to limiting greenhouse gas emissions. Forestry, like other agriculture sectors, will have a strategic role to play.

From forest regeneration to climate-smart agricultural practices, agroecology and better management of water resources, the report indicates viable paths that can contribute to the resilience of farming systems, reverse the widespread degradation of agriculture's resource base and reduce the intensity of greenhouse gas emissions that cause climate change.

The report also provides insights into lowering the barriers to adoption of appropriate response measures, explaining how inaction or delay could put future food security at risk worldwide, making it increasingly difficult for poorer countries to fight poverty and hunger.

Available online: http://www.fao.org/publications/sofa/2016/en/



Understanding the forest–agriculture equation

State of the World's Forests 2016 – Forests and agriculture: land-use challenges and opportunities. 2016. Rome, FAO. ISBN 978-92-5-109208-8.

Forests and trees support sustainable agriculture. They stabilize soils and climate, regulate water flows, give shade and shelter, and provide a habitat for pollinators and the natural predators of agricultural pests. They also contribute to the food security of hundreds of millions of people, for whom they are important sources of food, energy and income. Yet agriculture remains the major driver of deforestation globally, and agricultural, forestry and land policies are often at odds.

State of the World's Forests 2016 shows that it is possible to increase agricultural productivity and food security while halting or even reversing deforestation, highlighting the successful efforts of Chile, Costa Rica, the Gambia, Georgia, Ghana, Tunisia and Viet Nam. Integrated land-use planning is the key to balancing land uses, underpinned by the right policy instruments to promote both sustainable forests and agriculture.

Available online: http://www.fao.org/publications/sofo/2016/en/

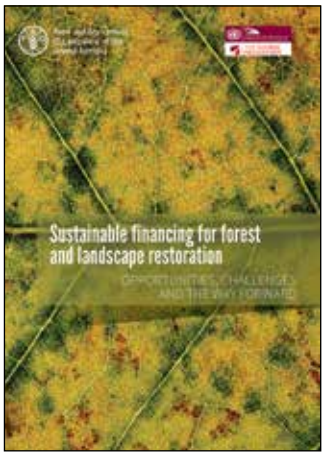
A landmark study on gender

Gender and forests – Climate change, tenure, value chains and emerging issues. 2016. C.J. Pierce Colfer, B.S. Basnett & M. Elias. New York, Routledge. ISBN 978-1138955042.

Despite pressure on institutions and policymakers to improve their work on gender, and foresters' eagerness to enhance gender aspects in their work, there has been no edited collection of analyses focusing on gender and forestry until now. This book aims to fill the gap. Its findings highlight women's potential contribution to, and more equitable sharing of, benefits from forests in the future and demonstrate the substantial advantages that gender mainstreaming brings for women, men and forests.

Building on methodologies and studies developed over the past 20 years, *Gender and forests* addresses 21st-century challenges with a bearing on gender and forests, such as climate change and tenure. It presents local case studies and comparative studies from around the world, as well as a "how to" list for successful implementation. Examples range from Swedish approaches to gender and climate change policies from a cultural perspective, to an examination of women's participation, leadership and decision-making power in forest management committees in Cameroon.

Forty authors from various disciplinary backgrounds, including the social sciences, natural sciences, animal and human nutrition, and American Indian and women's studies, contributed to the publication.



Overcoming the financial obstacles to forest and landscape restoration

Sustainable financing for forest and landscape restoration. Opportunities, challenges and the way forward. FAO & Global Mechanism of the UNCCD. 2015. Rome. ISBN 978-92-5-108992-7.

The degradation of land and forest resources threatens the livelihoods of the millions of people who depend on them. Every year, some 12 million ha of land are degraded while 7.6 million ha of forest are converted to other uses or lost through natural causes. Forest and landscape restoration (FLR) aims to reverse the degradation and upscale the sustainable management of natural resources.

The global community has shown strong commitment to FLR by embracing ambitious targets: the Bonn Challenge calls for restoring at least 150 million ha of degraded land by 2020; Aichi Target 15 of the Convention on Biological Diversity (CBD) aims at the restoration of at least 15 percent of degraded ecosystems by 2020; the New York Declaration on Forests targets the restoration of 350 million ha by 2030; and Target 15.3 of the Sustainable Development Goals aims to achieve land degradation neutrality by 2030.

However, there are continued difficulties in mobilizing and allocating adequate financial resources for large-scale FLR activities. FLR stakeholders will therefore appreciate this overview of the financial architecture related to FLR, which covers existing funding sources and financial instruments that could be used or adapted specifically, explores innovative financing mechanisms, and identifies the enabling conditions needed for sound FLR investments.

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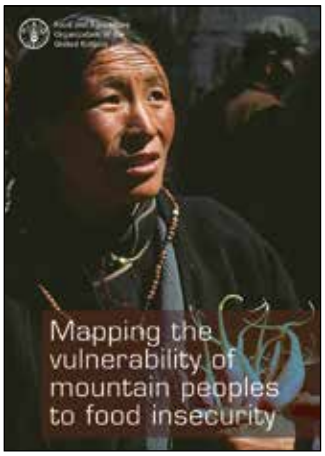


Hunger, malnutrition and poverty in mountain areas

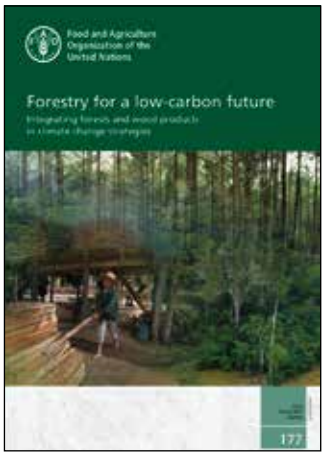
Mapping the vulnerability of mountain peoples to food insecurity. 2015. Rome, FAO.
ISBN 978-92-5-108993-4.

For millions of people living in mountainous areas, hunger and the threat of hunger are nothing new. Harsh climates and the difficult, often inaccessible terrain, combined with political and social marginality make mountain peoples vulnerable to food shortages. One in three mountain people in developing countries is facing hunger and malnutrition.

This study presents an updated geographic and demographic picture of the world's mountain areas and assesses the vulnerability to food insecurity of mountain dwellers in developing countries, based on a specially designed model. It includes an alternative and complementary approach to assessing hunger through the analysis of household surveys.

The results show that the living conditions of mountain dwellers have continued to deteriorate in the last decade. Global progress and improvements in living standards do not appear to have made their way up the mountains. This publication gives voice to the plight of mountain people and sends a message to policymakers on the importance of including mountain development in their agendas. Specific measures and investments are needed to break the cycle of poverty and hunger of mountain communities and slow the outmigration from these areas.

Available online: http://www.fao.org/3/a-i5175e.pdf



Including wood in climate strategies

Forestry for a low-carbon future: Integrating forests and wood products in climate change strategies. FAO Forestry Paper no. 177. 2016. Rome, FAO.
ISBN 978-92-5-109312-2.

Forests and forest products offer both developed and developing countries a wide range of options for timely and cost-effective climate change mitigation. Afforestation/reforestation offers the best option because of its short timescale and ease of implementation. Forest restoration and the reduction of deforestation also offer good mitigation potential.

Yet forest products also have a role to play. Wood products and wood energy can replace fossil-intense products in other sectors, creating a virtuous cycle towards low-carbon economies. The mitigation potential and costs of the various options differ greatly by activity, region, system boundaries and time horizon. Policymakers must decide on the optimal mix of options, adapted to local circumstances, for meeting national climate change and development goals.

This publication assesses the options and highlights the enabling conditions, opportunities and potential bottlenecks to be considered in making the right choices. Aimed at policymakers, investors and all those committed to the transition to low-carbon economies, it will support countries in using forests and wood products effectively in their climate strategies.

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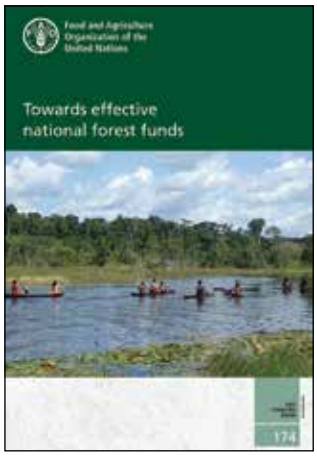


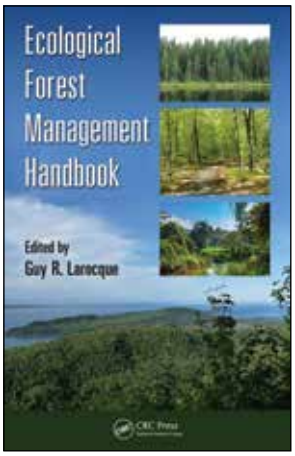
Making National Forest Funds work

Towards effective national forest funds. FAO Forestry Paper no. 174. R. Matta. 2015. Rome, FAO. ISBN 978-92-5-108706-0.

Forests play a crucial role in addressing climate change, food security and poverty alleviation. Yet financing sustainable forest management remains a challenge. It entails more than simply raising money for responsibly managed investment, requiring a more diverse financial basis as well.

This publication addresses the catalytic role of National Forest Funds (NFFs) in channelling investment. Based on a review of practical experiences, it outlines the general architecture and design elements of NFFs, as well as potential approaches and actions that could improve their performance. Its overall aim is to support countries in designing and operating NFFs effectively according to their specific needs and circumstances.

Available online: http://www.fao.org/3/a-i4359e.pdf



New guidelines on ecological forest management

Ecological Forest Management Handbook. G.R. Larocque, ed. 2015. London, CRC Press. ISBN 9781482247855.

Forests are valued not only for their economic potential, but also for the biodiversity they contain, the ecological services they provide and the recreational, cultural and spiritual opportunities they offer. This handbook provides a comprehensive summary of interrelated topics in the field, including management concepts, forest models and ecological indicators.

Featuring contributions from experts on the three main forest types – boreal, temperate and tropical – the book provides in-depth coverage of important issues in ecological forest management and includes case studies addressing ecological and socioeconomic issues. It illustrates how ecological forest management is a complex process that requires broad ecological knowledge while giving readers a deeper understanding of basic principles and applications.

Learning tool on Nationally Appropriate Mitigation Actions (NAMAs) in the agriculture, forestry and other land use (AFOLU) sector

Provides guidance in identifying, prioritizing and monitoring mitigation actions

- Introduces available sources of data and funds
- Showcases databases and tools for greenhouse gas estimation
- Reviews pathways for NAMA identification (i.e. fast track and in-depth analyses)
- Guides prioritization of different greenhouse gas emission reduction options
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Comprehensive modules for independent studying

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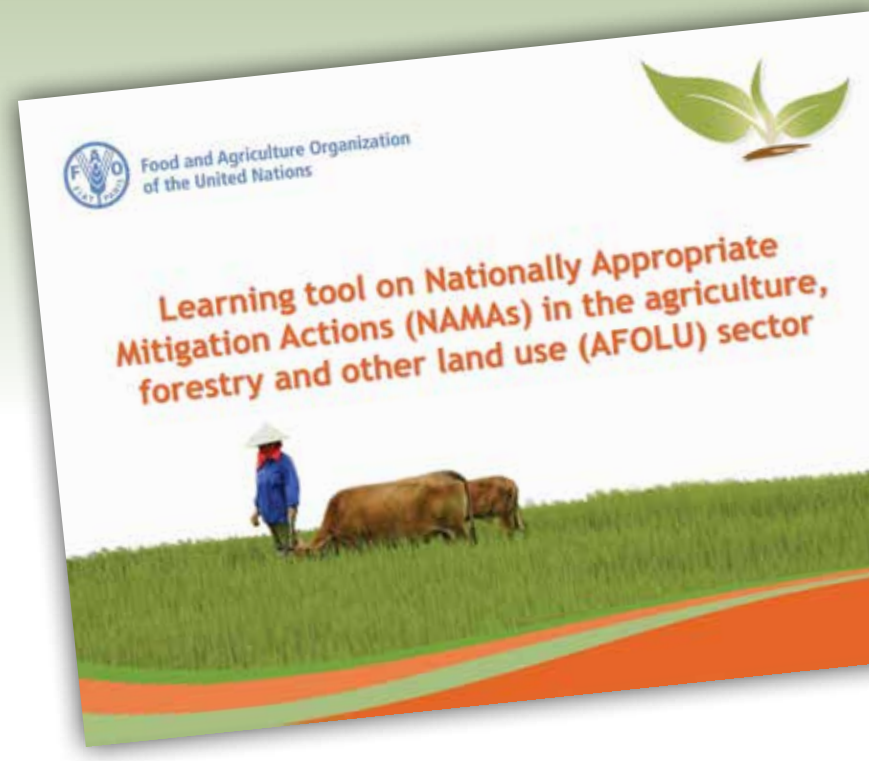

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