ISSN 1022–5439

ITTO Tropical Forest UPDATE

Volume 26 Number 3 2017

A newsletter from the International Tropical Timber Organization to promote the conservation and sustainable development of tropical forests

Holding the ground on mangroves

Mangroves are among the Earth's most productive ecosystems and they produce many goods and environmental services. When sustainably managed, they can support the livelihoods of millions of coastal people while storing globally significant quantities of carbon and reducing the vulnerability of coastal regions to storm surges and other threats.

The area of mangrove forests is decreasing in many tropical countries, however, due to poor management and increasing demand for coastal lands for development. A high priority for the global community, therefore, is arresting mangrove loss and restoring degraded mangrove ecosystems.

Inside: Special edition featuring selected materials from the International Conference on Sustainable Mangrove Ecosystems

ITTO

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Cover image: A mangrove seedling takes root on a patch of sand in Demak, Indonesia. *Photo: Yus Rusila Noor*

Image above: Young girls stand on a wooden landing among mangroves near their village in Indonesia. *Photo: Yus Rusila Noor*

On 18–21 April 2017, ITTO, the Indonesian Ministry of Environment and Forestry, the government of the Province of Bali and the International Society for Mangrove Ecosystems collaborated to convene the International Conference on Sustainable Mangrove Ecosystems to promote the conservation, restoration and sustainable management of mangrove forest resources in the tropics. Nearly 300 people from 25 countries attended the conference with the ambition of identifying ways in which mangrove restoration and sustainable management could contribute to the achievement of Sustainable Development Goals 13, 14 and 15 and the Paris Agreement on climate change. This special edition of the TFU is based on selected presentations made at the conference.

On page 3 we present a modified version of a leaflet published by the Building with Nature project (and presented at the conference), which makes the case for ecological mangrove restoration—in preference to planting—as the most effective way of re-establishing functioning mangrove ecosystems after (mostly human-caused) coastal destruction. One of the key techniques of this approach is the use of permeable structures made with bamboo and other locally available materials that reduce wave impacts, allow mud to settle and enable natural mangrove recovery.

Luiz D. Lacerda (page 8) presents a historical overview of threats to mangroves in Latin America and the Caribbean, where, today, two of the biggest threats are climate change and aquaculture. Efforts to restore mangroves have, to some extent, compensated for mangrove losses elsewhere, but Lacerda calls for a regional assessment of the mangrove resource to enable a coordinated response to the challenges of mangrove conservation and sustainable use in the neotropics.

José Otivo and co-authors (page 13) describe an ITTO project in Peru that is helping develop a strategy for sustainable mangrove use and conservation in what is called the northern mangrove corridor. The project has achieved successes but much more needs to be done, and the authors propose a bundle of measures to be carried out through a multidisciplinary approach.

Rantonirina Rakotoaridera (page 18) provides an overview of the status of mangroves in Madagascar, a new ITTO member. The National Commission for the Integrated Management of Mangroves was created in 2015 with the aim of improving the institutional coordination of mangrove management, and the author calls for more support for grassroots communities living in or close to mangroves, who are best placed to implement sustainable management.

Jacinto Samuel García Carreón (page 20) describes a recently developed and tested mangrove restoration methodology in Mexico. A quota system provides farmers with compensation for reverting lands back to mangroves, and the involvement of restoration specialists has been decisive. An important outcome, says García Carreón, has been a change in attitudes towards mangroves away from the previously entrenched belief that mangroves cannot be used sustainably.

Cécile Ndjebet (page 23) reports on how women's groups are helping restore mangroves in Cameroon with the help of an ITTO project. Women in rural coastal communities suffer more from mangrove degradation than other groups, she says, because mangroves provide spaces for women's farming and fishing and the collection of woodfuel and non-timber forest products. Among other things, the project has helped women in four communities rehabilitate nearly 400 hectares of mangrove forest; ultimately, the women aim to restore all degraded mangroves in their communities.

Finally, on page 32, we reproduce the "Bali Call to Action" issued by participants at the conclusion of the International Conference on Sustainable Mangrove Ecosystems. As a matter of urgency, say participants, stakeholders are urged to "redouble their work to ensure the conservation, restoration, protection and sustainable management and use of the world's remaining mangrove forest ecosystems".

Mangroves have crucial roles to play in sustainable development and the mitigation of climate change at the local to global scales. Many examples exist of successful mangrove restoration and sustainable management and use, some of them presented in this edition. Local people—especially women—are key agents for ensuring that mangroves perform their crucial roles at the land–sea margin. Holding the ground on mangroves has never been more important.

The conference programme and presentations, and other materials, are available at: www.itto.int/mangrove2017.

Preferencing ecological mangrove restoration

Wherever possible, mangrove restoration efforts should use an ecological approach that avoids the need for planting*

Nature's way, with help: Mangroves establish naturally behind a porous sediment trap in Indonesia. *Photo: Apri Susanto*

The term "mangrove" is used both to define the plants that occur in tidal forests and to describe the ecological communities themselves. Bridging land and sea, mangroves provide millions of people with vital sources of income and protect them from storms and floods. Mangroves serve as nurseries for fish, build up soils, protect against storms, store large amounts of carbon, and provide timber and medical plants. More than 60% of coastal wetlands, including mangroves, are severely degraded, however (Wetlands International 2017). Mangrove forests are under threat from development pressures, such as overharvesting; pollution; conversion to agriculture, aquaculture and urbanization; the oil and gas industry; and infrastructure development. The loss of mangroves and other coastal ecosystems, coastal erosion, coastal flooding and saline intrusion increasingly threaten the resilience of coastal populations.

Planting often fails

In general, it is more cost-effective to prevent the removal of mangroves than to lose and then restore them, but this is not always an option. Consequently, mangrove restoration is needed in many degraded areas worldwide and, if done properly, it will enhance coastal safety, fisheries, aquaculture and carbon sequestration. Mangrove planting in response to severe degradation has become very popular in Indonesia; for example, almost 15 million mangrove seedlings were planted under government initiatives alone in 2002–2016 (Kuswandono 2017); millions more were planted by community groups, non-governmental organizations and the private sector.

Many planting efforts fail to effectively restore functional mangrove forests, however. Mangrove restoration success is typically and pragmatically defined by the number of

Reclaiming: Women participate in coastal restoration through planting in Indonesia. *Photo: Jane Madgwick*

seedlings planted and sometimes by the survival rate after a short period. Many examples exist of planting efforts that demonstrate high initial survival rates but which have high rates of mortality in the longer term, typically after monitoring has ended. Some restoration efforts yield stunted, single-species stands growing at unnatural densities, which do not offer the aimed-for coastal protection, livelihood enhancement or other benefits. Successful restoration, on the other hand, results in the establishment of sizeable, diverse, functional and self-sustaining mangrove forests that do provide such benefits.

Recurring factors in the failure of mangrove restoration include:

- planting in areas where socioeconomic conditions are not right—for example, the local community is not involved or does not support the idea of conservation, or alternative livelihoods are lacking. If the community depends on aquaculture, for example, restored mangroves may quickly be reconverted to fish or shrimp ponds;

* This article is modified from *Mangrove restoration: to plant or not to plant?*, a leaflet developed by the partners of the Building with Nature Indonesia project and the Ecoshape Consortium and made possible by the Waterloo Foundation, the Dutch Sustainable Water Fund and the Otter Foundation. The leaflet is available at: www.wetlands.org/publications/mangrove-restoration-to-plant-or-not-to-plant

- mono-species planting, leading to non-functional mangroves with limited benefits and low resilience;
- planting the wrong species in the wrong places (e.g. in areas subject to too much or insufficient inundation or which are overexposed to waves and erosion or have poor-quality soils or water), resulting in high rates of mortality or low rates of growth;
- planting in places where the recovered mangroves block sediment and water flows, thus hampering recovery at a larger scale;
- planting in areas where the original cause of loss (for example altered water flow) has not changed;
- planting in places where mangroves are re-establishing naturally, disturbing the already-established plants and slowing down natural recovery; and
- planting in areas not previously covered by mangroves, such as open intertidal mudflats and seagrass beds or sandy beaches, damaging these valuable habitats.

Natural mangrove succession

Not all mangrove species can equally withstand the submerged conditions, wave exposure and salinity occurring at seafronts; natural mangrove forests, therefore, show a clear land-to-sea zonation with different species. Natural mangrove succession starts with pioneer species that facilitate colonization by others. Often, planted species are not pioneers, thereby affecting the natural zonation and colonization process. When the enabling biophysical and socioeconomic conditions are put in place during restoration, nature will do the rest. Mangroves will grow back naturally, without planting, as propagules and fruits are swept in by tides. This approach optimizes species-to-site matching, resulting in better survival, faster growth and a more diverse and resilient mangrove forest. In some cases, planting can assist or enrich the natural regeneration process. Properly restored forests with multiple species and natural zonation show greater variety in root types, tree size, foliage and fruits, fulfilling different functions and attracting diverse (fish) fauna; ecologically restored forests are also likely to be more resilient to change. Benefits are further optimized when connectivity with other habitats, such as seagrass beds and coral reefs, is re-established.

When to plant and when not to plant?

The practice known as "ecological mangrove restoration" relies on natural regeneration once biophysical conditions are restored. Planting is usually not needed, although there are circumstances in which it might still be useful. Sometimes planting is inevitable because of existing commitments or the popularity of the practice with stakeholders. In those cases, planting efforts need to be channelled (see below) to ensure they are useful and do not result in failure or even cause damage to the environment. At the same time, capacity building on ecological mangrove restoration is required.

Low tide: This mangrove seedling established naturally; the animal in the foreground is a mudskipper. *Photo: Yus Rusila Noor*

To channel the immense enthusiasm for mangrove restoration, the following two principles are crucial:

1) **Ensure biophysical conditions are appropriate for mangrove recovery:** mangroves may have been lost or degraded due to conversion to other land uses or as a result of changes in freshwater supply, sediment loss or other causes. These, in turn, might be linked to local infrastructure developments and engineering works on coasts and rivers further away and, consequently, mangroves may no longer be able to thrive where they once did. The regeneration of a healthy mangrove forest can only happen if the enabling biophysical conditions for mangrove growth are put back in place. This can be hard—but very rewarding—work. Ground-levelling and the restoration of hydrological flows will be needed in former aquaculture land; this can be done by strategically breaching pond bunds and restoring old creek systems. On rapidly eroding muddy coasts in Indonesia, Suriname and Viet Nam, permeable structures are being applied to reduce wave impacts, trap sediment and enable natural mangrove recovery.

2) **Ensure that socioeconomic conditions allow mangrove recovery:** if people have removed mangroves once, they can do it again; therefore, the socioeconomic root causes of removal need to be addressed. Where possible, economic activities need to be developed that sustainably benefit from mangrove restoration, thereby strengthening the business case for restoration. Land ownership and use rights need to be established, and there must be both a desire for recovery and the possibility of management. Successful projects empower communities, engage local governments and ensure that local actions are strengthened by policies and planning.

Holey wall: The aim of this porous sediment trap built by the Building with Nature Project in Demak, Indonesia, is to create suitable habitat for natural mangrove regeneration. *Photo: Yus Rusila Noor*

These two principles are the cornerstone of the "ecological mangrove restoration approach" (Lewis & Brown 2014), which has a sound scientific basis. Strictly speaking, the term "restoration" is reserved for the re-establishment of a pre-existing ecosystem, and "rehabilitation" refers to the recovery of ecosystem functions and processes without necessarily re-establishing the pre-disturbance condition. Note that the interventions involved in ecological mangrove restoration are very different from restoration by planting only, and they should be part of a coordinated programme involving experts of various disciplines—such as ecology, hydrology, coastal dynamics and sociology—as well as multiple stakeholders.

Planting: sometimes a valuable option

Planting might be valuable in the following conditions:

- Planting or sowing may be required when natural supplies of seeds and propagules are limited due to a lack of nearby parent trees or a lack of hydrological connection to these trees (inhibiting the dispersal of seeds and propagules). This is often the case on coastlines that have suffered widespread mangrove degradation.
- Planting may be done to re-introduce specific valuable species that have been lost from an area (sometimes called enrichment planting).
- Planting can be valuable for educational or cultural purposes. As a symbol of life, planting a tree can create lasting commitment and ownership among those involved.
- In severely eroding areas, mangrove-planting on remaining bunds can offer short-term relief by delaying the erosion of those bunds.

In cases where planting is deemed necessary, appropriate species-to-site matching is vital. Planting programmes should avoid non-mangrove habitat and areas showing natural mangrove recruitment.

Mangrove planting can play a role even if ecosystem restoration is not the primary goal, such as to ensure a sustainable wood source. Also, mangroves are often planted in combination with aquaculture systems (silvofisheries) to provide benefits to the system. The rows of mangrove trees planted along aquaculture pond bunds may not produce a "real" mangrove forest, but they can provide important benefits at the local scale, such as the stabilization of bunds, the production of brushwood and fodder, and shade.

Communities may be accustomed to the income they earn from nursery management and planting, and they may have considerable pride in, and ownership of, their planting efforts. Ecological mangrove restoration needs to find alternative ways to engage local communities, such as in the construction of permeable structures to trap sediment; the breaching of bunds; sowing; monitoring; and safeguarding restored mangroves. Simultaneously, sustainable livelihoods need to be developed to take pressure off the restored mangroves.

Where not to plant?

Open intertidal mudflats, sand flats, coral reefs and seagrass beds, which often occur where mangroves can also grow, support high diversities of crustaceans, molluscs, corals, birds, mammals and turtles, including many threatened and endemic species. These habitats are highly productive and support a very high biomass of benthic invertebrates and other animals that sustain productive inshore and offshore fisheries. They are valuable feeding

Reclamation: A local group of fishermen is restoring these fishponds in Banten Bay, Indonesia. The planted mangrove trees may not produce a "real" mangrove forest, but they will provide important benefits at the local scale. *Photo: Yus Rusila Noor*

sites for many millions of breeding and migrating waterbirds, such as geese, ducks, shorebirds and gulls. In several of the world's major flyways, mudflats and associated habitats serve as "bottleneck sites", providing crucial resting and feeding sites for migratory waterbirds. Converting such sites by planting mangroves would destroy vital habitats for these species and contribute to their decline.

The use of permeable structures

Healthy mangrove mud coasts are in a dynamic equilibrium; waves take sediment away, and tides bring sediment in. The root systems of mangroves help capture and stabilize the sediment. Many tropical mud coasts are experiencing dramatic erosion due to the conversion of mangroves, the installation of infrastructure, sea-level rise and soil subsidence. Coastal managers tend to fight coastal erosion with hard structures, but these disturb the balance of incoming and outgoing sediments and may cause further erosion. The first step in stopping the erosion process and stabilizing coastlines is to reverse the loss of sediment. Permeable structures made of local materials—such as bamboo, twigs and brushwood—can be placed along shorelines; these let seawater pass through, dampening waves rather than reflecting them. Waves lose height and energy before they reach the coastline, enabling mud to settle behind the permeable structures. Once the erosion process has stopped and the shoreline has started accreting, mangroves can re-establish without being washed away. Over time, the mangroves themselves will attenuate waves and trap sediment, thereby preventing erosion. This technique is being applied in the Mekong delta (Viet Nam), Demak (Indonesia) and near Paramaribo (Suriname).

Supporting successful mangrove restoration

Key steps that mangrove advocates and practitioners can take to support mangrove restoration are as follows:

- Embrace the ecological mangrove restoration approach and think twice before planting mangroves.
- Engage multiple experts and stakeholders, linking local knowledge with scientific expertise.
- Monitor and assess success against the desired purposes of restoration.
- Identify problems early and take corrective actions when necessary.
- Spread the word and share knowledge, experiences and lessons learned.

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Propagule pool: A sediment trap helps collect mangrove seeds for natural regeneration. In ecological mangrove restoration, mangroves grow back naturally, without planting, as propagules and fruits are swept in by tides. *Photo: Yus Rusila Noor*

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The changing pressures on neotropical mangroves

Despite restoration efforts and new policies and laws, climate change and other stresses pose ongoing threats to mangroves in Latin America and the Caribbean

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Thin green line: A small boat sails close to mangroves in the Jaguaribe estuary in northeast Brazil, with shifting dunes in the background. Dune velocity has increased due to climate change, threatening mangrove forests, especially in semiarid climates. New mangroves are colonizing recently deposited sands on the estuarine margin in the lower left of the photo. *Photo: Luiz D. Lacerda*

Latin America and the Caribbean harbour about 26% of the world's mangroves (3.58 million–4.54 million hectares). Notwithstanding their ecological and socioeconomic importance, mangroves in the region suffer from environmental pressures that vary spatially, in intensity and over time, and they are governed variously under federal-to-municipality laws. This article reviews the changing pressures on mangroves in the region and calls for an urgent regional review of the status of the mangrove resource and the threats it faces.

Pressures in the twentieth century

Mangroves in Latin America and the Caribbean were negatively affected by rapid socioeconomic change—especially urbanization and industrialization—in the second half of the twentieth century. The growth of urban settlements in coastal areas and the need for jobs, land, food and water to meet fast-growing demand triggered the overexploitation of mangrove products such as woodfuel, timber and fisheries. Development greatly outpaced the capacity to build adequate infrastructure, resulting in increasing pollution in coastal areas and the encroachment of mangroves by expanding urban areas (Lacerda 1993).

Effluents released from generally unregulated industrialization, including spills of oil and toxic substances, and eutrophication, added stress to the region's mangroves. Numerous incidents involving the release of oil and pollutants in the 1980s triggered an intensive effort to understand the effects of such releases on mangroves, and regulations and spill preparedness were strengthened for both offshore and onshore operations and port activities. The area of mangroves affected annually by oil spills in Latin America and the Caribbean is now eight times lower (13 hectares per year) than it was in the last 30 years of the twentieth century (100 hectares per year).

Expanding large-scale agriculture also had a significant impact by adding nutrient loads and toxic agrochemicals to coastal waters. The damming and diversion of rivers led to a region-wide decrease in sediment transport to coasts, altering the sedimentation–erosion equilibrium along coastlines and affecting groundwater salinity. Salt intrusion expanded the saline influence upriver, triggering mangrove migration inland, whereas the regulation and decrease of river flows caused the siltation of estuaries (Lacerda et al. 2002).

Salt was once produced in northeastern Brazil and the Caribbean margin; today, however, most salt ponds are abandoned, and mangrove recuperation depends on natural regrowth. Mangroves were exploited for charcoal, fuelwood, timber, bark and their associated fisheries, which had intermediate impacts on mangroves in the twentieth century; many traditional communities relied heavily on mangrove forest products as sources of energy and construction material.

Although responsible for 50–80% of all mangrove losses in Asia, aquaculture was only a minor source of impact in Latin America and the Caribbean at the end of the twentieth century compared with losses due to overexploitation, urbanization and industry. The exception was Ecuador, where 20% of the country's mangroves were converted to shrimp farms between 1979 and 1991.

New threats to neotropical mangroves

Today, neotropical mangroves suffer impacts from new drivers such as climate change and changes in the intensity of aquaculture, among other uses. On the other hand, the

Cause for reflection: An important outcome of increasing public awareness of the ecological importance of mangroves can be their incorporation as part of urban "green architecture". The Cocó State Park in the city of Fortaleza in northeast Brazil includes 750 hectares of mangroves, which serve as a focus of ecotourism and also as a filter for outflows from the city. *Photo: Luiz D. Lacerda*

replanting and rehabilitation of previously degraded or converted mangrove areas and the creation of marine conservation units are positive developments. Previously important drivers of mangrove degradation and loss, such as fisheries, tourism, salt production and industrialization, are considered today to be of minor overall significance; nevertheless, there is an urgent need for a regional assessment to better determine the impacts of such drivers at the local level.

Shrimp aquaculture

Today, shrimp aquaculture is the most significant human activity affecting mangroves in Latin America and the Caribbean, with shrimp production featuring in 22 of the region's 36 countries. Aquaculture provides economic options and jobs but also has significant negative environmental and social impacts. Mangrove conversion reduces water quality and degrades habitats for fish and shellfish of economic importance, frequently putting shrimp farmers in opposition to those whose livelihoods depend on mangrove resources. Shrimp farming increases the risk of inland flooding and the siltation of estuaries and displaces coastal communities. Moreover, many shrimp farms still rely heavily on wild-caught shrimp (either fry or pregnant females), which are transferred to ponds. On a large scale, this affects fisheries because of bycatch and disrupts food webs.

The shrimp ponds themselves can contaminate the surrounding environment with excess nutrients and trace metals of environmental concern. Of all sources of pollution in coastal zones, shrimp aquaculture has the highest emission factors for nutrients, mercury and copper. The effluent of shrimp aquaculture is mostly composed of fine sediments eroded from pond walls rich in non-refractory organic matter, the oxidation of which on reaching estuarine waters rapidly consumes dissolved oxygen. Notwithstanding the large emission factors, the small surface area covered by ponds relative to other uses means that the total load of nutrients and metals discharged to estuaries has been relatively minor to date, but this is changing. In the Gulf of California, Mexico, for example, copper emissions from about 83 000 hectares of ponds generate annual loads comparable with other anthropogenic sources. An aggravating factor is that aquaculture effluents are released directly into estuarine waters. In Brazil, about 600 000 hectares of previously protected salt flats became available for conversion under the new Forest Code, mostly to aquaculture (Silva et al. 2011). An urgent task for policymakers is to avoid repeating the experience in Asia, where conversion to aquaculture caused widespread mangrove destruction and environmental damage.

Increasing carbon dioxide concentration

The increasing concentration of atmospheric carbon dioxide (CO_2) has both direct and indirect impacts on mangroves. As C-3 plants, mangroves lack CO_2-concentrating mechanisms and respond positively to higher concentrations by augmenting primary productivity and biomass accumulation, and higher temperatures enable the expansion of mangrove ecosystems towards the poles. The indirect impacts, however, such as sea-level rise, an increase in the frequency of extreme climatic events, stronger oceanic forcing on continental shelves and estuaries, and anomalies in the rainfall regime, are significant sources of pressure on mangrove ecosystems. Their impacts vary enormously geographically, depending on local climate and geomorphology, mangrove typology and biodiversity, human uses in watersheds, and the interactions of the various stressors (Lacerda et al. undated).

Impacts of climate change

There is no scientific consensus on the overall impacts of climate change on mangroves in the region. The ways in which mangroves respond to rising sea levels, and how this response will vary between mangrove types (e.g. high-island versus low-island and oceanic versus deltaic), are poorly understood. Inland migration seems a likely response to sea-level rise where this is feasible (such as on large coastal plains), but responses to other factors are largely unknown. The capacity of mangroves to adapt to sea-level rise can be affected by upstream human actions that alter sediment supply or block inland movement (e.g. the establishment of aquaculture ponds on the landward fringes of mangrove ecosystems), with mangroves squeezed between a rising sea and human activities beyond the tidal influence.

Mangrove restoration

Mangrove replanting, rehabilitation and regeneration programmes are widespread in Latin America and the Caribbean and are having a significant positive impact.

Under the pump: This mangrove fringe forest has been degraded by the construction of hydraulic equipment for shrimp farming in northeast Brazil. *Photo: Luiz D. Lacerda*

The region lost about 88 000 hectares of mangroves between 2001 and 2010 but gained about 77 000 hectares, a net loss of 11 000 hectares (which was about 0.3% of the region's total mangrove estate). About 50% of this loss was in Ecuador, whereas there were major gains in Colombia (+14 800 hectares) and Brazil (+10 800 hectares), due mostly to afforestation and the recovery of degraded areas. Site-specific assessments are required of the impacts of mangrove restoration and reforestation programmes on mangrove forests, biodiversity and carbon storage.

How things have changed

Table 1 compares the factors affecting mangroves in Latin America and the Caribbean today with those in the late twentieth century and the effectiveness of societal responses. The analysis of the situation in the twentieth century is based on primary information obtained from a regional assessment conducted as part of ITTO projects implemented by the International Society for Mangrove Ecosystems (Lacerda 1993); the analysis for the present century is derived from an evaluation of secondary data available in the literature.

Societal responses to mangrove degradation

The destruction and unsustainable use of mangroves and their natural resources has triggered important societal responses that have somewhat decreased the rate of mangrove loss. The annual rate of mangrove loss in North and Central America, combined, decreased from 1.29% between 1980 and 1990 to 0.97% between 1990 and 2000 and to 0.77% in 2000–2005. In South America, the rate declined from 0.69% in 1980–90 to 0.38% in 1990–2000 and to 0.18% in 2000–2005 (FAO 2007). Laws regulating the exploitation of mangrove fisheries and forest products have been enacted in almost all countries. Efforts to strengthen controls on point-source pollution, such as that generated in the oil industry and the chemical sector, have been effective. Diffuse sources of pollutants are still significant, however; they are difficult to control and rarely taken into account.

Societal responses have reoriented the management and use of mangroves towards community-based approaches, including extractive reserves, mostly mediated by local authorities. Also, there has been an increase in the number of protected marine areas, some of which include mangrove forests, although the effectiveness of these in mangrove conservation is still a topic of debate.

The rehabilitation of degraded areas is often required in environmental impact assessments as a way of compensating for the impacts of developments such as tourism and urban expansion. Many rehabilitation projects, however, have failed to take into account the biogeophysical realities of sites or the causes of degradation and loss, with the ultimate result that many have failed. Almost no projects have included long-term monitoring, and their actual status is difficult to ascertain.

Many efforts to rehabilitate mangroves have failed to acknowledge pre-degradation traditional uses, resulting in conflicts with local communities. Also, most rehabilitation and replanting plans fail to address the potential impacts of climate change, compromising the long-term benefits that might be obtained and ultimately reducing the effectiveness of mitigation and adaptation actions. The new Forest Code in Brazil, for example, excludes salt flats as integral parts of mangrove ecosystems, strongly decreasing the resilience of the latter to sea-level rise. Community-based management, which has proved to be an effective, efficient approach, is

Table 1: Drivers of mangrove degradation and loss in Latin America and the Caribbean, before 2000 and in the twenty-first century, and the societal response

Drivers	Major impacts	Societal response	Significance before 2000	Constraints on response	Status after 2000
Urbanization	Solid waste and wastewater disposal; eutrophication and pollution; deforestation	Coastal zone management; improving waste treatment; green architecture	**Major** Widespread in the region	Economic crises and impoverishment of people	**Intermediate/stable** Widespread in the region; depends on economic situation
Industrialization	Effluent disposal; oil and pollutant spills; contamination of the biota; deforestation	Stronger regulations; improving waste treatment, security and containment measures; bans on tank washing	**Major** Restricted to industrialized nations	Societal response able to significantly decrease the impacts of this driver	**Minor/stable** Restricted to accidents
Agriculture	Increasing nutrient loads; eutrophication; agricultural pollution	Basin committees regulating land uses; restrictions on agrochemical use	**Intermediate**	Watershed committees failed to consider impacts on coastal zones; illegal use of agrochemicals	**Intermediate/stable** Major impacts due to intensive agriculture
Forestry and fisheries	Overexploitation of mangrove products; overfishing	Restraining mangrove wood use; extractive reserves; community-based management	**Intermediate**	Societal response able to significantly decrease the impacts of these drivers	**Minor/stable**
Tourism	Waste disposal; forest conversion	Environmental regulations; ecotourism; green architecture	**Intermediate**	Societal response able to significantly decrease the impacts of this driver	**Minor/stable**
Salt production	Clearing; changes in hydrochemistry and hydrology	Rehabilitation in abandoned ponds; natural regrowth	**Minor**	Societal response able to significantly decrease the impacts of this driver	**Minor/stable**
Damming	Erosion of coastal forests; siltation of estuaries; salinization of soils and pore water	Basin committees, including representatives of coastal communities	**Major**	Basin committees fail to consider downstream impacts on the coast	**Major/increasing** Particularly important in semiarid regions
Aquaculture	Altering nutrient fluxes; deforestation; eutrophication; pollution	Initial regulations and laws, public awareness	**Minor**	Regulation and laws do not take climate change into account; public awareness is insufficient; community-based management is weak relative to capital pressures	**Major/increasing** Widespread in the region and increasing by up to 10% per year
Climate change	Altering sediment and salt balance; remobilization of pollutants; increase in frequency of extreme events; mangrove migration	No specific societal response	**Not considered**	Societal response dependent on the country but irrelevant if not taken at a global scale; adaptation depends on the local environmental setting and adjacent human activities; conservation laws do not consider climate change as a variable; political backlash	**Major/increasing** Emissions rising; resilience threshold of mangroves unknown
Replanting and rehabilitation	Increasing area; carbon sequestration; greater availability of natural resources; coastal protection; reducing the impacts of climate change	Natural regeneration; individual or limited initiatives	**Minor**	Community-based capability; low relevance to government; lack of monitoring; environmental legacy of past polluting activities	**Major/increasing** Rehabilitation policies not regulated at the country level; regeneration process not monitored; plantings on seagrass beds

unable to cope in the face of large capital investments in, for example, intensive aquaculture and harbour development. A lack of economic planning in the commercialization of products from extractive reserves has hampered sustainability, and relatively few efforts have been made to create feasible markets for such products.

Finally, high water demand has led to an increase in river damming and diversions, but environmental impact assessments and socioecological planning of such activities tend to exclude consideration of coastal zones and mangroves. This greatly reduces the effectiveness of community efforts to conserve and sustainably use mangrove ecosystems.

Mangrove expansion: This mangrove forest in northeast Brazil is colonizing a newly enlarged river margin. In some areas, river margins are increasing due to sediment accumulation resulting from damming and a reduction in rainfall, which lead to a decrease in the transport capacity of fluvial flow. *Photo: Luiz D. Lacerda*

Conclusion

This article shows that the drivers of environmental impacts on neotropical mangroves have changed dramatically in the past 40 years. New stressors have reduced the effectiveness of existing societal actions towards conservation and sustainable management, and there is a high likelihood that the rate of mangrove loss and conversion will increase.

Some key questions remain to be answered. How will global climate change interact with local anthropogenic drivers? How will forest type influence the impacts on, and the responses of, mangroves to climate change? How do upstream anthropogenic drivers affect mangroves? Given such unknowns, there is an urgent need for a regional assessment, based on primary sources, across the mangrove-hosting countries of Latin America and the Caribbean to enable the sharing of experiences and a regional response to the challenges of mangrove conservation and sustainable use in the neotropics.

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Peru's northern mangrove corridor

An ITTO project is helping develop a strategy for conserving and sustainably using mangroves in Peru's Northwest Biosphere Reserve

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Canoe race: The aims of this canoe competition in the Tumbes National Mangrove Sanctuary in 2015 and a "treasure hunt" in 2017 were to increase public awareness of the importance of mangroves and to boost tourism in the area as a way of increasing incomes for local communities. *Photo: ITTO–MDA project*

The great challenge we face in conserving mangroves in Peru (and other countries) is generating tangible benefits from their multidimensional values. One requirement for doing this is to convince small producers that mangrove conservation and sustainable use is the best way to improve their quality of life. A second requirement is to persuade the private sector that mangrove conservation can help in creating private profits. And a third requirement is to persuade the public sector of the fundamental importance of investing in conservation and sustainable use—for example by providing seed capital to finance conservation processes. Bases on these three general requirements, Alternative Development Mechanisms (*Mecanismos de Desarrollo Alternos*, MDA)—an environmental non-governmental organization—is developing a strategy for the conservation and sustainable use of mangroves in Peru.

Existing situation

Mangroves in northern Peru are crucial components of the Northwest–Amotapes–Manglares Biosphere Reserve (one of five biosphere reserves in Peru).[1] This reserve, which was established in 1977, has only included mangroves since March 2016, when it was expanded (to 961 414 hectares) to include the Tumbes National Mangrove Sanctuary as a core area as well as the entire department of Tumbes and, in the department of Piura, the provinces of Sullana and Talara (SERNANP undated).

The main mangrove species in the region are red mangrove (*Rhizophora mangle*), mangle colorado (*Rhizophora harrisonii*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*) and button mangrove (*Conocarpus erectus*). These species are affected by anthropogenic activities, especially aquaculture, agricultural expansion and the dumping of solid waste from towns. Wildlife species include the Tumbes (or American) crocodile (*Crocodylus acutus*), a species endemic to the neotropics; perico cachetigre (grey-cheeked parakeet) (*Brotogeris pyrrhopterus*), which is close to extinction; and perrito conchero (crab-eating raccoon) (*Procyon cancrivorus*).

About 700 000 people live in the biosphere reserve (INEI 2015). Primary economic activities include the harvesting of crustaceans and molluscs from marine–coastal ecosystems, fishing and agriculture. In addition, there are oil extraction platforms and refineries and plants for processing and packing aquacultural and agroindustry products.

The Tumbes National Mangrove Sanctuary (now part of the biosphere reserve, as mentioned above) was created in 1988[2]; in 1997, it was recognized as a wetland site of international importance under the Ramsar Convention. This mangrove ecosystem provides local people with important resources and the tourism sector with recreation-related ecosystem services. Two towns close to the sanctuary, Puerto Pizarro and El Bendito, each with a population of about 6000 people (INEI 2015), have direct relationships with the mangroves. Other mangrove forests outside the sanctuary also need conservation strategies.

The northern mangrove corridor is a unique ecosystem in Peru and therefore warrants conservation; moreover, it provides ecosystem services for around 130 000 inhabitants[3] in the coastal towns of Piura (Vice and Vichayal districts) and Tumbes (Tumbes and Zarumilla provinces) (INEI 2015),

1 Unless otherwise indicated, the source of information in this section is SERNANP (2017).

2 Government of Peru supreme decree 018-88-AG.

3 Population of the districts of Tumbes, Zarumilla, Vice and Vichayal.

Ground work: A local man plants mangrove propagules in a degraded mangrove area in La Chepa, Tumbes, Peru. *Photo: ITTO–MDA project*

and many small and medium-sized shrimp enterprises depend on them. Nevertheless, the northern mangroves face the following problems:

- a low capacity—especially in local governments—to manage mangroves for their sustainable use and conservation;
- a lack of financial strategies to support conservation activities; and
- ecosystem fragmentation.

The National Service of State Protected Natural Areas (*Servicio Nacional de Áreas Naturales Protegidas por el Estado*, SERNANP)—the institution in Peru responsible for managing natural protected areas—helps maintain the Tumbes National Mangrove Sanctuary, but mangroves outside the sanctuary are yet to be placed in any conservation category. Some have become highly degraded due to pressures from local people and industries.

The project

Given the perilous state of the mangrove resource in northern Peru, MDA, in partnership with the National Forest Service (*Servicio Nacional Forestal y de Fauna Silvestre*) and SERNANP and with financial support from ITTO, started a project[4] in 2015 to improve the conservation of mangroves in northern Peru. The objective was to create a mangrove corridor that was adequately conserved, sustainable and supported by a financial strategy. The first stage of the project ended in August 2016 (the second stage started in April 2017 and will end in November 2017). The project has three main outputs: 1) the provision of legal assistance to ensure that subnational and local governments can make use of their competencies for mangrove conservation; 2) efforts to improve mangrove management and conservation; and 3) the development of a draft financial strategy to guarantee the sustainability of conservation policies.

Outcomes

To date, the project has achieved the following:

- The enlargement of the Northwest Biosphere Reserve (from 231 402 hectares to 961 414 hectares) in 2016 included the Tumbes National Mangrove Sanctuary, thanks to the support of the ITTO–MDA project.
- Three new mangrove protected areas have been created in collaboration with local governments and civil society, with a total area of 3804 hectares (see Table 1).
- Local environmental policies have been updated in five governments, in which mangrove conservation has been prioritized.

More than 50 families have been trained in the sustainable use of mangroves, and more than US$160 000 of public resources has been committed to support smallholder value chains (Table 2).

Promoting tourism in mangroves

With the purpose of promoting sustainable tourism in the Tumbes National Mangrove Sanctuary, the project promoted the first canoeing competition through the protected area in 2015. In 2017, it contributed to the "Búsqueda del Tesoro" ("treasure hunt") event organized by SERNANP and the Tumbes Regional Tourism Directorate. With the motto "Discover the magic of nature in the Tumbes National Mangrove Sanctuary", the treasure hunt, which was open to people of all ages, permitted travel by canoe along mangrove channels in the sanctuary to find three points and perform a series of "challenges" related to activities aimed at the restoration, conservation and sustainable use of mangroves, such as planting mangrove seeds, collecting trash (plastic bottles) and extracting black shells (*Anadara tuberculosa*).

The treasure hunt helped in educating people about mangroves and the importance of their conservation and sustainable use. The idea is to establish an annual contest to engage not only local people but also national and international tourists, thereby creating a tourism destination linked to mangrove ecosystems.

4 "Strengthening mangrove ecosystem conservation in the biosphere reserve of northwestern Peru" [PD 601/11 Rev.3 (F)].

Table 1: New conservation environmental areas in Piura and Tumbes

Name of conservation environmental area	Area (ha)	Creation law	Department
Mangroves of Estero La Chepa-Corrales	313.54	Ordenanza Municipal N° 004-2016-MDC-CM	Tumbes
Mangroves of Chulliyache	1595.38	Ordenanza Municipal N° 06-2016-MPS/A	Piura
Mangroves of Delta del Río Tumbes-Bahía Puerto Pizarro	1895.24	In process	Tumbes
Total	**3804.16**		

Ensuring strategy sustainability

A major challenge is to develop and implement a financial strategy that builds on the initial measures taken under the project and ensures their long-term viability. Mangrove conservation and production can be complementary when production systems respect ecological limits. To put such a complementary approach into practice, the following questions need to be addressed:

- What measures can be put in place to ensure that small-scale shrimp producers do not overharvest what is possibly their only means of subsistence?
- How can local-government decision-making best be influenced to bring sustainable economic benefits to local communities and avoid the authorization of industrial facilities that could cause mangrove loss or degradation?
- Who pays for mangrove conservation if everyone sees the ecosystem as a resource to be exploited and not a natural asset to be used sustainably?
- Who will give money for conservation in a region where everyone is so poor?

The efficient, productive use of mangroves is a means of increasing the value of mangroves. When local people are able to use their resources to improve their quality of life and local governments can increase their financial capacity through such productive uses, they become willing actors in support of conservation. The economic use of mangroves will also help finance the strict protection of core areas.

We are aware, however, that thinking only about economic efficiency and increasing production can have perverse effects and cause more destruction. For example, contrary to desired outcomes, an increase in profitability could increase pressure to deforest mangrove areas or overexploit them. That is why it is necessary to think of production and protection as a package—that is, a bundle of measures carried out through an interinstitutional, multidisciplinary approach (King et al. 2016). Such an approach would:

- use explicit strategies to increase the productivity of small and medium-sized collectors of shrimps, black shells and fish to reduce pressure in the wider mangrove area;
- increase the environmental performance of local government (e.g. by building capacities in monitoring, control, zoning and territorial planning); and
- identify instruments and channels for allocating resources from the public and private sectors to conservation actors.

All in the same boat: Representatives of local authorities, SERNANP, local communities and the ITTO–MDA project inspect a mangrove area as part of building an alliance for the sustainable use of the resource. *Photo: ITTO–MDA project*

Making a stand: These mangrove seedlings were planted as part of restoration efforts in the Estero La Chepa–Corrales Mangrove Conservation Area. *Photo: ITTO–MDA project*

In the case of the northern mangrove corridor, it is possible to work along the following lines:

- **Increase ecosystem productivity through biotechnologies and other technical assistance in sustainable-use areas:** the project has developed a partnership with a local research institute called Inca Biotec that is developing new techniques for increasing metabolism in commercial shrimp species, improving their genetics, and preventing diseases in cultivated shrimps. These technologies are being shared and tested with small producers, who can use them to increase profitability and their livelihoods.
- **Engage with medium-sized and large companies to invest in research and development, especially into the genetic resources of crustaceans and molluscs:** research and development is not cheap and it is important, therefore, to obtain the participation of companies with sufficient financial means. Are they willing to pay for such research and development? Some companies have damaged mangroves in the past, and such damage should be compensated, especially in a commercial context in which consumers (e.g. in export markets) are increasingly concerned about responsible consumption. Public regulations are also becoming stricter, requiring the mitigation of (or compensation for) damage caused by industrial activities. Companies will act when they perceive that engaging in conservation will generate value, increase trade or reduce reputational risks. The objective is to establish mangrove areas for the *in situ* conservation of genetic resources for related industries.
- **Encourage public investment in seed capital to build capacities among local producers committed to conservation:** as noted above, thinking only about economic aspects can be harmful for mangroves. We need a public sector that is active and committed and which has the capacity to develop and implement appropriate policies. Typically, local governments are weak and have only scarce resources, and it is essential that any available funds are spent efficiently and focus on key transformational activities. For example, new technologies can be deployed to delimit and zone mangrove areas. Another type of investment is to build capabilities for monitoring and regulating core mangrove areas. A third investment type is to support local enterprises by providing facilitative public goods (e.g. local roads and assistance to enterprises whose activities are compatible with conservation). A final form of public investment is to build conservation infrastructure and generate capacities among local producers to kick-start transformational processes.

The approach outlined here requires alliances between communities, the public sector and the private sector with the common goal of mangrove conservation and sustainable use. Such alliances can determine appropriate operational measures, facilitate them and, above all, support them financially.

Table 2: Public funds committed to supporting smallholder value chains using mangrove resources

Project	Beneficiaries	Source	Amount (Peruvian soles/*US$**)	Situation	Support provided by ITTO–MDA project
Strengthening tourism activities in the Estero La Chepa–Corrales–Tumbes mangroves	Ecotourism, Fishing and Collectors of Marine Products Association of La Chepa (AEPEPH)	Procompite**; Tumbes province, 2016	38 872/*12 250*	Approved	Technical assistance for project formulation
Improving ecotourism in the mangroves of Puerto Pizarro Bay, Los Tumbes, Peru	Puerto Pizarro Tourism Board	Procompite**; Tumbes province, 2016	42 083/*13 262*	Approved	Technical assistance for project formulation
Improving and equipping rural ecotourism in the community of Rica Playa–San Jacinto, Los Tumbes	Rica Playa Tours Ecotourism Association	Procompite**; Tumbes province, 2016	202 641/*63 862*	Approved	Technical assistance for project formulation
Improving the production, post-production and marketing of limes in the La Capitana Rural Association, district of de San Jacinto, Los Tumbes	La Capitana Rural Association	Proyectos de Servicios de Extensión Agraria (PNIA), 2017	224 100/*70 625*	Under assessment	Technical assistance for project formulation
Total			**507 696/*160 000***		

Notes: * Exchange rate: 1 US dollar = 3.1731 soles. ** Procompite (procompite.socodevi.org) is a competitive fund for local governments; here, the local government awarded the funds is listed, along with the year it obtained the funds.

Conclusion

There will be no conservation if local people do not obtain benefits from it. Mangrove conservation, therefore, needs to be associated with the social and economic development of communities that depend on these highly productive but fragile ecosystems. In addition, ensuring sustainable mangrove management requires strategies that are developed and implemented through true participatory approaches involving all actors with a stake in the mangroves.

The ITTO–MDA project identified, as a basic step, the need to expand the extent of mangrove protected areas. Another priority must be to support local and regional governments in designing policies for mangrove protection and including mangroves (which are usually forgotten or undervalued) in the scope of their work. To ensure sustainability in the long term, however, the people living in or near the mangroves need mechanisms by which they can use the resource while protecting it (a production–protection approach). In that sense, efforts should be strengthened to encourage local enterprises that harvest and process molluscs and crustaceans or tap the area's tourism potential. Stronger partnerships are needed with the private sector, including on research aimed at protecting and sustainably using mangrove ecosystems in the Northwest Biosphere Reserve.

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Managing Madagascar's mangroves

More coordination and capacity building are needed to ensure the sustainable management of the country's invaluable mangrove assets

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Frontline: Local people plant mangrove propagules in a restoration effort at the Mahavavy-Kinkony Wetland Complex in Madagascar. *Photo: Asity*

Madagascar—an island 400 km to the east of Africa—has nearly 300 000 hectares of mangroves, which is 2% of the world's resource and the second-largest area of mangroves in the western Indian Ocean (Rakotobe et al. 2015).[1] Mangroves are known to play diverse economic, environmental, social and other roles, and Madagascar's mangroves, therefore, are an extremely important resource.

Malagasy people are not the only ones who enjoy the benefits of their mangroves, which sequester carbon and are therefore of value to the entire planet. In addition, mangrove-based products are sold in both local and export markets.

Madagascar's mangroves are under threat, with an estimated 20% of the resource lost since 1990 due to various pressures (Rakotobe et al. 2015). The sustainable management of the remaining mangroves is becoming a pressing issue.

The role of mangrove forests in Madagascar

Fishing is one of the main means by which Madagascar's coastal communities earn their livelihoods. Mangrove forests are the most favoured fishing zone, especially on the west coast, where 98% of Madagascar's mangroves are located. Moreover, mangroves play crucial ecological roles in the fisheries sector: for example, shrimps—a major source of foreign currency in Madagascar—lay their eggs in mangrove forests, which are also sanctuaries for crabs and produce various other fish products. Depending on the financial means of operators, fishing is done at varying scales in mangroves, from subsistence, through small-scale commercial operations, to an industrial scale.

Mangrove timber is also in high demand. Coastal communities use mangrove timber as fuel and for processing fish products.

In some areas where forests are disappearing on land, mangrove forests offer an affordable and easily accessible energy source. Mangrove timber is processed into charcoal, which is used as fuel by urban citizens.

The mangrove species *Avicennia marina* has high calorific potential and is in high demand in the Boeny region, where lime is produced. Coastal communities also use mangrove timber for house construction because of its durability. Coastal-city dwellers favour the use of mangrove timber as pillars in their buildings.

Mangrove tree products are used in traditional medicine for their therapeutic properties in treating various disorders, such as stomach ache. Finally, mangrove forests play significant roles as habitat for many fauna and flora species, including species endemic to Madagascar.

Pressures

Although mangrove forests are widely recognized as important resources, they are vulnerable to various pressures. Commercial harvesting is not permitted in mangrove forests but, because mangrove charcoal and timber are in high demand, there is significant illegal harvesting and sale of these products. Especially in areas where land forests are disappearing, people have no choice but to harvest mangrove forest timber.

The unregulated use and overuse of mangrove forests results in deforestation and degradation. In addition to uncontrolled use, mangroves are affected by activities such as upstream deforestation and associated erosion, and urban pollution, both of which can lead to sedimentation and the consequent degradation of mangrove forests. Various other upstream activities can also cause hydrological changes (Jeannoda & Roger 2008).

1 Rakotobe et al. (2015) provide original sources for the data presented here.

Rich and under threat: Flamingos graze in the du Menabe mangrove wetland. Madagascar's mangrove resources are host to diverse fauna and flora, but they are threatened by overuse. *Photo: Vololoniaina Raharinomenjanahary*

Policy and governance

The Ministry of Environment, Ecology and Forests (*Ministère de l'Environnement, de l'Écologie et des Forêts*, MEEF) is responsible for the management of mangrove timber, but fishery and marine resources fall under the supervision of the Ministry of Fisheries Resources and Fisheries (*Ministère des Ressources Halieutiques et de la Pêche*, MRHP) and the State Secretariat in Charge of the Sea, respectively. The commercial use of mangrove forest timber and its byproducts (such as tannins) was regulated by the Forestry Administration and subject to the issuance of harvesting licences until 2000, when harvesting licences—including under user rights—were suspended in an effort to prevent illegal operation sand overharvesting. The measure has been unsuccessful, however: the government is unable to prevent illegal use because of a lack of enforcement capacity. As a result, mangrove timber continues to be harvested and sold in Madagascar.

The National Commission for the Integrated Management of Mangroves was established in 2015 with the aim of increasing the coordination of mangrove management. The Commission falls under the authority of both MEEF and the MRHP, and it aims to develop a strategy document for managing mangrove forests. The Commission includes members from various sectors with stakes in mangroves.

Stakeholders involved in mangrove management

A range of stakeholders is involved in coastal areas, such as the grassroots communities that manage mangrove forests under Madagascar's GELOSE (*gestion locale sécurisée*, or "secure local management") programme for transferring the management of natural resources to the local level. Local community groups also participate in mangrove management but lack any real legal basis.

Managers in charge of protected areas play roles in managing mangrove forests, especially in protected areas.

International non-governmental environmental organizations provide support in various areas, such as climate-change adaptation; the restoration of degraded mangrove forests; the development of alternative livelihoods in mangroves; the promotion of sustainable funding mechanisms for mangrove management; and the implementation of sustainable management. In some areas, local stakeholders implement activities similar to those of international non-governmental organizations, either on their own or with the support of such organizations.

Issues

Madagascar has an established legal framework, and the various mangrove forest stakeholders are doing their utmost to fulfil their duties. Numerous challenges remain in implementing the legal framework, however, due to a lack of means in the administration in charge of monitoring and control.

Grassroots communities are often unable to manage mangroves effectively because they have only weak management capacity, and government support is inadequate because its own capacity is lacking. The capacity-building and management efforts of other stakeholders are scattered, and there is a lack of coordination among the various actors.

MEEF and the MRHP are working to achieve a consensus on the measures that should be adopted for the efficient management of mangrove resources. On the one hand, MEEF wants new regulations on mangrove timber harvesting and marketing with a view to reducing the risk of uncontrolled and illegal use. On the other hand, the MRHP wants to prevent any degradation that could have detrimental effects on fishery product development.

The divergent views of the two ministries stem from a lack of information and understanding: it is difficult to make effective decisions on the basis of existing knowledge. Policymakers lack information, for example, on the potential land area to be restored; the lifecycles of species most in demand; the disruptions that harvesting could cause; and the industries that could be developed based on mangrove resources.

Future prospects

Actions taken in mangrove forests should promote development while ensuring that ecological integrity is unaffected. They should take into account the multisectoral nature of mangrove forests, and all stakeholders should be involved in and ensure the coordination of their activities. The National Commission for the Integrated Management of Mangroves can therefore play an important role.

Support should be provided to grassroots communities living close to the resource, who are best placed to operationalize activities in the field. Local initiatives should be encouraged, and successful projects now under implementation should be extended to other communities.

Priority activities should include:

- conducting surveys to identify areas for mangrove forest restoration or reforestation;
- developing management plans in consultation with local communities;
- developing mangrove forest restoration/reforestation activities;
- developing alternative or improved income-generating activities aimed at alleviating pressure caused by unsustainable activities (e.g. providing training in improved charcoal production techniques);
- promoting the planting of fast-growing species inland of mangroves; and
- conducting surveys aimed at ensuring the sustainable management and valorization of mangrove forests.

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Mangrove restoration in Mexico

Banning production has been counterproductive, and a return to sustainable use is required

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Go with the flow: The opening of canals in degraded mangrove areas to improve water flows is a successful restoration technique, with economic benefits for local communities. *Photo: Claudia Agraz Hernández*

Mexico has the world's fourth-largest mangrove forest estate, although the total area decreased from 856 000 hectares in 1980 to 776 000 hectares in 2015 (Valderrama 2017). The environmental legislation that protects mangrove forests in Mexico is robust. It has had effects contrary to its protection goals, however, because the banning and excessive regulation of activities in mangroves have led to land-use change and overexploitation and, consequently, to mangrove degradation and loss.

Efforts are underway in Mexico to combat the myth that mangroves should not be touched. The government recognizes that mangrove species are not at risk: rather, it is mangrove ecosystems as a whole that are under threat, and their degradation affects other ecosystems and economic sectors.

In recent years, the federal government has paid special attention to restoring degraded mangrove forests by promoting and financing the implementation of projects using an ecosystem approach. These projects have successfully tested a restoration model that includes restoring water flows and drainage and—when various parameters indicate that ecosystem health has improved—reforesting sites by either direct planting or the dispersal of plant propagules. The National Forestry Commission (*Comisión Nacional Forestal*, CONAFOR) has now implemented restoration activities on more than 7000 hectares of mangrove forests, testing its restoration methodology and demonstrating that degraded mangroves and former mangrove sites can be restored.

Characteristics of major mangrove areas in Mexico

There are six mangrove tree species in Mexico, but only four (*Rhizophora mangle*—red mangrove, *Avicennia germinans*—black mangrove, *Laguncularia racemosa*—white mangrove, and *Conocarpus erectus*—button mangrove) are distributed widely. The geological and tidal conditions in which these species develop vary considerably, affecting both tree height and biomass production. There are four clearly defined mangrove areas in Mexico with differing hydrological conditions:

1) The Yucatan Peninsula, which is a limestone platform with a karst landscape and groundwater hydrology that favours the growth of short mangroves.
2) The Gulf of Mexico, with soils derived from volcanic ash and large rivers that provide a constant flow of freshwater and generate tall, well-developed mangroves.
3) The Pacific coast, with an orography made up of large cliffs and granite rocks, where mangroves are found only in small bays, with the exception of national wetlands (*marismas nacionales*) in the region, which occur on a large plain. The supply of freshwater is limited and the marked dry season causes a seasonal increase in soil salinity.
4) Mangroves in dry areas, predominantly featuring *Conocarpus erectus*, where salinity is high due to the limited supply of freshwater, resulting in mangrove forests with low biomass productivity.

On the edge: An aerial view of a degraded mangrove area at Sinaloa, Mexico. *Photo: Ernesto Beltrán García*

Plain drains: Canals have been installed in this degraded mangrove area to improve water flows, thereby assisting the restoration process. *Photo: Ernesto Beltrán García*

Key problems

The key factors resulting in the degradation and loss of Mexico's mangrove forests are those that modify the hydrodynamics of sites and change physical and chemical environmental parameters. They include alterations to the environment caused both by human interventions such as the construction of infrastructure (e.g. dams, roads, bridges, tunnels and development projects) and by natural phenomena such as hurricanes. Some factors, such as pests, diseases and forest fires, have localized impacts in both space and time, and mangrove forests have the ability to recover quickly from these.

The causes of mangrove degradation differ by area. In the Yucatan Peninsula, the main factors are the occurrence of hydrometeorological phenomena affecting groundwater hydrology and tourism development; on the Pacific coast, the main problems relate to the construction of infrastructure such as dams and roads, which affect the supply of freshwater; and, in the Gulf of Mexico, the main problems are grazing and changing the land use to livestock raising.

Mangrove degradation and loss can cause major changes in site hydrodynamics and soil quality. In most studies on mangroves, soil assessments are "implemented" by citing another source, which is normally based on very small-scale field sampling and does not provide an adequate description or mapping of soils. Soil descriptions focus on the dominant landscape characteristics, classifying mangrove soils as solonetz, solonchaks or gleysols based on FAO's soil classification system. However, the first two classifications only make reference to the sodium and salt contents of the soil, and the third refers only to the anoxic characteristics of mangrove soils.

Based on the characteristics of the soil profile of a healthy mangrove forest, soils should sometimes be classified as histosols because the great accumulation of organic matter and the low quantity of oxygen resulting from flooding favour the formation of organic horizons. This, in turn, improves soil porosity, water permeability and aeration and also increases or accelerates the horizontal flow of water through tidal effects, thus ensuring the development of healthy mangrove forests. Moreno (2017) found that freshwater wetlands in the central area of Veracruz, Mexico, store more water and carbon than mangroves because they are permanently flooded, which reduces carbon oxidation.

Mangrove restoration in Mexico

CONAFOR has financed mangrove rehabilitation and restoration projects through a quota system that provides compensation for reverting the land use back to forests. This scheme has facilitated the launch of a restoration process involving the rehabilitation of site hydrodynamics and vegetation succession. The participation of mangrove restoration specialists has been decisive in the implementation of these projects and, for the first time, restoration projects of substantial size (more than 100 hectares) have been executed successfully, improving habitats in the areas where they have been implemented.

An important outcome of these projects is a change in the belief that mangrove ecosystems are untouchable. The projects have demonstrated that mangrove restoration is possible and that, in many cases, it is also possible to implement management programmes that allow both mangrove use and their conservation. This contrasts with the previous view that an environmental compensation scheme would not be feasible in mangrove forests (Flores 2007).

The projects have tested various restoration techniques, but it has been observed that the construction of canals to improve water flows—which could be freshwater, saltwater, or the confluence of the two—is an important technique for rehabilitating degraded mangroves. R.L. Moroyoqui (personal communication, 2017) showed, for example, that 2-metre-wide canals can reduce salinity for up to four metres on either bank, allowing the establishment of propagules alongside the canals.

Table 1: Mangrove area restored, and cost of restoration, 2013–2017

Year	Area (ha)	Amount (US$)
2013	603	628 000
2014	963	1 350 000
2015	140	372 000
2016	3808	7 420 000
2017	1555	3 610 000
Total	**7069**	**13 400 000**

Note: The dollar value was calculated at an exchange rate of 17.75 pesos to the US dollar. Dollar values have been rounded to three significant figures.

Various reforestation schemes have also been tested. The production of seedlings in nurseries—and the subsequent transport of the seedlings by small boat—adds to the cost of restoration. In producing seedlings it is important to subject the plants to brackish water tension and water stress so they can adapt to site conditions before outplanting. Although reforestation with nursery-produced seedlings has proved successful, the most cost-effective and efficient reforestation techniques are the direct-planting of propagules for red mangroves; the aerial dispersion of propagules for black and white mangroves; and the transplanting of seedlings from highly stocked regeneration sites to other sites.

Outcomes

In the period 2013–2017, CONAFOR financed the implementation of mangrove restoration projects covering about 7000 hectares (Table 1). The federal administration has given high priority to mangrove forests, focusing on taking stock of existing mangroves and restoring degraded mangroves. Of particular note is that, in addition to generating temporary employment and economic benefits for local communities, the projects have enabled the development of shrimp farms in the constructed canals, thus increasing shrimp production by 100% compared with the production achieved without canals, boosting the incomes of mangrove-dwelling communities.

Outlook and challenges

It is encouraging that the rehabilitation and restoration of degraded mangroves is possible; knowledge and guidelines exist to facilitate the conservation and development of mangrove ecosystems, which have such high environmental value. The Mexican government's policy is to support the restoration of mangroves and other wetlands, and there is a strong belief that the area of mangroves is now increasing nationally.

Bankable technique: The installation of canals can reduce salinity on banks and enable propagules to establish, such as these *Rhizophora* seedlings established by direct sowing. *Photo: Jacinto Samuel García Carreón/CONAFOR*

The challenge is to ensure that local communities can earn incomes from the use, management and appropriate harvesting of mangrove forests. Those responsible for enforcing mangrove-related environmental laws must realize that, with good ecosystem management and sustainable use, it is not only possible to ensure the conservation of mangroves but also to improve their quality and coverage. In the long run, this will generate more habitat for species and provide a wider range of ecosystem services.

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Cameroon's mangrove women

Women's groups are restoring and protecting their mangroves, including through an ITTO project, but they need continued support

by Cécile Ndjebet

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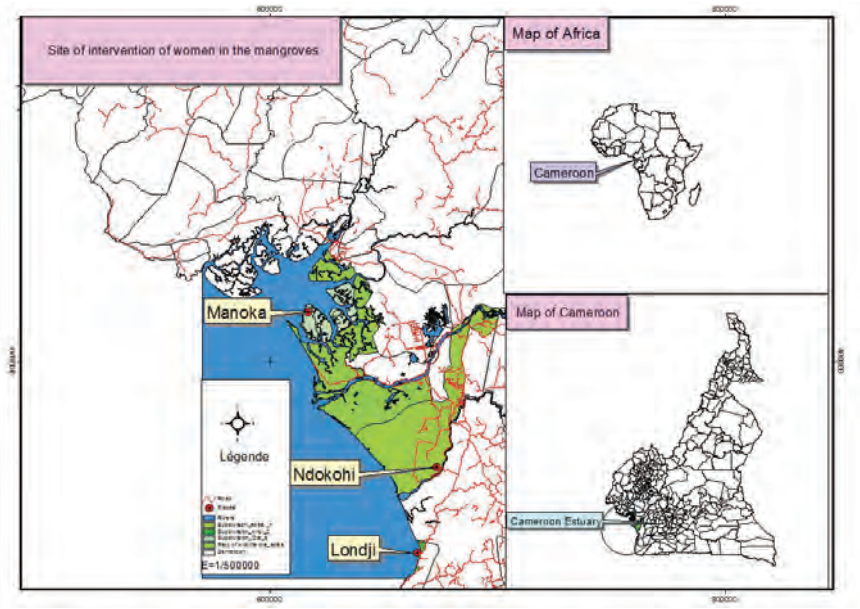
Mangrove restorers: A team from Londji village pose for a photo before heading to a mangrove restoration area to plant propagules. *Photo: Cameroon Ecology*

Cameroon's estimated 233 000 hectares of mangroves—the sixth-largest mangrove estate in Africa (UNEP 2007)—are among the most productive in the Gulf of Guinea. They are concentrated in three main areas: 1) Rio Del Rey, with an area of 128 900 hectares; 2) the Cameroon estuary, with an area of 102 250 hectares; and 3) Rio Ntem, with an area of 1 570 hectares (MINFOF 2014; Figure 1).

Cameroon's mangroves have exceptional biodiversity, perform multiple biological, economic, social and ecological functions, and contribute to the development of coastal communities. They are subject to strong pressures, however, and the resultant progressive degradation threatens their biological richness. Cameroon lost 20–25% of its mangrove forest estate between 1985 and 2014 (MINFOF 2014). Cameroonian mangroves are now being lost at an estimated 2.5% per year (FAO 2011), and degradation is ongoing at varying levels of intensity.

Figure 1: Cameroon's mangroves, showing the location of the three communities involved in ITTO project PD 492/07 Rev.3 (F)



The importance of mangroves

The Rio Del Rey mangrove area, in the Southwest Region, extends across the mouths of the Akwayafe, Ndian and Meme rivers. It is the second-largest expanse of mangroves in West Africa and one of the biologically richest in the world. The Cameroon estuary is composed of five administrative departments in two regions (Littoral and Southwest) and extends from the mouth of the Sanaga to Cape Bimbia, encompassing the mouths of the great rivers Dibamba, Moungo, Nyong, Nkam, Sanaga and Wouri. The Rio Ntem encompasses the mouths of the Lokoundjé, Nyong and Ntem rivers in the Southern Region.

Six main mangroves species or species groups occur in Cameroon: *Rhizophora racemosa* (red mangrove)—the dominant species (90%); *Rhizophora harrisonii*; *Rhizophora mangle*; *Avicennia germinans*; *Avicennia* spp.; and *Laguncularia* spp. (UNEP 2007).

There is a diversity of marine species, such as fish, crustaceans, oysters, the African manatee, crocodiles and turtles. According to Ayissi and Nanji (2007), 54 species of fish—14 of which are of great commercial importance—have been identified in Cameroon's mangroves in 39 genera and 26 families. Important families include Ariidae, Clupeidae and Sciaenidae (Table 1).

Table 2 lists some of the wildlife species occurring in or on the fringes of mangroves; other species include elephants (*Loxondata africana cyclotis*), buffalos (*Syncerus caffer nanus*), gorillas (*Gorilla gorilla*), chimpanzees (*Pan troglytes*) and drills (*Papio leucophaeus*). In addition, there is a great diversity of waterbirds and migratory birds.

Table 1: Some families and species of fish caught in Cameroon's littoral area

Family and species	Trade name	Local name(s)
1) Clupeidae		
Ethmalosa frimbriata	Bonga	Ndololo, belolo
Sardinella madereusis	Sardinelle	Bepa
Ilisha africana	Rasoir	Kanda, munyanya
2) Sciaenidae		
Pseudotolithus elongatus	Bossu	Nyendi
Pseudotolithus senegalensis	Bar	Musubo, broke marrate
Pseudotolithus typus	Bar	Musubo, broke marrate
3) Polynemidae		
Galeoides decadactylus	Petit capitaine	
Polydasis quardrfilis	Grand capitaine	
4) Pomadasys		
Pomadasys jubelini	Dorade grise	
5) Arridae		
Arius spp.	Mâchoiron	Kwakoro, yenda
6) Carangidae		
Caraux ronchers	Carange	Motondo, mutungu
Cornimus chrysirus	Carange	Motondo, mutungu

Source: CECO (2014).

Table 2: Mangrove wildlife species

Species	Scientific name	Local name (Bassa)
Crocodile	*Crocodylus niloticus*	Ngombe
Emerald tree boa	*Corallus caninus*	Mbom
Manatee	*Trichechus senegalensis*	Djaga
Antelope	*Taurotragus oryx*	Yoye
Proboscis monkey	*Macacusirus/Nasalis larvatus*	Koye
Turtle	*Pelusios gabonensis*	Kul
Nile monitor	*Varanus niloticus*	Ka'a

Source: CECO (2014).

Main drivers of mangrove degradation

In addition to natural causes of degradation, which are minimal, Cameroon's mangroves are subject to very strong human pressures that can be attributed to two phenomena: 1) anthropogenic activities carried out by all strata of people living inside and on the periphery of mangroves; and 2) the limited capacity of communities and governments to monitor areas and prevent illegal exploitation of the resource. Illegal operators are often equipped with much more sophisticated travel equipment and means than public authorities and local people. Key drivers include:

1) population growth in nearby cities, such as Douala, Edéa, Ekondo, Kribi, Tiko and Yabassi—20% of the people in these cities live in or near mangroves;
2) uncontrolled urban development in these cities;
3) the illegal exploitation of mangrove forests as a source of energy and timber—in Douala, for example, 40% of households and 70% of bakeries use mangrove wood as a source of energy, and mangrove poles comprise more than 60% of building materials (Cameroon Ecology 2013);
4) unsustainable and unregulated fishing;
5) encroachment by agro-industrial oil-palm and rubber plantations—an estimated 60 000 hectares are established in mangrove areas (Cameroon Ecology 2013);
6) oil and gas exploration and exploitation by foreign oil companies—such companies have destroyed 400 hectares of mangroves in Cameroon without compensating local communities (Cameroon Ecology 2013);

On the way back: This mangrove forest in Londji is recovering from degradation thanks to restoration work by local women. *Photo: Cameroon Ecology*

Prime location: Mangrove seedlings raised in a community nursery await planting as part of local mangrove restoration efforts. *Photo: Cameroon Ecology*

7) chemical and organic pollution of mangrove ecosystems by industries—in the city of Douala, for example, 11 types of industry dump waste along the coast (CECO 2104);
8) the lack of effective control of illegal activities in mangrove ecosystems—the government staff is insufficient and lacks adequate equipment to play this role; and
9) the lack of an appropriate legal and institutional framework for mangrove ecosystems.

Women's response to mangrove degradation

The communities of Londji, Manoka and Ndokohi are all in coastal areas of Cameroon: Londji is in the Rio Ntem mangrove system and Manoka and Ndokohi are in the Cameroon estuary (see Figure 1). Combined, the three communities encompass about 60 000 hectares of mangroves and have about 40 000 inhabitants. Women make up 58–60% of these populations.

A majority of people in the three communities depend on agriculture and fisheries, especially in mangroves, for their livelihoods. In Londji, fishing is the main activity, and fish products are both sold commercially and used for household consumption. In Ndokohi, women carry out agricultural activities in addition to fishing, the main food crops being plantain, cassava, maize and peanuts cultivated in very small fields. Manoka is an island, with some fertile areas suitable for gardening. Agricultural production there is mainly to meet household needs, and crops include pineapple and other fruits, vegetables (e.g. pepper and okra) and maize. In all three areas, women are very active in the collection and marketing of non-timber forest products, which provide both food and income.

The importance of mangroves for women

Mangroves play a vital role for local communities and especially for rural women. Women suffer more from mangrove degradation than other groups because mangroves are their means of living and their homes as well as their sources of food, income and medicine. Mangroves are spaces for women's agricultural and fishing activities: women collect wood for energy and housing and non-timber forest products for household consumption and sale in markets. Women are more involved than men in fish processing, the harvesting and use of non-timber forest products, and food-crop production. They generate substantial income through the sale of fish, oysters, non-timber forest products and (sometimes) agricultural products. It is estimated that a women's association composed of six to eight women can mobilize up to US$300 000 per year in income from fish and oyster marketing (MINFOF 2014). Women also use significant quantities of mangrove wood to dry fish and in that way can be counted among the drivers of mangrove degradation. A study carried out in the Cameroon estuary showed that at least 2500 m^3 of wood are used per day to smoke fish (MINFOF 2014).

In all three communities, women are in drastic situations because of mangrove decline. Water-borne diseases have increased among children and the elderly, mainly because of high water salinity. Floods have become more frequent, longer and higher and rainfall heavier; together with sea-level rise, women fear a tsunami in coming years if strong actions are not taken. Fish production has decreased drastically, and high-value fish such as grand capitaine, bar, bossu, rasoir and dorade grise are disappearing.

Women find it very difficult to earn a living without mangroves. With the heavy rains, agricultural production is often washed away by erosion; soil quality is declining, which reduces agricultural production; and many food products rot before maturing, leaving people without food. Also, temperatures are increasing; women are reporting extreme climatic conditions.

Table 3: Examples of local women's associations involved in mangrove restoration in the Cameroon estuary and Rio Ntem

Name of organization	Year of creation	No. of women	No. of men	Total members	Places of intervention/districts
Plateforme mangrove du Rio Ntem	2014	12	13	25	
Plateforme mangrove de l'Estuaire du Cameroun	2013	15	17	32	Douala 1*, Douala 2, Douala 3, Douala 4, Douala 5, Douala 6
Plateforme mangrove du Rio Del Rey	2014	10	16	26	Ekondo titi, Mundemba, Idabato, Issangele, Kombo Itindi, Bamusso, Kombo Abedimo
Coopérative pour le Développement de Londji	2014	18	12	30	Kribi 2
Association La mangrove de Manoka	2015	11	13	24	Douala 6
Association Mintin N'zangwa	2015	8	11	19	Doula 3
GIC PAFCAM	2007	9	7	16	Douala 3
GIC le Progrès de Ndokohi	2010	14	0	14	Edéa 1
GIC PPRM	2012	9	8	17	Kribi 2, Lokoundjé
Grand total		**106**	**97**	**203**	

* The number after some municipality names refers to the district number within the municipality.

Women at the forefront of mangrove restoration

To safeguard their lives and families, and to protect the environment, women in the three communities have decided to become directly and strongly involved in mangrove restoration and rehabilitation. More than 25 women's groups and associations have become engaged in mangrove restoration activities in the Cameroon estuary and Rio Ntem (Table 3 lists some of these), with technical and financial support from the Government of Cameroon through the Ministry of Environment, Nature Protection and Sustainable Development and the Ministry of Forests and Wildlife, as well as from ITTO[1], the Global Environment Facility and FAO.

The results have been encouraging. The women have established ten impressive community nurseries, producing a total of 50 000 mangrove seedlings; planted 25 000 seedlings in degraded mangrove areas with a survival rate of 90%; and improved awareness of the importance of mangroves among hundreds of women and youth in various villages. To reduce pressure on mangroves, the women have also developed alternative income-generating activities, such as vegetable production and beekeeping; encouraged improved cookstoves to reduce the use of mangrove wood; and mainstreamed agroforestry practices into food cultivation.

To date, nearly 400 hectares of mangrove areas have been rehabilitated thanks to the women of Londji, Manoka and Ndokohi. The ambition of these women is to restore the entire degraded area in their communities, estimated at more than 1200 hectares. To achieve this, three key issues in mangrove rehabilitation and restoration need to be addressed: funding, tenure security and private-sector engagement. Moreover, there is a need:

- to mobilize more funding for restoration, at an average cost of US$15 000 per hectare;
- for a policy and regulatory framework that secures those mangroves that have been rehabilitated by women and other social groups and to promote sustainable mangrove management in general;
- for more support for alternative income-generating activities for the women and local communities who depend strongly on mangrove ecosystems for their livelihoods;
- to engage the private sector in mangrove restoration because their activities are among the key drivers of mangrove degradation, with negative impacts on the lives of local people, including women; and
- to address the expansion of large-scale oil-palm and rubber plantations in the mangroves.

Achieving sustainable mangrove management in Cameroon

Sustainable mangrove management will only be achieved if:

- Women are empowered with adequate financial resources to develop mangrove-friendly alternative activities as well as adequate technical capacities in relation to mangrove silviculture, rehabilitation and restoration techniques.
- The energy crisis is adequately addressed: mangrove wood is highly appreciated as a source of energy. To stop the illegal exploitation of wood from mangroves, alternative sources of energy must be developed.
- Gender is mainstreamed throughout the various processes because women's activities, needs and interests are very specific. It is important to address the sustainable management of mangroves with a gender perspective.

1 PD 492/07 Rev.3 (F) "Participatory rehabilitation and management project for mangroves and watersheds in the coastal area of the Douala/Edéa wildlife reserve".

Muddy work: Women from Londji undertake replacement planting in a restored mangrove area. *Photo: Cameroon Ecology*

- The private sector is engaged in sustainable mangrove management.
- Collective action is taken with assistance from global funding mechanisms to address the key drivers of mangrove degradation.
- The successful initiatives carried out by local women and communities are scaled up.
- Local women and communities are provided with livelihood alternatives and are directly engaged in all processes related to the sustainable management of mangroves.

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New Assistant Director of Operations appointed

ITTO is pleased to announce the appointment of Ms Sheam Satkuru to the ITTO Secretariat as Assistant Director of Operations. Ms Satkuru, a citizen of Malaysia, has a law degree and several post-graduate qualifications, including a Masters in Law. She has worked for the Malaysian Timber Council for more than 20 years and was serving as that organization's Director for London and Europe before her appointment to ITTO. Ms Satkuru specializes in international trade, with strong experience in legal and policy analysis in the timber and forest industries, communications, public relations and office management. She will assume office on 1 November 2017.

Photo: Ken Sato/ITTO

Market trends

Is this the beginning of a new era for woodflooring manufacturers in the European Union and the United States?

by Mike Adams

Compiled from various sources, including the ITTO Market Information Service

In the European Union (EU), the domestic production of woodflooring is taking market share from imports. In the United States of America (US), imported woodflooring (solid and assembled) is losing market share, creating opportunities for US manufacturers. What a difference a few years make! Until recently, any discussion of flooring markets in the EU and the US would eventually have settled on the predominance of imports from China—but, no more.

Efforts by European manufacturers to increase competitiveness through innovation in products and marketing, aided by the relative weakness of the euro, have boosted EU woodflooring exports. In the US, major domestic manufacturers have expanded flooring capacity, and new producers have emerged. Woodflooring manufacturers should watch out, however: wood–polymer composites (WPCs) and rigid-core luxury vinyl flooring (LVT; in this context, "luxury" equates to "looks like wood") have appeal for consumers.

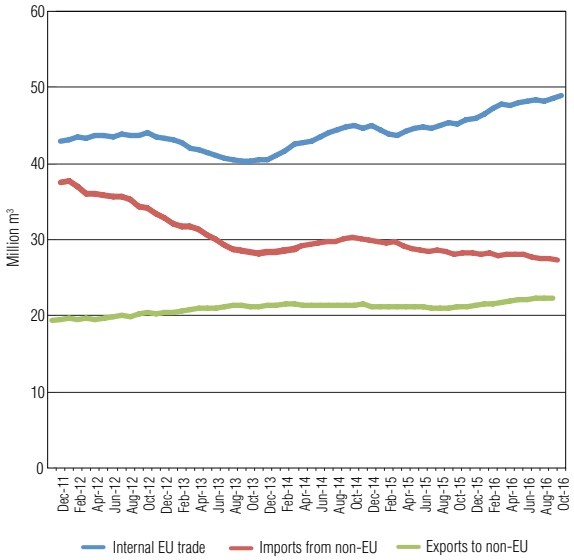
European Union

Rapidly growing internal trade in mostly temperate woodflooring

For the first time since the global financial crisis in 2008/2009, demand in the EU for hardwood flooring gained momentum in 2016, and this has continued into 2017. Trade patterns have changed, however, with domestic production taking market share from imports.

Figure 1 shows that internal EU trade in woodflooring has been rising since December 2013. This is due partly to the increasing consumption of woodflooring products manufactured in the EU and partly to the increasing role of manufacturing in lower-cost eastern European countries, which have been shipping more woodflooring to EU countries.

Figure 1: Imports, exports and internal trade in woodflooring, European Union, December 2011–September 2016



Note: Includes assembled and unassembled woodflooring panels.
Source: Forest Industries Intelligence Ltd analysis of Eurostat data for ITTO.

Efforts by European manufacturers to increase their competitiveness through innovation in products and marketing, aided by the relative weakness of the euro, contributed to rising EU exports of woodflooring products in 2016.

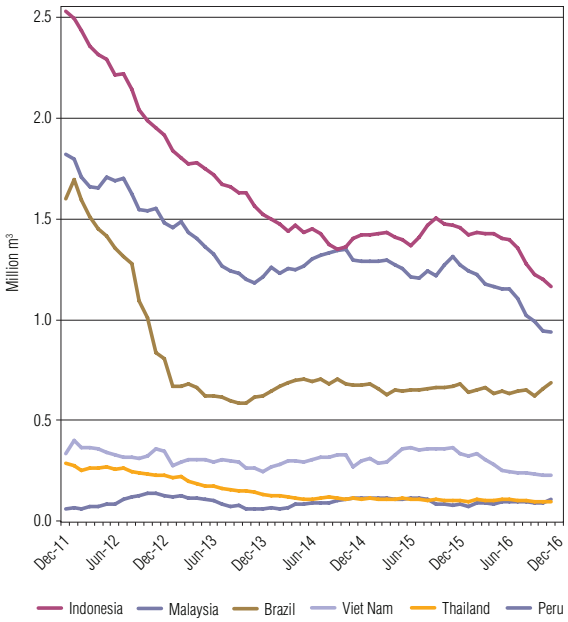
EU woodflooring imports continued to decline in 2016, due largely to falling trade with China, which dropped to its lowest level since 2005. Although China accounted for around 60% of total EU woodflooring imports in 2016, Chinese manufacturers have been losing market share to exporters from other countries. It is significant that shippers of flooring composed of temperate species have made most of the gains in the EU woodflooring market.

Solid oak flooring remains very popular, but competition is growing from laminates and non-wood materials. Ash was the second most widely used species for facing wooden floors in 2016, followed by beech and walnut. The advance of technology in the production of wood-look-alike products is a big problem for woodflooring manufacturers—consumers are often unable to differentiate woodflooring from non-wood alternatives.

EU imports of tropical woodflooring continue to decline

EU woodflooring imports from tropical countries have been declining for several years (Figure 2). The EU imported 1.16 million m^2 of woodflooring from Indonesia in the 12 months to November 2016, down from 1.45 million m^2 in 2015. Imports from Malaysia fell from 1.31 million m^2 in 2015 to 0.94 million m^2 in 2016 (Figure 2).

Figure 2: EU woodflooring import volumes from tropical countries, December 2011 to December 2016, 12-month rolling total



Note: Includes assembled and unassembled woodflooring panels.
Source: Forest Industries Intelligence Ltd analysis of Eurostat data for ITTO.

After declining by 18% in 2016, EU imports of woodflooring from the tropics fell by a further 7% in the first quarter of 2017, to 9900 tonnes. Although imports from Brazil increased by 35% in the three-month period, to 3300 tonnes, imports declined from all other significant tropical supply countries, including Malaysia (-9%, to 2300 tonnes), Indonesia (-32%, to 2000 tonnes), Viet Nam (-23%, to 700 tonnes) and Peru (-2%, to 600 tonnes).

The continuing decline in the EU's imports of tropical woodflooring in 2017 is part of a wider trend in which European manufacturers are capturing more market share. EU imports of woodflooring from China—its largest supplier outside Europe—are also declining. After falling by 12% in 2016, to 341 000 tonnes, EU woodflooring imports from China dropped by a further 12%, year-on-year, in the opening quarter of 2017 (to 82 000 tonnes).

Trade data reveal the continuing rise in internal EU trade, with western European distributors buying more woodflooring from manufacturers in eastern Europe. EU exports of woodflooring have also been rising, although the pace of growth is slowing with declining opportunities for market expansion in the Russian Federation and the Middle East. Taken together, these trends indicate a very challenging market environment for external suppliers of woodflooring to the EU.

The situation in Indonesia is intriguing, however. The country became more firmly established as the leading tropical woodflooring supply country into the EU in 2016. The dollar value of the EU's tropical wood imports (all products) from Indonesia has been static since the start of 2016, but value has been declining for most other leading supply countries.

This provides context for those concerned about the apparent lack of market growth for Indonesian wood products in the EU since the issuance of the first FLEGT[1] licences there in November 2016. Although total wood product imports from Indonesia are not rising, they are stable in a market that is generally declining, and Indonesia is increasing market share among tropical supply countries. What makes this remarkable is that the 40% part of the Indonesian trade (or 80%, or 20%, or 30%, depending on whom you read) comprising illegal timber has been eliminated since November 2016 (with the issuance of FLEGT licences). Other international markets—or the Indonesian domestic market—must be experiencing drastically reduced supply.

International flooring show highlights competitiveness

The intense and rising competitiveness of the European flooring sector was immediately apparent at the DOMOTEX 2017 fair, a leading trade fair for floor coverings held in Germany in January 2017.

As in previous years, the woodflooring on display at DOMOTEX 2017 was oriented heavily towards oak, which was presented in a wide variety of colours, textures and finishes. However, some manufacturers were looking to differentiate from competitors by offering new types of wood.

Analysts believe that grey, and blends of grey and beige ("greige"), will remain the top sellers and that dark floorings will continue to be less popular with buyers. Textured surfaces are seen as the next "big thing" in woodflooring and parquet flooring, and many companies exhibited "used" and grainy patterns and finishes designed to look brushed or as if made from reclaimed materials.

Vintage-look materials remain in fashion, along with knotholes, and this is true for both natural and laminated woodflooring, the latter now exploiting increasingly sophisticated digital printing technology.

1 FLEGT = Forest Law Enforcement, Governance and Trade.

New EU ecolabel criteria for woodflooring

On 25 January 2017, the EU published Decision (EU) 2017/176 in the official *EU Journal* establishing EU Ecolabel criteria for wood-, cork- and bamboo-based floor coverings. The new criteria require that any virgin wood, cork, bamboo or rattan in finished products originates in certified sustainably managed forests.

In addition, the Ecolabel criteria include a set of measures designed to ensure low energy consumption in manufacturing, drastically limit the content of volatile organic compounds, and ban the use of harmful chemicals for flame-retardant, binding and finishing purposes.

The EU Ecolabel is a voluntary scheme, which means that producers, importers and retailers can choose to apply for the label for their products. Although it isn't mandatory, the green procurement policies of many EU authorities now recognize and may give preference to products bearing the EU Ecolabel.

A copy of Decision 2017/176 is available in all official EU languages at: http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1486024464540&uri=CELEX:32017D0176

Various innovations were on display to improve the service life of woodflooring in kitchens and bathrooms, where traditionally wood is not widely used.

Consumer environmental awareness

Sustainability is high on the agendas of consumers and hence also those of architects, builders and retailers, especially among countries in northern and western Europe that are big importers of tropical timber—such as Belgium, Denmark, France, Germany, the Netherlands and the UK. As part of this, the EU recently established Ecolabel criteria for wood-, cork- and bamboo-based floor coverings (see box).

EU importers know that consumers are well aware of the importance of climate change, deforestation, illegal logging and sustainable forestry and that transparency in the timber supply chain is a prerequisite for successful marketing.

The use of tropical timber in products such as flooring depends on consumer preferences and fashion trends, and these evolve and vary between EU countries. For example, tropical timber is not considered fashionable in eastern Europe and is only used in limited applications. Interest in tropical timber in the Baltic countries does not go beyond importing it for further processing and then exporting it to other countries. Scandinavia is moving away from tropical timber towards native species that fit in better with the present-day fashion there.

Many markets such as flooring, where tropical timber was used until recently for its aesthetic appeal, are now moving towards lighter colours—hence the popularity of oak. This trend is also driven by the knowledge that tropical flooring in timbers such as teak, bangkirai and merbau is now less readily available (which has given a boost to ipé exports).

Gradual recovery in EU construction forecast to continue

The 83rd Euroconstruct Conference, held in June 2017, concluded that the recovery of the European economy is boosting construction output but that overall growth rates will remain slow for the next two years.

Euroconstruct reported that European construction output expanded by 2.5% in 2016, half a percentage point higher than forecast at the previous Euroconstruct conference in November 2016. The upgraded forecast reflects an economic upswing stronger than was expected six months ago due to greatly improved consumer confidence and the continuing loose monetary policy. Overall construction output is expected to increase by 8% in 2016–2018, with growth moderating in 2019.

Domestic consumer demand is increasing in most European countries, stimulated by declining unemployment. Investment has started to pick up, particularly because households and companies can still secure inexpensive financing, and foreign demand is developing favourably.

The pace of recovery remains relatively moderate, however, due to the sluggish implementation of economic reforms as well as longstanding weak growth trends. In general, European economic growth potential is lower than it was before the global financial crisis, due to the aging of the population and declining productivity growth.

United States of America

Improving competitive environment for US woodflooring manufacturers

Imported woodflooring (solid and assembled) lost market share in the US in 2016, and the underlying reasons for this represent an opportunity for US flooring manufacturers, according to *Hardwood Floors*, the magazine of the National Wood Flooring Association.

US manufacturers accounted for 67% of total woodflooring sales in 2016 (unchanged from 2015) and for 56% of total square-foot sales (up from 52% in 2015). US production of woodflooring increased by an estimated 9% in 2016, but imports (of both solid and assembled woodflooring) declined by almost 5%.

Although the decline in imports was relatively small compared with the growth of imports in the previous eight years, US woodflooring could continue to increase market share if US manufacturers invest in new production capacity.

Several factors are contributing to the slowdown in woodflooring imports, according to *Hardwood Floors*: price; the need for imported woodflooring to comply with Lacey Act requirements, which has encouraged US distributors and retailers to turn to domestic sources; and duties—China lost US market share when the US imposed antidumping duties and countervailing duties on assembled woodflooring, with the gap bridged by imports from Cambodia, Viet Nam and other countries in Asia.

The average price of woodflooring imports was only slightly below that for US-made products in 2007, but imports were more than 50% cheaper by 2015, according to *Hardwood Floors*; Asian suppliers were also able to provide a greater range of species and colours. Woodflooring imports grew by more than 20% annually in 2007–2015.

In 2016, however, import prices increased by an average of 9.6% and the price of Chinese assembled woodflooring grew by more than 13%. On the other hand, the price of US-made woodflooring declined by 8.2%.

China increasingly imports hardwood from the US to manufacture flooring and other wood products to export back to the US market, thereby ensuring legal sourcing from US forests. Higher US sawnwood prices and rising Chinese labour costs contributed to the higher-than-average growth of Chinese-made flooring prices in 2016.

Despite the relatively favourable circumstances for US woodflooring manufacturers, domestic manufacturers will only capture more market share if they invest in state-of-the-art woodflooring production facilities.

In the last five years, US woodflooring manufacturers have increased capital spending by only 20%, which is less than half of other floor-covering industries and a modest amount given the growth in the US housing and remodelling markets. The market outlook for imported woodflooring remains positive if suppliers are able to control costs and make it easy for US importers to comply with the Lacey Act.

Imports

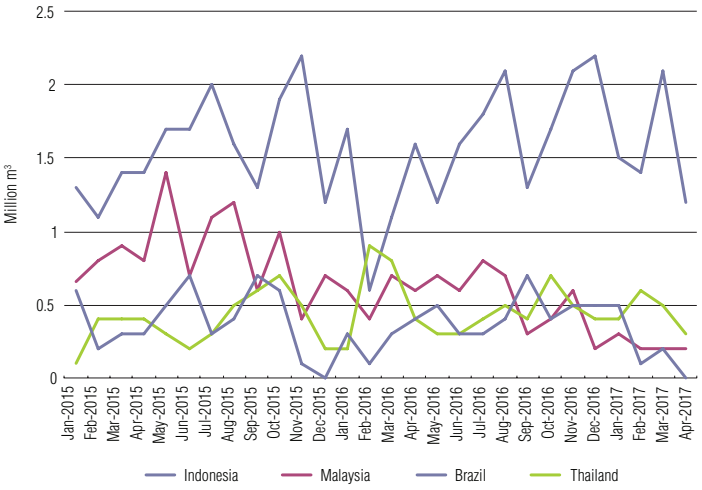
The top four hardwood flooring suppliers to the US—Canada, China, Indonesia and Malaysia—accounted for a little over 72% of all imports of this product in the first quarter 2017. Malaysia's shipments of hardwood flooring dropped by a massive 70% in the first quarter of 2017 (year-on-year) but, for the other top suppliers, shipments rose by 30–35%.

US imports of assembled hardwood flooring are around four times higher than those of hardwood flooring (solid flooring). Five shippers—Brazil, Canada, China, Indonesia and Thailand—accounted for around 70% of imports of the former. First-quarter shipments from China, the number-one supplier to the US, were little changed from the same period in 2016, but shipments from Canada, Brazil and Indonesia rose by 14%, 15% and 65%, respectively, while shipments from Thailand dropped by just over 25%.

The cyclical pattern exhibited by woodflooring imports (solid and assembled) is most pronounced for assembled flooring: imports dip during the US winter and pick up as weather conditions for construction improve (Figure 3). The renovation market, which is significant, is less affected by weather because the work is undertaken inside. Shipments of hardwood flooring to the US from Europe, notably eastern Europe, have been rising.

US imports of hardwood flooring fell by 15% in 2016, to US$40.5 million, although imports from China grew sharply. The main exporters of solid hardwood flooring to the US in 2016 were China (US$9.7 million), Indonesia (US$9.1 million) and Malaysia (US$6.3 million). Despite the competition from alternatives, US imports of assembled woodflooring were worth US$164.6 million in 2016, up by 21% from 2015, with all major exporting countries recording increases.

Figure 3: Monthly US imports of woodflooring (solid and assembled) from selected tropical countries, 2015–2017



Source: US Census Bureau.

The competition

Despite the improving competitive strength of domestic woodflooring, these are challenging times in the US market. Increasing competition from wood-look-alike tiles, planks and new and innovative LVT and WPCs are beginning to take share from manufacturers of solid and assembled woodflooring. In 2016, the strongest competition for woodflooring was from LVT products, especially click-installed LVT wood-look-alike boards.

Woodflooring market growth trends in early 2017 were hampered by slower-than-expected gains in new housing construction, a key driver of woodflooring sales. US woodflooring sales (shipments minus exports plus imports) were estimated to have increased by only 5% in the first quarter of the year. Woodflooring is estimated to have accounted for 32% of the value of overall sales of floor coverings (i.e. ceramic tile, laminate, resilient and woodflooring) in 2016, down from 35% in 2015, with losses of market share in both the residential and commercial building sectors. These recent declines come after woodflooring made sharp inroads in the market between 2002 and 2014.

The pricing of woodflooring has been a barrier to growth in market share in recent years. Average selling prices for woodflooring increased by almost 15% between 2011 and 2015, and the average selling price for woodflooring manufacturers was close to double that of the overall industry average for floor coverings.

The residential replacement market accounts for about 53% of total woodflooring sales, and this market is benefiting from rising existing-home prices, rising personal incomes and growing consumer confidence.

US flooring trends

Major US domestic manufacturers invested in expanding flooring capacity in 2016 and into 2017, and some new producers entered the market. Last year, all discussions were about WPC and rigid-core LVT. WPC is generally classified as a hybrid LVT, and it has helped boost sales in the resilient-flooring category beyond the vigorous double-digit growth already afforded the category by booming sales of regular LVT. With so much US domestic LVT capacity coming online, it should be a dynamic category over the next few years.

Laminate flooring lost market share in 2016, from 5.4% to 4.9%, as it struggled to fend off the advance of LVT. The most noticeable impact was on imports, which dropped by 16% last year, even as domestic mill shipments rose by 5%. Overall, laminate sales fell by 5%, to just over $1 billion.

Laminate flooring has to face the possibility of losing market share to WPCs, which target one of laminate's key selling points, its rigid structure, but without the susceptibility to moisture that laminate flooring has because of its fibreboard core. Laminates still have a big advantage, however—lower prices.

Retail flooring fashion

Fashions in woodflooring finishes continue to evolve in response to advances in technology that affect consumer choices. Light colours, textured surfaces and low-lustre finishes are popular in the US. Innovations in technology and product design mean that today's consumers have a wide choice of floor coverings.

Three of the most popular styles of woodflooring are longer, wider planks; wire-brushed surfaces; and cerused (a lime-washed effect).

Cerused finishes were popular in the Art Deco era. The original technique used a mixture of lime and water on the wood surface to "soften" the natural colour. Grey remains in favour as the fresher neutral. The trend started on the west coast and has been embraced across the country.

Wire-brushed textured flooring—in which the wood is brushed to expose the wood's natural grain and texture—is also highly appreciated in the US. Wire-brushed floors have the added advantage of requiring only low maintenance because the treatment helps disguise dents and scrapes. US retailers have reported growing interest in matte-finished, low-gloss woodflooring, which, like wire-brushed flooring, requires less maintenance than traditional high-gloss treatments.[2]

Prospects—home renovation and remodelling to become growth areas

The outlook for the woodflooring manufacturing industry in the US is improving, with housing starts rising and consumer confidence growing. The Center for Housing Studies at Harvard University projects that household growth will reach 13.6 million in the period 2015–2025, after which, however, it is expected to slow.

This projection depends on US economic growth and immigration policies: if immigration is curtailed, growth in housing construction will be lower in the near term. More certain is the projection by the Center for Housing Studies on spending by baby-boomers on home renovation and remodelling. People in the baby-boom generation will modify their homes in coming years, driving investment growth in renovation and remodelling.

Demand for interior woodwork is set to expand as housing starts increase, per capita disposable incomes improve and unemployment falls, but competition from imports and from WPCs and LVC could cause consolidation in the US woodflooring industry as unprofitable companies close.

2 See www.floortrendsmag.com/articles/100670-trends-in-retail-flooring for a guide to trends in US flooring.

Bali Call to Action for Sustainable Mangrove Ecosystems

As a matter of urgency, we, the 272 participants from 25 countries attending the International Conference on Sustainable Mangrove Ecosystems, held on 18–21 April 2017 in Bali, Indonesia, urge policymakers, land-use planners, mangrove practitioners and scientists, international organizations, the private sector, donors and coastal communities to redouble their work to ensure the conservation, restoration, protection and sustainable management and use of the world's remaining mangrove forest ecosystems.

Mangroves provide many goods and ecosystem services essential for the livelihoods of coastal communities, including sustaining fisheries, conserving biodiversity, and storing among the highest densities of carbon of any ecosystem globally. Mangroves cover about 15 million hectares but are under threat worldwide, with the total area declining by at least 20% since 1980. At least one-quarter of surviving mangroves are moderately to severely degraded.

Evidence and case studies presented at this conference demonstrate that, with adequate investment, sustainable mangrove management can play a significant role in conserving and enhancing carbon sinks, enabling adaptation to climate change, and achieving the UN's Sustainable Development Goals 5, 13, 14 and 15. The conference has also shown the leading role of women in the restoration and rehabilitation of mangroves worldwide and the importance of involving local communities in sustainable mangrove management.

Greater national and international efforts should be made and more funding provided, therefore, for mangrove conservation, restoration and sustainable management and use. Countries and those responsible for mangrove resources are invited to consider and implement the following key measures, if appropriate, to help ensure that mangrove ecosystems are protected, expanded and managed sustainably for the benefit of coastal communities, countries and the global environment:

1) Prioritizing the conservation and sustainable management and use of mangrove ecosystems in national policies, laws and regulations at all levels of government, and strengthening law enforcement to reduce the continuing loss and degradation of mangrove ecosystems.

Action stations: A curlew stands among a multitude of crabs on a mudflat in Indonesia. *Photo: Yus Rusila Noor*

2) Promoting sound land-use planning, clarifying land tenure and user rights for communities with consideration of cultural sensitivities, and ensuring the effective involvement and empowerment of local communities, especially women.

3) Promoting effective mangrove restoration through the improved assessment of degraded and deforested mangrove ecosystems, science-based decision-making to identify the best restoration strategies and practices, and long-term monitoring and management to determine and improve the overall success of restoration programmes and increase productivity.

4) Facilitating access to international financing mechanisms as well as national public and private-sector sources to scale up mangrove-based climate-change mitigation and adaptation and enhance the resilience of coastal regions and communities.

5) Generating and disseminating knowledge on the causes, patterns and consequences of change in mangrove ecosystems at the local to global scales, reporting on the status of mangrove management worldwide, and raising awareness of the vital importance of mangrove ecosystems to planetary well-being.

We thank the government and people of Indonesia and the Province of Bali for their kind hospitality in hosting the conference as well as ITTO, ISME [International Society for Mangrove Ecosystems] and other supporters for their generous contributions. This document does not necessary reflect the views of the entities and governments that provided funding for this conference.