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The land-sea interface

AQUATIC FOODS

Interview with World Food Prize Laureate Shakuntala Thilsted

CLIMATE CHANGE

Resilience through water security

WOMEN'S EMPOWERMENT

The role of cottage industries

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Dear Reader,

The insight that we have to think systemically rather than in silos if we want to master the complex challenges which humanity faces is gaining more and more ground. This applies in particular to the area where our basic resources of water and land meet: the coastal regions.

The increase in anthropogenic activities at this interface between land and sea – such as deep-sea fishing and intensive aquaculture, sand mining and real estate development, shipping and beach tourism – is having an impact on coastal ecosystems and their services. And this is also affecting the livelihoods of coastal communities, which are already especially hard-hit by the effects of climate change. It is all the more important to find governance structures that consider the interdependencies between land and sea and allow proper management of possible externalities.

At the One Ocean Summit in Brest, France, world leaders recently emphasised the need to do more for the protection of maritime ecosystems. In addition to mitigating climate change and fighting illegal, unreported and unregulated fishing, they are above all focusing on plastic pollution. Just how urgently action is needed is well demonstrated by the familiar images of maritime garbage patches, beaches covered with plastic and entangled seabirds and turtles which are circulated around the world again and again. It is not only marine and terrestrial flora and fauna which are threatened by these developments but also the income opportunities of millions of fishers and those living from tourism.

One phenomenon which has been given somewhat less attention over the last few years and has assumed dramatic proportions is sand extraction from seas, rivers and beaches to meet the immense global demand for construction material. Destroyed beaches, dunes and sandbanks, coastal erosion and dying coral reefs are just a few of the consequences this practice has. At the same time, urbanisation and infrastructure development are encouraging a reversed

trend – since waterfronts are attractive residential places, area is taken away from the ocean itself – with considerable ecological and socio-legal implications.

In addition to these developments, we present initiatives and programmes in this edition which are committed to protecting sensitive coastal areas. They centre in particular on nature-based solutions – which are inspired and supported by nature while simultaneously providing environmental, social and economic benefits. One of the most effective solutions among these is the preservation, rehabilitation and restoration of mangrove forests. Here, our authors show the role the private sector and civil society – and consumers – assume, alongside that of governance and research. For anyone seeking to tackle interconnected problems won't get far without multi-stakeholder action.

On that note, the Rural 21 editorial team wishes you inspiring reading.

Silvia Richter



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GOVERNING LAND-SEA INTERACTIONS

AN URGENT NECESSITY IN THE ANTHROPOCENE



The land and the sea are interconnected. Changes originating on land impact on the health of the seas, whose condition in turn bears on terrestrial ecosystems and on human well-being. Increasing anthropogenic activities in coasts – where land and sea interface – are intensifying these interdependencies. But the dominant governance approach, which separates responsibilities for land and sea, fails to account for land-sea interactions as an important frontier for advancing sustainability.

By Aisa O. Manlosa, Achim Schlüter and Anna-Katharina Hornidge

The coast has always been a dynamic area. Over centuries, many coastal areas have historically evolved from being fishing towns to large, modern cities providing a home to growing populations. Yet what makes contemporary coastal spaces a particularly important area for governing for sustainability is the diverse and

intensified changes in resource use that are causing significant impacts on biodiversity and human well-being at previously unprecedented scales. Accelerated anthropogenic use of coastal spaces is being enabled by increased technological abilities and economic investments which create large-scale ecological and social impacts.

Examples of such activities include coastal sand mining, increased shipping, deep sea fishing, intensive aquaculture, energy production, tourism and real estate development. These are associated with ecosystem disruptions such as habitat loss, biodiversity decline, the introduction of invasive species and aquatic pollution



Living on the coast in Hainan, China.

Photo: Lucia Herbeck

in its various forms. Coastal communities are adversely impacted when natural ecosystems which deliver ecosystem services for livelihoods and daily activities are degraded, and when their access to coastal resources is curtailed in favour of large-scale development by rich and powerful actors such as corporations and industries. The ecological and social impacts of intensified coastal resource use, and in consequence, land-sea interactions, have an important bearing on the Sustainable Development Goals (SDGs).

These issues are particularly urgent in low- to middle-income countries of the tropics and subtropics where poor and vulnerable communities tend to cluster in coastal areas. These

areas are more heavily impacted by climate change. They go through more rapid processes of social, economic and ecological changes coupled with low levels of public investment and weaker institutional capacities to govern. The ability of the poor to be food secure, nourished, and free from poverty depends on sustainable land-sea interactions. Governing this space appropriately is a necessary prerequisite for sustainable development. However, the broad scope of changes and challenges in the land-sea interface starkly contrasts with the wide lack of suitable integrated governance structures and processes. Land and sea remain separately governed, and work by government, non-government organisations, and scientists often remain sectoral. Governance for

land-sea interactions is therefore urgently required. Such governance mechanisms need to be explicitly oriented towards sustainability – that is, the conservation of diverse coastal and sea ecosystems, biodiversity and the realisation of human well-being for all, particularly the poorest and most vulnerable.

Intensifying human interventions in the land-sea interface

There is a long history and a long list of governance challenges in coastal areas. The coast is a contested area that serves multiple functions. For instance, seas and oceans are transport routes, and it is owing to this function that piracy has been a long-standing issue. The coast is also the primary site for fisheries, which is vital for food production and livelihoods. But, as mentioned earlier, different uses of the coastal zone have multiplied over time, and the intensity of use has increased (see Figure on page 6). This is true for many sectors.

Fisheries production has been inadequate to meet rising demands but aquaculture took over and now produces more than 50 per cent of human-consumed fish. This is accompanied by an increased nutrient load in coastal waters (becoming increasingly apparent for major aquaculture producers like China, Indonesia or Vietnam), growing demand for fish feed, which elevates pressure on wild catch in the main producing regions such as the Pacific Coast of Latin America and West Africa, more demand for coastal space and some knock-on effects on biodiversity, food security and human nutrition. Beach tourism has increased competition on beachfront land in coastal places around the tropical belt such as Costa Rica, Zanzibar and Thailand. Asymmetries in purchasing and political powers have enabled coastal grabbing. Such developments are accompanied by increased freshwater consumption, which often leads to saltwater intrusion and sewage water disposal. Additionally, the presence of tourists increases the demand for and price of food, which can impact on the affordability of food for local residents. The range of impacts is systemic.

Mining for sand, particularly illegal mining, as famously reported for India, Indonesia and Ghana, has especially increased in coastal areas and connected rivers. Not only does it negatively affect river flows, agriculture, soil, and coastal protection, it is often also harmful for particularly vulnerable parts of society which are openly exposed to illegal activities. Farther out at sea, offshore energy, oil and

gas extraction as well as other mining activities, pushed by blue growth initiatives, bring people, traffic, waste, money and competition for valuable resources to the coast. This acceleration on the coastal side is matched by the acceleration of activities in the hinterland. Examples include the conversion of rainforest into palm oil plantations, which leads to the release of more carbon dioxide into the atmosphere as well as nutrients and sediments flowing to rivers and eventually to the sea. Agriculture intensifies, causing less water discharge to estuaries and the transport of more pollutants. Societies have also increased the use of plastics, resulting in the well-known marine garbage patches, including the great garbage patch in the Indian ocean, as rivers and the rainy season flush plastics out to sea. Globally, the largest contributors of mismanaged plastic waste which could enter the ocean are China, Indonesia, the Philippines, Vietnam and Sri Lanka. Moreover, the shipping of recyclable waste, particularly to the so-called Global South, exacerbates problems in the management and proper disposal of plastic waste.

Why land-sea interactions should be seen as social-ecological systems

In several studies, coastal areas, in which land and sea interface, have been conceptualised as social-ecological systems (SES). This concept has been widely used in sustainability science to investigate the interlinked dynamics of environmental and societal changes. Conceptualising land-sea interactions as social-ecological systems enables a systemic and holistic perspective that can capture both ecological and social dimensions and straddle land and sea divisions to foreground connectivities, feedbacks, and relationships. However, while having started

Growth in aquaculture production, palm oil production and global maritime trade

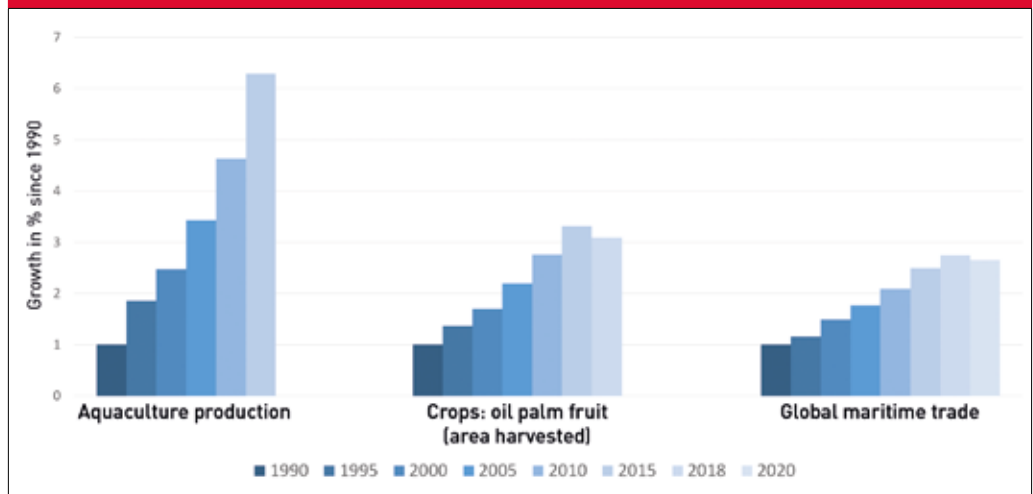


Figure by Soyla Kraus, Leibniz Centre for Tropical Marine Research.
Data sources: <https://ourworldindata.org/palm-oil>; <https://ourworldindata.org/fish-and-overfishing>; <https://www.statista.com/statistics/264117/tonnage-of-worldwide-maritime-trade-since-1990/>

to emerge in research, existing governance arrangements have not reflected this development in thinking.

One concrete example which highlights land-sea interactions and the need to conceptualise them as social-ecological systems can be found in the province of Bulacan, in the north of the Philippines. In 2020, the Philippine government approved a franchise for the construction of the New Manila International Airport, which will be constructed by the San Miguel Corporation. The infrastructure is expected to cover a coastal area of approximately 2,500 hectares, presently a home to fishing and fish farming communities, and coastal biodiversity. Opposition has mounted particularly from environmental groups, conservation advocates, small-scale fishers and fish farmers as well as religious groups given the impending loss of biodiversity and local livelihoods, the increased disaster risks and the fragmentation of local communities. However, land-sea interactions which underpin the social-ecological impacts of intensive and large-scale coastal

infrastructure development extend beyond the governance scope of existing institutional structures. Despite coastal biodiversity and associated livelihoods being directly at stake, the Philippines' Bureau of Fisheries and Aquatic Resources (BFAR), which is responsible for the conservation and management of coastal and aquatic resources, has not played a significant role in dealing with the issues emanating from the aviation and construction industries.

Impacts on people

Social factors underpin how social-ecological changes in the coasts impact on people. First, social inequalities mean that gains and losses from different anthropogenic activities in the land-sea interface tend to be distributed unevenly. In the example given of airport construction in Bulacan, fishing and fish farming communities have much less political power compared to government officials and investors, and much to lose given their precarious livelihoods. Such uneven distribution of impacts is structurally generated through the policies and institutions that govern the utilisation of coastal space. Lack of

Coastal pollution in Indonesia.

Photo: Leyla Knittweis

political will and the ineffectiveness of existing institutions to ensure the rights of those who are dispossessed of home and livelihood also play a role.

Second, in the context of land-sea interactions, questions of how gains and losses are distributed and to whom they flow are central to achieving sustainable outcomes. In the Philippine example, social costs in the form of diminished access to resources on which medium enterprises or smallholder livelihoods depend and people's reduced capacities to secure their well-being impact the poorest, while high economic gains accrue to the rich actors. Here, the poorest and most vulnerable are becoming excluded from accessing resources, and their livelihoods are compromised. These small-scale fishers and fish farmers often have fewer assets that are needed to cope with the disruption in their lives and have less capacities to transition to other livelihoods. Thus, dynamic changes in the land-sea interface can exacerbate the struggle of coastal populations to secure a good quality of life.

Governance – a challenging exercise

As shown above, multiple activities at the land-sea interface with many consequences for people are rising. Such activities are not only producing externalities which could be regulated by tools such as taxes and property rights, they are interdependent. This means that the degree of relationship is constantly changing in a non-linear manner, potentially with non-reversible tipping points. While different activities are regulated in silos, interdependencies between land and sea require an intelligent mix of manageable, feasible, and potentially complex webs of governance structures. These might include conventional but enforced and encompassing regulations, deliberation and participation, or new, innovative and adaptive property rights, ranging from private to state, or new forms of common ownership. Establishing these for highly heterogeneous activities and players as existing on the coast is a challenge for collective action. System size and complexity of interdependencies are often immense in land-sea interaction. For example, land-based activities in Tanzania might have devastating consequences via the Nile on livelihoods in Egypt, or even in other countries bordering the Mediterranean Sea. This indicates that governing the coast requires complex, multi-scale governance regimes, leading from the very local to the national, regional and global levels. Understanding these challenges is still in its infancy.

The Abidjan Convention

The Abidjan Convention, or the Convention for Cooperation in the Protection, Management and Development of the Marine and Coastal Environment of the Atlantic Coast of the West, Central and Southern Africa Region, was first signed in Abidjan, Côte d'Ivoire on the 23rd March 1981 and went into force on the 5th August 1984. It covers a marine area from Mauritania to South Africa (altogether 22 countries). As a legal framework for all marine-related programmes in West, Central and Southern Africa, it regulates marine pollution from ships, dumping, land-based activities, exploration and exploitation of the seabed, as well as ecosystem-based management of meadows, wetlands, barriers and lagoons.

The Nairobi Convention

The Nairobi Convention was first signed in Nairobi, Kenya on the 21st June 1985 and came into force on the 30th May 1996. It is part of UNEP's Regional Seas Programme standing in for a sustainable management of oceans and coastal areas in the Western Indian Ocean Region. Today, the convention has ten contracting parties. They cooperate closely and coordinate activities for the sustainable management of rivers, coasts and oceans. Both the Abidjan and the Nairobi Convention are institutionally supported by UNEP.

Coastal governance for sustainability

Coasts are hotspots of human-nature interaction. Uses constantly increase, while coastal ecosystems are challenged by sea-level rise, ocean acidification and land subsidence. Governing these accelerated change processes, intensified interests and increasing technological abilities requires substantial cross-sectoral and cross-scalar coordination. For national, regional and multilateral policy-making we thus recommend:

- Identify coastal zones (including cross-border coastal zones) as units to be governed in line with the specificities of coastal complexities in national and regional ocean governance frameworks, and multilateral, UN-level policy dialogues. Renew policy dialogues around Integrated Coastal Zone Management (ICZM) and link these with marine spatial planning initiatives under the Agenda 2030 of the United Nations.
- Further develop cross-border and ecosystem-based coastal zone management plans, as suggested by the United Nations Environment Programme (UNEP), and support their implementation especially in the immediately affected coastal zones of the tropics and subtropics.
- Strengthen institutional capacities at regional and national levels for cross-sectoral coordination and the implementation of transboundary, ecosystem-based coastal governance.
- Invest into awareness raising at the level of national governments and regional organisations (i. e. Regional Fisheries Management Organisations; Abidjan and Nairobi Conventions) through

multilateral and bilateral forms of international cooperation for the complexities of coastal governance.

- Foster participatory processes for the involvement of coastal stakeholders in local and national-level policy-making and for ecosystem-based integrated coastal zone management.

Patterns of resource use in many coastal areas in different parts of the world are being reshaped. The effects of such changes influence our collective ability as a society to achieve the Sustainable Development Goals. A social-ecological reframing of land-sea interactions and the building of suitable governance structures and processes that embody a social-ecological systems perspective will be a challenge to realise – but one that is urgently needed.

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Sucking away the sand

According to the United Nations, global demand for sand stands at a staggering 40 to 50 billion tonnes a year, the chief consumer being the construction industry. This article looks at why sand for building isn't nearly as abundant as might seem and at the pressure which sand mining in general and coastal sand mining in particular are putting both on the environment, people's livelihoods and food security, and it points to possible alternatives.

By Mike Gardner

The Earth's deserts contain huge expanses of sand. And yet desert countries like Dubai have to import vast quantities of sand to pursue their ambitious urban development projects. The reason for this is that wind-swept desert sand is usually too fine and smooth to perform the essential role which sand has in making concrete, that of binding the water and cement to create a paste which then hardens.

Water-swept sand, occurring in rivers, forming the beaches along coastlines and accounting for much of the seabed itself, tends to be much grittier, consisting of larger, rough-surfaced grains. As the need for sand increases, more and more of it is mined in river courses, along coasts, and even in the sea itself.

Sand is used in a wide range of electric and electronic appliances and equipment, including television screens, smartphones and solar panels. But urbanisation is the chief driver of sand mining. Today, around four billion people live in towns. The urban population is set to increase by a further 2.5 billion over the next three decades. The UN estimates that the world's present 31 cities with more than ten million inhabitants, also known as megacities, will be joined by a further nine by

2030. China and India are the countries with the world's largest construction sectors. From 2013 to 2015, China used as much concrete as the USA had throughout the entire twentieth century, and it accounts for roughly half of the world's overall concrete production. But India is hard on its heels.

Environmental and social impacts

While Indian Prime Minister Narendra Modi's ambitious goal of providing "Housing for all by 2022" may have run into financial difficulties, every day, huge convoys are still carting lorryloads of sand from pits and riverine mining sites to new settlements mushrooming around the country's burgeoning cities. Such extensive activities are taking a heavy toll on the environment, also with regard to sinking water tables. But the frenzy of building and its greed for sand also has profound social impacts.

"We are spending our sand 'budget' faster than we can produce it responsibly. By improving the governance of global sand resources, we can better manage this critical resource sustainably and truly demonstrate that infrastructure and nature can go hand in hand," said Joyce

Msuya, Acting Executive Director of the UN Environment Programme at the launch of its report "Sand and sustainability: Finding new solutions for environmental governance of global sand resources" in 2019. UNEP says that riverine sand extraction, together with damming, has "reduced sediment delivery from rivers to many coastal areas leading to reduced deposits in river deltas and accelerated beach erosion".

With demand far outstripping supply, sand mining has long reached the coasts, jeopardising the livelihoods of countless artisanal fishers and, given the importance of coastal fisheries, threatening food security as well. The most damaging way to extract sand in marine environments is to simply dredge it from the seabed. This is done largely with suction dredgers – stationary dredgers equipped with piping which can bring the sand from depths of up to 100 metres via a pontoon supporting the pump to the shore. Of course the dredgers don't just scoop up the sand. Everything living in it is taken away as well. The rapid depletion of sand in coastal areas has been highlighted by the construction of the Burj Khalifa, the world's tallest building, in Dubai. Sand for its construction had to be imported from Austra-



Suction dredgers bring the sand from depths of up to 100 metres to the shore.

Photo: Aleksandr Lesik – stock.adobe.com

lia because the seabed around the United Arab Emirates has been virtually sucked barren.

In addition to the removal of the seabed sand, which represents a habitat in its own right, coastal sand mining has a wide range of other environmental impacts. It does of course contribute to coastal erosion in general. In Karnataka, in India, for example, the government has had to invest in new barriers to prevent coastal erosion as a result of sand mining. Sand extraction can also destroy beaches, dunes and sandbanks which act as flood barriers. It has even been maintained that the devastating 2005 tsunami could have had a lesser impact if much of nature's own system of flood barriers had not been destroyed through sand mining by that time.

Rivers and estuaries deepened by mining activities can subsequently become wider, and mining can encourage salt water to enter surrounding terrestrial areas, a process which is compounded by sea-level rise. Turbidity is a further problem. Mining activities cause minute dust particles to be suspended in the seawater, creating a barrier which prevents sunlight from entering habitats and causing corals to perish. Fish and other organisms lack food and oxygen in such a disturbed environment.

UNEP also points to a "growing trend of unsustainable and illegal extraction in marine, coastal and freshwater ecosystems" which represents "a sustainability challenge with a display of the various extraction impacts on terrestrial, riverine and marine environments". In fact, only around a third of all sand traded worldwide has been mined legally. Especially in India, organised crime syndicates are heavily involved in sand theft, with menial tasks being performed by people desperately seeking income. Moreover, robbed of their livelihood base, many former fishers themselves resort to illegal sand mining.

Is unsustainable extraction of sand really necessary?

No, there are alternatives to sand mining in rivers and the sea. The infamous Trump Towers in Pune, India's seventh most populous city, were constructed mainly with manufactured sand, m-sand for short, by Panchshil Realty, builders for former US President Donald Trump. M-sand is made by entering boulders and stones into a series of crushers until they are pulverised into sand grains, but also into dusty and flaky particles – ultrafine matter which has to be removed in a special

washing process. All this requires a big energy input.

However cement, the second component of concrete, also consumes vast amounts of energy. In fact, cement is the third most energy-intensive material to produce after steel and aluminium. Energy is consumed in the electricity used in processing, in process heat and in transport. For every tonne of Portland cement, the type most commonly used, which is produced, reducing limestone to lime and carbon dioxide emits around a tonne of the latter into the atmosphere. This is one reason why supplementary cementing materials (SCMs) have already been used in concrete production for a number of decades. SCMs consist of recyclable industrial by-products which have been reclaimed. Not only are waste disposal volumes lowered in this manner, there is also less pressure on the natural resource of limestone. Into the bargain, concrete made with SCMs generally has a longer life. The chief SCMs used are fly ash and slag.



Only around a third of all sand traded worldwide has been mined legally.

Fly ash is emitted from coal-fired boilers, e.g. in power plants. In the USA, for instance, around 43 per cent of it is recycled. Slag is a by-product of smelting ores, but also of used metals, and consists of various metal compounds. It was already used as railway and road ballast in the nineteenth century, and today, one important area it is applied in is the manufacture of high-performance concrete for bridges.

SCMs are also used for high-performance concrete in India, and research has recently been conducted there on the role they play in reducing greenhouse gas emissions for this product. Further findings Indian scientists have come up with in this area include that adding SCMs to concrete mixtures lowers hydration



heat and enhances the strength and durability of concrete structures.

Finally, plastic is also finding its way into the manufacture of concrete. Since plastic waste is increasingly threatening marine ecosystems and hence adding to the problems of coastal as well as high-sea fisheries, using more plastic waste as a source of materials to manufacture concrete could reduce pressure on fishers both as an alternative to sand mining and in terms of recycling plastic waste. One new approach in this area has emerged at Montana State University, in the USA.

Researchers at the university's Norm Asbjornson College of Engineering have found that plastic can be added to concrete without weakening its structural strength if it is coated with certain bacteria. Otherwise, filling plastic into a concrete mixture disrupts the ability of the sand, water and cement to bind properly. The MSU scientists found that concrete with up to five per cent of bacteria-treated plastic had the same strength as traditionally mixed concrete. Given the energy-intensive production, even a five per cent addition of treated plastic could significantly reduce carbon dioxide emissions. Added to that, with concrete being used in such huge amounts, the new method would enable a considerable reuse of plastic.

To achieve the desired result, the researchers immersed the plastic in a solution containing a harmless bacterium, *Sporosarcina pasteurii*. The bacterium grows on the plastic surface, forming a biofilm. Calcium and urea are then added to the solution, causing the plastic to acquire a thin coating of calcite, which limestone is made of. The scientists have already used the coated plastic to seal tiny cracks deep underground in leaking oil and gas wells.

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Land reclamation for housing – the example of Côte d’Ivoire

Waterfronts are attractive residential places for rich and poor people in coastal African cities, albeit for different reasons. While expensive waterfront residences follow the global estate logic, shores form spatial niches attracting people with very low incomes. When building plots are in short supply, land is reclaimed by various practices – with considerable ecological and socio-legal implications.

By Irit Eguavoen

Abidjan is a coastal metropolis, and is the economic capital of Côte d’Ivoire. The city’s topography in the south is dominated by the Atlantic Coast, as well as by numerous peninsulas and islands of the Ebrié Lagoon, whose natural waterfronts and lands used to be swampy grounds with dense mangrove and marsh plant vegetation. The history of Abidjan and its economy, urbanisation, current form and pattern of spatial growth are closely intertwined with the use of the sea and the lagoon, as well as with the reclamation of water spaces as agricultural and building plots. The evolution of land spaces and some quarters through human-induced siltation and reclamation dates back about 60 to 70 years. Therefore, in everyday life, most Abidjanais are not aware that they are literally walking on grounds made from household waste, rubble and coffee ground, a by-product of the local coffee industry. Recently, large-scale land reclamation with sand for housing, seaports, industries and tourism has turned into a ubiquitous and highly visible sign of urban transformation in various places along Abidjan’s waterfronts.

Soweto Remblais – a quarter built on water

The history of the densely populated quarter Soweto Remblais, located at the lagoon front, is already inscribed in its name. The French verb *remblayer* means “to fill something up”. Located at the northern waterfront of the Bay of Koumassi, the quarter has its roots in a waste fill populated by poor families evicted from areas in Abidjan when these underwent urban restructuring during the early 1960s. By the 1980s, following more urbanisation projects and evictions, building plots were eventually in short supply. New residents began to incrementally reclaim the mangrove swamp. The unplanned settlement grew into a slum which was upgraded and formalised under a World Bank Programme during the 1990s. After 2011, following the Ivorian civil war and the post-electoral crisis, the settlement received more inhabitants. It turned into a hot spot for land speculation and the construction of multi-storey rental apartment blocks (*immeubles*). When I came to Soweto Remblais in 2016, reclamation with sand from the lagoon in order to increase the size of building land

had already begun. In 2019, I was strolling with Soweto residents on a newly established beach – actually more beautiful and cleaner than the Atlantic beach itself. By 2021, this wide beach had fully given place to new *immeubles*. For each *immeuble*, the ground was stabilised with rubble. Along the waterfront, the Koumassi mayor’s office had approved a number of bars and eateries.

Such spatial transformation is nothing unusual. It also happens in other riverine and coastal African cities. In Abidjan, the process neither attracts political attention nor do civil society actors seem to contest what is happening – although they ought to. Land reclamation in its various manifestations has speeded up and is creating irreversible material realities with severe ecological and social-legal implications.

Transforming public water spaces

Water bodies, such as the Ebrié Lagoon, are first of all public spaces, and as such are protected by national law and maritime law. In Côte d’Ivoire, every riverine shore includes

Most Abidjanais are not aware that they are literally walking on grounds made from household waste, rubble and sand.

Photos: Irit Eguavoen



Land reclamation practices in Abidjan

The most basic form of land reclamation is turning a swamp into an agricultural plot by removing the natural vegetation and mounding agricultural beds (see upper photo). This practice is widespread in Port Bouët Municipality located in low-elevated areas between the ocean and the lagoon. Small-scale horticulture provides employment for a few thousand people. Here, vegetables are locally produced for the city population. Now, this form of urban agriculture is increasingly coming under threat by the planned expansion of the international airport nearby and high population pressure. Horticulturalists report the loss of gardens caused by the sprawl of unplanned settlements. For example, Adjahui, with its more than 60,000 inhabitants, is situated on public airport land, on a peninsula opposite to the shore of Soweto Remblais. It accommodates many house owners who had to make room for *immeubles* as well as tenants, who could no longer afford the increased rental cost in Soweto Remblais.

The local water table in Adjahui is high given the proximity of the lagoon, and soils are not well suited for construction. House owners and construction companies first erect a low stone wall on the border of the building plot. Then they stabilise the ground by applying rubble, waste and sand (see lower Photo). This individual and incremental form of land reclamation has been practised for many decades, as the example of Soweto Remblais itself illustrates. It is especially widespread in swampland and along the lagoon shores. Some people even make use of the tides. While low waters in the lagoon allow construction work, the same sites are submerged in water at high tide. Incrementally, the plot and surrounding areas are fully reclaimed, and water spaces eventually turn into land.

The third form of land reclamation is professional large-scale sand mining from the lagoon with boats. Here, sand pumping from the lagoon is usually granted permission at ministerial level, without the involvement of municipal authorities and riverine communities.



a 25 metre wide public demarcation zone starting from the natural shoreline. Within this zone, construction is prohibited in order to protect rivers, lakes and lagoons from human-induced damage and prevent water-related hazards among the population. The district government of Abidjan nevertheless gave out

many waterfronts as long-term leases to private actors and investors, resulting in a quasi-privatisation of these public spaces for high-income groups and institutions.

The 25 metre zone requires a clear spatial and political definition of the natural shore

line. If such a definition is absent, individuals, professional investors and riverine communities can push the shore deeper into the water body by reclaiming land as can be observed in Abidjan. They then use the new shoreline as a reference for a new 25 metre zone, with the reclaimed land behind constituting a legal



Local fishers are losing out

Since the 1950s and earlier, the Ebrié Lagoon has attracted people from the Gulf of Guinea because of its rich fishery. Immigrants from what is today Ghana, Benin and Togo entered land arrangements with local fishermen's villages of the Ebrié, which are customary land owners in Abidjan. With the ongoing pollution and loss of lagoonal habitats, fish and crab stocks have decreased to the extent that women in fishermen villages have started to buy fish to smoke for sale because artisanal

fishing no longer generates sufficient harvest to support their livelihood. Today, most people in fishermen villages engage in other income-generating activities. Increased population pressure and progressing urbanisation are destabilising old land arrangements between some of the communities settled along the lagoon front and Ebrié villages, resulting in land conflicts and political tension between Ivorians and inhabitants of settlements with a migrant fishermen history.



Women in fishermen villages have started to buy fish to smoke for sale.

Photo: FAO/ Sia Kambou

grey zone. No secure land titles can be issued until the area is formally acknowledged and opened for privatisation by the district government.

Land reclamation is driven by different motivations, which also determine the speed of the process, the scale of spatial transformation, as well as the way water is turned into land. But whether slowly, incrementally and individually or rapidly, professionally and large-scale, ecological and socio-legal implications accumulate. At larger urban scales, they create new challenges or complicate political problem-solving for public authorities in the future.

New vulnerabilities and social inequalities

On the new reclaim in Soweto Remblais, investors build without legal land titles on plots that are not developed. They speculate on a later formalisation and privatisation, a process which may take a few years or even decades. In the meantime, tenants live without proper urban infrastructure in a tolerated settlement. Soweto Remblais residents suffer from rough roads and inundations because sewers are lacking and the water table is high. I visited a family who experienced water flooding their home on the ground floor. Water was gushing down their walls because of construction flaws. These hazards reminded them of the fact that they were actually living where the lagoon used to be. Still, the family considered themselves lucky to have found the flat. In Abidjan, a metropolis of five million inhabitants, affordable rental housing is very hard to find.

It is not surprising that houses on reclaimed land in Adjahui (see Box on page 11) were also prone to inundations. Frequently inundated areas in the unplanned settlement originate from the high water table and the low water infiltration capacity of the fluvial sands, which is further diminished by its increasing plastic waste content. Through land reclamation with waste, which conveniently resolves the local challenge of waste disposal, the peninsula is surrounded by an artificial plastic shore in many parts, which in turn complicates the flow of run-off to the lagoon. However, water damage in houses and inundated pathways does not bother most of the landlords. Many of them live in other quarters of Abidjan and rent out the residential units to households with very low incomes. As investors and speculators, they provide housing for tenants who are glad to have an affordable roof over their head.

In this manner, the local response to the housing crisis for low-income groups quickly contributes to the almost irreversible destruction of the natural lagoonal landscape with its countless habitats and precious carbon sinks. The informal estate market solution to this shortage and new constructions along shores create temporary housing solutions that bear new vulnerabilities for their poor inhabitants, while offering the middle classes illegal but lucrative investment opportunities.

Reduction of future political options

Just like other African coastal cities, Abidjan will need to take political decisions on how to meet present challenges, as they could accelerate in the future. Urban poverty and increasing

socio-economic inequalities, the prevention of social unrest, the expansion of city transport, the securitisation of food provision and environmental health, the mitigation of water-related hazards and the adaptation to climate change – all these challenges demand effective and well-thought solutions. The inner city lagoon with its shores and swampy grounds nearby is already part of these solutions given its manifold ecosystem services. Local fisheries, water transport and the regulation of temperature within the city are just some examples.

However, protecting lagoonal ecosystems and fully using their potential for future solutions is being undermined by short-sighted, large-scale sand-mining and land reclamation. As soon as these water spaces have been transformed into land, they are lost. Once a public space has been privatised or fully occupied by strong private interest groups, it gets very difficult for public authorities to remain in control and use these spaces for developing sustainable solutions and for civil society actors to claim these spaces back for public use.

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Down the river and into the sea – plastic pollution and its consequences

For years, plastic pollution of our global ocean, rivers and coastlines has been on the increase. Today, plastic is found on the shorelines of every continent, above all close to popular tourist destinations and densely populated areas. This has complex and costly impacts on export revenues, employment, food security, and the health of marine ecosystems and biodiversity. Our authors call for a source-to-sea approach to tackle the problem.

By Lynn Sorrentino, Janaka Da Silva and João Sousa

Plastic is ubiquitous. The synthetic organic polymer made from petroleum has properties which make it ideally suited for a wide variety of applications, including in packaging, building and construction, household and sports equipment, vehicles, electronics and agriculture. Thanks to this wide range of applications, plastic provides many benefits to society. But this is only one side of the coin. Given their low degradation, coupled with unsustainable production, use and disposal, plastics and microplastics have become a severe transboundary threat, affecting livelihoods and economics, human and ecosystem health, ecosystem services and clean water supplies worldwide. The exportation of plastic waste to nations with little infrastructure to handle the transfer effectively and the overall mismanagement of plastic waste is affecting every ecosystem on the planet.

As a survey from 2017 shows, to date, 8,300 million tonnes of virgin plastics has been produced world-wide. What is above all worrying

about this is that out of these 8,300 million tonnes, 6,300 million is now waste with only 9 per cent recycled and 12 per cent incinerated. At 79 per cent, the majority of plastic waste is accumulated in landfills or the natural environment. And each year, another 300 million tonnes of plastic is newly produced, half of which is used for single-use items such as shopping bags, cups and straws. The sheer magnitude is staggering and is choking our ecosystems.

How does plastic waste become plastic pollution?

Plastics are released into the environment at different stages of their life cycle. Transport sources include urban and stormwater runoff, sewer overflows, littering, inadequate waste disposal and management, industrial activities, tyre abrasion and wind. Plastic pollution in the ocean originates largely from the fishing industry, nautical activities and aquaculture. Un-

der the influence of solar ultraviolet radiation, wind and other natural factors, plastic breaks down into small particles called microplastics (particles smaller than 5 mm) or nanoplastics (particles smaller than 100 nm). Plastics produce greenhouse gas (GHG) emissions from their production, transportation and incineration – even emitting GHG while in landfills. When plastic waste is incinerated, it releases carbon dioxide and many other chemicals into the atmosphere, thereby increasing carbon emissions and air pollution overall. Open burning of plastic waste can pose significant risks for human health, owing to the release of noxious chemical substances such as dioxin and particulate matter.

The term plastic leakage refers to the potential amount of macro- and microplastics that are not kept in a circular loop or properly managed at their end-of-life, and thus leak into the environment. Data from the International Union for Conservation of Nature (IUCN) shows that at least 14 million tonnes of plastic ends



Plastic pollution in the ocean originates largely from the fishing industry, nautical activities and aquaculture.

Photo: NOAA

up in the ocean every year. Thus, plastic debris is currently the most abundant type of litter in the ocean, making up 88 per cent of all marine debris found from surface waters to deep-sea sediments. Improperly discarded plastics leak into the ocean through several pathways, but the primary transport mechanisms are rivers. In some places, like North Africa, most plastic leakage comes from open landfills and the wind effect. New research estimates that more than 1,000 rivers account for 80 per cent of global annual leakage of plastic to the ocean. Therefore, a source-to-sea approach is needed to deal with plastic pollution – preventing plastics from entering rivers is the key by ensuring proper waste management on land.

How coastal regions and the global ocean are affected

Coastal countries that rely on healthy marine ecosystems and fisheries for food and income face immense challenges if their waste management systems are not capable of handling plastic waste well enough to avoid it leaking into the environment. For example, a 2011 study demonstrates that the costs of clean up, loss of fishing gear and damage to vessels and equipment from marine litter costs the Asia-Pacific Economic Cooperation fisheries sector approximately 1.26 billion US dollars (USD) per year (2009 prices).

The economic losses for marine fisheries include aspects such as the lost value of dumped catch, the costs to repair fishing gear and nets, the overall costs of plastic nets causing fouling incidents and lost earnings as a result of reduced fishing time due to clearing litter from nets. By directly impacting fishing and fish stocks, plastic pollution in the coastal and marine environment has a negative effect on the livelihoods and food security of the people of coastal countries. The potential average annual cost of plastic pollution on marine fisheries in Mozambique, for example, is estimated at 347 million meticals (5.4 million USD), or 0.05 per cent of GDP, based on 2017 values. However, costs and revenue losses could potentially be higher due to an underestimation of the value of fisheries, but also due to aspects not included, such as the costs resulting from the impact of ghost fishing. Extrapolating research models such as those produced by the IUCN to other coastal nations with similar plastic pollution issues would likely show similar detrimental effects.

Marine biodiversity is also massively threatened by plastic pollution. Solid plastic particles



44 per cent of seabird species are affected by ingestion of marine debris.

Photo: NOAA

found in the ocean are ingested by marine fauna. Certain marine animal populations, especially those that feed exclusively at sea, such as seabirds and sea turtles, present plastic debris in their stomachs.

Entanglement in plastic debris is another manner in which animals are impacted. Abandoned, lost or otherwise discarded fishing gear poses special risks for large, air-breathing marine animals, such as whales, dolphins, seals, sea lions, manatees and dugongs, as they can become entangled in the nets and drown. According to a 2016 report of the Convention on Biological Diversity (CBD), the total number of species known to be affected globally by marine debris (mainly plastics) is around 800. These impacts can occur through different routes, primarily through the above-mentioned ingestion and entanglement, but also through the toxic effects of chemical additives. For example, 40 per cent and 44 per cent, respectively, of cetacean and seabird species are affected by ingestion of marine debris.

Moreover, marine plastics can affect marine biodiversity and ecosystems by facilitating the introduction of alien species. Free-floating marine plastics can disperse aggressive invasive species. The introduction of new species could endanger sensitive or at-risk coastal environments.

And last but not least, marine and coastal plastic pollution are threatening the income opportunities of communities which rely on beach tourism. The major economic cost of this plastic debris is the reduced aesthetic appeal of

coastal areas. Plastic debris is commonly found on many beaches around the globe. This adversely affects the tourism industry, leading to a loss of output, revenue and employment.

Addressing plastic pollution needs a holistic approach

Given the complexity of the problem, tackling plastic pollution requires a holistic, inclusive approach with participation across all stakeholders. Here, implementing circular economy (CE) practices represents one of the most important approaches. Whilst CE certainly requires strategies to improve business circularity, the participation and engagement of local citizens may play an equal role in other stages of the plastic cycle. In fact, communities certainly are amongst the first affected by marine plastic pollution. Directly impacted by the waste landing on their beaches, coastal citizens have a real incentive to act. Engaging them in circular economy projects with an inclusive approach not only provides them a source of livelihood, it will also increase their awareness and knowledge of plastic pollution in the long term, whilst contributing to improved local waste management practices (see lower Box).

Aside from implementing circular economy practices, there are many best practices to consider to eliminate plastic pollution from the municipal and national level. For example, alternative value chains could be developed, such as reusable containers designed to avoid single-use plastics and bottle-to-bottle recycling – these include advanced recovery systems involving consumers, retailers, bottling companies, manufacturers and others. The economic evidence is clear that deposit refund schemes (DRS) are also a good practice to implement, especially in combination with activities such as beach clean-ups. A recent IUCN analysis of the costs and benefits of current beach clean-ups in Cape Town, South Africa shows that adopting a DRS approach in conjunction with beach clean-ups could reduce the cost of beach cleaning by an estimated 14 per cent. Both the number of plastic bottles on beaches and the cost of a DRS will continue decreasing as bottle-return rates increase; in other words, the DRS will become more efficient. Although it is a local, specific example, there are implications for coastal tourism globally.

The improved management of plastic waste and the reduction of plastics flowing into the environment should be an integral part of any strategy that attempts to strengthen the economic sectors which depend on the marine

environment, when reviewing support to the blue economy, or addressing the Sustainable Development Goals (SDGs).

It is clear that reducing mismanaged plastic waste is a priority for most nations, as was indicated by tremendous support for the UNEA-5.2 draft Resolution “End plastic pollution: Towards an international legally binding instrument”. These nations will work over the next two years on a harmonised legal framework to eliminate plastic pollution. The framework is to come into force in 2024 and will establish a global plastic pollution management treaty, with national and regional solutions identified, funded and implemented. IUCN welcomes the move for an international legally binding instrument on plastic pollution. World leaders have recognised that high and rapidly increasing levels of plastic pollution represent a serious environmental problem at global scale, negatively impacting the environmental, social and economic dimensions of sustainable development.

The draft agreement is to lead to alternatives addressing the full lifecycle of plastics and the design of reusable and recyclable products and materials. Access to technology, capacity building, and scientific and technical cooperation will be increased. National governments and regional bodies should consider how their existing legislative frameworks will fit the new treaty, and focus also on sustainable plastic production and consumption and extended producer responsibility (EPR) where appropriate. In the case of plastic, there is a strong connection between the private sector (the main supplier of plastic to the market) and the public sector (generally responsible for the infrastructure to handle plastic waste) and as such, EPR schemes have emerged as a tool to better connect these two dimensions of the plastics value chain. The reality, however, is that many governments of developing nations are not likely to be able to implement EPR schemes effectively without careful assessment of the feasibility in their specific context; they will require additional support for implementation.

Policy-makers and national institutions should consider creating linkages to emerging initiatives that encourage a circular economy for plastic. One example of this is the Ellen MacArthur Foundation’s Plastics Pact Network. It brings together national and regional initiatives – plastics pacts – that emphasise how knowledge sharing among stakeholders and coordination of actions can be tailored for success.

Plastic pollution and the SDGs

The nature of plastic pollution impacts the entire environment, our society and the economy. As the issue is cross-cutting, the plastic pollution crisis affects the successful implementation of several Sustainable Development Goals (SDGs). A least twelve of the Goals – 1 (No poverty), 2 (Zero hunger), 3 (Good health and well-being), 6 (Clean water and sanitation), 7 (Affordable and clean energy), 9 (Industry, innovation and infrastructure), 10 (Reduced inequalities), 11 (Sustainable cities and communities), 12 (Responsible consumption and production), 13 (Climate action), 14 (Life below water) and 15 (Life on land) – have links to plastics. But there is only one indicator related to plastic pollution (14.1.1b), and it specifies micro-plastics.

Engaging communities to address plastic pollution

From 2019 to 2021, the IUCN supported nine small scale circular-economy initiatives in coastal communities in Eastern and Southern Africa and Southeast Asia, which created jobs and long-term economic opportunities. These innovative projects reduce pressure on coastal and marine resources, which are critical for the resilience of the local communities. In Kenya, Mozambique, South Africa, Thailand, and Viet Nam, the Marine Plastics and Coastal Communities initiatives for circular economy prevented over 240,000 kg of plastic from entering the ocean in a year of operation. But more importantly, these projects empowered coastal communities to clean their environments and created hundreds of sustainable livelihoods in five coastal communities. For the first two years, the total number of people engaged was 1,875, including waste-pickers, youth, recycling entrepreneurs and other community members. In the case of Thailand, 72 per cent of workers in the recycling centre were women.

In 2021, the Circular Plastic Economy Innovation Lab (CPEIL) was set up in Kenya, Mozambique, South Africa and Tanzania. At regional, national and sub-national levels, this programme accelerated the transition at scale towards a circular plastic economy as a driver of development of a sustainable, inclusive and resilient blue economy. Through the CPEIL, with mentorship and training, the IUCN identified and supported four small enterprises, one in each country, at regional, national and sub-national levels – over 20 entrepreneurs and community members benefited from the Lab to expand their existing recycling businesses for cleaner environments and circular economies in their countries.

The creation of blueprints to guide interventions, instruments, tools and capacity-building courses in the fight against plastic pollution is a final best practice to share. These blueprints demonstrate effective, quantifiable solutions to address plastic leakage. Key stakeholders from governments, private sector and civil society, united in a vibrant learning and leadership network, can co-generate and demonstrate demand-responsive solutions to plastic waste incorporating policy, business operations, and consumer behavioural changes. Evidence and lessons are packaged into a scalable blueprint for use and sharing.

A final note

Unsustainable global plastic production and consumption patterns and mismanagement and littering of waste have created the plastic problem and continue to exacerbate it. Existing linear take-make-dispose economic models are broken, and when combined with limited or non-existing infrastructure for waste management such as sanitary landfills and inciner-

ation facilities – which is the case of many developing nations – plastics end up in our land, rivers and ocean. The legal and illegal global trade of plastic waste may also damage ecosystems where waste management systems in the receiving country are not effective enough to contain the imported plastic waste.

Prevention of plastics from entering the environment is the key. It is no longer simply a matter of “reduce, reuse, recycle”, it must also include refuse (to buy plastics, plastic wrapped items, etc.), repair of times (avoid waste) and redesign for a circular economy.

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References: www.rural21.com

Fighting for coastlines devoured by climate change in Tunisia

The progressive erosion of the coastline is not only a danger to Tunisia's coastal infrastructure, but it also threatens nature reserves and dune systems with their important ecosystem functions. A KfW Development Bank project relies on a combination of grey infrastructure and nature-based solutions to combat deterioration – and on public participation and cross-sector cooperation.

By Sandra Wegner and Kai Wiegler

Tunisia's coastal region is the demographic and economic backbone of the country. Population is dense there, and tourism, industry, fisheries and agriculture are intense. It is home to two thirds of all Tunisians and generates 87 per cent of the country's industrial and economic activity. Seventy-six per cent of tourism accommodation and an important share of export-oriented irrigated agriculture are concentrated in the coastal zones. Major water resources are located there as well, including half of Tunisia's shallow groundwater resources. But the coasts are not only productive, they are also pretty. Out of the 2,300 kilometres of coastline, close to 700 kilometres consists of pristine sandy beaches of which about one sixth are dune zones worthy of protection. There are also numerous marine nature reserves along the coast and a total of 137,000 hectares of ecologically valuable and sensitive lagoons and salt marshes (also see upper Box). In essence, it is not exaggerated to say that the coasts are Tunisia's lifeline.

Coastal infrastructure and dune systems at threat

The cities along the coast, however, exert strong pressure on many of the ecologically fragile areas. In numerous places, development close to the coast, sometimes directly in the dunes, disturbs the natural balance between coastal erosion and sedimentation processes originating from the hinterland. As a result, the coast is eroding more and more and the coastline is shifting further inland, by approximately 0.2 to 1.35 metres a year. As a matter of fact, 13 per cent of the entire Tunisian coastline is at high risk of erosion. The sandy beaches, which are the basis of the country's tourism, are particularly affected and threaten to disappear at an increasing rate. This erosion process endangers not only coastal infrastructure, but also nature reserves and dune systems, which thus can no longer perform their ecosystem functions.

This situation is exacerbated by climate change, particularly by the rise in sea level, set to reach around 0.3 to 0.5 metres by 2050, and the increasing frequency and intensity of storms. The high socio-economic importance of the coast makes Tunisia one of the countries most vulnerable to sea-level rise world-wide. The consequences also include flooding of soils and salinisation of aquifers and estuaries. The latter is to be expected especially where they are overexploited owing to high population pressure. The lowering of groundwater levels increases the danger of rising saltwater intrusion as coastal erosion continues. Precious water resources are being lost.

Combining “hard” protection measures with nature-based solutions

The Tunisian Agency for the Protection and Development of the Coastline (*Agence de Pro-*



Lessons learnt from an ecosystem approach to Tunisia's El Bibane lagoon fisheries sector

With an area of 25,000 hectare, the El Bibane lagoon in the South of Tunisia is not only the largest of Tunisia's five coastal lagoons, but also the most productive one. It is especially well known for the quality of its fish. The El Bibane lagoon has likely been exploited since ancient times by fishers using dams and traps. Today, fish are still caught by these 'bordigues' – catch rooms where fish migrating from the lagoon to the sea can be trapped – as well as by lines and nets.

Fishing regulations in Tunisia are based on 1994 legislation prohibiting fishing areas and prescribing items such as fishing gear and mesh size, minimum authorised landing size, fishing seasons and protected species. But despite these laws, a decline in fish stocks in the lagoon lasting more than 50 years has not been halted. Some species have almost disappeared, catches are low, and the fish caught are getting smaller.

Therefore, at the initiative of the National Institute of Marine Sciences and Technologies (INSTM) and with support of the UN Food and Agriculture Organization (FAO), a management plan for the sustainable artisanal fishery of the lagoon was developed. It was based on the ecosystem approach to fisheries (EAF) which was adopted by the FAO in 2003 in accordance with its Code of Conduct for Responsible Fisheries (CCRF). The process started in 2016 and brought together the El Bibane actors and stakeholders: the concessionaire (a private

individual who pays money to the state to rent the lagoon each year and who employs 38 fishers and workers), the 87 private fishers who operate with fishing licences in the lagoon, and the administration at regional and central level, including, in addition to the INSTM, the regional body of the General Directorate of Fisheries and Aquaculture (DGFA), the Interprofessional Group of Fishery Products (GIPP) and the Coastal Protection and Management Agency (APAL). The management plan for the lagoon was adopted in June 2018 and comprises a fishing "Charter" defining the modalities of the fishing activity and good practices to be respected.

Some lessons learnt for the successful implementation of an EAF based on experience gained with El Bibane were published by FAO early in 2022. They include conducting a sound baseline study; the documentation of local fishery techniques and traditional knowledge/ traditional management rules; considering the opinions of all stakeholders (fishers, operators, managers, scientists, associations, groups, the young, the old, the more experienced, the optimists and the pessimists); and the collection of as many ideas as possible in order not to exclude any details or information. According to FAO, the work at El Bibane has prompted the neighbouring regions of Djerba island and Zarzis to request the implementation of the EAF principles.

More information: www.rural21.com

tection et d'Aménagement du Littoral – APAL) and KfW Development Bank are working against this deterioration with a coastal protection programme (see Box below). The programme addresses in particular coastal erosion and flooding. This is to be achieved by providing "hard" protection measures such as rubble mound seawalls and breakwaters as well as nature-based solutions, like beach nourishment and refilling or the protection, growth and stabilisation of sand dunes. The latter is done mainly by fencing off sensible areas, planting

of protecting vegetation and installing sand fencing for sand-trapping. This is accompanied by additional "soft" measures, such as supply and installation of public equipment regulating beach access (like fences and pathways), and participatory measures at municipal level, ranging from public consultations to co-management of the beaches with user group involvement.

So far, 27 kilometres of Tunisia's coastline has been rehabilitated at different sites in the mu-

nicipalities of Sousse, Soliman and Raf Raf, and on the island of Kerkennah. For this purpose, planting biodiverse and endemic vegetation in order to stabilise sands and dunes has been encouraged, whereas enabling natural rejuvenation has a priority in the project design. Furthermore, groynes, rubble mound seawalls and underwater breakwaters as well as beach nourishment have been constructed; they protect the respective coastal area against future erosion. To facilitate and improve the management of the beaches, public infrastructure has been established, including new dustbins, information panels, access control to beaches and parking spaces.

Tunisia's coastal protection programme

The Tunisian Agency for the Protection and Development of the Coastline (*Agence de Protection et d'Aménagement du Littoral* – APAL) initiated the coastal protection programme (*Programme de Protection du Littoral Tunisien* – PPLT) in collaboration with and financed by KfW Development Bank on behalf of the German government and the government of Tunisia.

The first and the second phases of the programme started in 2013 and 2015, respectively, financed by grants, and have been completed. The third phase started in 2019 and is financed by a loan. The fourth phase is expected to start in 2022, financed by a grant. APAL is also the project executing agency for PPLT. So far, it has signed agreements with the municipalities of Kerkennah, Raf Raf, Sousse, Hammam Sousse, Hergla, Chott Mériem, Soliman and Hammam Chatt. In the course of the project, in the next few years, another 45 kilometres of coastline is to be protected, including in the municipalities of Kantaoui Sud, Sousse, Bizerte, Chatt Mami, and Jerba.

All project phases have been accompanied by technical assistance supporting the APAL. In particular, the agency was provided with a Manual of Procedures that has helped strengthen and empower it with respect to managing the challenges. Training measures have been introduced for APAL staff as well as communal staff and civil society on various topics, such as sustainable infrastructure and participatory working methods. The creation of grievance mechanisms, including their management, has been supported, and civil society is now guaranteed participation in the monitoring of works and in the municipal institutions responsible for the seashore.

A participatory approach for ensuring sustainability

For the sustainable and proper maintenance of the infrastructure of each site, agreements have been concluded with the local municipalities (eight so far). The latter have been supported in installing a temporary commission for coastal protection (*Commission Non-permanente de Protection du Littoral Municipal*, CNPPLM) and preparation of beach management plans. The municipalities receive a budget for ensuring, together with the local population, the proper use, valorisation and maintenance of the structures (especially for the smaller components such as benches, parking spaces, information boards and rubbish bins). The CNPPLM can feed information on the status of maintenance work and detected shortcomings into the geographic information system that has been developed for the monitoring and management of infrastructure maintenance. Public participation is institutionalised by means of so-called *Comités Locaux des Sites* (CLS), in which residents, users and site associations are represented. Through their permanent presence on site, the CLS ensure continuous monitoring of the coastal protection structures. Together with the CNPPLM, they play an important supporting role in ensuring the sustainability of the project.

Benefits for nature and people

The above described and implemented coastal protection measures are in line with the “nature-based solutions” approach defined by the European Commission (see Box), as they provide a range of environmental, social and economic benefits. The measures are locally adapted and promote biodiversity. Dune sta-

Nature-based solutions

The EU Commission defines nature-based solutions as follows: “Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.” Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services.



Coastal protection project close to Hergla and Hammam Sousse. Ancient roman settlements are protected from further erosion via coastal walls and groynes.

Photo: Jonas Wresch/ KfW

bilitation measures preserve the specific habitat for flora and fauna. And maritime life is supported by enabling fish spawning areas within the breakwaters and groynes. Furthermore, the measures support the delivery of ecosystem services, such as erosion and flood control, provision of clean soil and freshwater resources by preventing saltwater intrusion and provision of places for recreation.

Future project activities are meant to continue building on the above-mentioned ecosystem services, promote more biodiversity and protect the respective natural habitat. Besides the dunes referred to above, already protected coastal areas = AMCP (*aires marines côtières protégées*) and the “*sabkhas*” (salty marshes) would be a field of activity in the future. These coastal and intertidal habitats provide a “natural barrier”, together with the coral reefs, kelp forests and seagrass meadows in front of coastlines. Their loss increases erosion patterns. If intact, they can help to decrease the need for “grey” infrastructure, i.e. human-induced infrastructure such as dams or seawalls.

The Coastal Protection Programme is encouraging stronger cooperation between the municipal institutions dedicated to the management of the shorelines and their respective neighbouring Marine Protected Areas (MPAs).

The latter also pursue a participatory management approach – only if the fishers have a say in at which locations they will no longer be allowed to fish will they comply with the corresponding regulations in the long term. Ideally, municipal coastal management can address decisions regarding marine habitats and shorelines with beaches, dunes and salty marshes taking into consideration what they really are: connected and interdependent.

The rising sea-level and flooding remain a threat for Tunisia's Mediterranean coast. With the coastal protection programme, around 30 kilometres of shoreline is expected to last 50 years. At least.

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Sustainable funding for the Mediterranean's marine protected areas

The Mediterranean represents roughly one per cent of the Earth's sea surface, but it is home to ten per cent of marine species known to date. It is also a breeding area for many key pelagic species. But like in other marine regions across the world, human activities and the effects of climate change are putting intense pressure on these marine resources. Founded in 2015 and headquartered in Monaco, the non-profit organisation The MedFund has set itself the goal of countering this development. By 2025, it seeks to support an area of 7,000 square kilometres of marine and coastal protected areas (referred to as MPAs or MCPAs).

MPAs are an essential tool for the conservation and sustainable use of marine and coastal biodiversity. They describe defined marine and coastal spaces where uses are limited and regulated in order to protect fauna, flora and ecosystems and to enable activities such as sustainable fishing and responsible tourism. In this manner, MPAs not only preserve the marine ecosystems and biodiversity, they also contribute to enhancing the marine environment by ensuring sustainable economic development for local communities.

According to the database Mapamed, as of 2019, marine protected areas represent eight per cent of the Mediterranean basin. However, as a consequence of a lack of sufficient funding, many of the roughly 1,200 existing Mediterranean MPAs cannot carry out their essential missions. Therefore, the MedFund aims at providing long-term funding to promote the development and effectiveness of these MPAs. Via a hybrid funding mechanism, composed of an endowment fund, a sinking fund and a revolving fund, it directly supports local NGOs and national agencies in charge of MPA management in Morocco, Albania and Tunisia. Items the money is intended for include the restoration of key habitats, scientific monitoring, maintenance of equipment and facilities, and improvement of surveillance.

In Tunisia, the initiative supports four of a total 19 MPAs: Kneiss Islands in the Gulf of Gabes, a Ramsar site and important marine nursery for the reproduction and development of fish and shellfish as well as a refuge for wintering and migrating avifauna; Kuriat Islands, a privileged place for the nesting of the loggerhead sea turtle – a vulnerable species in the Mediterranean; La Galite, a natural nursery for many vulnerable marine species; and Zembra-Zembretta, a Biosphere Reserve and the main Mediterranean nesting area for the Shearwater and the Peregrine Falcon. The aim is to promote sustainable artisanal fishing and ecotourism in the MPAs. For this purpose, the MedFund is cooperating with Tunisia's Agency for the Protection and Development of Coastlines (APAL), which is in charge of the management and development of the MPAs, and local NGOs.

The platform was initiated by France, Monaco and Tunisia with support of the Prince Albert II of Monaco Foundation and has currently 15 members, including six Mediterranean countries as well as regional civil society organisations.

More information: themedfund.org

IN BRIEF

Hardly any intact coastal regions left

Scientists at the Universities of Queensland, Australia and California, USA have performed a comprehensive stocktaking of coasts worldwide in the course of which, for the first time, the parts of the coastal zones lying below and above the water have been integrated. In the course of their survey, they noted that a mere approximately 15.5 per cent of coastal regions worldwide were exposed to low anthropogenic pressure, lying above all in Canada, Russia and Greenland as well as parts of Chile, Australia and the USA. In contrast, on a world average, nearly 48 per cent of coastal regions were already heavily affected – predominantly by human intrusions. In more than 84 per cent of countries, over 50 per cent of coastal regions were degraded. These strongly harmed and degraded areas also include habitats especially rich in biodiversity, with sea grass meadows or coral reefs in the sea and savannahs on the land side. Even in conservation areas, around 43 per cent of the coasts were exposed to high human pressure, the researchers found.

Paris Agreement limits still catastrophic for coral reefs

A team of researchers led by the University of Leeds, United Kingdom, have discovered that more than 90 per cent of tropical coral reefs will suffer frequent heat stress – their number one threat – even under Paris Agreement climate warming limits. In the past few decades, 84 per cent of the world's tropical coral reefs have had enough time to recover between heat waves that cause bleaching mortality. But the research team have found that even at warming temperatures of 1.5°C above pre-industrial levels – the level of maximum warming sought under the Paris Agreement – only 0.2 per cent of reefs will have sufficient recovery time between heat events and 90.6 per cent of reefs will suffer intolerable thermal stress. Heat stress causes the decline of all reef species and reduces food and livelihood opportunities for people.

Managing coastal biodiversity and sustaining livelihoods in a complex setting – the Gulf of Mottama Project in Myanmar

The mudflats and shallow waters of the Gulf of Mottama in South East Myanmar are renowned for their unique biodiversity. Within this area, the coastal population of some 1.5 million people traditionally gain their living from small-scale fishing and some inland cultivation. But overfishing and land speculation, leading to the destruction of mangroves, as well as the impacts of climate change, threaten the entire ecosystem. A Swiss Development Cooperation project is countering this.

By Jane Carter, Than Htike Aung, Wint Hte and Edwin Wennink

In the early months of 2021, the seizure of power by the military in Myanmar and the subsequent citizen protests made global headlines. A year on, far less is seen about Myanmar in the media – although the country's situation is deteriorating; the combination of an economic crisis, the Covid-19 pandemic, internal armed conflict and the internal displacement of people are resulting in a downward spiral of poverty. Already in June 2021, a United Nations report found that half of the country's 54.4 million people could be living below the official poverty line – effectively wiping out most development gains made since 2005. Inevitably, in such a situation, natural resources come under increasing threat as people seek ways to survive. Against such a grim context, this article offers a positive glimpse into the activities of a project with which the Swiss Agency for Development and Cooperation (SDC) has been supporting the promotion of sustainable livelihoods alongside biodiversity conservation in Mon State and Bago Region since 2015: the Gulf of Mottama Project (see Box).

A unique biodiversity

At the interface between land and sea, coastal ecosystems are always complex and diverse; this is especially true of the Gulf of Mottama in the South East of the country. The fresh water and nutrients borne by the rivers draining into the gulf, combined with abundant sunlight and high temperatures, result in a very high biological productivity. The rich benthic (bottom-dwelling) fauna and flora support at least 150,000 shorebirds, including many rare and highly vulnerable species, such as the critically endangered Spoon-billed Sandpiper. The Gulf is also home to a huge range of commercially important fishes and crustaceans, and a variety of other flora and fauna of conservation importance – and to a population of around 1.5 million who depend on the Gulf's valuable natural resources for their livelihoods.

But the valuable resources, and with them, people's livelihoods, are increasingly threatened. Fisheries stocks are declining, and mi-

gratory shorebirds face the risks of hunting and habitat degradation. Serious erosion along the western bank of the Gulf is destroying agricultural lands and displacing communities.

Combining conservation and livelihood objections

Against this background, the Gulf of Mottama Project was launched in 2015. Initially, the aim was to generate an understanding in each of the 30 selected villages of how sustainable livelihood and conservation objectives could be combined, draw up a Village Action Plan to this effect, and establish a gender-balanced committee to oversee decision-making and progress. Interventions focused on sustainable fishing and agriculture (chiefly paddy and green gram cultivation), training in alternative livelihood opportunities for young women and men (such as tailoring, rural mechanics and fish drying), access to affordable credit and disaster risk reduction. Gender ob-



Around 1.5 million people depend on the Gulf of Mottama's valuable natural resources for their livelihoods.

Photo: Helvetas Myanmar/ Wint Hte

jectives have not always been easy to achieve but are progressing, and 40 per cent of Village Development Committee office-bearers (although not in the most senior positions) are now women.

In the second project phase, the project expanded to 60 villages. Emphasis was given to consolidating village activities at township level – covering eight townships, five of which fall in Mon State, and three in Bago Region. Fishing and farming households were supported to come together in Fisheries Development Associations (FDA) and Coastal Farmers Development Associations (CFDA) at township level, and to interact actively with relevant stakeholders. Thus, for example, the FDAs developed strong working relations with the Myanmar Fishery Federation (MFF) through which it was possible to campaign successfully against illegal fishing. Such fishing entails the use of micro-small nets that trap indiscriminately, harvesting juvenile fish as well as adults.

Meanwhile, the CFDAs established their own seed banks, developed good relations with the rice millers for price regulation and quality control, and negotiated collective agreements with input suppliers. VDC level planning identified drinking water as an important concern, so project resources were allocated to WASH (Water, Sanitation and Hygiene) activities, especially drinking water infrastructure that could be readily moved if settlements had to shift due to coastal erosion. A Coastal Resources Management Plan (CRMP) was negotiated and drawn up in both Mon State and Bago Region and approved by the relevant authorities. The aim was for the CRMPs to become further embedded in government administration in phase III of the project, with national recognition; this is in keeping with the SDC Myanmar classification of the project under natural resource governance within its governance portfolio.

Action research for better understanding ecosystem interrelations

Concomitant with its support for livelihoods and institutional development, and in collaboration with academic institutions in Myanmar and Switzerland, the Gulf of Mottama Project has supported action research and data collection to deepen understanding of the unique ecosystem of the gulf. Examples of important project-funded research are on coastal erosion, fish migration and mangrove-associated livelihoods. The first of these studies showed

The Gulf of Mottama Project

The aim of the Gulf of Mottama Project (GoMP) is to conserve and sustainably develop the unique biodiversity of the Gulf of Mottama, benefiting the human communities that depend on it and increasing resilience to climate change. The Project began in September 2015, working in 30 coastal villages, and is currently in its third and final phase (January 2022 to December 2024), working in 60 villages. It is commissioned by the Swiss Agency for Development and Cooperation (SDC) with implementing partners Helvetas (lead), the International Union for Conservation of Nature (IUCN) and the local NGO Network Activities Group.

Key achievements to date:

- In 2020, the Ramsar area was extended from an original 42,565 hectares to 161,041 hectares – an increase of 380 per cent.
- As of 2020, illegal fishing had been reduced by 85 per cent, although the situation in 2021 was difficult to monitor.
- Shorebird hunting for food had been largely eliminated until 2020, but birds were again found for sale in markets in 2021.
- Over 120 ha of mangroves has been established as community forest under national legislation.
- Over 35 studies have been conducted on the ecology and/ or livelihoods of the area.
- Village Development Committees have been established in each of the 60 villages to plan and manage local resources according to a Village Action Plan.
- Eight Fisheries Development Associations and five Coastal Farmers Development Associations have been started at township level to coordinate relevant activities, with a membership totaling 1,550 fishers (389 of them women) and 2,192 farmers (724 of them women).
- Nearly 18,000 individuals (6,500 of them women) have received affordable credit for improved, sustainable livelihood activities.
- Almost 39,000 individuals (19,000 of them women) have gained access to clean drinking water and some 40,000 (17,600 of them women) have received information on safe sanitation and hygiene practices, including Covid avoidance measures.
- Over 4,041 individuals (1,032 of them women) accessed a Cash for Livelihoods scheme over the Covid period in 2020–21.

that coastal erosion is a cyclical phenomenon; currently the Western coastline (Bago) is being eroded and new deposits are forming on the Eastern side (Mon), but this will reverse over a period of 20 years or so. Rather than being caused by climate change, coastal erosion is exacerbated by it, so that villages established close to the coast may be forced to move two or three times within an individual's person's lifetime.

Fishing communities often have rich knowledge about fish behavioural patterns, but this is not necessarily reflected in official guidelines. The project-funded study by Fauna and Flora International (FFI) provided clear evidence that to spawn, the commercially important fish species Hilsa (*Tenualosa ilisha*) used to travel many kilometres upstream along rivers draining into the Gulf of Mottama, especially the Sittaung River. The creation of dams and the pollution of river waters has reduced spawning significantly, but in addition, government fishing bans are enforced at an inappropriate time of year. The Hilsa mainly spawn in January–February and juveniles are most found in freshwater over March–May. However, the

Department of Fisheries closed season is May–July, reflecting earlier colonial laws developed in other parts of the country for freshwater fish spawning times. Amongst other matters, the study concluded that the closed season fishing period should be locally adapted for Hilsa, and that community conservation areas for spawning and nurseries would be helpful.

Challenges are mounting

Climate change is a clear challenge in planning the sustainable management of the Gulf of Mottama, given that the area is especially vulnerable to climate-induced hazards such as cyclones, tidal surges, floods, saline intrusion and droughts. All these are predicted to increase as temperatures rise and intense precipitation events occur more frequently; disaster risk reduction measures must be considered accordingly. At the same time, economic, social and political challenges demand immediate attention.

Since the military take-over of government, the Myanmar economy has contracted mas-



The project interventions included training in alternative livelihoods opportunities such as fish drying.

Photo: Helvetas Myanmar/ Wint Hte

sively, with cash becoming difficult to obtain. Transport disruptions associated with the coup and Covid-19 have hit the fishing industry extremely hard, with many fishing households losing most of their income. This has forced these and other poor households into activities such as hunting for mud crabs and shorebirds. Whilst there is much potential for sustainable mud crab harvesting, the illegal capture of increasingly small crabs will inevitably reduce crab populations. Shorebird hunting had been largely eliminated, and its re-emergence is worrying.

The Covid pandemic has also negatively impacted both the health of local people and their incomes. Over the past 1.5 years, the Project has diverted resources to awareness-raising on Covid prevention, and to environmentally friendly means of bolstering the incomes of the poorest and most affected households, notably cash for work. The type of work supported

includes digging/ renovating village ponds, supporting mangrove planting and rehabilitation, and constructing basic infrastructure such as roads and embankments.

The new approach

Whilst significant achievements have been made, the military coup of the 1st February 2021 necessitated a major re-orientation of the project approach, at the same time as heightening the need for action. As a project of SDC, the Gulf of Mottama Project complies with Swiss government policy of suspending engagement with the de facto authorities. It has therefore ceased to promote the concept of a Coastal Resources Management Plan implemented through the Mon State and Bago Region administrations.

Phase III of the project is supporting the various stakeholders in the sustainable management of the Gulf of Mottama to argue their case to the authorities – effectively strengthening local level action. For this, the project is working with the Village Development Committee, Fisheries Development Associations, Coastal Farmers Development Associations, the Myanmar Fishery Federation and other relevant actors at township level to plan and implement the management of an Ecosystem Management Unit (EMU). The activities of the eight EMUs (one for each township) will be coordinated through a self-financing umbrella body, the Gulf of Mottama Ramsar Association (GoMRA). This GoMRA will follow the norms of the Ramsar Convention (see

Box), as signed by the earlier democratic government – its membership being representative of all those whose livelihoods are derived in full or in part from the natural resources of the area.

Ecosystem Management Units are a logical development that recognise the importance of working at ecosystem level (land and sea) to integrate conservation and livelihood goals. One significant example in this regard was the successful campaign against illegal fishing; when the fish catch increased markedly some six to nine months after the enforcement of a ban on illegal pike nets, all legal players in the fish value chain were convinced of the benefits of conservation. They could gain higher market prices at the same time as assuring fish reproduction for the future. This also becomes clear in a statement by U Aung Thet Htay, the Chairperson of the Myanmar Fishery Federation, Mon State: “If we cannot control illegal fishing, after six months to a year, we will only be able to catch rosy jewfish. We won’t be able to get Hilsa and other good fish species. If controlling is done, we will be able to catch many types of fish.” (Rosy jewfish or croaker, *Johnius belangerii*, is a relatively cheap fish; Hilsa is far more prized).

Similarly, members of the mangrove community forest group of Kar Te village are clear about the conservation/ livelihood link: “Now, mangroves are conserved. In the future, our livelihoods will improve as we can easily get fish and other resources. Because of mangroves, resources such as fish, shrimps and crabs will become more abundant.” (Daw Htwe Nge in a video interview).

These testimonies, and others like it, show the impact of the project on the awareness of all stakeholders and give hope for the future sustainable management of the Gulf of Mottama through the activities of those who depend on it the most. It is on supporting such collective and coordinated stakeholder action that the project will focus in the coming three years.

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The Ramsar Convention

The Convention on Wetlands, commonly known as the Ramsar Convention, was signed in 1971 in the city of Ramsar in Iran. It aims to halt the world-wide loss of wetlands and to conserve, through wise use and management, those that remain. When a country accedes to the Convention, it must designate at least one wetland site as a Wetland of International Importance. The Gulf of Mottama was declared a Ramsar site in 2017. The site was extended in 2020.



Mangrove forests are home to a rich and diverse flora and fauna of both terrestrial and marine origin.

Photos: Martin Zimmer

Mangrove forests – a nature-based solution for climate change mitigation and adaptation

The mangrove is a true jack-of-all-trades. Mangrove forests are excellent carbon sequesters, they protect coastal regions from erosion and storms, and they provide habitats for countless organisms. However, the forests have suffered severe area losses, and here, our authors take a look at approaches which might compensate for the decline and enable a sustainable conservation of this valuable natural asset.

By Martin Zimmer and Véronique Helfer

While in very rare cases, relict mangrove forests can reflect past sea-level and develop far inland (up to 170 km according to Aburto-Oropeza et al.), mangrove trees and shrubs generally grow along tropical and subtropical coasts, inhabiting the mid and upper intertidal zones of soft sediment shores. They can form dense and extensive monospecific stands or multi-species assemblages, covering sheltered coastlines, bays and lagoons, or estuaries. The global distribution of mangrove forests ranges from approximately 30° N to approximately 30° S – except for the west coast of Africa and South America and the south coast of Australia, where the distribution limit coincides with the 20°C isotherm of sea surface water. Some 65 “true mangrove” species (plant species which only occur in mangrove environments, as opposed to “mangrove associates”, which can occur in mangrove forests but also in other terrestrial or aquatic habitats) are known from the Indo-West Pacific region; the Atlantic-East Pacific region is home to only a mere dozen of “true mangrove” species.

Like salt marshes and seagrass meadows, mangrove forests are renowned for their high rate of carbon sequestration and carbon storage per unit area. The values they generate with these services, often referred to as blue carbon ecosystem services, are higher than for any other forests, and are recognised as key contributors to climate change mitigation. Interestingly, some mangrove forests of the Atlantic-East Pacific exhibit similarly high productivity and biomass stocks to those of the species-rich forests of the Indo-West Pacific. Hence, the major driver of mangrove productivity, growth and carbon sequestration, does not seem to be species richness (taxonomic biodiversity); recent studies rather suggest that the functional (trait) distinctiveness of the coexisting species is the major driver.

Besides the blue carbon ecosystem service, which is of value to humankind world-wide, mangroves provide many other co-benefits to local stakeholders of tropical coasts, who often depend on natural resources from mangroves

for their livelihood and well-being, and rely on mangroves to protect their coasts and homes from erosion and storm damage. For example, mangrove trees act as ecosystem engineers and foundation species in a dynamic soft-sediment environment by providing habitats for organisms that require a hard substratum. Their aboveground structures (aerial roots and stems) release stress and disturbance of the benthic and epibiotic fauna by slowing down currents and attenuating waves. Their aerial roots are used as substratum by organisms such as mussels, oysters, barnacles, sponges and algae, and offer shelter and feeding ground for animals like fish and shrimps during high tide. Thus, mangrove forests are home to a rich and diverse flora and fauna of both terrestrial and marine origin. Many of these species, along with other natural resources, provide food and income to local stakeholders. Mangrove crabs and various shellfish species are collected and used as food. Mangroves act as habitat, shelter and feeding ground (nursery) for juveniles of numerous fish and shrimp species that spend their adult lives

Mangrove reforestation – not at all costs

Nowadays, the approach of mangrove reforestation is well perceived in society, possibly because of the many successful forest reforestation activities on land. Numerous advertisements for diverse commercial products these days promise the planting of trees upon purchase, and more and more of them explicitly refer to mangrove reforestation. However, some of these offers have been reported in the media to be unserious or even fraud. This development warrants the implementation and establishment of effective control mechanisms and internationally accepted certificates.

Multiple mangrove reforestation activities have been undertaken over the past years, often mobilising the public to plant vast numbers of mangrove seedlings in unvegetated mud flats. But most of them proved to be failures with high plant mortality rates of up to 100 per cent. Recently, the Mangrove Specialist Group (MSG) of the International

Union for Conservation of Nature Species Survival Commission (IUCN SSC) expressed their concerns about simplistic calls for mass planting, for four reasons:

- First, an emphasis on tree-planting may distract from the priority of protecting existing mangrove forests.
- Second, studies from around the world have shown that most attempts at mass planting of mangroves fail.
- Third, mass planting often focuses on only one or two species that are easy to plant and creates species-poor stands that may not perform all the ecosystem processes of a natural forest.
- Fourth, growing and planting mangroves can be very expensive and time-consuming. If planting is not necessary, then this diverts funds from other conservation activities and breeds cynicism.

in adjacent ecosystems, such as seagrass meadows or coral reefs, or in the open sea. Thus, they provide both rich fishing grounds for local fisher people and feeding areas for predators. Fodder, teas and (alcoholic) beverages, food, honey and medicine are traditionally produced from mangrove leaves, fruits and flowers. The wood of many mangrove species is dense and hard, and it exhibits high caloric value, rendering it an excellent construction material, particularly for use in seawater, and well suited for the use as firewood or for charcoal production.

The attenuation of waves and currents by the complex three-dimensional structures of aerial roots and stems leads to sediment deposition and stabilisation. The resulting hydrodynamics

inside the forest also significantly contribute to ecosystem services of relevance for humankind world-wide. Fallen leaf litter, dead wood or rotting fruits from inside the forest are kept from tidal out-washing by the tree architecture. Drifting seagrass blades or algal wrack are deposited by the tides and retained inside the forest. This huge pool of organic matter – called blue carbon, when referring to only the carbon components – is incorporated into the sediment by the burrowing fauna or by sediment deposition. Blue carbon stocks in the saline and anoxic environment of the mangrove sediment are stable against decay over centuries and millennia. Together with the extraction of carbon dioxide (CO₂) from the atmosphere and its long-term storage in the above- and belowground tree biomass, these processes render mangrove forests one of the most efficient nature-based solutions for climate change mitigation. Further, protecting and rehabilitating mangroves has an immense potential for climate change adaptation.

How the ecosystem can be preserved and protected

Despite the increasingly acknowledged relevance of mangrove forests for local societies and their value world-wide, they have encountered drastic area losses over the last decades through human activities. Even though current loss rates are well below 0.5 per cent on a world-wide average, we are still losing

some 50 hectares of mangrove area every day. The major threats to mangrove forests encompass clear-cutting and habitat degradation by pollution (from nearby settlements or industries) or eutrophication (from hinterland agriculture or untreated sewage).

After large-scale forestry, the second major driver of mangrove clear-felling is the construction of aquaculture ponds. In many regions of the world, extensive mangrove forests had been transferred into aquaculture areas over the past decades. While decreasing productivity and increasing risk of diseases often force the owners to abandon ponds after around a decade, the changes in topography and hydrodynamics upon constructing the ponds render the area inaccessible to natural recolonisation by mangroves afterwards. In recent years, novel concepts have been applied to try to avoid, or compensate for, large-scale area losses through implementing, for instance, Integrated Mangrove Aquaculture.

Ecosystem-based management. For the sake of societal acceptance, any reasonable protection measure has to take into account requirements for the (sustainable) use of natural resources by local communities. Thus spatial conservation prioritisation, the choice of areas for protection versus use, needs to consider both the present situation and integrity of mangrove forests and projections, predictions and scenarios of their future distribution, extension and status. Along this line, Ecosystem-Based Management (EBM) takes in-depth information for ensuring the persistence of mangroves in a given area into account. Recognising previous management failures, e.g. disregarding societal perceptions and needs, or lacking knowledge of particular ecosystem processes, EBM aims at combining conservation, sustainable use and fair allocation of benefits from natural resources. It requires detailed and reliable information about the ecosystem to be managed. However, we are still lacking the knowledge of e.g. drivers of ecosystem processes or impacts of resource-use.

Restoration – from natural recolonisation to active planting. Degraded mangrove areas may be suitable for mangrove (re-) establishment, ranging from facilitating natural recolonisation of restored habitats to the active planting of a selected set of species that provide a locally or regionally urgently needed set of ecosystem services. One approach of the former is Community-Based Ecological Mangrove Restoration (CBEMR), based on the concept of Ecological Mangrove Rehabilitation (EMR) described by Lewis & Brown



Stingless bees produce honey from mangroves.

in 2014. To facilitate natural regeneration, CBEMR acts on mitigating mangrove stressors through re-instating conditions of e.g. topography and hydrodynamics from before the anthropogenic disturbance. One focal aspect of EMR and CBEMR is the engagement of local communities and sincere consideration of social, economic and ecological factors before undertaking any action, and the monitoring of the success of all actions.

When and where previous conditions cannot be restored or propagule supply from nearby systems is limited, assisted recolonisation of degraded mangrove areas through active planting of seedlings or saplings might prove necessary. However, planting efforts can only succeed if species also fit into an area, for example with respect to tidal regime, hydrodynamics or sediment supply. A recent White Paper of the IUCN Mangrove Specialist Group pledges for thorough consideration of strategies and alternatives before investing in, and wasting efforts

DEFINITIONS

Ecosystem-Based Management (EBM): environmental management approach taking into account the multitude of interactions within an ecosystem, including humans, rather than considering societal issues, species or ecosystem services in isolation.

Ecological Mangrove Rehabilitation (EMR): rehabilitation of mangrove forests via community engagement for consideration of social, economic and ecological factors, and relying on monitoring to inform corrective actions over time.

Community-Based Ecological Mangrove Restoration (CBEMR): holistic approach, aiming at recovery of mangrove areas through including local stakeholders, such as local or international NGOs, or regional government units, taking into account both ecological and societal aspects to combat specific challenges to mangrove recovery.

Ecosystem Design (ESD): implementation of novel ecosystems in degraded areas, or steering of existing ecosystems and their use, in order to sustain or improve ecosystem service-provisioning and ensure the sustainable use of these services.

Restoration: returning a degraded ecosystem back to its former state or condition.

Rehabilitation (also referred to as Ecological Restoration): re-establishing conditions of a degraded habitat in order to initiate a trajectory of development towards ecosystem recovery.



Villagers help preparing coastal protection measures in Fiji.

on, planting hundreds and thousands of mangrove seedlings in vain (see Box on page 24).

One special case of mangrove restoration is the establishment of mangroves in and around aquaculture ponds (Integrated Mangrove Aquaculture, silvo-aquaculture), aiming at optimising the compromise between the economic gain from aquaculture and the multiple socio-ecological benefits of mangrove ecosystems (also see article on pages 28–29). While mostly considered in the context of blue carbon-storage and climate change mitigation, other beneficial effects of mangrove stands, such as the above-mentioned protection of the coastline and nearby infrastructure from damage through storm surges or other extreme events, stress the value of these approaches to ecosystem-based (climate change) adaptation as a special case of nature-based solutions.

"Building with nature"

Most mangrove restoration and rehabilitation efforts focus on high biodiversity and near-to-natural ecosystem structure. A recent approach concentrates on the provision of ecosystem services according to human needs and demands. Ecosystem Design (ESD) aims at (re-)establishing those (simple) communities that most efficiently provide (a set of) ecosystem services of high demand by local societies (or humankind world-wide). Thus, while traditional restoration focuses on the ecosystem, Ecosystem Design has the use of ecosystem benefits by local communities at its very heart. Designed ecosystems do not (necessarily) aim at high biodiversity but rather restrict the community to a number of species which, in concert and interaction, are most efficient in driving those ecosystem processes that underlie the required ecosystem service(s). Thus, for instance, species-specific differences in rates of

CO₂ sequestration and storage as measure of climate change mitigation would result in establishing those species that are most efficient in this regard. Along the same line, species that are particularly efficient in wave attenuation or sediment stabilisation would be established with priority, if coastal protection were the ecosystem service aimed at. Like EBM, Ecosystem Design requires in-depth understanding of the environmental requirements and ecophysiology of a multitude of species, as well as of their interactions with other species – for many inhabitants of mangrove forests, we still lack this detailed knowledge. As for EBM, Ecosystem Design for now has to rely on "informed guesswork". Ellison et al. consider the anthropocentric and high-intervention approach of "building with nature" through Ecosystem Design – as opposed to the ecocentric "bringing nature back" approach of EMR – a strategy of the future.

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Conserving mangrove ecosystems, securing livelihoods – the seafood sector can play its part

The international community of states is stepping up its calls for the private sector to be involved in the achievement of climate and development goals. Taking pioneering projects in Costa Rica and India as examples, this article illustrates what the (organic) shrimp farming sector can do to conserve and restore mangrove ecosystems.

By Udo Censkowsky

As well as being of great ecological benefit, mangroves are highly valuable in socio-economic terms. For marginalised population groups in particular, the ecosystem services that mangroves provide are vital elements of their livelihood security. Often, though, the associated activities contribute directly to the degradation of these already endangered ecosystems. The problem cannot be solved by the public sector alone; the private sector and civil society are also called upon to help develop sustainable and inclusive value chains that enable people in or on the fringes of mangrove ecosystems to continue to make a living there. What is crucial is that income generation – whatever its basis – is linked directly or indirectly to mangrove conservation.

What shrimp production has to do with mangrove conservation

Many commercially exploited prawn and shrimp species (together with many other fish species) spend the initial stages of their lives in mangrove ecosystems. Without this nursery they would be unable to develop in the wild. In the 1990s and the first decade of the 2000s, a significant proportion of the world's mangrove stands were uprooted to make way for agriculture, fish farming and salt production – and in many cases for shrimp farming. Today, the conversion of mangrove sites for economic use is banned in most countries. Unfortunately, though, there are repeated reports of illegal activities. In addition, although conversion for agriculture or fish farming does not usually receive official approval, exemptions from the ban are often granted for purposes such as tourism and the construction of housing and infrastructure.

One of the requirements attached to the certification of organic shrimps is a ban on felling mangroves in order to establish shrimp farms. Some certification bodies, such as the German association Naturland, also consider a farm's site history in detail: if mangroves previously covered more than 50 per cent of the site, cer-

tification is refused, while if they covered less than 50 per cent, reforestation must take place on the farm. Beyond that, however, the participating retailers and their suppliers are not subject to any specific requirements – such as a duty to actively support mangrove restoration in the areas from which the shrimps originate.

On behalf of various companies in the organic shrimp industry, the German consultancy firm bluesensus has developed organically certified value chains, often linking them to pilot mangrove conservation measures. The following section describes how these measures – which are supported on a voluntary basis by three German companies (Ristic GmbH, Alnatura and Aldi Süd) – not only help conserve valuable ecosystems but also improve the living conditions of local people and enable them to earn an income. Working with a local subsidiary in Costa Rica, the fish trading company Ristic has developed the production of organic shrimps in the Central American country and now supplies the organic supermarket chain Alnatura and the discount retailer Aldi Süd; Alnatura and Aldi Süd also buy organic shrimps from India.

Restoring the hydrology of salinated areas

On the Nicoya Peninsula in northwest Costa Rica, tourism – together with arable and livestock farming – is the main source of income. Salt used to be produced there in earth ponds on the coast. Many of these earth ponds were created in the mangroves but they are no longer economically viable and lie idle. Yet because of the dams that have been created there and the high salt levels in the soil, mangroves cannot re-establish themselves or can do so only very slowly.

The Costa Rican environmental organisation Fundecodes aims to restore the hydrological condition of the areas previously used for salt extraction by removing dams and digging small channels to improve the flooding of the sties.

Fundecodes regularly holds meetings with the local community to raise awareness of mangrove conservation; it also involves local schoolchildren in litter picking. The planting tasks and the work on restoring the hydrological situation are performed by local people, who are paid for what they do. With the help of the local population about ten hectares have already been restored; this is due to be expanded to around 17 hectares in 2022. Via its local representatives, the Costa Rican environment agency Sinac is closely involved in all the activities.

The companies Ristic and Alnatura have been providing financial support for the restoration schemes since 2015 in Nicoya, where some of the farms that supply them with organic shrimps are located. Alnatura donates 15 euros for each pack of organic shrimps that it sells; on top of this, Ristic contributes a fixed amount annually. Both companies also fund measures to protect the privately owned Karen Mogensen Nature Reserve, which is nearby. The owners of the reserve, the NGO Asepaleco, are seeking both to prevent forest fires and to gradually extend the protected area. In 2021 Alnatura provided co-financing for the purchase of a former cattle farm on a 25-hectare site adjacent to the reserve. This area is now being protected and trees are being allowed to regrow naturally. This also helps to conserve the mangrove sites, because the forest cover significantly reduces erosion and silting of the mangrove stands. The forest now covers almost 400 hectares and is playing an increasingly important role in the supply of water to the coastal community.

Removing mangrove fern, supporting shellfish gatherers

Close to Costa Rica's most southerly organic shrimp farm on the Osa Peninsula is the 14,000-hectare site of the Terraba-Sierpe Wetlands, which form the largest area of mangroves in the country. Mangrove fern (*Acrostichum aureum*) grows on more than 2,000 hectares of the site. The clearance of

mangroves along the larger river arms some decades ago for timber and tannin production enabled the fern to spread widely. It currently grows to a height of two to three metres and forms a dense tangle of roots and rhizomes that has so far prevented the mangroves re-establishing themselves naturally. Although the mangrove fern is native to the region, these areas provide far fewer ecosystem services than the adjacent mangrove sites.

Over the course of some three years, cooperation with the regional NGO Osa Conservation, the fisherpeople's association Apremaa and the National University of Costa Rica resulted in the production of a restoration strategy which provides for environmentally sound removal of the mangrove fern and subsequent reforestation of mangroves. This has led to the restoration of some 50 hectares of mangrove cover between 2018 and 2021. Because the fern constantly regrows, it is necessary not only to cut the mangrove fern and plant the mangroves but also to rework the site regularly. This is particularly important in the first year after planting. This work is carried out by hand with a machete – a strenuous task that has been performed by the men and women of the fisherpeople's organisation. The costs of the trial, the supervision by the NGO Osa Conservation and the work of the fishermen's organisation have been funded as part of an Aldi Süd develoPPP project. The develoPPP programme established by the German Federal Ministry for Economic Cooperation and Development (BMZ) is aimed at companies seeking to invest sustainably in a developing or emerging country. The private-sector company must provide at least 50 per cent of the funds; the remainder is co-financed by BMZ.

Apremaa has used some of the payment to acquire a plot of land on which a small shellfish processing centre has now been established. The organisation's members earn money by collecting the piangua shellfish and selling them to middlemen. In future they will be able to process the shellfish and sell it themselves at better prices.

Protecting dykes, promoting sustainable tourism

According to the NGO Germanwatch, India is one of the 20 countries most at risk from climate change. The sea level is rising, and the cyclones that travel across the Indian Ocean have devastating consequences for coastal communities. Visitors to the Sundarbans of West Bengal (see article on page 28) will



Mangrove upgrowth after around two years in the Terraba-Sierpe Wetlands, Costa Rica.



A small channel to improve the flooding of the sties in Nicoya, Costa Rica.



Talking to the women's group in Lakshmipur, India.



Terraces and fences as a preparatory measure for integrated mangrove aquaculture in West Bengal.

Photo: Udo Censkowsky

notice that people are establishing permanent dykes or renovating old ones. The life of the dykes can be extended by replanting mangroves on the polders in front of them – not a trivial task, because at each site it is necessary to study the soil and flooding conditions in order to identify suitable species of mangrove. In organising this, the Indian NGO NEWS (Nature Environment & Wildlife Society of India) focuses on training women's groups and their mangrove stewards and on embedding the interventions in the village communities.

As with all afforestation projects, planting the mangroves is the easier part; a far more complex task is preserving the planted areas long-term. This requires the cooperation of local people. For example, fishermen need to keep to agreed channels for their boats, and livestock owners must promise to keep their cattle or goats away from the mangrove plants so that they don't eat them. Involving all the local stakeholders – especially the community's administrative authorities – and working regularly with the locally active women's group can ensure the protection of the sites.

The organic food retailer Alnatura sells organic black tiger shrimps from West Bengal. It has supported the project since 2016 by donating 15 eurocents for each pack of shrimps that it sells. In 2020 the women's group in Lakshmipur district used the proceeds to build a viewing tower on the dyke and construct a small tea shop for Indian tourists, who come mainly to see the increasingly extensive range of birds. After a two-year delay as a result of the pandemic, tourism is due to get going this year, thus generating income for the women's group. More than five hectares have been afforested at this site.

Combining extensive afforestation with agriculture

A relatively small part of the Indian Sundarbans is a protected nature reserve that people need a permit to enter; by contrast, the larger part of the Sundarbans is inhabited, and mangroves occur there at far lower density. Because almost all the available land is used, there is virtually no scope for extensive afforestation – unless new land is created by the dynamics of the Ganges river delta. Here afforestation in combination with passive conservation measures (such as fences and mangrove stewards) can speed up the process of land formation. As an incentive to run the tree nursery and engage in planting and monitoring work, the local NGO partner NEWS has developed a

participatory approach to income generation. In one case the participating families decided to start keeping hens and selling eggs. The discount supermarket Aldi Süd buys organic black tiger shrimps in West Bengal and as part of the develoPPP project mentioned above it has funded extensive afforestation that is combined with income-generating activities. Between 2017 and 2021 areas totalling some 40 hectares have been afforested at two sites, in each case with the involvement of a local women's group. The women's groups were trained and provided with necessary equipment to enable them not only to keep hens for egg production but also to run their own replacement breeding. Solar-powered incubators for the hens' eggs were purchased for this purpose. Previously the women had to buy the chicks they were going to rear.

Integrated mangrove aquaculture

As another aspect of the Aldi Süd project, three pilot farms for integrated mangrove aquaculture (IMA) were set up in West Bengal. This has involved the NGO NEWS and the organic shrimp producer Blue Sea Aquaculture, which is based in Calcutta, incorporating more than ten hectares of mangroves into existing organic shrimp ponds. This form of production, which was previously unknown in India, has great potential – especially for regions that will be particularly affected by sea-level rise over the

next 50 years. Integrating mangroves will help stabilise pond dams, increase biodiversity, alter the microclimate and bind carbon. Above all, though, the mangroves in the scheme developed by bluesensus and NEWS will also improve the living and growing conditions for shrimps, fish and crabs in the ponds. As yet this is a pilot project that still needs to be refined and scientifically monitored.

Systematic expansion of the initiatives is envisaged

In India and Costa Rica functioning structures have been established that enable the initiated projects to be implemented quickly and thus contribute to the mitigation of global warming. In India the search is under way for partners who are interested in investing in the further development of integrated mangrove aquaculture. In Costa Rica the aim is to restore the 2,000 hectares of mangrove fern as an intact mangrove ecosystem as quickly as possible. Further supporting research is also needed to help with issues such as exact measurement of carbon storage at the individual sites.

The seafood sector, which deals in products from tropical brackish water aquaculture and thus often has a direct connection with mangrove ecosystems, is an obvious candidate for such involvement. Bluesensus and the German NGO Global Nature Fund are currently de-



Women's group involved in extensive afforestation in West Bengal.

Photo: Sourabh Dubey

veloping a scheme that will give the seafood sector a very easy means of participating in the financing of restoration measures (see also following article). If all Germany's sellers of organic shrimps were to adopt the Alnatura model, this could make a significant contribution to climate change mitigation and help improve the living conditions of many people on the brink of poverty.

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A multi-stakeholder partnership for integrated mangrove aquaculture in the Sundarbans

Shrimp farming often involves the felling of valuable mangrove forests. Through the Sustainable Aquaculture in Mangrove Ecosystems (SAIME) project, the Global Nature Fund and partner organisations in India and Bangladesh aim to halt the loss of these valuable ecosystems while securing the livelihoods of small-scale aquaculture farmers.

By Ralph Dejas

More than a third of all mangrove stands in the world's tropical coastal regions have been lost since the 1980s. This means that the habitats of these salt-tolerant plants are shrinking three to five times faster than tropical rainforests or coral reefs. These valuable coastal ecosystems are being deforested for firewood and settlement, but more than half of the cleared area is being used for new aquaculture ponds. In many of the world's coastal regions, prawn and shrimp farmers are felling mangrove forests because species-rich river deltas are perfectly

suitable to aquaculture of the tasty crustaceans. The aquaculture market segment has grown dramatically in recent years. Seafood produced in various forms of pond farming, in net cages or in other closed-circuit systems now accounts for more than a third of the global seafood market. Global consumption of fish and seafood now averages 20 kilos per person per year, and the figure is rising. While sustainable aquaculture presents opportunities to use controllable production to combat the over-fishing of the world's oceans, the drawbacks of

inappropriate methods are obvious: fish meal used as feed in aquaculture systems contributes directly to overfishing. Often, too, the breeding ponds are over-fertilised and polluted with antibiotics.

The Sundarbans (the word is Bengali for "beautiful forests") are the largest contiguous mangrove area in the world, yet they are under severe threat. This unique ecosystem extends from the east coast of India to Bangladesh. The area, the home of the last wild

Bengal tigers, is under great pressure from intensive shrimp farming. The Global Nature Fund (GNF) has been involved in mangrove conservation in Asia since 2005 and has been active in the Sundarbans region since 2018. In the Sustainable Aquaculture in Mangrove Ecosystems (SAIME) project, a multi-stakeholder partnership, the GNF is working with two local environmental organisations – the Nature Environment & Wildlife Society of India (NEWS) and the Bangladesh Environment and Development Society (BEDS) – and with Naturland, Germany's largest internationally active organic agriculture association with extensive aquaculture expertise. Together these organisations are developing approaches to the sustainable conservation of mangrove ecosystems in aquaculture landscapes. SAIME also receives professional advice via a supportive working group comprising experts from the Leibnitz Centre for Tropical Marine Research (ZMT) in Bremen, Germany, the food trade and a consultancy company (bluesensus) that specialises in the sustainable seafood business. The project region has an important light-house function: almost 85 per cent of global shrimp production is based in Asia, much of it in India and Bangladesh.

Win-win for people and nature

On 40 model farms in the Sundarbans the partners are pursuing a methodological approach that complies with one of the basic principles of the Global Nature Fund's work at the interface of environmental protection and development cooperation: nature-based solutions. Instead of turning to complicated technology that is often hard to install, use and maintain in more remote parts of the world, the project relies on simple yet innovative methods that use what nature itself provides. For the SAIME project this means helping the pilot farms establish what is known as Integrated Mangrove Aquaculture (IMA). In IMA the farmers plant mangrove seedlings directly in the breeding ponds in order to combine shrimp farming with mangrove conservation. This enables a variety of synergies to be exploited: the mangrove trees stabilise the dams, protect the ponds from floods and provide shade. The shrimps thrive in the roots and feed on fallen leaves. In addition, biodiversity on the pilot farms increases, and the farms serve as a place of inspiration and training for other farmers in the surrounding area, so that knowledge of this practical and functional method is passed on. The aim is to replant mangroves on damaged coastal strips, which will thus be stabilised in a way that is compatible with shrimp farming. In

India alone, the 40 partner farms in the project have already planted more than 6,000 trees in 2019 and 2020, the first two years of the project. The seedlings are grown in tree nurseries that were set up as part of the project and are managed by women. By the end of 2021 more than 100,000 mangrove seedlings had been produced in the project region.

The purpose of the project is not to expand shrimp farming in the partner regions but to put it on a sustainable footing while at the same time creating sustainable livelihoods for the shrimp farmers. It therefore started with awareness-raising campaigns on sustainable aquaculture by the partner organisations NEWS and BEDS. Interested shrimp producers then made their farms available as pilot sites. The partner organisations are also training the shrimp farmers in sustainable aquaculture and training the women in the tree nurseries. The shrimp farmers receive the mangrove seedlings free of charge; the cost – and the women's income – is funded by the project. The shrimps are currently being sold via local markets. In Bangladesh a cooperative has been formed and a cooperative building erected. This serves as a training facility and also as a contact point for the farmers, giving them the opportunity to pool their harvests. To facilitate this, there are also plans to erect a cold store. The long-term aim is to achieve organic certification for the farmers via a group certification scheme, so that they can obtain higher prices for their shrimps.

Consumers and retailers have a part to play

Farmed shrimps are an important export product for India and Bangladesh and they provide a livelihood for many people in the project region. In view of the need to strike a balance between social and humanitarian considerations on the one hand and environmental concerns on the other, it makes more sense to encourage an innovative nature-based solution – such as Integrated Mangrove Aquaculture – rather than simply criticise aquaculture for its adverse impact on mangrove forests. But it is also important not to dismiss the problem as a matter for southern Asia to deal with: via the decisions that we make as consumers, we Eu-



The tree nurseries are managed by women.

Photo: Ralph Dejas/ GNF

ropeans are partly responsible for the way in which shrimps are produced in other parts of the world. In consequence, one of SAIME's key objectives is to improve the small-scale farmers' access to the market and achieve positive impacts on the supply chains. The project therefore involves the German retail trade and informs consumers about the social and environmental benefits of sustainably produced shrimps. The example of Alnatura, one of the largest organic food retailers in Germany, shows that this can work well (see article on page 26).

The SAIME project runs initially until March 2023. It is funded by the German Federal Ministry for Economic Cooperation and Development (BMZ), with additional financial support from Daimler Truck AG and Mercedes-Benz AG. The project is already carrying out valuable activities, including capacity-building by local civil-society organisations, linking and strengthening the local smallholder population and creating durable North-South and South-South dialogue structures. There are plans to bring other food retailers on board in addition to Alnatura, so that they can help raise awareness among consumers in the Global North. Because of the coronavirus pandemic, much of the discussion of this issue with food retailers in Germany has so far had to take place remotely. The Food for Biodiversity association, which the Global Nature Fund played a part in founding in March 2021, now brings key stakeholders in the food sector together and engages them in constructive dialogue.

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Evidence-based regulation for sustainable development – coastal protection in Ghana

Taking the example of the Environmental Protection Agency (EPA Ghana), our authors give an account of the coastal protection activities of an environmental authority – the research and monitoring projects it conducts, how it collaborates with other stakeholders to co-manage the environment, and their impact in environmental legislation.

By Sheila N. A. Ashong and Peace D. Gbeckor-Kove

Ghana has a coastline of about 550 km which hosts several ecosystems such as mangrove stands, lagoons, estuaries and rocky and sandy beaches with high species biodiversity (see Box). Accounting for 6.5 per cent of the nation's terrestrial area and 30 per cent of its population, the coastal area is vital for the national economy, supporting the fisheries, transportation, energy and petroleum sectors. For example, ten per cent of the rural population are employed in the fisheries and aquaculture value chain, which contributed about one per cent to GDP and represented 4.9 per cent of agricultural GDP for the period 2017–2020. Women play very important roles in this sector, ranging from owning fishing vessels and financing fishing trips to managing the marketing and pricing of fish. The post-harvest sector is also largely dominated by women, who form the majority of the fish processors and fish marketers.

But like in most countries, Ghana's coast is under threat from human activities such as increasing urbanisation caused by migration and a high population growth rate, increasing infrastructure development, economic growth and industrialisation, wetland and mangrove degradation, water pollution, coastal erosion, fisheries degradation, invasive aquatic weeds, poor sanitation and plastics pollution. One example of the resultant

impacts of such challenges on coastal communities is the recent tidal waves experienced at Dzita and Fuveme in the Keta municipality, which left hundreds of people displaced and was accompanied by significant damage to personal and public property.

Coordinating environmental protection

The management of the coastal resources is distributed across several institutions: the Environmental Protection Agency (EPA), the Ghana Maritime Authority, the Fisheries Commission, Ghana National Petroleum Corporation, the National Petroleum Authority, the Petroleum Commission, the Wildlife Division of the Forestry Commission, the Ministry of Local Government, the Ghana Tourism Authority and the Coastal Development Authority. EPA's role is explained in more detail in the following.

Established in 1999 by the Environmental Protection Agency Act, EPA's mission is to co-manage, protect and enhance the country's environment and to seek common solutions to global environmental problems. To meet its mandate for positioning environmental governance and management within the broader framework of Ghana's development path and to define strategic themes and actions, the

Agency works in liaison and co-operation with government agencies, District Assemblies and other bodies. Its coordinating role has served to enhance and inform action for regulatory improvement and support efforts in all other sectors beyond that of the environment. The enforcement of the Environmental Assessment Regulations 1999, for instance, guides development activities across all national economy sectors.

Since its inception, the Agency has collaborated with numerous stakeholders to ensure the achievement of its mandate regarding coastal zone management. Several plans have been developed and implemented to protect and manage coastal and marine resources while promoting sustainable development: the Coastal Zone Management Indicative Plan (1990), the National Environment Action Plan (1994), the Integrated Coastal Zone Profile of Ghana (1998), the National Action Plan to address the depletion of marine and coastal resources (2011) and the National Oil Spill Contingency Plan (2020). In addition, the Agency coordinated the implementation of the Ghana Environmental Resources Management Project, that resulted in the delineation of the five coastal Ramsar sites: Muni-Pomadze, Densu Delta, Sakumo, Songor (a UNESCO Biosphere Reserve including the Volta Estuary) and the Keta Complex.

Coastal erosion at Ada, on the southeast coast of Ghana.

Photos: Peace Gbeckor-Kove



Institutional collaboration for research

EPA collaborates with relevant institutions for research and environmental data generation to inform policy and regulations on the environment. The research information serves to strengthen the lead role EPA plays in signing and ratifying conventions for the country. Hence, the Agency hosts the secretariat for key international conventions on desertification, climate change, marine pollution, oil spill contingency planning, biodiversity, ozone and chemicals regulation (also see Box on page 32). Some recent research activities are described below.

Beaching of cetaceans in Ghana's waters

There was a remarkable increase in the incidence of the beaching of cetaceans (whales and dolphins) on the coast of Ghana between 2009 and 2013. To fully understand the various causes of whale mortality, EPA convened a meeting of key stakeholders to discuss the issue, after which a study was conducted to investigate cetacean deaths. Interviews were conducted and questionnaires were administered in incident communities in the Western and Central Regions in February 2014, and interactions were held with various community assemblies. The Fisheries Commission, Ghana Navy (Western Command), the Ghana Maritime Authority, the NGO Friends of the Nation, Ghana's Western Region Development Network of NGOs (Werengo) and the NGO Hen Mpoano ("Our Coast") were also consulted. Focus group discussions were held with the Traditional Authorities, and members of the various coastal communities were visited. Photos were used to identify species and determine possible causes of mortality. The study suggested ship strikes, entanglement with fishing gear and ingestion of marine debris (polyethylene) as possible causes of cetacean mortality. It was also observed that Ghana already had extensive legislation to aid the conservation of biodiversity and protection of the environment.

Occurrence of pelagic sargassum species and assessment of their socio-economic impacts on livelihoods

Sargassum vulgare and *Sargassum filependula* are naturally occurring brown algae found in coastal waters. Given an unusual increase in the incidence of sargassum in Ghana since 2009, the EPA coordinated a project in 2015 covering species in the coastal waters of the country and assess their socio-economic impacts on 36 coastal communities in which the varieties *Sargassum natans*, *Sargassum fluitans* and *Sargas-*

Ghana's coastline

Cutting across 37 districts located in four of the country's 16 regions which have a diversity of cultures, Ghana's coastal area has, over the years, gained increasing local and national relevance for the development of settlements, industrial purposes, infrastructure, port facilities, petroleum industries and residential purposes, among others. Critical infrastructure found in this area includes the Ports of Takoradi and Tema, Ghana National Gas Company, Accra Sea Water Desalination Plant and manufacturing companies such as Ghana Cement Limited and Pioneer Food Cannery. The area has salt deposits of silica, limestone and feldspar, and holds an immense potential for tourism development.

sum vulgare were identified. All 150 individuals interviewed in the coastal fishing communities (of whom over 81 per cent were fishermen) indicated they had sighted *Sargassum* spp. washing ashore in the period. Thirty-five per cent reported that seaweeds were washed ashore seasonally, and 65 per cent that sargassum occurred all year round. A reduction in the quantity and effects of the weeds from the Western Region towards the Volta Region was observed. The main impact of the seaweeds on the coastal communities was that their accumulation on beaches impeded movement of canoes, damaged fishing nets and resulted in low fish catch and a loss of revenue for fishermen. The results of this study have been published and the recommendations duly factored into the development of the National Invasive Species Strategy and Action Plan 2020. The strategy draws on previous lessons to address invasive species through measures such as early detection and rapid response, improved control and management, capacity development and education.

State of the Marine Environment (SoME) Report for the Western Region

This study formed part of the Ecosystem Based Approach to an Integrated Marine and Coastal Environment Management in Ghana pilot project, which was co-funded by the Government of Ghana and the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) as part of the International Climate Initiative. EPA implemented the study in four coastal districts, the key stakeholders being regulators, academia, users, NGOs, fishermen, fishmongers, Traditional Authorities and District Assemblies. A desktop review was conducted of available primary and secondary information from stakeholders involved in the manage-

The coastal area also has five Ramsar sites – wetlands of international importance according to the Ramsar Convention – and important natural and cultural heritage sites. Plant and animal species include white, red and black mangroves, the baobab, the leatherback turtle, the red chin tilapia and the West African manatee.

The historically strong cultural presence and spiritual attachment of rural coastal communities is made evident in the coastal fisheries, with a significant proportion of the population unwilling to be involved in other livelihood activities taking them away from the coast. Cultural practices include weekly no-fishing days and the performance of rites at the beach during the annual festivals to invite a bumper harvest.

ment of Ghana's marine and coastal environment, and was complemented by assessment reports, the use of traditional knowledge and expert elicitation during stakeholder consultations. Fishermen and mongers gave accurate descriptions of the life cycle of key fish species.

Three mangrove species were found in the study area: the red mangrove, which is the dominant species, the white mangrove and the black mangrove. They were all found to be on the decline due to over-harvesting and habitat conversions. Also, five species of turtles were spotted, three of which (leatherback, green and olive ridley) currently nest on the sandy beaches. The dominant fish species include the sardinellas, anchovies, mackerels for the marine ecosystem and tilapia species for the fresh and brackish water systems.

Other environmental pressures identified in the area are fisheries activities, offshore hydrocarbon exploitation, plantation development and sand winning, sea defence infrastructure, shipping, submarine cables and pipeline installations, tourism/ recreation, and waste generation and disposal (marine debris and plastics). These human activities have harmed habitat conditions, reducing their ability to continually provide quality ecosystem benefits. An expert elicitation workshop found the habitats to be in good condition, although environmental quality was said to be on the decline.

Over-fishing, excessive fishing capacity, illegal, unregulated and unreported (IUU) fishing and use of unapproved fishing methods had negatively impacted on the fisheries sector, particularly with regard to the socio-economic well-being of people depending on fisheries for their livelihoods. Inappropriate waste dis-

posal, especially of plastics, was found to affect the marine and coastal environment. Offshore hydrocarbon exploitation was noted to be still in its initial stages, although the industry's environmental pressure on the marine and the coastal environment was increasing. Generally, environmental pressure from submarine cables, pipeline installations, sea defence infrastructure and plantation development is low within the study area.

The study recommended to promote effective collaboration among regulators, researchers, industry players and coastal communities for resource exploitation. Other recommended measures to address the issues identified include regular monitoring and applied research as well as sustainable financing to ensure continuous conservation education, enforcement of requisite laws and regulations by the relevant institutions, while collaborative management (co-management) of the fisheries is recommended to strengthen fishermen's resource management capacity.

The active participation of the coastal population in the workshops, data/ information collection and validation of the study results played a major role in preparing the SoME report, launched in February 2022, and policy briefs. Additional summary reports are to be developed for selected decision-makers.

Stakeholder sensitisation and promotion of International Days

As a way of creating awareness on environmental issues, EPA has carried out various activities for a range of stakeholders over the last few years. These include:

Contribution of EPA's research programmes on environmental regulation

EPA's research is geared towards generating information to inform policy and educate the public e.g. through State of the Environment Reports. Implemented programmes of relevance to the coastal area include:

- ecological baseline studies of the Keta Lagoon (1990–2000) to meet Environmental Assessment requirements and establish the pollutant status of the lagoon;
- the Lower Volta Mangrove Project (1996–1998), which aimed at sustainable management of mangrove stands;
- climate change vulnerability and adaptation assessment of water resources, agriculture and the coastal zone project (1997–1999);
- Keta Sea Defence Project work (2000–2004) aimed at protecting Keta and its environs from sea erosion and improvement of socioeconomic and environmental conditions;
- the Save the Seashore Birds Project (1985–1995) to protect the birds and raise awareness on the need for conservation; and
- the Darwin Initiative of West Africa Project, which provided training for biodiversity assessment.

- education on environmental sustainability for members of faith-based and community-based organisations;
- provision of support to environmental NGOs to undertake awareness creation at sub-national and local level;
- development of environmental education materials (flyers, booklets, wall-charts, teachers' source book, etc.) on key environmental themes for schools;
- development and distribution of supplementary readers on environmental issues for schools;
- preparation and publication of State of Environment Reports; and
- implementation of schools outreach programmes.

Moreover, the Agency collaborated with various stakeholders, including coastal communities and school environmental clubs, to cele-

brate World Environment and World Oceans Day. Starting in 2022, the International Biosphere Reserves Day will be added to the list of International Day celebrations, in which partnerships formed with waste management companies such as Zoomlion and Jekora Ventures and with the Fisheries Commission have been key to the success of activities.

In spite of the achievements outlined above, the enforcement of existing legislations still faces several challenges, and there is room for improvement, with a clear need to strengthen the capacity of the existing institutions as well as to continue stakeholder sensitisation. A dearth of information remains on the impact of plastics, presenting opportunities for research to inform recycling initiatives as well as to look at using harvested sargassum to produce compost for agriculture and possibly developing the coral reefs along the western coast for ecotourism.



Community stakeholders at a validation workshop held in Sekondi Takoradi in December 2019.

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“ Diversity is the fundamental principle to use ”

Aquatic foods and food systems have long lived in the shadow in agricultural research. Last year's award of the World Food Prize could change this. Prize recipient Shakuntala Thilsted on healthy nutrition for the poor and vulnerable, the role of progressive governments and simple solutions with a big impact on women's empowerment.

Ms Thilsted, last October, you were awarded the 2021 World Food Prize, often referred to as the “Nobel Prize for Food and Agriculture”. Would you have ever expected to receive this award?

No. I never thought it would come to me, especially because traditionally the focus in food and agriculture is still largely on food crops, on livestock, while aquatic foods don't figure much. So in that respect I was extremely happy to get the award because it was shining light on an area that is unrecognised and underrepresented in the global narrative.

Was does this award mean to your research work?

Well, I have to say that a number of things came together last year. 2021 was also the year of the UN Food Systems Summit, where I was able to bring in aquatic foods and aquatic food systems quite prominently. There was a lot of talk about land and food at the Summit, but not much about water, so it was very opportune to be able to bring in water systems and foods from water, both marine and inland. And we had COP 26 in Glasgow, Scotland, integrating food systems and climate. Now, for example scientists are talking about the value of seaweed, molluscs and low trophic aquatic foods which are good for nature and the environment. At the same time, I can bring in the aspect of aquatic foods being superfoods and being nutritious, especially for the poor and vulnerable. So there has been a lot of good convergence. But research investment still largely concentrates on food crops rather than on aquatic foods.

You are a co-author of the UN Nutrition discussion paper on the role of aquatic foods in sustainable healthy

diets. In a nutshell, what is so special about aquatic foods?

The first thing is their diversity. For when we talk about aquatic foods, especially in high-income countries, for example, they may know salmon and they may know tuna. When you go to a village in Bangladesh and you ask children to name fish species for you, in next to no time, you can get 50 names. I doubt this would be the same at a Danish school. And it is not just the case with fish, but with other animals, plants and microorganisms as well. The way how aquatic foods are used, especially in low- and middle-income countries, is also quite different from the ways people use these foods in rich countries. Here, we know about the slice of fish or grilling a piece of fish, whereas in poorer countries in Africa and Asia, we have mixed dishes bringing with them vegetables, spices and the whole fish. And then there are all the nutrients coming with this rich diversity. It's not just protein, it's minerals, it's vitamins, it's essential fatty acids, so again you have a diversity of contributed nutrients, which is important. And with COP 26, there is also the focus on sustainability. Aquatic foods are good for the people and for the environment.

Only four per cent of food systems-related research since 1970 has included aquatic foods. Why has the role of aquatic foods and food systems in research been overlooked for such a long time?

I have asked myself that question too. Just look at milk powder, which has been used for school-feeding programmes for five generations now. Even in rich countries, where you don't need it, you still have milk in school programmes. And then, look at the nutrition-

al value of fish powders and how fish powder can contribute to nourishing children in Africa. Milk has calcium and protein, but not much else, whereas fish powder comes in with vitamin B12 for cognition. This neglect of aquatic foods could have something to do with strong private sector influence. Look at the big companies that work with grains, for example, where many interests and much money are involved.

So why did you decide to focus on this topic in your research work?

Most people working with food and within agriculture start from the production side and the inputs for production. But I start with consumption. Looking at consumption data, you see what the important foods for people's diets are, you see their value for supplying nutrients. You end up looking at a greater diversity and a greater range of foods. Unfortunately, with our agricultural patterns, we have moved to monoculture, and I think we have not fully realised the danger we have put ourselves in by looking at agriculture and food with this very narrow lens. Just imagine the cost of overweight, cardiovascular diseases and diabetes all of which are related to the ways we produce and eat food. What if we took some other very important factors into consideration, for example the effect of proper nutrition on cognition? Instead of thinking about food as provoking diseases and heart attack, we could say: Wow, let's look at the way we eat and think about how we can positively influence school performance. What a difference this would make!

And why aquatic foods?

I left working with rice and vegetables because I see the power of aquatic foods with all its nutrients being superfoods. Another reason was that I did much of my work in Bangladesh, which is highly dependent on aquatic food. But this applies for many countries in Africa as well, where the food with the highest density of nutrients is dried fish. It is also eaten by population groups living very far from the coast who get fish from inland water bodies. Dried fish is easy and inexpensive to move across borders because it doesn't need refrigeration. But the only way women can preserve the fish is with sun-drying. If we had developed very good systems for solar-drying, if we had proper packaging for this fish, we would save so much loss and waste we have with this very important



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food. More than a third of the food produced globally is lost and wasted. So shouldn't we be putting our investments in research in reducing loss and waste rather than in producing more?

What developments do you see in aquatic food-related research?

I see that now people are talking more about diversity and not just salmon production for the rich in aquaculture. The link to climate is also becoming more important. And more groups are working with the nutritional value of different aquatic foods. What also is about to change is that when we talk about quality, we should be really considering both nutritional quality and food safety. Food safety is an area that needs a lot of work going forward.

Which brings us to the knowledge gaps ...

Aquatic foods is new on the agenda of foods, so the gaps are big compared to staple food crops like rice or maize. And they are across the board. For example, a lot of women are engaged in capture fisheries. These women are invisible in the data. There are also big data gaps with respect to which aquatic foods are consumed and by whom, as well as regarding nutrient content and composition, and the food safety aspect. We know nothing about microplastics in aquatic food. Research should also be done on the complementarity of foods. When you combine foods, how does this give you better value than each of the separate foods? There are components, food substances, that enhance the value of the other foods. That's an area of work that no-one has touched as yet. Another aspect is that so far, the research focus has been on the monetary value – what you produce, how much you can sell, at what price, what the monetary value is for the exporting countries ... But monetary value is only one value. For instance, how would you value a nutritious food which promotes school performance or a woman's health? A healthy woman goes on to having a healthy child and gives intergenerational benefits. So, our global notion of value only as monetary value is extremely short-sighted and narrow.

You were also Vice Chair of the UN Food Systems Summit 2021 Action Track 4 – “Advance equitable livelihoods:” How can aquatic foods contribute to this goal?

Action Track 4 was the only one of the five Action Tracks that was specifically on people, and the focus that we took was on women, youth and indigenous peoples. Look at the number of women working in aquatic foods, for example in Africa. Fishing is mainly done by men, but the supply chain's part – drying,

processing of fish, smoking – is all women's work. And many indigenous peoples are coastal populations where fishing is a major part of their livelihoods. So especially for indigenous peoples and women, aquatic food systems play an important role.

Do you feel that with the Summit, the global narrative regarding food and nutrition has changed?

As far as the Summit's stance is concerned, yes. But now, we need to put solutions in place. This is all the more important as with Covid-19, the numbers of poor and malnourished people have increased tremendously. There are some obvious solutions that many have talked about, for example, school feeding programmes. We need to ensure that school feeding programmes reach the poor and vulnerable, and that here, we talk not only about rice or maize, but also about nutritious foods and a diversity of foods so that we can have children who are well-nourished, can do well in school and thereby can be an asset to their communities and their countries. It would be fantastic if we could combine school feeding with nutritious aquatic foods and have that as part of the solutions moving forward.

It didn't take a Food Systems Summit to make you a food systems thinker – the impact of your work has long been crossing over different disciplines and sectors, and it has been influencing politics as well. Can you give some examples?

One fascinating example is Odisha. People knew about my work in Bangladesh and asked me if I would go to Odisha with pond polyculture, which I did. In just three years, we were able to implement pond polyculture, school feeding programmes with dried fish, mother and child healthcare programmes and take-home rations with dried fish.

How was this possible?

Because the State Government – which is extremely progressive – could see the value in it and supported it. In Odisha, as in many rural parts of India, each village has a pond called the Gram Panchayat tank, which means the village community water body. We were able to get the State Government to allow us to introduce pond polyculture in 600 ponds. Each tank was allotted to a women's self-help group, each comprising ten women. We gave them the training and the support and staff, and they started doing pond polyculture with fish in these tanks. We did this for about two years. And last December, the State Government decided that all the 74,000 village tanks in the



Preparing fish chutney.

Photos: WorldFish

State would be allocated to women's self-help groups for pond polyculture. Can you imagine moving so fast in such a short time?

Women's empowerment through aquaculture, as it were ...

Yes. But there is still much more to be done. If we want to have a positive effect on women's livelihoods and women's income and nutrition, they must be represented throughout the whole system: at policy level, when you form the strategies and the interventions, but also when you do the assessments, asking what went right, what went wrong, how something can be done better. There is a big gap in this respect in all the ways we do development and use scientific knowledge. And the other important point is that we should be able to combine new scientific knowledge with traditional knowledge. Now, with all the tools we have available – data, new technologies – doing it should be easier. But it's still not done.

Why?

One thing is the knowledge, the next thing is how you extract it. We use our modern-day methods to extract traditional knowledge, as we do with scientific knowledge, whereas traditional knowledge rests on storytelling, for example. But we don't use storytelling in modern technologies. So we haven't been able to mesh those two.

Is the role of women in food value chains different in Africa and Asia?

No. But in Asia, there have been more groups working specifically with women and women's empowerment, for example, the Grameen Bank movement. Another fact is that in an African village, households are spread apart from each other. If you go to a village in Bangladesh or India or Vietnam, it's physically close, so it's easier for women to get together, learn from each other and be a group than it is in Africa. And if you take Bangladesh, for example,

which has progressed a lot regarding women's development, there is another reason. Everyone in Bangladesh speaks the same language, they all speak Bangla. So, it's easy to converse and work together.

You have also been distinguished for the development of innovative food products – by the 2021 Arrell Global Food Innovation Award. Can you tell us a little about this?

Where I started and what people call an innovation now is the pond polyculture. I was the first to say that when we do aquaculture in ponds, we shouldn't have just one fish species. And we shouldn't have just large fish species which are farmed but also small indigenous fish within the mixture. Everyone said: Oh no, the small fish will harm the growth of the large fish, and the production system will be less profitable. But I said: Let's try! And what we found out was that polyculture of large and small fish gives you greater quantity, greater nutritional quality – because the small fish come in with all the micronutrients – and a more resilient system because you are using different levels and different niches in the pond. And, importantly, you are not using chemicals to clean the pond, you can't do that because now you are using the indigenous fish species. So, it was a win-win-situation. But I also realised that one thing was having the fish in the pond, but another thing was moving the fish from the pond to the pot. We developed ways in which women would not depend on the men to harvest the fish. They themselves can have a net for the fish that they can pull with a pulley. This is how they can get small amounts of fish, take it to the kitchen and use it as part of the meal.

You also invented products like fish powder and fish chutney. What was the idea behind that?

When you are working in rural areas, people talk a lot about women's empowerment and women's engagement, but yet they do not look at their workload. With products that are nutritious and ready to eat, you can cut down the time for the women and also give them a constant source of nutritious food. If you make a chutney of high nutritional value, you can add it as a condiment to the main meal. Or when you prepare a porridge for the child, you can add a tablespoon of fish powder, then you will have a very nutritious meal. One of the very important benefits of products like these is that you are removing the moisture content. The food has a long shelf life at room temperature, and you can keep that for a long time, but most importantly, nutrient concentrations are increased four-fold. Getting much more nutrients in a very con-

centrated amount of food is extremely important for young children because their stomach capacity is quite small. The foods that are eaten in Africa are often bulky, with a low nutrient concentration. So again, with very simple solutions, you are addressing very grave constraints and eliminating or reducing them.

How do you get acceptance for these products?

First of all you have to use taste and flavour that match the community you work with. But once that is settled, you need to bear in mind that all parents and grandparents want their children to be healthy and smart. So already there you have a great degree of acceptance. If you can get the knowledge to the people in a way that they understand and show them the importance for the health and for the cognitive development of the child, then you have gone a long way. It is not as difficult as people think it is. It is just that they don't take the time and effort to be able to show the benefits.

One of the most difficult things with research is getting it to the ground and scaled. What is your recipe for success here?

Engagement with the communities. Finding solutions that fit with the communities and where they are engaged and also manage the solutions. One example is Cambodia, where we worked with the community refuge ponds – these are sanctuaries within the communities and are managed by them. In the dry season – we are talking about wetlands – you have these sanctuaries in the villages where there is water so that the fish and other aquatic foods can move there, and when the rains come, they move out. And regarding scaling, many years ago, I did pond polyculture in Nepal in the Terai. People only think of Nepal as a mountainous country, but 60 percent of the population live in the Terai, which is the same agro-ecological zone as Bangladesh. I took women from the Terai to Bangladesh so that they could learn about pond polyculture. And up to today they are still continuing. This is also the case in other areas. Before the pandemic, I had submitted an application to the United Nations International Fund for Agricultural Development stating that I would like to take some Cambodian farmers to communities in Kenya in order to work with them to organise themselves in groups of both women and men,



A woman using a mola gill net – an innovation developed by Shakuntala Thilsted – in Bangladesh.

construct and manage community fish refuges and discuss with them the multiple benefits.

What is the most exciting, the most satisfying part of your work?

Two things: working with the communities and seeing change, especially the acceptance of the benefits of the work I do for women and young children. The other part of it is the mentorship of young professionals and seeing others take the work I do to the full heights. It is so giving when you see that what you have done continues and grows.

And the most frustrating one?

Being able to attract the funding is pretty frustrating. And even when you get the funding it's still frustrating and challenging because it's small, and it's for a short period.

So what is next?

I want to put up a large programme looking at the nutritional value and food safety and the benefits for environment and climate of diverse aquatic foods, including seaweed. No-one has worked with this before in such a composite manner.

If you prepared an article on aquatic food, what would be the most important keyword?

Diversity. It's amazing. In our world, in our own life we want diversity, we don't want to eat the same food every day, we don't want to wear the same clothes every day, but yet, in a lot of our development schemes, we eliminate diversity. For me, diversity is the fundamental principle we must all use.

Shakuntala Thilsted was interviewed by Silvia Richter.

Chocolate made in Africa – the start of a small revolution?

By exporting raw materials, many African countries are still giving away the opportunity to generate value at home through a processing industry of their own. The cocoa sector is one of the areas in which this applies. Some entrepreneurs are now starting to explore the market for themselves. Is there a future for chocolate made in Africa?

By Christian Selbherr

Côte d'Ivoire is the world's largest producer of cocoa. Each year it harvests more than two million tonnes of cocoa beans; this is around 40 per cent of the global crop. Until recently, though, there was not a single manufacturer in the country itself that was turning the coveted beans into powder, butter and – in particular – chocolate. Almost the entire crop was exported – and then in some cases re-imported as chocolate.

Axel Emmanuel Gbaou felt that that needed to change. A few years ago he left a well-paid job in a bank in France and set up his own small

business, “Le Chocolatier Ivoirien”, in Côte d'Ivoire's largest city, Abidjan. Emmanuel's parents were cocoa farmers – but he stresses that that is nothing special. “Everyone in our country grows cocoa.” Even the country's president Alassane Ouattara and the football star Didier Drogba have invested some of their wealth in cocoa plantations.

Cocoa was also the basis of the “miracle ivoirien”, the Ivorian economic miracle. Unlike many other African countries, Côte d'Ivoire did not plunge immediately into crisis after gaining independence in the 1960s. For twenty years it notched up economic growth of around ten per cent per year – growth that hinged largely on the development of agriculture. By the second half of the 1970s the country was already the world's largest producer of cocoa. The economy only started to falter when world market prices for coffee

and cocoa tumbled from 1978 onwards. At the same time, necessary reforms were neglected while the aging long-term president, Félix Houphouët-Boigny, was in office. Côte d'Ivoire remained in thrall to the old colonial power, France.

Not enough wealth stays in Africa

Africa still exports too many resources and does not manufacture enough products itself. In the case of cocoa this seems to be gradually changing. Several African businesses have been founded recently, albeit often in cooperation with European partners. From Ghana comes a chocolate called “Fair Afric”, while Ghana's neighbour is the home of the “Choco Togo” brand. “Of the two million tonnes of cocoa produced in Côte d'Ivoire each year, at least a small proportion can remain here in the country,” comments Axel Emmanuel. Nevertheless, the competition remains huge – not least because the exported cocoa is an excellent source of revenue for the Ivorian government. Taxes and export duties ensure a plentiful flow of money into the state coffers. But international confectionary corporations have started to acknowledge their responsibility. The World Cocoa Foundation has adopted a Cocoa Action strategy, which is supported by nine major companies including Nestlé, Mars, Mondelez and Ferrero. The stated aim is to abolish child labour and poor wages. On the other hand, in its analysis of the cocoa trade, Germany's Südwind Institute is among those that criticise the strategy on the grounds that much still depends on companies' good will and voluntary commitments. Despite legislation prohibiting child labour, an estimated two million children still work on cocoa plantations in Côte d'Ivoire and Ghana.

And prices are still far too low to provide cocoa farmers with a secure living. “On the TV they say that we farmers are paid 1,000 francs per kilo of cocoa beans,” says Nanan Yao Kouassi, who owns a small cocoa plantation in the village of Loulougro, not far from Yamoussoukro, the capital of Côte d'Ivoire. “But that's not true.” In Kouassi's view the



Axel Emmanuel
with his chocolate specialities.

Photos: Jörg Böthling



Cocoa farmer Nanan Yao Kouassi is paid the equivalent of around 1 euro for a kilogram of cocoa beans.



Women drying cocoa beans after fermentation. The women could earn more money with roasted beans.

state cocoa authority needs to turn its attention to prices and stabilise them throughout the country so that the producers can live from what they grow. “Regardless of what they say on the TV news, we only get 700 francs per kilo.” 655 West African francs are equivalent to one euro.

The cocoa revolution

Chocolatier Axel Emmanuel sees in this one of the main problems. “In our region it is unfortunately the case that people don’t have enough entrepreneurial spirit. They sell their goods straight away because they need the quick money.” The farmers are often forced to do this by poverty, and shrewd middlemen exploit their plight. Axel Emmanuel is working on alternatives. For example, he organises courses for women in the villages. “They need to learn how to roast the cocoa beans themselves after harvesting.” Roasted beans com-

mand a higher price. Axel Emmanuel buys his beans roasted, sourcing them direct from local producer groups. “I pay them the equivalent of five euros per kilo.”

He hopes that this will stimulate the domestic economy. He advertises himself and his wares on the Internet with the catchphrase “Cocoa revolution”; in France he has business partners who deal with sales to Europe.

The young entrepreneur also wants to see his chocolate take off on the Ivorian market. But isn’t chocolate far too much of a luxury product that not everyone can afford? The farmers themselves eat fish or grilled chicken with rice. Not chocolate, surely? On the contrary – there are more and more customers in Côte d’Ivoire too, says the chocolatier. This is the case, for example, in Abidjan with its high-rise office blocks and its housing projects in which the growing middle class is taking up residence. People buy less street food there. Instead they

go to the supermarket, where they find imported goods from Europe and Asia – and, increasingly, the chocolate made in Côte d’Ivoire as well.

While Axel Emmanuel is showing how his staff make chocolate, other workers are preparing the wrappers. These are specially ordered from a printer, with a striking design in African patterns. “This order is going to the USA,” says the chocolatier. The customers there are emigrants from Côte d’Ivoire. They have become wealthy in America and want to demonstrate that. So they treat themselves to a delicious product: chocolate from Abidjan. The taste of home, going out into the world.

Christian Selbherr is an editor and journalist with “*missio magazin*”, a journal published by the Catholic aid organisation *missio*, based in Munich, Germany.

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The company boss insists on producing nothing but top-quality goods.



The wrapping of the chocolate bars has been inspired by typical African patterns.



Climate-resilient and sustainable water management is crucial for water security and resilient livelihoods in rural India.

Photos: GIZ WASCA/ Travelling tripod films

Strengthening India's resilience to climate change through water security

India is among the countries most affected by climate change. Building on the concept of Integrated Water Resource Management, the Indo-German Development Cooperation Project “Water Security and Climate Adaptation in Rural India (WASCA)” aims at improving water conservation, management and productivity in high water stress areas of the country while improving rural livelihoods. For this purpose, the implementation of location-specific interventions is being linked with India’s public works programme MGNREGA.

By Caroline Ostendorf, Meekha Hannah Paul and Jagdish Purohit

Warming trends and increasing temperature extremes were observed in most parts of the Asian region over the past century. The majority of climate change risks come down to water, including floods, droughts and cyclones. As a result of increased water demand and lack of good management, water scarcity coupled with water quality concerns is expected to be a major challenge for most countries in the region in the near future.

This also applies to India, a country that comes up seventh in the Global Climate Risk Index (most affected countries in 2019). By 2050, 600 million people in India are expected to live in moderate and severe climate hotspots. About 82 per cent of rural households do not have individual piped water supply, and 163 million live without access to clean water close to their homes. More than 30 per cent of Indian lands are impacted by desertification and land degradation, and this outcome is strongly

linked to poor water management. Ground-water resources, which account for 62 per cent of irrigation water, are declining. Furthermore, 70 per cent of India’s surface water is contaminated. Heavy reliance on rainfall and lack of efficient irrigation systems are major problems in rural areas, where almost 70 per cent of the Indian population live.

Recognising the importance of water for climate resilience, the Government of India specially established a nodal ministry for all issues related to water in 2019: the Ministry of Jal Shakti. It brings all national agencies working on water, including the National Water Mission, the Central Water Commission, the Central Ground Water Board, the River Boards and the Department of Drinking Water and Sanitation, under one umbrella. In the same year, the Indo-German development cooperation project “Water Security and Climate Adaptation in Rural India (WASCA)” was

launched, supporting the Indian Ministry of Jal Shakti and the Ministry of Rural Development in enhancing water resource management. The project, implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (see upper Box), aims at improving planning and financing mechanisms for sustainable water management, demonstrating climate-resilient water management measures, and strengthening cooperation with the private sector. To move closer to the objective of sustainable water management and climate resilience, various measures have been combined, as described below.

A new approach for (rural) water management

The project approach centres on the Composite Water Resource Management Planning Framework (CWRM). The CWRM builds on the concept of Integrated Water Resource

Management (also see lower Box). It provides a step-by-step process to develop and implement sustainable water resource management plans at the lowest administrative and hydrological unit in a catchment area or river sub-basin. It involves systematically and scientifically characterising the landscape and assessing natural resources and local life support systems for effective planning, financing, and cooperation at local, regional, and national levels. Working within the framework of the watershed, the method is to begin at the top and come down the slope. It intends to conserve every drop of water starting at the ridge and reduce both the surface runoff volume and the velocity of water to a considerable extent. This, in turn, allows better management of water flowing from the ridge to the valley and ensures efficacy, economic stability and durability of soil and water conservation structures downstream. Here, a simplified planning approach using remote sensing, Geo-Information-Systems (GIS) and non-spatial information on land, water, soil, forest, climate, vegetation, and pastoral resources has been developed. The aim is to achieve a reduction in soil erosion and an increase in the conservation and harvesting of rainwater and productivity of lands, but also employment generation and social upliftment of local communities.

The CWRM planning process is aligned closely to India's MGNREGA – the world's largest public works programme – with an annual budget in excess of eight billion euros and a coverage of more than 155 million families. Through public works, MGNREGA creates rural infrastructure and community-level assets augmenting the natural resource base and contributing towards water conservation, land, and soil management. Each year, there is a community-level planning process driven by the local governments for assessing the demand for public works under MGNREGA, estimat-



Localisation of digital planning tools simplifies landscape characterisation and the assessment of natural resources under CWRM.

The WASCA Project in a nutshell

The Indo-German development cooperation project Water Security and Climate Adaptation in Rural India (WASCA), implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ), runs from April 2019 to March 2022 in the Indian States of Rajasthan, Madhya Pradesh, Uttar Pradesh, Tamil Nadu and Karnataka (in the latter State via a special Studies and Experts Fund project with the State Government). The lead executing agencies in India are the Ministry of Rural Development and the Ministry of Jal Shakti. The project contributes to Sustainable Development Goals

(SDGs) 1 (No Poverty), 2 (Zero Hunger), 6 (Clean Water and Sanitation) and 13 (Climate action).

In preparing the Composite Water Resource Management Planning Framework (CWRM) approach, experiences from different governmental programmes – including the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), the Prime Minister's Irrigation Programme PMKSY and the Jal Jeevan Mission aiming for ensuring piped water supply to all rural households – were drawn on, as was expertise from think tanks and preceding Indo-German development cooperation projects.

Integrated Water Resource Management and the CWRM Framework

The Global Water Partnership defines Integrated Water Resource Management (IWRM) as “a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems”. Key components that need to be addressed in the IWRM context to achieve sustainable water management include an enabling environment, institutional arrangements, and management instruments.

Based on these key elements, the Composite Water Resource Management Planning (CWRM) Framework contains several

themes and sub-themes under four components:

1. Interpretation of the area of interest (e.g. estimating water resources or assessing the water quality);
2. Capacity development and institutional mechanisms (e.g. stakeholder mapping, promoting the cadre of planners);
3. Preparation of the Composite Water Resource Management Plan – CWRMP (e.g. projections of emerging scenarios);
4. Implementation mechanisms (e.g. preparation of shelf of projects for proposed actions).

ing the types of work to be undertaken, prioritising the beneficiaries. The CWRM approach includes preparation and analysis of spatial and non-spatial datasets by the engineers and technical workforce, and then taking it to the community to help them make informed decisions during their planning process. CWRM planning builds on MGNREGA, leveraging its financial and technical resources, as well as converging with other government programmes, thus providing a holistic and sustainable solution for enhancing environmental benefits including water security in rural India.

Dialogue and capacity building are key to success

The WASCA project aims to build a knowledge network regarding integrated water resources management and to strengthen capacities of more than 5,000 employees of public

and private institutions, as well as of stakeholders at different levels, to plan and implement respective measures. This includes trainings for smallholder farmers in the efficient use of resources to better cope with the impacts of climate change as well as developing skills for the technical staff of the MGNREGA and other government programmes to implement water management measures and work with digital tools.

At the same time, collaboration between government departments and other stakeholders is promoted to develop strategies and activate platforms that concentrate technical and financial resources for planning and implementing climate-resilient water resource management and ensure the sustainability of project activities. To do so, holistic pilot measures at local or sub-catchment levels are taken up in selected districts. Some specific examples include the rejuvenation of traditional water bodies which

is being demonstrated in the Indian state of Uttar Pradesh, community nutrition gardens run by women collectives in Madhya Pradesh, and greening of barren hillocks and rejuvenation of traditional water bodies in the southern state of Tamil Nadu. Successful approaches are then to be scaled-up at the state and national levels. As the private sector footprint in water is high, dialogue and cooperation with companies is strengthened to leverage public-private financing and improve sustainable practices for local water security.

In the context of digital tools and technologies used in the field under the CWRM framework, including remote sensing and GIS data, an innovation hub on 'GIS-based planning and monitoring for public employment programmes' was rolled out in partnership with the Global Alliances for Social Protection II project, commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) under "International cooperation with regions for sustainable development [ICR]" in 2020 for knowledge transfer from India to Peru and Malawi via digital learning mechanisms.

An accepted approach

Initial achievements are visible. So far, 5,345 Gram Panchayats (GP; local governance institutions for rural areas), covering an area of 7.4 million hectares and a population of 22 million, have prepared CWRM plans and identified 700,000 water-related interventions. These interventions will be implemented over the next few years through MGNREGA and other government programmes. Across all project locations, this is expected to result in an additional 100 million cubic metres of

water resource conservation and constitutes significant adaptation, as well as measures to mitigate the impacts of climate change.

The CWRM approach has been accepted nationally and by state governments as a comprehensive and climate adapted planning approach for water security. The impact of the project interventions is expected to far exceed what can currently be measured, since WASCA has now been requested by the Indian Ministry of Rural Development to extend the capacity development support to scale up the GIS-based planning to all GPs in the project states.

Lessons learnt and way forward

Sustainable water management, including the maintenance of healthy ecosystems, is a critical tool for overall climate resilience. It is crucial to ensure that both natural and human systems are able to cope with future extreme events, adapt to changing conditions and transform in crisis situations. An integrated management of water resources is therefore required that balances the needs of ecosystems and people while taking into account future climate change-related impacts – not only in the immediate activities of the water sector such as storage, supply and sanitation, but also in other sectors that affect or depend on the availability and quality of water resources. This requires a coordinated approach between all sectors and across all scales (political, natural, and social), from local to national to transboundary. The WASCA project is an example of such an approach.

Given its success and the Indian Government's request, a second phase of the project is currently being prepared. It is planned to expand

the CWRM approach, strengthen coherent implementation through further capacity building and achieve national scaling-up of mechanisms to promote water security: The pilot regions will be expanded from seven to fifteen agro-climatic zones to be able to demonstrate the applicability of the landscape-based CWRM planning approach for all agro-climatic zones in India. The project will focus on further integrating local climate change information, the development of an impact monitoring system and innovative approaches for holistic management of water, land, and vegetation. This can also draw on agro-ecological and similarly sustainable agricultural approaches, which are increasingly being recognised by the Indian Government.

As a climate adaptation project, WASCA is contributing towards slowing the effects of climate change in the water sector and making rural regions in India more climate-resilient. However, the climate crisis is a global one and requires greater convergent efforts worldwide to make way for a sustainable future!

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Women engaged in MGNREGA work for implementing CWRM plans, thus building infrastructure for strengthening rural water security (left). CWRM contributes towards sustainable farming practices among smallholder farmers (right).

Local biopesticide production hubs and the empowerment of rural women in Tamil Nadu, India

Farmers who are faced with plant health problems can visit plant clinics staffed by plant doctors, who provide diagnoses and recommendations. In India, plant clinics have been referring farmers to local biopesticide production hubs, some of which are established and operated solely by women. These hubs provide environmentally friendly plant pest solutions. And they have empowered the women running them, as a very recent study demonstrates.

By Mariam Kadzamira, Malvika Chaudhary, Ramasami Rajkumar and Frances Williams

Cottage industries feature home-based systems of manufacturing on a small scale. In most cases, these industries make use of locally available raw materials, and they often benefit from indigenous skills and knowledge. Cottage industries play an important role in the Global South, especially in Asia and Latin America. Whilst economic development is the most attractive gain of cottage industries, studies have found that other social goals are achieved, including independence, decision-making opportunities and poverty reduction.

Against this background, cottage industries are also of considerable importance for women. They have helped women in parts of the developing world to improve their ability to define and act on goals, make decisions that matter to them, and participate in the economy and public life. In Tamil Nadu, India, several women's cottage industries producing biopesticides have been established, with the support of the MS Swaminathan Research Foundation (MSSRF). Most are linked to local plant clinics (see Box) that refer farmers to them when plant pests and diseases have been detected in their fields.

Women's economic empowerment put to the test

In Tamil Nadu, the first plant clinics were established in 2011, and became fully operational in 2014. Women's cottage industries existed during this time, but were not commercially viable. It was however observed that as the plant clinics became operational, there was a positive and increasing trend in the number of clients visiting cottage industries for their products. This was because they were referred to the women's cottage industries by the plant doctors. It was further observed that the women who were members of these local cottage industries became more confident and were better able to articulate themselves and engage in other spheres of the community.

The concept of plant clinics

Plant clinics provide plant healthcare advice through diagnosis and recommendation to farmers who are faced with pest concerns. They are staffed by trained plant health extension officers who are called "plant doctors" and are set up in different places – such as in local markets, community centres and/ or farmer cooperative centres. Farmers take samples of their sick crops to the plant doctors for free diagnosis and recommendations on how to manage the problem. Plant clinics, the introduction of which was promoted by the Centre for Agriculture and Bioscience International (CABI), have been in place since 2003, and current-

To find out what the source of this 'confidence' was, and to determine how other women's groups could learn from them, we conducted a survey in the Tamil Nadu area during the months of July and August 2021. A total of thirty-four women who are members of several cottage industries producing eco-friendly agricultural products including biopesticides were randomly selected and interviewed. We assessed empowerment by analysing four indicators: decision-making, productive capital ownership, access to and control of credit and finance, and leadership as evidenced by group membership.

Household decision-making. Evidence from various studies suggests that when women participate significantly in household decision-making processes, the overall well-being of the family improves. We therefore analysed women's involvement in their households' decision-making processes. With a share of 97 per cent, the majority of the women whom we interviewed are from households headed by men. In most of the households, the male spouse mainly makes the farming decisions pertaining to food crops (62 %) and cash crops (59 %). Women are much more equally involved in decision-making processes concerning livestock

ly there are over 5,000 in 34 countries across Africa, Asia and the Americas. Currently, 144 plant clinics are operating in India, eleven of which are active in Tamil Nadu. In 2021, a network of 40 e-plant clinics were set up and launched in Jammu Province, India.

Several studies have demonstrated that plant clinic users are better able to identify and manage pests and diseases and their users have higher crop productivity than non-users of plant clinics. In addition, plant clinics have been found to encourage the adoption of various Integrated Pest Management (IPM) techniques, including more rational and appropriate use of pesticides and increasing the use of cultural and biological control methods.

production (35 %; men: 32 %) and, as stated by nearly 97 per cent of all surveyed women, are fully in control of the decisions pertaining to non-farm activities, including their involvement in the cottage industry.

Most women surveyed are engaged to some extent in making decisions in their households about how income from cash crops (82 %), food crops (68 %) and livestock production (69 %) is utilised. Utilisation of income from non-farm activities, including that from the cottage industry, is controlled by the women themselves in the majority of surveyed households (94 %).

Access to productive capital. Asset ownership is one measure of economic empowerment. Access to productive capital, such as land, livestock, farm implements and households' assets, has a significant role in enhancing the livelihood outcomes of rural households. Productive assets help rural households to manage natural and economic shocks and risks, smooth consumption and manage income. We analysed access to 14 productive assets. The women we interviewed are from households with access to a wide variety of productive capital with all the women saying that in their households they have agricultural land, a house

or other building structure and large consumer durable assets.

With most large assets, women we interviewed were less likely to have sole ownership (see upper Table). For example, we found that amongst the surveyed women, a very small proportion had sole ownership of agricultural land, large livestock like cattle or mechanised farm equipment such as tractors or water pumps. On the other hand, non-agricultural land for a residential or commercial building and means of transport such as motorbikes or push bicycles were more likely to be solely owned by a woman. Amongst the women we interviewed, we found that in each case, just over half had sole ownership of non-agricultural land and means of transport.

In almost all the surveyed women's households, women have sole ownership of a mobile phone. With mobile phones, information pertaining to various developmental issues, including agricultural and health services, can be delivered, and they can help access credit and finance and be useful in many other ways. Therefore, mobile phone ownership has been found to be empowering for rural women across the globe.



Access to credit. Access to finance, especially micro-credit, is seen by some development experts as a cure-all for rural women's empowerment. Others however argue that, especially on its own, without other social benefits, outside the broader poverty reduction sphere, access to credit is insufficient for women's empowerment and can result in undesired outcomes. For example, studies from Bangladesh found that microfinance led to increased levels of debt amongst already poor households and worsened economic, social and environmental vulnerabilities. A study from Ghana, on the other hand, states that the benefits of microfinance were linked to conflicts amongst spouses and the neglect of perceived female domestic responsibilities due to women's devotion to their enterprises.

However, credit remains one of the necessary ingredients for increasing and accelerating rural women's empowerment. On this basis, we therefore analysed access to as well as control over finance and credit services of the surveyed women. All of them have various sources of credit and finance in their communities, and from each category of credit, there are women who are eligible to borrow. At 53 per cent, over half of the women interviewed stated that their households were eligible to borrow from formal lenders. Just under a third of the sur-

Ownership of assets		
Type of asset	Sole ownership by women (%)	Shared ownership by women and other household member (%)
Agricultural land	24 %	77 %
Large livestock	24 %	76 %
Fish pond/ fishing equipment	-	-
Small livestock	17 %	83 %
Chickens, ducks, turkeys, pigeons	33 %	67 %
Non-mechanised farm equipment	8 %	92 %
Mechanised farm equipment	14 %	86 %
Non-farm business equipment	40 %	60 %
House or other structures	3 %	97 %
Large consumer durables	12 %	88 %
Small consumer durables	33 %	67 %
Mobile phone	97 %	3 %
Other land not used for agriculture	54 %	46 %
Means of transportation	58 %	42 %

Note: 'Other household member' is actually almost always the 'male spouse'. But this could also be another person - for example for female headed households or widows this could be their older children or another relative.

Access to credit							
Type of credit source	Interviewed women are eligible to apply for loan	Somebody in household of interviewed woman has borrowed from source	Person who made decision to borrow		Person who decided how to utilise borrowed funds		
			Woman	Male Spouse	Woman	Male Spouse	Other non-household member
NGO	✓	✓	100 %	-	100 %	-	-
Formal lenders	✓	✓	61 %	39 %	58 %	42 %	-
Informal lenders	✓	✓	50 %	50 %	50 %	50 %	-
Friends/ relatives	✓	✓	30 %	70 %	70 %	20 %	10 %
Group micro-finance	✓	✓	75 %	25 %	63 %	25 %	12.5 %
Informal credit/savings groups	✓	✓	100 %	-	100 %	-	-

 Mostly the woman makes decisions and controls income use
  Mostly the man makes decisions and controls income use

veyed women also say that their households are able to borrow from friends and relatives, and just over 20 per cent maintain that their household is able to borrow from group micro-financing schemes. Amongst those reporting that they are eligible to borrow, somebody from their household has borrowed from the available source of funding. This implies that those who are able to borrow (i.e. are eligible) always do so when credit is available. The decision by the surveyed women to get credit from a particular source is mostly in their

hands for most sources, except for borrowing from friends and relatives or from informal lenders (see lower Table).

It should be noted that in cases in which credit facilities are via groups (i. e. NGO-based schemes, group microfinance schemes and informal credit and loan groups), it is the woman who has control in terms of the decision to borrow from that source or not. This can be attributed to most groups being gender-segregated, with women staying in their



Women preparing biopesticides at a cottage industry.

Photo: MSSRF, Tamil Nadu, India

own groups, as with the case of the cottage industries under study. We can further see from the Table that all women who borrow from NGOs and informal credit and savings groups have full control in decisions on how the funds are utilised. This can be attributed to the fact that before funds are dispersed by an NGO or savings and credit groups, the women must provide a “business case” – albeit informal – stating what they intend to use the funds for and how they will repay the loan. For all other sources of credit, the spouse or other individuals from outside the household contribute to decisions on how borrowed funds should be utilised. These findings imply that community groups, especially those that are gender-segregated are key for women’s access to and control over credit. Whether access to credit produces unintended/ undesired outcomes, as discussed briefly above, is beyond the scope of this study, but is an area that should be considered prior to the establishment of any development programme that wishes to use credit and finance schemes as a means of contributing towards rural women’s empowerment.

Group membership. From our findings above, we see that women’s participation in community groups can be empowering as it allows them to access and control credit and finance. We find that on average, at 80 per cent, a large proportion of surveyed women who live in a community where a community group exists are active in such a group. This includes agricultural producer groups, microfinance groups, mutual help or insurance groups, trade and business association groups

and other types of women-only groups. This is an important finding as many other studies have demonstrated that rural women participating in community groups tend to be more empowered than women not doing so. One leader of a cottage industry stated: “I had the confidence to join several groups in my community, after seeing the benefits of being part of my cottage industry.” Field practitioners and policy-makers should therefore continue to provide support for the establishment of community groups as a means to reach women and as a tool for increasing women’s empowerment. The type of participation that the women have in the groups and the benefits that accrue from different groups for the women and their families or household are beyond the scope of this study, but represent an area that should be considered for future research.

Summing up ...

Women in India’s Tamil Nadu who are engaged in cottage industries have increased their empowerment via the operation of local production hubs for biopesticides that are linked to a network of plant clinics. We have seen evidence of empowerment in several aspects:

- Women have control over their participation in and income from cottage industries. This means that supporting cottage industries has potential to increase the empowerment of women who participate.

- Most productive capital and assets are jointly owned within a household by women and the male spouse. However women have sole ownership of mobile phones. This has many positive implications, including the delivery of agriculture, health and finance services via mobile-based applications.
- Women participate in household decision-making processes, and they have control in decision making related to accessing and utilising credit and finance from group-based lending. These findings imply that community groups, especially those that are gender-segregated, are key for women’s access to and control over credit.
- Participation in community groups amongst interviewed women is very high, implying that community groups are held in high esteem and should be promoted and supported as a vehicle for increasing women’s empowerment.

There is need for both public and private promoters to continue supporting the development of women’s cottage industries as participation in these industries can contribute to women’s empowerment. Our study also shows that links between key industry players and cottage industries which the women are operating can catalyse the operations of the cottage industries, leading towards economic viability. This is the case with the plant clinics in Tamil Nadu, which acted as a business catalyst for the local biopesticide hubs operated by the women’s cottage industries.

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