Implementing the Strategic Action Programme for the South China Sea and Gulf of Thailand (SCS SAP Project)

**First Meeting of the Regional Working Group on Mangroves**

Teleconference, 1 December 2021

# BEST PRACTICES IN HABITAT MANAGEMENT

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#### 1.1.1. Effective management using innovative and integrated approach

**Establishing a Framework for Sustainable Management of Mangroves Based on Government Policy at the Fangchenggang Demonstration Site**

***Context and Challenges***

In the past, the main threats to mangroves in Fangchenggang have included land reclamation for mariculture and industry, including port development; gleaning of benthic invertebrates, including clams and sipunculid worms; and grazing animals in mangroves. These problems arose due to the poverty of local communities; inefficient management; and low awareness of both the public and government of the economic significance of mangroves. Ultimately this resulted in the neglect of mangrove resources in both national and local sustainable development planning. Through implementation of the UNEP/GEF project, the significance of mangroves has been recognized nationally through the establishment of a national level reserve and through inclusion of mangrove values in provincial and municipal sustainable development plans.

***How to Maintain Fangchenggang Urban Mangroves during Rapid Local Economic Expansion***

Urban mangroves along the eastern coastline of Fangchenggang are not within the Beilun Estuary reserve, and some ten years ago it was planned that they would be reclaimed for industry associated with port development. This plan was changed and revised mangrove regulations enforced, and the urban mangroves were then entrusted to, and managed by, Xindi Company, which was consequently compensated with land for conserving the mangroves. Xindi Company has undertaken a number of activities within the project including: preparation of plans for rational use of the area of urban mangroves as an educational park; replanting of mangrove trees in the secondary growth area of urban mangroves; and eco-farming within the urban mangroves.

Following completion of the planning and economic feasibility analysis a year ago, Xindi Company has applied for approval to construct a mangrove ecological park within the urban mangroves. The feasibility plan has already been examined and evaluated by an official meeting of the Fangchenggang local government that has agreed to enlarge the mangrove area managed by Xindi Company from 200ha to 333ha. The planned urban mangrove park, if established, would be the first Urban Mangrove Park globally.

***Financial Approaches and Associated Proposals to Promote FCG Mangrove Conservation, Restoration and Rational Use***

Financial sustainability is crucial to conserving and sustainably using mangroves. Before the UNEP/GEF project commenced in Fangchenggang, financial support for the Beilun Estuary Marine Nature Reserve was far below that required for successful management. Through the implementation of the South China Sea Project, the reserve has attracted greater attention from government at all levels by conducting public education with technical support from the Guangxi Mangrove Research Centre. Following implementation of the project, the reserve has received funds of about 3.6 million Yuan from the Fangchenggang Local Government and the Guangxi Provincial Government.

The construction of the education centre in the Beilun Estuary Marine Nature Reserve has been completed and mangrove specimens are currently on display in the main display hall.

In 2007, a fund of 28.6 million Yuan for wetland conservation and construction from both the central Government and Guangxi Provincial Government was allocated to the reserve. In total the money allocated to the reserve following the GEF project was seventeen times greater than the funds the reserve received for the fifteen years before the project.

In January 2008, the reserve was designated as a Ramsar Site, which will further enhance the prospects for sustainability of the reserve. Public awareness regarding the importance of mangroves has been enhanced through replanting campaigns, the production of newsletters, and fostering the development of a "Mangrove friendly association" at the community level.

***Planning and Initial Actions to Foster Further Regional Cooperation on Mangrove and Coastal Ecological Research and Education***

Financial support from government is vital to ensure that non-profit research facilities such as the Guangxi Mangrove Research Centre (GMRC) can carry out research and regular monitoring on mangroves. The Guangxi Mangrove Research Centre was not among the key institutes supported by local government in the past, but its role was re-evaluated following implementation of the GEF project. The centre has played a key role in, and contributed to, raising awareness of governments regarding the significance and economic importance of mangroves and other coastal wetland systems.

In 2007, the Guangxi Key Lab for Mangrove conservation was approved within the GMRC to: strengthen research into mangroves for improving management of marine ecosystems; and training experts and improving expertise. In Beihai, the establishment of the Guangxi Marine Environment, Resource and Economics School was approved by the provincial government and 100 students will be enrolled

The Guangxi Mangrove Research Centre successfully convened and organized the China Mangrove Wetland Forum in Beihai in 2007 and was preparing plans for exchange between young mangrove researchers including sponsoring two or three young mangrove researchers in the region to come to China and work in the centre and the Fangchenggang Site for two or three months.

***Lessons learned***

The rapidly expanding economy in China has caused more and more serious environmental problems, while at the same time the Chinese government has realized that natural resources and the environment are important factors that can influence economic sustainability of the nation. To address environmental issues, the Chinese government is striving to explore new approaches to establish more effective environmental management systems, to create appropriate management mechanisms, and to improve scientific research and education.

Ideally, natural resources should be used as the basis for the national sustainable development strategy but the ideas and views of local officials, experts, and stakeholders in the private sector and local communities concerning how these resources are to be used and managed need to be taken into account by the government in decision-making.

Reference: http://www.unepscs.org/South_China_Sea_Knowledge/Lessons_Learned/SCS_Lessons_Learned.html

**Community Involvement, Public Awareness and Education for Mangrove Conservation and Restoration in Trat Province, Thailand**

***Context and challenges***

The Thatapoa – Namcheio area is diverse with 33 true mangrove species and 36 associate mangroves species. Eight villages are located in the conservation forest area while a total of 21 coastal villages in Trat Province depend upon mangrove resources for at least part of their livelihood and income. The mangrove forest in Trat has been used for many years as a source of charcoal and tannin, extracted under government concessions, which were terminated in 2001. The major cause of mangrove degradation in the 1970s and the early 1980s was clearance for the construction of extensive shrimp culture ponds, which proved unsustainable in the long-term. Extensive shrimp culture declined in the late 1990s and at present local villagers earn their living through coastal fishing, and the collection and sale of mud crabs and grapsid crabs. Mangroves were progressively removed up to 1996 and substantial areas of abandoned shrimp farms require re-planting with mangrove.

Despite the cessation of government concessions in 2001 and decreased investment in shrimp aquaculture, mangroves continue to be degraded. The main threats to mangroves at Trat include: illegal encroachment into mangrove forest areas for human settlement and expansion of some intensive shrimp ponds; over-fishing and the use of illegal fish gear in and adjacent to mangroves; and erosion of the mangrove forest fringe caused by intensive operation of fishing boats in near shore areas. Proposed to the Provincial Governor that the spread of shrimp farming in mangrove areas be halted. In the case of the Pred Nai community the desire to conserve mangrove come from the need to protect their own land for occupation and use of the animal resources for food.

The Pred Nai villagers formed a cooperative to protect mangroves from outside investors who wanted to extend shrimp farms in the area. Following the collapse of the shrimp farms, the community commenced reforestation using local traditional knowledge. Around 1998, Pred Nai Mangrove Conservation and Development group was established to manage and conserve the Pred Nai mangrove forest under a community-based mangrove management plan.

The actions of the community have become a model for community-based forest management, and Pred Nai village was selected as the lead village of eight target villages involved in the project such that it could mentor other villages and lead community education activities.

Other community-based activities implemented by the group include establishment of a crab bank, construction of near shore reefs as nursery areas for juvenile fish, and construction of bamboo pole fences to protect sensitive areas from intensive fishing. In addition, this group has purchased mud crabs in the local markets for release in mangrove plantations to enhance production and although hard scientific data were not available to substantiate the benefits of this practice, local peoples' experience suggests that this enhances subsequent crab catches.

***Management Plan Development and Conservation***

Initial steps in the development a mangrove management plan for the Thatapoa – Namcheio forest conservation area included collection of information and data at the village level. Limited existing capacity in villages for the conduct of resource and socio- economic surveys was overcome through training members of the Pred Nai Mangrove Conservation and Development Group in the areas of survey design and execution, data and information management, and management plan development. These trainees were subsequently responsible for guiding other villages through the process of plan development during community meetings and training exercises. The result of this highly participatory process using local leaders from the Pred Nai village resulted in the involvement of 17 villages in plan

development compared to the 8 initially envisaged. Villagers from Pred Nai were trained in the conduct of forest patrols and transferred knowledge and skills learned to leaders from other villages. The villagers from Pred Nai also led the establishment of a community-based patrols network.

***Awareness Building and Community Education Activities in Trat***

Activities focused on building an understanding of the functions and values of mangrove ecosystems and education activities have been implemented at both the government and community levels. Three youth camps involving groups of 100 school children and teachers were organized and led by officers from the mangrove resources research and development station and community leaders. Activities during these camps focused on mangrove rehabilitation, resource assessment and monitoring.

In order to facilitate the re-planting programme in the Province the Department of Marine and Coastal Resources provided education in mangrove rehabilitation and published a manual of re-planting techniques and an evaluation of previous experiences in mangrove restoration in Thailand that identifies appropriate techniques for use in Trat Province.

Public awareness was enhanced through the widespread distribution of five issues of a quarterly project newsletter for stakeholders and improvement of the existing Mangrove Learning Centre, and further development of the boardwalk through the mangrove areas.

Reference: http://www.unepscs.org/South_China_Sea_Knowledge/Lessons_Learned/SCS_Lessons_Learned.html

**Rehabilitation of Habitats and Sustainable Use of Fisheries Resources in the Con Chim Area, Thi Nai Lagoon**

***Context and challenges***

Thi Nai Lagoon covers an area of 5,060 ha and represents a major wetland ecosystem in Binh Dinh Province. The significant areas of mangrove and seagrass are essential to the viability of local fisheries in the lagoon but past levels of unregulated resource exploitation have led to the ecosystem functions being lost. Natural fisheries production is around 36 tones of fin-fish, 75 tones of crustacean and 600 tones of mollusks annually, whilst the forest supports 10 resident bird species and some 37 species of migratory water-birds use the habitats of the lagoon. Con Chim Marine Sanctuary, with an area of 480 ha, has been developed by the Binh Dinh Fisheries Department in collaboration with the local coastal communes whose livelihoods rely heavily on marine resources.

Thi Nai Lagoon once supported a mangrove forest of 1,000 ha with associated seagrass beds over an area of 200 ha. These ecosystems resulted in high biodiversity and provided favorable conditions for an abundance of aquatic species which supported the livelihoods of human communities adjacent to the lagoon, especially the population of Quy Nhon City.

Unfortunately, the area and condition of the mangrove forest has degraded drastically, with as much as one- third of the lagoon area being converted into aquaculture. In addition, the increasing discharge of wastes from the city and port of Quy Nhon and neighboring areas has accelerated the pace of environmental degradation. The consequence of these adverse changes has been marked economic losses caused by: the lagoon bottom and navigable channels becoming shallower; the aquaculture industry facing more frequent disease outbreaks; the lagoon landscape having been adversely affected;

and bird "sanctuaries" having become abandoned. These changes have resulted in lost potential to develop ecotourism which is viewed as a major source of income for most of the central provinces of Viet Nam.

The ecological and economic problems resulted in the provincial authorities attempting to develop feasible solutions to partially rehabilitate depleted natural resources, enhance the economic benefits, and conserve the natural resource base. This project on rehabilitation and sustainable use of the aquatic resources of Thi Nai lagoon is expected to provide solutions to the problems of resource management.

***Practices Implemented by the Demonstration Site Project***

Attempts to solve the environmental problems of Con Chim lagoon requires determination and a recognition of the scale and extent of the challenges associated with designing a management plan that is both acceptable to all stakeholders and will at the same time take into consideration the environmental and socio- economic complexities of the lagoon system and its multiple uses.

It is also necessary for the plan to be agreed at all levels from provincial government down to the grass- root levels; for the communities to achieve a high degree of understanding of the reasons behind the designs chosen; to establish links and mechanisms for co-cooperation among all sectors, especially between the fisheries and forestry sectors; to involve and have support from scientists, institutes and relevant organizations that can provide expertise and advice; and to diversify involvement from central to grass-root levels, and from international and private organizations.

To address the problems associated with the conflicting uses of the lagoon a zoning map for future resource uses in Con Chim has been developed, that clearly demarcates zones for conservation of mangroves and seagrass, environmentally friendly aquaculture, as bird sanctuaries, and for fishing using appropriate gear.

**Zones of Con Chim Marine Sanctuary:**

1. seagrass and resource protection (15 ha);

2. environmentally friendly aquaculture plus re-planted mangroves (25.1 ha);

3. bird protection and office site (9.4 ha);

4. concentrated mangroves (38.7 ha);

5. integrated mangroves and aquaculture (10 ha);

6. research and fisheries resource recovery (26.2 ha);

7. sustainable aquaculture extension (in Con Gia – 33.4 ha);

| | |
|---|---|
| | 8. mollusc farming (11.6 ha);<br>9. for capture fisheries (310 ha). |

***Rehabilitation of mangrove and protection of seagrass***

To address the problems of habitat degradation community-based re-planting schemes for both the intensive and integrated use zones of mangroves have been developed and the local community has been directly involved not merely in re-planting but also in protection and management of the newly established young mangrove forests. Species diversity within the mangrove has been enhanced through the establishment of multi-species mangrove seedling nurseries. The degradation of seagrass habitats has been addressed through increasing the awareness of the local communities to the vulnerability of seagrass beds to destructive fishing gear and the identification and protection of core areas of seagrass in the lagoon

***Community Education and Awareness***

One of the underlying causes of the environmental degradation in the area was the lack of community awareness of the significance and role of the natural habitats in sustaining fisheries production in the lagoon. As a consequence, a programme of community awareness was developed to foster an understanding of conservation issues and sustainable practices amongst the local communities. This programme included education of children at local schools, the development of educational posters, pamphlets and displays on the environment, particular species of importance, and conservation activities and their use in the Con Chim information centre. Through involvement of the local community in the planning of small-scale tourism trips to the Con Chim Marine Sanctuary, awareness and understanding of the involved individuals has been enhanced.

***Establishing Sustainable Aquaculture Practices and Local Livelihood Assistance***

Activities have included the identification of environmentally and economically sound aquaculture techniques for appropriate species that can be employed by the local communities. This is based on trials to assess various models for multi-species culture and development and implementation of best practices amongst the local aquaculture practitioners in the area. In addition, through development of a co-management system involving the local communes in planning and implementing activities fishers previously involved in destructive practices have been encouraged to move into areas of sustainable aquaculture production, through provision of funds for the purchase of seed and grow-out facilities, as well as technical assistance

***Lessons learned***

The ecological complexity of the lagoon system with its mosaic of mangroves, seagrass and soft sediment benthic communities reflects the natural variation in topography and sediment characteristics of the lagoon floor, which has been greatly altered by past aquaculture activities. The seagrass and mangroves are critical nursery habitats for the larvae of aquatic species such as crustaceans and mollusks, which have been adversely impacted by changes in water quality and sediment characteristics. Past overfishing and the use of destructive fishing gear have altered the structure of the animal and plant communities whilst removal of mangroves and changes in sediment characteristics have necessitated trials to ascertain whether particular areas are suitable for replanting mangrove and whether changes in practices will result in natural recovery of some communities.

The project has benefited from favorable policies and finance from the Provincial People's Committee, domestic as well as overseas organizations, and from international expertise in mangrove recovery and

coastal fisheries conservation. The co-management approach which has directly involved local fishing communities has worked well. Initial outcomes in terms of mangrove restoration and adoption of new models of shrimp farming and oyster rearing plus mangrove re-planting, shrimp and tilapia farming, and oyster culture have proved successful. It is hoped that developing tourism while recovering significant habitats of mangroves and seagrass will help to improve local livelihoods.

The present efforts however, represent only the first stage in the rehabilitation of significant habitats and protection of fisheries resources in the Con Chim Marine Sanctuary and Thi Nai lagoon. Education to raise local awareness of the problems and potential solutions has only just begun. Outbreaks of shrimp disease are still occurring at a high frequency, and economic development of the local people is still at a low level. A major constraint has been the lack of adequate and sustainable financing.

Reference: http://www.unepscs.org/South_China_Sea_Knowledge/Lessons_Learned/SCS_Lessons_Learned.html

### 1.1.2. Rehabilitation

**To Plant or Not to Plant? Insights from Mangrove Restoration in Rufiji Delta, Tanzania**

***Contact and challenges***

The Rufiji Delta is home to the largest concentration of mangroves in Tanzania, but over the years it been affected by a complex set of factors, including climate change and anthropogenic pressures, triggering a loss of mangroves and a reduction in their quality and productivity. These factors include overharvesting of mangrove trees for wood fuel and building materials, conversion of mangrove areas for other uses such as salt production, human settlement and agriculture, and, in particular, rice farming and cattle grazing. Nonetheless, Rufiji is different from Guinea Bissau. In Guinea Bissau the hydrology was drastically disturbed, which led to mangrove loss; in Rufiji that is not the case. Studies conducted by Wetlands International on the status of ecological resources in the Rufiji Delta estimate that about 7 004 ha of mangroves were lost as a result of rice farming between 1991 and 2015. This translates into an annual loss of about 292 ha. After several years, rice fields are abandoned but mangroves do not return.

Globally, tens of millions of Euros have been spent on mangrove restoration in recent years, but the majority of these restoration projects have failed. With success rates ranging between 15 to 20 percent, a lot of conservation funding has gone to waste (Kodikara et al. 2017). This is the result of using inadequate restoration techniques and a failure to resolve socio-economic and institutional barriers to effective restoration.

***Actions taken***

In recent years, experts from the Mangrove Action Project have piloted the so-called Community Based Ecological Mangrove Restoration (CBEMR) Approach. Rather than relying on active tree planting, this approach focuses on creating the enabling environmental conditions for natural recovery in sites that have been disturbed by human interference. This is achieved by implementing measures that restore hydrology, sediment dynamics and soil conditions. Planting is only applied when necessary; for example, in the absence of a nearby seedstock that supports natural mangrove recruitment. Beyond

introducing technically sound restoration approaches, the CBEMR approach also addresses socio-economic factors that compromise long-term sustainability of mangrove restoration and constrain implementation at a landscape scale. Wetlands International first put this approach into practice in Cacheu National Park, Guinea Bissau, where it restored a total of 200 ha of mangroves in three years. Of these, 60 ha of mangroves were established through planting, while 140 ha were restored through the CBEMR approach. Whereas planting projects yielded mixed results, the CBEMR measures demonstrated a rapid recovery of enabling environmental conditions and a mangrove recolonization rate that was faster than expected.

An analysis of the situation led to a novel restoration approach; rather than just planting, Wetlands International is now restoring the environment to allow for regeneration. This includes clearing of grass cover, removal of the invasive climber Derris trifoliata and digging channels to increase water flow. Where propagules are not abundant, enrichment planting is done. Monitoring is conducted with Mangrove Watch, a system of maps and remote sensing tools that allows restoration efforts to be tracked on a large scale.

***Long-term sustainability***

The MCA Programme adopted a holistic approach by working simultaneously on strengthening institutional capacity for sustainable mangrove management, livelihood improvement and participatory mangrove restoration. In restoration, the programme works with community organizations in the Delta, local district governments, national government authorities such as the Tanzania Forest Service and non-governmental organizations such as Pakaya, Foundation for Energy, Climate and Environment, and WWF Tanzania. By jointly initiating the work, the programme learns about the issues that need to be addressed for successful restoration, facilitates monitoring and ownership of the interventions. This approach of awareness-raising and learning has proved to be essential for long term sustainability and upscaling of the successful approaches.

In addition, with the understanding of the intricate links between local livelihoods and ecosystem health, the programme not only involves the communities in active restoration, but also develops models to promote replicable community-led livelihood activities such as sustainable fisheries and non-fish mangrove products. Moreover, to ensure sustained restoration, joint patrolling efforts informed by Mangrove Watch2 will be introduced to provide regular updates of where mangroves are threatened in the delta

***Lessons from implementation****:*

• The approach has the advantage of substantially reduced implementation costs compared to planting. Because of these lower costs, considerably larger areas can be restored using assisted natural regeneration approaches compared to widespread planting.

• Natural regeneration occurs under specific biophysical, socio-economic and cultural conditions. Therefore, restoration should be backed by sound data and evidence, particularly on threats, changes in the environment and perceptions of communities who live and interact with the mangrove ecosystems on a daily basis.

• For successful implementation and ownership of the approach, there is a need to strengthen the institutional and individual capacity of involved stakeholders.

• Embedding restoration in a larger framework of mangrove management such as review and implementation of mangrove management plans is a central component of sustainable mangrove management and restoration.

Reference: https://www.wiomsa.org/wp-content/uploads/2020/09/WIOMSA-Magazine-Issue-11_September2020.pdf

**Pioneering Mangrove Restoration Project in WIO region, Kenya**

***Context and challenges***

In Africa, mangrove forests have been neglected, abused and removed. Whereas forest restoration has been used as a tool to manage lost and degraded mangrove areas around the world, trial mangrove plantation in Kenya started in the 1990s. These early planting experiments were conducted at Gazi bay in the South coast of Kenya.; and involved all major species of mangroves in Kenya.

Located in the south coast of Kenya, the 615 hectares of mangroves of Gazi Bay maybe regarded as the most studied mangrove ecosystem in Africa. All nine species of mangrove trees that have been described in the Western Indian Ocean (WIO) region can be found in Gazi bay; either as pure or in mixed stands. *Rhizophora mucronata* and *Ceriops tagal* are the dominant species, occupying almost 80 percent of the mangrove forest formation. Mangroves in Gazi Bay have traditionally been exploited for timber and non-timber resources. However, in the 1980s, over-harvesting of mangroves for industrial fuel-wood led to clear felled areas that have failed to recover naturally.

***Action taken***

In 1990, a pilot mangrove reforestation programme was initiated to rehabilitate degraded intertidal areas, restock denuded mudflats, and transform disturbed forests into more uniform stands of higher productivity. Planting of propagules and saplings was done in 1x1 $m^2$ and 2x 2 $m^2$ matrices respectively. By 2019, more than 0.6 million trees of mainly *Rhizophora mucronata, Ceriops tagal, Avicennia marina* and *Sonneratia alba* had been planted as monocultures in a total area of 18.0 hectares. Survival rates range from less than 100% in high energy sites to 97% in protected sites away from the sea. Maximum annual increment (MAI) varies with species. *Sonneratia alba* recorded a maximum growth rate of 1.1 meters/year while *Ceriops tagal* had the lowest MAI of 0.3 meters/year amongst cultivated mangroves species. The cost to successfully restore mangroves in Gazi Bay ranges from USD 150/ha to USD 1000/ha, depending on the type of planting material, planting techniques and site conditions. Transplanting of saplings (either nursery raised or wildings) costs three times more than direct planting of propagules. This is minus the cost of maintenance and monitoring in the initial five years, which is estimated to average USD 1 000/yr.

***Lessons learned***

There are many lessons that can be derived from the mangrove restoration experiments in Gazi. Of great importance are the gains associated with trials and errors approach that was used in establishing the different mangrove species across the intertidal complex. This allowed our understanding of ecological range of species and silvicultural treatments. Based on this, we learnt that the species, *Sonneratia alba* should always be grown in areas close to the sea. *Avicennia marina* has a wide tolerance range to salinity and as such can be grown both at the near shore as well as on the landward side. Using our experiences in Gazi, we have developed an annual calendar for mangrove reforestation in WIO that is based on seasonality of the species. To maximize success, planting should be planned to coincide with the season of highest propagule production across all species.

**Other lessons learned are**:

i. The need for regular and long-term monitoring using communities in order to track growth performance of trees

ii. Continued awareness creation on the value of mangrove ecosystem and the need to conserve it enhances community ownership of the restoration project

iii. Stakeholder participation is key to successful mangrove restoration projects.

iv. Development of alternative Income Generating Activities (IGAs) is important to bolster community livelihoods whilst reducing overdependence on mangrove forest resources.

v. Mangrove restoration should be mainstreamed with national forest programs for sustainable financing. Our mangrove restoration scheme in Gazi has adopted mixed approaches involving government agencies, non-governmental organization, donor agencies, and local communities. Involvement of multiple stakeholders allows sharing of resources and expertise. Community participation is central in the establishment, maintenance, and long-term monitoring of replanted mangrove sites. While there exist few hurdles such as use of inappropriate planting techniques, sustainable financing is among the major challenges hindering successful mangrove reforestation activities in Kenya. To address this, deliberate effort should be made by governments and international partners to increase support for mangrove restoration during the UN's Decade of Ecosystem Restoration scheduled from 2021 – 2030.

Reference: https://www.wiomsa.org/wp-content/uploads/2020/09/WIOMSA-Magazine-Issue-11_September2020.pdf

**Unleashing Madagascar's Community-led Mangrove Restoration Movement**

***Context and challenges***

Madagascar's mangrove forests represent roughly 2 percent of the world's mangroves and are the fourth largest in Africa in extent. They supply coastal people with a wide range of benefits including income, food, building materials, fuelwood and charcoal. Despite the importance of mangrove ecosystems, remote sensing analysis shows a nationwide net loss of 21 percent (57 359 ha) from 1990 to 2010. This loss puts the livelihoods of coastal populations at significant risk.

***Actions taken***

To address Madagascar's mangrove loss and increase mangrove forest cover, Blue Ventures created a Blue Forest programme in 2011. This established initiative currently supports over 50 coastal community groups across five sites along the west coast of Madagascar (Bay of Tsimipaika, Bay of Mahajamba, Barren Isles, Belo sur mer and Bay of Assassins) where 98 percent of the country's mangroves are located. This article shares the experience of mangrove restoration in Bay of Assassins located in the southwest Madagascar. In the Bay of Assassins, the mangrove restoration activities started with a participatory workshop organized at village level. The workshop identified the direct and underlying causes threatening mangroves, with a view to finding potential solutions and strategies for mangrove preservation and management. Putting an area under strict protection and replanting the heavily degraded mangrove areas were identified by communities as the urgent actions needed for the restoration and preservation of remaining mangrove forests. The actions proposed by the community

aligned with the commitment of the Government of Madagascar to restore 4 million ha of forests (mangroves included) under the African Forest Landscape Restoration Initiative (AFR100).

***Lessons learned***

The active participation of the community is crucial to ensure that degraded areas are rapidly replanted. Community members were provided with technical and administrative assistance by Blue Ventures' field technicians. Customary regulation (known as Dina in Malagasy) was established to govern the management of the mangroves in three areas: strict protection areas, sustainable harvest areas, and replanting areas. Degraded areas were identified through participatory mapping and ground truthing. Once the targets for restoration had been established, the replanting session was scheduled and the annual goals were defined. Community members were then supported in replanting and monitoring the replanted area.

The focus of the replanting was on species that were previously cut down, including *Ceriops tagal, Rhizophora mucronata* and *Bruguiera gymnorrhiza*. For these species, direct plantation of the propagule (seeds) is possible and they can be collected immediately before planting.

The rainy season (October to April) is the best time for planting in most regions. This is the time when the propagules are abundant and mature, and the sea level is high. It is important that planting takes place at low tide and at the beginning of spring tide to ensure that the propagules are submerged twice daily, for several days. The dates of the mangrove replanting sessions were planned and decided by communities themselves and communicated in advance to the Blue Ventures' technicians who ensure that the techniques for replanting are followed and respected. A technician participates in each session. A short video, which describes the spacing of the plantation and the collection of good seeds, is shown prior to the start of the replanting sessions and the technician is on hand to offer support.

In the southwest region, reforestation is an activity that promotes the active participation of women and youth who are empowered to challenge inequalities. Although community members are not paid when collecting seeds or undertaking replanting activities, some of the individuals in these vulnerable communities are not in a position to replant the mangroves on a voluntary basis, even though they are fully aware that the degradation of the resource directly impacts the fisheries on which they depend. In order to address this issue, in the southwest, meetings were organized by Blue Ventures to consult the community on the best way to increase participation at the replanting events. Through these discussions, Blue Ventures and the communities came to a mutual decision that the best solution was to provide meals to the communities after a mangrove replanting day. In the Bay of Tsimipaika, where the deforested mangrove area is enormous (over 1 000 ha), the active participation of the community is crucial to ensure that degraded areas are rapidly replanted and not left uncovered for too long. Thus, each of the existing groups in the village (football teams, community saving groups, youth groups, women's associations, etc.) were mobilized to participate in replanting efforts. The groups were invited to agree to their annual mangrove replanting targets (in hectares) for which they would be supplied with various goods to support their livelihoods, including cooking materials, uniforms, etc. To date, 478 ha of degraded mangrove have been replanted by communities with an average survival rate of 75 percent.

Communities have confirmed that when the mangroves are restored, there is a direct and positive impact on their fishing activities, with their catches increasing in size. Although multiple stakeholders are jointly contributing to mangrove replanting efforts in order to restore mangrove ecosystems, community-led mangrove restoration has been particularly successful. Locally led efforts, such as those in Madagascar, are proving vital for pushing forward the AFR 100 policy to restore Africa's forests.

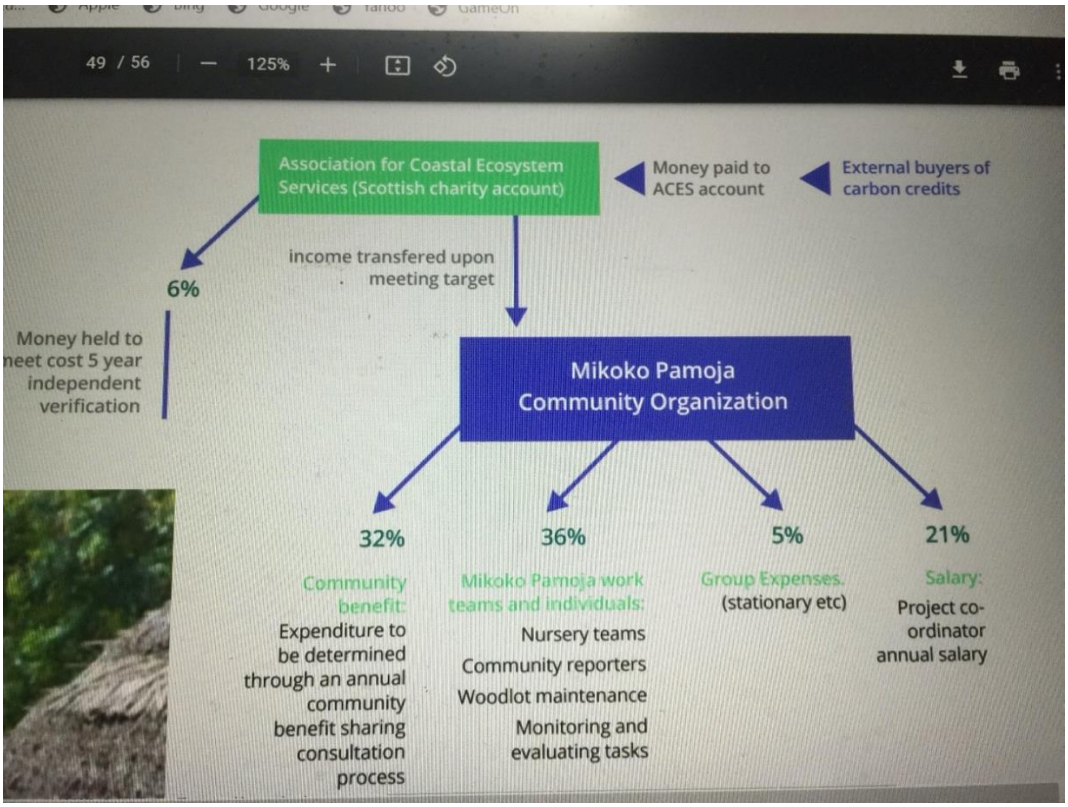
Reference: https://www.wiomsa.org/wp-content/uploads/2020/09/WIOMSA-Magazine-Issue-11_September2020.pdf

**Restoring and Protecting Mangroves through Carbon Financing:** A pioneering carbon offset project is saving mangroves and generating direct income for communities at Gazi Bay in Kenya

Since 2013, a team at Kenya Marine and Fisheries Research Institute (KMFRI), working with partners in the United Kingdom, has generated USD 15 000 per year through the sale of mangrove carbon credits. The initiative is backed by international organizations such as Earthwatch Institute (UK), World Wildlife Fund, Saudi Aramco, WIOMSA and the Natural Environment Research Council of the UK. KMFRI team has spent the last three decades working with local communities in Gazi Bay, approximately 65 km south of Mombasa, to restore and protect disappearing mangrove forests in the bay. As illustrated in the accompanying map, at Gazi Bay several villages surround the 615-ha mangrove forest. Local communities depend on mangroves for wood and non-wood products and services, such as firewood, building poles, traditional medicine, fisheries resources and shoreline protection. However, mangroves have been extensively used and degraded since the 1980s through local and commercial logging, both legal and illegal. The loss of mangroves has led to shortages of firewood and building poles, a decline in fisheries and increased coastal erosion and a consequent urgent need for the rehabilitation, conservation and sustainable utilization of mangrove resources at Gazi Bay.

A programme to rehabilitate degraded mangrove areas, and transform disturbed stands to uniform stands of higher productivity, was launched by KMFRI at Gazi Bay in the 1990s. The programme gained momentum in 1994 when the local community was fully integrated into the reforestation and monitoring effort. In 2012, Saudi ARAMCO, through Earthwatch UK, supported a short training course on community-based mangrove reforestation and management. The course targeted local people who were trained on mangrove nursery establishment, out-planting and maintenance. In 2013, communities adjacent Gazi bay signed a commitment to replant some 4 000 mangrove seedlings per annum in the degraded areas of Bay through a carbon offset programme called “Mikoko Pamoja”. Mikoko Pamoja or “mangroves together” is the first community-type project in the world to restore and protect mangrove forests through the sale of carbon credits on the voluntary carbon market. More than 60 percent of revenue raised through Mikoko Pamoja is channelled to a special community benefit fund, headed up by local representatives, for spending on priority community projects in the fields of water and sanitation, education and health. The remainder of the money generated is used to hire a project coordinator and local laborer to help protect an initial 117 ha of mangroves, and replant mangroves in degraded areas.

**MIKOKO PAMOJA: BENEFIT SHARING**




In 2017, Mikoko Pamoja received the coveted United Nation's Equator Prize for its remarkable work of advancing mangrove conservation for climate benefits, community development, and biodiversity conservation. In the same year, Hollywood actor, Leonardo Dicaprio, supported the replication of Mikoko Pamoja in Vanga, located 70 km south of Gazi Bay; in a transboundary conservation area between Kenya and Tanzania. Today, Vanga Blue Forest or VBF – is offsetting double the volume of CO2 captured by Mikoko Pamoja and thus generating USD 30 000 per annum for community development and conservation. The future goal is to expand Mikoko Pamoja to include seagrasses, and replicate this innovative community-based project in other mangrove areas in the Western Indian Ocean region.

Reference: https://www.wiomsa.org/wp-content/uploads/2020/09/WIOMSA-Magazine-Issue-11_September2020.pdf

**Wetlands International is restoring mangroves on Galeta Island, Panama**

The mangrove restoration area on Galeta Island is made up of two tracts of land, one is 5.4 hectares and financed by the company AES GAS NATURAL ATLÁNTICO, S. DE RL. and the other is 0.5 hectares and financed by AES PANAMÁ S, DE RL. The selected area was part of a former telecommunications base of the United States armed forces. In order to build the base, they made fillings to cover the wetlands and inside the mangrove forest they built channels to divert the waters. In other words, the

loss of the mangrove forest was caused by a change in land use, totally modifying the landscape. At present the area is surrounded by a beautiful mangrove forest and is a protected area called Galeta Island Protected Landscape.

The restoration proposal implemented by Wetlands International consists of the construction of water channels to return to a more favorable condition for the restoration of the mangrove forest. We have planted three species: Rhizophora mangle in the most flooded areas and in the channels, then Laguncularia racemosa together with Conocarpus erectus in the less flooded areas.

The success of the channels was measured by how connected they are with the surrounding wetland restoration area. The presence of marine, estuarine, and freshwater fish at the species level to indicate level of salinity and marine influence into the canals was also evaluated.

Reference: https://www.mangrovealliance.org/mangrove-restoration-on-galeta-island/

### 1.2. Coral reef and seagrass related practices

#### 1.2.1. Effective management using innovative and integrated approach

**Integration of Traditional Wisdom and Practices in the Development and Implementation of a Coral Reef Management Plan and Legislation**

***Context and challenges***

Current actions resulting in degradation of reef state in Selat Nasik waters include the "mining" of live coral for house foundations. Reef watchers report however, that the intensity of mining has decreased significantly following the public awareness campaigns. The use of cyanide to catch ornamental fish by fishermen from outside Selat Nasik Sub-District is ongoing. Unregulated mangrove cutting to obtain fuel wood is still common in Selat Nasik Sub-District, and is mainly done by individuals engaged in collecting and processing *beche-de-mer*. The use of trawl nets (*Pukat Kongsi*) by fishermen from outside Selat Nasik Sub-District is still common in the areas where this fishing practice is potentially destructive to coral reefs.

***Actions taken***

Selat Nasik Sub-District of Belitung District was selected as a demonstration site within the coral reef component of the UNEP/GEF South China Sea project. The objective of this demonstration site was to develop a community-based management system that would ensure sustainability of the coral reef ecosystem in order to increase community welfare and to reduce poverty. Activities at the demonstration site of Selat Nasik involved numerous stakeholders from local government and communities. A Management Board was established at the district level with members drawn from local institutions such as the Department of Marine Affairs and Fisheries, *Bappeldada*, Education Services, Tourism Services and NGOs. The management board conducted regular meetings to discuss the implementation of activities with the site manager.

Activities at the Sub-District and Village levels involved: promoting community awareness and education; consideration of local regulations; development of a resource management plan; information and public awareness activities; and evaluation of alternative livelihoods. Public awareness activities included several community meetings, production and distribution of T- shirts and calendars to the Selat Nasik community.

Education activities took place in cooperation with the Education Service of Belitung District, and a syllabus was prepared and 1,400 guide books "*Pesisir dan laut kita*" (The Coast and Our Sea) were produced and distributed to all elementary school children in the Sub-District. Local teachers were also trained in using the guide book.

Control of activities on the coral reefs was undertaken through regular patrols by 20 volunteer reef watchers. The reef watchers received training on: map reading; how to undertake patrols; the preparation of reports; and basic training on how to evaluate the state of coral reefs in a simple way. The reef watcher programme was managed at the village level with each village responsible for the selection of reef watchers and the programme was provided with two boats each equipped with binoculars and life jackets.

The Research Center for Oceanography LIPI conducted an initial survey of coral reef condition and determined that the coral reefs in this area were still in good condition. The percentage of living coral cover varied from 46.9% to 91.5%, and economically valuable benthic species such as the giant clams *Tridacna* spp. were still abundant.

Activities to increase the volume and availability of information involved socio-economic and ecological surveys, which showed that community understanding of the importance of coral reefs developed during the project. The socio-economic surveys also provided information on activities that could be undertaken to develop alternative sources of income, and the results of the ecological surveys showed that coral reef condition in Selat Nasik was still good.

Two ways of enhancing community income were identified. The first involved enhancing production and quality of locally produced fish crackers, and the second the preparation of new products including jerked fish (*dendeng ikan*) and durian toffee (*dodol durian*). One hundred and thirty-five trainees took part in training on these alternative livelihoods.

***Incorporating Traditional Knowledge and Practices into Local Management Regulations***

The development of the resource management plan and local regulations, proceeded quite slowly initially due to the need to compile all relevant information and to consult with the legal section of the local government of Belitung, the head of the sub-district, village chiefs and prominent figures in the community, including fishermen.

These discussions took place against a background of previous actions by the community of Gersik village that had agreed internally in 1970 on preventing the use of certain fishing gear. The community agreement outlines a number of "rules" including the fact that anyone fishing in Gersik waters must use the same gear as local fishermen; and banning the use of light fishing. The community of Gersik village, specialize in line-fishing for mackerel, snapper and other pelagic species. In addition, they also own "weir" or fish fences in the water near their houses. They believe that if all fishermen follow their rules, the catch will be sustainable and believe that the use of lift nets and light fishing will adversely affect their catch.

Up to the present time 6 quarrels have occurred with outside fishermen, resulting initially in warnings to the fishermen to cease, followed by more drastic actions including stoning and impounding fishing boats and gear. In the 1990s an agreement was reached between the Local Government of Belitung District and the Local Government of South Bangka according to which fishermen from South Bangka catching fish in the waters of Gersik village, must follow the regulations that have been developed by the Gersik fishermen.

Some years later, a disagreement between the fishermen of Gersik, Belitung District and Pongok, Bangka District arose in which the latter were accused of violating this agreement. A meeting was convened on April 30, 2003 in Belitung to resolve the dispute and agreed to adopt the following principles:

- All disputes be settled in an amicable manner through discussion and not by force;
- Weir (*rumpon*) located close to the operational area of purse seine (*paying*) must be marked with a 2m pole;
- Fish traps (*bagan*) may not be operated in the area of the weir;
- Fishermen using fish traps are to report to the Village Head or community chief before fishing;
- In the wet season the waters surrounding Bakau Island, Karang Gading, Karang Air, Karang Delapan and Karang Berekam are open for both *paying* and *bagan* fishermen; and,
- In cases of violation the offender will be prosecuted according to the existing laws.

***Integration of Local Wisdom in the Management Plan and Regulations***

To integrate the existing agreements initiated by the fishing community of Gersik village into the Resource Management Plan for the entire Selat Nasik Sub-District required a series of activities including widespread consultations followed by preparation of a draft Resource Management Plan incorporating zones of use throughout the Selat Nasik Sub-District. "Red" zones were designated as areas that are completely protected; "yellow" zones are areas of defined and limited use; while "green" zones represent areas that are open for all kinds of activities. The community's aspirations and desires were taken fully into account in defining these zones. Once the draft plan had been prepared public consultations were organized with the communities of the Selat Nasik Sub-District, after which the draft was revised and presented to the local government for comment and discussion. At the same time drafts of local regulations on coral reef management and fishing activities and the use of gear based on the Gersik agreements were considered by the Local Government of Belitung District.

***Lessons learned***

Development of local regulations (*Perda*) on the management of coral reefs has been done by several other districts in Indonesia. Therefore, the potency of replication would be quite high. Nonetheless the phasing and the necessary timing for replication for each locality is quite different.

The principles adopted at the site for dispute resolution between fishermen have potential for replication in other areas of Indonesia's South China Sea coast. Particularly in the Riau Islands area and coastal waters of West Kalimantan province where similar fishing methods are used and conflicts exist.

The experiences at the Belitung site have been used to plan a future fisheries initiative in Indonesia aimed at improving the management of important fisheries habitats. The success in integrating local wisdom in local management plan development has potential for up- scaling to the sub-region level as part of this initiative.

The community awareness and education materials have potential for direct use in adjacent sub-districts and districts and efforts are being made to make these accessible via the Selat Nasik website. Translated versions of the training materials developed for the site could also be used in other South China Sea countries in the design of awareness building activities.

Reference: http://www.unepscs.org/South_China_Sea_Knowledge/Lessons_Learned/SCS_Lessons_Learned.html

**Network of Small - Scale Sanctuaries in Masinloc, Philippines**

***Context and challenges***

Masinloc, in Zambales Province is accorded high priority among the Philippine biodiversity conservation priorities particularly with respect to benthic mollusks, and corals; and pelagic cetaceans, turtles, and whale sharks. It is imperative therefore that the Local Government Unit and all other stakeholders play a proactive role in ensuring sustainable use for the long-term benefit of both the artisanal fishing community and larger private sector enterprises.

The issues and challenges facing coral reef conservation and sustainable use in the area include illegal fishing, poaching in the marine protected areas, and marine and coastal pollution. In terms of the legal and institutional frameworks available to address these issues, there is a need to integrate the efforts of all the stakeholders and to create opportunities for leveraging complementary interventions. Financial sustainability needs to be addressed to ensure that successful management interventions can be sustained over the long-term.

The Masinloc Coral Reef Demonstration Site was designed to establish a network of small-scale sanctuaries under adaptive co-management and to demonstrate the benefits of this approach. The objective was to establish three new sanctuaries to replicate the oldest marine sanctuary in Luzon, the San Salvador Marine Sanctuary. These four sanctuaries are being managed individually by management bodies composed of representatives of fishers, women's groups, youth organizations, barangay council chairman on environment, advised by representatives of the national line agencies and the local government unit (municipal level). The provision of assistance both by the UNEP-GEF South China Sea Project and the Local Government Unit of Masinloc and other stakeholders such as the power plant, fish cage operators and resort owners, has paved the way to the establishment of a management system that facilitates enforcement, monitoring, and financial sustainability.

***Experiences in Institutional and Financial Arrangements***

The experience of the Masinloc Coral Reef Demonstration Site provides a springboard for future efforts to sustainably manage the coastal waters and resources of Masinloc. The coastal waters have many users and managers, each with their own interests and objectives in using and benefiting from the coastal waters. Hence, there is a need to synchronize and synergize efforts to enhance resource management.

The Masinloc Coral Reef Demonstration Site provided an opportunity for the stakeholders, both users (fishers, aquaculture operators, resort owners, power plant managers, mining firms, and the Port Authority) and managers (Local Government Units, Department of Environment and Natural Resources, and Bureau of Fisheries and Aquatic Resources) to meet together as the Coastal Resources Management Board. This Board was given responsibility for the overall administration, management, policy formulation and implementation of actions relating to the sustainable use of coastal waters. The board is chaired by the Municipal Mayor and representatives of all the stakeholders are members. Regular quarterly meetings are convened to update members on the interventions and initiatives in managing the coastal waters of Masinloc.

Responsibility for fund raising has been left to the management councils of the individual MPAs for special projects that they deem a priority, such as fencing of the guardhouse in Bani. Entrance and visitor's fees, for snorkelers and divers are also collected and proceeds from the sale of products at the livelihood centre and other donations have been deposited in a Coastal Resource Management Trust Fund. Although these amounts are minimal to date the financial system is now in place in advance of the anticipated boom in ecotourism. Fines and penalties for violations of the MPAs and CRM Code are also deposited in the trust fund. In addition, an annual budget of PHP500,000 from the 20% Development Fund of the Local Government of Masinloc, and 10% of the revenues from the operation of the Power Plant are deposited in the Coastal Resource Management Trust Fund.

***Experiences with Law Enforcement and Monitoring***

Four guardhouses have been installed adjacent to the MPAs which are strategically located in the north, south, east and west of San Salvador Island. Consequently, the *Bantay Dagat* do not need to conduct frequent boat patrols, hence saving on the costs of gasoline. Each guardhouse is manned by a team of four law enforcement members who guard the MPA and adjacent coastal areas against illegal fishing. Blast fishing has been eliminated following the apprehension of one of the blast fishers in

late 2007. The Coastal Law Enforcement Team led by the Chief of Police in Masinloc, supported by the Special Action Force of the Philippine Army conducts regular patrols and makes arrests in support of the *Bantay Dagat* Federation.

Two fishers from each MPA Council have been trained in identification, listing and counting fish using local names seen along a 10 meter wide transect. Another two fishers were trained to estimate coral cover using the benthic life-forms and all individuals were trained in simple data analysis and presentation of results. Twice yearly monitoring will be undertaken and the results posted in the *Barangay* Hall for public information.

***Stakeholder Involvement***

Stakeholder involvement has been fostered since the inception of the project and the initial proposal was developed with full participation of the local government, the Department of Environment and Natural Resources and the Bureau of Fisheries and Aquatic Resources. The Management Board was formally established through Executive Order of the Mayor and an ordinance by the *Sanguguniang Bayan*, and has been working on: the formulation of the Coastal Resources Management and Zoning Plan; establishment of new marine protected areas and their networking; monitoring; law enforcement; information campaigns; stock enhancement; coral transplantation; and other capacity building activities. To reduce stress from fishing pressure, some 199 hectares of the Masinloc coral reef or about 9% of the 2,200 hectares is designated as a strict protection zone, as a Marine Protected Area legitimized by *Barangay* Ordinance and *Sangguniang Bayan* Resolutions. In addition to this, 80 hectares have been designated as reserved areas where regulated and traditional fishing methods are permitted. As a direct result of the strengthening of the *Bantay Dagat* and formation of Coastal Law Enforcement Team, a significant reduction in the incidence of illegal fishing has been recorded by the *Bantay Dagat* Federation

***Lessons learned***

The co-management approach was adopted in order to ensure sustainability of the management system through mainstreaming of the coastal and marine environmental programme into both local and national government regular programs thus becoming part of government basic services to the constituents. The involvement of the stakeholders not only as participants in the activities but in setting the directions and in strategizing for the smooth implementation of activities has enhanced the probability of sustainability and replication.

The advantage of the co-management approach is the increased involvement of the stakeholders in project implementation, monitoring and evaluation. This project provided an opportunity for all stakeholders to share in decision making with respect to collective action directed towards ecological enhancement and environmental protection and management. Whilst such an approach yields benefit in the longer term it must be recognized that deliberations on issues and concerns takes much time.

The establishment of small-sized MPAs and their networking through an adaptive co-management approach has a very high potential for replication. It is a good practice to involve all stakeholders in the management and protection of the coastal and marine environment. Other bays in the Philippines could replicate this strategy which provides for sustainable utilization and at the same time sets aside areas for strict protection for both natural and induced coral reef rehabilitation and enhancement.

The potential benefits of the small-sized MPAs may in theory not be as significant as one large site. The experience at Masinloc suggests however, that the small sites are easier to manage and have been more effective in terms of local community participation in management. It has been noted that larger

MPAs have mainly been established at the central government level and their total area have rarely been managed effectively. Small MPAs offer a possible solution to this.

Reference: http://www.unepscs.org/South_China_Sea_Knowledge/Lessons_Learned/SCS_Lessons_Learned.html

**Sustainable Tourism Based on Coral Reefs at Mu Koh Chang Island, Thailand**

***Context and challenges***

The aim of the Mu Koh Chang coral reef demonstration site is to remove or reduce the causes of coral reef degradation at Mu Koh Chang through: the application of a new model of co-management in the area; restoring certain degraded areas for education and tourism purposes; and assessing the carrying capacity of the reefs for marine based tourism. The project outcomes have highlighted the importance of coordination between and amongst government institutions, the private sector, and local communities in order to promote sustainable tourism development.

During preparatory meetings with stakeholders in the area, the causes of coral reef degradation at Mu Koh Chang were identified as being: infrastructure development, leading to soil erosion and coastal sedimentation; unplanned expansion of tourism businesses resulting in rapid increase in tourist numbers; unskilled SCUBA divers and snorkelers damaging coral colonies in shallow water; use of anchors by boat operators in reef areas; lack of awareness of the local community of the importance of marine ecosystem to community income from tourism; illegal fishing using chemicals and nets of illegal mesh size and collecting of sea cucumbers and abalone; lack of co-ordination among management agencies; and a lack of manpower and poor law enforcement.

***Raising Awareness on the Ecological Importance of Coral Reefs***

Public awareness activities have included training for students, tourism operators, government staff and local people on the ecology of coral reefs and how to use these sustainably. Activities to encourage and empower volunteer groups in coral reef conservation were initiated and all activities emphasized stakeholder participation since a high level of public participation is crucial to successful sustainable management.

Information has been disseminated using a wide range of methods including radio and television broadcasts, posters and 20 permanent notice boards featuring the coral reefs and coastal resources of Koh Chang. A manual concerning fisheries management and coral reef conservation and a handbook of coral reef and related marine organisms of Mu Koh Chang have also been published. A quarterly Thai Coral Reef Newsletter has been launched and copies are distributed to all stakeholders involved in coral reef conservation both at Mu Koh Chang and throughout Thailand. The webpage *www.thaicoralreef.in.th* provides background to the project; basic knowledge concerning coral reef ecology; and a calendar of upcoming events related to coral reef conservation and management.

***Using Coral Restoration as a Means of Raising Awareness***

To raise community and tourist awareness of coral reef restoration a small demonstration site for coral restoration was established at Koh Kra. Site size was small for ease of control and management for the benefit of tourism, education, public awareness, and research. Natural coral fragments were used in order to increase the survival rate of such fragments that might otherwise be buried. The techniques and

methods used were kept simple, using cheap materials available from local suppliers and those that provided a hard substrate for coral recruitment. Four methods are displayed at the site: provision of substrate in the form of pyramids of concrete pipes; attaching branching *Acropora* spp. with screws to PVC pipe frames in the coral nursery area; provision of additional substrate using clusters of concrete blocks to encourage natural coral recruitment; and, attaching coral fragments to dead branching corals by means of plastic straps.

***Developing Sustainable Tourism***

Tourism development projects in tropical coastal areas frequently result in significant coral reef degradation. Studies on carrying capacity of tourism sites are critical in order to undertake sustainable tourism planning. Although designated in 1982 as a National Park, Mu Koh Chang was designated in 2002 as an area having special or unique tourism features and identified as a new tourism destination in Thailand. Most tourists who visit Mu Koh Chang are involved in marine aquatic sports and activities such as snorkeling and SCUBA diving. The number of visitors in 2007 was approximately one million, four times the number visiting in 2003.

In order to develop guidelines and measures to control the number of visitors and prevent tourism damage to the natural environment, a study was undertaken to determine the ecological, physical, facility, and psychological carrying capacity of Mu Koh Chang. For the ecological carrying capacity the national park conservation targets were taken as relative impact indicators, and existing visitor use correlated with existing ecological impacts. The study identified the carrying capacity type that limited the recreation use of each site and the recommendations have been taken into account in planning further development. This enabled identification of an appropriate tourist user fee for visitors to the site. These fees are being used to support and sustain coral reef conservation interventions at the site.

***Changing Past Practices and Developing Alternative Income Sources for Fishermen***

In order to reduce the overall pressure from fishing and use of illegal gear, local fishermen were trained in more sustainable livelihoods such as mariculture and as diving guides and tour boat operators. A local guide centre was established enabling visitors to contact and directly engage local boat and dive operators and this has increased significantly the income of small boat operators. At the same time visitors have gained insight into sustainable management activities being undertaken in the area.

A mooring buoy committee has been established as a sub-committee under the Mu Koh Chang National Park Committee to agree on the location of mooring buoys. The committee is composed of boat and dive operators and encourages use of such buoys to prevent anchor damage to sensitive corals. Mooring buoys were installed at sensitive sites. An underwater snorkel trail has been established and mapped with a plastic guide highlighting points of interest along the trail. Underwater guides to the corals, fish and marine benthos of Mu Koh Chang have also been produced.

***Networking Among Government Institutions, Private Sector and Local Communities***

The project has sought to encourage collaboration and coordination among government agencies, private sector enterprises, NGOs, and local communities during planning, operation and evaluation of all activities in order to strengthen co-management. Natural resource management in Thailand tends to be through centralized management by government agency with little decentralization of authority or control. Management of sustainable tourism at Mu Koh Chang, falls under the responsibility of several government entities each of which has their own management body, with little co-ordination between them and a resultant over-lapping of activities. The Mu Koh Chang Demonstration Site objective, of developing a management plan and guidelines for sustainable utilization of coral reef resources required the participation of all related stakeholders from both local and national levels. This plan indicates

appropriate activities, decided by the meetings of all stakeholders that should be implemented in the area and has now been accepted for implementation by all responsible agencies. The process has facilitated co-operation between the various government agencies.

***Lessons learned***

At the time of its designation as a National Park in 1982 few resources were made available to implement management measures. The creation in 2002 of a public organization to maintain a balance between nature conservation and tourism development in Mu Koh Chang resulted in a relatively large amount of funding being spent on tourism infrastructure development and establishing new management frameworks but the local community was involved only in implementation.

In 2007 and 2008 Mu Koh Chang has been visited by several study groups consisting of government officers, researchers, site managers, scientists, mayors and governors from this region. The most important objective of those study tours has been to share experiences gained from implementation of the demonstration sites. A group of 20 senior government officials from Viet Nam's coastal provinces visited Koh Chang in 2008 and have already commenced implementing some of the innovations in Viet Nam. The success of the management model in Mu Koh Chang can be applied to other areas in Thailand and other countries in the South China Sea.

Reference: http://www.unepscs.org/South_China_Sea_Knowledge/Lessons_Learned/SCS_Lessons_Learned.html

**Eco-tourism Supports Marine Conservation Area in Malaysia**

***Context and challenges***

The islands and surrounding waters off the coast of Sandakan in northeast Sabah, Malaysia are home to 500 species of reef fish, 300 species of corals, 25 species of seagrass and algae, and 7 species of giant clams. Part of the Coral Triangle region, this area is known for its exceptional coral reef diversity and its marine resources have high economic value, particularly for fisheries. The reefs however have been subjected to unsustainable fishing and illegal and destructive fishing practices which have compromised coral reef habitats.

***Actions taken***

In 1997, the owners of Lankayan Island Dive Resort (LIDR) initiated the establishment of the Sugud Islands Marine Conservation Area (SIMCA), to counteract illegal and destructive fishing in the area and to protect turtle nesting habitats, fish populations and coral reef habitats. SIMCA is a privately managed no-take marine protected area located 80 km from the coastal town of Sandakan in northeastern Sabah, Malaysia. The reserve covers 463 km2 of the Sulu Sea and includes the islands of Billean, Tegapil and Lankayan.

SIMCA was established as an IUCN Category II Conservation Area under the provisions of the Sabah Wildlife Conservation Enactment 1997. Category II areas are managed to preserve natural conditions and provide opportunities for recreation, so fishing and other extractive activities are prohibited. The heads of Sabah Parks, the Department of Fisheries, Sabah Wildlife Department and LIDR met on Lankayan to discuss the idea of a privately managed marine reserve. Following this meeting, LIDR drafted a proposal and management plan; the reserve was subsequently gazetted in 2001. LIDR funded

SIMCA's establishment, which totaled around RM200,000 (US $63,600). In 2003, the government of Sabah, in the guise of the Sabah Wildlife Department, a unit within the Ministry of Tourism, Development, Environment, Science and Technology, leased the conservation area to Reef Guardian. The lease agreement runs for 30 years at the cost of RM60,000 (US $19,000) per year. The lease has an optional ten-year extension.

***How successful has it been?***

SIMCA is managed by Reef Guardian, which is a private not-for-profit organization wholly owned by Pulau Sipadan Resort, the parent company of Lankayan Island Dive Resort (LIDR). LIDR, the only accommodation within the reserve, helps fund Reef Guardian operations by levying a conservation fee on all visitors to the resort. Reef Guardian uses funds derived from the visitor fees to establish surveillance systems, monitor the reserve, enforce regulations, train personnel, and undertake conservation and outreach programs. Since establishment of the conservation area, incidences of illegal fishing and turtle poaching have declined and fish abundance and turtle egg laying have increased.

Reef Guardian monitors and enforces reserve regulations and runs marine conservation and outreach programs. Reef Guardian is staffed by 15 personnel who are stationed on Lankayan Island. The team is led by a marine biologist, who develops scientific research programs and outreach initiatives. Other staff members are responsible for ecological monitoring, turtle hatchings, radar surveillance and reserve enforcement. Staff operations are aided by Reef Guardian's three high-speed patrol boats and radar equipment. Enforcement officers patrol the reserve's boundaries and have powers of inspection and seizure. The officers are trained and certified as Honorary Wildlife Wardens. They are permitted to arrest offenders with assistance from the local enforcement agency. The combination of regular patrols and radar surveillance has all but halted illegal and destructive fishing in the reserve.

Compliance with regulations is high, in part because no fishing families live within the reserve. Prior to the construction of LIDR, there was one family residing on Lankayan. After being consulted, however, the family approved development plans for the island. Despite the success of SIMCA, it remains the only privately managed marine protected area in Malaysia. The owners of LIDR have encountered institutional resistance whenever they have suggested similar initiatives to the Government of Sabah.

***Lessons learned***

Visitor fees have provided sustainable financing for management of the reserve and investment in personnel training and surveillance technology to enforce the rules and regulations of the conservation area. In collaboration with government enforcement agencies, Reef Guardian has reduced threats such as illegal fishing and turtle egg poaching. As a result, there is a comparatively high abundance of commercially important fish, and turtle nesting at Lankayan Island has increased. Private management can be effective in conserving biodiversity in MPAs, and may well exceed regionally unsuitable locations.

Reference: https://reefresilience.org/case-studies

**Temporary Reef Site Closures During Coral Bleaching Thermal Stress in Thailand and Malaysia**

***Context and challenges***

From March to September 2010, a thermal stress event occurred across Southeast Asia. Satellite-based monitoring tools produced by NOAA's Coral Reef Watch (CRW) program were used to describe thermal stress patterns in the region. These tools were used to help local agencies respond to the potential bleaching. Predicted coral bleaching was confirmed through in situ observations undertaken by the Department of Marine Park Malaysia (DMPM), Thailand's National Parks, Wildlife and Plant Conservation Department (DNP), university researchers, industry partners, and other stakeholders.

Undertaking practical, timely management actions before and/or during thermal stress events can reduce negative impacts on corals and reef ecosystems. Such actions include restricting potentially stressful activities on the reef such as construction, water sports (e.g., diving, snorkeling), and fishing, before, during, and after a bleaching event. In addition, enhancing overall reef health and condition (resilience) can help corals to resist environmental stress and recover more easily.

***Actions taken***

Sites of actions: Malaysia (Kedah, Terengganu and Pahang states); Thailand (Trang, Satun, Chumphon, Krabi and Phnag Nga provinces)

In Malaysia, initial reports by government, university, NGO, and industry stakeholders confirmed bleaching had affected 60-90% of corals in the region. In response, DMPM closed 12 out of 83 dive sites within Malaysian national marine parks to divers and snorkelers from July 2010 until the close of the tourist season in October 2010. The onset of the monsoon season extended this closure until early 2011. DMPM undertook consultation with key reef stakeholders and press releases by the Director General of DMPM publicly communicated the closures and the reasons for them. These were supported by comments from NGOs (including ReefCheck Malaysia), along with calls for research and action to enhance understanding of and protection for reefs.

In Thailand, thermal stress was greater than in Malaysia, and resulted in over 80% of corals impacted at all sites. In response, and following a recommendation from the Department of Marine & Coastal Resources (DMCR), the DNP closed dive sites in national parks in December 2010. Eighteen popular dive sites within seven of 26 national parks on both sides of the peninsula were closed for 6-18 months to allow coral damaged by bleaching to recover. During this period, public awareness of marine conservation was promoted through local media. In the Gulf of Thailand, bleaching impacts were lower and bleached coral became a tourist attraction which provided additional opportunities for outreach and education. In addition to the site closures, authorities monitored coral status during the closures, increased enforcement, and also increased anchoring sites at locations unaffected by the closures to reduce boats damage to reefs.

***How successful has it been?***

In Malaysia, DMPM surveys of affected reefs in October 2010 and in the early months of 2011 found that corals had mostly recovered, with only a loss of ~5% of corals. Based on these results, the temporary closures were officially lifted in June 2011 for the usual beginning of the tourist season.

In Thailand, averaged across all reef sites, less than 5% of the damaged coral had recovered by 2011. Site closures were therefore extended to 18 months at some sites. The amount of young coral found suggested that while reef recovery through recruitment was occurring in some areas; it was dependent on the health of upstream reefs which provided the necessary coral larvae for recovery. These results

demonstrated the importance of considering the ecological connectivity between healthy and damaged sites to better understand recovery prospects and patterns.

Tourism industry responses to the closures in Thailand were varied. The Phang Nga Tourism Association sought to cooperate with government efforts to protect marine life and to encourage collaboration between government and private tourism operators. Phuket and Andaman diving communities expressed concern that the closures would lead to overcrowding at other popular sites outside marine parks, such as around Phuket. In response, efforts were made in some locations to cap tourist numbers and/or to limit visits to during high tides (to reduce accidental contact with corals). There was also concern regarding follow-on impacts of the closures on the tourism industry, such as reduced accommodation bookings. General consultation with industry partners and stakeholders continued through DMCR and DNP, including through engagement programs such as Strengthening Andaman Marine Protected Area Networks (SAMPAN) and in partnership with research organizations (e.g., the Phuket Marine Biological Centre).

Stakeholder learning workshops were held in multiple locations in Malaysia, Thailand and Indonesia during 2013 to identify gaps in scientific knowledge and build capacity for supporting social and ecological resilience to future bleaching events. Assessing the effectiveness of closures during coral bleaching events on promoting coral survival and reef recovery was identified as a key future research task through this study. Workshop participants acknowledged that selective site closure or reduction in usage could be beneficial for reefs, but also recommended implementing restrictions other than site closures during bleaching events. Other key responsive actions identified through the workshops included: (i) improving engagement, coordination, and communication between stakeholders about coral reef management issues; (ii) implementing education and outreach programs to raise awareness, particularly for snorkelers and divers; (iii) enforcing existing rules, particularly those related to marine parks and fisheries; (iv) improving communication and coordination during bleaching events by developing and/or socializing Bleaching Response Plans and forming Response Committees; and (v) developing and implementing codes of conduct and certification programs for divers, dive operators, snorkel guides, and tourism businesses.

***Lessons learned***

- Establish and maintain effective stakeholder networks. Having these in place prior to disturbance events can establish trust relationships if/when responsive actions become necessary. In the event of mass coral bleaching, coherent and guided actions are needed (e.g., through the Malaysian National Coral Bleaching Action Committee that was established with various stakeholders following the 2010 event or through Thailand's National Coral Reef Management Plan).
- Use predicted bleaching conditions from NOAA Coral Reef Watch tools to make proactive management decisions and support communication efforts.
- Prevent coral damage from snorkeling in the shallow reefs before, during and after disturbance events. This may involve establishing alternative sites or only visiting reefs during high tides.
- If temporary closure of diving sites is deemed necessary, clear and early communication of actions with industry stakeholders is important. Ongoing communication through any period of closure is also important; this includes informing the public and tourists concerning status of coral bleaching.
- Reduce sediment load onto coral reefs from coastal development, wastewater discharge from boats and land-based activities.
- Training and capacity building (e.g., in appropriate coral bleaching survey techniques) is important for local marine park rangers and other specialist monitoring groups.
- Together with network partners, conduct research and monitoring for coral conservation and restoration. For example, this can inform the success of temporary closures on coral health.

- Develop effective mechanisms for response project implementation under national coral reef management plans. This may include providing sufficient capacity and funding needs to relevant government agencies for monitoring and enforcement.
- Support multi-national reef conservation efforts to enhance recovery of disturbed reefs.

Reference: https://reefresilience.org/case-studies

**Reducing Local and Direct Environmental Impacts Associated with Diving and Snorkeling Tourism Activities to Increase Reef Resilience, Green Fins**

***Context and challenges***

Coral reefs are globally important ecosystems facing intense and unprecedented pressures. Major global issues like marine debris, coral bleaching and illegal fishing mean that experts predict at least 60% of the world's coral reefs will be destroyed within the next 30 years. Meanwhile, the tourism industry dependent upon these reefs continues to show considerable economic growth. According to the World Travel and Tourism Council (2014), tourism and travel sector activities generate 9.8% of GDP and support nearly 277 million people in employment, representing one in every eleven jobs globally. The World Tourism Organization predicts that, by 2020, over 1.56 billion international trips will be made each year, most of them intra-regional and with the highest numbers in Europe, followed by East Asia and the Pacific, with coastal tourism constituting a significant part of this.

However, tourism can constitute a locally significant driver of environmental degradation, putting pressures on the ecosystem through direct and indirect impacts associated with developing infrastructure as well as other activities. SCUBA diving and snorkeling are nowadays accessible to, and enjoyed by, a mass audience, which brings more and more people into marine habitats with very limited knowledge of the fragility of the environment. Intensive SCUBA diving and boating can directly damage marine habitats, making them susceptible to other stresses and degrading marine life health. Reports have shown that areas heavily used for recreational diving show higher incidences of coral tissue abrasion from anchor damage and diver damage as well as increased coral disease when compared to less frequently visited sites. As a result, marine tourism currently constitutes an increasing threat to the natural resource from which it has grown, and thus risks to undermine a key source of development and income to coastal nations. Local impacts such as these will greatly reduce reef resilience in the face of global threats like climate change. If left unmanaged, the rapid growth of the diving and snorkeling industry could cause significant damage to coral reefs, particularly in areas of high biodiversity.

***Actions taken***

There are a number of past initiatives on tourism impact management in general and diving specifically, with a number of guidelines available to help individual divers reduce their impact on the reef (e.g., Confédération Mondiale des Activités Subaquatiques, CMAS "10 Golden Rules", Coral Reef Alliance "Best Practice When Diving", Project AWARE "Ten ways a diver can protect the underwater environment", Mesoamerican Reef Alliance "A Practical Guide to Good Practice"). However, there are no initiatives like Green Fins which combines a code of conduct with performance assessment and public-private collaboration. Green Fins is currently active in six countries: Indonesia, Malaysia, The Maldives, The Philippines, Thailand, and Vietnam

Green Fins was initiated in 2004 to transform the threat of the diving and snorkeling industry into an opportunity to protect coral reefs. Green Fins is implemented internationally through a partnership between the United Nations Environment Program (UNEP) and The Reef-World Foundation (Reef-World). It is a proven approach (Hunt et al. 2013, Roche et al. 2016) encompassing three main elements; a 15-point environmental code of conduct for dive centers complemented by a robust assessment system to monitor and promote compliance; support towards developing or strengthening implementation of relevant regulatory frameworks; and strategic outreach to and capacity building among dive centers and their customers as well as government partners. Almost 500 operators across Asia have committed to protecting coral reefs by working towards following the Green Fins environmental Code of Conduct.

Annual assessments are conducted by qualified Green Fins assessors who measure members' performance against the list of 15 code of conduct activities and associated assessment criteria. Every business activity is given a score in a 330-point impact scoring system; activities posing a greater threat to marine biodiversity (e.g., dropping an anchor) are given a higher impact score than those not posing a threat (e.g., lack of environmental awareness material). Therefore, the lower the score, the lower the impacts the businesses have on coral reefs. Continued participation and Green Fins certification are dependent on centers lowering impact scores from year to year. Solutions or alternatives to high-risk activities are agreed upon in collaboration with each business manager. Solutions can range anywhere from effectively separating and recycling the operation's waste to monitoring local coral bleaching levels. Participation in relevant environmental activities such as citizen science programs or reef cleanup activities is promoted. Assessor training and qualifications are provided by Reef-World to reduce issues associated with inter-assessor variability.

Green Fins works by engaging relevant national authorities and building their capacity to use Green Fins as part of wider marine resource management programs. Green Fins is currently active within the national government frameworks of Indonesia, Malaysia, Maldives, Philippines, Thailand and Vietnam. In Malaysia, the Department of Marine Parks Malaysia (DMPM) adopted Green Fins as a national program in 2009. Recognizing that Green Fins contributes to national priorities and commitments under the Convention on Biological Diversity it has been included in the Department's Key Performance Index (KPI) as well as being a key component of the department's action plan for delivery of Aichi Target 10. In the Philippines, the Green Fins Code of Conduct has been adopted as a guideline for environmentally sustainable diving under the Departmental Administrative Order (DAO) Sustainable Coral Reef Ecosystem Management Plan (SCREMP), leading to some national resource allocation for work with the diving industry. Similar efforts are underway in the Maldives and Vietnam.

***How successful has it been?***

Green Fins is a proven approach to reduce local direct threats to coral reefs associated with diving and snorkel activities, thus building their resilience. Since 2004, Green Fins has expanded throughout popular diving destinations in Indonesia, Malaysia, Maldives, Philippines, Thailand and Vietnam. Nearly 500 dive and snorkel centers have signed up to be Green Fins members by committing to follow the 15 environmental points of the Code of Conduct since the program was launched. In countries where Green Fins has been integrated into National Government action plans, memberships are continually increasing and activities are set to expand to new locations throughout each country. In locations where Green Fins members have been reassessed annually, average assessment scores have continually improved, proving the success of Green Fins as a replicable management strategy to reduce damage to coral reef ecosystems.

Fifty-three qualified individuals from the National Governments of the Philippines, Malaysia, the Maldives and Vietnam have been trained as Green Fins Assessors to enable further expansion and

continued implementation of Green Fins within their respective countries. As Green Fins is introduced to new countries and new locations, new assessors will be trained.

Hundreds of representatives associated with the diving and snorkeling industry (including dive guides, instructors, boat crew, boat captains, resort managers, resort staff, marine resource managers, Government officials and the general public) have received environmental training focused on reducing the threats of the industry on its local natural resources. Twenty-seven local dive guides or instructors from the Philippines have received further training on the conservation and sustainable management of their local coral reefs and have become Green Fins Ambassadors.

***Lessons learned***

- Green Fins has successfully been replicated across tourist destinations in six Asian countries. This has been driven by demand from the industry as well as keenness from the government to manage tourism activities in all major tourist sites. Replication is possible because Reef-World has made capacity building for all levels of implementation readily available through outreach materials, Operational Handbooks and training programs.
- Due to high industry demand, over subscription of dive centres can quickly become difficult for Green Fins management teams to oversee. It is therefore recommended that implementation focuses on single destinations. Once activities are fully established, replication to a new site can be considered, and so forth.
- The global tourism market is changing and the Asian tourism market is currently booming. Green Fins has successfully engaged all of these major global tourism markets with outreach and communications adapted to each audience (e.g., Chinese, Japanese, and Korean).
- The approach is documented, and comprehensive guidance material and training is available to resource managers globally through the series of Handbooks for implementation at the dive and snorkel centers, tourist destinations, and at the national government level.
- There is a comprehensive collection available in multiple languages and designed to address key environmental challenges within the diving and snorkeling industry.
- Green Fins builds meaningful partnerships between the private and public sectors. This has been critical for the successful replication of the program across six countries.
- Uptake by government has been key in building Green Fins momentum. Government participation is the result of Reef-World and UNEP clearly communicating how Green Fins delivers on their national and international environmental commitments, as well as provides opportunity to strengthen relevant laws and regulations.
- Green Fins drives sustainable economic growth and better-informed consumer choices.
- Dive Centres which adopt Green Fins have noticed a more loyal repeat customer base that make longer stays and are willing to pay more for services. UNEP and Reef-World are committed to continuing the development, implementation and expansion of Green Fins into new sites and countries, and are looking for partners to collaborate with.

Reference: https://reefresilience.org/case-studies

### 1.2.2. Monitoring and adaptive management

**Coral Bleaching Response and Monitoring in the Kiunga Marine National Reserve, Kenya, Western Indian Ocean**

***The challenge***

Kiunga Marine National Reserve (KMNR) is located at the northernmost stretch of the Kenyan coastline at the confluence of two major ocean currents (the north-flowing East African coastal current and the south-flowing Somali current), which creates nutrient-rich upwelling. The reserve covers 250km$^2$ and provides a refuge for sea turtles and dugongs. The coral reefs found within KMNR are comprised of mainly patch reefs, with fringing reef in the northern part. Seagrass beds form the most extensive wildlife habitat in the KMNR. Mangroves also provide critical habitat for various species, serving as forage and resting areas for sea turtles and nursery grounds for juvenile fishes. These mangrove-dominated environments equate to approximately 30% – 40% of Kenya's mangrove stock.

The primary goal of the reserve is to safeguard the biodiversity and integrity of physical and ecological processes of KMNR, for the health, welfare, enjoyment and inspiration of present and future generations. Although resilience principles were not initially taken into consideration during the design of the reserve in 1979, they have since played a major role in the management of the reserve. The 1998 mass bleaching event triggered interest in the effects of climate change, and subsequently resilience principles were incorporated into the management plan.

Climate change, El Niño Southern Oscillation (ENSO) related events, and overfishing are a threat to this area. Kiunga reefs are ecologically marginal due to a natural barrier provided by major rivers separating them from other Kenyan reefs, and to the influence of high nutrients from upwelling off Somalia. The Kiunga reef system has not recovered from the 1998 bleaching event as quickly as other reefs along the Kenyan coast.

Numerous factors have made management of the reserve challenging. Due to the area's proximity to the Somali border, it is difficult to enforce management schemes and patrol the area. The local community does not have a strong appreciation for sustainable resource exploitation in an area of constant lawlessness. The World Wildlife Fund (WWF) and Kenya Wildlife Service (KWS) are working to promote environmental education and awareness programs that co-manage natural resources with the local community. The area's remoteness also makes management challenging because of logistics, high operational costs, and the difficulty of recruiting and retaining skilled and dedicated personnel.

***Actions taken***

To address the issues of management capacity, WWF and KWS have partnered with conservation and research organizations to carry out regular monitoring to both share costs and attract expertise. With the assistance of partners, the goal has been to reduce impacts (such as fishing) by encouraging sustainable gear and practices, thus improving the reef ability to withstand natural disturbances.

Currently, coral reef resilience monitoring is being implemented due to the development of an International Union for Conservation of Nature (IUCN) methodology. In 1998, the ENSO-related bleaching event generated a partnership between Coastal Oceans Research and Development in the Indian Ocean (CORDIO) East Africa, United Nations Environment Programme (UNEP), Kenya Marine and Fisheries Research Institute (KMFRI), and Kenya Wildlife Service (KWS) for monitoring. These partners focused on monitoring bleaching (using a Global Coral Reef Monitoring Network methodology), while a wider team of 20 local fishermen monitored other coral reef ecological indicators such as fish, invertebrate and benthic populations, as well as the use of fishing gear. In 2006, a

monitoring partnership with KWS began monitoring coral disease. In 2008, monitoring of coral reef resilience began in partnership with IUCN, CORDIO and KWS. Indicators that are being monitored include coral size class, herbivorous fish populations, coral condition and other wider resilience indicators such as oceanographic, anthropogenic and ecological factors. These various monitoring programs have guided management interventions by forming the benchmark for a zoning plan, and by enhancing co-management of natural resources due to increased participation and knowledge of fishermen in the region.

***How successful has it been?***

The integration of resilience principles in the management of the KMNR has improved management of resources due to increased knowledge of the reserve and its resources. Additionally, co-management has been enhanced and relationships with the local community have improved. Lastly, the level of awareness of coral reef conservation within the local fishing communities has increased. This has changed the attitude of fishermen, who now recognize the importance of conserving their environment for the future and are now less likely to use destructive fishing gear.

***Lessons learned***

- Functional partnerships between government agencies and NGOs are critical for effective management and cost reduction.
- Community buy-in is critical to establishing resource ownership and raising awareness/knowledge of environmental/climate change issues within the local community.
- It is recommended that resilience studies and principles be understood and communicated among scientists, resource managers, and resource users.
- It is critical to reduce the human impacts on reserves to provide a foundation for resource managers to better mitigate against the impacts of climate change.
- Raising the profile of climate change is critical so that managers can help the community understand the real and present threat to natural resources.
- Working to increase community understanding of the importance of taking a resilience-based approach to management is critical to management success.

Reference: https://reefresilience.org/case-studies

### 1.2.3. Reef restoration

**How We Pushed 400 Tons of Coral Back into the Ocean after a Cyclone**

***Context and challenges***

The Whitsunday Island group supports approximately 6,000 hectares of fringing coral reefs. It is one of the most highly valued and used regions of the Great Barrier Reef Marine Park for tourism and recreational activities. Manta Ray Bay, at the northern end of Hook Island, is an iconic area for tourism due to the easily accessible fringing reef, its status as a no-take marine reserve (green zone), and the high density of large reef fishes. An important feature of the site is the large *Porites*coral ‘bommies’ (large individual coral colonies) which provide high complexity habitat where reef fishes tend to

aggregate. On the 28th of March 2017, the Whitsundays were hit by severe tropical cyclone Debbie (Category 4; 225-279 km/h winds). This resulted in widespread damage to island and marine habitats (including coral communities and tourism infrastructure.

Manta Ray Bay was in the direct pathway of the cyclone and the amount of energy delivered by the storm was enough to pulverize branching corals and to dislodge and push many of the large coral bommies high into the intertidal zone. These exposed Porites bommies ranged in size from 0.5 m to 2.5 m in diameter. High mortality of live coral tissue in the intertidal area occurred during the following days. The loss of the large bommies was perceived as a loss of one of the unique aspects of Manta Ray Bay and in their new location they restricted beach access for small vessels.

***Actions taken***

Queensland Parks and Wildlife Service (QPWS) and Great Barrier Reef Marine Park Authority (GBRMPA) staff, through the joint Field Management Program (funded by both the Queensland and Australian governments), were asked by commercial operators from the tourism industry if the bommies in Manta Ray Bay could be relocated back into the subtidal environment. The intention under this action is that this would provide structure for future coral larvae settlement, attract fish, and improve site access and aesthetics.

One of the ecological risks identified was that physically moving the heavy bommies would damage live coral along the path. However, a preliminary benthic survey conducted by QPWS Marine Parks staff estimated that the Manta Ray Bay reef flat was only supporting approximately one percent live coral cover post cyclone Debbie. Following this, a broader site assessment was conducted which included safety, biosecurity, ecological and environmental considerations. A cost/benefit and feasibility analysis were conducted to assess if moving the bommies would be the best option. The estimated costs of two days of use of earthmoving equipment and supporting barge were deemed to be off-set by the projected benefits: habitat restoration, improved aesthetics and beach access to a highly popular location, ongoing access to public moorings, increased understanding of coral recruitment/recovery and demonstration of proactive management after an extreme weather event.

A preliminary decision was made to proceed with the proposal of relocating the coral bommies back below the low water mark with the stated objectives of: (1) increasing substrate available for potential coral larval settlement in the future and habitat complexity to support fish and other biodiversity, and (2) improving the aesthetics and access to Manta Ray Bay Beach. Once a scope of works was agreed, GBRMPA assisted with the provision of a rapid authorisation to the state government (QPWS) under Part 5.4 of the Great Barrier Reef Marine Park Zoning Plan 2003 (Zoning Plan). This part of the Zoning Plan allows for the GBRMPA to undertake, or authorise third parties to undertake, specific management activities on their behalf. This section of the Zoning Plan is increasingly being used to assist management as more direct reef restoration and rehabilitation activities and trial restoration programs are undertaken.

Highly experienced excavator and compact track loader operators were engaged to reposition the bommies back into the subtidal environment by rolling them over the reef flat at a very low tide. A 30 ton long-arm excavator was then used to push the bommies past the reef crest and over the slope using the full ten meter extension of the excavator arm. In order to maximize site operations during the low tide window, a four-ton compact track loader equipped with a grab bucket was utilized to push coral rubble and smaller bommies substrate into the subtidal area of the fringing reef flat. All biosecurity inspections of earth moving equipment (prior to barge loading and site works), on-site operations and works were directly supervised by QPWS Marine Park's personnel. Over two days (20-21 June 2017),

an estimated 100 cubic meters of dead coral substrate (equating to approximately 400 tons) was placed back into the water below the low water limit.

***How successful has it been?***

Post-deployment monitoring: A follow-up site assessment was undertaken by QPWS staff on 4 August 2017 that showed that the bommies were stable and safe for in-water activities. After this the site began to be visited again by snorkel tourism operators, who described fish communities that included large schools of fusiliers, trevally, hump-headed Maori wrasse and herbivorous fish species.

Baseline assessment – (16 months later): In order to assess the ecological effects and potential benefits of repositioning the bommies, researchers from James Cook University conducted a rapid baseline ecological survey of the bommies in October 2018, approximately 16 months after they were repositioned. The objective of the baseline survey was to quantify the cover of remnant live coral tissue on each bommie, the degree of coral recruitment to the bommies, and the fishes that were associating with the bommies.

Methods: For the coral survey, each bommie was treated as an individual sampling unit (replicate). The total cover of remnant live coral tissue was visually estimated for each bommie. All juvenile corals (recruits) that had settled onto the bommies since June 2017 (between 1 cm and 15 cm in diameter) were identified to genus level.

All surveyed bommies were massive growth form *Porites* sp. colonies. The smallest of the bommies were approximately 1 m in diameter and the largest were approximately 2.5 – 3 m in diameter. Fishes were surveyed along a single 120 m transect that was run alongside the bommies, beginning at bommie 349 and ending at bommie 363 (Figure 6). All fishes that were associating with the bommies, and within a 4 m wide zone around the transect (total survey area of 480 m2), were recorded to species.

Remnant coral tissue on repositioned bommies: The majority of surveyed bommies (16 out of 22, 73%) had some original live coral tissue remaining. The cover of remnant live coral tissue on each surveyed bommie ranged from 0-20%, with a mean across all bommies of 5.9% (± 1.6%). Many of the bommies were in an inverted position (upside down) at the time of the survey. There may have been additional live coral tissue remaining if the bommies had been repositioned in their correct orientation. *Porites* sp. colonies have the capacity to recover through asexual reproduction of remnant coral polyps, and to overgrow the underlying skeletal structure and recolonize dead sections of the colony, provided that these sections are not overgrown by macroalgae or other sessile organisms.

It is possible that the cover of remaining live coral tissue on the surveyed bommies will slowly expand and regrow over the dead sections of the colonies. The rate of remnant live tissue expansion is variable, and is influenced by numerous factors, including water quality, rates of algal grazing and coral scraping by reef fishes, future disturbances such as coral bleaching, flood plumes or cyclones, settlement of coral recruits to the dead sections of the bommies and the growth and expansion of those new colonies. Future surveys of the repositioned bommies should include estimates of the total percent cover of remnant *Porites* coral tissue on each of the bommies.

Coral recruitment to the repositioned bommies: Approximately one-third (8 out of 22, 36 per cent) of surveyed bommies had at least 1 recruit coral colony present. Four bommies had at least two coral recruits present and one bommie had six coral recruits. Coral recruits ranged in size from approximately 3 cm to almost 15 cm in diameter. Overall, ten coral genera were represented in the recruit colonies and included *Acropora, Pocillopora, Cyphastrea, Favia, Favites, Goniastrea, Psammocora* and *Hydnophora*. Given that the bommies were repositioned in June 2017, and that only one coral spawning season had elapsed prior to this baseline survey, it was encouraging to record the presence of a range of

species of coral recruits on the bommies. It is likely that there will be continued growth of the existing recruit colonies, and additional recruitment of corals to the bommies, if favorable conditions persist during the upcoming summer monsoon season and beyond. Future surveys of the repositioned bommies should include measures of the maximum diameter of all coral colonies recorded growing on the bommies.

Reef fishes associated with the repositioned bommies: Twenty species of reef fish from within eight genera were recorded on the single transect through the repositioned bommies. The fish genera represented were Acanthuridae (surgeonfishes), Chaetodontidae (butterflyfishes), Labridae (wrasses), Lutjanidae (snappers), Pomacanthidae (angelfishes), Pomacentridae (damselfishes), Scaridae (parrotfishes) and Siganidae (rabbitfishes). Damselfishes were the most abundant group, with the planktivorous *Neopomacentrus bankieri* being the most abundant species and the territorial herbivore *Pomacentrus wardi* being the second most abundant species. Roving herbivorous fish species, particularly *Acanthurus grammoptilus*, *Siganus doliatus* and *Scarus rivulatus* were observed grazing on the repositioned bommies and on the surrounding substrate. Numerous fish grazing scars were observed on all of the 22 surveyed bommies. Although algal turfs were growing on most areas of the dead coral bommie skeletons, the observed level of grazing pressure by reef fishes appeared to be effectively limiting the growth of algal turfs. Furthermore, no macroalgae were observed growing on the repositioned bommies or on the surrounding reef flat at Manta Ray Bay.

***Lessons learned***

Overall, it should be considered that the repositioning of the *Porites* bommies displaced at Manta Ray Bay during cyclone Debbie has delivered positive environmental and social benefits. Vessel access has effectively been restored to the beach, some remnant coral tissue on most of the bommies has been preserved, colonisation of the bommies by coral recruits has begun, and habitat structure has been maintained for reef fishes. Furthermore, the bommies provide three-dimensional habitat structure on the outer reef flat, and as the coral community develops on the bommies, and greater numbers of fishes associate with them, the shallow-water snorkeling experience for tourists will be enhanced.

We recommend that each of the bommies on the reef flat at Manta Ray Bay be permanently tagged and that the area be accurately mapped using diver-towed GPS, satellite imagery and GIS software. This will ensure accurate identification of each bommie and facilitate robust ecological monitoring of the area. It will also be possible to monitor any movement of bommies following any further extreme weather events. We also recommend that future surveys of the bommies should be conducted at similar tidal height to this baseline survey (2 – 3 m above LAT), and at a similar time of year (October or November).

Given that many of the surveyed bommies were in inverted positions (upside down), future restoration activities to reposition displaced *Porites* bommies should endeavour to orientate the bommies correctly. Correct orientation is likely to enhance recovery of remnant coral tissue.

In addition:

- The bay should continue to be managed as a ‘no anchoring area’ with public moorings maintained. This will minimize the risk to recovering corals from anchor damage.
- This site may now be suitable for trial coral restoration techniques (e.g., larval enhancement, ‘coral gardening’) to accelerate recovery.
- Time is a critical factor when seeking to increase survivorship of live impacted corals post impact. I.e., the faster they can be restored, the better!

- Site impact assessments were an important factor in expediting approvals to undertake the works.
- Manta Ray Bay is in a 'Green Zone' of the GBR and is therefore protected from fishing pressure. High numbers of grazing and herbivorous fishes may contribute to coral recovery by keeping down levels of algae turf and macroalgae that may compete for space. Monitoring the level of macroalgae growth on the bommies should be part of yearly monitoring.

Reference: https://reefresilience.org/case-studies

**Reef Rescuers: Coral Gardening as an MPA Management Tool (Cousin Island Special Reserve, Seychelles)**

***Context and challenges***

In 1998, the mass coral bleaching event, caused by the coupling of El Nino and the Indian Ocean Dipole, severely affected the reefs of the Seychelles Archipelago. The 1998 bleaching catastrophe decreased live coral cover by up to 97% in some areas and caused many reefs around the islands to collapse into rubble (which later became covered with algae). In the following decades, coral recovery has been extremely slow in the inner granitic islands of Seychelles. Despite the existence of numerous no-take Marine Protected Areas (MPA) – an effective tool to bolster coral reef recovery – it has taken almost 20 years to see coral cover at pre-1998 levels in most areas in the region. Due to continuous global threats, such as changes in climate and ocean chemistry, MPAs alone may not be enough to assist in the recovery of coral reefs in the Seychelles. Consequently, more active conservation strategies are needed to promote reef recovery and build reef resilience and to achieve the long-term conservation of coral reef ecosystem services.

***Actions taken***

The slow post-bleaching recovery motivated active restoration efforts in the inner islands of the Seychelles archipelago to assist in natural recovery. In 2010, Nature Seychelles launched the Reef Rescuers Project on Praslin Island. Financially supported by the United States Agency for International Development (USAID) and the Global Environment Facility (GEF) through the United Nations Development Program (UNDP), this climate adaptation coral restoration project seeks to repair coral bleaching damage in selected sites around Praslin and Cousin Island Special Reserve, a no-take marine reserve.

Through this project we are piloting the first-ever large-scale active reef restoration project in the region using 'coral gardening,' a technique that involves collecting small pieces of healthy coral, raising them in underwater nurseries and then transplanting them to degraded sites that have been affected by coral bleaching. Forty thousand fragments of coral from 10 different branching/tabular species (*Acropora hyacinthus, A. cytherea, A. abrotanoides, A. appressa, Pocillopora damicornis, P. grandis* – senior synonym of *P. eydouxi, P. meandrina, P. verrucosa, Stylophora pistillata, S. subseriata*; species identification after Veron 2000 and nomenclature after the World Register of Marine Species) have been raised in 13 underwater nurseries located inside the Cousin Island Special Reserve. Between November 2011 and June 2014, a total of 24,431 nursery-grown coral colonies were transplanted to 5,225 $m^2$ (0.52 ha) of degraded reef within the Cousin Island Special Reserve.

With the onset of a weak-to-moderately strong El Niño-Southern Oscillation (ENSO) event starting late summer to early fall 2014 and continuing through 2016, we had a unique opportunity to determine the effectiveness of the choice of coral reef species (initially chosen based on survival rates during the last seawater warming anomaly) and the restoration process itself in alleviating the impact of warmer ocean temperatures. We are using standardized protocols to monitor the survival, reproduction, recruitment and bleaching response of donor and transplanted colonies. We continue monitoring at the transplantation site and two control sites, representing a healthy and degraded coral reef. Such monitoring allows us to evaluate the effectiveness of the restoration effort. Additionally, we are assessing the costs of large-scale reef restoration via coral gardening and the life cycle of coral reef restoration technology.

***How successful has it been?***

The long-term "success" of this mass transplantation is still being monitored but the project has already had positive outcomes. Forty-one practitioners from 11 countries have been exposed to reef restoration techniques by "on the job" work as volunteers up to three months on site, and eight experts have to date been formally trained through a full-time six-week classroom and field-based training program. Before-and-after comparisons in coral cover at the transplanted site showed that the restoration project resulted in a 700% increase in coral cover, from about 2% in 2012 to 16% by the end of 2014. Similarly, we have documented a five-fold increase in fish species richness, a three-fold increase in fish density, and a two-fold increase in coral settlement and recruitment at the transplanted site. We also found that our coral transplants responded better to stressful conditions resulting from increased sea temperatures and a harmful algal bloom. The transplanted corals appear to recover faster and better than corals at other sites. The response of the transplanted reef to thermal stress bleaching is still being monitored. The preliminary analysis of the costs of reef restoration via coral gardening and the life cycle of coral reef restoration technology together with the ecological results so far support the application of large-scale, science-based coral reef restoration projects with long timescales to assist the recovery of damaged reefs. A proposal to scale up the coral farms to a mariculture venture so as to reduce costs through economies of scale has been accepted by the Seychelles government and funding is currently being sought.

***Lessons learned***

A tool kit is currently being put together to highlight the lessons learned from the project. In summary, we have learned that:

- Survival of coral donor colonies is high.
- Survival of nursery colonies is high for the selected species listed above.
- There is a natural supply of corals (corals of opportunity) to be grown in the nurseries and that eliminate the need to re-fragment nursery-grown or donor colonies.
- Nurseries become floating reef ecosystems.
- Natural cleaning of coral nurseries and coral ropes reduces nursery maintenance and increases transplantation success.
- There is a positive transplantation effect on settlement and recruitment of new corals, fish diversity and density.
- The response of transplanted corals to bleaching causative events needs close monitoring to assess the effects of coral gardening on building bleaching resistance.
- There is citizen science interest internationally in receiving training on coral reef restoration.

- Partnerships with the tourism sector can be developed to establish coral gardens (seascaping) as a guest attraction and as a key part of the industry's environmental management programs and Corporate Social Responsibility (CSR).
- Large-scale coral reef restoration needs to be considered as a cost-effective tool to include in the MPA manager's toolbox.

Reference: https://reefresilience.org/case-studies

**Using Coral Restoration and Ecotourism to Increase Local Participation and Financial Benefits of Resource Management Efforts, Figi**

***Context and challenges***

Fiji's coral reef ecosystem is the most extensive in the South Pacific and provides fisheries and tourism opportunities that are primary GDP earners and integral to the well-being, culture, and survival of Fijian communities. The southwest coast of Viti Levu, Fiji's largest and most populated island, is flanked by the country's longest fringing reef system and has been affectionately known as the Coral Coast since resort tourism began on its shores in the 1950's. The wide, shallow lagoons filled with colorful fish and corals just meters beyond the white sandy beaches are the icon that made the Coral Coast famous and over the last 50 years has created a thriving tourism economy that today caters to more than 20% of Fiji's tourists. Since time immemorial, these reefs have supported the subsistence needs of the indigenous resource owners. However, the spectacular reef ecosystem that became the icon of the Coral Coast has been degraded by the compounded effects of local impacts from high fishing pressure and coastal development along with climate change stressors threatening the backbone of the local economy and the livelihood and food security of coastal villages and settlements.

The Korolevu-i-wai district is located in the heart of the Coral Coast and consists of the four traditional villages of Votua, Vatuolalai, Tagaqe, and Namada amongst which numerous settlements, residential areas, and tourism developments are interspersed. Overall, the district has a resident population of over 2,350 people living in more than 420 households, less than half of which are resource owners in the district. Along its shores lie numerous resorts and guest houses that offer over 450 guest rooms, largely on leased native land. The adjacent reef system is approximately 9km$^2$ in area and is the Customary Fishing Ground of the Vanua Davutukia, the native resource owners of the district. The reef system is relied upon by most families in the district to meet their household food requirements, and is particularly depended upon when tourism arrivals and thus employment opportunities and income are down. In 2000, Fiji's coral reefs suffered from the first-documented widespread, intensive bleaching event that resulted in extensive coral death. Korolevu-i-wai reefs lost much of their living coral with the shallow, backreef lagoon (where fishing and tourism activities mainly occur) being most severely impacted. Local impacts from overharvesting and other destructive fishing practices along with climate-related stressors have severely degraded the reef ecosystem to the point where coral communities have largely been unable to recover from the 2000 bleaching. The once majestic Korolevu-i-wai reefs now have <10% living coral cover, are largely overgrown with seaweeds, and the for hook and line fishing is less than 200 gm of fish/person/hour.

***Actions taken***

The Vanua Davutukia of the Korolevu-i-wai district began with marine resource management efforts in 2002 with the support of the University of the South Pacific's Institute of Applied Sciences (USP-IAS) and Fiji Locally-Managed Marine Areas (FLMMA) program. A simple, district-level resource management plan that identified perceived threats to the resources and mitigating actions to be taken was developed and adopted.


Korolevu-i-wai community-based marine management plan 2014-2019. No-take areas are outlined in red and orange and marked with the years they were established in, traditional villages are marked with stars and named, additional rules that apply for entire fishing ground are listed below, and the two bottom right photos show the traditional ceremony and offering to establish the management plan from 2014 to 2019. Photo © Reef Explorer Fiji Ltd.

In 2006, the Vanua Davutukia began working closely with Reef Explorer to implement and review their management plans and monitor the success of their activities. A suite of educational, research, and community development activities were undertaken to address priority issues along with extensive management planning activities and reviews of the community's marine resource management plan in 2007 and again in 2014. The ultimate goal of the management plan is to bolster local incomes and traditions by replenishing and reviving local marine resources – a grassroots approach to rural development and conservation of natural resources. Management plans are developed via participatory techniques and include the establishment of community-based no-take marine protected areas (MPAs), fisheries enforcement and compliance activities, addressing pollution threats, enterprise development,

and biological and socioeconomic monitoring for use in adaptive management of the community's conservation and development activities. Some 6 to 10 years after their establishment, the MPAs had 500% more live coral cover and 50% greater species richness of coral than adjacent fished areas, little to no seaweeds, and 30% more food fish, 50% more species of food fish, and 500% more biomass of food fish than the adjacent fished areas (Technical Report).

The development of small-scale coral cultivation and restoration efforts is one of the activities that Reef Explorer has been assisting district villages with since 2006. This initiative began in village MPAs, largely as an educational and economic tool, but has evolved to become an integral and growing part of management activities, particularly as a climate change measure and to engage village youth in marine ecotourism and conservation.

As corals are a keystone species to the reef ecosystem providing essential habitat and otherwise supporting an amazing diversity of life, the restoration of coral communities is necessary for the recovery and resilience of local fisheries and the conservation of marine resources. With the assistance of village youth groups, coral nurseries established in four Korolevu-i-wai MPAs and one fished location were expanded and by 2016 a total of 7000+ new coral colonies were being propagated annually for use in restoration efforts.

Rope nurseries have been the easiest and most cost-effective method for propagating new corals of any species that have a branching morphology. Finger-sized fragments are inserted into the braided rope with each rope being stocked with corals that have similar growth rates. Photo © Reef Explorer Fiji Ltd.

Capitalizing on the success of MPAs in assisting the recovery of coral communities, coral colonies are asexually propagated from corals located in the MPAs through fragmentation of selected donor colonies or collection of unattached coral fragments. Selected donor colonies largely consist of heat-tolerant lineages of corals identified during previous coral bleaching events, but in some cases species that are rare at the sites are used as donors for fragments. Finger-sized fragments are grown out on ropes or cement discs in 'coral nurseries' until they are larger (6-10 months) and later transplanted back to the reef at restoration sites.

Areas of the reef that are lacking in living corals despite otherwise being suitable habitat are selected as restoration sites where propagated corals are transplanted. By assisting areas of the reef to recover in terms of coral cover and species richness using heat-tolerant coral lineages, coral restoration can be used as a climate adaptation strategy and play an important role in promoting the recovery of the coral communities necessary to support fisheries enhancement in these areas. By providing an attraction that can be used in local ecotourism enterprises, coral restoration can also help provide economic opportunities that reinforce the sustainable use and conservation of marine resources.

Generally, corals of the genus *Acropora* have been selected for propagation as they are fast growing and contribute greatly to the habitat complexity and overall coral species diversity found on healthy reefs. However, other coral genera (*Porites*, *Montipora*, *Pocillopora*, *Stylophora*, *Seriatopora*, *Echinopora*, *Merulina*, *Hydnophora*, and *Psammocora*) are being propagated as they are dominant genera in the reef community, can be used to help secure and consolidate substrate, and/or are resilient to thermal stress and less affected by crown-of-thorns starfish predation. In total, multiple lineages of more than 50 species of hard corals are used in the restoration efforts.

Our transplanting strategy consists of creating mixed species assemblages across available hard bottom area. In these patches, different lineages of the same species are planted in close proximity to each other to help promote successful reproduction with each other during spawning months. In combination with the careful selection process for donor colonies, this strategy can not only increase coral cover with more resilient corals, but also bolster the reproductive success of these heat-tolerant lineages.

Corals are most commonly transplanted onto the reef substrate using a mix of cement and plaster. Corals are transplanted in mixed species assemblages at the restoration sites in an aim to improve the survivorship and the reproductive success of these heat-tolerant lineages of corals. Propagated corals are also being used for research examining heat tolerance and the reproductive ecology of corals.

In conjunction with the establishment of the coral nurseries, youth groups are being assisted by Reef Explorer to develop plans and capacity for operating snorkeling tours of the coral nurseries and restoration sites in their respective MPAs. Currently, snorkeling tours are operated by youth in two of the four villages providing employment and financial benefits to the villages.

***How successful has it been?***

Since 2006, 50,000+ corals consisting of more than 50 species have been propagated and transplanted back to the reef in village MPAs, and village youth have received basic training in cost-effective coral propagation techniques, reef ecology and fauna, and integrating this work into guided snorkeling tours.

As the coral restoration work has progressed, a variety of international guests have visited specifically to learn from or observe the project and assist with coral transplanting efforts including the Governor of Tokyo, Locally-Managed Marine Area (LMMA) country representatives from all Asia-Pacific member countries, Fiji government and NGO representatives, Fijian students, American and Australian Travel agents, study abroad programs from U.S. and Australia-based universities, and numerous international conservation practitioners and marine educators from around the Caribbean and Pacific. Guest visits have provided thousands of dollars of income to village funds, village youth, and have been used to further develop coral restoration efforts. Additionally, the propagation technique was adopted by American researchers for several years providing further income generating opportunities for the local community through the preparation for and propagation of corals for use in experiments.

This coral restoration program serves as a pilot effort for other communities to learn from and has resulted in improved local marine management capacity and compliance, and ecotourism strategies. These efforts have brought thousands of dollars into the hands of villagers and supported the

continuation and expansion of coral planting efforts and capacity building for snorkeling guides. Overall, coral restoration activities have enhanced local marine conservation efforts by:

- Providing economic incentives for conservation;
- Bolstering participation of village youth in marine conservation efforts;
- Improving local knowledge of coral life history and reef ecology through 'hands-on learning';
- Further integrating community-based resource management efforts with Fiji's growing tourism industry; and
- Helping coral communities re-establish and adapt to increasing sea water temperatures so as to support local fisheries and coral community resilience.

***Lessons learned***

Key lessons learned from the coral restoration efforts over the last 13 years include:

- Simple asexual coral propagation methods can be quickly learned and effectively implemented by community members for coral restoration efforts.
- Corals in the genus *Acropora*, though often utilized in restoration efforts, have been those that are most susceptible to disease and predator damage. Propagating a variety of genera intermixed throughout the nursery helps reduce predation and improves overall success.
- Restoration efforts are much more effective and successful in well-established no-take areas, areas with good water quality conditions, and/or reef areas with healthy herbivore populations.
- Strong local governance and community support and participation are critical to the success of coral reef management and restoration efforts. Involving village youth in the efforts along with community leaders and elders promotes compliance and sustainability of the outcomes.
- Economic incentives foster greater community support for and participation in coral reef management.
- Combining coral restoration with income-generating activities such as snorkeling tours can improve community interest in coral restoration and conservation activities while providing financial support for the effort.

Reference: https://reefresilience.org/case-studies

**Coral Nurture Program. Great Barrier Reef, Australia**

**Context and challenges**

Australia's iconic Great Barrier Reef (GBR) has experienced catastrophic loss of coral (>30%) from mass bleaching via back-to-back marine heatwaves (2016-17), with a third event underway in 2020. These unprecedented impacts solidified concerns that conventional GBR management – largely marine area protection and mitigating deteriorating water quality – was no longer sufficient to secure the GBR's future. This prompted government investment into national intervention – and dynamic adaptive-management options. The tour operator industry largely sustains the GBR's $6.5B per year asset value and has an overwhelming desire to maintain and restore the quality of their "high value" reef sites

(Suggett et al. 2019). While the desire was in place to specifically adopt established coral propagation practices for site-tailored reef rehabilitation (e.g., from the Caribbean, and rapidly developing elsewhere), capacity was limited by fundamental legislative, governance, and operational barriers designed for reef protection. The objective was to develop low-cost approaches that could dovetail into existing operations and thus be cost effective, but also easily adopted into existing tour operator business models.

***Actions taken***

Initial activities, "Phase one" (February 2018-February 2019), were designed in partnership with the government's Great Barrier Reef Marine Park Authority (GBRMPA) to design the workflow for, and in turn implement, coral propagation practices. Detailed site ecological surveys, alongside assessments of historical site knowledge, were conducted to help guide the first nursery and propagation and outplanting permits. A novel physical attachment device consisting of a nail and a strap, the Coralclip® (photo below), was invented, which sped-up planting by one or two orders of magnitude faster (and hence more cost-effectively) than was previously possible via conventional chemical fixatives used to date (Suggett et al. 2020). From this first phase, over 2,500 corals were maintained in the new nurseries and nearly 5,000 corals outplanted to Opal Reef in the space of a few weeks (Suggett et al. 2020), largely during routine vessel operations and using operator staff to outplant.

Subsequent "Phase two" CNP activities (April 2019-April 2020) examined how the approach developed for the test site and tourism operator via phase one, applied to multiple reefs with different environments and coral condition, and among multiple tourism operators with different business models. Efforts focused on ensuring standardized workflows for establishing nurseries and outplanting across operators and sites – including training, site evaluations, and data reporting (in part for ecological trajectory assessments as well as permit compliance; photo below).

***How successful has it been?***

As of May 2020, over 50 nursery platforms have been established and over 17,000 corals planted across six major high-value tourism sites, as a result of the Coral Nurture Program tourism-research partnership. Operators were equipped with the knowledge and tools to "pivot" and redeploy efforts and resources from tourism to site rehabilitation during the COVID19-induced tourism downturns. Planning has begun towards "Phase three", which includes broader (regional) adoption amongst the tourism industry – as well as other key GBR stakeholders, notably Traditional Owners – and fully tracking ecological responses of the outplanting sites, to ensure these initial efforts inform 'what works best, where and when' in deciding future scaling of activities.

***Lessons learned***

Adapting nursery and outplanting design to fit location-specific requirements*:* Tools were conceived specific for the conditions that had driven the need for restoration. For example, numerous coral species (across all growth morphologies) had been impacted at GBR sites, and therefore floating platforms were designed in favor of existing "coral tree" structures to consistently accommodate any taxa, but also within often physically dynamic outer reef sites (Suggett et al. 2019).

Monitoring and implementation: Based on the extent of outplanting achieved in phase one for the test site, it was clear that attempting to 'fate track' 1,000s of outplants was impossible, and instead the outplant 'success' evaluations were established around ecological approaches using marked replicate plots of reef (and un-amended controls). Initial installation of nursery platforms at all sites provided very visible demonstrations relatively quickly to the operators and their tourist customer base of active

site rehabilitation practices. Active outplanting was slower to adopt, and ultimately was best executed in targeted 'campaigns' when staff were available without impacting on regular operations.

Empowerment and capacity building is key: Empowerment and capacity building are at the core of the approach and philosophy of CNP. Stakeholders want to save the reef, and researchers want to help support robust methods to do this. Therefore, the partnership we built between researchers and tourism operators (or any other stakeholder) capitalized on the passion and drive of all involved to make positive change. The desire to optimize effective practice(s) tailored to the GBR has been critical in ensuring key lessons are learned prior to initiating projects purely for commercial gain, in particular where the ecological impacts are yet to be fully resolved. Importantly, scientific rigor has been central in driving increased social licensing, learning through implementation, but under well controlled environmental and social conditions. This has been central in building trust amongst researchers, stakeholders and the wider public to better define when restoration is (and isn't) appropriate for the GBR.

Reference: https://reefresilience.org/case-studies

**A Trial of Coral Reef Restoration at a Large Spatial Scale, Okinawa prefecture, Japan**

***Context and challenges***

Coral reefs in the Okinawa prefecture, Japan, are important habitats supporting high biological diversity and high value fisheries and tourism industries. However, in the early 2000s, coral cover around the Okinawan islands had dropped below 10% due to a range of disturbances including bleaching, predation by *Acanthaster* cf. *solaris*, soil erosion, and eutrophication. In 2010, The Okinawan prefectural government declared a "21st century vision for Okinawa" that aimed to review economic and public values of coral reefs and natural coastlines and develop a new system / framework for its conservation and restoration.

***Actions taken***

The prefectural government conducted a 7-year project (2010-2016) for the technical development and research on coral reef restoration accompanied by various other projects on reef conservation including public awareness and education. The project contained 2 major programs; 1) pilot study of coral outplanting at a large spatial scale, and 2) research on coral reef restoration.

The pilot study of coral outplanting at a large spatial scale was conducted at three locations: Onna, Yomitan and Zamami villages. Activities included:

- Seed (Juvenile) colony production
- Growing corals in a nursery
- Outplanting (at 3 ha)

Research on coral restoration included:

- Reviewing the literature on coral culture and outplanting
- Conducting genetic analysis of coral populations for genetic diversity
- Assessing the appropriate density of seed colony for coral outplanting

***How successful has it been?***

A systematic cycle of seed production and nursery processes was developed for large scale restoration to provide coral seeds across 3 hectares.

- At Onna village, all coral seeds for outplanting were produced from asexual reproduction from nursed colonies which consisted by 20 *Acropora* species and 30 other coral species. Coral seeds were also produced by sexual reproduction at private research institutes in Aka Island and Kume Island for outplanting.
- At Yomitan village, coral seeds were produced at the local facility with asexual reproduction for outplanting.
- At Zamami village, coral seeds were collected from the natural recruitments on the ropes of the aquaculture facility in the village. The seeds were also produced from the natural larvae during the mass spawning for outplanting.
- The outplanting area using seeds by asexual reproduction was highest in Onna village with an area of 2.74 ha. The number of seeds were also the highest at the Onna village with 104,687 colonies.

For the research phase, current and past information on coral transplantation and restoration were collected to summarize and develop recommendations for future restoration efforts. Genetic analysis of coral populations was also conducted in this project for examining genetic diversity of cultured seed colonies. Finally, the population density of outplanted colonies was assessed to identify appropriate density for successful reproduction.

- A genomic analysis of the coral *Acropora digitifera* (Dana, 1846) showed that the species did not have a single gene population in Nansei islands including Okinawa, but there were specific markers at the DNA level for different areas and island localities.
- *Acropora tenuis* (Dana, 1846), a popular species for coral restoration, had at least 2 genetic populations in Okinawan waters. However, these 2 populations were not clearly identified, but had different population genetics structures depending on the site.
- The genetic analysis revealed that the genetic structure of the coral population was complex around Okinawa prefecture and seed colonies and donor colonies for outplanting should be collected from the site near the outplanting to prevent destruction and disturbance of genetic structure of the population. As *Acropora tenuis* (Dana, 1846) didn't show any population cloned in its natural habitat, seed colony for restoration should be produced by sexual reproduction. Even when seeds from asexual reproduction were used for outplanting, the donor colonies should be identified on genotypes and seed colonies should be outplanted at the different locations for successful fertilization with different genotypes when they are mature.

***Lessons learned***

The cost of seed production is still high and should be reduced for sustainable restoration. Seed production by asexual reproduction cost JPY2,000 (US$39) per seed colony compared with JPY2,700 (US$24.82) – JPY3,500 (US$32.18) for seed produced by sexual reproduction. Improving the cost-effectiveness of seed production would require simplifying and optimizing the techniques for both sexual and asexual reproduction, and improving survival after outplanting.

Sustainable system on reef management at the local level is important: Onna village showed successful restoration led by the Fishery Cooperatives during the project. That village has had strong enthusiasm and policy for sustainable development since coral conservation efforts started in 1998 after they

experienced mass coral bleaching. The Fisheries cooperative from the village has had many projects to prevent soil erosion, eutrophication and predation of *Acanthaster solaris*, and protect not only their fisheries resources but also tourist resources. In 2018, the village was declared a "coral village" to respond to another mass coral bleaching event that occurred in 2016, and continue to address challenges of reef conservation for sustainable development. These experiences have accelerated their conservation policy and activities on sustainable use of natural resources and led to long term reef restoration actions.

Local community development for sustainable resource management should be emphasized in the context of the reef restoration. Public awareness and education for the community would support long-term and sustainable actions on reef restoration and integrated management along the coast.

There exists the need of countermeasures against coral bleaching induced by high water temperatures. Both outplanted and natural coral colonies had severe damages from the mass bleaching in 2016. More research on vulnerable sites, genetic strain of resistance for high water temperature and technical development of shading of natural sunlight would provide possible countermeasures against coral bleaching.

To follow-up on these lessons, a new project is underway until 2022 to tackle the challenges of enhancing seeds' survival and growth, increasing research on larval dispersal and population dynamics of the outplanted colony, and the effectiveness of ecological, economic and social values, of reef restoration for local communities.

Reference: https://reefresilience.org/case-studies

# II. Integrated management of habitats and land-based pollution

### 2.1. Designing management plan

**Fisheries *Refugia* as a Tool for Integrated Fisheries and Habitat Management at Phu Quoc Archipelago, Viet Nam**

***Context and challenges***

The Phu Quoc Archipelago was selected as a coral reef and seagrass demonstration site of the UNEP/GEF South China Sea Project. This archipelago is a priority site of the Viet Nam Biodiversity Action Plan and the diverse marine ecosystems (seagrass, coral reefs, and mangroves) surrounding the 14 islands support a range of pelagic and demersal fisheries. The main objective of this demonstration site was to develop and establish a co-ordinating mechanism among provincial sectors and between Viet Nam and Cambodia in management of coastal waters of Kien Giang and adjacent transboundary areas. Other activities involved enhancing public awareness regarding the significance of seagrass and coral reefs for fish stocks and improving the capacity of provincial policy makers, managers and local communities to guide the sustainable use of natural resources and habitats at the site

The key achievements of the site include: the development of a rich database of information on coral reef and seagrass communities which has been used in the zoning of two pilot areas for management, namely the An Thoi coral reef sub-site (400ha) and the Ham Ninh seagrass sub-site (6,300 ha); effective operation of a cross-sectorial Project Steering Committee; improved awareness and business practices within the tourism sector; and use of data and outputs as part of broader coastal and marine planning at the archipelago. The mid-term evaluation of the project identified however, that a key threat to the longer-term sustainability of project interventions at Phu Quoc was a low level of integration of fisheries issues into habitat management and vice versa. This threat was considered particularly high at the Ham Ninh commune, which is almost entirely dependent on fishing in the adjacent seagrass sub-site.

The Ham Ninh seagrass sub-site represents 8 percent of the total known area of seagrass in the South China Sea. It supports a variety of economically important species including swimming crab, cuttlefish, shrimp, rabbitfish, octopus, strombus snail, and seahorse. The species are harvested using a wide range of fishing gear and practices, including gill nets, demersal seines, pelagic purse seines, demersal trawl, push netting, traps, intertidal gleaning and raking, and hookah diving.

Intensity of fishing operations in the near shore waters of the site are such that serious community concern was expressed regarding the degradation and loss of seagrass habitat as a result of fishing and consequent effects on the longer-term availability of local fish resources critical for local income and food. The widespread use of active fishing gears such as demersal trawls and push nets in seagrass areas of the site was noted as a key source of conflict between fishermen.

**Fisheries *Refugia* as a Tool for Integrated Fisheries and Habitat Management at Ham Ninh**

In this connection, the focal point of the UNEP/GEF South China Sea Project in Viet Nam was consulted and the fisheries *refugia* concept was introduced to the Phu Quoc Management Board as a means of improving the management of fish stock and habitat links at Ham Ninh. The use of the fisheries *refugia* concept was well received by the Kien Giang Department of Science and Technology (DoST) and Department of Fisheries (DoF), as well as representatives of the Ham Ninh commune

Subsequent consultations were undertaken with commune fishermen, fish traders, and women involved in inshore gleaning and processing. It was noted that by emphasising the “sustainable use” aspects of *refugia* rather than the “no-take” approach adopted as part of classic marine protected areas systems

adverse reactions at the community level were avoided. This was viewed as being a necessary pre-requisite for any dialogue regarding improved fishing practices within the site. A joint project involving DoST, DoF, the UNEP/GEF fisheries component and Phu Quoc demonstration site, Phu Quoc MPA Authority, Border Army, and fishermen and fish traders of the Ham Ninh Commune was launched in 2007 to establish and manage a pilot fisheries *refugia* site at the Ham Ninh seagrass area.

***The Approach***

The overarching goal of the fisheries *refugia* pilot activity is to improve the integration of fisheries and seagrass habitat management at Ham Ninh through the establishment and management of critical fisheries *refugia* (spawning and nursery areas), to improve the longer-term security of fisheries yields and to reduce the rate of seagrass degradation and loss. Specific activities conducted to date include: development of an inventory of fisheries *refugia* sites for important fish species, including seasonality of spawning and age/size of recruitment from nursery areas for key species; preparation of a fisheries profile for Ham Ninh commune; identification of specific fisheries and habitat management issues at the site; and recommendations for future management. It is planned that operational management of fisheries *refugia* at Ham Ninh will be undertaken by Kien Giang's Department of Fisheries under the guidance of the local MPA Authority.

***Importance of Community Participation in Identification of Refugia Sites***

At the time of project development information regarding the links between fish stocks and habitats at Phu Quoc was scarce. Little or no data on the distribution and abundance of fish eggs and larvae were available for identification of spawning locations or important nursery locations for fish stocks. This problem was largely overcome by a high level of involvement of fishermen from the local commune in all consultations and exercises to identify *refugia* sites.

The level of acceptance by fishermen of the *refugia* concept was such that they ultimately led activities to identify specific spawning and nursery areas in consultation with local fisheries and environment department staff, and border army officials. This provided sufficiently high level of interaction between all sectors that management issues and solutions could often be discussed and agreed at-sea aboard small- scale fishing vessels. Such dialogue was necessary to enable the level of sharing of ideas and perspectives between stakeholders required to identify solutions to problems directly related to the primary source of food and income for the local community. Involvement of scientists from Viet Nam's Institute of Oceanography in the process assisted in the interpretation of local community and fishermen knowledge.

***Lessons learned***

It is anticipated that the experiences gained at this demonstration site will be suitable for application in other areas of Viet Nam and the South China Sea generally where over-fishing and the use of inappropriate fishing gear are significant impediments to more sustainable use of fisheries resources and habitats. The achievements at Phu Quoc were considered during the third Regional Scientific Conference and have been used by the Regional Working Group on Fisheries as a basis for the development of national programmes of activities as part of a planned project to establish a regional system of fisheries *refugia*.

In the past many marine protected areas in Southeast Asia have been promoted in terms of their potential to improve the state of fisheries and their habitats, but have rarely included mechanisms to ensure the effective integration of fisheries considerations into management. In contrast fisheries departments and ministries largely focus on achieving sustainable yields from fish stocks. Experience of this pilot activity at the Phu Quoc site suggests that cross-sectorial co- ordination can be achieved

through the fisheries *refugia* concept that has provided a platform for building partnerships and enhancing communication between the environment and fisheries sectors, at the provincial and local levels.

Reference: http://www.unepscs.org/South_China_Sea_Knowledge/Lessons_Learned/SCS_Lessons_Learned.html

**Using Reef Resilience Assessments to Inform Marine Reserve Design in Angoche, Mozambique**

***Context and challenges***

Mozambique is located on the southeast coast of Africa along the Indian Ocean. The Aghulhas Current flows southward along Mozambique's coast, supporting a high diversity of fish. Along the coast, mangroves, coral reefs and seagrass beds provide food and habitat for marine life, including seabirds and nesting sea turtles. Millions of people living in coastal communities depend on the sea and its resources for survival.

Mozambique is one of the poorest countries in Africa. Ninety percent of the population lives on less than $2 per day, life expectancy is 53 years, and 11.3 percent of the population is HIV/AIDS positive. Marine resources here are threatened by destructive fishing practices that devastate fisheries and destroy fragile ecosystems. Of particular concern is illegal fishing by international boats in coastal waters that are the basis of local fisheries. Coral reefs are also at risk from rising sea temperatures and cyclones that generate storm surges, flooding, and sedimentation.

***Actions taken***

In 2012, the Government of Mozambique established the Primeiras & Segundas Environmental Protected Area (PSEPA), the second largest marine and coastal reserve in Africa, spanning 260 km across two provinces and three districts. The Primeiras & Segundas seascape is unique because it contains one of the most abundant and diverse hard and soft coral communities in Mozambique; large seagrass beds; intact mangrove forests containing eight species of mangroves; rare coastal forest habitat; deep cold water upwellings and an abundant diversity of marine life including marine turtles, seabirds and other keystone species. The coastal region is also home to nearly 400,000 inhabitants whose livelihoods depend on the resources which make for such an enriched and diverse area.

To alleviate poverty and improve the management of natural resources in fishing communities of the Primeiras & Segundas Archipelago within the Protected Area, the Africa Region of The Nature Conservancy (TNC), the World Wildlife Fund (WWF), CARE, and local communities are working together. The Primeiras & Segundas Program envisions a future in which marine and terrestrial ecosystems are thriving and the poor who depend on them have better lives and broader options. The program aims to improve food and nutrition security and opportunities for vulnerable populations in ways that conserve ecosystems and species of global importance, while reducing the burden on the Primeiras and Segundas Archipelago's fragile ecosystems. Key strategies include:

- Support government and stakeholders in the design and implementation of the Management and Business Plan for PSEPA to protect essential estuary and reef spawning grounds
- Reduce destructive fishing practices
- Diversify livelihood options

- Introduce improved agriculture and fishing practices, including aquaculture
- Improve resilience of the estuarine-mangrove and reef systems and coastal communities to climate change
- Engage communities in a governance framework which ensures management and sustainable use of natural resources
- Influence policy and practice at local to global levels for increased revenue flow and ownership of resources to local communities

Resilience is a key concept and management strategy of the Primeiras & Segundas Program in Mozambique. TNC's primary role in the partnership in Mozambique is to bring coral reef resilience science and experience to the design and implementation of the PSEPA. In 2009, local project staff were trained in coral reef resilience concepts. Additionally, in 2009 a preliminary assessment of coral reef resilience was conducted. While extensive coral bleaching was observed in some locations, possibly due to storm surge associated with a recent hurricane, coral reefs showed several indicators of healthy and resilient coral reef communities:

- High coral cover, diversity and recruitment
- Good water quality and consolidated substratum
- Minimal coral disease
- While coral reef fish communities showed some effects of fishing pressure, reef fish communities were in relatively good condition, with healthy populations of herbivores (which play a critical role in coral reef resilience).

In 2010, eight marine scientists from TNC, WWF, CARE, and the Unilurio University – Mozambique, plus two members of the local project team, conducted a more detailed assessment of coral reef resilience and the status of key fisheries species of reef fish. Information about key indicators of coral reef resilience (water quality, substratum type, cover, variety and size structure of coral communities, fish species richness, and density and biomass of herbivorous reef fishes) and the status of key fisheries species (density, biomass and size of key species) was gathered during the assessment.

This information will be used to design the PSEPA's Management and Business Plan, aimed at achieving biodiversity and fisheries objectives in the face of climate change. These data also create a baseline for the monitoring effort, which will be used to monitor the status of the coral reefs over time, and to evaluate the success (or otherwise) of the established Protected Area.

Results of the assessment are used to inform regional strategies such as:

- Reserve declaration to secure the ecological integrity of the area.
- Design of a resilient MPA network for the area; including identifying high priority areas for protection that are likely to be most important for enhancing reef resilience to climate change.
- Development of a fully integrated resilience plan that includes coastal and estuary environments and methods for measuring the social and economic, as well as ecological, health of the system.
- Design and implementation of a long-term monitoring plan, including the provision of essential training to scientists and community monitors.
- Community enforcement and monitoring of marine protected areas.
- Evaluation of monitoring data annually to inform adaptive management.

- Building the capacity of local scientists regarding coral reef assessment methods and resilient MPA network design.

***How successful has it been?***

- In 2013, TNC facilitated a final Conservation Action Plan as the foundation for the Government mandated marine reserve management plan. The coral reef assessments were critical information to help document the current condition, degree of threat and management strategies for these coral reefs.
- Reef resiliency strategies will feature prominently in the Management and Business Plan for the PSEPA which is currently being developed.
- Protecting these reefs is critical for the fishing industry – artisanal and commercial – and therefore a key foundation of the management objectives.

***Lessons learned***

- Resilience Assessments provide a baseline for monitoring the status of coral reefs over time, and to evaluate the success (or otherwise) of the established Protected Area.
- Ecosystem Based Adaptation and resilience science is new in Mozambique and clearly there is a significant ability to replicate this approach along the coast. Additionally, it is clear that reef resilience must be evaluated in the context of the larger system.
- There is a need to focus on terrestrial land use, mangrove protection and estuary health in order to restore the fishery and reduce pressures on these reef communities. Only by managing the bigger system will these reefs have a chance to adapt to increased stresses from climate change.

Reference: https://reefresilience.org/case-studies

## 2.2. Watershed management

### Wastewater Treatment and Fishing Legislation in Bonaire

***Context and challenges***

Collectively, the island of Bonaire and the Ramsar areas of several satellite islands (Klein Bonaire and Lac) form the Bonaire National Marine Park (BNMP), Netherlands Antilles. The park encompasses 2,700 hectares of fringing coral reef, seagrass and mangrove ecosystems and contains diverse habitats from the shore to intertidal environments, and from coral reefs to deep water environments.

Bleaching and hurricane events have affected this area in the past. Only mild bleaching occurred in association with the 1998 El Niño bleaching event, resulting in good recovery. In 1999, Hurricane Lenny affected the shallow reefs of the leeward side of Bonaire and Klein Bonaire; however, recovery was similarly high, with recruitment rates 3.5 times higher than the rest of the Caribbean, and high survival rates. More recently, the 2005 and 2006 bleaching events resulted in bleaching of approximately 9% and 10%, respectively. However, in both events the recovery rate after the thermal stress subsided was almost 100%. After a bleaching event in 2010, 10% of corals bleached and died leading to a sharp decline in coral abundance in 2011. Combined with losses of herbivorous parrotfish to overfishing, this has led to an increase of macroalgae.

Aside from these natural disturbances, this region is threatened by pollution, coastal development, invasive species (lionfish and *halophila* seagrass) and growth in tourism activities.

***Actions taken***

The mission of the Bonaire National Marine Park is to protect and manage the island's natural, cultural and historical resources, while allowing ecologically sustainable use for the benefit of future generations. The BNMP strongly believes that the first step to ensure healthy and resilient corals is to protect water quality and reduce all stresses. Within this framework, the BNMP has been taking different conservation and management actions to address the distinct problems of overfishing, coastal development, pollution, and negative impacts of tourism.

In 2010, legislation was passed to improve environmental protection, and as of 2014 was still in place and starting to show improvements in the environment. The legislation includes protection of identified resilience factors like: full protection of herbivorous fishes, full protection of many carnivorous fishes, and stronger rules and regulations on fisheries. The new legislation also includes improvements in procedures for coastal construction and more stringent construction guidelines.

***Overfishing***

To address the documented decline in predator fishes like groupers, grunts and snappers, the BNMP started lobbying the government and different stakeholders in 2004 to create fish protected areas (FPAs). Within this lobbying work, a group of fishermen, dive operators, government officers and others stakeholders from St. Lucia visited Bonaire to explain to their counterparts how FPAs in Bonaire would benefit both fisherman and tourism operators. A few months later a group of fishermen, government officers, BNMP Rangers and tour operators visited St. Lucia with the same purpose. In 2008, after intensive negotiations, two FPAs were established on the leeward side on Bonaire, encompassing approximately 4 km of a no-take zone. In 2010 the harvest of parrotfish and use of fish traps were banned.

***Coastal Development and Pollution***

In addition to fishing pressures, Bonaire is experiencing rapid coastal development. To minimize the impact of construction practices, the BNMP developed an officially approved booklet together with the Department of Physical Planning, Department of Agriculture and Fisheries, the local waste management company, construction companies, land owners, developers, and local NGOs. The BNMP ran an intensive nutrient monitoring program during 2006-2008, and Nov. 2011- May 2013 that covered the entire leeside of Bonaire and all-around Klein Bonaire. This nutrient monitoring program was run in cooperation with the Central Government, the Department of Physical Planning of Bonaire and the Harbor Branch Oceanographic Institution in Florida. Preliminary data show that the levels of dissolved nitrogen are high and that the most probable cause is due to sewage and unsustainable irrigation practices in the coastal zone. To mitigate this sewage water input to the sea, the BNMP worked with resort operators to establish "water balances," and to improve fresh water and waste water management. This work has ended with the establishment of a local sewer system.

With over four years of nutrient monitoring data indicating high levels of nutrients in the area, a wastewater treatment facility is under construction. The facility plant is designed to move wastewater away from the shoreline and is anticipated to be in operation by late 2014. A temporary plant is in place and has been operating since 2011 while construction continues on the main plant.

***Tourism***

Dive tourism is an essential component of the economy of Bonaire, generating significant income and creating employment, and it is vital that dive operators and their clients are well educated about potential

negative impacts and means of reducing them. In 2008, the BNMP developed a "Reef Ranger" course. This course has been mandatory since 2010 but not yet fully implemented. The goal of this program is to maximize active support for coral reef conservation by providing standardized training for dive staff, tailored to local circumstances. BNMP recognized that dive operators and divers can be natural ambassadors for coral reef conservation since they have a vested interest in maintaining healthy and diverse marine ecosystems.

Effective communication is also a fundamental goal of Stichting Nationale Pareken (STINAPA) Bonaire, which successfully manages two nature parks of Bonaire National Marine Park and Washington Slagbaai National Park. Communication with the general public and stakeholder groups is a main priority for the BNMP, prompted by a group of residents who indicated a decrease of awareness and involvement, and no sense of ownership of the BNMP. As a result, an on-going communication campaign titled "Nature is our livelihood," was developed to provide knowledge and change attitudes about conservation issues. Providing adequate information concerning the importance of nature conservation and the sustainable development of Bonaire was considered of utmost importance. The campaign has been successful in some areas and is currently undergoing an evaluation.

***How successful has it been?***

***Overfishing***

Monitoring has taken place regularly since 2003 in Bonaire. The ban on fishing of parrotfish (and use of fish traps) has led to an increase in parrotfish population density and biomass after 2011, and, despite a decrease in coral abundance due to bleaching, coral cover began to increase again (while macroalgae cover decreased) in 2013. Perhaps due to an increase in predation, *Diadema* urchin populations have decreased.

***Coastal Development and Pollution***

A temporary water treatment plant was built on Bonaire and began operation in late 2011, and a second will be in operation in late 2014. It is estimated that a total of 17.5 to 35 tons of nitrogen a year will be removed from waste water. However, recent nutrient monitoring in late 2013 showed that water quality indicators on the west coast of Bonaire signal eutrophic conditions, though levels of nitrogen have been decreasing slightly. Some sampled sites had high levels of fecal bacteria numbers, and increasing levels of phosphorous. Generally, sampling has showed a slight improvement since 06-08 values, but nutrients remain at threshold levels.

***Tourism***

A strong conservation ethic persists in Bonaire, mainly due to the large revenue from tourism focused on SCUBA diving and snorkeling. The focus of this environmental work has been on local people rather than tourism, although tourism has increased in the last few years.

***Lessons learned and recommendations***

- Involvement of key stakeholders is critical. No conservation plan will succeed long term without complete support of interested parties.
- Involve all stakeholders from the beginning; demonstrate that what you want to implement (with their help) has unique value, and that they are the beneficiaries of this plan/action.
- Set up an implementation plan (simple is better), discuss it with the stakeholders when ready make it public, and follow it step-by-step with little improvisation.
- Once the plan is implemented, inform stakeholders about news of progress as well as failures. Transparency is critical!

- Create clear rules, laws and procedures. People are more willing to support what they understand and trust.
- Communication campaigns can help provide updated information to the general public and government officers.
- The development of Integrated Coastal Management can reduce the amount of stressors on the reef to improve resilience to future climate change.
- The development of a course similar to the "Reef Ranger" program can improve the sustainable practices of reef divers and other water sport practitioners.

Reference: https://reefresilience.org/case-studies

**Community Support for Watershed Management Leads to Ridges to Reefs Protection in Palau**

**Context and challenges**

Palau is located approximately 800 km east of the Philippines, and consists of a series of islands approximately 459 km2 in total size. Palau's coral reefs are considered to be one of the "Seven Underwater Wonders of the World." Located on the northeastern margin of the "coral triangle," Palau's coral reefs have both high species diversity and high habitat diversity. Palau's reefs contain more than 350 species of hard corals, 200 species of soft corals, 300 species of sponges, 1,300 species of reef fish, and endangered species such as the dugong, saltwater crocodile, sea turtles, and giant clams. In addition to Palau's diverse marine resources, it has the highest terrestrial biodiversity of all countries in Micronesia.

Coral bleaching during the 1998 bleaching event was as high as 90% at some sites, with average mortality reaching 30%. Following the bleaching event, the construction of a ring road around Babledaob Island (the largest Palauan Island) began. The road construction led to widespread clearing of forest and mangroves, causing soil erosion into rivers and coastal waterways that impacted seagrass beds and coral reefs. At the same time, Palauans started noticing declining coral reef health and fish stocks, and degraded quality of freshwater resources. Studies conducted by the Palau International Coral Reef Center (PICRC) revealed that the degradation of reefs was a direct result of land-based sediments, which cause reduced coral cover, lower coral recruitment, and excessive growth of algae. Reefs in Airai Bay, a lagoon on the southeastern end of Babeldaob, were particularly affected by sediment.

***Actions taken***

Research on reefs that were impacted by bleaching and land-based sediments brought greater awareness of ecosystem connectivity, which shifted the conservation efforts in Palau to entire watershed areas. PICRC scientists presented their findings to communities in Babeldaob as evidence of the importance of terrestrial ecosystems in protecting coastal water quality and coral reef health. In response, community members lobbied the governing body of Airai state, the second-most populated state in Palau, to ban the clearing of mangroves, which act as important buffers between the marine environment and terrestrial runoff.

It has always been easy to captivate interest in marine conservation because of close connection of Palauans to fish that provide a source of protein to feed Palauan families. However, there has been a lag in terrestrial conservation efforts because of limited interest in conserving forests. As a result of research

showing impacts of land clearing on soil erosion, water quality, and the subsequent impact on coastal marine environments, Palauans began to see the need to protect forests. However, the need was seen as important because of the threat to the marine environment. Not until the discussion was about protecting fresh water for water security was a strong connection between Palauans and the terrestrial system made. The recognition that surface water contributes to water security and does not respect political boundaries led traditional and elected leaders to come together to discuss how they could ensure water security for their communities. The creation of the Babeldaob Watershed Alliance (BWA) successfully merged the interests of communities, government agencies, conservation practitioners, and traditional leaders to protect entire watershed areas that ultimately protect the water source.

The creation of the BWA was an effort of young conservation practitioners who saw the need to conserve terrestrial systems. These young champions enlisted the guidance of Paramount Chief Reklai of Melekeok, who then inspired Chief Ngirturong of Ngermelnegui State, and the adjacent state. The two traditional Chiefs and the elected leaders of the two States established the largest terrestrial protected area that protects the water source for both States. After seeing the successes of this effort, other States began to join the Alliance and establish terrestrial protected areas within their States to protect water sources. Today, 9 of the 10 states in Babledaob are now a member of the Alliance.

***How successful has it been?***

Prior to the formation of the BWA and its conservation efforts, there was only one terrestrial protected area, Lake Ngardok. As a result of the efforts by BWA to raise awareness and assist local communities to establish terrestrial protected areas, there are now eight additional protected areas with a total coverage of 25.2 $km^2$.

A major success of the BWA was the signing of 'Master Cooperative Agreements' between several states on Babeldaob, which identify collective conservation goals and incentives for progress toward these goals. Other major outcomes include the establishment of new terrestrial protected areas and completion of several community-level land management plans. The BWA has also improved communication between local communities and government agencies and conservation organizations such as the U.S. Fish and Wildlife Service and the Micronesia Conservation Trust (MCT), allowing for better coordination and streamlined assistance to meet local priorities.

The BWA was instrumental in engaging with 9 Babeldaob States through Conservation Action Planning (CAP), which identified important conservation targets, threats, and key strategies for addressing these threats. Through the efforts of the BWA and with support from The Nature Conservancy and the Palau Conservation Society, all these sites used the action plan that resulted from the CAP to draft and finalize management plans for these sites. This has allowed them to access funding from the Green Fee through the Protected Area Office and Protected Area Network Fund. The Alliance (now titled the Belau Watershed Alliance) continues to assist these sites, through working with various partners to build organizational and management capacity to manage these sites.

***Lessons learned***

- Relevance to livelihood—Conservation targets must be linked to quality of life with the focus shifted away from species and ecosystem conservation towards protecting community culture and way of life. This shift is significant in that the BWA found natural allies in the traditional chiefs who, despite the modern democratic government, are still widely recognized as stewards of all commonly shared resources and defenders of the Palauan culture and way of life.

- Leadership —Identification of an individual who can act as project champion is key. The charismatic leadership of High Chief Reklai added credibility and authority to the BWA's message and engaged the traditional leaders of other states to rise to the same challenge.
- Relevant and sound science—Available and effective communication of sound scientific information is essential. The scientific data documenting the negative impacts of sediment on coral reef communities increased awareness in some and empowered many others by validating what they were already seeing on their reefs.
- Awareness of social, cultural and political context—Palau, much like other small cultures in a modernizing world, has complex, sometimes subtle, but often intersecting social, cultural and political landscapes. Understanding and navigating through this complexity is not always given enough emphasis in conservation projects. In the case of the BWA, young local conservation practitioners who understood the science and the culture were able to communicate the scientific information and leverage community support.
- Reducing/managing land-based source of stress to the marine environment will help build resilience of the reefs through rapid recovery following major natural disturbances.
- Healthy herbivore populations on the reefs will facilitate coral recovery through high recruitment and post recruitment survival.

Reference: https://reefresilience.org/case-studies

**Comprehensive Watershed Improvements in Laolao Bay, Saipan**

***Context and challenges***

The island of Saipan is the most populated island in the Commonwealth of the Northern Mariana Islands (CNMI) with just over 48,000 people. On the eastern side of Saipan, Laolao Bay is a popular fishing and diving site among residents and tourists alike. Unfortunately, the coral reefs and the rest of the marine ecosystems in the bay, including sea turtle habitat, are suffering from extremely degraded water quality due to a variety of point source and non-point source pollution. Ecological monitoring studies from the development of a golf course in 1991 provided baseline data for the bay, and in combination with more current monitoring, results show negative changes to the coral reef assemblages and fisheries over the last 20 years.

The upland area of the watershed is a mix of residential lots (many of which have septic systems), a golf course, and agricultural and other private land uses. As a result, the bay is subject to erosion and runoff pollution from unpaved roads, unpermitted development, land clearing, and agricultural practices. Heavy rain events exacerbate the problem as stormwater carries soil and pollutants into the bay. Land-based pollution from upland watersheds has resulted in excess nutrients and macroalgae in Laolao Bay.

***Actions taken***

In order to improve water quality and coral reef health, which in turn can enhance tourism and the local economy, the CNMI Division of Environmental Quality (DEQ) embarked on a multi-year, multi-million dollar engineering, road construction, re-vegetation and outreach project at Laolao Bay. A National Oceanic and Atmospheric Administration (NOAA) grant was awarded to DEQ through the

American Recovery and Reinvestment Act (ARRA) for road and drainage improvements and revegetation. The following actions were taken to reduce erosion and sediment transfer into Laolao Bay:

***Road Improvements***

The two access roads to Laolao Bay are Laolao Bay Drive and Gapgap Road. About a half a mile of Laolao Bay Drive was paved and storm water runoff controls were installed to redirect water into a series of sediment chambers at the bottom of the road. The unpaved portions of Laolao Bay Drive and Gapgap Road (which leads to a popular dive site from the village of Kagman) have been regraded to improve drainage. Plans were created to realign Gapgap Road to follow the natural curve of the land, decreasing erosion and sedimentation into the bay, although they have not yet been implemented.

***Hardening Stream Crossings***

The unpaved portion of the road was hardened at six stream crossings to prevent chronic erosion.

***Revegetation***

1600 seedlings of 12 native or naturalized species have been planted over a 14acre area in the upper badlands of the watershed that had been damaged by land clearing and fires.

***Community Outreach***

Signs have been posted at beach access points to educate people about littering and sea turtles. Brochures were distributed to schools to teach children about revegetation efforts, and project slides were shown at the local movie theatres. Volunteers have been involved with raising awareness about the project and the threats to the natural resources in the bay. A social marketing campaign was launched in 2012 called “Our Laolao”, encouraging visitors to take pride in the resources of the bay and clean up litter along the beaches.

***Biological and Water Quality Monitoring***

The DEQ and Coastal Resource Management Office (CRM) Marine Monitoring Team partnered with the Pacific Marine Resources Institute to conduct ecological monitoring of benthic substrate, coral communities, algal diversity, invertebrate densities and fish communities. Data from this assessment were compared to a similar study done in the fall of 1991 and the spring of 1992, before the construction of the Laolao Bay Golf Resort. The Division of Fish and Wildlife (DFW) Sea Turtle monitoring program surveys the beaches for turtle nesting sites. Fishing pressure and catch-per-unit effort are also monitored by DFW.

For the duration of the ARRA funded project, water quality was monitored at the reef flat on a monthly basis for temperature, pH, salinity, total suspended sediments, turbidity, and nutrients. During rain events, stormwater at ten locations where stormwater crosses the access road, some of which have been improved with ARRA funds, was sampled.

***How successful has it been?***

The paving of 0.4 miles of Laolao Bay Drive was completed in April 2012. The new drainage system includes a curb and catch basin system, subgrade drain pipe, concrete sediment chamber, and a gabion sediment chamber. A total of 1.9 miles of unpaved parts of Laolao Bay Drive and Gapgap Road were regraded utilizing techniques learned from workshop training. Six stream crossings were constructed of reinforced concrete fords and included rip-rap slope protection.

DEQ partnered with the Department of Land and Natural Resources, DFW, CRM and the U.S. Department of Agriculture’s Natural Resources Conservation Service (NRCS) on the reforestation of

the watershed. More than 1,600 plants representing 12 native species and 5,000+ linear feet of Vetiver grass were planted in 2010 and 2011 across the 14-acre deforested upland site above Laolao Bay. Monitoring is ongoing, but within the first year, a 67% survival rate had been observed.

Several stakeholder workshops were held in order to educate the community about the project and get feedback. Fifty-five community volunteers attended training on revegetation. Along with the two beach signs for turtles and anti-littering, theatre slide Public Service Announcements (PSAs) were shown at the local movie theatre for six months, and radio PSAs were broadcasted on three stations for six months. Informational materials such as posters and brochures were distributed to 32 schools.

The Laolao Bay Coral Reef & Water Quality Monitoring Plan was completed in 2010. The DEQ-CRM Marine Monitoring Team completed a baseline ecological survey of the reef flat and slope in 2011. Compared to 1991 data, results indicated a significant increase in macroalgae, mainly consisting of red algae, but also seasonal brown algae. It is anticipated that the completion of road improvements will result in improved water quality and a decrease in algal cover, thus having a positive influence on reefs in the future.

Water quality monitoring of streams, reef flats, and the outer reef have been conducted regularly for 12 months to measure nutrient levels. During rain events, turbidity measurements are taken at ten stream locations to measure the effects of the road improvements and revegetation in the area.

***Lessons learned***

- It is expected that with the completion of the road improvements and upland restoration activities that algae biomass will be reduced. However, ecological responses may take several years to realize. The biomass of herbivorous fish will play a large part in the control of algae on the reef.
- There are many societal components in Laolao Bay, such as historic sites, fishermen, and divers. A social diagram should be made to compliment the natural resource management work to make sure those social considerations are included in long-term planning.
- Private landowner conservation practices should be encouraged.
- In addition to existing natural resource targets, causes of forest habitat loss, overharvesting of Tangantangan (castor oil plant) for charcoal, soil, and birds should be considered as potential conservation targets for Laolao Bay.
- Through this project, agencies and the public have learned a great deal about how sensitive the watershed is, and the value of preventing land-based pollution. This will hopefully lead to better protected lands in the future and especially in the case when lands are being developed.
- Not every problem in the Laolao Bay watershed has been fixed. Poorly developed roads and aging individual wastewater treatment systems are continuous problems. Despite increases in the resilience of Laolao Bay in the past few years, the watershed and the coral reef continue to face threats.

Reference: https://reefresilience.org/case-studies

### 2.3. Livelihood alternatives

**Farmers of the Sea – Sea Cucumber Farming as an Alternative to Fishing, Tampolove and Ambolimoke, Southwest Madagascar**

***Context and challenges***

Many developing countries are facing interconnected challenges of poor health, unmet family needs, gender inequality, food insecurity, environmental degradation and vulnerability to climate change. One such country is Madagascar, where 92% of the population lives on less than US$2 per day. Semi-nomadic fishing communities along the southwest coast are some of the poorest and most isolated in the country; almost wholly reliant on the marine environment for food, income, transport and cultural identity. In recent years, they have observed declining fish catches, owing largely to pressure related to market-driven exploitation, as well as increasing subsistence demands from the growing coastal population.

In response to this decline in catch, initiatives to diversify livelihoods and as such reduce fishing pressure have been taken by many of the communities with the help of non-governmental organizations (NGOs). One such alternative income that has been explored in the region is sea cucumber farming.

***Actions taken***

In an effort to protect marine biodiversity and sustain traditional fisheries along the southwest coast of Madagascar, Blue Ventures, an international non-governmental organization, worked with local communities to establish a locally managed marine area (LMMA); networks encompassing temporary fishery closures; permanent marine reserves; and designated aquaculture zones. The LMMA is called Velondriake, which means, "to live with the sea", and it covers more than 750 km of marine, coastal, and terrestrial habitats. To increase resilience and the recovery potential of the coral reefs and mangrove areas to climate change and anthropogenic pressures, various forms of fisheries restrictions, such as banning destructive fishing methods and introducing permanent no-take zones, have been developed. These were agreed upon by local stakeholders through community meetings attended by representatives elected from each village.

The community-based sea cucumber farms in southwest Madagascar were developed by Blue Ventures, in partnership with other NGOs, The Royal Norwegian Society for Development (Norges Vel), and Indian Ocean Trepang (IOT) a local company that manages a sea cucumber hatchery in Toliara and developed the hatchery methods. Toliara is the main town in southwest Madagascar and the fifth largest city in Madagascar. The aim of the project is to provide an alternative and supplementary income to fishing and thereby increase food security and resilience to climate change.

Blue Ventures began piloting holothurian mariculture in March 2007 with the Women's Association of Andavadoaka. The trials provided the opportunity to test materials and pen design, as well as begin to collect biological data on growth rates and stocking densities. In September 2009, two local NGOs, Blue Ventures and Trans'Mad Development secured grant funding from the Regional Programme for the Sustainable Management of the Coastal Zones of the Countries of the Indian Ocean Countries (ReCoMaP). Funding was used to establish sea cucumber farming as an alternative livelihood for local communities in southwest Madagascar. Both organizations collaborated with a sea cucumber hatchery in Toliara to carry out village-based mariculture of juvenile *Holothuria scabra* in six villages to commercial size. Depending on season, site and food availability, individuals reached harvest size in 9-12 months. A feasibility study was carried out in 2009 to assess extension of the activity and increasing the commercial focus, profitability and value captured by the producers/farmers.

From 2010 to 2015, the project had expanded to over 40 farms concentrated in 2 main sites where growth and conditions have been most suitable. The main site in Velondriake is based in the village of Tampolove. When the farm was first established in Tampolove, the community was consulted by Blue Ventures, and social surveys were carried out to establish potential farm families. By this time a bond of trust already existed between the community of Tampolove and Blue Ventures, who had been working in the community for several years to establish Velondriake. The sea cucumber farm in Tampolove employed 38 farming teams and over 170 individuals. Each team managed one pen and over 50% of both team leaders and members were women. Earnings from the farm were split between all the individuals in each farming team. A school farming team was also established, consisting of students, teachers, and parents and profits go towards tuition fees for the children in the community.

In 2013 and 2015, cyclones and disease broke out in the area which damaged the farms. As a result, sea cucumber juveniles stocking ceased and in 2016 the project was fully re-evaluated and experimental trials were undertaken. In the same year, the previous model was deconstructed and a new model based on the assessment findings was constructed.

Since 2018, two farms are active in Tampolove and Ambolimoke villages. The project has a total of 81 farms: 39 in Tampolove and 42 in Ambolimoke. Each farm is managed by 2 farmers and in total 162 farmers are involved in this project, with 59% women.

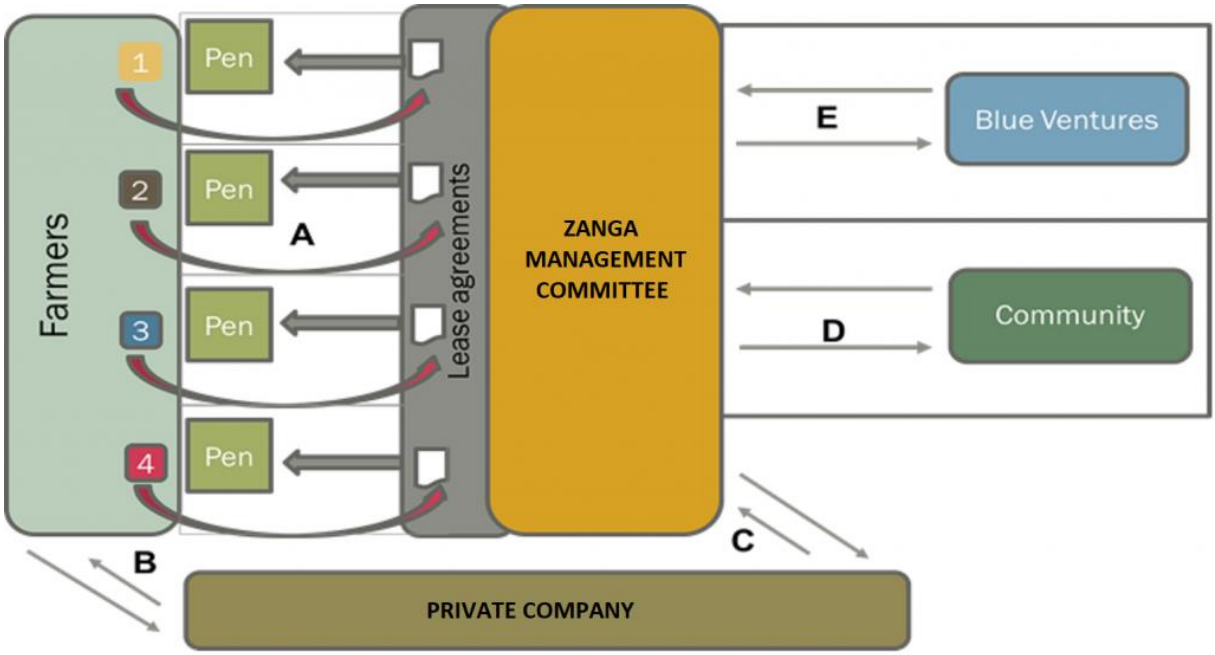
The new aquaculture farming model currently in place employs a novel governance system that aligns the governance model with existing traditional community governance and legal systems already in place. The community developed best practice aquaculture farming guidelines in situ with technical guidance from Blue Ventures, and then consolidated this within an agreement that everyone agreed to sign and adhere to. The community integrated this agreement into local traditional governance structures that were ratified by community elders and traditional authorities. A farmer's agreement, with rules made by farmers, with integration of this agreement into local governance structures helps assure adherence.

The farmers' agreement is made in the community where sea cucumber farming is practiced, and there a structure is created at the start of operations that is responsible for development, monitoring and enforcing of the governance systems. This structure is called *Zanga* (Malagasy word for Sea Cucumber) Management Committee (ZMC) and is composed of a general assembly, an advisory board, and a hired operational body. The general assembly consists of all sea cucumber farmers within the community and also includes the hired operational body which consists of ZMC hired personnel who have responsibilities within the farming model such as supervisors and guards.

The Advisory board consists of the President of the *Velondriake* Association (the local fisheries management body for the LMMA) and a *Velondriake* Association aquaculture representative, along with a technical expert from the NGO Blue Ventures. The traditional village leaders in the community, the clan chiefs, and the President of the *Fokontany* (local neighborhood structure) have crucial roles in the legitimacy of any decisions that are made by the ZMC, and ultimately, they are responsible for ratifying new regulations.

At the level of the ZMC, supervisors, who are farmers themselves, were recruited by the ZMC and trained technically by Blue Ventures to carry out the technical supervision work for sea cucumber farming. After a year of training and supervision, supervisors are able to lead all activities related to sea cucumber farming according to the established rules.

A lease agreement is established at the level of the ZMC and is the cornerstone of the sea cucumber farming model as it defines its principles and rules regarding all farming activities and ensures that farmers are adhering to best practice aquaculture guidelines.




Novel governance system: ZMC and lease agreement. Image © Blue Ventures

***How successful has it been?***

The first sale of sea cucumbers took place in 2009 and net income has been increasing each year, although a decrease in income was seen in 2013 when cyclone Haruna caused large-scale loss of sea cucumbers. Increases in income can be attributed to: new techniques to improve juvenile survival rates (e.g., the introduction of nursery pens), increase in the technical abilities of farmers, and introduction of guards to reduce theft. Following the implementation of these new techniques juvenile survivorship rose from 46% in February 2009 to a peak of 76.9% in August 2011.

Since 2017, with the new model in place, based on the assessment and experimental trials findings, farms were standardized in size (900 m2 each) with 2 farmers per farm. The nursery was no longer needed because there was less threat of sea cucumber predators in the area. By carefully ensuring that the carrying capacity of the site is respected, there has been no disease in the new model pens.

After several months of growing in sea pens since the model was reconstructed, the first harvest took place in November 2018. The average net monthly income per farmer reaches US$42 and the average monthly return rate reaches 60%. The model is now more sustainable because the farmers are able to pay all operational costs including the purchase and transportation of juvenile sea cucumbers, as well as the salary of ZMC supervisors and guards. All farmers receive an income after the harvest and selling to a private partner and are never in debt. In addition, the farmers grouped in the ZMC contribute to a community pot which will contribute to the development of the whole community.

The creation of the ZMC and the lease agreement successfully eradicated the occurrence of theft. The fact that the lease agreement was defined by the community and the farmers and that it can be modified by the General Assembly has facilitated its abidance. Farmers are starting to make changes when needed, each farmer can make a change by bringing the necessary arguments. The lease agreement also incorporates a conservation agreement, linking farmers with the LMMA Velondriake and incorporating innovations in terms of conservation such as the designation of a No Take Zone within the sea cucumber farms. In total 8 ha of No Take Zone has been designated.

***Lessons learned and recommendations***

Establishing alternative livelihoods is challenging. It requires collaboration between many partners and building new governance systems within local communities. In addition, communities in this project faced difficult living, financial, environmental, and political conditions.

Results are rarely published due to many aquaculture projects being part of the private sector, and as such, experiences and lessons learned are rarely shared. Blue Ventures has tried to overcome this by sharing their experiences through a range of media and products:

- A sea cucumber farming handbook has been produced, with support from ReCoMap
- In December 2013 Blue Ventures in partnership with the University of Dar es Salaam hosted a landmark workshop on community-based aquaculture in the Western Indian Ocean
- Blue Ventures is a member and supporting partner of Community Based Aquaculture in the WIO, an informal regional network
- In March 2019 Blue Ventures in partnership with FAO, KOICA and the government of Zanzibar organized a training on Sea Cucumber farming in Zanzibar
- Work is in progress with partners to establish a formal stakeholder association for sharing knowledge and promoting sustainable aquaculture models in southwest Madagascar

***Key lessons learned and recommendations from the project include:***

- Continued aquaculture support through local technicians is important
- The recruitment of farmers' supervisors by the ZMC allows for more durability (less turnover)
- Strong relationships between the private sector and communities are important for success
- Built in progressive models of payments, learning, etc. are necessary. For many fishers this is their first time running what is essentially a small business. Constructing a model which avoids farmer's debt is crucial
- Establishing a trial period to determine socioeconomic and ecological conditions suitable for the project is important for success
- Implementation of a governance system which involves the community in each step of the governance design and implementation has shown enormous gains for community-based sea cucumber aquaculture. This system was developed by farmers and their wider community through a collaborative process and that buy-in has led to success
- Clarifying best practices and formalizing farmers' rights and obligations in a contract is crucial. Those not abiding by these contractual obligations are held accountable, not by implementing livelihood developers or their commercial partners, but instead by other farmers and their community

Reference: https://reefresilience.org/case-studies/madagascar-sustainable-livelihoods

# III. Transboundary Management and Regional Cooperation

**Transboundary Water Management between Kampot Province (Cambodia) and Kien Giang Province (Vietnam)**

***Context and challenges***

The transboundary waters between the two provinces of Kampot, Cambodia and Kien Giang, Viet Nam are characterized by shallow water conditions favorable to the growth of seagrass and coral reefs, whilst the adjacent coastlines support important mangrove habitats. As a result, the area supports abundant living marine resources that sustain adjacent villages.

Based on initial assessments, the seagrass area in these transboundary waters is more than 37,000ha including 12,000ha in Kien Giang and more than 25,000ha in Kampot Province, making them the most extensive in the South China Sea. The seagrass meadows in Kampot are located in parallel to the coastline of Prek Ampil, and extend 150-300m from the shoreline, being widest in front of Bokor National Park. The area has a gentle slope with seagrass occurring at depths from 1-4m. Seagrass beds in Kien Giang Province are mainly distributed in the shallow coastal waters of the Phu Quoc archipelago.

Based on recent taxonomic surveys 10 seagrass species have been identified in the transboundary waters, while data collected in Phu Quoc indicates that associated species richness is high with 113 species of macro-algae; 71 species of mollusks; 26 species of crustaceans; 19 species of annnelids; and 15 species of echinoderms.

Based on surveys conducted in 2006 around 6,240 tonnes marine products are harvested from the seagrass beds in Kampot Province per year, with an approximate annual value of 7,500,000 US dollars. Based on fishing household surveys the catch per unit effort of fishermen has been declined annually since 2000 due to an increase in the number of fishermen and the use of illegal fishing gear.

Phu Quoc is an important landing area and fishing ground in Kien Giang Province. Total fisheries yield has increased from 30,969 tonnes in 1993 to 50,000 tonnes in 2000 and to 60,246 tons in 2006. The main fishing grounds are south of Phu Quoc in the vicinity of the An Thoi islands where squid is an important component of the catch and to the east of Phu Quoc island which is an important swimming crab spawning ground. Finfish are the main contributors to total fisheries production and around 67 species of teleost fish are caught in the area, of which representatives from the families Carangidae, Scombridae, Hemirhamphidae, Serranidae, Lutjanidae, Lethrinidae and Synodontidae are the dominant demersal species. Trevallies, jacks, mackerel, and anchovies dominate the pelagic catches. In 2001 landings of mackerels and anchovies were around 3,500 and 12,500 tonnes respectively.

The most important endangered species found in the transboundary waters is the Dugong (*Dugong dugon*) which is frequently encountered in the north and north- east of Phu Quoc Island, and also in Kampot coastal areas. According to reports of the Kien Giang Department of Fisheries (2004 – 2005) 5 species of dolphins were recorded in the waters of Kien Giang, including: *Orcaella brevirostris, Tursiops aduncus, Sousa chinensis, Stenella longirostris, Stenella coeruleoalba*. However, appearance and movement of dolphin herds in transboundary waters are not well known. In addition, 3 sea turtle species have been recorded from the area, including: Green Turtle (*Chelonia mydas*), Hawksbill (*Eretmochelys impricata*) and leatherback (*Dermochelys coriacea*). Recent surveys in Phu Quoc suggest that sea turtle numbers are declining and that only five nesting beaches are still in use in the Phu Quoc archipelago.

***Transboundary Problems in Environment Management***

Increases in the number of fishing boats and better fishing gear causes increasing pressure on the resources and habitats that could lead to decline in fish stocks and yields. Trawl fishing, which is not allowed in the near shore waters of either Cambodia or Viet Nam, occurs commonly on seagrass beds and in shallow waters of both Kampot and Kien Giang provinces. This is one of the greatest sources of damage to seagrass habitats and biodiversity, particularly young seagrass shoots, small juvenile fauna, and endangered species. Transboundary fishing activities occur daily as fishing boats from Viet Nam fish in seagrass beds adjacent to the Kampot coastline and *vice versa*. Fishing using toxins and electricity still take place in the waters of both provinces.

There is a lack of coordination in fisheries management and the marine resources are exploited by fishermen from both provinces without definition of fishing ground boundaries. Informal trade in marine products, including endangered species, occurs daily between the two provinces and an effective mechanism for joint management of fisheries has not yet been developed for this large marine area.

Many recent development projects have occurred in the coastal waters of both provinces in order to meet development plans with respect to increasing income for local government and communities. Given that poverty alleviation is the first priority of the Governments, environmental management for sustainable development has not been adequately considered in planning and practices and there remains a lack of coordination between economic development and environment management.

***Awareness of Local Communities on Sustainable Use and Law Enforcement***

Public awareness of the importance of seagrass in the local communities has improved. The knowledge of villagers regarding the sustainable use of resources is however still limited and local people concentrate on securing direct and short-term rather than long-term benefits. Law enforcement is not effective enough due to weak capacities of both provinces.

The management groups of Kampot (Cambodia) and Kien Giang (Vietnam) have been working closely to address these problems, including how to reduce illegal fishing and trade of endangered species. Initial steps have included the preparation of guidelines for assessment and monitoring, and how to provide training and share information between sites.

Training on assessment, monitoring and transplantation of seagrass was provided by Vietnamese scientists to local staff of the Kampot Provincial Government and local community leaders, and agreement reached on survey methods to be used by both provinces. Both parties have agreed on the software and baselines for use in the joint GIS database and have developed a joint programme of activities for funding by both governments and bilateral aid and assistance agencies.

Issues that need to be further addressed under this joint agreement include: collaborative actions to reduce illegal trade and illegal fishing; determining sustainable stock sizes and use rates; enhancing the capacity of technical staff; and strengthening of community involvement in resource management.

***Development of a Coordination Mechanism and Cooperative Framework***

The local governments of Kampot and Kien Giang Provinces have cooperated in matters of mutual interest under a friendship alliance since the early 1980. In the year 2003 cooperative mechanisms and agreements regarding administrative management between the two provincial governments were established, and yearly consultative meetings between both provincial governments on improving bilateral cooperation have been conducted.

In the year 2005, collaborative mechanisms to support natural resources and habitat management were established under the SCS project. Three Joint Meetings between the Management Teams of the Kampot and Phu Quoc Demonstration Sites were convened to discuss different areas of cooperation and to prepare guidelines and an operational framework, encompassing the sharing of data and information. In March 2008 a Memorandum of Agreement on the Framework for Cooperation in the Management of Coastal Ecosystems and Natural Resources between the Province of Kampot (Cambodia) and Kien Giang (Vietnam) was signed by the Vice Chairperson of the Kien Giang Provincial Peoples Committee and the Deputy Governor of Kampot.

***Goals and Objectives of the Cooperative Framework and Priorities in Joint Management***

The goal of the agreement is to enhance and strengthen cooperation between the two provinces in the fields of biodiversity conservation, reversing environment degradation trends, and sustainable use of resources, in order to improve the livelihood of local communities

The objectives of the agreement are to: strengthen institutional arrangements for management of natural resources and marine environment in the transboundary waters between the two provinces of Kien Giang and Kampot; improve the management capacity for natural resources and marine environment in the transboundary marine zone; enhance awareness of managers and local communities regarding the importance of conservation within the two provinces of Kien Giang and Kampot; develop cooperative research programmes and exchange information, including sharing of data and databases; maintain financial sustainability for long term management, conservation of natural resources and marine environment in transboundary waters between the two provinces of Kien Giang and Kampot

Reference: http://www.unepscs.org/South_China_Sea_Knowledge/Lessons_Learned/SCS_Lessons_Learned.html

**Designing an Effective MPA For Multi-Country Mesoamerican Reef**

***Context and challenges***

Stretching for 625 miles along the coastline of Honduras, Guatemala, Belize and Mexico, the Mesoamerican Reef (MAR) is the second largest barrier reef in the world. It encompasses a rich mosaic of coastal wetlands, lagoons, mangrove, seagrasses, sandy cays and a common structure, the coral reefs. These ecosystems host more that 500 fish species, 60 coral species, 350 mollusk and other marine mammals, algae and seagrasses. It is home to critically endangered species, like the largest population of manatees in the Western Caribbean, saltwater crocodile, sea turtle (green, hawksbill and loggerhead), Nassau and Goliath grouper, and the largest aggregation of whale sharks in the world.

An estimated 2 million people are directly woven into the fabric of the MAR's rich coastal environments, highly dependent on its healthy ecosystems for food, water, livelihoods and income. Thousands of artisanal (small-scale) fishermen and the fishing industry in Honduras depend on the MAR's fisheries, including lobster, conch, snapper and grouper. Its marine and coastal ecosystems provide the foundation for the region's multi-billion dollars tourism industry, near US$5 billion per year, spent by more than 8 million tourist and 3 million cruise visitors.

Climate change is heightening the value of marine and coastal ecosystems, which provide valuable services for fisheries, tourism and water quality, but most importantly, under future climate change

scenarios, beach stabilization and reduced vulnerability from sea level rise and stronger tropical storms. UNAM´s monitoring stations in Puerto Morelos demonstrated that during Hurricane Wilma reef barriers reduced the wave energy at least six times before hitting the coastline, converting 12 meters height waves in 2 meters height. Moreover, mangroves and seagrasses ecosystems are important carbon sinks that are essential to maintain or restore. One hectare of coral reef can provide goods and environmental services worth at least US$ 130,000, and US$ 50,000 of those derived from reduced vulnerability in the face of climate change.

The main threats affecting the MAR are overfishing, pollution from inland and coastal settlements, runoff from agriculture, sedimentation, coastal ecosystems conversion due to coastal development and inappropriate tourism practices. Climate change driven stressors, such as increased sea water temperature, sea level rise, stronger storms and sea water acidification, are pushing ecosystems to their limits and affecting their capacity to sustain human use and pressure. As a result, conserving marine ecosystems and addressing climate change impacts on human communities have irrefutably become the same goal.

***Actions taken***

The Nature Conservancy's conservation goals in the Mesoamerican Reef are to:

1. Complete a conservation area network for the Mesoamerican Reef
2. Create permanent finance mechanisms that cover the basic management costs of MPAs
3. Establish a network of sanctuaries for fish stocking/repopulation no-take zones, and fisheries management systems to sustain artisanal fisheries and healthy ecosystems
4. Develop regulations, incentives and land-use zoning mechanisms to address coastal development
5. Promote ecosystems-based adaptation

To reach these goals, TNC works within the following strategies:

*Establish mechanisms, plans and policies for successful ecosystem - based adaptation to climate change.*
This includes social and ecological vulnerability analyses to develop appropriate adaptation strategies, as well as economic analyses to assess alternative scenarios based on climate change adapted coastal models. TNC will also work with the four country governments and key stakeholders to support the development of the official Mesoamerican Reef Agenda for Conservation and Adaptation for Climate Change.

*Promote low impact coastal development*

Based on experience in Mexico, TNC will catalyze the organization of an alliance with concerned private investors and buyers which will promote principles, concepts and practices among the private sector as well as influence governments in other MAR countries. This strategy also includes providing support to municipal, state or national land use zoning mechanisms to ensure the incorporation of climate change considerations.

*Promote an effective network of conservation areas*

In coordination with TNC, government agencies, universities and NGOs conducted an ecoregional assessment of the area that identified a network of 31 conservation areas. The assessment incorporated the resilience principles. Most conservation areas are already under a protected areas designation; however, there are important gaps (600,000 ha) that must be filled to complete and maintain a connected

and functional network (2,3 million ha). To complete the gaps identified in the ecoregional plan and add 500,000 hectares in the conservation areas network, TNC will conduct national policy work around the critical areas of Northern Cozumel, Xamanha, Mahahual, and Isla Mujeres wetlands, Central Belize and Turneffe, Omoa and Trujilo. In 2010, the largest MPA in the MAR (684,000 ha) was created by the Honduran government. TNC will support the effectiveness of the new MPA by conducting vulnerability analysis, adaptation strategies and information for the management plan. A key element of this strategy is the declaration of no-take zones within the conservation area network. The goal is the addition of 20 new no-take zones by 2014. This network of marine protected areas and no-take zones will protect at least 80 percent of the 38 validated fish spawning aggregation sites (SPAGs) and 60 percent of the potential SPAGs. TNC will work towards the goal by securing governance and political commitment to establishing fishing refuges and supporting mechanisms. The development of fishing refuges strategies for Quintana Roo, Belize and Honduras are currently underway. A final component of this strategy is the design and management of fish banks which requires a network of community managers and experts to coordinate and disseminate the process.

*Develop long term financial mechanisms to sustain conservation and low impact developments.* To effectively fund and manage the conservation network, one new sustainable financing mechanism for each country will be developed (e.g., ecosystem services fee through diving, spearfishing, etc., or airport departure fees). For example, in Belize the Belize Reef for Life mechanism was developed. TNC, Oak Foundation, a multilateral bank and the Belize Government worked together to form an agreement in which the government commits to key conservation actions and a capital fund of US$ 100 million is established to support climate change adaptation and conservation activities in coastal and marine areas. Commitments from the Belize Government will ensure the accomplishment of the aforementioned objectives and strategies, and will be achieve with the support form TNC and the capital fund.

***Lessons learned and recommendations***

- To overcome the challenge of working on a multi-country region, effort is made to regularly remind stakeholders and partners to see beyond their site and country vision, and identify regional conservation priorities and approaches.
- Coordinating efforts with partners at the site, at the national and regional level, can allow joint forces to achieve efforts like the rapid reef assessment and the ecoregional assessment that otherwise would not have been achievable independently.
- A portfolio of priority conservation sites should identify areas within MPAs, but most importantly, should include areas outside protected areas that need urgent attention.
- A threats analysis can identify the most important threats, and develops strategies to face such challenges.
- A region-wide rapid reef assessment can advance understanding of habitat representation and replication, and preliminarily identify resilient reef sites.

Reference: https://reefresilience.org/case-studies/mesoamerican-reef-mpa-design-2