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PEMUTERAN BAY CORAL PROTECTION FOUNDATION

Indonesia

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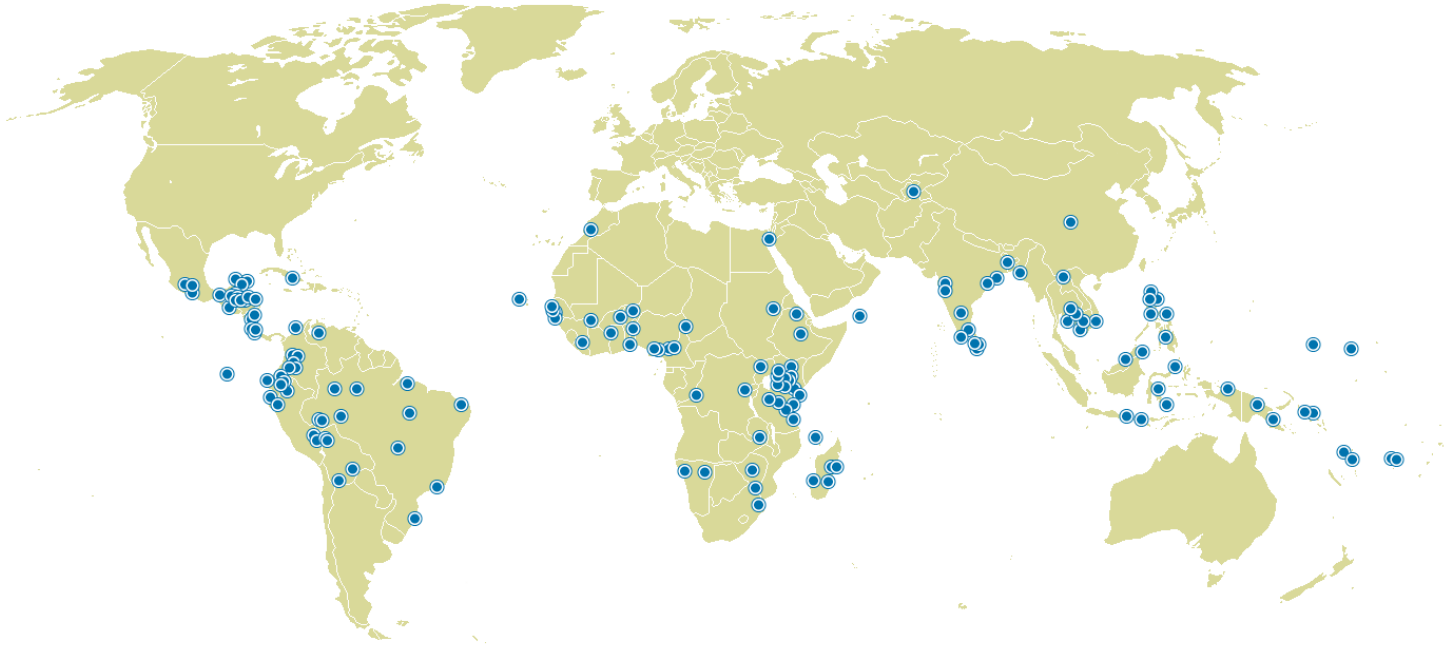
Local and indigenous communities across the world are advancing innovative sustainable development solutions that work for people and for nature. Few publications or case studies tell the full story of how such initiatives evolve, the breadth of their impacts, or how they change over time. Fewer still have undertaken to tell these stories with community practitioners themselves guiding the narrative.

To mark its 10-year anniversary, the Equator Initiative aims to fill this gap. The following case study is one in a growing series that details the work of Equator Prize winners – vetted and peer-reviewed best practices in community-based environmental conservation and sustainable livelihoods. These cases are intended to inspire the policy dialogue needed to take local success to scale, to improve the global knowledge base on local environment and development solutions, and to serve as models for replication. Case studies are best viewed and understood with reference to '*The Power of Local Action: Lessons from 10 Years of the Equator Prize*', a compendium of lessons learned and policy guidance that draws from the case material.



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PROJECT SUMMARY

Pemuteran Bay Coral Protection Foundation was started in response to the collapse of the local fishing industry near the Pemuteran community in Bali, due in large measure to coral reef loss from sedimentation, rising water temperatures, and unsustainable fishing methods such as reef bombing. The organization oversees more than 70 artificial 'biorock' coral reefs, which have restored fish stocks and marine biodiversity. The chain effect of connecting the artificial reefs has helped to rejuvenate local subsistence fishing livelihoods.

Hundreds of community members have been trained in artificial reef building. The community has created a *de facto* locally managed marine protected area, with community enforcement of regulations that prohibit destructive fishing practices. An ecotourism enterprise draws scuba divers from around the world and provides an additional source of income. Ecotourism revenues have been reinvested into local schools, environmental education, and shoreline restoration projects to control erosion.

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KEY FACTS

EQUATOR PRIZE WINNER: 2012

FOUNDED: 2000

LOCATION: Pemuteran, western Bali

BENEFICIARIES: Fishing households and local businesses

BIODIVERSITY: Coral reefs and fisheries

Background and Context

Indonesia's coral reefs are the largest and most species-rich in the world. However, only around five per cent of these reefs – which sustain fishing, mariculture, diving and tourism industries – remain in excellent condition. Pemuteran Bay Coral Protection Foundation (*Yayasan Kerang Lestari Teluk Pemuteran*) is a community-based marine protection and coral restoration initiative that was established in response to the degradation of coral near Pemuteran, a small fishing village on the north coast of western Bali. Pemuteran, which translates roughly as "come back to you", is home to a population of approximately 8,000 people, many of whom are descended from settlers who were relocated by the Indonesian government following a volcanic eruption in 1963. Pemuteran has historically been one of the poorest villages in Bali; with a climate too dry to cultivate rice, the community depended to a large extent on subsistence fishing for survival. The revitalization of the local fishing industry and the development of new livelihood activities have therefore had a transformative effect on community wellbeing.

The tourism sector

Like many communities in tropical coastal areas, Pemuteran has increasingly looked to tourism to provide opportunities for income and employment. Although far from the tourist resorts of southern Bali, Pemuteran's black sand beaches, shallow reefs and relatively mild currents and waves make it an ideal location for diving and snorkelling. This combination of factors has made it an attractive destination for tourists. But while many coastal villages that have staked their economic futures on tourism have allowed for large-scale resorts to flourish and degrade local ecosystems and marine resources, Pemuteran has been developed in an environmentally conscious way from the beginning.

Tourism has transformed the standard of living in the community by providing new jobs and income. The development of the tourism industry in Pemuteran, however, has reflected traditional Hindu values that promote harmony with nature. All hotels and dive shops in the village contribute a percentage of their revenue to an environment and development fund that is administered by the village government. The fund has paid for the restoration of temples, the development of a village environment management plan, and improvements to the village schools.

Locally managed marine protected area

The village conservation ethic found its clearest expression when traditional law was invoked to establish a marine protected area in the waters offshore. Despite this progressive step towards responsible stewardship, Pemuteran Bay reefs were badly damaged in 1998 when the South-East Asian economic crisis forced displaced workers and farmers to turn to the sea for survival. Mass destruction of marine ecosystems resulted, as fishermen from outside the community resorted to reef bombing and cyanide fishing. Corals on Pemuteran's outer bank reefs were almost entirely destroyed and much of the

remaining coral was killed later that year as a result of high temperatures, sedimentation and the further use of poison for fishing. As a result, the local fishing economy collapsed, as did the ecotourism industry.

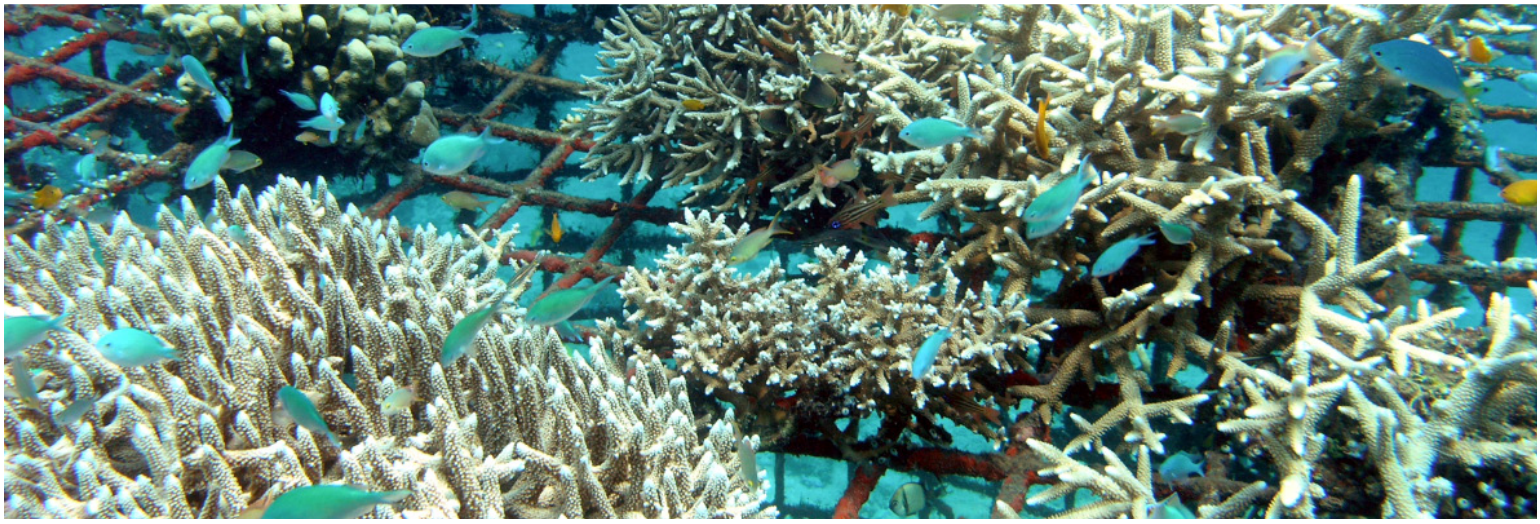
Rejuvenating reefs with Biorock coral nurseries

In 2000, recognizing that community food and income security were severely threatened, the Pemuteran village community began to strictly enforce local laws against destructive fishing practices and initiated efforts to rejuvenate local coral reefs. To begin the reef reconstruction effort, the community collaborated with the Global Coral Reef Alliance to install a series of 'Biorock' coral nurseries – technology that uses low voltage electrical currents on underwater steel-frame structures to encourage the growth of coral and other reef life – in the waters offshore from Pemuteran's beaches. The first structure was installed in 2000, with funding provided by a local hotel. Following suit in 2002, another hotel owner took an interest in the project and provided seed funds for a workshop to organize and train community members in the construction and installation of Biorock reefs. Today, there are over 70 Biorock reefs in Pemuteran totalling half a kilometre in length. Financing for the project has been entirely community-driven and locally raised: the structures used in the Biorock technology are funded by ecotourism revenues from local hotels and businesses, while individual donations from visitors are also used to sustain the initiative. It is also community members that have taken the lead on reef maintenance. The formerly barren reefs have been transformed into spectacular coral gardens which are now thriving and teeming with fish.

Pemuteran Bay Coral Protection Foundation

The initiative operates without a defined organizational structure; it represents a collaborative effort between the community of Pemuteran, local hotels and dive schools, and the researchers who developed Biorock technology. The foundation itself has evolved somewhat organically, with the installation of the first Biorock structure providing a catalyst for the reintroduction and strengthening of the locally managed marine protected areas. Several community-based initiatives and self-help groups have emerged to support the work of the foundation, including carrying out activities such as the maintenance of Biorock reefs, planting vetiver grass on the shoreline to reduce erosion, and patrolling the protected area to enforce fishing restrictions. A centrally located Biorock Centre provides information about the technology and the community initiative. From relatively humble beginnings, the Pemuteran Bay Coral Protection Foundation is now amongst the largest coral reef restoration projects in the world.

Key Activities and Innovations



Biorock Technology

Biorock technology was developed by marine scientist Wolf Hilbertz and marine biologist Thomas J. Goreau. It uses low voltage electrical currents on underwater steel-frame structures to encourage the growth of coral and other reef life. The electrical current causes dissolved minerals in the seawater to precipitate and stick to the steel structure. Gradually, layers of calcium carbonate build up around the steel tubes. Since the calcium carbonate coating that forms is so similar to natural reef substrate, corals take to biorock reefs very readily. The steel structures are anchored to the seabed, and can be powered by solar panels, wind turbines, wave generators or land-based transformers. Because Biorock does not require sophisticated construction techniques or substantial material inputs, it is particularly well suited to remote developing regions where raw materials and technical know-how may be in short supply.

Other methods of reef restoration often rely on affixing corals to hard structures with cement or glue. The success rate of this approach is highly variable and depends to a large extent on water quality and temperature, both of which must be ideal. Experiments have shown that Biorock can help to counteract some of the factors that cause corals to die-off, including high temperatures and pollution, and that the technology is much more resilient in fluctuating and variable conditions. Also, coral typically grows between two and six times faster on Biorock than naturally occurring coral, while survival rates are between 16 and 50 times higher, even after extended periods of high water temperature. Biorock is also more effective than sea walls or similar structures at reducing beach erosion: while these structures simply deflect waves, Biorock reefs absorb wave energy, reducing the impacts of the waves on the shoreline. Consequently, waves deposit sand onto the shoreline, building up the beach rather than washing it away.

Coral reef rejuvenation in Pemuteran

The success of the Pemuteran Bay Coral Protection Foundation can be attributed to a combination of community-based action – namely, the creation of the locally managed marine protected area – and the installation of Biorock reefs. The community has restored local reefs and, in so doing, reinvigorated the local fishing and ecotourism sectors. The support of the Global Coral Reef Alliance has been instrumental in this, through training community members in how best to deploy this innovative technology in service of growing back coral reefs. Equally crucial has been the foundation's local funding model, which sees ecotourism revenues from village hotels and businesses flowing into the construction and installation of the steel structures which provide the literal foundation for ecological restoration.

Improvements in the health and functioning of local marine ecosystems were quickly apparent. The Biorock structures stimulated rapid coral growth in a few short months, which, in turn, led to a number of requests to expand the project. Over 70 Biorock structures have been installed along the Pemuteran coast since 2000, covering an area of two hectares and making this the largest coral reef nursery and restoration project in the world. Coral grown on mineral accretions (as with Biorock) are brightly coloured and support abundant and diverse fish populations. Plans for the future include new solar-, wind- and wave-powered Biorock structures. Large-scale restoration is planned for the reefs on Pemuteran's offshore banks to restore the village fisheries.

The community's Biorock Centre employs local villagers to monitor and maintain the restoration project. The centre also houses educational materials on marine ecosystems, coral reef regeneration, Biorock technology, and community restoration efforts. Pemuteran Bay Coral Protection Foundation also conducts public awareness activities and training sessions on the dangers of destructive fishing

methods to supplement its reef restoration work. A village training program has also been established to provide local youth with the education and language skills needed to work in tourism.

Underwater coral sculpture gardens

One innovation unique to Pemuteran is the Reef Gardeners Programme. Using Biorock structures, the community has constructed a sculpture diving trail, with design features inspired by Balinese temple gardens. Underwater coral regeneration structures have been designed in the shape of boats, giant sea turtles, and Balinese goddesses – together forming an offshore reef that is also an art installation. The reef is powered by solar panels, which are kept afloat on rafts and which are maintained and serviced by community members. The sculpture trail has been a draw for dive tourism, with proceeds reinvested into the Reef Gardeners Programme. Community maintenance includes rescuing and transplanting naturally broken corals; removing the snails and starfish that feed on coral and damage the reefs; and planting vetiver grass along the Pemuteran shoreline to help stabilise the beach and reduce shoreline erosion. Tourists also have the option of contributing to the project through the Coral Adoption Programme, whereby they can 'sponsor' their own coral. In exchange for regular sponsorship payments, the sponsor's name is grown in limestone letters next to their coral.

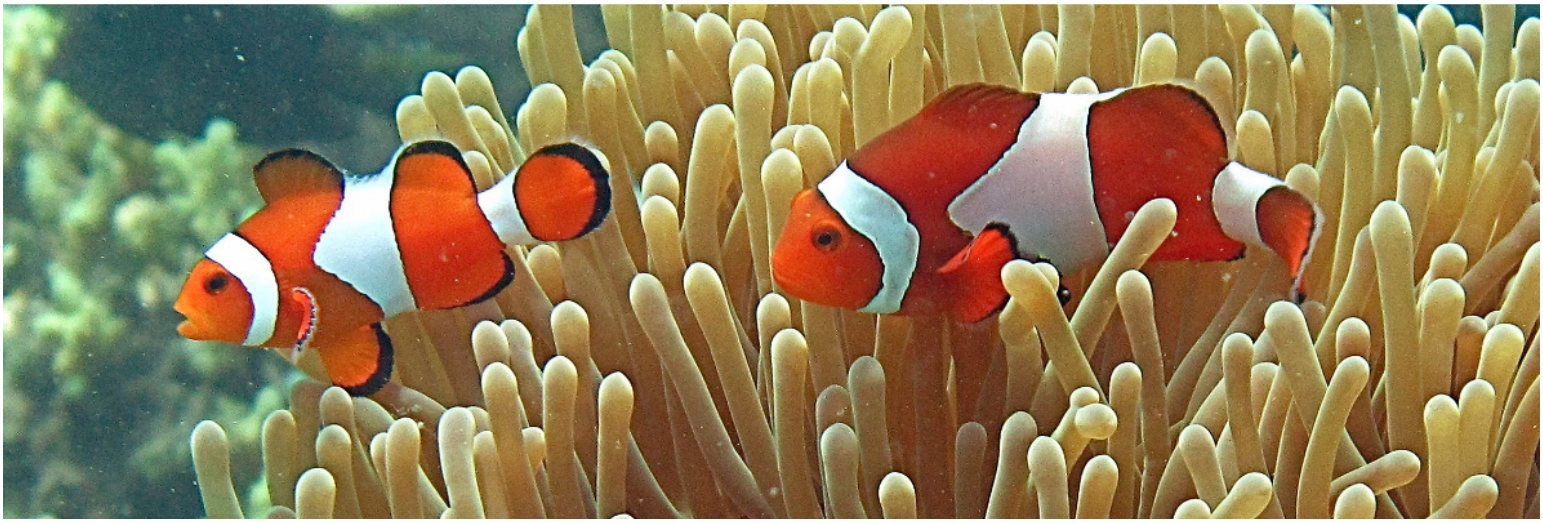
Enforcing community-based marine resource management

In addition to coral regeneration, the community has focused on strengthening the management of its marine resources. A previously declared but loosely enforced Village Marine Protected Area has been reinvigorated, with a community patrol – *pecalang laut* – established to enforce regulations banning destructive fishing practices. Because traditional Balinese village laws are recognised by national law enforcement agencies, the community was able to declare and demarcate its own protected area without requiring permission from central government authorities. The *pecalang laut* is a *de facto* village police force that monitors the marine protected area. Violators and transgressors of community regulations receive a warning first, and, if they persist, their boats and fishing equipment are seized, they are arrested, and are prosecuted by the Indonesian police. This support from national enforcement agencies has been critical to the success of local conservation efforts.

Improving waste management and reducing soil erosion

The Pemuteran community aims to improve water quality in the bay by addressing land-based as well as sea-based threats. The spillover of waste (especially plastics) into the sea has been a particularly damaging trend. During the dry season, the community has thrown garbage and refuse into dry river beds, where it sits until it is flushed out to sea in the rainy season. At the same time, land clearance has accelerated soil erosion and the sedimentation of mud. To address these problems, the organization has prioritized waste processing and recycling programs, as well as a plan for more effectively dealing with the treatment of sewage. The community has also addressed soil erosion through the planting of vetiver grass along shorelines, reducing the run-off that tends to smothers reefs.

Impacts



BIODIVERSITY IMPACTS

The primary biodiversity impact from this project has been the regeneration and restoration of coral reefs. Biorock technology has been deployed to transform what was a damaged and degraded marine ecosystem into a thriving reef. The technology is simple yet innovative. Once installed, the ocean currents flowing through the structures cause minerals from the sea water to build up around the steel tubing. Within a short amount of time, the steel structure is coated in calcium carbonate. The build-up is similar in composition to naturally occurring reefs and is quickly "colonized" by coral and other marine organisms that are attracted to the electric field and the shade offered by the structure. Coral fragments from other natural reefs are also attached to the Biorock frame, giving them a second life. Because the electrical current creates the ideal chemical conditions for coral growth, corals expend less energy creating these conditions, leaving more energy for reproduction and regeneration. As a result, Biorock coral typically grows at three- to five-times normal growth rates. Biorock reefs quickly take on the appearance of natural reefs, and provide a refuge for an abundance and diversity of marine species.

In addition to promoting fast coral growth, Biorock technology protects corals from the fluctuations in water temperature and environmental changes that often degrade reefs. Corals grown on Biorock have been found to be more resistant to environmental changes and to have significantly higher survival rates after severe temperature episodes than corals growing on natural reefs. The technology therefore represents a pioneering innovation in adaptation and resilience.

The rate and extent of environmental recovery in Pemuteran Bay has been nothing short of dramatic. The combination of Biorock technology, local enforcement of a marine protected area, and education within the Pemuteran community on the importance of marine conservation has led to the wholesale transformation of what was a wasteland of dead coral into a thriving marine ecosystem that is teeming with fish. The abundance and diversity of marine species around the reefs continues to grow, including populations of dugongs, which were considered locally extinct prior to the project. Enforcement of village regulations inside the marine protected area has also led to effective prohibition of destructive fishing methods. These efforts, along with improvements in community waste management, have led to a range of environmental benefits that also improve community wellbeing.

SOCIOECONOMIC IMPACTS

Coral restoration efforts have transformed the local economy, empowered the community, and changed local attitudes about the value of healthy ecosystems to income generation and local livelihoods. Greater awareness about the extent to which anthropogenic actions were degrading marine life, and the effect this was having on the local economy (most notably the fisheries and tourism sectors), has been at the very centre of community conservation efforts and local behaviour change. The community, once actively engaged in reef bombing and fishing with cyanide, has recreated and rebuilt itself based on a collective identity that prioritizes coral reef regeneration and conservation. In turn, conservation has paid dividends by leading to the recovery of dwindling fish stocks and attracting a new market of environmentally and socially conscious tourists and divers. Central to the community's environmental and economic recovery has been the strengthening of local marine protection measures, established years prior, but widely shirked or disregarded: the initiative has therefore built on a pre-existing conservation ethic that is rooted in local Hindu traditions. The community now strictly monitors and enforces its locally managed marine protected area, which incorporates regulations on destructive fishing practices.

Diversified and rehabilitated livelihoods

The greatest socioeconomic impact from the project has been improvement in local livelihoods. Previously, Pemuteran was one of the

poorest villages in Bali, owing in part to dry climatic conditions that limit rice cultivation. The primary source of income is subsistence fishing, with few other livelihood options open to the average villager. Through reef restoration efforts, Pemuteran Bay Coral Protection Foundation has rescued the local fisheries, which faced collapse only a decade ago. Local fishermen have observed a massive recovery in fish populations in the protected area. Growth in ecosystem health and fish populations inside the protected area has had positive spillover effects outside the protected area, where catch sizes have also grown.

The local ecotourism sector has also rebounded, creating new jobs and revenue streams for the community. Previously, the steady decline in reef health had predictably negative impacts on local tourist traffic, which was based largely on scuba diving and ecotourism activities that rely on species abundance and diversity. Bans on destructive fishing and coral regeneration have allowed populations of marine species to recover, which has led to an upswing in dive tourism. Tourists now pay to dive in the coral sculpture trail, while hotels and dive schools pay a village tax that supports community development projects. A recent survey showed that 40 per cent of tourists visiting Pemuteran were not only aware of village coral restoration efforts, but came to the area specifically to see the rejuvenated reefs. Pemuteran hotels are now regularly booked to capacity year round.

Gains for youth and women

As in other regions of Indonesia, the subsistence fishing community in Pemuteran has generally had limited access to education, skills training and investment capital. Since the Pemuteran Bay Coral Protection Foundation began, the vast majority of local families now have at least one member of the family working in the tourism industry. Jobs in the tourism industry, however, require a certain level of education, skills and language proficiency. Growth in the industry has, as a result, led to renewed interest in the pursuit of formal education. Where once local livelihood options were limited to subsistence fishing, and formal education was perhaps considered a luxury, a higher premium is now placed on education as a pathway to better, more secure employment.

Local youth have been notable beneficiaries of the revived ecotourism industry, receiving both vocational and conservation training that was previously unattainable. Women, however, have perhaps benefited even more. Where local women once had few employment opportunities, were traditionally relegated to domestic work – gutting and cleaning fish – and had little if any control over household finances and decision-making, ecotourism has opened windows of opportunity for employment and financial autonomy. More than half of the jobs in the local ecotourism sector are currently held by women, challenging traditional gender roles and empowering women in village public life.

POLICY IMPACTS

A distinctive feature of Indonesian law is its respect for the bottom-up governance of traditional Balinese society. Legal space has been made for villages to enact their own regulations without going through the national government. These local by-laws receive the full support of the national government, however, on the implementation side. This policy climate created the conditions for the community to declare a marine protected area in Pemuteran Bay and enforce local laws that were in turn recognised at the national level. The support of national police and regulatory authorities with monitoring and identifying transgressors has been an important ingredient of the locally managed marine protected area's success.

The many achievements and accomplishments of the initiative have made Pemuteran Bay a regular destination for Indonesian policymakers looking for examples of environmental conservation and sustainable livelihoods. Over the past decade, Pemuteran has hosted repeat visits by successive Ministers of Tourism, Fisheries and Marine Affairs, Environment, and Energy. These visits have sought to inspire the Government of Indonesia to make fisheries habitat restoration a major goal of national fisheries policy. The project has also been mentioned by government ministers at international conferences including Meetings of the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC).

Sustainability and Replication

SUSTAINABILITY

Pemuteran Bay Coral Protection Foundation relies exclusively on local resources and financing. The initiative enjoys a high level of local buy-in and is viewed as an extension of the community's desire to pursue economic development in ways that restore and conserve nature. Financial sustainability is achieved through a model of voluntary taxation, whereby dive shops and hotels – who both attract and benefit from tourism revenues – pay a levy to fund ongoing conservation activities. Currently, the project relies on no outside donor funding and is self-sustaining. This model, however, is contingent on continued tourism traffic to the region and to the community.

Another important dimension of the initiative's sustainability model is the low level of investment needed in the construction and maintenance of Biorock technology. Local people have been trained in the design and assembly of the steel structures, using materials that are locally available. These skills are easily transferred, as is knowledge on the repair and upkeep of the reefs. The power needed to electrify Biorock structures can come from a number of sources, including solar and wave technology. Plans are in place to increase the number of wave-, wind- and solar-powered structures along the reef. As of 2012, the marine tourism area extending along Pemuteran beach is almost at capacity in the number of Biorock structures it can contain; the focus now is on maintaining existing reefs, although plans to install wind and solar powered reefs continue.

The initiative has become a source of great pride in the community, and local ownership of the project is high. Support for the project is not surprising given the improvements it has brought to local livelihoods and incomes. A number of community groups have sprung up to maintain and support the initiative, including the local marine guard to enforce the protected area regulations and the "Reef Gardeners" who maintain the reef and plant vetiver grass along the shoreline to reduce erosion. Local families host tourists through home-stays, while local businesses including hotels and dive shops educate guests on the initiative and the importance of coral restoration. Local schoolchildren, too, use the project to learn about marine resources and the environment.

REPLICATION

The project began in 2000, when the first Biorock reefs were installed and the first community members were trained in their construction and maintenance. Over a decade later, there are now more than 70 separate Biorock structures in Pemuteran Bay, with a combined length of over half a kilometre, creating the world's largest and perhaps most successful coral reef restoration project. The project has inspired other local governments to take greater interest in coral conservation. Similar restoration projects have been implemented in other parts of Indonesia, including Lombok, Sulawesi, Java, Flores and Sumbawa. Pemuteran Bay has become a national model of best practice in community-based natural resource management. The project has also become a demonstration site for stakeholders interested in hands-on conservation, fisheries, and coral reef restoration learning. The community has hosted several major coral restoration training workshops. Students from Indonesian, German and British universities have produced research theses based on the initiative, while students from Indonesian universities regularly attend seminars and workshops at Pemuteran focused on both Biorock technology and community development. The success of the project has been reported widely in national and international media and has been the subject of several full-length documentaries.

PARTNERS

Since its inception, Pemuteran Bay Coral Protection Foundation has worked closely with the Global Coral Reef Alliance (GCRA), a non-profit organization made up of volunteers and researchers in the field of coral reef restoration and management. GCRA researchers developed the Biorock method of coral reef restoration and have provided training and support to the Pemuteran community.

FURTHER REFERENCE

- Pemuteran Bay Coral Protection Foundation website: http://biorockbali.webs.com/
- Global Coral Reef Alliance website: www.globalcoral.org
- Biorock FAQs: http://www.biorock.org/faq-page
- Goreau, T.J. 2009. Tourism and Sustainable Coral Reefs. See: http://www.globalcoral.org/Ecotourism%20Biorock%20complete.pdf
- Pemuteran Bay Coral Protection Foundation's Equator Initiative profile page: http://www.equatorinitiative.org/index.php?option=com_winners&view=winner_detail&id=120&Itemid=683

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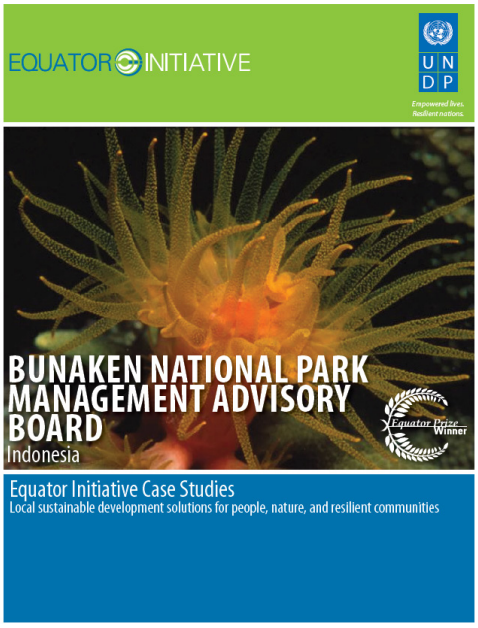

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