RESILIENCE SOURCEBOOK

Inspired by the 2013 Milstein Science Symposium
Understanding Social and Ecological Resilience in Island Systems
Informing Policy and Sharing Lessons for Management

CASE STUDIES OF SOCIAL-ECOLOGICAL RESILIENCE IN ISLAND SYSTEMS

American Museum of Natural History
Center for Biodiversity and Conservation

LAND CLEARING AND DREDGING CAUSE SEDIMENT PLUMES THAT THREATEN CORAL REEFS

Pohnpei, Federated States of Micronesia

The Setting

Pohnpei, located at N 6° 59′; E 158° 12′, is one of four island states that make up the Federated States of Micronesia (FSM) in the western Pacific. Pohnpei is comprised of five municipalities, each headed by a different chief, or *nanmwarki*. One high island and seven atolls make up the state of Pohnpei, with the main island of Pohnpei at its center. The main island, which serves as the seat of state and national government, has an extensive barrier reef and a shallow lagoon (with an average depth of less than 50 m). Pohnpei Island is approximately 30 km in diameter, with an estimated land area of 345 km^2. The island is mountainous, with peaks reaching nearly 800 m.[I] The island's terrestrial ecosystems consist mainly of tropical forests, while the perimeter is ringed by extensive mangrove forests. Pohnpei is considered one of the wettest places on Earth, with a mean annual rainfall of over 4 m in low-lying areas and 8 m in the highlands, which contributes to high freshwater inflows into the surrounding lagoon.[II]

Pohnpei is home to about 35,000 people. The population in Pohnpei is growing slowly, with substantial emigration; however, domestic consumption of local marine resources remains high and is a significant stressor on sustainability.

Pohnpei is home to one of the UNESCO World Heritage sites, Nan Madol, the ancient ruined city built atop a coral reef. The area supports a diverse group of corals – dominated by widespread species that can be found across most of the Indo-West Pacific, with a few endemic and globally rare species present.[III]

There is significant dependency on coral reef systems in Pohnpei because of the high consumption of reef fish and the low levels of income. A 2011 report found that over 554 metric tons of reef fish are extracted from Pohnpei's reefs annually for local markets, while more recent estimates suggest overall catch volume may be up to 8 times higher and well above sustainable biocapacity. This unsustainable harvesting has put substantial stress on the coral reef systems and threatens food and economic security. Unfortunately, management of marine resources in minimal and existing enforcement is ineffective.

Like other Pacific island countries and territories, colonialism shifted the economy from subsistence to a cash economy. Western presence on Pohnnpei intensified between 1830 and 1880 because of its popularity as a rest stop for whaling vessels.[IV] Spain and Germany disputed rights to the area until it was claimed in 1914 by Japan. The United States had jurisdiction in the region after World War II and accelerated the transition from subsistence to cash economy. Resources that

[I] Turak, E, DeVantier, L., 2005. Reef-building corals and coral communities of Pohnpei, Federated States of Micronesia: Rapid ecological assessment of biodiversity and status. Conservation Society of Pohnpei, Pohnpei, Federated States of Micronesia.
[II] Victor, Steven, et al., 2006. Sedimentation in mangroves and coral reefs in a wet tropical island, Pohnpei, Micronesia. Estuarine, Coastal and Shelf Science 66(3): 409-416.
[III] Turak and DeVantier 2005.

were once used solely for subsistence became commercialized for local consumption in part to purchase imported and manufactured goods.

Pohnpeians are a major producer and consumer of *sakau* (*Piper methysticum*). Traditionally, *sakau* (called *kava* in other regions) is grown in agroforestry plots with other native edible plants, such as breadfruit, bananas, and mangos. The *sakau* plant is prized for its root that has narcotic properties. The root is ceremonially pounded, mixed with water, and then laid in the bark of *Hibiscus tiliaceus*, a local tree. This bundle is then squeezed by hand until a brown liquid is extracted and caught in the cup of a coconut. The highest-ranking clan member or guest receives the cup first before it is passed to others according to their rank or prestige. Historically, *sakau* was of great cultural importance and was prepared only on momentous occasions or presented as a sign of respect.[V] Though it is still used in these traditional ways, today *sakau* is more often being used for recreation due to its hypnotic and sedative effects. In recent years, *sakau* has become a main cash crop and is implicated in helping to drive commercial overfishing, since fishing proceeds often go in part to *sakau* purchase. Increasingly, Pohnpei's highland interior is being cleared for *sakau* planting.

As a former Trust Territory, Pohnpei is very much influenced by the United States and continues to rely heavily on US international aid. Environmental management has been guided by American standards, albeit ineffectively. More recently, management efforts have been focused on incorporating local ecological knowledge in resource protection, although with minimal success. Micronesians maintain strong ties with the marine environment, however poor management planning and enforcement, resource commercialization and an open access system of resource use have combined to produce unabated and unsustainable fishing, while the lack of educational and employment opportunities has resulted in an ever-increasing fisher population and high levels of fishing pressure.

The Disturbance

With increasing economic activity on the island of Pohnpei, sediment plumes from run-off, dredging and sand mining have been persistent and increasing. The island's heavy rains and steep slopes make it particularly vulnerable to erosion and run-off. During heavy rains, these plumes can range from one to fifteen miles wide and encompass wide swathes of the lagoon. Under-regulated dredging, road construction, and logging have been contributing to increasing sediment plumes that have negative effects on Pohnpei's marine ecosystems. In 2009, Pohnpei's airport expanded, roads were repaired and dredging was used to complete the new airport extension. In addition, the increasing popularity and commercialization of *sakau* has led to increased forest conversion for *sakau* cultivation, exacerbating the problem of sediment plumes.

S*akau* planting has increased soil erosion in upland forests, overwhelming the capacity of mangroves to stem run-off into the marine environment. Landslides have increased, as have sediment loads in rivers. With minimal environmental enforcement, the problem of sediment plumes continues largely unabated.

Impacts to coral reef systems

Sedimentation frequently smothers Pohnpei's

Photo credit: Kevin Rhodes

[IV] Ragone, D., et al. 2001. History of plant introductions to Pohnpei, Micronesia and the role of the Pohnpei Agriculture Station. Economic botany 55(2): 290-324.

[V] Balick, M. J., Lee R., 2002. Traditional use of sakau (kava) in Pohnpei: lessons for integrative medicine. Alternative Therapies in Health and Medicine 8(4): 96-99.

surrounding reef ecosystem, with impacts highest in inner lagoon areas. Outer reefs are also vulnerable, but are buffered by their physical structure and distance from the source of sedimentation.

Inner lagoon reef systems in Pohnpei do not experience much water flow, so much of the sediment in run-off settles on the reef. This silt can interfere with coral larval dispersal and settlement, recruitment, and recovery. Run-off can also result in the loss of water quality, a risk of local eutrophication, a reduction in photosynthetic capability, an increase in loss of energy when sessile organisms rid themselves of particulates – and, in some cases, burial and death of corals. High sedimentation in areas that are already stressed from other disturbances like dredging or a bleaching event threatens the health and resilience of coral reef systems. Some experts have warned that these poor land-use practices will cause the collapse of Pohnpei's reef ecosystems.[VI]

The Response

Pohnpeians feel they have a strong cultural connection to the environment. Despite this connection, however, there has been no significant government or community response to the increasing sediment plumes or the noticeable effects on the local marine environment. Communities are very aware of the stress to their coral reef system from sedimentation. It is likely that sedimentation is impacting reef productivity, thereby affecting the livelihoods of local fishing communities. While the impacts are grave and palpable, they have yet to inspire a government response to address the situation.

Photo credit: Kevin Rhodes

The Result

Reefs may take considerable time to fully recover from sedimentation, particularly given the level of overfishing on herbivorous fishes and invertebrates important to removing algae and sediments from marine waters. More vulnerable species such as humphead wrasse (*Cheilinus undulatus*), bumphead parrotfish (*Bolbometopon muricatum*), giant clams (*Tridacna gigas*) and reef sharks (from the family *Carcharhinidae*) have declined.

Recommendations

To date, the Pohnpei government and people have failed to address this serious threat to reef ecosystems. The following are recommendations for how Pohnpeians might facilitate a recovery and protect reefs from further threats.

– *Collaboration*. Collaboration can be an effective strategy between international and regional agencies and also with academic institutions. Regionally, collaboration between sectors is also helpful. For example, in 2002, the Conservation Society of Pohnpei and Pohnpei Environmental Protection Agency began an outreach program to local schools called the "Green Road Show" to teach environmental studies to elementary school children. This can serve as a model for future collaborations.

– *Permits allocated for development must be accompanied by detailed ecological site analysis*. Pohnpei's Environmental Protection Agency is quick to allow dredging or sand mining permits with little, if any, environmental evaluation of the area being developed. To remedy this, permits for development should only be allocated after a detailed assessment of potentially affected ecosystems and communities in order to establish baseline values. In the case where

[VI] Victor et al. 2006.

development will impact an adjacent reef system, community members with rights to that reef system need to be involved in the permit process. Ongoing monitoring can identify negative impacts and can provide the rationale for remediation. For example, in order to measure runoff resulting from development, flow and current patterns of surrounding waterways need to be considered and sedimentation levels should be determined before, during and after dredging processes.

- *Restructuring of environmental and conservation agencies*. Economic incentives and political processes heavily influence Pohnpei's government with insufficient attention given to environmental conservation. Legal and management frameworks need to change so environmental considerations will be prioritized. Currently, there is insufficient environmental enforcement on Pohnpei. Strengthening environmental protection should be a high priority.

- *Find a way to unify stakeholders to effect change*. The need to organize and bring together government agencies and communities is pivotal to effective conservation outcomes. An example of an integrated management system is the establishment of fishing advisory councils with stakeholders to develop management protocols. This gets fishing communities involved so there will be a unified voice. Locally managed marine areas (LMMAs) are also a great example of collaborative efforts to effect change. Pohnpei's Enipein LMMA demonstrates how local support of marine protected areas empowers the community to protect and monitor its reefs. Traditional leaders implement enforcement, making it more effective.

Lead Organizations

- Micronesian Conservation Trust (MCT)
  http://www.mctconservation.org
- College of Micronesia
  http://www.comfsm.fm

Partners

- Conservation Society of Pohnpei
  http://www.serehd.org
- The Nature Conservancy
  http://www.nature.org
- US Forest Service
  http://www.fs.fed.us
- United Nations Development Program
  http://www.undp.org
- Global Environmental Facility
  http://www.thegef.org/gef/
- US Department of the Interior
  http://www.doi.gov/index.cfm
- Local groups

Resources

- Market Forces and Nearshore Fisheries Management in Micronesia
  http://walker-foundation.org/Files/walker/2011/TNC_Rhodes_etal_Micronesia_Market_Forces_Fisheries_ReportNo._6-11_(Final)_1-Dec-11.pdf

As told to Alexandra Donargo with contributions from Kevin Rhodes.

The Milstein Science Symposium

The collection of this case study and others like it results from the April 2013 Milstein Science Symposium, Understanding Ecological and Social Resilience in Island Systems: Informing Policy and Sharing Lessons for Management. Held at the American Museum of Natural History, the Milstein Science Symposium convened local resource managers, researchers, educators, island leaders, policy makers, and other leading conservation practitioners to examine characteristics, qualities, and processes that may foster resilience for coastal and marine systems as well as explore interactions, linkages, and feedback loops in complex social-ecological systems and what this means for management. The Milstein Science Symposium was organized in collaboration with The Nature Conservancy, the Gordon and Betty Moore Foundation, the National Science Foundation, The Christensen Fund, the Coral Reef Alliance (CORAL), the Scripps Institution of Oceanography at the University of California San Diego, the University of California Santa Barbara, the United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries, and Small Island Developing States (UN-OHRLLS), and the Wildlife Conservation Society.

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CENTER FOR BIODIVERSITY AND CONSERVATION

In 1993, the American Museum of Natural History created the Center for Biodiversity and Conservation (CBC) to leverage its institutional expertise to mitigate threats to cultural and biological diversity. The CBC develops strategic partnerships to expand scientific knowledge about diverse species in critical ecosystems and to apply this knowledge to conservation; builds professional and institutional capacities for biodiversity conservation; and heightens public understanding and stewardship for biodiversity. Working both locally and and around the world, the CBC develops model programs and tools that integrate research, education, and outreach so that people -- a key factor in the rapid loss of biodiversity -- will become participants in its conservation.

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