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Title: Economists hear “Words of the Lagoon”: Coral Reef Conservation through Long-term, Equitable Agreements

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Ecological and socioeconomic conditions in Oceania have changed dramatically since Bob Johannes wrote about the specialized ecological knowledge and traditional conservation ethic of the People of Palau in the now well-publicized *Words of the Lagoon, Fishing and Marine Lore in the Palau District of Micronesia*, published in 1981. A multitude of factors have appeared, from “roving bandits” to the elevated extinction risk faced by reef-building corals and outright uncertainty about whether coral reefs will survive the next century. Indeed, *21st century Words of the Lagoon* indicate that coral reef owners face a multitude of challenges posed by encroachment and illicit fishing, over-exploitation of marine resources, marine pollution, sedimentation, climate change, and a need to maintain or raise living standards in the face of declining resources.

Not all changes are unfavorable to coral reef conservation in Oceania: coral reef owners are now widely recognized for their efforts to protect and manage a marine ecosystem that is established as a globally valued natural asset. This is a bright spot in an otherwise gloomy outlook because, we argue, coral reef owners increasingly face potentially insurmountable challenges when they pursue coral reef conservation alone, working primarily in isolation.

Oceania’s coral reefs are undergoing increasingly significant ecological alterations from local and global anthropogenic disturbances. Even if localized anthropogenic stressors are minimized, the effects of global climate change (e.g., rising sea surface temperatures and sea levels, ocean acidification, and concurrent spread of pathogenic disease) will continue to precipitate ecological change in coming decades. Furthermore, the severity and distribution over time and space of such changes will be difficult to predict and monitor. Because the effects of shifting climate on corals are potentially severe and uncertain, management for ecological resilience across a set of sites, informed by targeted science, is now a necessary condition for successful conservation of coral reef ecosystems in Oceania.

Moreover, we recognize that biodiversity conservation involves an economic opportunity cost¹ that must be addressed to achieve both social and ecological resilience. In response to climate change, for example, precautionary management for maximum resilience may prescribe a pronounced reduction in marine resource consumption by coral reef owners perhaps in conjunction with no-take marine reserves. In particular, it may require a level of resource exploitation that is lower than the level desired by coral reef owners acting purely in their self-interest (e.g., exploitation levels for sustainable harvesting may

¹ The sum of all that is given up in order to achieve desired conservation outcomes, e.g., cost of lower rates of consumptive extraction, cost of adequate surveillance and enforcement, and costs of scientific monitoring and adaptive management.

significantly exceed levels prescribed for biodiversity outcomes and management for resilience). Coral reef owners cannot be expected to make resilient commitments to long-term management that is in the interest of a global community unless it is to their direct and measurable benefit.

We also recognize that there are significant costs associated with effective coral reef management in an age of climate change and roving bandits. It will now be necessary to focus on ecosystem recovery from disturbances, resistance to alterations, and reversibility to ecosystem changes. This focus is consistent with an ecosystem-based management approach that recognizes the need to maintain ecosystem health and performance, which relate directly to productivity and yield of exploited species, in relation to both subsistence and local income-earning activities. Adequate enforcement measures, information sharing and peer-to-peer learning among coral reef owners, especially in remote locations, are increasingly cost-prohibitive for coral reef owners. Measures that are often beyond the means of coral reef owners acting alone (e.g., long-term financing of enforcement, technology inputs, and targeted science) are increasingly critical to long-term success.

Finally, we recognize that conventional forms of conservation practice involving protected areas and related actions have been largely ineffective, historically having been applied without due respect for customary land and resource tenure, traditional practices and rights. There is critical need for a concerted move toward co-management of coral reefs that places high priority on strong communication and targeted science that in many cases is functionally combined with traditional practices.

Given the global-scale threats to coral reef ecosystems, limited resources of coral reef owners and their governments, and logistical challenges involved with working across many small islands and atolls in Oceania, there is a need to effectively combine resources through long-term agreements based on an appropriate set of economic incentives. There is also a strong rationale for targeting a project scale that is consistent with the scope and scale of anticipated climate change effects on coral reef ecosystems. Thus, there is a justification not only for abovementioned agreements, but for a network of agreements that can facilitate adaptation to climate change by allowing local managers to share capacity and technology, foster peer-to-peer learning, and support coral reef monitoring on a large spatial and temporal scale (while standardizing sampling protocols). Meeting these challenges requires innovation, coordination, and steady financing that can be beyond what coral reef owners and their governments can muster working alone.

In response, we outline an approach that combines the resources of coral reef owners, coral reef investors, and scientists under a model for conservation agreements. Our model combines economic incentives, social principles, and targeted science to develop conservation agreements that are equitable, socially and ecologically resilient, and suited to climate change adaptation.

The approach has three main objectives:

1. Protection and management for maximum ecological resilience (the capacity of system to absorb stresses and continue functioning) and adaptation to effects of shifting climate
2. Enhanced well-being of coral reef owners by addressing their employment, health, cultural, and education needs and aspirations (and devolving project authority to coral reef owners to, for example, allow them to select social investments for this purpose)
3. Pacific-wide investigation into the climate change stress response of corals and the inherent variability in those responses, in the presence or absence of localized anthropogenic disturbances

Conservation agreements are negotiated *quid pro quo* arrangements between two parties- coral reef owners and a set of investors and scientists who provide financing and technical assistance. Under the agreement, coral reef owners formally commit to reef protection, management, and monitoring. In exchange for verifiable commitments to these measures, they receive two guaranteed benefits: 1.

Financing of reef management, enforcement, and monitoring, in accordance with a reef management plan, and 2. Annual contribution to a social development fund used by and under the control of the community of coral reef owners. The agreement is subject to periodic third-party audits and is financed using an endowed fund (the certainty of agreement financing is an essential incentive). Coral reef protection, management, and monitoring are explicitly defined, e.g., establishment and verifiable enforcement of a network of no-take and managed marine zones. A set of metrics is used to track performance. If coral reef owners breach the terms of an agreement, benefits are reduced until they return to full compliance. The parties are provided periodic opportunities e.g., every five years to renegotiate agreement terms. Oversight of the agreements and any re-negotiations are made with assistance of a board of agreement trustees, selected to provide equitable representation of coral reef owners, coral reef investors, and the scientific community. Agreements can be re-negotiated and renewed after their term expires. Any re-negotiations would be subject to a set of by-laws, a pre-determined protocol for re-negotiations, and final approval of the board of trustees.

We further describe the approach as:

- A. Highly direct: the agreement is a *quid pro quo* transaction- coral reef owners receive benefits in exchange for verifiable management and conservation
- B. Able to meet the needs of Pacific Islanders: social investments and technology access are included in the benefits package tied to an agreement
- C. Long-term: agreements are for 20 years and renewable
- D. Bottom-up empowering: project control is devolved to coral reef owners, who have ultimate responsibility for management and monitoring
- E. Replicable: communities of coral reef owners will demand something that demonstrably enhances their well-being and helps them protect their reefs
- F. Sustainable: the approach maintains or enhances the ecological platform of the economy, culture, and heritage at our project sites
- G. Performance-based: financial flows and support are contingent upon documented compliance with the agreement

Model demonstration, now proceeding in Palau at the request of a traditional leader, is the first phase of a strategy and long-term vision for implementing conservation agreements at scale to cost-effectively deliver local-to-global conservation benefits directly tied to enhancements in human well-being. We recognize that successful adaptation to the effects of shifting climate is best served by a (primarily social) network of such agreements. Thus, a network of these agreements is envisioned for each of three regions of Oceania (Micronesia, Melanesia, and Polynesia), beginning with a “proof-of-concept” network in Micronesia that is developed from two existing projects: 1. Helen Reef atoll in Palau, 2. Ngulu atoll in Yap, and a third site, to be identified. To date, each of these projects has completed biological surveys, management plans, and progress toward developing the necessary local capacity to manage, monitor, and administer projects.