MARGINAL ISLANDS AND SUSTAINABILITY: 2,000 YEARS OF HUMAN SETTLEMENT IN EASTERN MICRONESIA

MARGINALNI OTOCI I ODRŽIVOST: DVIJE TISUĆE GODINA NASELJENOSTI OTOKA ISTOČNE MIKRONEZIJE

Frank THOMAS
Oceanica Centre for Arts,
Culture & Pacific Studies
University of the South Pacific
Suva, Fiji Islands
thomas_fr@usp.ac.fj

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Summary
Low coral islands in the Pacific are often perceived as marginal habitats for human settlement. This view is supported by the small and fragmented islet landmass, poor soils, lack of perennial surface fresh water, and extreme vulnerability to flooding by storm waves, and more recently, rising sea-level attributed to global warming. The atolls and table reefs of Kiribati and the Marshall Islands have produced some of the earliest dates for human settlement of eastern Micronesia. Sustainability for the last 2,000 years was just as likely the result of relatively low population densities, low impact extractive technologies, and efficient use of limited resources, as the application of intentional and unintentional conservation practices.

Key words: Kiribati, Marshall Islands, historical ecology, conservation

1. INTRODUCTION
With over 40,000 years of human settlement, the Pacific islands display great ecological and cultural diversity. Yet, the forces of globalization are an ever present threat. Although environmental degradation and the loss of traditional languages and cultures by the advent of modernity are not limited to islands, the latter appear more vulnerable to disturbance compared to continental areas. Until relatively recently, it was generally assumed that anthropogenic impacts on island ecosystems were the result of Western influence via the introduction of alien crops, ornamental plants, and animals, causing widespread damage to the environment.1 No one can deny that threats to island biodiversity continue at an accelerated rate as a consequence of human population growth, urban expansion, monoculture, pollution, and overfishing. A half century of research has, however, revealed that indigenous people were also capable of altering their terrestrial environments to a significant degree prior to the arrival of outsiders.2 These impacts can sometimes be traced to the early stages of human settlement, leading in some cases to resource depression, extirpation, and extinction. By contrast, the influence of indigenous societies on marine resources is less well documented,3 and remains a fruitful topic for research in light of suggestions that rapid disper-

3 A. Anderson, “Short and sometimes Sharp; Human Impacts on Marine Resources in the Archaeology and History of South
sal, notably in the case of the Lapita expansion across the southwest Pacific beginning about 3,500 years ago, could have been driven in part by the impact of early humans on nearshore and intertidal resources of high value that could be efficiently harvested, such as flightless birds, colony-breeding seabirds, turtles, large reef fish, and invertebrates.  

2. LOW CORAL ISLANDS

It is argued that without a fair amount of human-induced environmental impact, Remote Oceania (the islands lying to the north and east of the main Solomon chain, Figure 1) would not have been successfully colonized by people lacking a well-established agricultural base. While the importance of food production to early colonizing groups needs to be demonstrated, agriculture subsequently expanded to the extent that islands became largely transformed into anthropogenic landscapes. Some human-induced impacts had a destructive effect on island biota, but it is difficult to imagine life on some islands, especially low coral islands - atolls and table reefs or low coral islands lacking a lagoon (Figure 2), without introduced root and tree crops. Patrick Kirch characterized such islands as ‘consummate man-made environments’.

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Figure 1

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Low coral islands best exemplify the close links between marine and terrestrial ecosystems. As islands formed by biogenic agents (unconsolidated carbonate sediments deposited by waves on reef platforms), atolls and table reefs can be regarded as especially constraining habitats for human existence. The challenges faced by people, both past and present, include low soil fertility, absence of perennial surface fresh water, and extreme vulnerability to flooding by storm surge because of low elevation of the highly fragmented landmass, only a few meters above mean sea-level. There are some 300 atolls and low coral islands in the Pacific Islands region and many more individual islets. Several archipelagoes are dominated by these limestone islands, such as the Tuamotu, Tuvalu, the Marshall Islands, and Kiribati, and their vulnerability to environmental disturbance is well known. Kiribati (Gilbert Islands Group or western Kiribati) and the Marshall Islands have produced some of the earliest dates for the human colonization of eastern Micronesia, about 2,000 years ago coinciding with the post-mid-Holocene drawdown in sea-level, which resulted in the atolls and table reefs to become emergent and habitable.

3. FOOD PRODUCTION

Once coral islands became suitable for human habitation, colonists continued to face several challenges, notably in setting up a viable subsistence base given low soil fertility and in some cases insufficient rainfall. The range of food crops that could sustain people on low coral islands was limited compared to what could be grown on the more fertile volcanic islands. Nevertheless, coral island societies

devise various strategies that took full advantage of edible wild resources, including abundant marine life, in addition to foods that were successfully introduced.\textsuperscript{11}

Pits excavated down to the brackish water lens for the cultivation of giant swamp taro (\textit{Cyrostosperma chamissonis}) are among the most outstanding features of the landscape, particularly on the wetter islands (Figure 3). In Kiribati, over 20 cultivars have been identified, with some varieties grown mainly for prestige and ceremonies. Swamp taro cultivation entails a sophisticated system of mulching and fertilization using leaves from a variety of trees. Pits were commonly excavated in the middle of islets where the lens is thicker. Some of the pits were lined with coral boulders to stabilize the walls. Those who still practice this form of food production have their own secret techniques of composting.

Taro pit cultivation has witnessed a general decline for variety of reasons, including damage by historically-introduced pigs, crop disease, tropical storms, growing dependence on food imports, and increasing salinization of the water table associated with global warming and sea-level rise.\textsuperscript{12} Given the dynamic nature of atoll geomorphology, anthropogenic traces on the landscape can easily be obliterated unless located well inland, such as swamp taro pits and associated mounds.\textsuperscript{13} Excavation and dating of ancient surface soils under taro pit spoil dirt in adjacent mounds yielded evidence of early land clearing.\textsuperscript{14} Accordingly, the oldest dates for human occupation usually will be found in association with landscape alteration. One of the first tasks that colonists needed to perform was to clear vegetation in preparation for taro pit digging, because corms (swollen underground plant stems) can take nine months to several years to mature.\textsuperscript{15}

Coral island societies relied heavily on tree crops, such as breadfruit, pandanus, and coconut, to meet dietary needs and provide material for a host of products.\textsuperscript{16} Agroforestry (Figure 4) is a distinguishing

characteristic of the earliest agriculture in the Pacific Islands and is still an important component of contemporary atoll landscapes, even in urbanized settings in houseyard and urban gardens. In addition, food preservation technology reached its zenith on coral islands, as people developed ways to process certain foods that they could last through periods of scarcity and for use as sea rations among communities that regularly traveled between islands. Fermented breadfruit, dried pandanus paste, and dried arrowroot starch could be stored for years.17

As most of Kiribati and the northern Marshall Islands are located in the dry belt of the equatorial oceanic zone, periods of drought are common. The usual way of accessing water was through the digging of wells, but water was also collected from coconut palm fronds and trunks, as well as empty giant clam shells. Coconut water and toddy (coconut sap) could provide additional nutrients.

4. MARINE RESOURCES

If opportunities for agricultural intensification in the past were limited, the lagoons generally teemed with fish and other marine organisms, providing food as well as raw material (fish bone, shells, coral) for the manufacture of tools and ornaments.18 Fishponds and fish traps made from loosely built walls of coral boulders were extensively used prior to European contact (Figure 5).19 What is less clear, however, is the extent of human impact on the marine environment. Elsewhere in Oceania, there is evidence that overfishing by indigenous communities resulted in a decrease in the average size of available resources, particularly of shellfish, that can be distinguished from the effects of natural disturbance.20

17 M. Merlin et al., Keinikkan Im Malan Aelōń Kein: Plants and Environments of the Marshall Islands (Honolulu: East-West Center, 1997).
While marine losses have not been widely reported from coral islands and the chronology of some documented losses remains uncertain, the very high ratio of reef to land would have ensured abundant protein resources, with little noticeable impact by human communities that remained generally small. However, resident human populations might have had a noticeable effect on less mobile organisms, such as certain shellfish. It has been suggested that people on Utrōk Atoll in the northern Marshall Islands may have extirpated the Bullmouth helmet shell (*Cypraea cassis rufa*) sometime in the past. However, the presence or absence of marine species in a particular habitat is largely determined by chaotic or unpredictable recruiting of juvenile organisms that shape the structure of reef assemblages over time. This is not to deny that some species, by virtue of biological, ecological, and behavioral attributes, display levels of resilience to human exploitation. Less resilient organisms, like the giant clam, *Tridacna gigas* in the Marianas, New Caledonia, and Fiji disappeared presumably because of being overexploited. Along with other members of the *Tridacna* family, this species is considered vulnerable to gathering pressure, even when using traditional gathering methods.

5. COPING WITH ENVIRONMENTAL STRESS

Environmental stress can be reduced by the use of social capital. Land tenure systems and kinship networks enabled people living on coral islands to maximize choice of residence and group affiliation to access resources. In reference to the Marshall Islands, Hart highlighted the underlying collective effort required to ensure survival, as illustrated by strong mutual social obligations. This framework could be regarded as a prerequisite for effective resource management.


Land tenure systems developed to safeguard terrestrial production among kin groups, while being flexible enough to enable neighboring communities to access resources in time of need. Various cooperative strategies ensured that people could claim rights to resources, made possible, for example, by adoption and intermarriage, trade, and sometimes cyclical migrations to alleviate problems of over- and under-population, thus contributing to sustainable practices. Despite their abundance on most atolls, marine resources were at times subjected to avoidance practices, which would have enabled stocks to recover. For example, the concept of mo (taboo) in the Marshall Islands still applies within some inhabited and uninhabited atolls where large bird colonies live and turtle nesting is known. By chiefly decree, northern atolls lacking sufficient rainfall to support permanent human settlement were designated as ‘game reserves’ to be exploited at certain times only and in an orderly and ritualized way. These atolls have also retained much of their original flora, however sparse.

On small marginal islands, the need to devise strategies for managing population growth may have arisen quickly, so as not to outstrip resources. Warfare, cannibalism, infanticide, and abortion may contribute to population regulation, but there were also non-destructive means such as ritual celibacy, prolonged lactation, and adoption as an alternative to ensuring continuity of the family line. However, it may be that in some instances under-population was a more serious threat to community survival than population pressure. Initially at least, relatively large families and clans would be necessary to ensure adequate levels of resource production. Populations responded to the vagaries of environmental perturbation in a most successful way:

The atoll populations used flexible social processes for the control of fertility and rates of reproduction; they actively managed recovery from the demographic challenges of contingency events and ensured their continuity as atoll populations occupying enduring settlements.

While European-introduced diseases between 1850 and 1900 contributed to population decline in Kiribati, the Marshall Islands, and other several other localities because of the inhabitants’ relative epidemiological isolation, depopulation also followed in the wake of Western-induced labor migrations during the same time period to various other Pacific Islands and beyond to work on plantations and mines. Another important cause of depopulation was inter-group warfare encouraged by political, economic, and religious rivalries, with the establishment of external trade and missionary influence.

Interisland contacts would confer advantages in the event of demographic instability and shortages in food and raw materials as a result of environmental perturbation, such as that caused by drought or cyclones. Because of their marginality for human existence, coral islands occupy a prominent posi-

28 M. Merlin et al., Keinikkan Im Mełan Aelōń Kein: Plants and Environments of the Marshall Islands (Honolulu: East-West Center, 1997).
tion in discussions centered on exchanges. Atolls may be connected to ‘high’ volcanic islands, but in the absence of the latter, elaborate internal networks were established. These networks functioned to distribute resources between coral islands that differed in terms of productivity, both terrestrial and marine. These differences were linked to variation in rainfall, and also to intra- and inter-islet size, as well as the degree of lagoon closure, shape, and depth.

As with other coral island groups, populations in the Marshall Islands were linked by inter-community support networks, which were adaptive in light of latitudinal variation in rainfall, resulting in differential production of foodstuffs between the dry north and the wetter south and the risk of cyclone damage, prompting Marshallese chiefs to secure land holdings scattered over several islets of the same atoll, as well as land rights to resources on other atolls. Inter-island links in the Gilbert Islands formed smaller regional network clusters.

6. HISTORICAL ECOLOGY

In recent years, historical ecology has emerged as one of the most useful and comprehensive approaches to understanding how environments and landscapes were affected by climate change, early human settlement, historical interactions, and modern development and industrialization. This approach, which combines the natural and social sciences using paleoecology, archaeology, land use history, and long-term ecological research, has potential for examining natural and cultural phenomena that generated changes to island ecosystems.

Compared to ‘high’ volcanic islands, atolls and table reefs have received scant attention from archaeologists focusing on historical ecology. More specifically, little is known about paleoclimatology, the introduction of exotic fauna, the extent of human-induced environmental impacts, and social transformations on low coral islands prior to Western contact. Given the unique environmental challenges posed by coral islands, it is all the more surprising that pre-European ecological research has been largely neglected. By contrast, the last two decades have witnessed a host of environmental studies, from sea-level rise to contemporary human impact on terrestrial and marine ecosystems. As noted above, a number of studies have looked at the long-term effects of human exploitation and environmental change on fish, invertebrate, and sea mammal populations, resulting in declines in species diversity and reduction in

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average age and size.\textsuperscript{45} It is possible that low coral island societies were more acutely aware of resource limitations than communities on larger ‘high’ islands, and thus realized early on the need to conserve resources.\textsuperscript{46} This assumption needs to be critically examined. Optimal foraging models derived from human behavioral ecology\textsuperscript{47} have been very useful in distinguishing conservation behavior \textit{per se} (conservation by design) from its effects.\textsuperscript{48}

\textbf{7. CONCLUSIONS}

Because of their small size, limited and at times fluctuating resources, and relative isolation, low coral islands are of interest for evaluating aspects of past human adaptation to challenging environments. Much remains to be learned regarding their cultural transformation to sustainability before European contact. What stands out is that several communities were able to live sustainably through the interaction of factors such as relatively small populations, low impact technology, efficient use of resources via the application of specialized agricultural techniques and fishing methods and an understanding of environmental cues and fluctuations, and conservation practices (both intentional or by design such as the presumed deliberate extirpation of resource-competing pigs and unintentional as illustrated by optimal foraging strategies).\textsuperscript{49}

In a general sense, it can be argued that islands, and especially low coral islands, are microcosms of larger, but equally fragile environments.\textsuperscript{50} From some of the volcanic islands in the Pacific, archaeologists have uncovered evidence for extensive landscape change resulting from vegetation clearing, soil erosion, and species extinction. Debate continues regarding the role of humans versus climatic factors as the leading cause for these changes, but it is reasonable to assume that human impact on the environment exacerbated in some cases the effects of natural disasters, sometimes resulting in major social disruption. More data are needed to evaluate the degree and main causative agent of environmental change in low coral island settings.

The interlinked topics of ‘sustainability’ archaeology, historical ecology, and conservation\textsuperscript{51} highlight the many challenges faced by contemporary Pacific island communities as they attempt to cope with changing environments, economies, and social values, which more than ever pose a threat to sustainable livelihoods. While the past, as documented through historical ecology, can provide some of the knowledge and tools for sustainable livelihoods, we also need to be critical of the effectiveness of traditional coping strategies under new conditions of growing population, altered land- and seascapes, escalating

climate-related hazards, and changes in community and individual needs.\textsuperscript{52} Surely, adjustments will have to be made to assist in developing long-term ecologically secure approaches to survival. For example, ethnographic data, primarily collected during the first half of the 20\textsuperscript{th} century, confirmed the existence of traditional fishing regulations in the form of taboos with attendant secular and supernatural sanctions, and more recently some rural villages and local councils have limited access to certain fishing grounds.\textsuperscript{53} Reviving conservation practices could be quite challenging nowadays in a transformed natural and social environment.\textsuperscript{54} Hope remains, however, with approaches that can strengthen the resilience of communities and their ecosystems for both sustainable development and climate change adaptation.\textsuperscript{55} The persistence of some conservation practices, albeit on a small scale, is illustrated on outer islands in Kiribati in the form of aquaculture of giant clam and cockle species, representing the live storage of animal meat, in enclosures demarcated by coral cobbles (Figures 6 & 7).

We should moreover look at culture as a vital link between past, present, and future. Several low coral communities were successful in achieving sustainability for centuries, and their accomplishments deserve to be recognized and celebrated. Knowledge and practices are dynamic, just as cultures are. Culture on low coral islands and elsewhere in the Pacific islands region is still firmly rooted in community obligations. Kin- and community-related activities can reduce risk and uncertainty. Reciprocity as embodied in the Kiribati concept of \textit{bubuti}, a request that cannot be refused, best exemplifies the close ties between people living in a challenging physical environment. As the anthropologist Tony Whincup remarked ‘the integration of people and place’ for \textit{I-Kiribati} (the people of Kiribati) has indeed become an imperative of survival.\textsuperscript{56} An integrated understanding of land- and seascapes for sustainable livelihoods is strongly

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\textsuperscript{55} D. Storey and S. Hunter, “Kiribati: An Environmental ‘Perfect Storm’,” \textit{Australian Geographer} 41 (2010).

\textsuperscript{56} T. Whincup, “\textit{Te Wa}: The Traditional Canoe of Kiribati,” http://www.spasifikmag.com/freetravelarticletewaphotoessay/ (accessed on 2 November 2010).
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linked to a sense of place. Historical ecology has often documented the transformation of place, whose custodians today, the local communities, will need to take on an increasingly active role to manage their biocultural world successfully.

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SAŽETAK

Niski koraljni otoci u Pacifiku često se doživljavaju kao marginalna staništa za naseljavanje ljudi. Ovakav stav dolazi zbog malih i fragmentiranih komadića kopna, otočića sa siromašnim tlom, nedostatkom trajne površinske vode za piće i ekstremne izloženosti poplavljanja od olujnih valova, a u novije vrijeme i dizanja razine oceana zbog globalnog zatopljenja. Atoli i niski, ravni grebeni otočnih državica Kiribati i Maršalovo otočje imaju povijest nekih od najranijih naseljavanja ljudi istočne Mikronezije. Održivost u posljednjih dvije tisuće godina bila je vjerojatno posljedica relativno slabe gustoće stanovništva, ekstraktivnih tehnologija malog utjecaja i učinkovitog korištenja ograničenih resursa, kao i primjena ciljanih ali i nenamjernih postupaka zaštite prirode.