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Landscape Catastrophe and Landscape Enhancement: Are Either or Both True in the Pacific?

Matthew Spriggs

That significant changes have occurred in the vegetation and landscape of the Pacific Islands during the course of human occupation is no longer doubted and has been amply demonstrated by publications during the past ten to fifteen years.[1] What caused these changes has occasioned debate, however. Three commonly considered possibilities (not necessarily mutually exclusive) are often canvassed (cf. Butzer 1974): (1) climate change affecting vegetation and other aspects of the ecosystem; (2) catastrophic events or sequences of events such as volcanic eruptions, earthquakes or hurricanes; and (3) human interference with the vegetation cover by clearance and/or fire.

There is at present no evidence that the islands of Remote Oceania (Pawley and Green 1973), those south and east of the main Solomons chain, were occupied before 3200 B.P. (see Spriggs in press, b, for discussion). For Eastern Polynesia, the time depth of human occupation is even shorter: less than 2,000 years in Hawaii, 1,000 years in New Zealand (Aotearoa). There is no evidence for major climatic shifts in the region during the past 3,000 years, and it is not clear how minor climatic shifts, as argued by some researchers (e.g., Nunn 1990, 1991:17–28), could have led to the vegetation and landscape changes that have been documented. Higher relative sea level between about 5000 B.P. and 2000 B.P. (Nunn 1991) may well have had an important role in shaping coastal environments, but where the sediment came from that subsequently filled former marine embayments still needs to be considered and is not adequately explained by Nunn's appeal to river-channel response or coincident uplift (Nunn 1991:12).

Catastrophic events or natural hazards have been important in shaping the island environments of the Pacific (Kirch 1984: Chapter 6), but on their own they cannot be the full explanation for the changes observed. This leaves human impact as an extremely important factor—though certainly not the only one—in vegetation and landscape changes in most nonvolcanically active areas of the region. Nunn's claim that "most writers have linked post-settlement environmental changes in the Pacific islands solely to human activities" (1991:16, cf. 8, 28) is absurd. Recent researchers have sought to give human impact its due place among the causal agents, following a long period when such impact was scarcely acknowledged. It should be remembered, too, that natural hazards can be particularly damaging "when ongoing social and economic conditions are such as to expose the production system and the land to abnormal harm from such events" (Blaikie and Brookfield 1987:142).

All human groups have an impact on their environments, whether hunter-gatherers (for Australia see Flood [1983:213–15] and Kimber [1983]) or, as in the case of the settlers of Remote Oceania, agriculturalists. Clearing of vegetation from hillsides to create gardens leads to higher erosion rates, particularly on tropical soils. Any gardening of the usual tropical crops will inevitably lead to higher than natural erosion rates.

Sustaining human life in Remote Oceania without an agricultural economy based on introduced plants may well have been impossible prehistorically (Spriggs in press, b). Few edible plants were naturally available, and the only edible nonmarine fauna of significance were fruit bats (which never reached Hawaii), birds, and, on some islands, lizards (Dye and Steadman 1990). The islands were certainly not "Paradise" when they were first settled.

Agriculture requires gardens, and gardening on forested islands requires forest clearance, usually by fire. Windward forests tend to regenerate quickly, while the more diverse, leeward dry forests regenerate much more slowly after clearing and are more susceptible to further human disturbance and alteration.

CATASTROPHE OR ENHANCEMENT: DOES IT DEPEND ON WHERE YOU STAND?

The scale of forest clearance for agriculture on some islands was massive: in the main Hawaiian Islands, for instance, many thousands of square kilometers of forest had been cleared before European contact. The leeward dry forest had virtually disappeared by A.D. 1778, replaced by grassland or agricultural field systems. On Hawaii Island three of the leeward field systems have been partially investigated and are known to have covered at least $216\ \mathrm{km}^2$. The full extent of these, and of other large agricultural field systems on the island that have yet to be examined in any detail, have never been defined, and so the total area cleared of forest that was there before contact may be at least an order of magnitude higher.

The forest was replaced by a managed, highly productive environment capable of supporting dense human populations (Kirch 1985). Integral to this environment were the "barren" grasslands described by early visitors to Hawaii. These grasslands produced crop mulch, which was necessary in the drier garden areas, and *pili* grass, which was the usual thatching material for the roofs and walls of all Hawaiian structures.

One effect of this massive vegetation alteration was the removal of the habitat of many species of birds (Olson and James 1984) and of land snails, such that more than half of the species of each group became extinct. Today we see this as an ecological catastrophe but there is *no* evidence from oral tradition that this process was even remembered by later Hawaiians.[2] As Steadman et al. have noted of Polynesia in general, "Even if these hunters became aware of the scarcity of certain species after decades or centuries of exploitation, they could do little to prevent predation by rats and dogs, or possible avian pathogens introduced with chickens. Moreover, these people were unlikely to alter their agricultural practices for the sake of preserving forest habitats for birds" (1990:148).

Another concomitant of forest clearance that might be seen as disastrous is greatly accelerated erosion. Today soil scientists often denounce practices such as slash-and-burn agriculture that lead to increased runoff and erosion from hill slopes. These same soil scientists, however, also describe the alluvial soils in the valleys that are the products of this erosion as some of the prime agricultural lands of the region. These alluvial plains were previously viewed as the products of slow natural erosion processes, whereas they can now be seen to be extremely recent creations and the direct result of humanly accelerated hill-slope erosion (Spriggs 1985).

It might be argued, however, that all the benefit is to the valleys, leaving the hills stripped of soil and barren. In some cases this is clearly the case, as "badlands" and "fern desert" areas of various Pacific islands testify (see Chapter 8). But one might argue that they are no great loss to agricultural systems, often representing areas of naturally thin and not very productive soils on steep slopes that would require extensive terracing to make them fit for sustained cultivation.

Clearly critical, too, are erosion and soil-formation rates on various slopes and bedrock types. Accelerated erosion is not always of a catastrophic kind, and not every gardened hillside is inevitably destined to lose all of its soil cover. Soil development may keep pace with soil loss. Drier lower-slope areas in leeward Hawaii have benefited from the products of erosion from higher, wetter areas in the past 500 years. With the development of gardening on the upper slopes, accelerated erosion has transported sediments to lower areas of previously barren lava flows, allowing gardening in places where it was not previously possible (Schilt 1984:270, 274–76). There is no evidence that the upslope areas were losing soil at such a rate that gardening in them was impaired by this process.

Sudden influxes of large amounts of sediments into the valley bottoms during extreme rainfall periods would have led to flooding and destruction and burying of agricultural systems, creating at least short-term catastrophe. One such flood on Aneityum in Southern Vanuatu, "the greatest known on the island," was described by the Reverend Gunn in the early years of this century:

> Though the wind sometimes reached hurricane force, there was no cyclone; but the rain poured incessantly for 28 hours. Next morning the harbor—ordinarily one of the finest sights in the islands—was one great mud pond, with earth carried down by the river. As news came in from other districts about the rain, I learned that all the valleys were under water when the flood was at its height, and natives seeking places of safety had to wade breast-high, or swim. Many taro plantations were buried in mud. . . . But in one narrow, deep valley, formerly a death-trap in times of flood, the height and force of the water surpassed that in any other part of the island. Owing to a land-slip, the water rose 60 feet high, then, breaking the barrier swept seaward in resistless torrents, carrying huge boulders, taro patches, houses, the school, lately built, coconut trees, etc. Fortunately few people were in the valley at that time, or there would have been a large death roll. As it was, a man and a boy were drowned. [Gunn 1911:7]

The interplay between human interference with the vegetation and natural catastrophic events can be seen at work in such situations (see Spriggs 1981:96–102). But would the occasional catastrophic flooding of valley floors, clearly reflected in their alluvial sequences, have rendered them unfit for agriculture for significant periods? In considering this, we come to some methodological problems to do with the identification of garden soils and the interpretation of radiocarbon dates.

THE IDENTIFICATION OF GARDEN SOILS

On Aneityum, soils of former furrow-irrigation gardens on Pleistocene alluvial terraces were examined by the geomorphologist Marc Latham and myself in 1979 (see Spriggs 1981). The only features of these soils that distinguished them from natural topsoils were homogeneity of the humic horizon, a marked difference in structure and firmness between the upper (cultivated) and lower horizons, with a sharp break between them, and the presence of manganese staining at depth. Of these features, only the manganese staining could possibly be said to distinguish these soils from dryland agricultural soils. On the recent alluvial plains, at least where they are adjacent to the rivers and are particularly well drained, even manganese staining is absent, so that irrigation—and indeed cultivation of any kind—can only be established on the basis of associated remains of stone-lined plot boundaries or channels.

In other areas of the Pacific, soils associated with different techniques of irrigation may be more distinctive in structure. Thus, as described by Kirch (1977:253-55), pondfield soils are generally distinct from naturally formed soil types. The effect of waterlogging creates an eluviation, reduction state in the upper A horizon and an illuviation, oxidation state in the lower B horizon. Kirch noted that this effect on soils under pondfield irrigation has been reported from Hawaii, (East) Futuna, Japan, Thailand, and Malaya but not from Ifugao pondfields in the Philippines. Such conditions do not occur in all soils under pondfield conditions, and they are at least in part a function of the length of time a pondfield has been in use.

Kirch (1977:254) notes another physical feature of irrigated (specifically pondfield) soils to be the presence of limonite concretions, "hydrated iron-oxide tubes which apparently formed around *Colocasia* roots under aqueous conditions. . . . It is probable that the limonite concretions resulted from the oxidation of the surrounding sediment by plant roots." There are, however, a variety of ways in which iron concretions can form in the soil, and the reported association with the pondfield soil could be fortuitous (Phillip Hughes, pers. comm.). Although (as noted by Kirch) pyrolusite concretions around sugarcane roots in Hawaiian soils have been described, similar tubes forming around taro roots have not been reported in field studies of the crop.

Kirch (1977) suggested that additional criteria, such as textural difference, pH, or total organic content, should be investigated to try to identify pondfield soils in archaeological contexts. As I mentioned, textural difference is one criterion used on Aneityum to distinguish cultivated soils, but with the more sandy soils on recent alluvium the difference is not distinctive. Total organic content is generally higher in the upper rather than the lower horizons of natural soils and so again is unlikely to be distinctive of irrigated or dryland gardening. On Aneityum, pH content did not distinguish garden soils from other sediments revealed in section.

Thus when a sediment is found in an excavation or exposed river section, it can only be firmly identified as a garden soil when it is associated with structural remains (stone-lined channels, plot boundaries, terraces, and so on) that can be identified as features related to agricultural exploitation. Where such evidence is lacking, identification as a garden soil can only be made very tentatively. For further discussion of these issues see Allen et al. (1987:36-37).

INTERPRETING RADIOCARBON DATES

Radiocarbon dates from within irrigated or other garden soils may be misleading for a number of reasons. In discussing charcoal found within pondfield soils, Kirch (1975a:306) notes three possible sources: (1) initial clearing and burning of the site before pondfield construction; (2) burning of fallow growth during the period the field was in use; and (3) an upstream source with charcoal carried in by the irrigation water. Thus dating material from a pondfield soil does not necessarily date first use of the pondfield. A similar range of sources for the charcoal found in the furrow irrigated soils of Aneityum Island can also be postulated. Similarly, with tilled soils (dryland or irrigated), charcoal present within them may only relate to the latest phases of use when the soil was last turned over. This must always be borne in mind when interpreting dates on charcoal within garden soils.

In cases where charcoal has been fluvially transported into the garden area, there is a possibility that it will give a date far older than that of the time of its incorporation into the soil, because of charcoal storage in sites in the catchment. This has been found to be the case under certain circumstances in Australia (Blong and Gillespie 1978). The opportunities for such storage on most Pacific islands, however, would appear to be much less than in the very much larger sandstone catchments studied by Blong and Gillespie. A sequence of radiocarbon dates from a stratigraphic section should always be preferred to single dates when evaluating the possibility of charcoal storage, and all dates on dispersed charcoal found within sediments should be treated with caution.

It is debatable whether dispersed charcoal found within garden soils can be attributed to any particular source among the possibilities I have mentioned. The most secure dates are those obtained for in situ hearths or ovens, but even here the possibility of old wood being used for fuel means such dates can only be used as maxima (see Gillespie and Swadling 1979). Initial agricultural use may well have involved the clearing and burning of old-growth forest, with trees perhaps several hundred years old entering the archaeological record as charcoal. Early dates for initial clearance may in part reflect this old-wood effect.

A further obvious problem is that working even with calibrated dates a single age range will often span more than 100 calendar years at one standard deviation (s.d.) and 300 years at two s.d.[3] The best we can do in assessing whether there is a "significant" time difference between two layers representing garden soils is to see whether they overlap at two s.d. (a 95% confidence level). If such an overlap does not occur, it might be suggested (but note my caveats on charcoal sources) that the period of abandonment between them was of considerable duration.

ALLUVIAL AND COLLUVIAL SEQUENCES

There are few studies of alluvial deposition in areas of prehistoric Pacific agriculture that give more than single dates from within river sections or excavations. The examples I shall use come from (East) Futuna in Western Polynesia and appear in the work of Kirch (1975a, 1976, 1981, 1994) and of Frimigacci and his colleagues (Di Piazza 1990; Di Piazza and Frimigacci 1991; Frimigacci 1990); from Luluku in windward O'ahu (Allen et al. 1987), from Makaha in leeward O'ahu (Yen et al. 1972), and from my own research on Aneityum in southern Vanuatu (Spriggs 1981, 1985, 1986).

An analysis of the dates from sites on these islands reveals two important findings. First, in several cases there is a significant gap of several hundred years between initial human presence at, and use of, a site and evidence for a second (usually gardening) use. Second, at sites used within the past 1,000 years no significant gaps in use between periods of alluvial or colluvial deposition can be established. This applies whether we are talking of initial human use of a site within the past 1,000 years or second and subsequent uses after a significant gap. A single depositional sequence is often illustrative of both findings.

Futuna, Western Polynesia

Kirch's excavation at the Tavai site (FU-11) on Futuna revealed 10 layers (Fig. 5.1), including an occupation layer (Layer IX) representing a village site on a

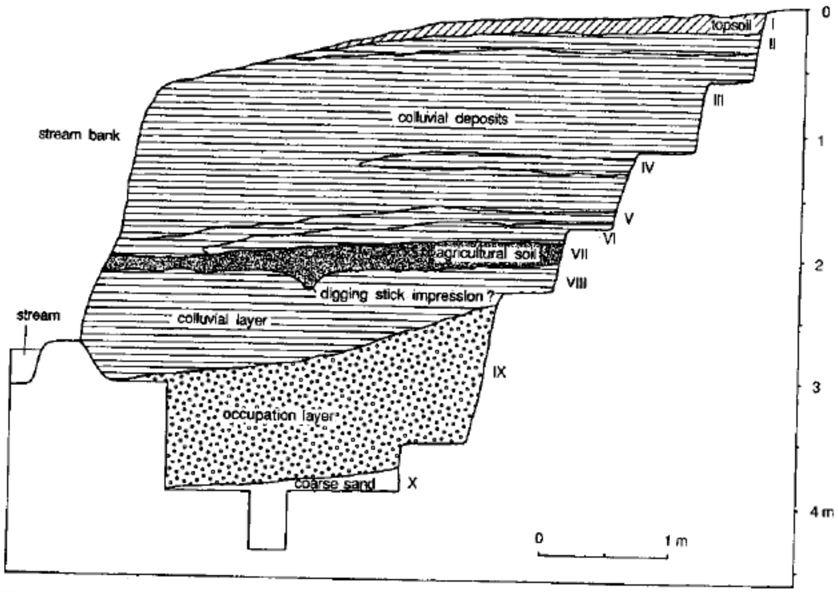

Figure 5.1 Stratigraphic section at Tavai (FU-11, *now* SI-09)*, Futuna, Western Polynesia (after Kirch 1981)*

gravelly clay coastal plain a few meters from the shoreline (Kirch 1981). This occupation is buried by a clay sediment derived by erosion from upslope (Layer VIII), and Layer VII above this is interpreted as an agricultural soil on the basis of abundance of charcoal, a concentration of charcoal in the northwest corner of the excavation suggestive of a swidden burn pile, and a probable digging-stick impression. The soil is "a compacted horizon of clay-sand which stands out clearly within the section" (Kirch 1981:129). The upper six layers are interpreted as having been transported to the site through sheet wash, debris flow, and slumping. Although some charcoal flecking was noted near the base of Layer VIII, these upper layers appear to have been devoid of charcoal. Whether any of them might also represent gardened soils cannot be established. The important point, however, is the significant gap in time between initial use of the site for settlement at 2303 to 1998 B.P. and its subsequent garden use dated to 1382 to 1060 B.P.

In later research on Futuna, Frimigacci and his colleagues (Di Piazza 1990; Di Piazza and Frimigacci 1991; Frimigacci 1990) investigated the site of Asipani (Fig. 5.2). Here an early Lapita and Plainware occupation is buried by alluvial deposits, on top of which is a taro pondfield soil (Layer 6). Above this are two more topsoils (Layers 4 and 2), separated by further alluvial deposits.

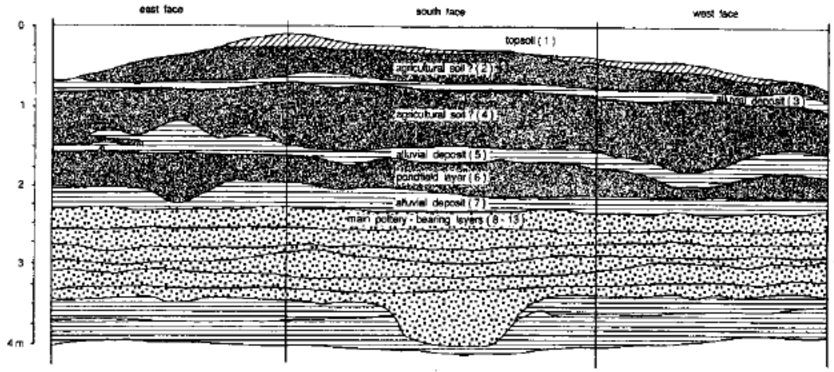

Figure 5.2 Stratigraphic section at Asipani (SI-*001), Futuna, Western Polynesia (after Di Piazza and Frimigacci 1991)*

Areal excavation of the Layer 6 garden soil revealed individual planting holes and a drain (Di Piazza 1990). The two upper topsoils are of the same texture as the pondfield horizon and have also been interpreted as agricultural, although not necessarily irrigated. There is an area of pondfields currently in cultivation adjacent to the Asipani site. The latest dates for the ceramic occupation of the site are 2054 to 1873 B.P. and 2704 to 1860 B.P. The Layer 6 pondfield has been dated to 1122 to 958 B.P. As with the Tavai site, there is a possible 1,000-year gap in human use between the initial and the second utilization of the site. The upper two garden soils are undated, but use and rebuilding of three agricultural systems within the past 1,000 years or so certainly betokens a quickening level of activity at the site compared to the previous millennium.

Another site investigated by Frimigacci's team is at Moasa, an upland site situated on the edge of the *toafa*, or fern desert, in the interior of the Vailala Valley (Frimigacci 1990:167–68; Di Piazza and Frimigacci 1991). Excavation revealed four humic clay horizons, interpreted as swidden agricultural soils separated by alluvial and/or colluvial deposits (Fig. 5.3). The lowest of them (L. 13) has been dated to 1235 to 970 B.P., the middle two (L. 11, 10) combined to 434 to 0 B.P., and the upper garden layer (L. 7) to 490 to 314 B.P. The gap between first postulated garden use and secondary use is significant, on the order of 500 years, whereas the upper dated garden soils are not separable by radiocarbon dating. As with the Asipani site, we find higher rates of deposition and greater evidence of human use over time. A note of caution must be raised here, however. These layers have been identified as agricultural on general textural properties and the presence of charcoal. Their identification as gardened soils, though plausible, cannot be said to have been firmly established by these criteria.

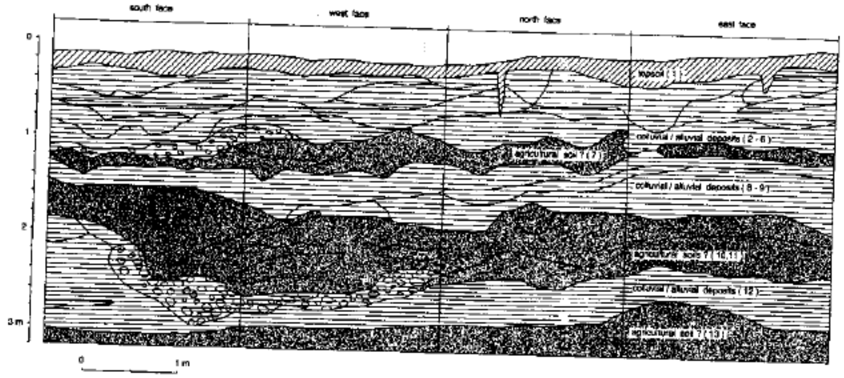

Figure 5.3 Stratigraphic section at Moasa (SI-*013), Futuna, Western Polynesia (after Di Piazza and Frimigacci 1991)*

An excavation by Kirch in an abandoned pondfield system between the Nuku and Leava areas revealed a pondfield horizon buried beneath the surface system (Kirch 1976:47–49). The buried horizon has been dated to 304 to 0 B.P., revealing rebuilding of the system in the recent past at a time indistinguishable by radiocarbon from the present. Other buried pondfield horizons on the island remain undated (Kirch 1976:47–49; Di Piazza 1990:160). As Di Piazza notes, land suitable for irrigation is scarce on Futuna, which is why after floods and cyclones these systems are reestablished in the same place. Overbank flooding, such as occurred on Futuna in 1986 during cyclone Radja, may necessitate the temporary abandonment of some pondfields but may also create conditions suitable for the creation of new ones (Di Piazza 1990:161).

O'ahu Island, Hawaii

Extensive agricultural excavations have taken place in windward O'ahu at Luluku (Allen et al. 1987). Trench 3 in site G5-85 (Features 34, 35, and 38) is particularly instructive (Allen et al. 1987:76–87). Layer VIII has been interpreted as a buried pondfield topsoil remnant that had developed on the Layer IX alluvial deposits (Fig. 5.4). It was truncated by a colluvial deposit (L. VIIb) and the fill behind a buried pondfield-terrace wall. There are three radiocarbon dates for this layer, although one of them is clearly anomalous (see discussion by Allen et al. 1987:174, 177). If this is excluded from consideration then Layer VIII dates to 1550 to 1340 B.P. and 1350 to 1070 B.P., a combined range of 1505 to 1305 B.P. Such an age would represent one of the earliest dates for hu-

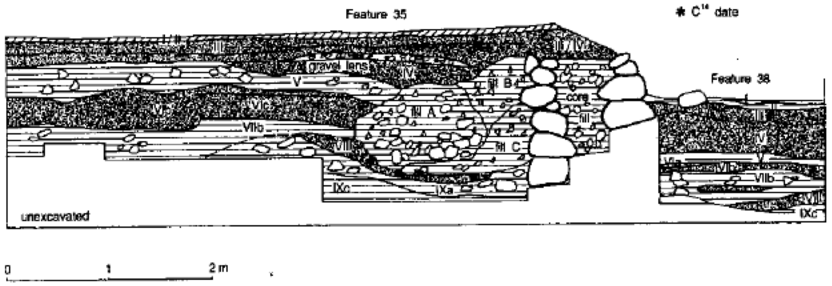

Figure 5.4 Stratigraphic section of parts of Features 35 and 38, Trench 3, north face, Luluku (G5-85), O'ahu, Hawaiian Islands (after Allen 1987)

man occupation in the Hawaiian Islands. Incorporation of old wood seems likely as part of initial forest clearance, and the dates should be used only as maxima.

Layer VI, above the colluvium that covers and partially truncates Layer VIII, represents one or more pondfield horizons associated with some of the fill phases and terrace-facing construction. Combining the two dates from this layer in different pondfields gives a generalized date of 675 to 551 B.P. It is again worth noticing a significant gap between initial use of the area and second use, even allowing for the "old-wood factor" in the earlier dates. Layer V represents another episode of erosion and colluvial deposition, and Layers III and IV represent pondfield A and B horizons that developed on this deposit, relating to the surface terrace facing. Layer III dates to 540 to 327 B.P. at one s.d. but overlaps comfortably with Layer VI when taken at two s.d. (650 to 290 B.P. for L. III, 700 to 520 B.P. for L. VI).

Other depositional sequences at Luluku do not go back as far as Layer VIII in Trench 3, but they do illustrate the point about rapid response to catastrophic flooding and deposition in the irrigated system. Test Pit 2 (Feature 9) contains multiple pondfield layers separated by colluvial and alluvial episodes of deposition (Allen et al. 1987:71–74). Layer VI is a pondfield horizon dating to 305 to 0 B.P. Colluvial sediments (L.V) cover this, and Layer IVb above is interpreted as a probable pondfield topsoil. Above this is a fill deposit, part of a platform for stream retention. A buried stone facing may have served the same function in relation to earlier pondfield use. Layer III is a pondfield layer dating to 445 to 293 B.P., and the current topsoil also relates to former pondfield use. Up to four separate pondfield uses are thus indicated for the past 300 to 450 years.[4]

In nearby Trench 1 (Features 7–10) the same picture is revealed (Allen et al. 1987:65–71), with up to five separate pondfield episodes (Fig. 5.5). Layer VIII is the lowest of these and is undated.[5] It is separated from another pondfield topsoil (L.VI) by a colluvial deposit. The Layer VI pondfield dates to 670 to 520 B.P. Between this and the next undated pondfield level (L. IIIc/IV) in some places is a further colluvial deposit. Immediately above this pondfield episode is another, represented by Layers IIIa and IIIb, and the current surface layers are also former pondfield deposits. Layer IIIb has produced a date of 476 to 290 B.P. This sequence suggests four separate pondfield uses in the past 600 or so years, and an earlier undated use.

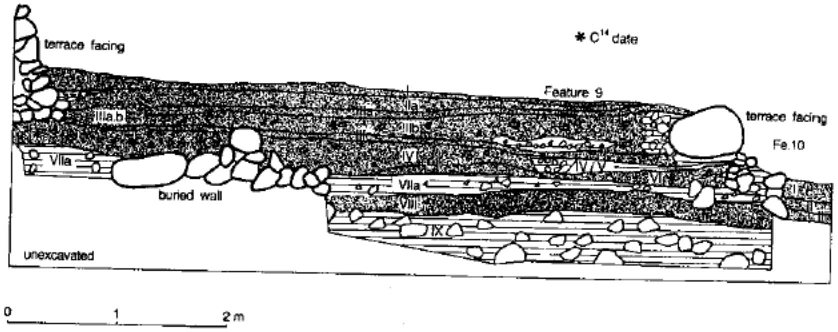

Figure 5.5 Stratigraphic section of part of Features 9 and 10, Trench 1, north face, Luluku (G5-85), O'ahu, Hawaiian Islands (after Allen 1987)

Also on O'ahu, the pioneering excavations of Yen and his colleagues in the upper Makaha Valley in 1970 (Yen et al. 1972) revealed two separate pondfield layers in a series of excavations within an extant agricultural system (site C4-286). One radiocarbon sample related to the initial construction of the earlier system at 660 to 510 B.P., while two further samples related to the period of use of that system at 544 to 441 B.P. and 526 to 319 B.P. The upper pondfield use dated to 313 to 0 B.P., overlapping at two s.d. with the dates for the earlier system. The two periods of use were separated by an episode of alluvial flooding and destruction.

Comparable studies on a Kaua'i Island pondfield system by Schilt (1980) and Athens (1982) have produced somewhat confusing results but also point to an early initial use of the site, a significant period of abandonment, and then at least two phases of pondfield use, probably in the past 300 years.[6]

Aneityum Island, Vanuatu

Four sites on Aneityum (Fig. 5.6) offer somewhat comparable information (see Spriggs 1981 for details): Imkalau (AT37), Lelcei River (AT555), Aname (AT196), and Anetcho River (AT188).

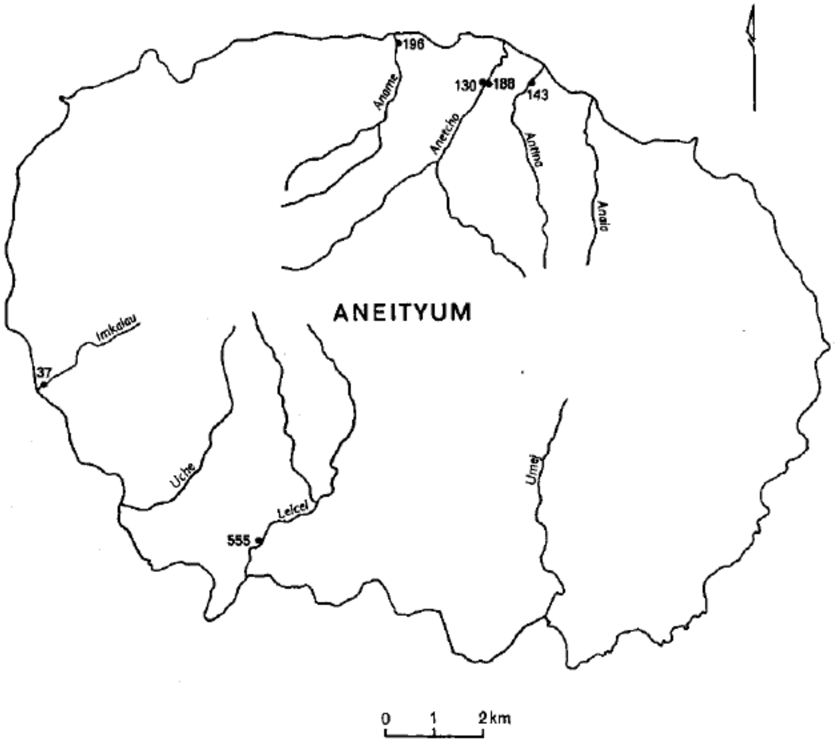

Figure 5.6 Map of Aneityum, Vanuatu, showing sites mentioned in the text

At Imkalau the evidence of initial human use of the area is in the form of charcoal-rich alluvial deposits covering a coral reef platform that is now some 175 m inland (Figs. 5.7, 5.8). These deposits were laid down between 2328 and 2065 B.P. and between 1863 and 1617 B.P. There was then a hiatus in alluvial deposition, and marine sand or beach deposits built up. A burial near the base of these dates to 1248 to 1142 B.P. On top of this marine deposit is an occupation site providing a range of dates from 1056 to 929 B.P. down to 669 to 540 B.P. This occupation site is buried by a further marine-sand deposit, on top of which developed a garden soil associated with structural remains of a terraced dryland garden system. This soil gives a date of 537 to 463 B.P. and is buried by recent alluvium. The Imkalau site is another example where there is a significant time gap, more than 500 years, between initial use and secondary use of a site. Admittedly the evidence for the initial use is indirect, showing significant erosion within the catchment as a result of the burning of vegetation cover, presumably in gardening.

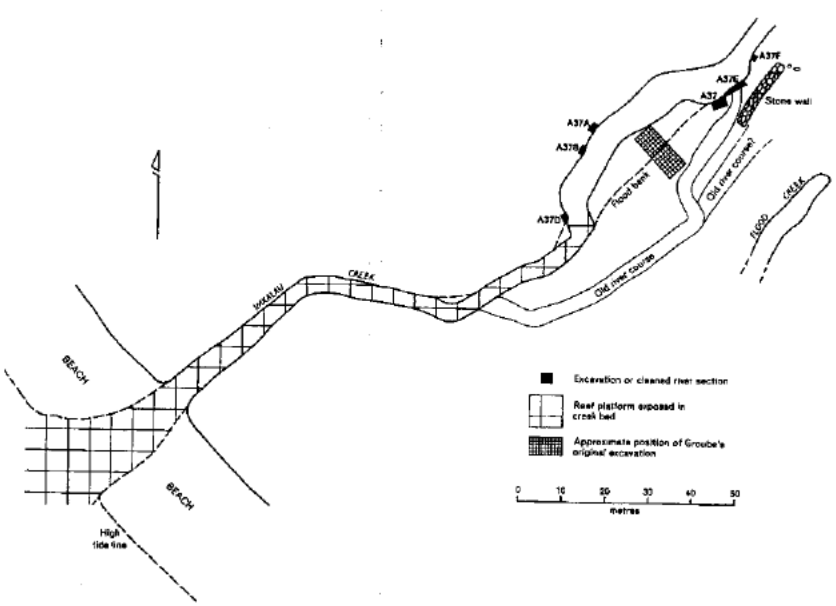

Figure 5.7 Location map for Imkalau Creek excavations (AT37), Aneityum

In the Lelcei Valley a river exposure (AT555) revealed three buried A horizons. As at Imkalau, the lowest horizon revealed only indirect evidence of gardening, in the form of charcoal within the sediment. A concentration in Layer III.2 just above the river level gave a date of 1682 to 1320 B.P. An earth oven was associated with Layer II above this and dated to 642 to 515 B.P. It is the first direct evidence of use of the valley floor. In other sections exposed along the Lelcei River three or four main horizons have been found, but evidence of agricultural exploitation, in the form of stone plot boundaries and walls of dryland gardens, is only seen in the upper two horizons. A similar time gap between first use and second use of the area is evident in Imkalau and Lelcei.

Moving to the north side of Aneityum we find a similar pattern in exposures along the Aname River at site AT196 (Fig. 5.9). Three hundred meters behind the present shoreline a reef platform and overlying beach deposits were revealed in the riverbed, beneath nearly 2.5 m of alluvial deposits (River Section 2). The uppermost part of the beach deposit contains charcoal flecking as well as shell and has been dated to 1880 to 1290 B.P. (charcoal) and 2148 to 2013 B.P. (shell). These dates overlap at two s.d. The alluvial deposits immediately above this correlate with a horizon from another river section approximately 50 m upstream that dates to 490 to 0 B.P., with a probability of 0.69 that

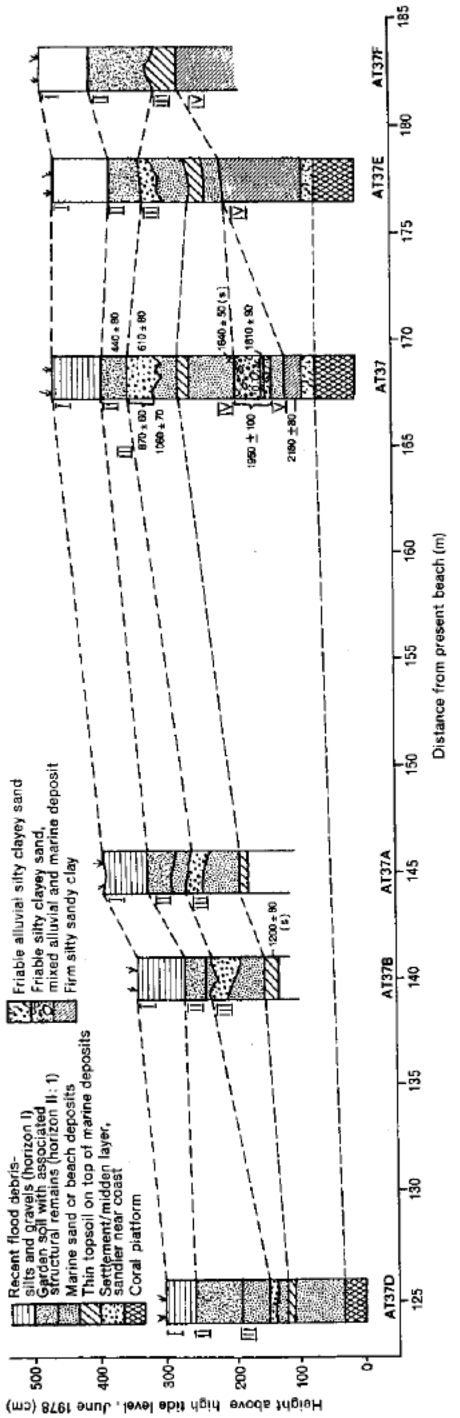

Figure 5.8 Imkalau Creek stratigraphic sections (AT37), Aneityum. S after a radiocarbon date denotes a marine-shell sample

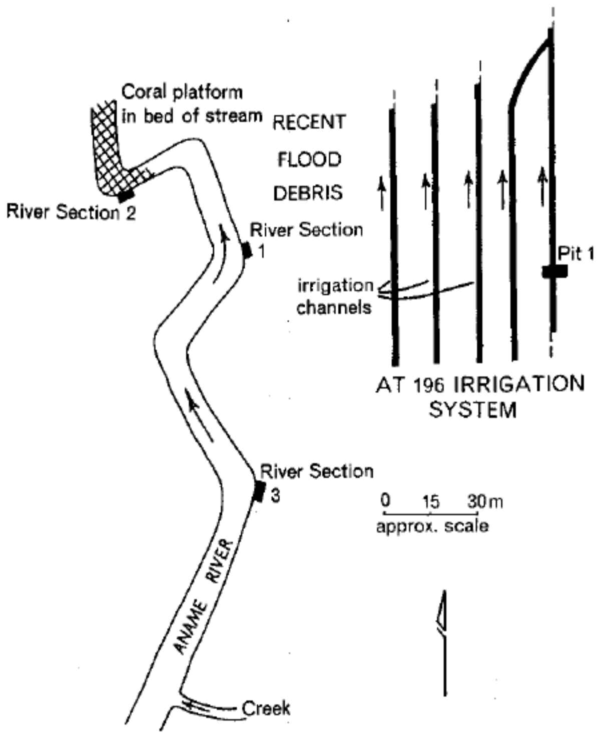

Figure 5.9 Location map for Aname River sections (AT196), Aneityum

the date is between 480 and 260 B.P. (L.II.3 of River Section 1). A buried topsoil (L.III.1) below this dated horizon provides an age from a charcoal concentration of 644 to 513 B.P. The two dates overlap at two s.d. A lower buried topsoil (L.IV) at this exposure has not been dated but correlates with a layer dated at a farther exposure, River Section 3, about 85 m upstream, dated at 663 to 519 B.P.

Adjacent to the river is a large furrow-irrigated garden system. A test pit within it (Test Pit 1) showed a similar general stratigraphy, with the two phases of irrigation use postdating a layer equivalent to that at River Section 1 dated to the last 490 years B.P. (Fig. 5.10). Using the strict criteria I outlined near the beginning of the chapter it is not possible to establish that the topsoils buried below the irrigation system were garden soils. There is evidence, however, for at least four cycles of soil formation and subsequent alluvial deposition within the past 650 or so years. Erosion and deposition rates seem to have increased considerably in the catchment at some point between about 1550 and 550 B.P. given the beach and reef deposits exposed at River Section 2.

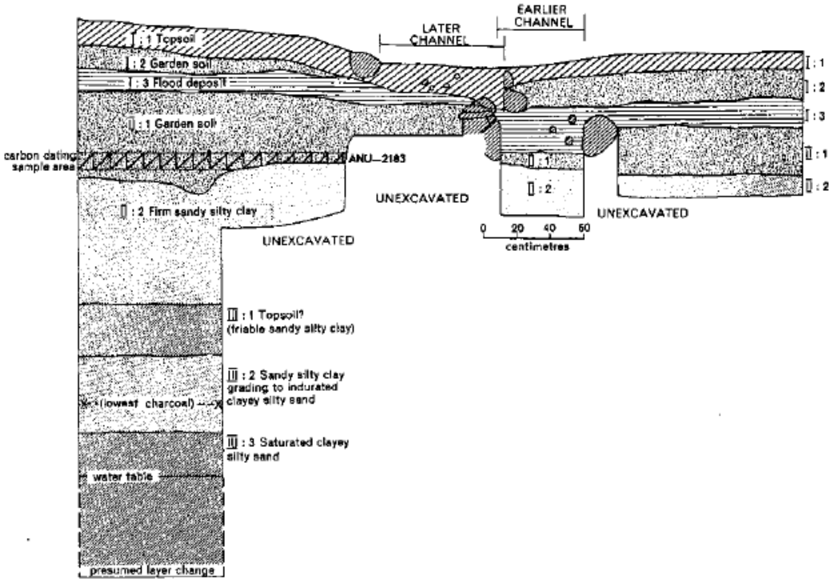

Figure 5.10 Stratigraphic section, Test Pit 1, AT196 Irrigation System, Aname, Aneityum

Similar rapid deposition within the past 950 years has occurred in the Anetcho catchment to the east, and probably in the next river east again, the Antina. In the Anetcho River a deep section was revealed, with up to five possible topsoil horizons exposed (site AT188). Charcoal flecking occurs throughout the exposure. The lower horizon is undated, but an earth oven in Layer IV.2 at 3 m below the top of the riverbank has provided an age of 990 to 720 B.P. This overlaps at one s.d. with a date on dispersed charcoal from Layer III.1 between 1.35 and 1.5 m below the ground surface of 1060 to 790 B.P. Associated with horizon II is a stone-lined creek or large storm drain. Stone-lined storm drains for dryland gardens are exposed in a river section 50 m upstream associated with horizons II and III at site AT130 (Fig. 5.11). There are further structural remains associated with the top near-surface horizon I.

The close network of storm drains found in horizon III is not found in the surface agricultural systems recorded during the 1978-80 archaeological survey of the northern half of the island. It may represent an initial attempt to control flooding and allow gardening during a period when the valley floor was much wetter than it is today and therefore more liable to inundation.

A sequence similar to that at AT130 was recorded in the Antina River to the east at site AT143 (Fig. 5.12). Parallel stone-lined storm drains were revealed at the base of the riverbank in the lowest of three agricultural horizons. The lowest storm drains both here and at AT130 are also "stylistically" similar in that the boulders and cobbles generally used in their construction are smaller than those in surface examples of storm drains noted during the archaeological survey. Dates from horizons I and II associated with dryland-garden remains all came out as "modern," whereas no date was obtained for horizon III. By analogy with AT130 and AT188 horizon III, this horizon would appear to be of equivalent age, about 900 B.P. Downstream of this site structural remains associated with horizon I appear to relate to an irrigation system (AT389) that seems to be a recent feature relating to the latest prehistoric or early historic (post-1830) period.

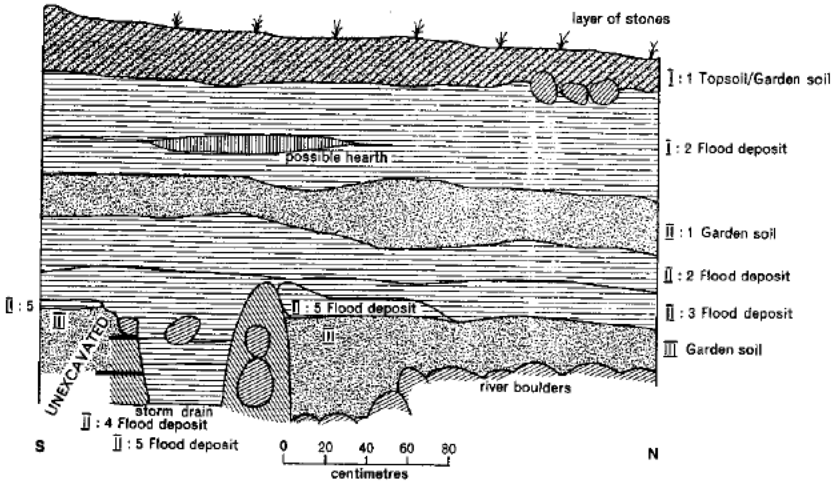

Figure 5.11 Stratigraphic section, River Section 1, Ivanauad (AT130), Anetcho River, Aneityum

Nunn (1990:130), in reviewing the Aneityum data, suggests that "tectonic change may have had a significant effect; rapid coseismic uplift may have been responsible for the unexplained breaks in alluviation at some sites." He suggests a similar explanation for the Futuna data. While seismic effects are certainly felt on Aneityum and have been a contributing factor to landscape change (Spriggs 1981:102, Appendix 1), the pattern of significant breaks in alluviation occurring *only* in the early parts of the valley-fill sequences comparatively soon after human arrival would not seem to be convincingly explained by such effects. If the uplift rates proposed by Nunn had the effects he suggests, then a major change in the tectonic regime in the past millennium or so, as opposed to the previous one, would have to postulated.

I interpret the sequences from these different island groups to mean that

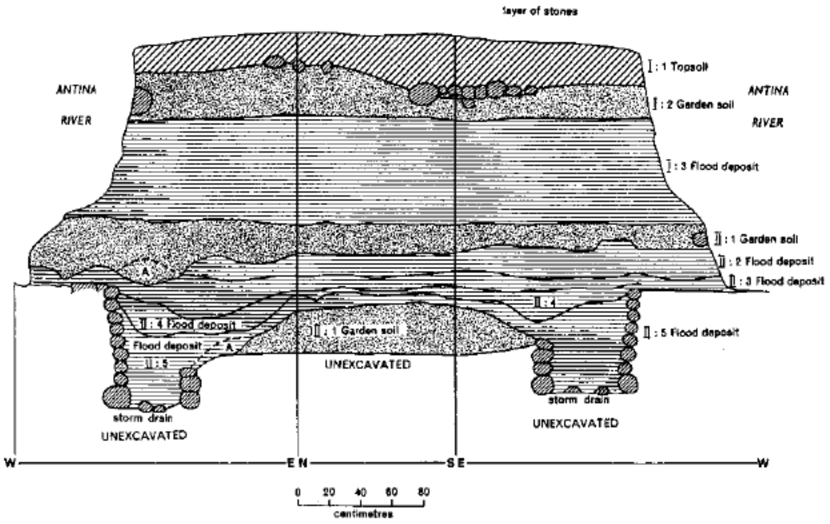

Figure 5.12 Stratigraphic sections, Pit 1, AT143, Antina River, Aneityum

early occupation by small groups was less intensive, as land was not in short supply. These groups could respond to problems of land degradation and catastrophic flooding by moving elsewhere. Later on, with greater subsistence and social demands (see Brookfield 1972) in evolving chiefdoms, this option was no longer possible. In addition, a greater labor force was available to repair and/or rebuild agricultural systems damaged by human-accelerated erosion and deposition. The upper parts of alluvial sequences often reveal several rebuildings of irrigation and other garden systems, at intervals not distinguishable from each other by radiocarbon dating. It was these intensive valley agricultural systems that often formed the economic base for evolving chiefdoms in the region (Spriggs 1986, 1990).

DESTRUCTION OF THE INSHORE ENVIRONMENT

Perhaps more important than the denuding of hillsides in the creation of the valley-floor agricultural systems were the effects on the near-shore and reef environments. The most direct result was the physical covering of former embayments or reef flats. On small islands this would have had an important effect on the availability of reef resources. On Tikopia, for instance, the result of human-induced erosion combined with natural inputs was a reduction in total reef area by 41% (Kirch and Yen 1982). Suspended sediment from runoff would have had a deleterious effect on reef growth in inshore waters as well. One would need to have an idea of reliance on marine resources by the inhabitants of particular islands before and after phases of erosion in order to put an economic value on the loss of marine resources. A feedback seems quite possible between degradation of the marine resource base and development of the terrestrial economic base: a decrease in the marine resource as a result of erosion caused by agriculture would necessitate a further intensification of agriculture, leading to further effects on the marine environment.

Late shifts toward greater exploitation of pelagic fishing grounds after early reliance primarily on inshore reef fishing have been noted in some island groups. Green (1986) points to an almost exclusive reliance on inshore fish at Lapita-period sites, in contrast to more varied fishing strategies and fishing for pelagic species later in the archaeological sequences. Kirch and Yen (1982:289–90) note that coral reefs have a substantially greater biomass than benthic and pelagic communities. The quest for deep-sea fish may have been at least in part necessitated by a deterioration of the inshore reef environment. The development of fishponds and aquaculture in Hawaii (Kikuchi 1976) may also have some connection to such factors.

CATASTROPHE AND ENHANCEMENT

Here and elsewhere I have argued that what has previously been argued as "landscape degradation" in the Pacific can often be viewed as "landscape enhancement," in terms of an island's capability for feeding its human population. Many of the issues that allow for judgment as to whether land degradation has occurred are detailed in Blaikie and Brookfield's book on the subject (eds., 1987). Starting from a definition of degradation as "a reduction in the capability of land to satisfy a particular use" (1987a:6), they note that this is context specific. A shift from hunting and gathering to agriculture brings into relevance a different set of intrinsic qualities in an area of land that may be more capable or less capable in the new context.

Blaikie and Brookfield also discuss the issues of time lags and temporal scale (1987b:66–68). I earlier raised the question of whether what we can now see as long-term benefit, such as the creation of alluvial coastal plains suitable for intensive agriculture, would be perceived in the short term of a human life as land degradation: erosion of hillsides, dumping of flood-borne sediment on valley floors, and so on. At this scale radiocarbon dating does not help, except to point out that several episodes of flooding and rebuilding of agricultural systems can be identified on various islands over periods of a few hundred years. Long-term deleterious effects on the agricultural system do not appear to have resulted from flood episodes.

At the ethnographic, short-term scale, events such as landslips whose initial effect can be to destroy crops and trees may also be viewed in a positive light. They potentially add to the total gardened area, especially where there is a slumping of cliffs as described by Kirch and Yen: "Various economic trees were buried under debris in two affected areas, estimated at 3 and 2 ha. An informant—while acknowledging that it was fortunate that one of the landslides stopped just short of the highest house at Paepaevaru village—was more concerned with plans to try plantings of *taro* or *ango* (turmeric) on the 'new' land" (1982:148). Kirch and Yen (1982:43) also note that the two largest taro gardens they observed in 1977 were on old landslips of some 15 to 25 years earlier.

There are also cases where catastrophic erosion is not simply taken advantage of but is purposefully induced. "Hydraulicking," the shifting of soil and gravel by the release of impounded water, is a commonly used technique in irrigation-terrace construction and repair in the Ifugao area of Luzon in the Philippines. Conklin describes how "hundreds of meters of temporary canals and ditches may be dug across house terraces, hillsides, and even through other pond fields so that artificial streams can transport rock and gravel fill as well as earth and soil to new terrace levels" (1980:16–17). Similar techniques are known from the Americas and are reported as part of stone-ax quarrying techniques in the New Guinea Highlands (Spores 1969:563; Vial 1940:159). Such techniques would have been eminently suitable for the construction of terrace systems in the Pacific, requiring only a mimicking of processes easily observed in nature. They are not, however, remembered or used in Pacific communities today so far as I am aware.

I conclude that changes to the landscape, although sometimes dramatic at the level of individual events, such as landslips or flood-borne deposition, were expectable, controllable in their effects, and to an extent channeled toward particular outcomes. Blaikie and Brookfield note that not all human impact increases degradation, and they view it as "an equation in which both human and natural forces find a place" (1987:74). Their formula for assessment is: net degradation = (natural degrading processes + human interference) − (natural reproduction + restorative management). The numerous examples that one can cite of terracing, storm drains around and in gardens, stone lining of rivers to control their courses, planting of trees to stabilize dunes and shorelines, and so on, speak to the many responses of populations in the Pacific to potential degradation. In all but a few cases, Easter Island being the most notable (Flenley and Bahn 1992), the landscape changes that humans induced created conditions for continued growth in agricultural production rather than putting such growth at risk.[7] Given a large labor force, the floods and landslips that on occasion buried their gardens may have been seen as opportunities for extension of the gardened areas, with the soil refertilized by the influx of sediment. There is at least no evidence from the archaeological sequences of any long-term disruptions caused by such events.

POSTSCRIPT: THE WEST DISCOVERS THE ENVIRONMENT

Until comparatively recently it was often assumed that small-scale non-Western societies in regions like the Pacific were so much a part of their natural surroundings that they were very like the other fauna and the flora of the region, and their presence did not alter the natural equilibrium or balance of the islands (see Chapter 1). These populations were seen as representing Rousseau's *homme naturel*, man in a state of nature, "noble savages" in harmony with the environment, in contrast with "civilized man," who had somehow fallen from grace and so was out of step with the environment. It is a romantic notion, a viewpoint informed by the biblical view of the Fall, and it also allows for considerable paternalism and exploitation with regard to the supposedly childlike indigenous populations.

I find it significant that in independent Pacific nations people find it easy to live with the idea that their ancestors, and frequently they themselves, actively altered their island environments. Although these Pacific Islanders often manage their resources wisely, it seems inappropriate to attribute to them a traditional, self-conscious conservation ethic of the kind that has developed strongly in the West since the 1960s and 1970s. In terminally colonized Pacific countries that have been heavily affected environmentally by immigrant populations, people often talk of a golden age before the arrival of the "white man," when their ancestors lived in harmony with the environment. They profess that their ancestors did indeed have a strongly developed conservation ethic, which the West is only now catching up on.[8] In such places—Hawaii and New Zealand (Aotearoa), for example—if evidence is presented that the indigenous inhabitants had in fact had an impact on the environment, the news is greeted with angry denial by native activists and a certain degree of glee by the media. The implication of reporting in the media is often that although the environment has been altered (!) by Westerners, this is acceptable because the natives had already ruined it, thus weakening claims for indigenous land rights and the self-respect of the native community, or at least respect by nonnatives.

Although it was clearly the case previously that because they were "innocent" the indigenous populations could justifiably be dispossessed of their land, the new message is perhaps that because they are not so innocent after all, they deserve all they got. Thus "liberal" guilt is assuaged.

An example is press coverage of a dispute in Australia over the proposed mining of Coronation Hill in the Northern Territory, opposed by Aborigines, who are said to believe that impact on an area they hold sacred will disturb a Dreamtime creator-being and bring about a catastrophe. A report on the Aborigines' claim and in particular on the findings of anthropological consultants has been summarized and quoted by the *Melbourne Age* (22 April 1991): "It [the report] says that according to the mythology of conservationists, hunting and gathering people such as the Aborigines had a special association with the wilderness. 'But there is little substance to this myth . . . in fact, Aborigines played a major role in altering the Australian environment,' the report says. 'They probably contributed to the extinction of many species of large animals.'" The report also describes Aborigines as Australia's first miners, "extracting flint and ocher from deep underground mines."

I do not mean here to criticize the quoted report by Ron Brunton of the Institute of Public Affairs (Brunton 1991) but to make the point that, in demonstrating the human element in environmental change in the Pacific during the past several thousand years, we must be aware of the political content and implications of our findings. Unless presented sensitively, they are likely to be seized upon by those with political agendas we may not have considered and may well not want to subscribe to. We surely owe the descendants of the people we study some consideration in guarding against misrepresentations of our findings that seek to deny indigenous people their dignity and their land.

Notes

I thank Patrick Kirch and Terry Hunt for soliciting a contribution to their session at the Pacific Science Congress. My attendance at the congress was partially funded by the Australian National University, and this chapter was typed in the Department of Prehistory (now the Division of Archaeology and Natural History) of that institution. The figures were drawn by Winifred Mumford and Ian Faulkner of the Australian National University, Canberra.

1. Some notable works, by no means an exhaustive list, include Allen-Wheeler 1981; Allen 1987; Beggerly 1990; Brookfield, ed., 1979, 1980; Flenley and King 1984; Golson 1977; Hope and Spriggs 1982; Hughes 1985; Kirch 1975, 1976, 1982, 1983, 1988; Kirch and Kelly 1975; Kirch and Yen 1982; McGlone 1983; Powell 1970; Schilt 1984; Spriggs 1981, 1985; Yen et al. 1972.

2. In this discussion I shall, like Blaikie and Brookfield (1987:26), duck "the difficult environmental-ethical question such as the extinction of endangered species, or conflicts between national parks and other human uses of the biome, where ethical judgements assume greater importance." Like them again, I have chosen in this chapter to see land degradation "in terms of the altered benefits and costs that accrue to people at that time and in the future."
3. Calibrated radiocarbon ages are presented in this paper using the CALIB computer program (version 2.0) of Stuiver and Reimer (1986). Unless otherwise indicated, dates are given as the calibrated range at one s.d.
4. Allen's statement that "while the ^{14}C date from Layer III (A.D. 1435–1665) overlaps the A.D. 1135–1435 glass date from Layer IVb, the A.D. 1490–1950 date from Layer VI is either in error due to the small size of the accelerator-processed sample or reflects disturbance" (1987:74) is a misrepresentation of the radiocarbon results. They overlap at one s.d. and so are essentially indistinguishable. There is thus no need to postulate any error in the Layer VI determination. Little reliance can be placed on volcanic-glass age determinations from Hawaii, given problems of source-specific hydration rates, effect of storage temperature, and lack of interlaboratory comparability in hydration measurement.
5. A date for a horizon supposedly equivalent in Trench 1A gave an unacceptably late date of 290 to 0 B.P. Allen notes that this layer is "a very sandy soil affected by groundwater" (1987:76, cf. 177).
6. Schilt's original report of excavations at site D10-12 suggested that the lower of two pondfield horizons (her Layer III) was related to a radiocarbon date that calibrates to 1297 to 1094 B.P. Stone waste flakes and bifacially flaked tools were found in this level. Layer II represented a flood deposit. From dispersed charcoal within a possibly equivalent layer came a date of 514 to 314 B.P., said to be associated with habitation activities. This and the alluvial Layer II deposit were overlain by an upper pondfield horizon, which was dated to late prehistoric and early historic periods on the basis of some stone artifacts found within it and historical records of the use of this area for irrigated gardening (Schilt 1980:60–61). Further excavations by Athens (1982) failed to confirm the early date for agriculture. Two pondfield horizons were again encountered in Athens's Trenches A, B, and C (Layers V and II in his more detailed stratigraphy). Three Layer V dates were all within the range of 302 to 0 B.P. Layer V and the upper part of Layer VI were associated with a stone-tool assemblage and three possible post molds, suggesting to Athens an initial precultivation use of the site for habitation, which had been disturbed by later pondfield use. It is likely that Schilt's early date was in fact associated with this disturbed-habitation component. If so, there is a considerable hiatus between first (habitation) and second (pondfield) use of the site. In Trench B a second date was obtained from Layer III.2, in between the two pondfield horizons. Athens rejected it as anomalously early, but it does in fact overlap at two s.d. with the Layer V date from Trench B. Schilt's Layer II date came from another part of the site, where only a single pondfield horizon (her Layer I) was present. It can be interpreted as a terminus

ante quem for pondfield agriculture, supporting its dating to the past 300 or so years.

7. The refutation of an oft-quoted similar but more extreme scenario for Easter Island in the case of Kaho'olawe in the Hawaiian Islands is detailed elsewhere (Spriggs 1991).
8. I base these remarks on personal observation of reactions to the proposition that indigenous Pacific peoples had altered their environments in conversation with villagers in Vanuatu and Papua New Guinea, compared to reactions among generally urban-dwelling Hawaiians and Maori. I claim no statistical validity for my sample, but I have witnessed the enjoyment of these villagers in setting large conflagrations in and outside their garden areas. Whether Hawaiians had such a traditional "conservation ethic" is a topic worthy of further research, particularly given the somewhat unique (for the Pacific) level of social stratification recorded at European contact. Does a particular kind of environmental consciousness follow from this, different to that in less-stratified parts of the region?

6

The Historical Ecology of Ofu Island, American Samoa, 3000 B.P. to the Present

Terry L. Hunt and Patrick V. Kirch

Thirty-five years ago Raymond Fosberg (1963:5) wrote, "It is clear that the arrival of man has invariably increased, to some extent, the degree of instability in these [island] systems. With the advent of modern man this increase has frequently assumed catastrophic proportions." At the same symposium in 1961, Cumberland (1963:191) pointed to early "Moa-hunters" in New Zealand as responsible for massive disturbance and modification: hunting and the widespread use of fire had driven several species of birds to extinction. In contrast, Cumberland (1963:193) argued, the Maori—then believed to be descendants of a second Polynesian migration to New Zealand—were conservationists and nowhere caused wholesale transformation of the environment or disastrous disturbance of the ecosystem. These and similar views expressed at the symposium pointed to an emerging paradox: Polynesians were seen as conservationists, yet island environments had been greatly transformed.

Archaeologists and natural scientists have learned a great deal in the Pacific through interdisciplinary research since the Fosberg symposium. Their studies document biotic and landscape transformations resulting in the past decade or two, independent research by anthropologists, archaeologists, biogeographers, and ecologists had led to little historical understanding of the long-term dynamism of island environments or of the critical role of human populations in shaping island landscapes.

One area that still requires much research, however, is that of prehistoric human population growth on islands, and the relation between demographic transitions and the anthropogenic transformation of island ecosystems. Gordon Wolman writes that "the absence of satisfactory historical information relating both land and population change to the many factors that influence both suggests the obvious need for comparative studies combining demography, land use, and environmental change" (1993:27). Again, because of the various advantages that islands offer, it may be that such comparative studies will be more readily carried out in island contexts. For example, paleodemographic research in the Hawaiian Islands is producing increasingly fine-grained reconstructions of the rates of prehistoric population growth, reconstructions that can be measured against paleoenvironmental evidence for human impacts through agricultural expansion and intensification (see Chapters 11 and 12), among other forms of human impact. Moreover, the rich ethnographic record of Pacific Island societies allows us to explore the social and ideational correlates of demographic change, such as various forms of population regulation, whether voluntary or coercive.

The past few years have been an exciting and stimulating period in Pacific Islands archaeology, paleoecology, and historical ecology, thanks to the heightened levels of cooperation and collaboration among scientists from both the natural and social sciences. We fully anticipate that the pace of research will accelerate, and we hope that future advances will contribute as much to contemporary efforts to comprehend the human dimensions of global change as to the historical understanding of how island landscapes came to be as we see them today.

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