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Terrestrial food production and land use in prehistoric Samoa: an example from Olosega Island, Manu'a, American Samoa

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Abstract

Samoan terrestrial production is vastly under researched archaeologically and few projects explicitly explore such a topic. This paper reports a food production system found in the interior of Olosega Island, one of three islands within the Manu'a group of American Samoa. This production system was part of a divided landscape, in which the residential was separated from the non-residential. This division was created by a large ditch that cuts across the landscape that was likely used for water diversion. Swidden horticulture was a key component in this production system, practiced upslope of the large ditch. Arboriculture occurred within the residential area downslope of the ditch. Such a production system illustrates the multiple paths cultures can take to increase production while staying resilient in their unique environment. The human population of Olosega utilized numerous ecological niches in order to minimize variance while also creating a productive food exploitation system.

Introduction

Agricultural landscapes are common archaeological features in Polynesia and have served as important research topics to explore many questions about prehistoric societies (e.g. Addison 2006, 2008; Allen 2001, 2004; Field 2002; Kirch 1975, 1994; Kirch *et al*. 2004; Ladefoged *et al*. 2003; McCoy 2005; Riley 1973; Rosendahl 1972; Tuggle and Tomonari-Tuggle 1980). However, one archipelago, Samoa, is well-known for its lack of identifiable traces of cultivation, even though it developed into a complex chiefdom comparable to many others in Polynesia (Goldman 1970; Sahlins 1958). Prior research in the archipelago has failed to identify large scale cultivated landscapes with substantial surface modification similar to other regions (Carson 2006:5), although isolated features are commonly found over the landscape (see Carson 2006; Clark and Herdrich 1988, 1993) and smaller scale modified landscapes have more recently been documented (e.g. Addison and Gurr 2008; Carson 2005; Cochrane *et al*. 2004).

In June of 2010, an intensive and extensive survey was conducted in the interior of Olosega Island, Manu'a Group, American Samoa over an area encompassing roughly 117 hectares. While archaeological remains had been documented in the area prior to this project (e.g. Hunt and Kirch 1987; NPS 1999), only minor recording had been accomplished and no systematic survey had been conducted. Thus, the primary goal of the 2010 project was to document the settlement system present on the island, both the archaeological settlement distribution and the prehistoric subsistence patterns extant on the modern landscape. Few projects in the Samoan archipelago have had such a focus (but see Carson 2006; Clark and Herdrich 1988; Jennings and Holmer 1980; Pearl 2006), and this is the first attempt at such a project on the small islands of the Manu'a group.

A horticultural system found in the interior of Olosega Island is reported here (see also Quintus 2011). By combining present day environmental data with archaeological data obtained during survey, a picture of the late prehistoric production system on Olosega emerges, a picture which had been all but unknown except for speculation and isolated features. This survey identified a large ditch interpreted as a water control device. This ditch acts as a division in the landscape separating the main food production area from the primary residential area of the settlement. The subsistence system as a whole served to minimize variability in production, protecting against environmental and cultural perturbations. Although this work is preliminary in nature, its potential to contribute to a better understanding of prehistoric Samoan production is unquestionable.

Environmental and archaeological setting

Olosega Island is one of three small islands, with Ofu and Ta'u, which constitute the Manu'a group of American Samoa. Olosega is only divided from Ofu by a small channel, connected to one another by a bridge (Figure 1). Highly productive fringing reefs skirt Ofu and Olosega, with the most developed reefs situated on the south and west coasts. Prehistorically, these reefs provided resources that were an important component of human subsistence (Clark 2011; Nagaoka 1993), and continue to provide important resources for modern populations. Present villages are situated close to these productive reef zones. One freshwater marsh is located on each island, in Olosega Village on

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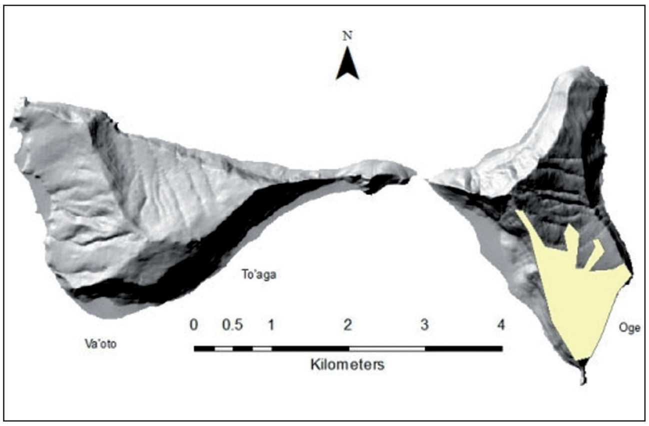

Figure 1. Olosega Island. Light shading indicates surveyed area.

Olosega and near Va'oto on Ofu. These marshes are used for taro (*Colocasia esculenta*) cultivation, a practice which Addison and Gurr (2008) suggest originated in prehistory.

Olosega is characterized by steep cliffs on the west side and broadly sloping land above near-vertical cliffs on the east (Figure 2). The highest point on the island, Piumafua Point at 629 masl, overlooks the western coastal plain which is presently occupied by Olosega Village. Much of the island formed as a result of pre-caldera volcanics consisting of thin-bedded olivine (Stearns 1944:1313); 500,000 years of stream and storm erosion have modified the landscape to its current configuration. Within the interior of Olosega, intermittently running streams are abundant and rainfall is plentiful. Thus water availability is normally not a problem today, neither for crops nor for the human population. Vegetation is dense and it consists of a variety of native and introduced plants with a stark division between vegetation types apparent in the project area (Liu and Fischer 2007), specifically a division between modified and secondary growth forest (Figure 3). The slope is high in much of the project area (over 20 percent in most areas), but flatter land is situated in the northeast corner. Soil primarily consists of Fagasa-Ofu silty clays formed from volcanic ash deposits (USDA n.d.), likely derived from eruptions on nearby Ta'u over the last 150,000 years. Although not prime for agriculture by American standards, this soil is well-drained and has the ability to produce crops. While steep cliffs impede the movement of people into the interior of the islands, the hike can be accomplished in a little under an hour.

Early settlement appears to have been concentrated on the coastal plains, in proximity of the highly productive reef zones (Clark 2011; Kirch and Hunt 1993). Over time there appears to have been an expansion into the interior of the island evidenced by late prehistoric remains in the interior of both islands, although no dated sequence is available (Quintus 2011). Late prehistoric remains on the coast are limited with isolated features lightly dispersed (Best 1992; Hunt and Kirch 1987; Kirch and Hunt 1993; Moore and Kennedy 1996; Quintus 2011; Radewagon 2006). The paucity of coastal sites dating to the late prehistoric period

Figure 2. Interior of Olosega Island.

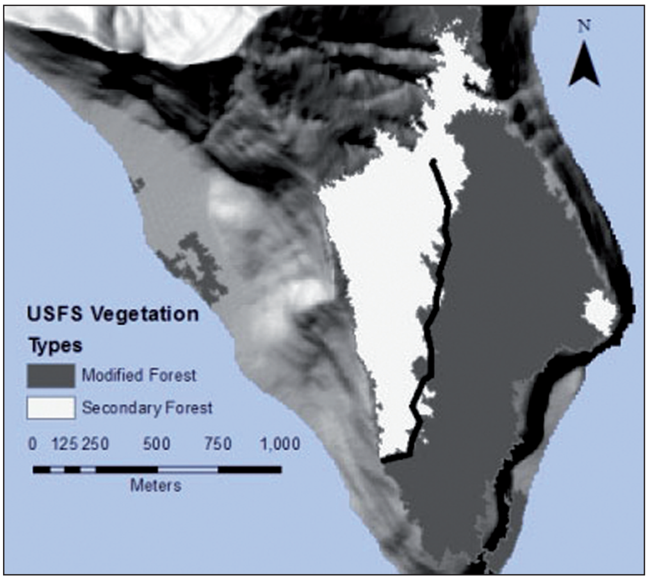

Figure 3. Vegetation map with Feature 38 dividing managed forest from secondary forest.

may be a reflection of the fact that researchers have focused on finding early sites.

Samoan food production

Ethnohistorically and ethnographically documented food production methods in the Samoan archipelago were based on some form of simple swidden horticulture and arboricultural gardens. Such documented production systems led many to characterize the system as being non-intensive, the vast majority of production being accomplished on a household scale (see Hiroa 1930; Carson 2006; Kirch 1994; Watters 1958). Even though swidden systems were the basis of the production system, variability existed with wet system cultivation and arboriculture also practiced.

Taro was the primary crop grown in Samoa, but other crops were also grown including yams (*Dioscorea* spp.), giant taro (*Alocasia macrorrhiza*), banana (*Musa* spp.), coconut (*Cocos nucifera*), and breadfruit (*Artocarpus* *altilis*). In many cases cultivated areas were close to habitations, usually directly inland of the settlements. However, as land was left in fallow and as cultivatable land became scarcer, area for cultivation was sought farther from the settlements on steep slope, while in other areas the environment dictated where production could occur. For instance, Hiroa (1930:545) states that the area under cultivation on Olosega is a considerable distance from the settlement requiring a long walk on a zigzagging path into the interior of the island. Plot size was dependent on the area available for cultivation and the needs of the family and community. Most plots were kept by individual families, though larger villages may have also had communal cultivation areas, especially on the larger islands of Savai'i and 'Upolu (Watters 1958:340). Traditionally, areas for plots were cleared using stone tools and fire. The area is burned only if needed to clear brush, cut plant remains are otherwise left to rot and used as mulch (Watters 1958:348). Planting was accomplished using a digging stick (*oso*) and a planting stick (*oso to*) (Hiroa 1930:545). At times, populations multi-cropped with tree crops (Carson 2006), which protects against failure due to crop-specific disease and pests by mimicking the natural forest growth.

On Ofu, Olosega, Tutuila, and Aunu'u, taro is grown in naturally occurring marsh lands that may have been manipulated in prehistory, the best example being the marsh on the island of Aunu'u (David Addison pers. comm.) (Figure 4). Estuaries, ponds, and drainages were also used on 'Upolu but whether human manipulation was involved is questionable. When taro is grown in these marshes, the growing season is reduced and tuber size decreases (Watters 1958:343). Other crops, primarily banana and sugarcane (*Sacharum officinarum*), are grown on the pathways separating wet-field sections.

Tree crops are also grown abundantly, specifically coconut, breadfruit, and banana. As aforementioned, some of these crops are grown in cleared swidden plots but the majority, especially coconut and breadfruit, are grown within the village area. At times, these trees are planted within stone circles to retain soil, a practice which may extend back into the prehistoric period (Carson 2006:13). These tree crops are a large part of the production system, yielding a large portion of the terrestrial food resources. Their role, which has received some attention by researchers in the archipelago (e.g. Misa and Vargo 1993; Tuitele-Lewis 2004), must not be underestimated since it may greatly affect interpretations regarding intensification and increased use of terrestrial goods over time (e.g. Addison 2006, 2008).

Figure 4. Olosega Marsh planted with taro.

Samoan terrestrial production is under researched archaeologically, probably because few substantial surface modifications relating to production have been identified in a specified area, though modified landscapes have been identified (David Addison pers. comm.; Carson 2005; Quintus 2011). Non-residential terraces have been found on slopes that may have functioned as workshop or temporary housing areas for people cultivating those slopes (Clark and Herdrich 1993:167; Quintus 2011:68-72). While these terraces may never have been put under cultivation, their presence possibly evidences horticultural expansion. Increased soil erosion in valley bottoms has been inferred to indicate increased use of surrounding slopes for cultivation, although such evidence is limited to just a few areas (Clark and Michlovic 1996:156; Hunt and Kirch 1987:113; Pearl 2006:62-64). It has also been suggested that modern practices, such as marsh cultivation and stone ring cultivation, have their origin in prehistory, though this remains untested (Addison and Gurr 2008; Carson 2006).

Water control has been suggested in few areas, and the reasons for that water control are variable in each case. On Tutuila, Adam Thompson interpreted features to be taro pondfields, but these are not well documented and their spatial extent is limited (Addison and Gurr 2008). Interpreted water control devices have been identified in Falefa Valley on Upolu (Ishizuki 1974:49), but this interpretation is questionable. Instead, these features, as described, may be morphologically similar to the ditched terraces identified on Olosega (Quintus 2011:83-84). Elsewhere in Falefa Valley, however, Davidson identified large ditches that were noted but not recorded at the time (Davidson 1974:157).

Few published examples of field systems with permanent boundaries have been documented. Those examples that have been described, most notably those on Tutuila (Carson 2005; Cochrane *et al*. 2004), are small and have been interpreted to be a combination of family plots. Other examples of modified landscapes have been identified elsewhere, but documentation is limited. For instance, pits used for cultivation have been found within lava rock on the Tafuna Plain of Tutuila (Addison pers. comm.).

AS-12-02

Situated on the broad slopes in the interior of Olosega, site AS-12-02 was first noted by Kikuchi in 1963 and formally given a site number by Jeffrey Clark in 1980. Kikuchi (1963) suggests its location to be defensive, but gives no details as to the size or nature of the settlement. Clark and Epi Suafo'a (NPS 1999) recorded a number of *tia'ave* (Star mounds) on the ridge top overlooking Olosega village, but again did not visit the primary portion of the settlement, although some terraces were recorded by Suafo'a and assigned site numbers. Likewise, Terry Hunt conducted a small reconnaissance survey in the interior and recorded a few features leading him to suggest that the site is likely to be quite substantial (Hunt and Kirch 1987:28-29). It was not until 2010, however, that an intensive and extensive archaeological survey was conducted, which recorded over 200 archaeological features dispersed over the southern portion of Olosega's interior (Quintus 2011).

Located within the site are abundant residential and non-residential remains, many of which are terraces. Even though a majority of these terraces exhibit signs of habitation, which include curbing stones, coral paving, and stone paving, some did not. The terraces with substantial coral pavings are found in the flatter areas, while terraces with no surface remains are more common in steeper areas, which may be a product of either erosion or their function (Figure 5). Terraces ranged in size and each size is present in most areas, though larger terraces seemed to be present only on the flat land on the eastern side of the project area (Quintus 2011:68-72). In addition, specialized feature classes, including star mounds and ditched terraces interpreted as ceremonial features because of their unique surface structures of upright coral and basalt and their bounded nature, were recorded.

The general distribution of features suggests a tiered political landscape which includes potential clustering and a central feature (Quintus 2011:73-75). Such a distribution has been documented on the islands of Upolu and Savai'i, but Olosega is the first settlement in American Samoa where clear indications of hierarchical leadership are present within the settlement pattern. The monumental architecture, in the form of star mounds, suggests the presence of a substantial labor force that could be called upon for public construction projects, but whether this labor force is comparable to the modern *aumaga* (untitled men) is unclear.

Because this project was focused on understanding the settlement pattern and layout of the site, no excavation was undertaken and, therefore, no datable material was recovered. Although an absolute chronology is unavailable for the site, artifact and feature types suggest habitation in the late prehistoric period. Limited excavation of star mounds elsewhere in Samoa, which were found in abundance on Olosega, indicates that they were primarily built in the last few hundred years before the historic period (Clark 1996). In addition, the lack of pottery and volcanic glass, combined with the presence of late adze types, suggests a later date.

Feature 38

Although a number of ditches were identified throughout AS-12-02, one stood out as unique. Feature 38 is a long ditch measuring between 1–3m in width and 1–2m in depth that cuts across the interior of Olosega (Figure 6). The feature originates on the ridge top overlooking Olosega Village and terminates in a stream-bed near the centre of the island, but variation exists. Near the ridge top the feature is quite wide at 3m and 1m in depth, while toward the termination point, the ditch narrows to 1m but deepens to 2m below the natural ground surface. Possible stone facing is present on the upslope bank, but these areas are few and the facing is difficult to identify. A stacked stone retaining wall, located on the downslope side of the lower bank, is present at the northern termination point (Figure 7).

At low points in the landscape, usually within stream-beds, the downslope bank of the feature is lost while the upslope bank is present and still clearly identifiable. Outside of these low points the feature remains morphologically a ditch, with two banks. When morphologically a ditch in low areas, channels are cut within the feature (Figure 8). These channels are between 1–3m in width and all but one is cut in the lower bank (Figure 8). The lone identified channel that is cut into the upslope bank is morphologically similar to the other channels, but is deeper.

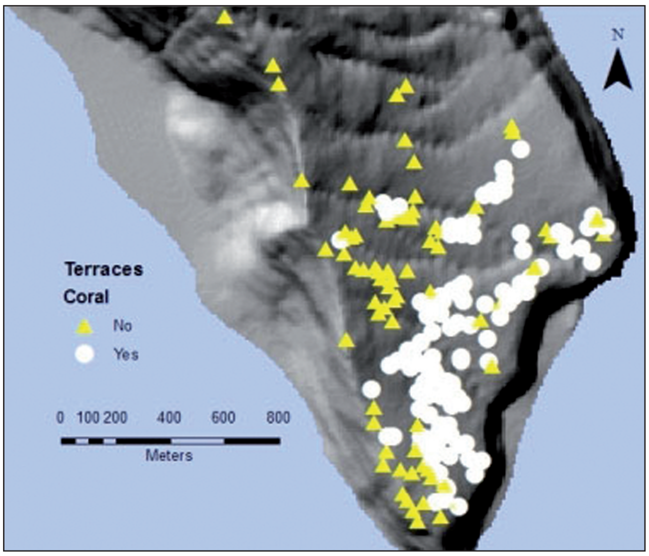

Figure 5. Distribution of coral remains on terraces.

Figure 6. Feature 38 near the ridge line.

Figure 7. Stone retaining wall near the northern termination point of Feature 38.

Figure 8. Channel cut into the bank of Feature 38.

Settlement layout and food production

The prehistoric remains present on Olosega are part of a divided landscape, one that separates the primarily residential from primarily non-residential; the village from the bush (Table 1). This division is created by Feature 38, which stretches across the south half of the island (Figure 3). This divided landscape can not only be seen in reference to the archaeological remains, but environmental evidence also suggests a significant division.

Downslope of Feature 38, flatter areas are common and terraces exhibiting evidence of residential remains were identified. Larger terraces, specifically those interpreted to have had a special function in the settlement, are located among these dispersed residential remains and every example of ditched terraces is located downslope of Feature 38. Environmentally, this area is characterized by managed forest vegetation, specifically referring to the amount of coconut, breadfruit, pandanus (*Pandanus tectorius*), and other economically important plants. Additionally, a small number of circular stone alignments was identified that may have been used as soil retention devices for planting.

Upslope of Feature 38	Downslope of Feature 38
Non-residential Terraces	Residential Terraces
Star Mounds	Ditched Terraces
Secondary Forest	Modified Forest
Severe Slope	Gentle Slope

Table 1. A divided landscape.

To the upslope of Feature 38, the area is characterized by heavily sloping land with dense vegetation cover. While terraces are present in the area, most do not exhibit signs of sustained residential use, but surface structures are present on some. These terraces are located near stream-beds, the density of terraces being much lower than that downslope of Feature 38. All star mounds, monumental platforms usually located outside settlements on ridges, are found on the ridge overlooking Olosega, all but three of the twenty-three located upslope of Feature 38. Vegetation in the area can be classified as secondary growth consisting predominantly of fau (*Hibiscus* spp.).

Because Feature 38 occupies such an important position in the settlement and is clearly a unique feature which is readily visible on the landscape, its function is important in understanding activity areas. Clearly, water moves through the feature as evidence of water erosion is common on the banks of the ditch and the channels cut within the ditch were likely used for water drainage. As noted above, the two vegetation types, managed forest and secondary forest, are separated by Feature 38 with the boundary being clear and defined.

Today, managed forests are commonly found throughout village areas, specifically in use as formal arboriculture gardens. Because this pattern is present on Olosega, it is probable that arboriculture was occurring downslope of Feature 38. Secondary growth forest upslope of Feature 38, on the other hand, was likely put under traditional swidden cultivation with terraces scattered throughout the secondary forest either being used for additional growing areas or temporary shelters, which has been suggested as a functional interpretation for similar terraces on Tutuila (Clark and Herdrich 1993:168).

The location of the ditch, and the nature of swidden cultivation systems, suggests that the feature may have been used to drain water and sediment away from the downslope arboriculture system and residential remains, eventually draining through the channels into the intermittent stream banks. Such a process would have potentially replenished nutrients within the stream-beds making cultivation in those areas more productive. Thus, although the ditch was used to divert water instead of to irrigate, such an activity may have inadvertently occurred.

Although no chronology is available, Feature 38's relationship with other features in the area suggests a relative chronology for the production system. It runs adjacent to many features in its path, but never cuts through another feature and is never built over by another feature. It is likely that Feature 38, therefore, would have to be built after many of the other features. This may suggest that erosion caused by upslope cultivation was a problem and a device was needed to protect the residential area from that erosion. If such a relative chronology is accurate, it suggests that the production system was already in place before the creation of the ditch, and the ditch merely acted to sustain the system.

In sum, the production system on Olosega is characterized by different components, namely arboriculture and dry-land cultivation. The arboriculture component appears to be primarily located within the primary residential area of the settlement, while swidden cultivation was practiced outside of this area. Given ethnographic evidence it is likely that multi-cropping occurred in the swidden gardens (Carson 2006:15), providing a necessary protection against disease and soil erosion, which resulted in a reliable harvest on average years. Additionally, the extent of the arboriculture system suggests its productivity was high and that it contributed significant foodstuff to the population. Through time, features were constructed (i.e. Feature 38 and the upslope terraces) that added to the productivity of the area and protected against extreme environmental degradation (i.e. erosional movement).

Discussion

The prehistoric peoples living on Olosega had a complex and intensive terrestrial food production system. While such a statement is warranted given the production system described above, such a system remains slightly different than elsewhere in Polynesia. For instance, no irrigated pondfields or large, bounded field systems are present on the landscape. Instead, the production system on Olosega is characterized by the use of multiple resources that are able to occupy a number of different ecological niches. The use of such a strategy is well-attested in Near Oceania (Latinis 2000; Terrell 2002; Terrell *et al*. 2003), but remains to be studied in great detail in Polynesia where large dryland field systems and irrigation networks receive the bulk of attention, though some exceptions can be noted (e.g. Addison 2006; Allen 2001; Kirch 1994). The system on Olosega provided resources to a developing political system, evidenced in the archaeology by centralized leadership and large habitation spaces, without clear indications of many known avenues of intensification.

The use of different ecological niches provided a risk management device in an environmentally unstable landscape that is susceptible to tropical storms and is without permanent stream flow. Tropical storms, in particular, have been known to cause significant damage to both tree and tuber crops in the Samoan Archipelago (Paulson 1993:45-47). Because these environmental perturbations were known, it is not surprising to see such a risk management system in place. As has been noted elsewhere in Polynesia (e.g. Addison 2008; Allen 2004), risk management played an integral role in sustaining the population by allowing that population to be resilient through various environmental and cultural perturbations.

Although important in understanding political formation, the idea of intensification has been overemphasized in comparison to other characteristics of changing production systems; a point alluded to by Leach (1999:321). Brookfield (2001) convincingly argues that changes other than those that may be classified as intensification, such as diversification and flexibility, may be as important in terms of their effects on the historical sequence but are commonly ignored or given only minor attention. Changing production and its effects on different aspects of society and environment cannot be understood by merely exploring intensification through time. For instance, on Olosega early settlement appears to have focused on the coast and subsistence focused on marine resources and low intensity horticulture (see Nagaoka 1993; Quintus 2011). The expansion of the population into the interior had the potential to bring about significant changes in the population dynamics given the opportunity for the expansion of cultivation systems and the diversification of the subsistence economy. The changes in subsistence economy on Olosega can be referred to as what Latinis (2000:43) calls "subsistence system diversification". New ways of producing are constantly sought as populations grow and expand in new areas adding subsistence flexibility and diversification.

Clearly, this is an example of what Leach (1999) would refer to as expansion and not intensification. Expansion, especially expansion of the sort seen on Olosega, produced many of the same results as intensification, specifically increased yields for a growing population using techniques and methods that required the need of innovative technology while increasing labor input. Certain innovations were not possible, specifically irrigation networks, even though the benefits of water control were likely known to the population (Addison and Gurr 2008). Ecological limitations produced developmental constraints in the production system which factored into the decisions of the human population to employ other techniques to maximize productivity, namely intensive arboriculture similar to what Addison (2006, 2008) has documented in the Marquesas. Such a situation allowed this production system to support a large population while only cultivating a fraction of available land (Coulter 1941). Prior researchers, most notably Hiroa (1930) and Watter (1958), described such a production system as being non-intensive, pointing to the lack of complex irrigation networks. Intensity, however, characterizes food production on Olosega and lack of irrigation does not correlate with lack of intensity in other areas of the system.

As Morrison (1994) and Leach (1999:321) argue, intensification and change in production systems is not the result of a single cause, but the result of a continuous process that includes a number of different factors that affect the cultural system in different ways and result in entirely different historical trajectories. Although population pressure, political development, environmental variability, and other factors may be more visible and may singly appear to cause changes to production systems, the cultural history of the area and the systemic relationships between different cultural characteristics drive change. Change in the Pacific cannot be understood through linear evolution alone, be it unilinear or multilinear, but needs to be examined through the lens of non-linear, dynamic systems approaches (see McGlade 1995).

Conclusions

Changes in terrestrial food production cannot be seen as a similar process in different regions, from simple to complex and from swidden to irrigation (Addison 2008; Leach 1999). Olosega is an example of why this is necessary. Because swidden horticulture remains the dominant form of cultivation, it has been characterized as less intensive and productive than other areas in the region (Hiroa 1930; Kirch 1994; Watters 1958). Examining this system within a complex systems approach illustrates the intricacies of the system that had not previously been documented. Specifically, the production system on Olosega is characterized by subsistence diversification that acted as a risk management device ensuring productive yields needed for the developing political systems evident in the settlement pattern (Quintus 2011).

Much work remains to be undertaken in the Samoan Archipelago, specifically exploring the systemic relationships between different facets of society and how each influences the others. Chief among these is the production system, which has received minimal research attention. Olosega is but one area, although it is the first area that has yielded information regarding the total production system. Vast amounts of land remain unexplored on the deeply dissected island of ‘Upolu, and it is likely that when these areas are examined, interpretation and preconceptions about the local production system will change immensely. Each island must be examined independently as different environmental and cultural influences are likely to have affected each area differently, giving each a unique subsistence pattern.

Acknowledgements

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