A Socio-Economic Analysis of Mangrove Degradation in Samoa

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Abstract: Urbanization and monetization systems have contributed to the reclamation and exploitation of mangroves, which have had some significant effects on the livelihood of those who rely on it. Informal uses of mangroves have received very little attention because they do not contribute to national revenue, and the inextricably linked effects of urbanization and monetary systems on mangrove degradation is lacking. The purpose of this study is to examine the socio-economic impacts of development on mangrove ecosystems and those who depend on it in four coastal villages of Samoa. Fifty households’ questionnaire-assisted interviews were conducted first, to provide the social, cultural and economic value of mangroves to the local inhabitants. Second, to identify activities that have changed mangrove ecosystems, and then, to examine how these activities have changed the local inhabitants’ social, cultural, and economic relationships with their environment. Findings suggest that, in two cases, land reclamation has strictly and seriously degraded mangrove resources particularly in terms of marine food supplies. For two other cases, increased accessibility to town and the monetization of the rural economy are also factors involved in the decline in quantity and size of fish catch due to the increasing reliance on sales of mangrove food resource for cash. This study supports the position that modern developmental initiatives must be carefully monitored to ensure that they do not undermine the social and economic well-being of resident communities, particularly in areas such as Samoa where a large proportion of the population relies on land and marine resources for their survival.

Key words: mangrove degradation, coastal reclamation, socio-economic analysis, Samoa

Introduction

Within the last two decades, the status of mangroves has elevated so rapidly that it has gained public attention in the face of a perceived impending global environmental crisis. Manifestations of this concern include extensive studies on Southeast Asian mangroves by Aksornkoae et al. (1986), Ajiki (2000), Ong (1982), and in the Pacific by Lal (1983), Thaman and Ravuvu (1989), and Thaman (1994). Most of the studies revealed that mangroves possess a very important function, which extends far beyond the geographical immediate areas they occupy, not only in sustaining their physical environments but also the human populations. Contrary to this view, the case studies do not reflect the consequences of mangrove degradation in the case of Samoa. Furthermore, informal uses of mangroves have received very little attention because they do not contribute to national revenue, and literature on the effects of urbanization and monetary systems being conducive to mangrove degradation is lacking.

Pressures on mangrove forest areas are often great because they may appear to be relatively low-cost sites for construction through reclamation for a variety of facilities as discussed by Kunstadter (1986). Problem in assessing the costs and damage control in the mangroves may be difficult because the consequences are often geographically and socially remote from the places where the decisions are made and the environmental interventions take place. In effect, development strategies encouraging mangrove destruction through reclamation creates poverty among those who are overlooked but whose social, cultural, basic subsistence and economic livelihood is dependent on these ecosystems. This is what the author regards as inappropriate development.

At the turn of this century, impact studies concerned with social, cultural and economic effects due to over-fishing in mangroves or conversion of mangroves to other land uses are
addressed and confined only to public symposiums with intentions to discuss sustainable measures of mangrove use. Recognizing that the impacts of the decrease in mangrove forest will lead to flooding—affecting development projects—and a decline in fish catches, timber, firewood and charcoal production, it is not surprising that they are only evaluated as being economically devastating to national economic returns. Redclift (1987: 49) argues that it should be remembered that those who are concerned with the fixed limits of resources are the 'urban bureaucrats' who are more concerned at the cost to the quality of their life posed by flooding, pollution, industrial waste, food poverty, and particularly profit reduction.

Just recently, in Teruya and Kishimoto (2000) for instance, reforestation schemes are promoted because Thailand mangrove forests has decreased due to over-logging for charcoal and firewood production, and conversions into shrimp cultural ponds and tin mining. Fleeting references were made to those informal socio-economic variables without monetary value, which are always indiscriminantly misrepresented in these formal figures. Furthermore, exploitation and conversion of mangroves by capitalists are promoted by government public policy as in the Southeast Asian cases (Aksornkoae et al. 1986; Ajiki 2000; Ong 1982). Pursuance of economic development poses a contradiction to sustainable development as expressed at the symposiums.

Symposium documents as such, adequately review the promotion of economic development through deforestation and conversion of mangrove forests, which is the principal factor behind mangrove degradation particularly in Southeast Asian countries. Therefore, inadequate studies attribute mangrove destruction to be inextricably linked to the forces and the global expansion of urban and monetization systems. As Redclift (1987: 4) puts it 'the environment has suffered more neglect at the hands of social scientists than any other comparable subject.' In the absence of theoretically refined work on environmental issues, when geographers enter the field, they have been content simply to collect data, and to provide criteria for land use classification. Thus, available studies on impact on mangrove environment are divorced from social and economic theory. Evidently, mangrove literatures are abundant, from physiological, taxonomical, geomorphological nature to biogenic researches extensively conducted by Chapman (1976), MacNae (1974), and Saenger et al. (1983), and in the case of Samoa, Nakamura (1992), Liu (1992), and Taule’alo (1993). Studies concentrating on socio-economic impacts have been limited and therefore academics' contribution in minimizing mangrove destruction has made little progress.

On a more optimistic note, attempts at discussing how ecologically destructive it is to convert mangroves through aquaculture economic ventures have been conducted in Malaysia by Ong (1982). One attribution to this is the reconnaissance of ecological theoretical paradigms, which has given rise to environmental, social, cultural, spiritual, and economic variables in relation to the survival of natural ecosystems in synergy with humans, likewise, the importance of mangrove ecosystems to those who depend on it. Studies conducted within these parallels include Thaman (1994), Thaman and Ravuvu (1989), Olson (1997), and Bird (1986) within the Pacific, and Silva (1986) in Sri Lanka. An impact research study on particular social, cultural and economic aspects in relation to the converted land uses of mangroves upon the lives of those who dwell in and live from them is needed to clarify these relationships. In considering the absence of an adequate methodology in the literature reviewed above, it is only appropriate that at this point in time an evaluation of how mangroves can be recognized as a beneficial and important ecosystem to the livelihood of the coastal communities be undertaken. Following this, an assessment is provided on the residents' socio-economic effects on areas where development activity has occurred, degrading mangrove areas.

The basis of this research can be a methodological means of showing how developers should manage and conserve mangroves for the well-being of the indigenous people who rely on them. Cox and Elmqvists (1982) argue that this is a way towards sustainable social, economic and environmental development. The purpose
of this study is to provide an analysis of mangrove degradation in four coastal villages of Upolu Island in Samoa: Pata, Sataoa, Vaitoloa, and Fugalei. Development activities have been undertaken without prior assessment of their potential impact on the mangroves, therefore the author hypothesizes they have effects on the livelihood of mangrove-dependent communities. Mangroves' natural ecosystems will be proved as an important foundation for the social, cultural, and economic activities of coastal communities. In transforming mangrove ecosystems through modern activities, and in polluting them, villages' livelihood becomes threatened. Since Samoa is not well endowed with mangroves, it is imperative to identify the social and economic importance of mangroves to the Samoans and then to evaluate and understand the effects of deteriorating mangrove ecosystems so as to minimise further destruction.

Background to Samoa

Location, population, and landform

Samoa, which forms part of the Samoan volcanic archipelago, lies in the South Pacific Ocean (Figure 1). The total land area is approximately 2,800 sq km and its two main islands are Savaii and Upolu. In 1991, Samoa had a population of about 160,000 residing mostly on Savaii (45,000) and Upolu (116,000) where the capital of Apia is located (GWS 1991a). Eighty percent of Samoan land is customary owned, while only fifteen percent is private land. The remaining land is government owned (GWS 1990).

Geologically, Samoa is relatively a young volcanic island country controlled by five distinct volcanic episodes (Wright 1962). Each episode has produced extensive lava flows cascading seaward from high volcanic cones characterized by Upolu's central highlands, which gradually decline towards the coast. Upolu is densely populated particularly on these fertile and flat coastal areas, where swamp and mangrove communities are a common feature in drowned valleys and barrier impounded river/stream mouths. The high population density of about 742 person per sq km, along the coastline, has placed increasing pressure on coastal areas for the destruction and reclamation of mangroves for residential housing, road expansions, buildings, industries, and businesses (Taule'alo 1993).

Climate, soils, and vegetation

Southeast trade winds, specifically dominant atmospheric circulation features of the South Pacific Convergence Zone (SPCZ), makes Samoa's climate generally hot and wet throughout the year (Curry 1962). Average annual rainfall varies from 2,500 mm to over 6,000 mm in the highlands, while mean annual tempera-

Figure 1. Location and relief map of Samoa.
Source: The contours were quoted from Ward and Ashcroft (1998: 10)
Vegetation characteristics of Samoa.

The vegetation communities represented here are only a schematic sketch of the five vegetation categories from all over Samoa, illustrating that the highlands are affected by southeast trade winds of more than 80 and 50 per cent of the time during the dry and wet season respectively. Lowland vegetation occurs on almost all coastal areas of Samoa including the:

1. **Littoral vegetation** having four types of plant communities: the herbaceous strand or beach; littoral shrubland; *pandanus* scrub; and littoral forest.

2. **Wetland vegetation** includes five communities: coastal marsh, consisting of herbaceous wetland situated on the coast; montane or mountain marsh, occurring in montane craters and depressions; mangrove scrub dominated by 'togo fafine' (*Rhizophora mangle*) which are small sized trees; mangrove forest dominated by the 'toga tane' (*Bruguiera gymnorhiza*), which are large trees forming closed canopy forests; and swamp forest situated where fresh water saturates the soil. They occur on the west coast for example Pata, Falelatai, central north and south coasts of Vaisusi and Safata bay, and in Apia coastal regions.

3. **Rainforest vegetation** has five communities: the coastal, lowland, ridge montane and cloud forests.

4. **Volcanic vegetation** comprises lowland and upland volcanic scrub.

5. **Disturbed vegetation**

Source: Adapted from Taule'alo (1993: 13).

Soils of Samoa are formed from basalt, most of which are generally clay in texture, free draining and relatively shallow (Wright 1962). In the coastal areas, marsh soils are not extensively found in Samoa, but where they occur they are inundated by sea at high tide, which supports mangrove forests such as those on reef and lagoon systems, including mangroves (SPREP/EAJ/OECC 1993).

Temperatures range from 20 to 30 degrees Celsius at the coast. A distinctive dry season appears from May to October, and two major cyclones within the last decade have caused widespread destruction in Samoa in the rainy season. The cyclone damages have had disastrous effects on loss of biodiversity for some period of time within the conservation areas, catchments and have resulted in increased soil and coastal erosion on reef and lagoon systems, including mangroves (SPREP/EAJ/OECC 1993).
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Whistler (1992) categorised six vegetation types illustrated as in Figure 2: littoral, wetland, rainforest, upland scrub, volcanic, and disturbed vegetation. Mangrove scrubs and forests are part of the wetland community dominated by the Togo fafine (female mangrove) or Rhizophora mangle and the Togo tane (male mangrove) or Bruguiera gymnorrhiza. Although it has been stated that much of the mangrove ecosystems had been disturbed by human activities, an accurate estimate of the total area that has decreased over the last century is unavailable, which is a manifestation of its negligence.

Social economic situation

Like many South Pacific Island nations, Samoa has endeavoured, since independence, to develop a modern economy and to diversify from traditional village agriculture and primary products. However, seventy to eighty percent of Samoa's population are still rural based and rely upon a subsistence lifestyle (GWS 1990). Primary economic resources in rural villages include: fish and shellfish caught in lagoon, reef and mangrove areas; coconuts, bananas, yams and breadfruit from plantations; domestic animals; and other produce from household gardens, with the majority of resources harvested by villagers becoming part of the village subsistence economy (GWS 1990; Fairbairn 1993). The balance of the primary resources is sold in Apia, forming part of the cash economy (Zann 1991).

The significance of the primary sector is shown by the fact that related activities account for 50% of the Gross Domestic Product (GDP), 60% of the workforce, and 80% of export earnings of the national economy (World Bank 1991). In this respect, Samoa, since European contact, is no longer a society of self-sufficient local units (Meleisea 1988). Imported food and other items are now established as basic household necessities. These changes are reflected in the way locals use the mangroves for both subsistence and for earning cash. Cash income is used to purchase some of what are now basic necessities such as soap, sugar, tea, flour and other foodstuffs.

The Status of the Mangrove Environment in Samoa

The mangrove ecosystems of Samoa

Samoa mangroves are at the eastern limit of the Indo-Pacific mangrove distribution and are confined to a few suitable places where sand spits cut off stretches of shore and terrigenous sediments accumulate in swamps, or in sheltered rivers and stream mouths in the coastal areas of Upolu (Lafaele 1993; Park et al. 1992; Vodonaivalu (undated); Whistler 1992). There are two dominant mangrove species—Rhizophora mangle grows at the seaward edge with canopies ranging from 5 to 10 metres, and Bruguiera gymnorrhiza is more common inland and grows up to 15 metres or more (Sasaki 1992). Other exclusive mangrove related species are appended in detail in Vodonaivalu (undated), Whistler (1992), and Lafaele (1993).

Within the two large mangrove areas of Vaipus Bay and Sataoa-Saanapu of Safata Bay, Thollot (1993) found thirty-five species from about twenty-two families, predominantly mullet catches of Liza melinoptera. In Sataoa-Saanapu, there were five dominant species-Chanos chanos, Therapon jerboa, Caranx papuensis, Upeneus vittatus, and Liza melinoptera. These species have also been commonly recorded in mangroves of other South Pacific countries such as Vanuatu, Fiji, New Caledonia, and American Samoa.

Mangrove utilization and modification

Mangroves provide: food; firewood and charcoal; timbers for boats, poles for fish traps, pipes, and tool handles; dye and tannin; and medicinal herbs for the local inhabitants (GWS 1994; Thaman 1993; Whistler 1996). However, Samoa's mangrove environments are undergoing considerable modification which threaten the elimination of mangroves for traditional uses (Nakamura 1992). As early as the 1960s, Cumberland and Fox (1962) reported mangrove deforestations and reclamation for settlements, while Richmond (1991) recorded the reduction of almost all mangroves due to harvesting by local inhabitants for firewood use. East of Apia, at Moataa, a major portion of its mangroves...
was also reclaimed in the early seventies for the purpose of constructing a major hotel (Polu 1994). The area is now barren and deserted, and in a FAO/UNDP fisheries survey by Zann (1991), this reclamation resulted in a rapid decline in mullet (anae) finfish catches, which the local inhabitants relied upon as a major source of food. A more important effect has been the loss of the mangroves as a barrier from cyclones and destructive storm surges.

According to Liu (1992), about five percent of Vaiusu mangrove area has also been converted to other uses and most of the remaining stands are severely disturbed by adjacent and on-site land use conversion, rubbish disposal and consequent pollution. Furthermore, the second largest Government expenditure is in infrastructure improvement such as road construction in which mangroves situated along the coasts are destroyed to build roads, evidenced by the main road running from Apia to all inland areas (GWS 1992; SPREP/OLSS 1993). The destruction has encouraged widespread erosion on the coastal areas through direct wave attack, shoreline adjustment, sand mining and poorly designed sea walls (Zann 1991).

In view of the significant role that mangrove communities have on coastal productivity, it is clear that one of the main reasons for the low fish yield (28 kg/ha/yr) of the urban reefs of Upolu is the indiscriminant development and degradation of associated urban mangroves. Given the small community and limited range of species of mangroves, the destruction of these ecosystems will be economically devastating, given that seventy to eighty percent of the population still rely on fish as a source of protein (Zann 1991; GWS 1991b).

Growing awareness of mangrove degradation and its effects

Despite low population growth of about 0.6%, limited industrial and mining activities on Upolu, signs of mangrove deterioration are progressing. Early in 1994, public concern was expressed in a petition signed by over 800 concerned residents and environmentalists' society, Siosiomaga Society (Polu 1995: 13). The petition, which called for a halt to the development and destruction of the mangrove swamps, was ignored. Fugalei region proceeded to be subdivided and sold with plans to construct a road through Vaitoloa in Vaiusu Bay to serve the anticipated settlers on the new subdivision.

Land lying below high water mark, including mangroves is public or government owned land and this gives them the authority to halt the destruction or construction that is taking place. Yet, instead of ordering the cessation of large-scale reclamations in the Fugalei regions, the government declared the Sataoa-Saanapu mangroves as a reserve. This region is susceptible to low levels of degradation whereas the destruction at Fugalei is intense. In fact, the Sataoa-Saanapu conserved mangrove area is a follow up of a local environment Conservation Area Scheme funded by the Global Environment Facility under the South Pacific Regional Environment Programme in Apia as a South Pacific Biodiversity Conservation Programme. This scheme, administered by the Lands and Environment Department, is to preserve the mangroves' biological diversity as attested by the World Convention on conserving Biological Diversity at the Earth Summit, in Brazil, 1992.

The government, being more interested in fueling economic growth, extended this agenda to capitalise on the project by developing the area as part of an eco-tourist project for the Samoa Visitors Bureau. It was considered that in this way, attempts to preserve mangroves could also generate income for the local inhabitants.

Other attempts at inculcating awareness of the importance of mangroves are already progressing. Colourful posters published by the SPREP are available as educational resources for primary and secondary schools, to support environmental education agendas incorporated into the social studies and geography curricula. Strangely, despite these concerns, planned schemes to destroy mangroves are increasing. There is a need to review environmental legislations regarding mangroves otherwise they will always be vulnerable to any form of exploitation.

So far, efforts toward conserving mangroves are currently merely token gestures purporting to participate in the international awareness of the fragility and preciousness of the environment. Genuine efforts at protecting the man-
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The mangrove environment can be carried out if only those in positions of power empathize with those whose lives are dependent on the mangroves. Making an inventory of the country's mangroves is not enough. Thus, if the elimination of mangroves continues, sustainability and survival of subsistence societies like Samoa will seriously deteriorate and poverty levels will increase. The importance of understanding the impact of development on the mangrove ecosystem cannot be overstated since it is the first step in working towards minimizing their destruction.

Method of the Study

Surveyed locations

The areas selected for this study have the largest mangrove concentration, but ones which are susceptible to destruction and exploitation. Selection of Fugalei and Vaitoloa sites was based on the need to find out if such development related projects have had adverse effects on the local community. They were then compared to areas of Sataoa and Pata with relatively limited mangrove destruction. Each of these villages has experienced different levels of degradation as outlined in Table 1.

Fugalei, which lies in the heart of Apia, reflects mangrove degradation resulting from land reclamation into increased residential and commercial settlements in the transforming periods from years 1983 to 2000 in Figure 3. Most of the settlements are now turning into shantytowns, and there is flooding due to obstruction of the mangroves through landfill for the new commercial activities. The relocation of the new market recently has led to health hazards from the overflow of septic tanks (Polu 1995). According to the leader of the Siosiomaga Society, an environmentalists' group, these problems are evident of improper planning on the part of the local authority (To'o 1996).

In the same vein, Vaitoloa is an area subjected to various forms of pollution. In the early 1970s, it was a refuse and waste disposal site for the urban residents of Apia, and pollutants flowing from the Vaitele industrial sites. A fishpond had started but was abandoned. Although the dump is closed to further dumping, by reclaiming it as shown in Figure 3, secondary growth of different plant species are currently colonizing and depleting the mangrove area, thus changing the breeding grounds for marine organisms that use to grow and live there. Vast swamps have also captured the area and settlements have grown sporadically.

Conversely, Pata is a rural site subjected to limited degradation but was selected to provide an assessment of the full potential of an undisturbed mangrove area therefore there are no alterations in terms of the areal extent of mangroves in these two areas as depicted by Figure 4. Sataoa mangrove site is an eco-tourist reserve established in the early 1990s.

The respondents and questions

Interviews in Samoan language and a reconnaissance survey were conducted on the most experienced fishers in the village, chosen in the course of casual conversation, during a house-to-house survey about the role mangrove play in their lives. Selection of the respondents was acquired from asking 'who are the best fishermen in the village?' Most of those fishermen referred to by the contacts were the elderly people and the heads of the households known as matais or chiefs who were thought reliable in the provision of the responses. Selection of the best fishers is an approach that is deemed effective by other scholars. Johannes explicitly stated that "for the marine environment of the tropical Pacific Islands it is the local fishermen who possess this knowledge" (1982: 258). Local fishermen's traditional knowledge and skill "constitute an encyclopedic reservoir of practical sea lore of a stupefying richness" (P. Ottino and Y. Plessis (1972) quoted in Johannes (1982). Kundstadter (1986) also observed that if mangroves deteriorate, it will be the fishermen, not the mangrove developers, who suffer directly from the loss of spawning grounds of the mangroves areas, converted for economic gains. However, some of the other family members interviewed had some contact with the mangroves through other mangrove-related activities. This approach of using traditional knowledge facilitated the identification of appropriate
Figure 3. Mangrove distribution in the study areas of Vaitoloa and Fugalei, Upolu Island, Samoa in 1983 and 2000.
Source: Map 1983 was adapted and compiled from N.Z.M.S 174.3rd edition, May 1983. Published by Department of Lands and Survey, Government of Western Samoa by arrangement with the Surveyor General of New Zealand. Map 2000 was adapted and compiled from Topographic Map Samoa-U1 Upolu West. Published by Lands, Survey and Environment. Apia, Samoa.

Table 1. Activities influencing different levels of degradation in the selected study villages of Pata, Sataoa, Vaitoloa, and Fugalei of Upolu Island in Samoa

| Activity                | Pata   | Sataoa  | Vaitoloa | Fugalei |
|-------------------------|--------|---------|----------|---------|
| Land reclamation        | Low    | Low     | Low      | High    |
| Shanty towns            | Low    | Low     | Moderate | High    |
| Refuse & waste disposal | Low    | Low     | High     | High    |
| Pollution               | Low    | Low     | High     | High    |
| Eco-tourist development | na     | a       | na       | na      |

*a: available
*na: not available
subjects who had either current use of the mangroves, or have had some interaction with the mangroves sometime in their lifetime, even if they no longer have the use of it.

This study, which was conducted in December 1995 to January 1996, was largely based on a survey of the behavioural responses of people in relation to mangrove degradation and other uses. In the sites, fifty households were surveyed and in the urban mangrove villages of Fugalei and Vaitoloa a higher proportion of fifteen households were investigated since they were the major mangrove areas affected by urban development, through reclamation, believed to be the main factor causing mangrove destruction. Ten respondents were interviewed from the rural areas of Pata and Sataoa, assumed unaffected by development, and serving as a means of control for the purpose of this study. The questions asked were categorised in the following three sections of A, B, and C described below.

Section A involved the respondents’ sources or means of income, investigated to identify the degree of reliance of the respondents in the selected mangrove sites. This represents what Walsh (1996) terms ‘background information.’ Questionnaire-assisted interviewing was conducted through casual or informal conversation (on a one-to-one basis) in the vernacular tongue of the respondents.

Section B concerned the respondent’s knowledge of the activities relating to the utilisation of the mangrove and an analysis of the changes that may have existed in the times devoted to these uses. Information gathered was also based on the knowledge of the finfish and non-finfish species found in the mangroves. The proportion of catches sold or distributed, and changes that have occurred, changes in average catch in finfish and non-finfish organisms found in the mangroves, and changes in abundance or size of these products were also collected. Development-related activities, which have affected these uses in a negative or beneficial way as imposed on the people and the mangroves were also queried. It was hoped that the responses to these questions would provide a picture of the impacts of mangrove reclamation and other development on the livelihood of the villagers.

Section C included an open-ended query on any further comments or opinions of the respondents regarding the mangroves and devel-
opment related activities.

Results and Discussions

Residents' awareness of mangroves

Since on average 54% of the respondent no longer use the mangrove resource, the focus here is to discover the reasons for non-use and the extent of these relative to the socio-economic and cultural activities supported by an undisturbed mangrove environment. The following were the residents' awareness of the importance of mangroves elicited through the uses they perceived as beneficial to their environment.

Beneficial functions of the mangrove ecosystem

The result in Figure 5 illustrates that the villagers living in and around the mangroves recognised at least seven distinct functions of mangroves that are beneficial to the community as a whole in Samoa. Relative importance of a use was estimated by comparing its frequency of being cited as important by the total number of respondents.

Cyclone and wind barrier All the Sataoa and Pata rural respondents and some of the Vaitoloa residents (28%) viewed that the most important function of the mangroves was the reduction of damage to settlement by cyclones, harsh waves, strong winds and storms. The mangroves' location at the interface of the land and sea protects homes, crops, vegetable gardens and livestock. This function was strongly emphasised by all Pata villagers, who claimed that they were spared the ravages of cyclones and strong winds because of the barrier afforded by mangroves. Similarly, at Vaitoloa and Sataoa, villagers claimed that it was the removal of a large area of mangrove for a major road construction that has exposed houses to the destructive forces of cyclones. It can be argued that the perceived importance of such a function can be influenced by the occurrence of two successive cyclones in the early 1990s.

The natural resilience of mangroves to function as a cyclone and wind defence is widely discussed in Chapman (1976) and others. Miyagi (1992) and Mochida (1992) also respectively demonstrated through illustrations how the physical, geomorphic and biogenic factors control the processes of land and silt succession enabling mangrove to act as buffer zones. These were supported by comparative studies conducted in Okinawa and Iriomote mangroves of Japan, in relation to mangroves of Micronesia in Pohnpei and East Kalimantan, Indonesia.

Habitat for marine/terrestrial organisms

Q.B2. What are three important functions of mangroves that are beneficial to the local community or Samoa?

| Function                                      | Percentage | N   |
|-----------------------------------------------|------------|-----|
| Landfill                                      | 7.3%       | (11)|
| Soil improvement                              | 8%         | (12)|
| Producing food for marine/terrestrial organisms | 9.3%       | (14)|
| Erosion control                               | 10%        | (15)|
| Shades for domestic animals                   | 15.3%      | (23)|
| Habitat for marine/terrestrial organisms      | 22%        | (33)|
| Cyclone/wind barrier                          | 28%        | (42)|

Figure 5. Responses on the beneficial functions and the relative importance of mangroves to Samoa from 50 households in Pata, Sataoa, Vaitoloa, and Fugalei, Upolu Island, Samoa. Total percentage of 99.9 is rounded to the nearest whole number of 100%.
The second most frequently cited function is as a habitat for marine and terrestrial organisms (22%), illustrated by the variety of finfish, shellfish, and crab species cited by the respondents in Table 2. Of particular importance are the alogo (Acanthurus lineatus), pone (Ctenochaetus striatus), tuna (Anguilla marmorata), lupo (Alectis ciliaris), malauli (Carans ignobilis) anae (Liza melanoptera, Mugil cephalus, Valamugil engeli spp.), lo (Siganus fuscescens), and avaava (Therapon jarbua) finfishes; tugane and pipi (Gafrarium tumidum) shellfishes; and the ua, (Sesarma erythrodactyla), tupa (Cardisoma carnifex) and paalimago (Scyllar paramamosian) mangrove crabs. The Siphonosoma australae worm or ipo, which was uniquely reported in Vaitoloa was not reported by the other respondents.

Finfish of a similar Family have been found in Okinawan mangroves such as the Lutjanus, Mugil cephalus, Siganus and Therapon family although the particular species varied (Shokita 2000). In contrast to the Thai finfishes, Aksorn-

| Table 2. Composition of finfish, shellfish, and crab species identified by the respondents in the local study areas |
|---------------------------------------------------------------|
| **Family and eel species**                                      |
| **Family Name**                                                | **English Name** | **Scientific Name** | **Samoan Name** | **Site cited** |
|----------------------------------------------------------------|------------------|---------------------|-----------------|---------------|
| Acanthuridae                                                   | Surgeon fish     | Acanthurus lineatus | alogo.          | P S V F       |
|                                                               |                  | Ctenochaetus striatus | pone            | P S V F       |
| Anguillidae                                                    | Freshwater eel   | Anguilla marmorata   | tuna            | P S V F       |
| Carangidae                                                     | Trevallies       | Alectis ciliaris     | lupo            | P S V F       |
|                                                               |                  | Caranx ignobilis     | malauli         | P S V F       |
| Chaetodontidae                                                 | Butterfly fishes | Chaetodon species    | tijitif          | P S V       |
| Chanidae                                                      | Milkfish         | Chanos chanos       | ava              | P S          |
| Cichlidae                                                     | Tilapia          | Oreochromis         | tilapia          | V F          |
| Gerreidae                                                     | Mojarras         | Gerres argyeus      | matu             | P S          |
| Leionogathidae                                                 | Ponyfishes       | Leionathus equulus  | muumu            | P S          |
| Lethrinidae                                                    | Variegated emperors | Lethrinus variegates | mataelele       | P S          |
| Lutjanidae                                                     | Snappers         | Lutjanus argentimaculatus | mu, palu,     | P S V       |
|                                                               |                  | Lutjanus fulves     | tamala            | P S          |
| Mugilidae                                                      | Mullet           | Lisa melinoptera spp. | anae            | P S V F       |
| Mullidae                                                       | Goat fishes      | Malloidoichthys     | iasina           | P            |
|                                                               |                  | Flavoineatus        | tauleia          | S            |
| Pomacentridae                                                  | Damsel fishes    | Abudesdf sordidus   | matu             | P S          |
|                                                               |                  | Chrystipera biocellata | tuuu            | P S          |
| Serranidae                                                     | Groupers         | Epinephelus maculatus | gatala         | P S V        |
| Siganidae                                                      | Rabbit fishes    | Siganus fuscescens  | lo               | P S V F       |
| Terapondidae                                                   | Crescent perch   | Therapon jarbua     | avaava           | P S V F       |
| Siphonosoma australae                                          | —                | Siphonosoma australae | ipo             | V            |

| Shellfish species                                               |
|---------------------------------------------------------------|
| **English Name**                                               | **Scientific Name** | **Samoan Name** | **Site** |
|----------------------------------------------------------------|---------------------|----------------|----------|
| Mangrove oyster                                                | Crassostrea mordax  | tio            | S        |
| Venus shell                                                    | Gafrarium tumidum   | tugane, pipi   | P S V F  |

| Crab species                                                   |
|---------------------------------------------------------------|
| **English Name**                                               | **Scientific Name** | **Samoan Name** | **Site** |
|----------------------------------------------------------------|---------------------|----------------|----------|
| Red-clawed crab                                                | Sesarma erythrodactyla | ua             | P S V F  |
| Land crab                                                      | Cardisoma carnifex  | tupa           | P S V F  |
| Green mangrove crab                                            | Scylla paramamosian | paalimago      | P S V F  |

Location: P=Pata; S=Sataoa; V=Vaitoloa; F=Fugalei
koae et al. (1986) stated that the most common one is the *Chanos chanos*, surprisingly identified mainly by the rural villagers of Pata and Sataoa. Crabs of a similar family species (*Scyllar serrate*) have been also noted as far as Dar es Salaam in Tanzania, Africa by Hartnoll (Mai-noya et al. 1986), in Okinawa, Japan by Shokita (2000), and also again by Aksornkoae et al. (1986) in Thailand. Particularly in Thailand, where the mangrove genera of about 27 species exist, more diverse marine organisms of finfishes, crustaceans and molluscs have been identified from fishing trips in the surrounding mangrove villages of Ko Lao and Had Sai Khao, Ranong Province, southern Thailand (Aksornkoae et al. 1986). Interestingly, the presence of *Helice leachi* crab species, proven through experiments by Shokita (2000) most commonly found feeding on the *Bruguiera gymnorrhiza* mangrove leaf, was not identified by any of the respondents or of the studies that have been undertaken in Samoa, despite the vast growth of the *B. gymnorrhiza*. The importance of mangroves in offering an area of refuge and spawning ground for marine organisms has been extensively recognised in Kunstadter (1986), Hamilton and Snedaker (1984), MacNae (1974), Saenger et al. (1983), and many others. In the case of the *ipo*, the only other two areas that a worm has been evident is the *latju* (*Teredo spp*) reported by the Australian Aborigines in Bird (1986), and the *Sipunculid* worm of the Thai and Malay mangals in Shokita (2000).

With regard to terrestrial birdlife organisms, only two Sataoa and a Vaitoloa respondent acknowledged that three types of birds were commonly seen feeding on fish from the mangroves. At Sataoa, these are the *toloa* (*Anas superciliosa* or ‘grey duck’), *matu‘u* (*Egretta sacra* or ‘Pacific reef heron’), and the *seu* (*Rhipidura nebulous* or fantail). At Vaitoloa, glimpse of the *gogosina* (*Sterna sumatrana* or Black-naped tern) was reported. The *toloa, seu* and *gogosina* have cultural significance in some of the Samoan proverbs and songs (Taule’alo 1993). In the three villages of Vaitoloa, Sataoa and Pata, most of the families rear domesticated pigs and chicken. They also reported that mangroves are where some of their pigs and chicken roam to find food like earthworms for the chickens while the pigs like to burrow in the mud swamps.

Presence of fish eating birds such as egrets, cormorants, storks, sea gulls, herons and kites have been also reported as far afield as the mangrove areas of the Indus delta and the Karachi area of Pakistan (Qureshi 2000: 33). This is an interesting finding despite the vast distance of these places in the far east of the Asian borders from Samoa.

**Shades for domestic animals** Mangroves, in the provision of shade (15.3%) was also seen as vital for sheltering and protecting these terrestrial livestock and poultry animals not only for domestic use but also as a source of local consumption and income for the dwellers. On occasions, neighbouring families would come to buy these products but the sales are very informal, and were most significant in Vaitoloa and Pata. This is a significant observation because in the 1989 Agriculture Census of Samoa, 91% of all households keep some type of livestock, that is, 42% have cattle, 83% have pigs and 86% rear chickens (GWS 1990). Taule’alo (1993) endorses that livestock is primarily raised for home consumption and for ceremonial occasions.

Use of mangrove areas for shade is also recognized by the Australian Aborigines. In association with the terrestrial animals of the Samoa villagers, it is the Aboriginal people of the Yolngu tribe in Arnhem Land north of Australia, who move to the cool, shady environment of the mangroves particularly in the dry season. This is most common when strong southeast trade winds bring heat and dust to the coastal plains enabling Aboriginal people to escape and seek refuge in the mangroves (Bird 1986).

**Other beneficial uses** Mangrove mud and litter was also noted as an important food provider for the organisms depending upon it in the case of Vaitoloa and Sataoa. Mud obtained from the swamps above the high water mark provides soil for farmland improvement in the case of Vaitoloa and Pata for the growing of crops and vegetables. Landfill, including the prevention of front and backyards from erosion and natural disaster, in the form of *a paepae* (landfill), were particularly reported by the Fugalei and Vaitoloa residents. The mud swamp is also stated to have healing properties.
for the pigs that roam in the mangrove areas of Vaitoloa, Pata and Sataoa as reported earlier.

**Socio-economic and cultural uses of mangrove products**

As expected, the significance of the functions reported above of mangroves in its physical state influences socio-economic and cultural activities, therefore it is not surprising that the data in Figure 6 showed that mangroves had a range of socio-economic and cultural importance. Villagers residing in and around the mangrove area use mangrove trees for their basic subsistence, cultural and socio-economic living in the form of three most important uses for construction (19%), decoration (14%), and fuel and fishing equipment (12%) materials. Coincidentally, in the village of Ko Lao, Thailand, with the exception of decoration, mangrove forests are predominantly a source of wood for fuel, house construction, fishing gear, and for catching marine animals (Aksornkoae et al. 1986). Yet, in contrast to Samoa, in the Southeast Asian countries, particularly the peninsular of Malaysia and Thailand, mangrove products are manufactured on a large scale. In Malaysia for instance, *nipa* fronds from the mangrove areas are cut and processed to make *nipa* shingles for roof thatching and sold while the younger *nipa* leaf sheaths are used for cigarette-wrapper manufacturing (Chan 1986). As for Thailand, mangrove forest wood is processed for charcoal, timber and lumber, and the marine organisms form the basis of the fishing industries, which in turn form the primary employment sectors providing a formal income (Aksornkoae et al. 1986). Conversely, Samoa mangrove uses are more on a small scale, serving only the local coastal communities and the town market (in terms of selling marine mangrove products and leis).

**Construction uses** Specific constructional usage involved the provision of mangrove timber for posts to build houses, kitchens, and pig sty(s) while thinner wood is used for roof rafters. This is most common in the rural areas of Pata and Sataoa and to some extent in Vaitoloa. Most of the dwellings in Samoa have kitchens or *umukuka* separate from the main house, which is usually made of commercial timber. The traditional rural housing or Samoan cottage (*fale Samoa*) is open and has no walls so the poles are those from the mangroves. This type of dwelling is common in the villages and is commonly used only for leisure or relaxation because of its coolness.

The separate kitchens have similar architect attributes of a Samoan cottage but are enclosed with fences and sometimes with a built-in compartment to keep animals from entering. However, poles for posts and thinner wood for fences are also extracted from the mangroves. Even in the urban villages these housing styles and kitchens do exist as evident in Vaitoloa. Pig sty(s) are also located separately outside the housing compounds, and the fences are constructed from either the *Rhizophora* or *Bruguiera* woods. The woods are hard, according to the respondents and therefore such a use is very convenient, particularly in the case of the *Bruguiera* since they are taller. Fish traps in all three areas of Pata, Sataoa and Vaitoloa, which are installed further out into the sea in a circular fashion, are made of mangrove wood sticks.

Using mangrove wood for house construction is also a common practice in Laut villages of Java except that they do not have separate kitchens (Mantra 1986). In a similar fashion

Q. B3. What are the four most important uses of the mangroves?

| Use                              | Percentage |
|----------------------------------|------------|
| Construction                     | 19% (48)   |
| Making decoration                | 14% (35)   |
| Collecting firewood              | 12% (32)   |
| Making fishing equipment         | 12% (32)   |
| Making tools                     | 12% (31)   |
| Extracting marine food           | 11% (29)   |
| Canoe making                     | 9% (23)    |
| Domestic                         | 3% (8)     |
| Recreation                       | 3% (7)     |
| Gathering medicinal herbs        | 3% (7)     |
| Tannin/dye                       | 2% (4)     |

Figure 6. Responses on the socio-economic and cultural uses of mangroves from 50 households at Pata, Sataoa, Vaitoloa, and Fugalei, Upolu Island, Samoa.

All percentage figures were rounded off to their nearest whole numbers.
with regards to pig sty(s) and fish traps, Mai
noya et al. (1986) reported that coastal people of
Tanzania also use mangrove products for their
pig pens and fish traps. On the other hand,
wood is mass produce and exported to other
countries or even on the local market, as men-
tioned earlier, in Southeast Asia. For instance,
in the case of Malaysia, a Rhizophora pole is
felled and sold for US$0.40 for those near the
river. The rate increases progressively to
US$0.60 per pole inland. The worker can cut
and transport about 30 to 40 poles a day and
normally works 15 to 20 days a month. Yet at
the jetty, poles are sold to consumers at a price
of US$0.70–$1.50 each (Chan 1986). At the mo-
ment there are signs of deterioration yet still
these mangroves are exploited on a macro level.
Therefore, their sustainability level cannot
meet the exploitative measures.

In Samoa, changes of a different nature are
evident. All of Sataoa, for example, has been
restricted in that their mangrove area is being
strictly allocated for preservation. Many had
used other forests inland to obtain posts par-
ticularly for housing and kitchen surroundings.
Lands are mainly communal or customary land
and so the families also have access to forests
inland. Conversely, all of the residents in
Fugalei and 14 out of 15 residents of Vaitoloa
stated that these uses have been replaced to
some extent by commercial timber. The
change, according to the Fugalei respondents,
was not by choice, as the reclamation of man-
groves had removed their traditional timber
supply. However, in some cases, for those who
cannot afford commercial timber, the rubbish
dump has become their source of timber, hence
the condition of housing in Fugalei is very poor
and reflects the poverty of the region.

A similar situation has been acknowledged in
the coastal village of Segara Anakan, southern
Java, Indonesia, where large areas of man-
groves have been lost to land reclamation and
there is obviously a decline of timber resources
(Mantra 1986). In Thailand, the destruction of
mangrove trees has led to decline over a 10 year
period by concessionaires, whom the villagers
called "the owners of the charcoal kilns", for
charcoal production (Aksornkoae et al. 1986).
In a similar vein, Chan (1986) and Silva (1986)
reported that the Ko Lao and Had Sai Khao
villagers of Malaysia and Sri Lanka are also
suffering from the decline of mangrove timber
attributed to felling and logging for forest tim-
ber commercialisation.

Making decoration Decorative flowers are a
popular form of personal adornment with some
families having made it a source of income in
Vaitoloa and Sataoa. The use of the mangrove
flower for decoration and long flower necklace
is quite unique since none of the studies have
reported such a use. In general lei (ula) made
from mangrove flowers and other flowers are
sold by a number of families, since it is seen as
an important facet of Samoan celebrations in
village feasts, ceremonial activities, school
graduation or prize giving, or any other func-
tion.

Even around Christmas, Vaitoloa dwellers of-	en improvise by extracting branches or young
plants of mangrove to substitute for a Chris-
tmas tree. Flowers and ferns are also used for
church decorations for Sunday services as in
the case of Sataoa. Ferns obtained from the
mangrove, are also potted and sold. According
to the respondents, pot plant sale is a recent
activity, which came about with the establish-
ment of the Sataoa-Saanapu eco-tourist reserve
project. None of the Fugalei respondents
claimed to rely on the mangrove for their deco-
rative needs, besides their mangroves were lit-
tered with broken glasses and hence, dangerous
to enter.

Firewood Fuel in the form of firewood, and
the provision of material for making fishing
equipment, are perceived as equal in impor-
tance. Pata and Sataoa respondents all relied
on the mangroves for firewood, as the main
source of fuel for cooking. Sometimes, women
and children are involved in gathering and col-
clecting firewood. At Vaitoloa, although some
depended on mangrove firewood, many pre-
ferred charcoal and kerosene bought from the
shops out of convenience rather than necessity.
Fugalei respondents bought firewood from the
nearby market because mangroves were al-
ready demolished but for those available, it was
unbearable to enter. Firewood is a prerequisite
for the performance of the Sunday umu or
ground oven traditionally held every Sunday,
or preparation for a big feast or celebration that involves food giving, hence the importance of firewood as one of the socio-economic and cultural importance.

The use of mangrove wood for charcoal especially for commercialisation, commonly reported in Southeast Asian countries, is not a practise among the Samoan mangrove residents in this study or any other study conducted in Samoa. However, the use of mangrove for firewood fuel namely the Bruguiera and Rhizophora species is being reported in the mangrove dwellers of Thailand although no data on the amount of firewood consumed is available (Aksornkoae et al. 1986). Whilst the Samoans did not distinguish the effectiveness of the species for firewood, people in Thailand as well as Fiji (Lal 1983) recommend the Rhizophora as an effective firewood and source for charcoal production. Similar changes are occurring in using kerosene as an energy source for cooking and lighting, along with fuel wood and charcoal from the mangroves evident in the homes of Tanzanian people in a study conducted by Nkonoki (Mainoya et al. 1986).

Making fishing equipment Fishing equipment made from mangroves includes crab and fishing traps, fences, and lines, as expected mainly from the rural mangrove dwellers. The respondents from Vaitoloa and Fugalei respectively said that they did not make fishing equipment anymore, partly due to its replacement by modern fishing equipment. Yet, they also chose not to fish in the mangroves for fear of food poisoning from garbage pollution at Fugalei and discarded industrial machinery waste at the former rubbish dump at Vaitoloa.

Making tools Tool making is an integral part of sustaining a livelihood and ranks fourth in terms of cultural uses of mangroves for making digging sticks and garden stakes. This was most common for Pata and Sataoa respondents. Pata and Sataoa residents were also farmers in that they also cultivated land for subsistence and commercial means. This is quite significant in that about 80% of land in Samoa is customary owned. The villagers had customary land cultivated for growing banana, taro, yams, and other staple crops. Even surrounding their traditional housing were evidence of similar crops being planted with digging sticks, and surrounded by garden stakes to protect the crops and gardens from pests such as dogs, pigs and chickens. The growth of crops in the front and backyards of Samoan houses is a terminology that was referred to as ‘garden crops’ by Thaman and Ravuvu (1989), common in Tongan and Samoa front and backyards. Hence the importance of garden stakes and digging sticks manifested in the rural dwellers responses. Vaitoloa had garden crops to a small extent but Fugalei respondents had limited space for planting, reflected in the lack of responses.

**Extracting marine food** For those engaged in fishing, one or more of the following products are extracted from mangrove swamps: finfishes including eels, shellfishes and crabs. In this survey, extraction of marine food products from the mangrove swamps ranks fifth in importance, serving as an important source of protein. Finfishing and non-finfishing, like flower collecting and making leis, have similar characteristics in the division of labour regarding who is involved in which activity. With reference to the fishermen counterparts of Vaitoloa, Sataoa and Pata, finfishing usually takes place at night and it requires greater physical strength because of the net-fishing method. This often excludes women who also have the responsibility of looking after the children and attending to domestic duties at night. At times, crabs are caught or collected by men, particularly in Sataoa, and also Pata at night, but collecting shellfish is predominantly a female activity. Women are seen to collect crabs when the need is there to obtain cash for children's school fees or to meet other immediate obligations such as paying electricity bills before the deadlines.

Conversely, in Vaitoloa and Fugalei, the fear of food poisoning has been the deterrent to fishing in the mangrove swamps. Fugalei possessed the added disadvantage of distance (about one hour’s walk) from the shoreline, a result of the reclamation of land from the mangroves. Tinned fish, corned beef, frozen meats and chicken from the market and general stores have become substitutes.

In contrast to the coastal mangrove villages of Thailand (Aksornkoae et al. 1986), Malaysia
(Chan 1986), Java in Indonesia (Mantra 1986), and Sri Lanka (Silva 1986), fishing, like charcoal and wood production, from the mangrove forests is a significant primary resource industry contributing to the national revenue income. In the local region, shrimp and prawns are a major high-price income earner for the mangrove dwellers. However, Samoa, like Tanzania (Mainoya et al. 1986), does not commercially exploit mangrove marine resources on a large scale but only for local consumption and to periodic sale in the local market only when cash is required. In fact in Sri Lanka, the reported high average income varies with the prawn season, whilst fishing is regarded as a more stable income throughout the year in the mangrove fringed lagoon communities of Rekawa and Kalametiya, Sri Lanka (Silva 1986). Prawn and shrimp was more of a fresh water organism found in the head river streams, not in the mangroves, as considered by some Samoan respondents.

Other socio-cultural uses Mangrove wood is also used for outriggers and connectives of canoes. Canoe timber itself is obtained not from the mangroves but carved from other trees found along the inner margins of the mangroves such as the fau (Hibiscus tiliaceus), talie (Terminalia catappa), mosooi (Cananga odorata), tamaligi (Samanea saman), and niu (Cocos nucifera). Interestingly, Tanzania also uses mangrove wood for boat hulls, masts, and oars (Mainoya et al. 1986). Respondents who did not rely on the mangrove for outrigger material were no longer engaged in finfishing, such as a hundred percent in Fugalei.

Streams flowing through the mangroves were of little use for domestic activities, such as bathing, washing clothes and dishwashing because of the reliable supply of reticulated water and stored rainwater. However, in the event of a prolonged interruption in the domestic water supply most claimed that they would fall back on mangrove stream water. Awareness of pollutants in the swamps has discouraged respondents in using mangroves for recreation and domestic use. In fact, Sataoa, Vaitoloa, and Fugalei respondents reported that they did not swim in the mangrove streams anymore. While Vaitoloa respondents blamed this on the un-sanitary conditions of the mangroves streams due to rubbish pollution, Fugalei respondents said that the reclamation has been so extensive that areas once suitable for swimming disappeared. Even at Pata, some of the respondents refrain from using the mangroves for swimming. The deterrent in this case is the fear of the supposed effects of 'ava Niu Kini' (Derris malaccensis) natural poison used for fishing.

From a different viewpoint, recreation of mangroves is manifested in tourist conservation attraction as in the case of Okinawa because it is regarded as an exotic ecosystem according to Miyawaki (1986). This function is offered not to the local dwellers but to the national tourists. This is a function that has been recently developed as a formal use of the Sataoa mangroves known as a Community-based conservation project with the assistance of the local government departments such as the Lands and Environment and Conservation section in Samoa. Due to this, local dwellers of Sataoa mangroves abstained from using the mangrove resources abundantly and excessively.

The use of mangroves for medicine is indirect since most of the medicinal plants are non-exclusive species such as laugase, pualulu or lauauta (Phymatosorus scolopendria), fueselela (Hoya australis), nonu (Morinda citrifolia), mati (Ficus tinctoria), fuesina (Vigna marina), matalafi (Psychotria insularum), togotogo (Cantella asiatica) and milo (Thespesia populnea). Only a few respondents utilized these in their remedies, and used their knowledge as a means of earning money.

This finding suggests limited knowledge of the mangrove dwellers in Samoa in using mangrove species in healing and treatment in contrast to the residents of Thailand, where Bruguiera mangrove plant species is used to relieve constipation, the Acanthus species for treating kidney stones, while the Avicennia species is to treat thrush in children and others for menstrual fevers (Aksornkoae et al 1986). Beyond Asia in the continent of Africa, the Rhizophora species is well recognised by the Tanzanians as a remedy for hernia (Mainoya et al. 1986).

Last, but not least, the tannin from the bark of the Bruguiera was once important as a dye
used on bark or *tapa* cloths. Only a few of the respondents still obtain dye or tannin from the mangroves. This has been replaced with modern artificial dyes, screen-printing, tie-dyes, and is no longer popular. On the other hand, the bark cloths are seldom worn these days despite Yamamoto's (1990) discussion, and in ceremonial exchange they have been substituted with modern cloth obtained from the stores. Yamamoto (1997) proposed in her analysis that the introduction of western imported material is supposedly the reason for this transformation. Like Samoa mangrove dwellers, Aksornkoae et al. (1986) observed that the practise of obtaining tannin is also becoming rare in the case of Thailand, although the reason for their usage differs. With modern equipment available, dyeing of fishing nets with tannin is rare since traditional nets are now substituted with nylon nets.

**Residents’ evaluation of mangrove reclamation**

This evaluation attempts to provide a picture of the four study communities’ degree of reliance on their respective mangroves. It aims to examine how the destruction of mangroves has affected the villagers in terms of the time spent in the mangroves for the satisfaction of their socio-economic and cultural needs. The research provided the following general picture of the level of affluence among the inhabitants in the four locations studied.

**Residents’ socio-economic status**

Figure 7 shows that 37% of the respondents' income derives mainly from semi-subsistence means. This involves living off the land and sea and selling part of the products of their efforts for instance, selling of staple crops, handicrafts, poultry, pigs, flowers and pot-plants, finfish, shellfish and crabs in order to obtain cash for the purchase and satisfaction of other needs. Half of this percentage proportion (18.5%) is derived predominantly from selling marine products and crops. This aspect, suggesting a transition from subsistence to cashing in on marine and land resources, is a significant trend also acknowledged and supported by Yamamoto (1990), Meleisea (1988), and GWS (1990).

As such, 30.4% of the respondents' total income is also obtained from remittances abroad, 27.2% from wages, and 5.4% from self-employed ventures. Those who had incomes from wages were found predominantly in Fugalei and Vaitoloa because of their proximity to Apia whilst the incomes from self-employed activities were found only at Fugalei. Many

Q.A2. What are your sources of income?
1. Subsistence  2. Semi-subsistence  
3. Wage employment  4. Others (specify)

![Figure 7. Sources of incomes of 50 respondents from the villages of Pata, Sataoa, Vaitoloa, and Fugalei, Upolu Island, Samoa.](image-url)
respondents had multiple sources of income, which was quite common among the households.

Of the four study areas, Fugalei’s economy is the least. Although there were incomes derived from wage employment those employed were involved in blue collar jobs with incomes of $90–$60 tala per week, but not from selling mangrove fish or related products. In retrospect, those who received cash from abroad had a monthly remittance of $200 tala, which was the only source of income for a mother of five. Others who received less had remittances of $100 tala only twice in a year. There were very few food gardens or ‘garden crops’ in the area. Self-employment in Fugalei invariably involved petty trade such as operating a barbecue stand, a flea market stall or a small general store selling daily basic food and sundry necessities. According to a Fugalei respondent who operates a barbecue stand, the income derived is meagre, and “the monies from day to day sales goes back into purchasing the goods for the barbecue stand. If we get $150 tala, $100 alone would be spent on meat and $30–40 will go into buying other ingredients. So we save about $10 or $20 if we’re lucky…” The same family, make ends meet by receiving remittances additionally from relatives abroad. Parallel to this, many of the families could barely have any supplementary income left for any means other than trying to meet sufficient basic necessities.

Vaitoloa respondents are better off economically than those in Fugalei because most of the residents are white collar, therefore more highly paid. Others had additional incomes from semi-subsistence means from fish, garden crops, poultry, and pig sales. None of the respondents are self-employed and a few also received remittances. The general economic status of Pata is similar to that of Sataoa, and being rural communities, the pattern of sources of income is very different from either their Vaitoloa or Fugalei counterparts. None were self-employed and the majority received regular remittances from overseas. Only a couple were also wage earners and all were semi-subsistence farmers. Everyone at Pata and Sataoa sold marine food products (including finfish, shellfish and crabs), as well as other products such as crops, handicrafts, poultry, livestock, and pot plants. Added to this, is the claim by all respondents at Pata and Sataoa, that need of extra cash to meet personal, family, village or community obligations known as fa’alavelave beyond daily needs is satisfied through the sale of fish from the mangroves as in Figure 8. All families at Pata and Sataoa (10 each) and 9 respondents from Vaitoloa satisfy their extra cash needs from the mangroves. Thus we see the heavy reliance of Pata and Sataoa on their mangrove environment relative to Vaitoloa, and the comparative absence of mangrove-derived income at Fugalei.

![Figure 8. Responses on the special occasions or ceremonies for which respondents would make more than the normal use of the mangroves from 50 households at Pata, Sataoa, Vaitoloa, and Fugalei, Upolu Island, Samoa. The responses were those identified by the respondents.](image-url)
A Socio-Economic Analysis of Mangrove Degradation

Sataoa villagers for instance, enter the mangroves every day, especially for firewood and food. Yet when it is mangrove marine products for income, it is about 4 to 5 times a week. This is a higher average compared to Vaitoloans. They only enter the mangroves during the weekends 'when they have time,' or if they really need extra income particularly for immediate fa’alavelave. The heavy reliance of the two rural areas on income from mangrove marine products is further supported by the increase in the proportion of fish sold at present compared to earlier, as reported by the survey.

A significant fact is that whereas about ten years ago, no respondent sold 100% of his total catch, today, 20 of them do so. Similarly, those who reportedly sold 75% of their finfish catch earlier were only about 5. This has increased to about 18. Consequently, the percentage of those who sold 25% and 50% of their catch has declined. Figure 9 respectively supports the allegation made by rural respondents (Sataoa and Pata) that in recent years, there has been an increase in fishing effort and a very significant increase in the sale of mangrove marine food-stuffs. Respondents said that the pressure for increased monetary income to satisfy newly required needs and traditional family and community obligations has been the cause of this. Generally, the sale of finfish and shellfish informally occurs by the roadside or door-to-door, whereas crabs are usually transported to the fish market in Apia, where they fetch a higher price. This is most pronounced in Pata.

Changes in residents’ life

With the exception of Pata, all respondents experienced impacts and therefore a change in their relationship with their mangroves as a result of development-related activity. The beneficial effects may be summed up as improved accessibility to Apia, since all lauded improved accessibility to urban services such as banks, airports, hospitals, post offices, and especially markets to sell their marine products, food crops and handicrafts. Respondents also said that improved accessibility has allowed them to take advantage of cheaper basic food-stuffs in town.

Sataoa, Vaitoloa, and Fugalei respondents reported four development-related activities: road constructions, commercial activities, eco-tourism, and industrial expansion. The perceived negative effects in Figure 10 by the respondents were: destruction of the habitat and spawning grounds for marine organisms on which the local inhabitants were once reliant or are still reliant for their dietary protein and income; relocation or displacement of homes; restriction/deprivation of use to a freely available resource; and land alienation. Although not common to all areas, other less frequently cited negative effects were: unsanitary environment, retreat of shoreline, noise and air pollution, and increased flooding. The following elaborates the four most common negative effects of development related activities at Sataoa, Vaitoloa and Fugalei.

Habitat destruction

When respondents were asked about their awareness of changes in the duration of time they spend in the mangroves compared to the days prior to their area’s particular development-related activity, they reported an increase

Q.B8. Of the catches, what % is sold (the balance i.e either consumed or distributed), and has there been any changes?

|                | 1990 | Current study |
|----------------|------|---------------|
| 100%           | 5    | 9             |
| 75%            | 14   | 18            |
| 50%            | 25   | 18            |
| 25%            | 0    | 0             |
| 0%             | 43   | 48            |

Figure 9. Number of responses on the changes in the proportional percentages of the total catches sold from 50 households in Pata, Sataoa, Vaitoloa, and Fugalei, Upolu Island, Samoa. Past responses were extracted from a survey conducted by Zann (1991) in 1990 and compared to the responses given in the current study. The proportion of the catches 0%, 25%, 75%, and 100% were options provided to the respondents. Respondents were asked to circle more than one option if appropriate.
Q6. Has development (e.g. roads, buildings, services, urban development) had any negative impacts? List up to three negative impacts and explain.

| Impact                        | % of Respondents |
|-------------------------------|------------------|
| Habitat destruction          | 19% (23)         |
| Relocation of house           | 19% (23)         |
| Deprived resource             | 15% (18)         |
| Land alienation               | 15% (18)         |
| Unsanitary environment        | 13% (16)         |
| Shoreline retreat             | 8% (9)           |
| Noise, air pollution          | 7% (8)           |
| Flooding                      | 4% (5)           |

Figure 10. Responses on the perceived negative effects of development related activities by 40 households from Sataoa, Vaitoloa, and Fugalei, Upolu Island, Samoa. Pata was unaffected by development, therefore omitted in this part of the analysis.

in hours of finfish and nonfinfish fishing but a reduction in finfish and non-finish catches, and longer hours spent in obtaining the same quantity of firewood, timber for posts, and wood for making tools and equipment. Figure 11 depicts the changes in time taken to satisfy these socioeconomic and cultural needs.

The figure portrays that at present an additional two to three hours are spent in obtaining food from the mangroves either in the form of finfinishing (including eels) or non-finish catching of shellfish and crabs. The time required to locate the suitable size of timber for kitchen and pig-sty fences has also increased by about two hours, and an hour in fuel collection. Note also, the decline in the time spent on collecting material for decorative purposes. This is due to the restriction imposed by the Land and Survey Department on this activity because of the ecotourism project at Sataoa.

A commonly cited reason for refraining from collecting decorative material in Fugalei and Vaitoloa was the dangers posed by broken glass, rusty nails stuck on boards, and metal waste dump in the mangroves.

However, it is important to recognise that the decline in the use of mangrove resource at Vaitoloa and Fugalei is not solely due to the destruction of mangroves. Increasing urbanisation of Vaitoloa and Fugalei also plays a major part in this decline. Vaitoloa respondents, for instance, attributed the decline in mangrove use to a change in their lifestyle, such as preferences for modern conveniences like kerosene oven, tinned fish and frozen meat, coupled with the lack of time because working parents, working young adults and schooling children have less time for obtaining food and non-food resources. Added to this is the relative lack of manpower. The average household size in Vaitoloa and Fugalei was 6.2 and 6.3 respectively compared to 8.2 and 8.8 at Sataoa by national statistics (GWS 1991a).

Respondents were also very aware of the decline in the size of finfish and non-finfish catches. Estimated catches are based on figures most frequently cited by respondents including those at Fugalei who estimated their catch sizes in Samoan units of measure. The quantity of fish for example was measured in *tauia*. A *tauia* is a string of about 12 medium-sized fish (22 cm), 10 if large (28 cm), and 15 if small (18 cm). A *taupaa* is a string of 10 small crabs. Shellfish was measured in terms of baskets or *ato* (equivalent to about 2 to 3kg in weight).

Table 3 illustrates the changes reported by respondents. Surprisingly, declining catches were also reported at Pata, despite the undisturbed state of its mangroves. The largest change was reported in Fugalei. Prior to land reclamation, the average catch per fishing trip of finfish was 4 *tauia* and 6 eels, 4 *taupaa* or strings of crabs, and 5 *ato* or baskets of shellfish. These were also usual when compared to the absolute zero now because of the destruction of Fugalei’s mangroves.

Overall, it appears that fish catches decreased by 43% at Pata, 33% at Sataoa, 80% at Vaitoloa and 100% at Fugalei. Eel catches had a remarkably decline of 67% in Pata and 100% in the other three areas. Crab catches decreased by 57% at Pata, 50% at Sataoa, 75% at Vaitoloa...
Figure 11. Responses on the changes in hours spent on mangrove related activities from 40 households at Sataoa, Vaitoloa, and Fugalei, Upolu Island, Samoa. Pata was unaffected by development, therefore omitted in this part of the analysis.

Table 3. Responses on the changes in average catch per trip from the mangrove areas now compared to the past from 50 households in Pata, Sataoa, Vaitoloa and Fugalei of Upolu Island, in Samoa

Q. B9. Has there been a change in average size or abundance in the catches now compared to the past?

| Activity                  | Pata Present | Pata Past | Sataoa Present | Sataoa Past | Vaitoloa Present | Vaitoloa Past | Fugalei Present | Fugalei Past | Change Pata | Change Sataoa | Change Vaitoloa | Change Fugalei |
|---------------------------|--------------|-----------|----------------|-------------|------------------|---------------|----------------|-------------|-------------|---------------|----------------|----------------|
| Fish (tauaia)             | 4            | 7         | 5              | 9           | 1                | 4             | 0              | 4           | 40%         | 33%           | 80%            | 100%           |
| Eel                       | 2            | 6         | 0              | 6           | 0                | 6             | 0              | 6           | 100%        | 100%          | 100%           | 100%           |
| Crab (taupaa)             | 3            | 7         | 2              | 4           | 0                | 4             | 0              | 4           | 57%         | 50%           | 75%            | 100%           |
| Shellfish (ato)           | 2.5          | 5         | 1.5            | 5           | 1.5              | 4.5           | 1.5            | 5           | 50%         | 70%           | 77%            | 100%           |
| Ipo                       | —            | —         | —              | —           | 0                | 4             | —              | —           | —           | —             | —              | —              |

—: not cited

and 100% at Fugalei. Shellfish catches decreased by 50% at Pata, 70% at Sataoa, 77% at Vaitoloa and 100% at Fugalei. Interesting too is the complete disappearance of the peanut worm or ipo (Siphonosoma australe) cited from only Vaitoloa, where it was formerly collected as a local delicacy. This corresponds with Zann's (1991) finding on stock depletion of finfish and non-finish in the urban mangroves attributed to the destruction of their habitat and spawning ground.
Relocation and land alienation

Relocation of homes coincides with land alienation. Development related activities such as road construction required re-location of families, which in turn separated families from their customary-owned lands. This was most pronounced at Sataoa where villagers are now sandwiched between a road and an area of mangroves for which clearance for settlements or any other destructive activity has been prohibited by the Lands and Environment Department. Comments from respondents at the various areas illustrate the resentment felt about this change in their relationship with their mangroves. According to a Vaitoloa respondent, a road constructed leading up to the mangroves encouraged rubbish dumping from the urban residents, and "has created unhealthy conditions, destruction of habitats for the marine life that was once our sole means of protein." A grandmother at Sataoa, whose grandson was killed on the road, also expressed her bitterness with regards to the changes resulting from road development.

Relocation is also encouraged by environmental disasters such as flooding, and unsanitary conditions resulting from obstructed drainage due to land reclamation.

Restriction and/or deprivation of resource use

The impact of alienating customary owners from their lands and mangroves is profoundly felt in the restrictions regarding resources use. Complaints on this restriction were most evident at Sataoa because of the Sataoa-Saanapu region having been declared by the Lands and Survey Department as an eco-tourism reserve project. A Sataoa respondent expressed that ginger farming, proposed as an income-generating project to restrain them from using the mangroves, was time consuming. For instance: "...The disadvantage of ginger farming is that you have to wait for it to grow before you can harvest it. After that you need money for some bus fare to go and sell it in the markets and stores or to a businessman who exports it in Apia. Finally, what you get will only last you a day or two."

Similarly, Fugalei respondents said that before the mangrove was cleared, their daily consumption was primarily free marine products obtained from the mangroves. However things have changed, and food and firewood had to be bought everyday to sustain themselves, with money which could be used in assisting with their children's educational expenses.

Mangrove Degradation and its Impacts in Samoa

The results presented here are indicative of three processes-first, the effects of urbanization on mangroves and the well-being of the local residents; second, the influence of a monetary system on the cultural aspects of the local residents; and third, the effect of Conservation projects on the rural residents' livelihood. Regional disparities are inevitable, as the degree of urbanization and monetary system affects the nature of the socio-economic backgrounds of the residents in relation to the utilization of mangroves through existing sources and means of income, and way of life, and the resulting changes. A discussion of these causes of mangrove degradation is imperative.

Progress of mangrove degradation

Proceeding degradation of mangroves is evident through reclamation, and to an extent, rubbish dumping, particularly in the urban areas of Fugalei and Vaitoloa due to rapid urbanization. Although Samoa has environmental legislation enacted by the Lands and Environment Act of 1989 to protect forests such as mangroves, efforts to cease reclamation of mangroves particularly in Fugalei have not been enacted, since the Environment Impact Assessment regulation is still in its final stages of preparation. Due to government negligence, mangroves, which should have been government-owned land had been subdivided and sold to promote reclamation for commercial activities. Just recently, residents have been relocated and only commercial activities are progressing by the new anticipated landowners. This is mainly the case at Fugalei, where signs of urban expansion are in line with road developments on the reclaimed areas.

In regards to Vaitoloa, the rubbish dump has been reclaimed and secondary forest and
swamps had spawned across the area. In effect, the spatial extent of mangrove has declined. In contrast, rural mangroves of Sataoa-Saanapu area have been protected under environmental promoted programmes as a concomitant to global actions to preserve natural ecological areas. Surprisingly, these have had some effect on traditional fishing patterns and uses of mangrove environments as expressed by the residents in the research survey results. Road development is also evident as in the case of Pata.

**Socio-economic effects**

Road construction and relocation of new urban facilities have irreversibly affected the local ecosystem and the social and economic aspects of the residents in the form of various transitions. Reclamation of mangroves is not substituting mangroves, but a permanent destruction is resulting in the loss of a freely available resource and habitat for marine spawning grounds, and the relocation of residents. In effect, the decline in mangrove uses for house construction, decoration, fuel and mangrove marine food products is continuing. Traditional fishing pattern and practice, which was the primary local livelihood, have changed and other mangrove related activities have declined with the depletion and loss of mangrove habitats and resources. Exemplars are evident by limited mangrove-related activities evinced by all the respondents in Fugalei who stated that they no longer use the mangrove resources. In line with this, is the depletion of mangrove food product through null fish, crab and shellfish yields, and decline in wood for construction, firewood, and for making fishing equipments and canoes. Cessation of fishing activities affected eating habits and local imported foods have been obtained as substitutes. Degradation of mangroves has also led to a modified social and economic livelihood by engaging in various forms of employment. In the case of Fugalei, some residents have taken up low-income jobs, while others who had a source of remittance entered low skilled, free entry but labour intensive activities such as small market, barbecue and sundry item stalls. Without a freely available resource, residents are forced into a livelihood that entails monetary exchange to purchase the necessities for their survival. The stalls and those without means of employment are supported by remittances while some of the remittances are used to set up these low income enterprises. Spatial dislocation of residents has also resulted. The socio-economic situation in urban Fugalei area is analogous with the perceived situation in Southeast Asian cities where urban immigrants of squatter settlements have established vending stalls to make ends meet (Hugo 1992).

In regards to Sataoa-Saanapu, traditional house construction, firewood collecting, making of fishing equipment, and fishing patterns have been altered not because of mangrove destruction but because of the constraint imposed by the government agency. However, low fish catches have been reported because respondents attribute this to the influence of the monetary system on the traditional cultural practices. A term coined by Yamamoto (1990) to describe this process is 'acculturalization.' This is where the personal, family, village and church fa'alaovelave or obligations have been transformed by substituting money valuables with some of the traditional goods needed for ceremonial exchanges. Paying electricity, school fees, and purchasing soaps, sugar, flour and other modern necessities have required cash, which can be obtained from making more than the normal use of mangrove marine products. While the residents are extracting more out of the mangrove marine areas, low fish, shellfish and crab catches and sizes have been reported. In the case of Fugalei, fishing or crab catching or even shellfish collecting is non-existent and the market has been their means of marine food especially for the Sunday lunches or toanai as is the tradition in Samoa. Like the Fugalei counterparts, population relocation is directed inland, and this is supported by the national census where Sataoa-Saanapu uta (inland) has increased by 0.8% while Sataoa-Saanapu tai (coast) has become depopulated (GWS 1991a).

Road development had assisted in providing accessibility to the local markets convenient for transporting fish but particularly crabs because they are high cost products for cash. Tourism had also developed initiatives of selling leis to
assist the rural families with an additional source of income. With the exception of selling leis, Pata is similar to Sataoa-Saanapu in this case.

In Vaitoloa, availability of modern conveniences, limited time because of an active working group, and the rubbish dump has contributed to less involvement with mangrove related activities, although some do maintain some degree of reliance on the mangrove for sustaining their livelihood. The vanishing of the *Siphonosoma* worm, reliance on imported food from the stores, according to some residents is because of the fear of being poisoned by the aftermath of a rubbish dump being recently removed and reclaimed. Unlike Fugalei, the impression given by the majority of Vaitoloa respondents was that the loss of the use of the mangrove resources were not seen as catastrophic, since people had adapted to this loss or change in their mangrove environment by adjusting their lifestyles to the modern conveniences.

This transformation from a traditional to modern livelihood was expected. Residents of 12 households out of 15 interviewed were economically stable through well off jobs mainly within the Mormon Church compound, an institution that paid well. Hence, they could afford material goods for domestic cooking and freezer foods and only entered the mangroves during weekends to seek fuel and fish for the Sunday *umu* (or ground oven) for the traditional *toanai* (lunch). For Fugalei residents, since they could not enter the mangroves for such commodities, the nearby market is their source of food and fish for their Sunday *toanai*.

**Conservation Measures**

This impact study of mangrove degradation is the first study undertaken in Samoa and is a useful means of assessment in evaluating social, economic, cultural and environmental costs of environments undergoing certain degradation. The findings of the survey suggest that development related activities have brought about both positive and negative effects. The negative effects, however, appear to be more numerous, illustrated by the arising of problems developing from an irreversibly changed local ecosystem, and in turn affecting livelihoods of the local people concerned. This is particularly evident in the urban mangrove areas.

This paper also concludes that mangrove degradation is not solely due to development related activities. Local communities, especially those in rural areas, increasingly overexploit their mangrove resources to meet increasing *cash* needs which appeared to be stimulated because of increasing access to the urban centre, facilities and products afforded by improved roads and transport, and a monetization of personal, traditional family, church, and village obligations. Thus, mangroves are in need of protection as much from overexploitation by traditional users as by destruction through development related activities. Alternative measures have to be found as a means for Pata villagers to obtain cash.

Nevertheless, conservation measures, as in Sataoa, may be necessary for all mangrove ecosystems in Samoa. While that of Vaitoloa and Fugalei may be too late to save in view of the speed at which development related activities have been allowed to proceed, others in the country should be carefully monitored. Only then, can mangroves be used in a sustainable manner.

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Notes

1. Socio-economic profiles are evident in symposium presentations as in Kunstadter, et al. (1986). Recent ones include UNU (2000) and Centre of Advanced Study in Marine Biology Annamalai University in India 2001.

2. *tala* is the Samoan currency unit for dollar. $1 US dollar is equivalent to a little more than $3 *tala* even up to now.

3. Obligation is ambiguously referred to fa'alavelave and Yamamoto (1990 and 1997) confines the definition of fa'alavelave as the ceremonial exchange taking place at life crisis occasions and house or church dedication ceremonies. She categorized four aspects of a fa'alavelave-matrimonial ceremonies, title inauguration ceremony, funeral, and church dedication ceremonies. In this survey, the author defines *fa'a-lavelave* in the context of the research participants. This includes reasons for the respondents making more of the normal use of extracting mangrove products to obtain cash for:

   Personal obligations (identified as *la'u fa'a-lavelave-my obligation*) involve paying; electricity bills; school transport, uniform and stationery and tuition fees;

   Family obligations or *fa'a-lavelave* (identified as *mo le fa'a-lavelave a le matou aiga-for our family obligations*) including contributions to: weddings; funerals; chief or matai title settlements or *saofa'i*; graduation or *fa'auuga* of a member of the family from a Theological college (whether it is an ordained Catholic priest, London Missionary Church pastor or Methodist pastor or *fesoasoani*), or even from a tertiary institution, a family visit to a relative from overseas or *asiga* as a formal recognition of a visitor from overseas especially if the visitor has been the source of financial remittance, or *fa'amonololi* as in a box of clothing or food.

   Village obligations (known as *fa'a-lavelave a le nu'u*) involve contributions to village projects as in-*fa'a-lavelave* or opening ceremony of a new school, church, or hall. Others include *fa'aga* (literally meaning 'feed') of the guests who may be invited to attend this celebration. The *fa'aga* is also for village church pastor and/or village schoolteachers, and also for their village participants of a church conference, e.g the Theological Malua *fono* or meeting (held once a year in May) and other village gatherings. Villages have responsibility to fund and build their own schools so they are also responsible for feeding the staff and administrators of their district schools. Families take turn to provide food (*fa'aga*) for the school personnel and their *faisfeau* as long as the system is operational, which is organized and decided by the village council or *fono*.

   Church obligations (*fa'a-lavelave a le lotu*) include *aofa* or donations for the pastor or priest of the village parish. This is a fortnightly affair. Another donation, which is an annual event, involves the contribution for the development and administration of the church affairs as in *taulaga*.

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