

Environmental change of selected mangrove areas in Samoa

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Introduction

The term 'mangrove' is both well understood and difficult to accurately define at the same time¹. Ecologically, mangroves are characteristic littoral plant formations, which occur along sheltered coastlines on muddy substrates at the interface of land and sea if certain conditions prevail. Mangrove forests are one of the most productive and biodiverse wetlands on earth. Yet these unique coastal tropical forests are among the most threatened habitats of the world.

Mangroves form a small but significant component of the biota of Samoa. Their occurrence also marks the eastern limit of the Indo-Pacific mangrove distribution². Three mangrove communities have been recognised in Samoa³. The most common mangroves are *Bruguiera gymnorhiza* and the red mangrove (*Rhizophora samoensis*). In Samoa, these two communities typically occur adjacent to each other: The *R. samoensis* on the seaward fringe below the high water mark and *B. gymnorhiza* on the landward side at about the high water mark⁴. One very small and rare occurrence of the *Xylocarpus moluccensis* mangrove has also been found at Sala'ilua on the south coast of Savaii. Tidally adapted plants such as saako (*Acrostichum aureum*) and fau (*Hibiscus tiliaceus*) on the landward side flank the mangrove species. The total extent of mangrove communities in Samoa has been estimated to be about 1270 hectares, or less than one percent of the land area of Samoa⁵.

In addition to fish, Samoan mangrove areas are home to a number of birds, mammals and invertebrates. For example, at the Sataoa-Saanapu mangrove site, recorded bird sightings include the Pacific Reef Heron (*Egretta sacra*), Pacific Black Duck (*Anas superciliosa*), Pacific Golden Plover (*Pluvialis fulva*), Purple-capped Fruit-Dove (*Ptilinopus porphyraceus*), Samoan Whistler (*Lalage sharpei*), Samoan Broadbill (*Myiagra albiventris*) and Cardinal Honeyeater (*Myzomela cardinalis*). Flying foxes (*Pteropus spp.*) also occur in the Sataoa-Saanapu mangroves, as do invertebrates such as the mangrove crab *Scylla paramamosian* and crabs of the genus *Uca*⁶.

Mangrove communities in Samoa are important not only as refugia for biota, but also the following reasons. Firstly, the complex root system of the mangrove trees trap sediments and act as an agent of land reclamation, forming natural breakwaters, which protect the land from wave action and coastal erosion. Secondly, nutrients in land-based runoff may be retained within the mangrove ecosystem before they reach the reefs and cause damage. Thirdly, many fish species inhabit the mangrove areas at some stage during their life cycle, especially prior to spawning. Fourthly, they provide multiple resources to the local village economies. For example, they are the source of mangrove crabs, mangrove wood for fuel and outriggers of small canoes, and bark which is used to make a dye for tapa cloth. The crab fishery contributes significantly to the subsistence and income of families living adjacent to mangrove areas.

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Ironically, while Samoans may be aware of the importance of the mangrove ecosystems, they have carried out and continued to undertake activities that lay peremptory blame to the degradation of mangroves. Growing population expansion and the need for food and shelter have exposed mangroves to ecological degradation in Samoa. Overfishing coupled with a worrying loss of fish nurseries from mangrove destruction was one of three main environmental issues facing Samoa⁷. Indeed, as early as 1963, it was recognized that mangrove swamps had previously been more extensive, and that removal of mangroves for firewood had contributed to coastal erosion⁸. The removal of mangrove vegetation was of special concern, not only because the mangroves shielded vulnerable coastlines from wave attack, but also because their disappearance would have unforeseen consequences for local sediment budgets and sediment transport pathways.

A case study of three mangroves communities

Of all the sites in Samoa which carry stands of mangroves, three have been selected for in-depth study. The Saanapu and Sataoa site is considered to be the least degraded wetland in Samoa and of high conservation value, while the mangroves at Vaiusu Bay and Moataa near Apia are both very seriously degraded⁹.

Saanapu and Sataoa mangroves

The mangroves at Saanapu are located north of a large fringing sandy spit, which indicates a predominant longshore direction towards the north-east. A stand of coastal rain forest separates the mangroves at Saanapu and Sataoa, and a tidal channel runs through both stands of mangroves. The substrate of the mangrove community is sandy to muddy with large volcanic rocks present, which are suitable for algae and invertebrate growth¹⁰. Indeed, between 1970 and 1990 there has been a decrease in the width of the fringing spit near Saanapu, with a corresponding buildup of material adjacent to Sataoa.

In 1970, the combined extent of mangroves at Saanapu and Sataoa was 28.4 hectares. The Sataoa mangroves were abutted on the south-east side by the village, on the north side by tidal flats and plantations, on the west side by coastal rain forest, and on the south side by a strip of coastal forest (Figure 1). Likewise at Saanapu, the area north of the mangroves grew plantation crops, and to the south was a narrow strip of coastal forest and the village. A causeway through the mangrove forest at Saanapu provided vehicular access to the village. The tidal channel through each stand of mangroves was irregular and, through the Sataoa mangroves, was particularly narrow.

By 1990, changes to the extent as well as the distribution of the mangroves had occurred. It is apparent from Figure 1 that the mangroves at Saanapu had extended their range away from the tidal channel except in the vicinity of the road and a lobe of plantation crops. At Sataoa, the mangroves west of the tidal channel had remained static, whereas mangroves had colonised the northern extremity of the tidal flats. Some clearance of the mangroves in the northwestern part of the village dwellings had also taken place. The tidal channel through the Sataoa mangroves had noticeably increased in width and the area of tidal flats adjacent to the mangroves had become substantially smaller. The combined area of mangroves at Saanapu and Sataoa in 1990 was 30.1 hectares: a net increase of six percent. The increase in area appears to be representative of a healthy mangrove community where the mangroves are acting to colonise previously unvegetated ground.

When the fish population occupying the Saanapu and Sataoa mangrove area was examined a total of 20 species were found to be present. Crescent perch, mullet and damselfish were the

most commonly found species. All were caught for food. Diversity indices and evenness values were calculated from the catch, and it was concluded that the fish population at the mangrove area was quite stable⁹. This result is in harmony with the many claims that the Saanapu and Sataoa mangroves are the healthiest communities in Samoa.

The size of the fish caught tended to be small, indicating that the fish probably sheltered in the mangrove areas during their immature stages. That the fish caught in the mangroves⁹ were feeding on organisms found within the mangroves area was evident by the fact that the stomach content of the fish analysed consisted of algae, crab, bivalves and worms which inhabit the mangrove environment. This data provides strong evidence that the mangroves are being used as nursery grounds for many species of fish. Fish caught from the nearshore lagoon adjacent to Sataoa were in the vicinity of 130 kilograms of fish per hectare per year. It represents one of the most productive areas in Samoa⁴.

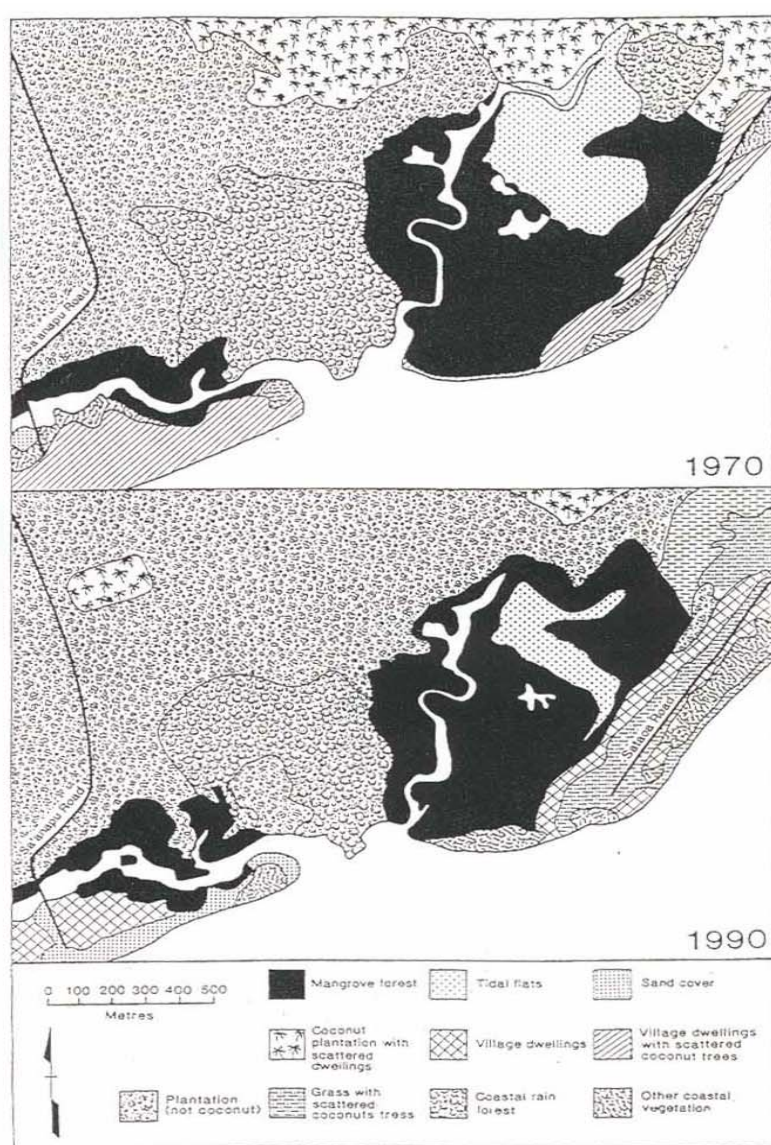


Figure 1: Changes in Vegetation Cover at the Saanapu and Sataoa Area in 1970 and 1990. Source: Author's research.

Vaiusu Bay mangroves

The geomorphological setting of Vaiusu Bay makes it an ideal setting for the development of extensive mangrove communities. *Rhizophora samoensis* is the dominant mangrove fringing Vaiusu Bay, but a few specimens of *Bruguiera gymnorhiza* are also present. Various Government offices, industrial plants, village dwellings and plantations, and remnants of coastal vegetation flank the mangroves at Vaiusu Bay.

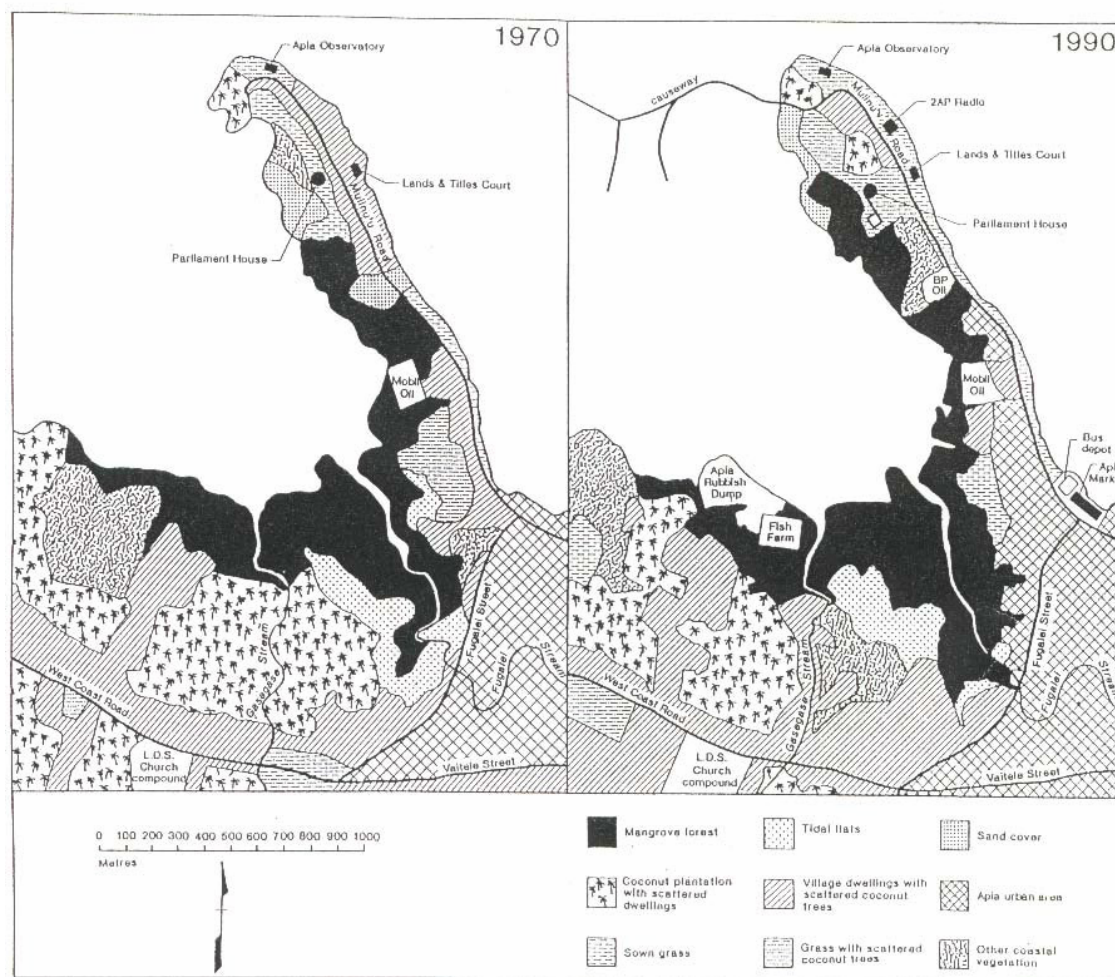


Figure 2: Changes in Vegetation cover in the Vaiusu Bay Area in 1970 and 1990.
Source: Author's research.

Figure 2 depicts the land cover surrounding Vaiusu Bay in both 1970 and 1990. The distribution of mangrove forest in the Vaiusu Bay area appears to have changed over two decades. The most obvious changes have been the clearance of mangroves to make way for the Apia Rubbish Dump, the Fish Farm, and some urban areas on Mulinu Peninsula. Alternatively, there have been notable increases in mangrove coverage on the leeward side of the Mulinu Peninsula and the landward side of the mangrove fringe along the Fugalei Stream. The extent of mangroves in 1970 was calculated to be 51.0 hectares, and in 1990 was 40.6 hectares. There has been a net decrease in mangrove extent at Vaiusu Bay of 20.4% in contrast to the increase experienced at Sataoa. Although there has been some recruitment of mangroves in favourable locations, field checking of the majority of the mangroves indicated that they were seriously stressed.

The dumping of rubbish in the mangrove areas bordering Vaiusu Bay has occurred since the early 1970s. A temporary rubbish dump existed at Sogi on the eastern side of Vaiusu Bay in the early 1970s, but was short-lived. In 1972, the official rubbish dump for Apia was relocated to the southern side of Vaiusu Bay at Vaitoloa¹¹. No sorting of waste material occurred and dangerous goods such as lead and acids in car batteries were given no special treatment. It was estimated that about 17,000 cubic meters or 3000 tonnes of waste were deposited annually at this dumpsite during the twenty years of its existence¹². During Cyclone Ofa in February 1990, waves over five meters high damaged the dump and much of the refuse were washed out to sea¹³.

The closing of the Vaitoloa dump in the mangrove area west of Apia marked a big step forward in the conservation of mangrove swamps and wetlands in Samoa¹². However, the rubbish that had accumulated over 20 years at that site has not been removed, and until the Vaitoloa dump is subject to a restoration program, leachate from the dump will continue to pollute the area. The rubbish dump is not the only threat to the Vaiusu Bay mangroves. Physical destruction of the mangroves has been caused by the rubbish dump and land reclamation works, and chemical alteration of the waters in the Bay has been produced by the rubbish dump, sewage effluents, and polluted wastewater. Although the dredging operations are physically removed from the mangroves, the presence of the causeways has restricted the flushing of Vaiusu Bay after storm events, thus trapping pollutant material in the Bay.

With this background on the degraded condition of the Vaiusu Bay mangrove area, the results of the fish survey at that location are not surprising. A total of 20 fish species were found to be present when sampling was conducted in November and December 1992, with one fish species (*Liza melinoptera*) comprising more than two-thirds of the total catch. This contributed to the very low diversity index and evenness value. In comparison to the Saanapu and Sataoa site, the results obtained for Vaiusu Bay are striking. Both areas showed similar species richness, but that the two fish communities did not have the same species composition. They shared only five species, most of which are known to live in habitats as diverse as from clear to brackish polluted waters. The common fish were the milkfish, crescent perch, trevally, goatfish and mullet (*Liza melinoptera*).

It was also noted that the fish fauna from the two sites did not have the same community structure, and that the low diversity index found for Vaiusu Bay was indicative of disturbed communities. While human impacts maybe largely responsible for the disturbance observed, it is reminded that natural factors like differences in aspect, habitat and geomorphology between the two mangrove communities also play a part in effecting the observed changes. It is noted that the mangrove reclamation is not solely responsible for the decline in fish, shellfish and crab catches. It was suggested that overexploitation of these resources for cash to meet newly stimulated demands by the villagers themselves is another factor.

Moataa mangroves

The third mangrove community examined in this study is located at Moataa west of Apia. The Moataa mangroves are bounded to the west by a spit barrier known as the Taumeasina Peninsula, which was formed by longshore drift to the northwest. The Taumeasina Peninsula is a 1.2 metre high sand bar sitting on top of about 30 meters of soft silt, indicating that sandy material has encroached onto previous estuarine areas. The Peninsula encloses a tidally influenced embayment, with a small stream flowing through the estuary which is fed by about ten natural springs on the south side of the bay. The mangroves in the estuary are predominantly *Rhizophora samoensis*.

The most dramatic changes to any of the mangrove communities examined in this study have occurred at Moataa. Figure 3 indicates that, in 1970, a large stand (9.1 hectares) of mangroves existed west of Taumeasina Peninsula. Tidal flats coconut plantations and some village dwellings fringed the mangroves.

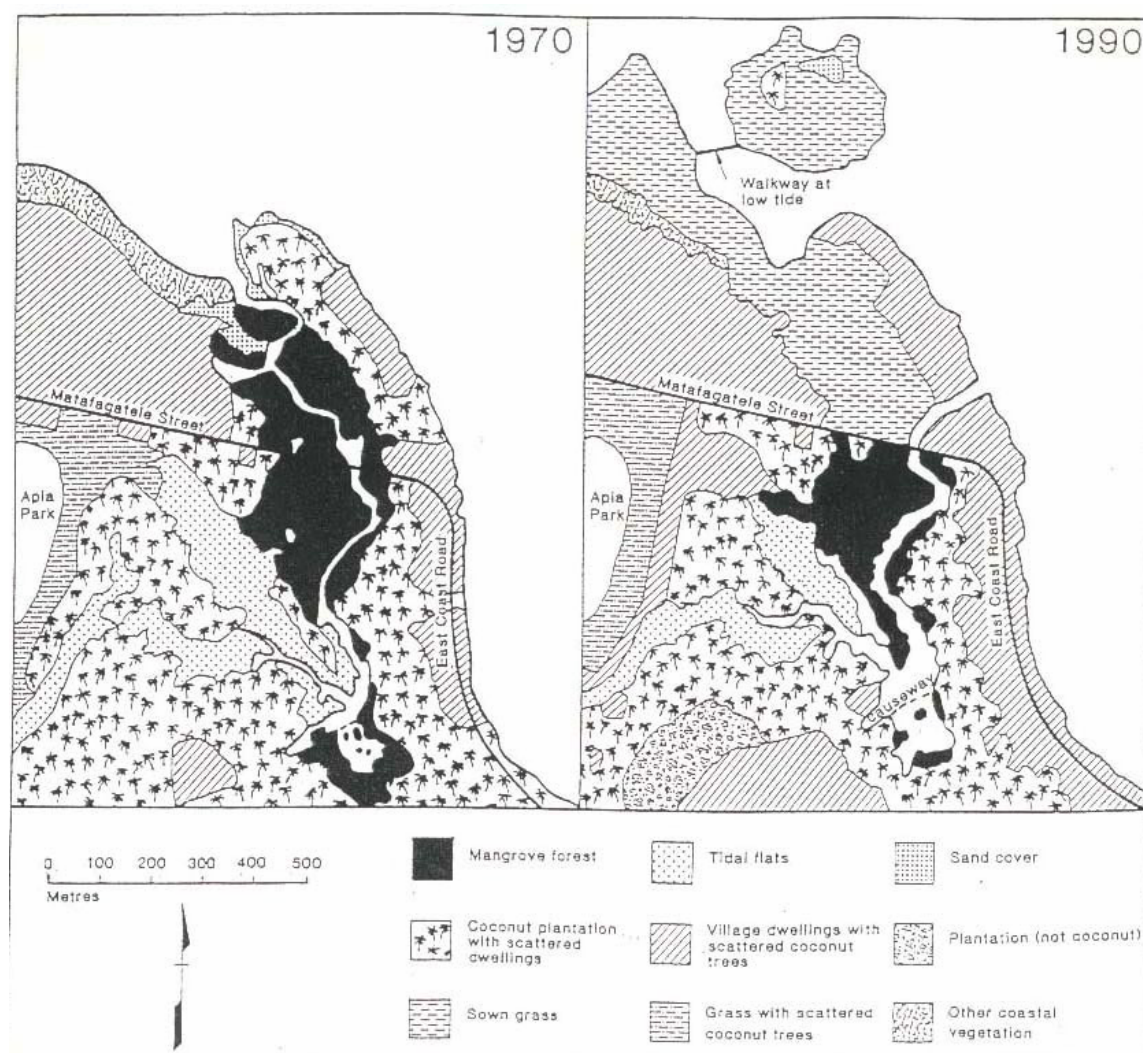


Figure 3: Changes in Vegetation Cover at Moataa between 1970 and 1990.
Source: Author's research.

By 1990, the extent and distribution of mangroves had dramatically changed. Only 5.0 hectares of mangroves remained and the drainage pattern of the tidal channel had been completely altered. The width of the mangrove fringe at the southern end of the estuary had narrowed, and there was a corresponding increase in the width of the channel. Of note was the complete disappearance of all the mangroves north of Matafagatele Road. This was due to plans to develop a tourist resort in the area. The land was reclaimed in 1974 and remained unused for 20 years. In August 1994, the village council negotiated with the government for the use of the land on a lease basis, whereupon plans were activated to convert the area to a sports complex to complement the facilities at Apia Park.

Thus about half of the mangroves at Moataa were destroyed for an aborted tourist development. There has been a long tradition of catching fish and other marine organisms

from the environs of the Moataa Stream estuary, but the richness of that resource has been severely depleted since the reclamation works started. At present there is no information available on the fish resources of the Moataa mangrove site.

Ethnohistorical evidences of change

Oral history¹⁴ is a picture of the past in peoples' own words. Practically, oral history is a tape-recorded interview, or interviews, in question-and-answer format conducted by an interviewer¹⁵.

The use of the oral history concept in this research was not aimed at considering cultural data. Rather, it is used as a means of reconstructing the environmental status of Samoa in the recent past.

Methodology

Interviews were conducted with villagers from Saanapu and Sataoa, the Vaiusu Bay area and Moataa to gain insight as to what each mangrove environment was like in the recent past. A total of forty-six interviews were conducted: eighteen from Sataoa and Saanapu, fourteen from Vaiusu Bay and fourteen from Moataa. A cross section of people were selected in an attempt to interview a diverse population to account for variations in age, gender, occupation and status within the village community, although more older people were interviewed than younger people. The interviews targeted people living directly next to the mangrove areas, as these people were assumed to interact with mangrove communities the most. Each interview was recorded on audiotape and then translated into English by the author.

According to oral testimony, the mangrove area had been, and still is, an important resource for catching fish, mud crabs, shellfish, peanut worms, freshwater eels, beach crabs and for obtaining firewood. However, in utilising this resource for meeting these human needs, changes to the mangrove environment have occurred. In relation to the changes observed in the mangrove environment, the oral history was analysed into three main areas: the differences observed in the vegetation; water quality changes in the recent past; and changes observed on marine resources around the respective areas.

Ethnohistorical evidence of changes in vegetation

The changes to the mangrove vegetation of Sataoa and Saanapu in the recent past were found to be minimal. The villagers were not aware of any major changes to the mangrove forest itself, although they did note that some of the larger mangrove trees had been blown down in the cyclones of 1990 and 1991. The informants who commented on the mangrove vegetation issue were 100% unanimous in their opinion that the mangrove area is still the same today as it had been in the recent past, both in areal extent and in health.

One resident mentioned the cutting of trees in the Sataoa-Saanapu mangrove area, and evidence of both this activity and the huge mangrove trees in the Sataoa and Saanapu area were found in the fieldwork. The fact that the Sataoa and Saanapu residents acknowledged the tree cutting activities, yet argued that the mangrove area had not changed over many years suggested that tree cutting has always been an integral part of the mangrove ecosystem, and that it has always been done on a sustainable basis.

The changes in vegetation identified for the Vaiusu Bay area were mainly related to the loss of huge mangrove trees. This occurred as a result of both cutting by locals for domestic use and through reclamation for the Apia settlement areas. Oral testimony from the older

informants in the Vaiusu Bay area recalled the presence of huge mangrove trees which were like a forest in the old days, very tall and very straight, and therefore suitable for house posts. The reporting of mangrove cutting by the younger generation in their testimonies indicated that this practice is still continuing in the Vaiusu Bay area.

The most obvious and distinctive change to the mangrove vegetation was observed at Moataa, where mangroves in the northern half of the estuary have been reclaimed for a hotel development that never materialised. That canoes were used for transportation in the mangrove area suggests how big the trees were in the Moataa area in the recent past. The fate of the huge trees was mainly for firewood, according to the oral history. While some of these big mangrove trees were encountered at Vaiusu Bay during the fieldwork, the complete absence of the *Bruguiera* trees at Moataa was striking, and reflects the severity and magnitude with which the cutting of mangroves has proceeded in the Moataa area in the recent past. The abundance of the fern *Acrostichum aureum* at Moataa now bears evidence to this mass cutting of the mangroves as the invasion of this fern takes place when mangrove areas are felled or destroyed.

Two other oral testimonies from Moataa noted that the change in the mangrove vegetation has accelerated soil erosion from the estuary edges into the stream, and the loss of trees has removed habitat for certain birds like the reef heron¹⁶.

It is clear from the discussions that there seems to be a bias in the recollections, as no one talked about the *Rhizophora* species, but only about the disappearance of the larger *Bruguiera* trees. This is because the Samoans do not discriminate between the two species of mangroves. It is their belief that the *Rhizophora* species will in time, grow large and become *Bruguiera* trees.

Ethnohistorical data on ownership and conservation of mangrove areas

The contradictory nature of the thoughts expressed on ownership and conservation concerning the mangrove areas in Samoa sums up the situation well. The varied views on the issues discussed continue to deprive the mangroves of appropriate management strategies to ensure their ecological sustainability. Oral histories from the three areas demonstrated that mangroves have been good providers to many local people over the years, and their conservation, protection and management must be given high priority. As one resident from Sogi proclaimed, the mangrove area behind his family is the story of his life, the history of his family, and the anecdote of the settlement of Sogi village.

Conclusions and recommendations

It has been demonstrated that the use of ethnohistorical evidence has provided complementary evidence on environmental changes in certain coastal areas of Samoa in the recent past, which were undiscovered until now. The correlation of some of these ethnohistorical accounts with scientific knowledge and written material were noteworthy.

It is also apparent that mangroves play an integral role in much of the marine resources of Samoa, and that marine resources contribute a large component of the average Samoan village economy. It is also apparent that the importance of mangroves has not been fully appreciated, allowing mangrove destruction to continue unabated in the past.

The key requirement in the reversal of environmental decline in Samoa is that the government, village decision-makers, and individuals throughout Samoa need to work

towards effecting change. Any suggestions made as to appropriate ways to manage environmental concerns must be structured within the framework of the faa-Samoa. The participation of village councils in management plans must be made a priority; and the issue of mangrove ownership must be clarified. The dual legal system operating in the country must be addressed.

In order to address the question of sustainable management of mangroves, it is first necessary to determine who owns the mangroves. This issue needs to be fully clarified before proper management of the mangroves can be achieved.

As a flow on from the ownership issue, the other major issue which needs to be addressed for effective mangrove management, is that of the policing of offences. At a national level, the Lands and Environment Act declares it an offence to pollute Samoan waters through discharges from floating crafts or land sources such as manufacturing establishments, or any place where they ultimately reach Samoan waters. A means of protecting the remaining wetland and mangrove areas of Samoa is given in Sections 119 to 123 of the Lands and Environment Act. However, no details of either the wording of the Act or the precise punishment of offences under the Act is given. Thus, even though the issue of mangrove ownership may have been established, regulations to enforce the Act so as to protect the mangroves and marine environment do not appear to exist.

The topics of marine management and mangrove conservation could be included in national forum discussions and talks by members of government departments with village councils. The aim should be to convince the village council to take the necessary action at village level to protect the marine environment. In this way, the mangroves and marine areas could be locally policed and protected against continued degradation.

It is asserted that every effort should be made to conserve¹⁷ all mangroves in Samoa. Furthermore, it is a belief that both national legislation and village laws should be enacted to ensure their continued existence.

Samoa is a beautiful place in which to either live or visit. However, if the people continue to operate without thought for environmental conservation and the Government of Samoa continues to encourage economic development without any thought about environmental impact, the country may not continue to provide a haven for both residents and tourists. All members of the Samoan culture need to work together to ensure that the country maintains the charm it currently possesses.

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