This report is based on observations made during visits to American Samoa from January 7-16 and July 19-31, 1970, while establishing coastal marine surveys on Tutuila and Aunu'u. Additional time was spent making comparative observations in Western Samoa.

**BACKGROUND**

Tutuila, the largest and most populous island of American Samoa, is a 20 mile long eroded ridge system of volcanic origin no more than 6 miles wide, with steep valleys clothed in vegetation and a fringing complex of coral reefs. Much of the island is still in a relatively natural state; the difficult terrain renders many areas inaccessible, and vegetation is quickly reestablished in areas previously disturbed but now abandoned. Settlements are largely restricted to the few relatively flat areas and the margins of the many bays along the coast.

Population growth and economic development on Tutuila have now reached the point where major degradation of the environment is occurring in those regions where the topography has concentrated the population. The rapid increase in population in the last 70 years (from 5,679 in 1900 to over 30,000 today) has outstripped the ability of the natural environment to cope with the wastes and land-altering activities of the inhabitants. The introduction of elements of modern technology has hastened this process, since often the adoption of compensating protective measures has lagged behind disruptive innovations.

The traditional Samoan culture developed in an environment where the few material needs of the people were easily met. Emphasis was placed on the patterns of social interaction developed within an extended family system, in which the individual's role and values were very different from those of western culture. The old ways were ecologically sensitive and in harmony with the environment. Cultural practices and taboos protected both the land and marine resources from serious overexploitation, and the people were close enough to their natural surroundings to see the cause-and-effect relationships of their activities. An improperly cultivated plot did not grow taro as well the next time. With the breakdown of the traditional culture and the increasing commercialization of activities, these traditional controls are being lost.
The problems in Samoa are in many ways typical of those in other parts of the world, and particularly in the developing nations. Cultural systems, developed in relative isolation with limited resources are now confronted by a flood of new ideas and forms of behavior and by access to the resources of other areas and the products of modern technology.

The island environment aggregates such situations both socially and ecologically. The isolation and small size of an island provide a smaller resource and population base, making it more difficult to establish and maintain a viable unit or stable system. Changes are more likely to lead to instability or the complete loss of a system element. Whether it be a pattern of family relationships or an endemic species, research and careful planning are therefore especially necessary in island areas if changes are to be successfully incorporated into the existing natural and social systems.

Ecology, as a science of interrelationships, provides a particularly useful approach to the study of the complex of problems accompanying change. While the central focus of the ecologist is on the natural environment, his view often must include man where a traditional society is intimately related to that environment or where human activities are altering natural relationships. No ecosystem is static; there is always a complex of organisms and factors in dynamic equilibrium. By studying the relationships between the parts, it is often possible to predict the effect of changes on the equilibrium, and thus to warn of harmful consequences or to plan a more desirable future environment. Before such ecological understanding can be applied, however, there must be agreement on the goals and priorities to be pursued. Reports such as this one can only raise alternatives and suggest possible consequences of those alternatives; the final choices must rest with the people and their government.

RESOURCES AND PROBLEMS

Population Growth

The islands of American Samoa are all very small, and the amount of habitable area is extremely limited. All of the local resources will be swamped and destroyed if the growth in population, now one of the most rapid in the world, is not halted. Many of the ecological problems derive from this. If the population is not stabilized quickly, it may be impossible to prevent massive environmental deterioration.

The present high level of food imports suggests that the population is exceeding the ability of the islands to support it, and the present productive base is inadequate to maintain even the present standard of living without considerable outside support. Further population expansion can only
aggravate the situation. This may be the most difficult ecological problem to solve, but it is also the most essential.

Land Management

EROSION. With steep land contours and heavy rains, erosion is a serious threat to both the land and the adjacent water areas. Any activity on land that removes the vegetation cover or alters land contours can lead to erosion, producing soil depletion, unstable land surfaces with frequent property damage, and silt and debris that clog streams, pollute drinking water, and erode reef areas. Construction sites and newly cleared land are particularly susceptible, and require special precautions and controls. There has recently been a considerable increase in the rate of land clearing for agriculture, particularly on the steeper slopes. The present land laws appear to encourage the total clearing of land in order to establish ownership. This poses a threat to considerable areas of forest, and could result in the deterioration of scenic values in the more accessible areas.

Road construction is a particular problem. The existing main roads are subject to occasional slides and have required considerable protective construction. The unpaved roads are frequently almost impassable, need repetitive grading, and are a constant source of silt and debris. The remainder of the island is even less suited to road construction, as the attempt to build a road to Mt. Alava has illustrated. The newly planned road system will inevitably involve considerable destruction, which can only be minimized with careful planning and the prompt paving and roadside planting of new construction. The road or trail improvement behind Aua, and the private road constructed with government equipment south of Pago Pago were both particularly poorly conceived and executed, and serious erosion can be expected in both areas.

AGRICULTURE. With the growth of the population and the resulting increased demand for food, traditional farming practices are subject to alterations that can have serious ecological consequences. The clearing of marginal land on steep slopes (some are over 50° from horizontal) can lead to erosion and rapid soil loss if some ground cover is not preserved, and may be unwise in any case. The western practice of completely baring the soil is also undesirable. The change from rotating plots with long fallow periods to continuous cultivation can produce not only reduced yields, but also a permanent decline in soil quality. The resulting need for fertilization will require careful research if water pollution and other damage are to be avoided. With increased population, more good land will be taken for houses and roads, further reducing the productive base. With the current lack of zoning, this loss will be greater than it might otherwise be.
WATER SUPPLY. In spite of the heavy annual rainfall, the current water supplies on Tutuila are barely adequate, with occasional rationing necessary in Pago Pago. Water collection and storage areas will have to be expanded and protected from development to preserve water quality.

WASTE DISPOSAL. In the old Samoan society, all the materials used came from the island, and returned quickly through natural recycling once they were abandoned. The present high level of imported materials, however, inevitably produces a serious waste disposal problem with such a limited land area. Old automobiles and appliances, sheet metal, cans and bottles, and plastics are or will become particular disposal problems.

Reefs and Coastal Areas

REEFS. The coastal waters and coral reefs around Tutuila are a most valuable resource, providing food, protection, recreation, and scenic beauty. The initial reef surveys conducted in January 1970 and repeated in July 1970 have demonstrated the considerable variety of reef types surrounding Tutuila, with a diverse and sometimes rich marine fauna and flora. Areas of particular interest included Nuuuli, Aumuu, and the southwestern coast beyond Leome, but many other areas and deeper waters have yet to be examined. These survey areas will serve as benchmarks to monitor changes in the reef biota over time at different points around the island.

Tropical reefs are particularly susceptible to ecological damage. Once damaged or destroyed, they can take 30 to 50 years to recover under optimal conditions. The occurrence of reef breaches and dynamiting for fish, together with dredging, pollution, and silting, threaten considerable reef areas around Tutuila. The reefs in Pago Pago Harbor have been seriously affected where they are not already destroyed. Intensive shell collecting, and even walking on the reefs, are having a noticeable effect on the reef flats in the more popular areas such as Nuuuli. The reef at Utulei so accessible to tourists has already been damaged by dredging, and one local observer reported a noticeable decline in the reef biota there over the last five years.

PALA LAGOON. One unusual coastal feature on Tutuila in the large Pala Lagoon near Nuuuli. Parts of the entrance have already been dredged during construction of the adjacent airport, and further development has been proposed for a fuel barge pier and possible recreation area. Features such as Pala Lagoon, with their shallow waters, estuarine conditions, and high productivity, are often breeding and nursery areas for commercially important fish and other animals. Deepening the bottom might significantly alter circulation patterns and bottom productivity, with uncertain effects on breeding conditions. The inevitable pollution from the barge traffic
would be particularly hazardous to lagoon life. The turbid water and poor circulation make the lagoon a difficult area to improve for tourists or recreation, and dredging would only aggravate the problem.

WATER POLLUTION. The lack of proper sewage collection and treatment is evident in many places. Water circulation in Pago Pago Harbor is poor because of its long narrow configuration and the small tidal amplitude. The wastes from the urban population and canneries have seriously polluted the water, although the new sewer line under construction should help to alleviate the problem. Sewage from ships in the harbor will be more difficult to control. Many villages lack any sanitation facilities, as a morning walk along the shore will demonstrate. With the increased population, such a lack can become a serious health hazard.

The proposed introduction of fertilizers and insecticides into common agricultural use could seriously threaten many reef areas. The heavy rainfall and steep terrain would allow much of these materials to be washed out onto the reefs, upsetting the reef ecology. The land and water areas cannot be treated separately, but must be considered as a unit.

CIL POLLUTION. Oil pollution in Pago Pago Harbor is a continuing problem. Large areas of the harbor are often streaked with oil which comes primarily from the fueling dock and the boats off the canneries. In July, oil deposits banded the shoreline. Whether this resulted from the recent sinking of a fishing boat at the cannery, or represented the cumulative effect of many small spills was not possible to determine.

DREDGING. Dredging activities in the harbor, at Nuulii, and at Faga'itua Bay have produced serious silt pollution and turbidity in the adjacent waters. Rain runoff and wave action continue the siltting problem even after dredging is halted. Dredging often upsets the normal water circulation patterns through and behind the reef. At Utulei, dredging for the swimming beach has produced a large basin with inadequate circulation, resulting in heavy silt deposits and murky water in an area intended for tourists and recreation.

Social and Cultural Factors

CULTURAL CHANGE. The traditional Samoan society is being swamped by the flood of American wealth, power, and influence, a phenomenon typical of many parts of the world today. The old social structure and value system are giving way to individual independence and materialism, especially among the young. The old ways are associated with poverty, discomfort, and arbitrary constraints on individual action. Traditions, crafts, and historically-significant sites are vanishing because there is no concern for the past.
One result of the introduction of American living standards and support has been an increased dependence on imports and outside aid. It is almost impossible to buy fresh fish on Tutuila, because the Samoans find it easier to buy imported canned products than to fish their own rich waters. Where the old Samoans planted and stored food for hurricane emergencies, it is now easier to rely on American disaster relief. American wealth appears almost unlimited to the Samoan village, so there is little incentive to take any initiative as a community, or to plan for the future.

Traditional elements of environmental control are also being lost, while new controls are slow to replace them. The village chiefs were responsible for the development and management of their family lands, and understood through long experience the limits of the resources. But now new ideas, equipment, and construction methods are adopted without their liabilities and limitations being understood.

EDUCATION. The educational system in American Samoa is one of its greatest assets, but also a serious responsibility. New ideas and values can easily be communicated to all the villages through the educational television network. Unfortunately, the system has been largely underutilized and misused. Creative programming adapted to local conditions and needs beyond the narrow limits of formal education has been stifled for lack of funds. The American programming used instead has only intensified the clash in values and accelerated the destruction of Samoan culture.

A central goal of the Department of Education has been to raise the Samoan school system to American standards and to prepare the large number of young people who will emigrate for life in America. While the highest possible quality should certainly be aimed for, too great an emphasis on America and American ways can instill a sense of American cultural superiority that will undermine the Samoan's sense of dignity and destroy his pride in his past. If everything a student learns in school is American, while his own heritage is seldom mentioned, he will naturally tend to look down on the latter. This tendency is accentuated by the predominance of Americans on the educational television staff and the large number of American teachers who come for only a few years. Samoan education should include the study of their language, social organization, history, and legends just as Americans learn their history, civics, and literature.

SCENIC VALUES. One other important resource of Tutuila, although less easily defined than the others, is the scenic beauty and the quality of life and environment that attract tourists. Because of the great distance of Samoa from continental areas, visitors will only come if there are distinctive features to the Samoan life and landscape. These attractions now exist in the towering green cliffs, the curving bays, the clear warm waters and beautiful reefs, and the fascinating culture of Polynesia. But much has already
been lost, and much more is in danger. Few traditional fale (houses) remain. Concrete and corrugated iron may be easier to build with and sturdier in hurricanes, but aesthetically they leave much to be desired. The villages often lack the neatness and order of those in Western Samoa. The encroachment of road construction and agriculture on the mountainsides overlooking the villages is also diminishing their scenic appeal, particularly around dramaticPago Pago Harbor. The problems with the waters and reefs have already been mentioned.

RECOMMENDATIONS

Before dealing with specific problems, it is necessary to define the general goals for the Samoan people and government on which these recommendations are based.

1. Long-term environmental stability, with ecological restoration compensating for any damage that occurs.

2. Economic self-sufficiency, with a level of productivity within the islands adequate to support the desired standard of living.

3. A high quality of life and environment, in which the people enjoy the basic human rights in healthy, attractive surroundings.

4. Preservation of the distinctness of Samoan culture, in which the strengths of the past are not lost in preparing for the future. The special features and potential of the Samoan islands and people should be reflected in social and material adaptations distinct from the homogeneous "Western Civilization".

Government

1. COMMUNICATION WITHIN GOVERNMENT. The present government structure is not ecologically sensitive; each department deals only with its specialized area of responsibility. Regular channels of consultation and discussion are needed between departments, especially between Public Works, Agriculture, and Marine Resources.

2. PLANNING. Provision should be made for a master plan and appropriate zoning controls, possibly applied by a planning commission. An alternative would be to have a professional planner within the government with whom the village leaders and land-owners would be required to consult before proceeding with major developments.

3. ENVIRONMENTAL STANDARDS. Legislation should be enacted and executive policy established setting environmental goals and standards, and establishing controls on certain types
of development. Government departments should be given the responsibility to consider these environmental goals and pertinent ecological factors in executing their functions.

4. ECOCLOGICAL OMBUDSMAN. An ecological ombudsman could be appointed to act on complaints and on his own initiative to halt environmentally detrimental activities and to institute remedial measures. He should deal directly with all government departments and with the legislature and village chiefs to implement defined ecological goals, with the right of appeal in serious cases.

5. CONTINUING EDUCATION. Lectures and short courses on ecological topics should be organized for appropriate government officials, members of the Legislature, and village chiefs. Instructors can be drawn from the various departments, from Samoans knowledgeable in traditional concepts and methods, and from visiting specialists.

6. RESOURCE SURVEYS. General surveys are needed of the resources of American Samoa, including inventories of the terrestrial and marine flora and fauna, mapping of forest and reef areas, agricultural, soil, and hydrological surveys, and determination of scenic, archaeologically significant, and scientifically important areas. Research should be encouraged into the ecology of the islands and reefs, and the potential of new crops and aquaculture.

Population

7. EDUCATION ON POPULATION PROBLEMS. Programs on population ecology should be arranged on educational television for both the school and evening adult audiences. The people must be given the ecological reasons for population control, what the alternatives are, and what island life would be like with too many people.

8. BIRTH CONTROL. A team including anthropologists, sociologists, and medical specialists should be brought in to work closely with local Samoans in recommending a birth control program to which the people will be receptive.

Land Management

9. ROADS. Road building in steep areas and construction that alters land contours should be minimized. All roads should be paved to stop the continual erosion and regrading. Better attention needs to be paid to drainage in road design.

10. CABLEWAYS. Cableways might be a better means of providing transportation to some villages on the north shore, since they are fast and do not disrupt the terrain. The existing cableway could be used as part of a network. Heavy materials would still have to be transported by sea, or eventually by helicopter.
11. CONSTRUCTION. All new construction, including that by the Department of Public Works, should be inspected to ensure that the necessary precautions are taken for environmental protection. The Department of Agriculture should develop a nursery of soil-retaining plants to be planted immediately on all slopes exposed by new construction.

12. LAND CLEARING. Some measures may be needed to control the clearing of steep slopes for agriculture in areas where erosion is shown to be a problem. Land ownership laws may need reform to eliminate the complete clearing of land as a means of establishing ownership, and to permit more productive patterns of utilization.

13. AGRICULTURAL PRACTICES. The Department of Agriculture should establish an experimental farm in a steep area to develop better soil-retaining techniques such as terracing or strip farming, and to try out new crops such as fruit trees that will require less soil disturbance. Farmers should be discouraged from baring the soil whenever possible.

14. FERTILIZERS. To minimize water pollution from runoff, fertilizers for agriculture should be of a relatively insoluble type that is worked into the soil and releases nutrients gradually. Applications should be selective, not massive (the same applies to insecticides).

15. WATER SUPPLY. A hydrological survey should be conducted to determine the watersheds and catchment areas necessary to maintain and expand the present supply of domestic water. These areas can then be incorporated into parks or conservation areas where development will be minimal.

16. CONTROL OF POTENTIAL WASTES. Since the majority of solid wastes for which there is a disposal problem come from imported materials, control can begin before importation. Containers or packaging that cannot be reused or easily destroyed can be prohibited. Large objects such as automobiles and appliances would be subject to a "disposal tax" upon importation to pay for their eventual removal.

17. WASTE DISPOSAL. Since land in American Samoa is so scarce, disposal might best be accomplished by incineration and/or dumping at sea, unless there are areas where land fill is particularly desirable. Plastics and floating materials should not be dumped at sea, as they will wash ashore. It may be practical in Samoa to sort wastes, using crushed glass for road fill, incinerating plastics, composting garbage, and dumping metal at sea. No open dumping should be permitted on land or reef areas.
Reefs and Coastal Waters

18. REEF PROTECTION. The reefs should be surveyed, and a series of preserves, parks, and controlled-use areas (fencing) established. Care must be taken to preserve viable ecological units, including adjacent land areas and watersheds as necessary. Laws are needed to permit the control of activities found detrimental to reefs, such as the overcollecting of corals or shells, or silt runoff from construction sites.

19. DREDGING. Dredging must be strictly controlled, with silt transport from the site carefully monitored. Dredged material should be removed entirely and stored if necessary on land. Newly-filled areas should be protected from erosion along their margins. Silt should not be allowed to contaminate living reef areas. Water circulation patterns should be watched carefully, and the creation of stagnant areas avoided.

20. UTILIZATION. The reefs and coastal waters are at present an under-utilized resource. Efforts should be continued to establish a local fishing industry. Investigations should also be conducted to determine the feasibility of aquaculture, particularly of animals such as lobster or shellfish whose high price per unit weight on the world market might make fresh or frozen export by air economical.

21. PALA LAPOON. The unusual nature of the Pala Lagoon habitat makes it an area to be developed with great care. Its present possible role as a nursery for juvenile marine life, and its potential for aquaculture should be evaluated before dredging it extensively or building industrial facilities.

22. SEWAGE TREATMENT. Small sewage treatment plants are needed in the developed areas, with outfalls going out beyond the reefs. No outfalls should be permitted in Pago Pago Harbor because of its poor circulation. Villages to small to warrant treatment plants should be helped to install simple septic tank or chemical systems of a design acceptable to the villagers. Previous attempts to encourage chemical toilets have apparently not succeeded, perhaps because they were inconvenient and represented too great a change from traditional habits.

23. OIL POLLUTION. Oil pollution incidents can be monitored from Mt. Akaa, and penalties should be strictly enforced. An oil boom and small clean-up system may be necessary around the fueling dock, and for harbor accidents.

Social and Cultural Factors

24. SCENIC VALUES. The natural beauty that makes Samoa so attractive to tourists must be recognized in planning and protected from impairment by development. Particular attention should be given to controlling construction and agriculture on the higher slopes, especially around Pago Pago Harbor, and to preserving and enhancing the natural aspects of the coastline.
31. TOURISM. The development of a tourist industry in Samoa will be most compatible with the other needs and desires of the people if it is selectively directed towards those who are interested in different places and cultures, rather than those just looking for another luxury resort. Samoan-style accommodations, trails and reef preserves, and a chance to experience the friendliness and hospitality of the Samoan people should be emphasized.

32. EDUCATION IN ECOLOGY. An ecologist should be appointed in the department of Education to help train science teachers and to develop programs in ecology, marine biology, and island studies for the educational television system. Evening programming should also be developed to increase the general awareness of and concern for environmental, social, and population problems. There may now be staff in the Department of Education who could be assigned some of these responsibilities.

33. EDUCATION IN SAMOAN CULTURE. Greater emphasis should be placed on the Samoan language and cultural heritage in the formal instructional program.

34. CULTURAL CHANGE. Specific recommendations are not within the scope of this report, but some general comments follow. The basic problem is one of a clash of value systems. The traditional Samoan ways cannot easily adapt to the new needs and influences of a world that is physically unified, while American values are supported by imported wealth and power. The government, large businesses, central educational system, etc. are American in style and personnel. Unfortunately, the American values most often adopted are the evident material ones, while Samoan concepts of human happiness and social responsibility, which may be more desirable in an island society than their American equivalents, are lost.

What is needed is to consciously aim towards a new value system, based on the worth of each human individual, balancing the advances of technology and material life (American) and values making for richness in social life (Samoan). Modern technology should be adopted selectively only where it can make a significant improvement in Samoan living standards. The educational system, government policies, and attitudes of the American administrators should encourage unity in diversity; recognizing that the differences between peoples are something to be proud of and to share for the benefit of the whole society. The final choices, of course, must rest with the people themselves. A healthy synthesis of values, however, can only come from a sense of human dignity, particularly among the young Samoans, based on the recognition that their traditional culture is equal in human significance to, if different materially from, the culture imported from America.
CONCLUSIONS

The problems in American Samoa outlined above call for an integrated program of environmental management. The land area is so limited that careful decisions are needed to prevent the waste of this scarce resource and to protect the three main island activities of agriculture, fisheries, and tourism. Parks need to be set aside for conservation purposes and for tourists. Prime agricultural land should not be lost to housing or commercial development if other areas can be adapted to these uses. Development of the land must not be permitted to endanger the reefs or their associated fisheries. Careful consultation with each village will be required, together with provisions insuring that all will benefit equally from the results. One village will not contribute land freely to a scenic park while its neighbor alone receives material benefits from that park as the site of a tourist hotel.

In a program of environmental management, education must play a central role, since so much of the application of ecological principles is done by individuals. Without popular support and participation, no such program can succeed. American Samoa is in a unique position to implement such a program through its educational system.

There is much to be learned from the traditional Samoan culture which has successfully coexisted with the island environment for hundreds of years. The old ways should not be discarded lightly, and there is much in the local taboos and practices of use to the modern environmental planner. To lose this cultural wealth would be a tragedy.

What is needed is to develop a new ecological balance between the society and the environment. The functions formerly served by the traditional practices, the wisdom of the village chiefs, and the closely-knit structure and communication of village life must now be incorporated in some form into the structure of government, the process of education, and a new sense of community spirit. The American pattern of specialization, by itself, has proven to be unresponsive to ecological and cultural needs.

American Samoa could potentially be an ideal model system of ecological management. It has on a small scale most of the problems of a developing nation, while its political status gives it both the assets and liabilities of access to American society and government. Its primary resources are its agriculture, fisheries, and scenic beauty, all of which are vulnerable to environmental mismanagement. The prosperity and happiness of the Samoan people depend on the innovative solution of the ecological problems of their islands, and the rest of the world would surely benefit from their example.
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