Agricultural diversity and traditional knowledge as insurance against natural disasters

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Introduction

Disasters are a fact of life in the Pacific. They are the cause of loss of life, resettlement and increased rural to urban migration, destruction of crops, animals , personal property and the natural environment, famines and increased malnutrition, disease epidemics, and in general, widespread suffering. Natural disasters which affect the island nations and territories of the Pacific include hurricanes, floods, droughts, landslides, earthquakes, disease and pest infestations, seismic seawaves, volcanic eruptios, frosts, fires and local tornadoes. For some types of disaster there is very little that we can do to prevent them, but given the right type of planning and technology, some such as floods or fires can be prevented or minimized. For some we can prepare for their eventuality, minimize the resultant damage, or insure optimum and most rapid rehabilitation.

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Role of traditional technology and knowledge

It is the belief of the authors of this paper that in terms of prevention preparedness and recovery or rehabilitation from natural disasters in the Pacific Islands that local traditional agricultural diversity and traditional knowledge have considerable value in helping island societies solve the problems presented by natural disasters.

At present, however, there is an increasing reliancy by individual island societies (eg. Villages, outer islands, etc) on central governments and overseas aid (either in the form of goods or money or expertise) to provide disaster planning and to provide relief and rehabilitation aid. In short these societies are becoming less self-reliant. If this continues we believe that this increasing dependence both by island societies on their central government or by island governments on overseas aid will:

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1. make the various Pacific Island societies excessively dependent on agencies outside their control and
2. in doing so islands are failing to use traditional means of overcoming the effects of natural disasters and will eventually lose the valuable knowledge.

This concern over the general loss of self-sufficiency is echoed by Eckholm (1976:181) in his book *Losing Ground Environmental Stress and World Food Prospects*, where he asks: "are food gifts to needy countries moral or even responsible if they encourage greater tragedy in the future? Similarly, Susan George (1976:192) in her book *How the Other Half Dies: The Real Reasons for World Hunger* asks whether the use of food aid is always an act of charity and believes that such contributions to the needy are often tied to gaining political leverage over the governments and to the expansion of the donor countries' commercial markets. This relationship also seems to hold true between isolated /rural areas and the urban/ commercial centers and seats of governments in the Pacific Islands where disaster relief serves a similar functions of gaining political leverage and expanding the market for store bought imported goods. Foe example

after 'Hurricane Bebe' in October, 1972 thousands of dollars worth of baby milk formula were given to Fiji. This no doubt led to an expanded market for this product despite the fact that one of the major factors responsible for increasing child malnutrition in the Pacific is the decreasing incidence and duration of breastfeeding (Thaman, 1979). While islanders seem to be placing decreasing emphasis on the preservation of marine products and the switch of emphasis to increased dependence on marine resource utilization in times of stress, they are increasingly willing to sit and wait for relief supplies of imported tin fish .... This again increasing the taste for and dependence on an imported substitute for locally obtainable resources.

Similarly, one of the authors while surveying the damage in Kadavu from Hurricane Bebe which struck the Fiji Group earlier this year noted that islanders were "sitting" and waiting for hurricane relief supplies instead of eating the uprooted taro and cassava which were abundant at the time.

A recent report to the Fiji Government on *Population, Resources and Development in the Eastern Islands of Fiji: Information for Decision-making*, (UNESCO/UNFPA, 1977:165), when discussing the widespread impact of natural disasters in the eastern islands of the Fiji group, remarks that in the past interisland trading systems, food preservation techniques, more appropriate non-coastal settlement patterns, diversified cropping, shift of food emphasis to wild resources etc., seemed to ward off widespread starvation. In other words, most islands seemed to be highly self-sufficient, and as late as the late of 1940's.

Offers of relief food to be paid in case even on delayed payment, were only accepted with reluctance and often refused. Similarly with housing it was estimated that 90 percent of housing was damaged or destroyed on the islands affected by the 1948 hurricane, yet five weeks later Ratu Sukuna could report that houses were practically all repaired and villages cleaned up (UNESCO/UNFPA 1977:192).

The report goes on to stress the increasing state of dependence by noting that:

> The shift to the modern pattern of very substantial dependence was therefore not an immediate consequence of colonialism. Greater vulnerability came before dependence. Villages themselves became more vulnerable first with the move to the coastal locations, and second with the adoption of light-constructed wood and iron houses by a minority. Consumption patterns became more vulnerable as a growing proportion had to be supplied by cash incomes and as the more fragile cassava replaced the yams and taro displaced from the best soils by coconuts. In cases of major disaster the central government provided a small measure of relief food supplies to villages as early as the 1880's but in the main reliance continued to be placed on local resources including wild food for many more years.

In short hurricane relief policy as it is currently being applied in the islands seems to be creating increased dependency by the smaller outlying island groups in both their own governments and commercial/import sector and as well as magnifying national dependence on the industrial powers.

There is no doubt that the economic, social and nutritional impact of natural disasters in the Pacific is great, and accordingly there is a need to design development strategies with the natural hazard problem in mind. But as Burton, Kates and White (1978:78-79) state in their book *The Environment as Hazard.*

> The failure of industrial nations to stem the rising tide of loss is a salutary lesson suggesting that the way to reduce that vulnerability of less-developed nations does not lie in emulating the experience of industrial nations. Where this has been done - in reliance on engineering works in Bangladesh and Sri Lanka in providing extensive central government relief in Tanzania or in improving meteorological skill without the social inability of warning in Bangladesh - the results have been costly.

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They go on to say that:

> There are alternative paths that may effectively preserve the knowledge and wisdom of the traditional society while adapting it to the needs and capabilities of the transitional society and blending it with new and established technologies. Any particular path is carefully structured by the special characteristics of the hazard concern and the unique vulnerability of the society in question. While we assert the existence of alternatives, we cannot point to well-trodden paths; these await discovery and development by processes of individual, collective, national, and international choice. (Burton, Kates and White, 1978:79-80).

Accordingly, it is the expressed purpose of this paper to put forward some ideas that might help Pacific planners and policy makers to evolve a more integrated approach to disaster planning, prevention, preparedness and rehabilitation through the marriage of traditional knowledge and technology with modern technologies and strategies. We will do this by looking at what we feel are some of the types of traditional knowledge and technologies that might be of value in minimizing the impact of natural disasters in Pacific islands and then suggesting how their usefulness relates to different types of natural disasters.

Types of traditional technology and knowledge

There is a great range of types of traditional technology and knowledge which seem to have potential value in lessening the detrimental impact of natural disasters in the Pacific islands. Some of these and a tentative estimate of their values in terms of disaster preparedness, prevention and rehabilitation are presented in the matrices in Tables 1 and 2. The balance of the paper will look at each type of traditional technology and/or knowledge and its value in terms of minimizing the impact of natural disasters.

Utilization of wildland resources

Wildland resources (A in Tables 1 and 2) are traditionally very important sources of dietary diversity (eg. Wild yams, ferns, nuts, grubs, insects, fruitbats, birds, wild pigs, nuts, fruits, greens, etc), housing materials (sago fronds, bamboo, grass thatching, timber, etc) and other important products such as fold medicines, firewood, etc. The importance of these resources has been stressed by numerous writers (Belshaw, 1957; Barrau, 1958 and 1959; Thaman, 1975, 1976b and 1979; Clarke, 1965; Hiroa, 1950; Lessa, 1977; Thaman and Ba, 1979; UNESCO/UNFPA, 1977; Brookefield, 1964; Brookfield and Hart, 1971; Bulmer and Bulmer, 1964). Their values in terms of prevention of damage or preparedness (Table 1) and for recovery from disasters (Table 2) is ranked very high.

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Their value, when cultural resources, eg. Crops, imported goods, fuel and medicine, homes etc. are destroyed or unavailable, is obvious, and the very existence of these resources provides insurance against predictable disasters and associated shortages of basic human needs. Furthermore, Clarke (1965) stresses that groups in New Guinea who have conserved their forest and wildland areas and who continue to eat "forest foods" have much more variety in their diet and are generally better nourished. Under the state of increasing reliance on hurricane relief supplies such as cabin biscuits, sugar, tinned fish, etc., not only will island communities become increasingly dependent on these imported items, they will also begin to suffer from malnutrition as a result of the lack of dietary diversity. For example, approximately 20 per cent of Fijian males enlisting to join UNIFIL forces in Lebanon were suffering from iron-deficiency anaemia (a disease which is generally restricted to women and which usually results from a lack of green leafy vegetables).

In short the utilization of wildland resources seems to be critical national and regional importance in terms of planning for natural disasters. In ensuring the continuing use of these resources two things must be done:

1. areas of natural vegetation must be preserved and protected as reservoirs of valuable food and other culturally valuable resources; and
2. the education system (both formal and informal) must ensure that Pacific people do not lose their traditional knowledge relating to the use of these resources.

Utilization of aquatic and marine resources

Aquatic and Marine Resources (B on Tables 1 and 2) also have a very important role to play in terms of natural disaster planning. They are generally minimally affected by most natural disasters, and like terrestrial wildland resources, provide excellent and easily accessible sources of food which can either be preserved, in case of the eventuality of a disaster, or can be used on an accelerated basis during the rehabilitation stages. The increased emphasis on marine foods after hurricanes in Fiji (UNESCO/UNFPA, 1977:171), during periods of drought in Papua New Guinea (Belshaw, 1957:92), and during frequent periods of food shortage in the low-lying atolls in Micronesia (Weins, 1962; Spoehr, 1949; Pollock, 1970 and 1976) has been stressed by numerous writers.

The importance of these resources can not be overstressed in terms of their role in natural disaster planning, and governments might possibly:

1. select areas which may be protected as gene pools or breeding grounds for aquatic and marine food organisms;
2. through legislation protect river, lagoon, reef, continental-shelf and deep sea (pelagic) marine resources from overexploitation and detrimental harvesting practices, both by local subsistence and commercial ventures; and,
3. ensure that the education system teaches younger

generations both sound ecological practices and the traditional fishing and foraging technique that are necessary to optimally utilize these resources. Klee (1976) in an article about "Traditional Time Reckoning and Resource Utilization" in the Caroline Islands stressed the fantastic reservoir of traditional knowledge and the use of marine resources which is being lost due to what might be termed inappropriate education and planning.

Shifting cultivation

Shifting cultivation (C in Tables 1 and 2), is the dominant agricultural system in most of the Pacific islands, is characterized by:

1. high crop diversity;
2. little or no input of expensive imported technology such as mechanization, inorganic fertilizers, pesticides, herbicides, imported hybrid seeds, etc;
3. the control of pests and weeds and the improvement of soil fertility and structure through the regeneration of fallow vegetations;
4. the use of forest or wildland resources for food, housing materials, firewood, medicines, dyes, oils, fish stupificants, etc; and
5. in general it is an agricultural attempt by man to recreate the stability and diversity of a natural forest ecosystem, i.e. creating a stable 'tropical agroecosystem' (Janzen, 1973).

Clarke (1977) in his article on "The Structure of Permanence: The Relevance of Self-subsistence Communities for World Ecosystem Management" stresses that these "paleotechnic" systems have a state of permanence and that only when degraded by "neotechnic" systems such as cash cropping, mechanization, etc. do they begin to lose their adaptive diversity, their genetic resources, their high energy input-output ratios (i.e. high food output per energy input) and their low output of environmental pollutants (pesticides, herbicides, fertilizers, etc.) Along with this societies often lose their sense of equality and autonomy when the traditional agricultural systems are degraded.

The agricultural diversity of shifting agricultural systems in the Pacific is well documented (Clarke, 1965 and 1977; Barrau, 1958 and 1961; Brookfield, 1964; Brookefield and Hart, 1971; Thaman, 1975, 1976 a and b, 1976/77 and 1979; Fisk, Hardaker and Thaman, 1976). This diversity gives a community insurance against natural disasters as different plants and different varieties of the same plants have differing susceptibilities to natural disasters (e.g., cassava is much more prone to hurricane blow-down than taro) and varying seasonalities which help to ensure that some food will be available after most disasters.

Other advantages of shifting cultivation systems include:

1. lessened susceptibility to devastation by pest and disease epidemics due to intercropping (monocropping which is characteristic of modern agriculture where large fields of a single plant type are planted together is much more susceptible to pest and disease attacks);
2. lessened susceptibility to hurricane and high wind damage because small plots isolated by stands of natural vegetation tend to be less prone to wind damage;
3. protection against erosion because the multi cropping system where trees, tall plants and short plants are interplanted with creepers such as yams, sweet potato or pumpkin tend to protect the soil from accelerated erosion and resultant landslides. Waddell (1973:28) in fact states that the traditional agricultural systems of the Raiapu Enga in highland Papua New Guinea "involve a high degree of technical elaboration designed to increase soil fertility, regulate moisture availability and minimize erostion". He goes on to say that "each territorial group can be viewed as a local ecological system, in the sense that each population subsists almost entirely on the resources of its particular territory".

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Pigs, chickens, ducks, dogs and other animals are also important compoents of many shifting agricultural systems, and also provide protection against the effects of natural disasters. As Waddell (1973:30) stresses when referring to the keeping of pigs in the Papua New Guinea highlands:

They provide an important source of protein, while feeding them highly perishable subsistence foods creates an effective, if inefficient means of storing readily available energy 'on the hoof', thus serving as insurance against periodic risk of crop loss from frost and other environmental hazards.

Shifting agricultural systems are also sources of food and other non-food items such as fine mats and tapa cloth which are important items of ceremonial exchange, which

help to maintain alliances and cement social relationships. These relationships may in turn provide insurance in terms of assuring help from exchange partner in times of natural disasters.

In summary shifting agricultural systems with their characteristic crop diversity, their ecological approximation of natural ecosystems and their relative degree of permanence indicates that these systems have existed through countless natural disasters and have attributes that make them particularly well suited to the Pacific islands where disasters are commonplace. Consequently, governments, agricultural departments and educational system as well as development planners should look at these systems not as impediment to national development but rather as systems that may provide the bases for a type of agricultural development which is not so susceptible to destruction from natural disasters. Finally, diversified cropping whether as part of shifting agricultural systems or other agricultural systems must provide some security against the effects of disasters.

Terracing

Terracing of some kind (D in Tables 1 and 2) was extensively used throughout most of Melanesia, Papua New Guinea, New Caledonia, New Hebrides, Fiji (Barrau, 1958:21) and Hawaii, and seems to have had considerable value in minimizing the impact of natural disasters. Walters (1960) stresses that bamboo palisade terraces in Fiji were used to secure a more even distribution of water over unstable steepland soils and to check the washing of fertile soil to the botton of the slopes. Brookefiels (1964:22) similarly mentions the construction of temporary "soil fences" which gave a terraced effect and diminished the gradient as much as five percent, the use of closely spaced *Cordyline* bushes to hold the soil, and in the Baliem Valley, the construction of stone walls across the slope (all of these examples from New Guinea).

Not only does terracing minimize run off erosion and landslides resulting from hurricanes, heavy rainfall, etc. but it seems to also help prevent flooding, and, along with other ingenious agricultural techniques such as the crescent-shaped yam gardens on the hillsides in New Caledonia, seems to act as an excellent means of preserving moisture during times of drought and in arid areas of the Pacific (Barrau, 1961:21).

Unfortunately, these techniques are diminishing "because of the work they entail, and arduous work is incompatible with the present way of life among the islanders" (Barrau, 1961:21).

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The planning implications of this seem to be that governments and/or communities themselves must make a firm commitment in terms of hard work to reintroduce terracing as a means of providing both increased agricultural production and insurance and protection against natural disasters. This has worked in China where through terracing and reworking previously naturally degraded areas, work bridges such as Tachai (formerly China's Red Banner agricultural commune) have increased production and decreased their susceptibility to drought. Terracing might be especially important in many Pacific island groups with recent volcanic soils which have a very high initial rate of erosion (Ollier and MacKenzie, 1974:63-68).

Forest reserves

To put it very briefly, forest reserves not only provide protection against landslides, erosion, flooding and hurricanes (in terms of acting as windbreaks), but it has also been shown that three cover helps to reduce the severity of radiation frosts, which have been the cause of famines in Papua New Guinea (Brown and Powell, 1974:6).

As mentioned above, forest reserves also have a very significant value in providing food resources, housing materials, fuel, fork medicines, etc. which are of considerable importance in disaster recovery. In fact the Monagai-Angioang of Papua New Guinea even looked on secondary forest regrowth as a "garden mother" that is as something out of which they would get later sustenance.

In short, many Pacific island cultures do keep some kind of forest reserves, and it is in the best interests of future generations for Pacific Island Planners to ensure that forest reserves are set up both in inland areas as well as along coasts, where mangrove and strand forests provide food, habitats, for food species and protection against coastal erosion.

Tree planting

Tree planting (F on Tables 1 and 2) , like forest reserves serve to control erosion, provide windbreaks, help in the regeneration of degraded land, are protection against radiation frosts, and provide crop and dietary diversity which are important disaster insurance. Papua New Guinea highlanders purposefully plant *Casuarina* and *Dodonea viscose* to help in the regeneration of soil fertility and structure and many other Pacific island societies have planted fruit trees such as breadfruit, coconut, pandanus, Polynesian vi-apple, Pacific lychee, mango, citrus, Malay apple (*Syzygium malaccense*) etc., as well as a very wide range of culturally valuable non-food trees (Barrau, 1958

and 1961; Powell, 1977; Thaman, 1975). Unfortunately, as the need for firewood increases, as people become more involved in the monoculture of cash crops, the incidence of planting, the abundance of these trees has decreased (Thaman and Ba, 1978 and 1979), and people have become more dependent on outside sources of these products, especially in times of disaster.

From a planning standpoint, there is definitely a need to encourage tree-planting, especially food trees, but also trees for firewood, and timber, and trees valuable for other cultural uses. There is also a need to look at forestry development from a much broader perspective, where timber trees are not the sole focus on which trees have the highest resistence to damage from natural events such as hurricanes, drought, frosts, fires, insect manifestations, etc.

Food preservation techniques

Traditionally, food preservation (G in Tables 1 and 2) was commonplace. The preservation of yams, sago and breadfruit was widespread throughout Melanesia (Barrau, 1958:73), with particularly ingenious methods for the preservation of breadfruit by fermentation or drying, being common throughout Polynesia and Micronesia (Barrau 1961:52-53, Hiroa, 1950; Pollock, 1970; Thaman, 1979). Taro, bananas, coconuts and Tahitian chestnut (*Inocarpus edulis*) were also preserved in some areas (Baxter, 1977:0), and salting and smoking are widely used to preserve fish and other marine foods as well as pork, wallaby and other terrestrial animal foods.

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These practices are very important for both disaster preparedness and recovery. It is also possible that crops destroyed by natural disasters could be preserved for future use. Unfortunately, the use of these often time-consuming preservation techniques are declining and again, outer island communities become even more dependent on the urban centers and more vulnerable to natural disasters. Again governments must ensure that many of these techniques are not lost.

Traditional housing

It is difficult to definitely state whether the benefits of traditional housing (H in Tables 1 and 2) outweigh the disadvantages. On one side traditional houses might be more susceptible to destruction by natural disasters such as hurricanes, floods, localized tornadoes (known as '*ahiohio*' Tonga), tidal waves, etc. but on the positive side, they are easily and cheaply replaceable (in areas where the spirit of community solidarity is still strong), because they are lashed together, they often give with strong winds, and because they are generally constructed of plant materials, there are fewer deaths due to falling walls, bricks, corrugated iron roofing etc.

The speed with which traditional housing can be rehabilitated is evidenced by a report from the Fiji Times (5/1/49) where it was estimated that 90 percent of housing in Southern Lau were damaged or destroyed on the islands affected by a 1948 hurricane,"yet five weeks later Ratu Sukuna could report that houses were practically all repairs and villages cleaned up (in UNESCO / UNFPA, 1977: 172). Another advantage of traditional housing is that many coastal or swampy areas, traditional homes are built off the ground on pilings (as in the case in coastal Papua New Guinea and in some of the Micronesian islands) or one stone or one rock piles of *paepae* (as in the case in Samoa and other areas of Eastern Polynesia). This type of construction would seem to lessen susceptibility to flooding and tidal waves as well as provide a healthier disease-free dwelling.

One thing can be said in terms of planning, and that is that traditional houses can be constructed quite rapidly after disasters from local materials, and that although international and governmental agencies may continue to supply tents and other emergency housing, it is of critical importance that people do not lose the ability to build such houses which are often much more ecologically suited to the various local environments than "European style brick wood or corrugated iron housing".

Traditional medicine

Throughout the world traditional medicine (I in Tables 1 and 2) has been responsible for curing illness, repairing injuries, etc. for generations and there are obvious advantages in terms of disaster preparedness and rehabilitation preserving medicinal plants and having "flock doctors" who retain knowledge of the preparation and prescription of traditional medicine.

In times of disaster, modern medical help may not be immediately available and the advantages of the availability of traditional medicines and medical advice are obvious. Consequently, there seems to be a pressing need, especially for isolated outer island communities to be encouraged to hold on to the knowledge of traditional medicine, and possibly as Fiji is currently trying to do to encourage and attempt to codify some of the traditional medical knowledge so that it will on one hand be preserve

and on the other ensure that it is administered only by those who are competent to do so.

Local trade networks

Though the Pacific Islands a vast network of trade systems has acted as a means of redistributing scarce resources. The maintenance of these traditional exchange systems (K in Tables 1 and 2), which almost always included food items (Brookfield, 1969: 4: Hughes, 1977; Lambert, 1979:12) is of critical importance during the recovery phase from natural disasters. Brookfield (1969:4-10) stresses the very considerable social and economic importance of reciprocal trade of valuable cultural items and large quantities of foodstuffs, often special foods which are in short supply. Fishcher and Fishcher (1957:167) mention the continuance of trade and exchange of food between the high and low islands in the Eastern Carolines as late as the mid 1950's, and how people of Lukunor in the Martlocks exchanged taro, which grew very well in there, for fish from other islands. Brown and Powell (1974) indicate that severe famines resulting from frosts and drought in the New Guinea highlands are usually avoided be depending on trading partners from less effected areas.

Finally, the UNESCO/UNFPA (19977:171) report on *Population Resources and Development in the Eastern Islands of Fiji* when discussing the changing effect of hurricanes, mentioned that:

> Where damage was restricted to particular islands, it was possible for the inter-islands, it was possible for the inter-island trading system which we discussed earlier in this chapter to be activated to supply needy islands, especially as the main period of shortage is not immediately after the storm when there are crops to be salvaged, but in subsequent months before new planting has come to maturity. Planting material as well as food might also have been transferred in this way.

Such trade and exchange networks seem to have been an ideal local means of minimizing the impact of post disaster hardships. Unfortunately, because of the increasing dependence on imported foods and expanded relief operations, outer islands are becoming increasingly dependent on central governments and overseas agencies for food relief. It is here that we believe that national and regional (South Pacific region) planners could do a lot. By encouraging regional specialization in food crops where there grow best and by giving incentives to the development of both intranational and international trade systems within the Pacific, not only will Pacific countries become less dependent on the metropolitan powers, but may also establish new Pacific island markets.

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Community work solidarity

We wish to only briefly touch upon this subject as the advantages of community work solidarity (L in Tables 1 and 2) for optimum preparedness and rehabilitation from natural disasters in obvious. Through community solidarity villages, towns or even isolated hamlets can have more abundant and more diverse agricultural resources (Thaman, 1978), can better carry out he often tedious preservation of plant and marine products, can have successful communal fish drives or hunting parties (from which meat or marine products can be smoked or salted and preserved), can carry out last minute precautions against disaster more rapidlym can rebuild homes and replant both short and long-term crops more rapidly, could more effectively look after the sick and injured, and finally less tangibly would probably have a better and more positive attitude in terms of community spirits which would help them in both the physical and psychological recovery from the disasters.

For example, a village exhibiting a high degree of internal cooperation could formulate local disaster preparedness programmes which might include activities such as propping bananas (with props prepared for the occasion in advance) or chopping the leaves of bananas, cassava and other plants when hurricane warnings have been issued. Such activities are much more feasible when there is cohesion within the community.

Unfortunately, since independence and as more young people leave the village community work solidarity is deteriorating (Hau'ofa and Ward, 1979). Nevertheless, it does seem that given active programmes to encourage its revival would be of great value, for example, in Western Samoa where the *asiasiga* or village inspection system has been reinstigated by the current government. A similar system in Fiji, the *buli* system, has been discontinued since independence and could profitably been reintroduced. In short, any system that governments or local agencies can do to encourage community work solidarity would seem to be of great value to improved disaster preparedness, prevention and rehabilitation.

Knowledge of plant and animal cycles

We have been unable to find much data on the importance of plant and animal cycles (M in Tables 1 and 2) and their role in disaster planning. Nevertheless this is an area where considerable basic and applied research is needed. There are numerous accounts of Pacific islanders with empirical knowledge of how early appearance of certain sea creatures has been a warning of impending natural disasters.

There is no doubt much truth in the fact that many of the plants and animals in the natural world are very sensitive to changes in natural phenomena and could be used as warning systems. Unfortunately, we know of no systematic research that has been done in this area.

Moreover, the knowledge of plant and animal cycles could also be of considerable value in helping disaster victims procure food, medicine etc. in times of stress.

Other traditional knowledge

There is undoubtedly other traditional knowledge related to traditional astronomy, meteorology, oceanography, plus a range of technologies which have been and should continue to be of value in terms of natural disaster prediction, preparedness and rehabilitation, and which should be studied.

Conclusion

In short, there is a vast body of traditional knowledge that has allowed Pacific islanders to successfully, although often tragically, deal with the continual threat of natural disasters. This body of technology. Empirical knowledge, and ways of doing things has been accumulated, selected and reselected over thousands of years as Pacific peoples have evolved systems of living in their various island groups for over a thousand years to as long as possibly 50,000 years in the case of New Guinea (Powell, 1977). New Guinea highlanders for example, may well have been practicing agriculture for as long as 9000 years (Golson, 1977:45), (which ranks them with some of the earliest agriculturalists in the history of mankind).

To lose such knowledge would be a *cultural disaster* and we feel that it is the role of Pacific island governments to attempt to integrate many of these traditional strategies of disaster prediction, prevention, preparedness and rehabilitation into national natural disaster planning programmes. This will require increased research, some changes in the education systems and a sincere commitment on the part of Pacific island countries to increase local and regional self-sufficiency and cooperation. As Clarke (1978) has stressed there is a pressing need to the "progress with past" and that "human ecologists" and planners must study long-lived human ecosystems and their principles of permanence". He goes on to say that:

> Now that all over the world communities like the Bomagai-Angpiang (a Traditional society in highland Papua New Guinea) are disappearing as 'victims of progress' (Bodley, 1975), the task remaining is to apply these principles (of permanence) and to build into the neo-technic-dominated ecosphere a structure of permanence. If we do not, we will all ... - neotechnic and paleotechnic alike - become victims of progress (Clarke, 1977:383).

Only through such holistic approach to natural disaster planning can we optimally minimize the immediate detrimental effects and long-term dependency caused by natural disasters in the Pacific islands.

Bilbliography

BARRAU, Jacques.1958: Subsistence Agriculture in Melanesia. *B.P. Bishop Museum Bulletin.*

BARRAU, Jacques. 1961: Subsistence Agriculture in Polynesia and Micronesia. *B.P. Bishop Museum Bulletin*, 223:

BAXTER, M.W.P. 1977: *Food in Fiji: Aspects of the Produce and Preprocessed Foods Distribution Systems*, Centre for Applied Studies in Development, University of the South Pacific, Suva.

BELSHAW, C.S 1957: *The Great Village: The Economic and Social Welfare of Hanuabada, an Urban Community in Papua*, Rouledge and Kegan Paul, London.

BODLEY, J., 1975: *Victims of Progress*, Cummings, Menlo Park,

BROOKFIELD, 1964. The Ecology of Highland Settlement: some suggestions. *American Anthropologist*, 66 (4, part 2): 20-38

BROOKFIELD, H.C. 1969: Introduction: The Market-place Chapter 1, In: *Pacific Market-place* (ed. H.C. Brookfield Australian National University Press, Canberra, pp. 1-24.

BROOKFIELD, H.C. 1972: *Colonialism, Development and Independence. The case of the Melanesian Islands in the South Pacific*, Cambridge University Press, London.

BROOKFIELD, H.C. 1975: *Interdependent Development*, Methven and Co., London.

BROOKFIELD and Hart, 1971: *Melanesia: A Geographical Interpretation of an Island World*, Methven and Co., London.

BROWN, M. and J.M. POWELL, 1974. Frost and Drought in the Highlands of Papua New Guinea, *Journal of Tropical Geography*, 38:1-6.

BULMER, SUSAN AND RALPH BULMER, 1964. The Prehistory of the Australian New Guinea, *American Anthropologist*, 66 (4, part 2) : 39-76.

BURTON, Ian, R.W. KATES and G.F WHITE, 1978: *The Environment as Hazard.* Oxford University Press.

CLARKE, W.C., 1965. From Extensive Shifting Cultivation. A succession from New Guinea. *Ethnology* 5: 347-359.

CLARKE, W.C, 1977. The Structure of Permanence: The Relevance of Self-subsistence Communities for World Ecosystem Management" In: *Subsistence and Survival: Rural Ecology in the Pacific* (T.Baylisa-Smith and R Feachmeds.), Academic press, N.Y., pp.636-384.

CLARKE, W,C., 1978. Processing with the Past: Environmentally sustainable Modifications to Traditional Agricultural Systems." Chapter 10 In: *The Adaptation of Traditional Agriculture*: Australian National University Development Studies Monograph No. 11:142-157

CURTI, Merle, 1963. *American Philanthropy Abroad: A History.* Rutgers University Press, New Jersey.

ECKHOLM, E.P., 1976, *Losing Ground: Environmental Stress and World Food Prospects.* Pergamon Press, Sydney.

FISCHER, J.L. AND A,M FISCHER, 1957: *The Eastern Carolines*, Pacific Science Board and Human Relations Area Files New Heaven.

FISK, E.K., J.B. HARDAKER and R.R. THARMAN.1976: *Food Production in the South Pacific (R.W. Parkinson Memorial Lectures)*, University of the South Pacific Suva.

GEORGE, Susan, 1976: *How the Other Half Dies: The Real Reasons for World Hunger*, Penguin Book, Harmondsworth, Middlesex.

GOLSON, Jack, 1977. The Making of the New Guinea Highlands, Chapter 6 In: *The Melanesia Environment* (ed.J.H. Winslow) Australian National University, Canberra, pp.45-56.

HAU'FOA, 'Epeli. 1978: *Corned Beef and Tapioca: A Report on the Food Distribution systems in Tonga.* Centre for Applied Studies in Development, University of the South Pacific, Suva.

HAU'FOA, E. and R.G. WARD, 1979. The Social Context Chapter 3 in *South Pacific Agricultural Survey 1979: Pacific Agriculture Choices and Constraints*, Asian Development Bank, Manila, pp.45-66

HOWLETT, 1962. *A Decade of Change in the Goroka Valley, New Guinea: Land Use and Development in the 1950s*, Ph.D Thesis in Geography, A.N.U., Canberra.

HUGHES, Ian. 1977:The Use of Traditional Resources in Traditional Melanesia. Chapter 4 In: *Melanesia Environment* (Ed.J.H. Winslow). Australian National University Press, Canberra, pp. 28-34.

JANIZEN, D.H. 1973: Tropical Agroecosystems *Science*, 82 (4118): 212-219.

JOHNSTON, W.B., 1959. The Cook Islands: Land-Use in an Island Group of the Southwest Pacific. *Journal of Tropical Geography.* 13:3857.

KLEE, G.A.1976: Traditional Time Reckoning and Resource Utilization. *Micronesia*, 12(2); 211-246.

LAMBERT, Julian, 1978: *Does Cash Cropping Cause Malnutrition?* Discussion paper for Annual Department of Primary Industries Economists Conference, Loloata Island, July 30 to August 2, National Planning Office, Port Moresby.

LAMBERT, Julian. 1979: Population Growth Nutrition and Food Supplies. *Population of Papua New Guinea*, ESCAP Country Monograph, United Nations Economic and Social Council. New York (in press).

LESSA, W.A. 1977; Traditional Uses of the Vascular Plants of Ulithi Atoll, with Comparative Notes. *Micronesia*, 13 (2): 129-190.

MGEE, T.G. 1975: Food Dependency in the Pacific: A Preliminary Statement. *Development Studies Centre working Paper No.2.* Research School of Pacific Studies Australian National University.

MILLER, C.D. 1927: Food Values of Poi, Taro, and Limu. *B.P. Bishop Museum Bulletin* 37: 1-25

MILLER, C.D. 1929: Food Values of Breadfruit, Taro Leaves, Coconut and Sugar Cane. *B.P. Bishop Museum Bulletin* 64: 1-23.

MILLER, C.D. 1953: The Nutritive Value of Some Native Foods Compared with Highly Milled Cereals. *Proceedings of the Seventh Pacific Science Congress* (Auckland) Vol.7: 428-429.

MILLER, C.D., K. BAZORE and M. BARTOW. 1965: Fruits of Hawaii: Description, Nutritive Value, and Recipes, The University Press of Hawaii, Honolulu.

OLLIER, C.D. and D.E. MACKENZIE, 1974: "Subaerial Erosion of Volcanic Cones in the Tropics." Journal of Tropical Geography, 39: 63-71.

PARKINSON, S.V. 1977: The South Pacific Handbook of Nutrition Fiji Y.W.C.A., Suva.

PETERS, F.E. 1957: The Chemical Composition of Some South Pacific Foods, Proceedings of the Ninth Pacific Science Congress (Thailand), Vo.15 (Nutrition): 129-138.

POLLOCK, N.J. 1976: Takapoto Report: A Sutdy of Diet in an Atoll Environment, Anthropology Department, Victoria University, Wellington (mimeo).

POLLOCK, N.J. 1970: Breadfruit and Breadwinning on Namu Atoll, Marshall Islands (University of Hawaii, Ph. D. Thesis), University Microfilms, Ann Arbour.

POWELL J.M., 1977. "Plants, Land and Environment in the Island of Papua New Guinea" Chapter 2 in The Melanesian Environment (Ed. J.H. Winslow), Australian National University Press, Canberra, pp. 11-20.

RODY, Nancy, 1978: Consumerism in Micronesia. *South Pacific Bulletin*, 28(1):9-13.

SPOEHR, Alexander. 1949: Majuro: A Village in the Marshall Islands. *Fieldiana: Anthropology* (Chicago Natural History Museum), Volume 39:1-266.

THAMAN, R.R. 1975: Tongan Agricultural Land Use: A Study of Plant Resources. *Proceedings of the International Geographical Union Regional Conference and Eighth New Zealand Geographical Conference*, (Palmerston North, December 1974), The New Zealand Geographical Society, Wellington, pp. 53-160.

THAMAN, R.R. 1976a: Legumes and Greens in the Pacific Islands. *Proceedings of Planning Seminar on Agriculture for Nutrition Improvement*, August 16-27, East-West Center, Honolulu (in press).

THAMAN, R.R. 1976b: *The Tongan Agricultural System: With Special Emphasis on Plant Assemblages*, University of the South Pacific, Suva (Published version of 1975 Ph. D. Thesis, University of California, Los Angeles.

THAMAN, R.R. 1976/77: Plant Resources of the Suva Municipal Market, Fiji. *Ethnomedicine*, IV (1/2) :23-62.

THAMAN, R.R., 1978: "Cooperative Yam Gardens: An Adaptation of a Traditional Agricultural System to Serve the Needs of the Developing Tongan Market Economy." Chapter 8 in *The Adaptation of Traditional Agricultural Socioeconomic Problems of Urbanization.* Australian National University Development Studies. Monograph No. 11:116-126. University of the South Pacific.

THAMAN, R.R., 1979. Food Scarcity, Food Dependency and Nutritional Deterioration in Small Pacific Island Communities. In: *Proceedings of the Tenth N.Z. Geographical Conference, Auckland*, pp. 1-18.

THAMAN, R and T.B.A. 1978: Utilization and Development of Fuelwood Resources in small Island Communities. *Proceedings of Seminar on Wood as an Alternative Energy Resource*, University of the South Pacific (U.S.P.) 3-4 July, Institute of Natural Resources, U.S.P. in conjunction with Department of Forestry, Suva, 56-65.

THAMAN, R.R. and T. BA. 1979: *Energy Needs and Forest Resources of Small Islands.* Paper presented at the 49th ANZAAS Congress and 10th N.Z. Geographical Conference Symposium on Problems of Resource Use and Development in Small Islands of the Pacific, 4 January.

UNESCO, 1976. *1974 Annual Summary of Information on Natural Disasters. Earthquakes, Tsunamis, Volcanic Eruptions, Landslides and Avalanches*, The UNESCO Press, Paris.

UNESCO/UNFPA (Population and Environment Project in the Eastern Islands of Fiji), 1977: *Population, Resources and Development in the Eastern Islands of Fiji: Information to Decision Making*, Development Studies Centre, A.N.U. Canberra.

WADDELL, Eric, 1973. Raiapu Enga Adaptive Strategies. In: *The Pacific in Transition* (H.C. Brookfield Ed.) Edward Arnold, London, pp. 25-54).

WATTERS, R.F., 1960. Some Forms of Shifting Cultivation in the Southwest Pacific. *Journal of Tropical Geography*, 14:35-50.

WIENS, H.J. 1962: *Atoll Environment and Ecology*, Yale University Press New Haven.

YEN, D.E., 1961: Sweet Potato variation and Its Relation to Human Migration in the Pacific (Abstract). In *Tenth Pacific Science Congress, Abstracts of Symposium Papers*, B.P. Bishop Museum Press, Honolulu, p. 141.

YEN, D.E., 1979. Pacific Production System. Chapter 4 In: *South Pacific Agricultural Survey 1979: Pacific Agriculture Choices and Constraints*, Asian Development Bank, Manila, pp. 67-100. ■

Ngdiak kobetik er ngii er cheroid eme douchii ra rebai

Without looking far afield, it was found behind the house

Sometimes we look far and away for a solution when in fact the solution might be found close at hand.

From the folk tale of Mesubed Dingal of Ngardmau, Palau