PAPERS

Where the exception confirms the rule: The cyclones of 1982—1983 in French Polynesia

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The island groups of French Polynesia, which had not experienced any really devastating cyclones since the beginning of the century, were hard hit several times between December 1982 and April 1983. This paper reviews the cost of damage from these cyclones and shows how lowered public awareness of the hazard in a low-frequency area combined with the special economic conditions prevailing in the Territory to make the total cost much higher than it need have been. Ways and means of rehabilitation are analyzed. The development of the thermal imbalance in the Pacific, which appears to have triggered this series of natural disasters, only seemingly exceptional, is briefly discussed.

Key words: Cylones; French Polynesia; South Pacific; Hydroclimates; Damage; Cost; Prevention; Preparedness; Rehabilitation.

INTRODUCTION

Between December 1982 and April 1983 the archipelagoes which make up the Territory of French Polynesia were hit by a strong tropical storm and five tropical cyclones which caused extensive material damage and fifteen fatalities.

This disastrous series is of special interest because, at first glance, it appears highly exceptional: not since the beginning of the century had these island groups been struck by any really destructive cyclones (Fig. 1).

The recent cyclones seem to have originated from a regional, and possibly global, thermal imbalance, the role if not the causes of which they confirmed (NOAA—UNDRO, 1983).

FRENCH POLYNESIA AND THE CYCLONE HAZARD

The 120 islands of French Polynesia are divided into four groups known as the Marquesas Islands, the Tuamotu-Gambier Archipelago, the Society Islands (Windward and Leeward) and the Austral Islands (Fig. 1). In an oceanic area roughly equivalent to the total surface of Europe, these islands barely amount to 4,000 km^2 of land. More than half the population (about 150,000) is concentrated in the capital town and main harbour of Papeete and its suburbs, on the island of Tahiti, which by itself carries 70% of the inhabitants (of whom 80% are Polynesian or part Polynesian), on slightly over one quarter of the total emerged land surface.

The local economy is dominated by Services and administrative activities, and relies heavily on financial spin-offs from the French Nuclear Testing Centre in the Pacific (Centre d'Expérimentation du Pacifique — CEP). France pays 70% of the Territory's expenditure. Coconut plantations, pearls, fisheries and tourism are the main local sources of income.

French Polynesia is well linked to the rest of the world, has sixteen fully equipped airports for domestic flights and an excellent telecommunications network. If necessary, the assistance of military planes and ships permanently based in the Territory may be requested. They are called out whenever the application of an emergency procedure (ORSEC Plan) is decided upon by the local Department of Civil Defence, as in Metropolitan France.

Although the archipelagoes of French Polynesia may be expected to experience tropical storms, available historical records do not point to this being a high-risk zone. Various sources (Visher, 1925; Giovannelli, 1940; Teissier, 1969; Service Météorologique de Polynésie Française, 1979, 1982) enumerate 62 known tropical depressions or cyclones as having passed through the area over the past 150 years.

The only destructive cyclone in the 19th century about which detailed eye-witness reports are available, occurred in February 1878. Subsequently, three severe cyclones caused close on 700 deaths in 1903, 1905 and 1906, mainly in the Tuamotu group. There appear to have been no further ones till 1966, and the few cyclones (a total of eight) recorded in the region after this date and until the recent series did not result in any casualties nor any serious damage.

During the 1982—1983 season however, nine tropical depressions, six of which reached cyclone strength (average wind speeds above 116 km/hr), moved through or skirted French Polynesia.

This high frequency must be considered in relation to the climatic and hydroclimatic anomalies that have been occurring in the tropical areas of the Pacific Ocean since 1982 and may well have facilitated cyclogenesis.

(1) The oceanic area south of 10°S, which includes the Society and Tuamotu Islands, recorded surface water temperatures exceeding by 2°C the seasonal average values. The variation was greater near the equator where the up-welling disappeared.

(2) A westerly current replaced the south-easterly sub-tropical current and helped the propagation of a KELVIN wave. It brought warm, moist and unstable air masses from the western Pacific into the northern parts of French Polynesia in the second half of 1982.

(3) The intertropical convergence zone was located south of the equator as early as November 1982. It merged with the secondary convergence zone of the South Pacific to form a large low pressure area lying between latitudes 10 and 15°S

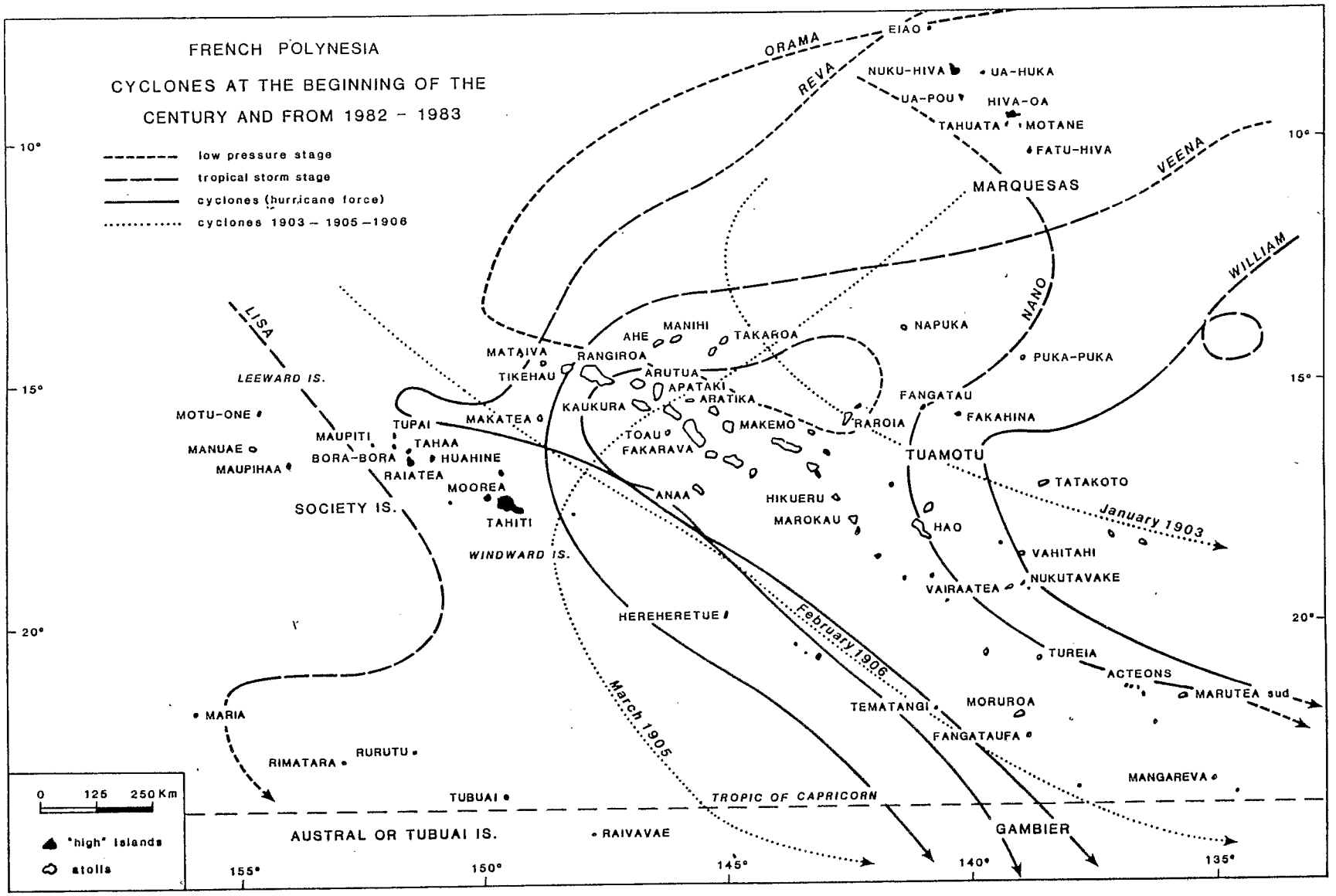


Fig. 1. Destructive cyclones in French Polynesia since 1900.

and extending from the 180th meridian to the coast of South America.

The reasons for these hydroclimatic and synoptic anomalies, which could be useful for long-term weather forecasting, are not yet clear, despite the rapid progress of knowledge about ocean/atmosphere interactions. This paper will deal only with the effects of the recent cyclones, more particularly in comparison with the cyclones previously experienced by French Polynesia.

FRENCH POLYNESIA'S CYCLONE HISTORY

Except for a few fragmentary data on earlier occurrences, detailed accounts and reports by eye witnesses are available only for the 1878, 1903, 1905 and 1906 cyclones. They were collected by Teissier (1969). It would be interesting to search the Polynesian oral tradition for clues to the prevalence of atmospheric disturbances before the arrival of the Europeans and up to the 19th Century.

6—8th February 1878. The most severely affected area was the northwestern part of Tuamotu group, and the hardest hit atolls were Rangiroa, Kaukura and Anaa. Several villages were destroyed by the sea. In Kaukura, the greater part of the population was caught unprepared in temporary dwellings put up in the northern part of the atoll for the copra-making season. One hundred and seventeen people died. In Anaa, the village of Tuuhora was razed to the ground, except for the church. It was to be destroyed again in 1906 and 1983.

13—16th January 1903. A cyclone of similar force but a greater span hit the central part of the Tuamotu group, severely damaging about ten atolls and killing 515 people. In Hikueru, where several hundred people from neighbouring atolls were temporarily settled in the most exposed area for the collection of mother-of-pearl shells, 377 died. Nearly 100 people perished in Marokau, either by drowning or when the church where they had taken shelter collapsed.

The survival strategies used during this cyclone (people scrambling to higher locations, or huddling in boats anchored in the lagoon) and the cyclone's action and effects as described by witnesses were all again observed during the 1983 cyclones: the prolonged flooding of the low-lying areas by the sea, the devastating action of breakers armed with debris, the washing away of all arable soil, the accumulation of thick layers of crushed coral (see Fig. 2), as well as the floods caused by torrential rains on the "high" islands (Marquesas and Society groups).

21—25th March 1905. A cyclone of similar strength hit the northern and western atolls of the Tuamotu group (Napuka, Takaroa, Arutua and Apataki). It caused much damage on the eastern coast of Tahiti, together with several shipwrecks, and took the lives of eight people.

7—9th February 1906. A strong, very extensive (some 350 nautical miles in diameter) and fast moving cyclone affected a large number of atolls in the Central Tuamotus, the northern and eastern coasts of Tahiti, the Leeward islands in the Society group and the Gambier islands. Out of a total death toll of 123, all but two people were killed in or near the atolls. Shipwrecks caused 17 deaths. Everywhere, the heaviest damage resulted from the action of the sea. The cyclone tide rushed a good 200 m into the centre of Papeete, destroying the habour facilities, a number of public

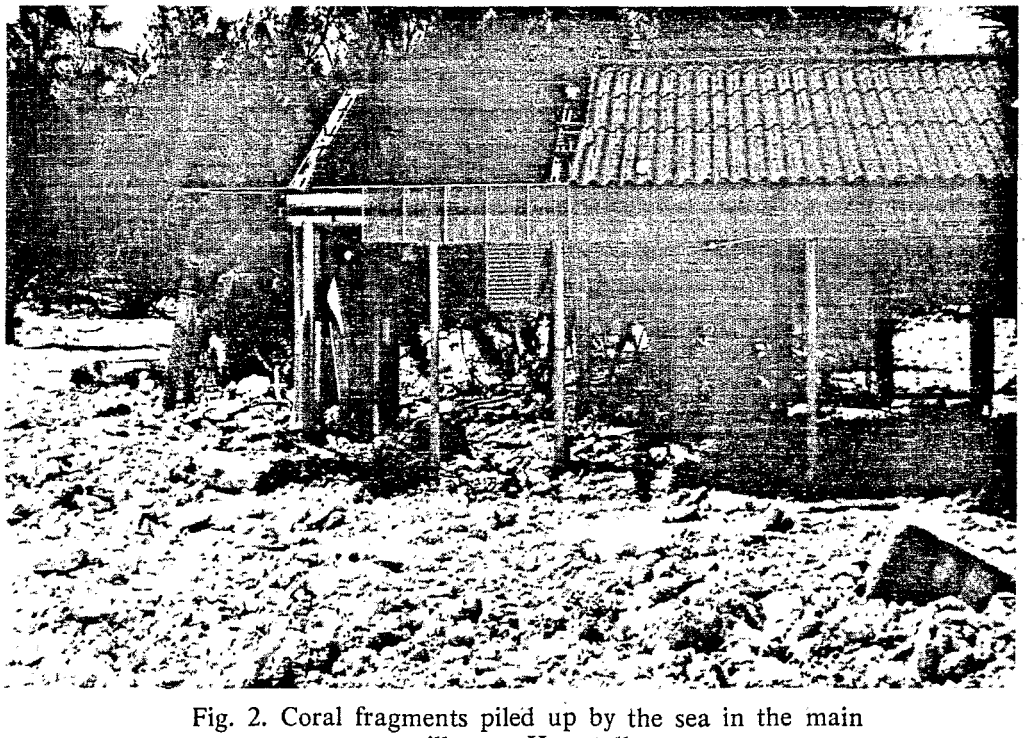


Fig. 2. Coral fragments piled up by the sea in the main village on Hao atoll.

Table 1. Characteristics of the 1982—1983 cyclones

Tropical cyclone/storm		Minimum atm. pressure at centre	Wind maximum gusting speed	Marquesas	Tuamotu				Society		Austral	Deaths	Injured	Storm surge	Floods	Wind
					W	C	E	G	WI	LI						
12—14th December Lisa	TS	985	122—119						*	*		2	2		Tahiti ‡	
20—27th January Nano	TC	980	150	*			*	*					6	‡	Marquesas ‡	‡
22—27th February Orama	TC	950	180		*				*			6	3	‡		
6—14th March Reva	TC	955	180		*	*			*	*		5	2	‡		
7—13th April Veena	TC	950	200		*				*			1	28	‡	Tahiti ‡	
15—21st April William	TC	965	120									1	5	‡		
Total		(millibars)	(km/h)				*	*				15	46 (a)			

(a) Twenty of whom had minor injuries. W: West. C: Centre. E: East. G: Gambier group.
WI: Windward Islands. LI: Leeward Islands. *Affected archipelagoes or parts of. ‡ damage caused by . . .

Table 2. 1982—1983 cyclones. Geographical distribution summary of direct damage

	Windward Islands							Leeward Islands							Tuamotu-Gambier								Marquesas							Most severely affected islands
Lisa	*	*	*	*	*		*	*	*	*	*	*		*																Bora-Bora, Raiatea, Tahiti
Nano															‡	‡		*				E,G	‡	‡	*	*	*			Ua Pou, Hao, Puka, Tureia, Nukutavake, Fangatau, Gambier
Orama	*	*													§	§	§	‡	‡	§	‡	N, W								Arutua, Toau, Kaukura, Aratika, Manihi, Ahe, Anaa
Reva	‡	‡			‡		‡	‡	*		*	*		‡	‡	‡	*	‡		‡		NW, S								Mataiva, Anaa, Hereheretue, Tematangi, Raiatea, Anaa, Tahiti Ouest, Moorea
Veena	§	§	§	‡	‡	‡	§								‡	‡		‡		‡		NW								Tahiti Est, Moorea, Tikehau, Mataiva, Hereheretue, Ahe, Manihi, Rangiroa
William															§	‡		*		‡		E, G								Nukutavake, Vahitahi, Fakahina, Acteon, Marutea, Tatakoto, Vairaatea
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	

Direct damage to: 1. Housing; 2. Equipment; 3. Boats; 4. Coconut plantations; 5. Crops — livestock; 6. Fisheries — pearl farming; 7. Tourism (Hotels); 8. Parts of archipelagoes: East, West, North, South, Gambier. Damage: *Moderate. ‡Significant. §Considerable

buildings and more than 300 houses. On the windward side of Tahiti, the northern coast of Taiarapu peninsula was devastated (as it was again in 1983), the hardest-hit being the village located on the low-lying little peninsula of Tautira, which was completely flattened by the storm tide. Because people managed to reach the nearby mountain slopes, the casualty toll was lighter than might have been expected.

THE CYCLONES OF THE 1982—1983 SUMMER

The most striking feature brought out by Table 1 is the comparatively small number of human casualties. This may be accounted for by:

- Improved forecasting, warning systems and telecommunications (people were told to take emergency measures for safety 10 to 26 hours before the actual strike, depending on places).
- The lack of fortuitous population concentrations in risky locations and temporary settlements, as was the case in 1878 and 1903 on the atolls.
- The rapid succession of cyclones which led people to take precautionary measures in spite of their unfamiliarity with the hazard.

Two thirds of the deaths were caused by shipwrecks (8) or by being swept off a ship (2). Four out of the five others were caused by collapsing buildings or falling trees; the remaining one was by electrocution. Most of the injuries were caused by flying debris, falling trees or collapsing buildings.

However, the glaring inadequacy of the housing in relation to the hazard; its location in exposed areas having already been directly hit; the lack of collective shelters on the atolls; and the undisciplined behaviour of some people who acted without due care after the cyclone warnings had been issued, make it tempting to ascribe this light toll in part to chance and sheer good luck.

Table 2 summarizes the main types of direct damage caused by the cyclones in the various island groups.

THE COST OF THE CYCLONES

The currency in use in French Polynesia is the Pacific Franc (value: 0.055 French Franc). For convenience, all the quoted value figures were converted into U.S. dollars at the uniform rate of eight French Francs to one U.S. dollar. The total cost of the direct damage sustained was estimated to be between $100 and 115 million. For the sake of comparison, French Polynesia's total budget was $157 million in 1982. A percentage breakdown of the cost of the direct damage caused by the successive cyclones in the different island groups is given in Table 3.

In the Tuamotu group, the cyclones affected only villages and village-type community facilities, the one exception being the military base on Hao atoll. The relatively large proportion of the damage borne by the Windward islands reflects the high concentration of population, hence of housing, infrastructures and activities in these islands. Damage might have been far worse, since none of the cyclones came within 50 km of the coast of Tahiti to threaten Papeete directly.

Total direct damage to productive sectors of the economy, infrastructures, transport systems and communication networks, but excluding housing, personal belongings, public buildings and coconut plantations, amounted to nearly $32 million. Neither the indirect losses incurred by the productive sectors, nor the damage to French military buildings and infrastructures on the island of Tahiti and on Hao, Fangataufa and Mururoa atolls have been taken into account.

Breakdown of damage to productive sectors is as follows:

- Agriculture, livestock, forestry: nearly $5 million.
- Fisheries and pearl farming: nearly $3 million (2.5 million in the Tuamotu group alone).
- Handicrafts and industry: nearly $1.5 million, more than half of which was to electric power plants in a rather undiversified sector.
- Tourism and the hotel trade: nearly $5.2 million, 3.9 million of which was to officially registered hotels which are mainly located in the Society islands.
- Business activities: more than $3 million. The total of the above sums comes to over $17 million.

The total cost of damage to infrastructures (road systems, harbour and airport facilities, bridges and transport systems, telecommunications networks), amounted to nearly $15 million. More than three quarters of this sum will be spent on the necessary repair works and on building collective shelters on the Tuamotu atolls.

Table 3. The cost of the direct damage caused by successive cyclones in the different island groups

Archipelagoes / Cyclones	Windward Islands	Leeward Islands	Tuamotu Gambier	Marquesas	Percentage of total damage caused
Lisa	34	66			2
Nano			57	43	5
Orama	10		83	7	14
Reva	40	40	15	5	21
Veena	90		7	3	57
William			100		1
Percentage of total damage experienced	63	9	22	6	100

Available figures and data for the cost of the cyclones that struck at the beginning of the century are inadequate for a proper comparison to be made. It is however clear that in terms of the consequences of natural hazards, French Polynesia has followed the global trend of a considerable increase in the cost of property damage, together with, for an equal risk, a striking decrease in the death toll.

The total amount of direct damage does not include the cost of the secondary or indirect consequences of the cyclones. These consequences, which may sometimes prove positive, are always difficult to evaluate with any accuracy. We shall merely outline some of the more significant features.

French Polynesia possesses about 50,000 ha of coconut plantations, many of which are old and poorly cared for. Most of them are located in the Tuamotu Islands. Tuamotu copra is bought from producers at a guaranteed price that is heavily subsidized by the territorial government which also pays out of the local budget for collection and transport to an oil factory in Papeete. The factory's processing capacity (28,000 tons) is far greater than the current total copra production (19,000 tons). Wastage of nuts and loss of cyclone-felled trees is estimated to have halved the total production anticipated for 1983. More than two thirds of the losses occurred in the Tuamotu group. Production is expected to return to normal levels in the Leeward group of the Society archipelago in 1984 and to reduce the deficit by more than half. But the secondary effects of the shaking received by the palms, and injuries to root and leaves, are likely to make themselves felt for five or six more years.

The traditional land tenure system in force in these islands, which is based on joint ownership, led the authorities to adopt a collective and indirect mode of relief and rehabilitation, involving the regeneration of coconut plantations.

Joint ownership and secondary damage effects raise similar problems as regards rehabilitation of individual orchards on the atolls, where breadfruit, limes and bananas are often cultivated on soil brought in especially from "high" islands.

Indirect and secondary effects may also impede the rehabilitation of pearl farming, a fast-growing activity which has generated employment for a large number of atoll people.

Tourism is another economic sector where the secondary effects of the cyclones appear difficult to control and to evaluate. The number of visitors to French Polynesia rose from 20,000 in 1966 to 115,000 in 1982. The reaction of the main tourist sources (North America, Western Europe) to the negative image of Tahiti created by this unexpected series of cyclones was awaited with great concern by the local Tourist Bureau, whose apprehensions turned out to be justified.

While the total number of tourists visiting French Polynesia in the first three months of 1982 was 35% higher than over the same period the previous year, it rose by only 1.5% in 1983 as compared with the same period in 1982. Figures for the following three months (20.3 and 1.9%) showed the same trend. The reaction of the French market was particularly marked in this quarter with the number of visitors dropping more than 6% below the 1982 second quarter total.

RELIEF AND REHABILITATION

As the cyclones followed one another, relief operations initiated by the authorities became more and more exceptional. The economic and political background was to

Fig. 3. Damage by the sea at Ahe, Tuamotu, in cyclone Orama: the result of the "flotation effect" on a house.

Fig. 4. The central part of Tuuhora village after cyclone Orama. Note the damaged church and evidence of the action of the sea. Photograph reproduced with permission of Navy Squadron 12 S.

some extent responsible for this: an economic slump aggravating unemployment, and local elections (for the designation of the districts' local councils and mayors) coinciding with discussions between the local and French governments to define a new status of "extended autonomy" to the Territory. Under the present set-up, the local (territorial) government has to set apart funds from its own resources, or create new resources by raising levies or loans, for any economic rehabilitation operations. The central (French) government provides funds for emergency relief, notably to help individuals having lost all or part of their personal belongings. A total of $6.9 million was earmarked for such direct assistance, but only one fifth of this amount had actually been made available to the local authorities by the end of August 1983.

To coordinate relief and reconstruction, the local government established a Territorial Agency for Rehabilitation (TAR). The remedial operations undertaken by TAR, will be described below. The repair of general public infrastructures and the rebuilding of community facilities will entail a total outlay of between $48 and 69 million. If central government funding and reimbursements by insurance companies are also taken into account, the amount of funds spent on rehabilitation will come to at least half of the total assessed value of the damage. The government of French Polynesia will raise the funds needed partly from its own budgetary resources, partly by levying a special 0.5% tax (of CIF value) on imported goods (except for essential foodstuffs), and partly through loans.

The levy is expected to produce $10 million. Loans from local banks ($16 million) and from the French Government financial institution known as the Central Fund for Economic Cooperation ($24 million at 4% interest) will provide the bulk.

It is important to note that a technical committee for the study of prevention of natural hazards was set up by the local government practically at the same time as TAR. Since then, various groups of the committee have been investigating prevention, safety and preparedness measures to be taken in order to minimize the effects of possible future cyclones.

RECONSTRUCTION OF DWELLINGS

Housing was rightly considered as the first priority of the rehabilitation policy. Damage to the houses of the well-to-do was as common though not as serious as damage to the vulnerable dwellings made of light European-type materials such as wood, various kinds of panels and sheet iron. In fact, traditional materials and building techniques have now virtually disappeared from the French Polynesian scene. Preventive attempts to strengthen structures as the cyclones drew near were made seldom, or in an ineffectual or dangerous manner. Self-built housing is predominant in these islands and even where houses are erected by tradesmen, basic safety rules are often incompletely applied or totally disregarded in the construction process. Hence ignorance, unconcern and irresponsibility might, to a great

extent, account for the high amount of damage to housing. Surveys made after the cyclones by town planning and housing authorities suggested that at least 80% of the destruction of housing resulted from structural defects or faulty building practices.

A TAR survey showed that out of a total of 3,522 dwellings destroyed or damaged in Tahiti and the neighbouring island of Moorea, 493 had lost their roofing only and 933 their whole roof, including the frame. The origin of the complete destructions (totalling 1,218 houses) often lay in the inadequate size of the structural elements, or the absence of any proper structure. On the coastlines of the "high" islands as well as in the inhabited parts of the atolls, the impact of the wind was compounded by the storm tide producing a flotation effect and battering waves (see Fig. 3).

Reconstruction programmes had to tackle two apparently incompatible tasks at the same time: rehousing the many homeless families as quickly as possible, and initiating a proper prevention policy. For the low-lying islands, the solution of collective shelters was preferred, because of the high additional costs that large-scale adaptation of individual houses to the hazard in highly vulnerable sites would have entailed. In the past, as also during the last cyclones, churches often served as collective shelters, successfully in many instances, as on Anaa. But a number of them were also partly or totally destroyed, and this fact underlines their unreliability (see Fig. 4).

About forty collective shelters are to be erected in the Tuamotu group, on the inhabited atolls with permanent populations ranging from 10 to 1,000 people.

These shelters will be multi-purpose and fitted out for daily use as a town hall, hospital or radio-room. The total cost should be in the vicinity of $7 million. Ten of them were to be completed by the end of 1983 on the atolls where the hazard is greatest. Technically, stilts were preferred to raised platforms which are costly and require the use of heavy equipment that is difficult to bring ashore on most of the atolls.

The problems raised by the rebuilding of individual dwellings are more complex. The vulnerability of the houses was certainly, in many cases, perpetuated by slipshod repairs and makeshift rebuilding. New building regulations are shortly to be adopted for public buildings, making them capable of withstanding windspeeds of over 200 km/hr, but will be difficult to enforce in respect of individual private homes. Overall improvement is bound to be slow and will require large-scale education of the public and probably insurance incentives, if not constraints, as well.

TAR's action in the different archipelagoes varied according to priorities and the relative urgency of local needs. In the Tuamotu group, quick intervention was required because of the total destruction of housing on many atolls and the decision to build collective shelters. At the beginning of August 1983, one third of the reconstruction programme had been completed there. Surveying and drafting of plans for the new village of Tuuhora, on Anaa, the only village that was to be re-sited, were completed in September (Fig. 5).

In the Leeward Islands as in the Marquesas, homeless.

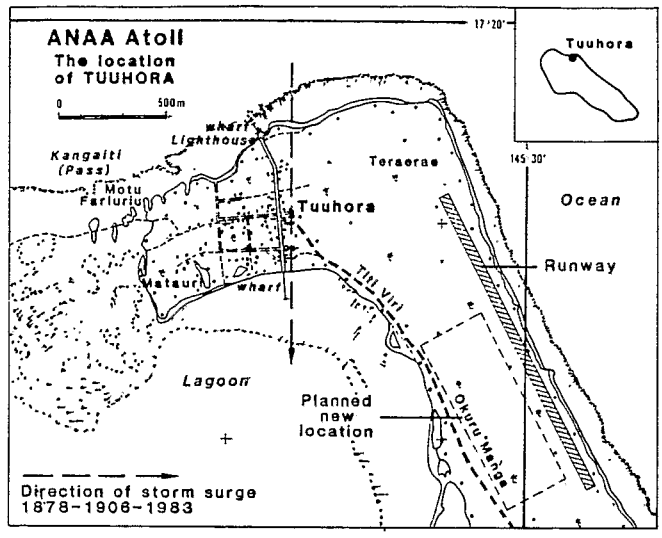


Fig. 5. Planned relocation of Tuuhora, the only village to be re-sited.

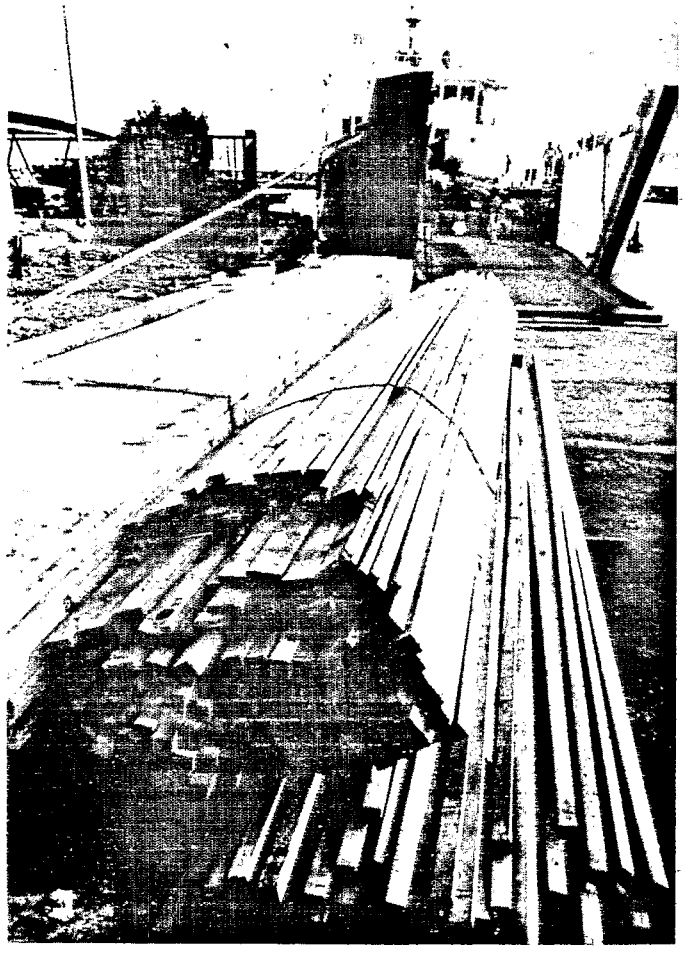


Fig. 6. Shipment of materials for the reconstruction of Tuamotu villages in the harbour of Papeete (Tahiti). The ship is designed for easier unloading on the atolls.

families (respectively 823 and 78) were sent the materials they needed to repair or rebuild their dwellings (Fig. 6). In these island groups, where the Agency was not directly involved, the circumstances and effectiveness of the reconstruction differed from one island and/or district to another, depending on how individualistic or cooperative the people were and on the local authorities — mayor, mutoi (local policeman) — who were responsible for sharing out the materials received from TAR amongst the families. Cases of abuse of this power were not rare.

For the rebuilding of completely destroyed dwellings, TAR designed an extendable house with an integrated and bolted timber frame covered with 9 mm plywood sheets for the walls, and a sheet-iron hipped roof. This type of house is in conformity with the new standards that are supposed to be gradually adopted. A model house was erected in every district and TAR technicians trained instructors (usually taken from among district council workers) to help people build their new homes. The amount of assistance given varies with the manpower available in each family.

For partly destroyed dwellings in Tahiti and Moorea, TAR provided free materials and technical assistance to families. People requiring assistance were classified according to a set of criteria including number of dependents, homeowner's status (if tenant, amount of rent paid), extent and location of damage sustained and total family income. Using this classification, TAR plans to give direct assistance for the repair and reconstruction of more than three quarters of the 3,522 damaged houses and for the replacement of more than 80% of the 1,218 totally destroyed houses. The total cost of this aid programme will exceed $11.7 million, three quarters of which will be spent on new building and the rest on repairs.

By August 1983, about one third of the families having had their houses partly destroyed and meeting TAR eligibility requirements had received assistance. Almost one quarter of the new houses were ready to be put up and distribution to families was about to begin.

Distribution of damage to housing in Tahiti and Moorea in relation to population size may be seen from maps (Fig. 7). The southern part of the windward coast and the northern part of Taiarapu peninsula were, with the north-east coast of Moorea, the most severely affected areas, notably by cyclone Veena.

REHABILITATION IN THE PRODUCTIVE SECTORS

In September 1983, the local authorities were intending to allocate between 5 and 9 million dollars through TAR to the rehabilitation of the productive sectors.

In the agricultural sector, TAR will give priority assistance to the 2,000-odd farmers and stock-breeders who declared damage or loss of their production instruments (machinery, buildings), which will be reimbursed at an 80% rate, and production losses, reimbursed at a 50% rate.

About 20% of the individual files approved for assistance had been processed by the end of August 1983. The total cost involved should reach $2.3 million. Besides this, TAR will contribute to the rehabilitation of coconut plantations by expanding a regeneration programme that was already underway before the cyclones struck. One active adult in every coconut-gowing family will be paid to plant young selected palms in the most seriously damaged plantation areas on 17 atolls. As many as 290 families are likely to participate in this programme in 1983, the target being to replant 1,000 ha out of a potential surface area of 3,500 ha. About 280 ha of replanting had been completed on Anaa Kaukura, Ahe and Tikehau by the 1st September. The dual purpose of the programme is to provide producers with a complementary source of income until yields return to normal levels, while ensuring increased production in the future.

In the fisheries sector (including pearl farming), TAR funding should be about $1.4 million, two thirds of this sum being spent in the Tuamotus. Remedial action will focus on rehabilitation of the fishing fleet (160 boats were totally destroyed or lost, 100 suffered at least 50% damage), replacement of fishing gear and rebuilding of fishtraps, and provision of new equipment such as cold storage facilities. As regards pearl farming, only the small privately owned or cooperative ventures will receive assistance from TAR. The bulk of the funds will go into fishing boats.

Rehabilitation of the tourist sector will absorb less than one million dollars. TAR assistance will be provided for buildings only. The French Government and special local development schemes set up during the last 10 years will give some assistance for replacement of fittings and furnishings lost or damaged in hotels. Indirect losses will not be considered and the smaller the hotels the higher the rate of compensation will be. In the special case of village-level tourist accommodation (rooms rented out by local people) common in the Tuamotus, assistance will be as for private dwellings, with some additional technical control.

THE FUTURE OF THE REHABILITATION POLICY

The influence of the economic and social background

Some feel that the injection into the local economy of $50 to 60 million by rehabilitation programmes, together with the mobilization of personal savings and bank loans to cope with the problems created by the cyclones, could prove beneficial.

Demand should be stimulated and unemployment drop, initially in the building and public works sectors, and subsequently in all branches of activity as rehabilitation funds fan out (Sacault, 1983). Other close observers of the local economy point out, however, that the unusual needs arising from the cyclones had, after six months, mainly brought about a decrease in private spending. Most families appear to have tried to meet their extra needs out of their normal earnings rather than by drawing on their savings, thus thwarting any chance of an economic boost.

Though not enough time has elapsed for the situation to be viewed in proper perspective, one may well wonder in any case how long such an hypothetical boost could last and what shape it would take in an economy of the French Polynesian type.

In recent years, services and administration (i.e. civil service departments, dependent on either the local or the

central government) accounted for about 80% of the G.D.P. It is difficult to see therefore how rehabilitation could stimulate the badly damaged productive sectors sufficiently to propel the Territory towards economic self-reliance. The CEP alone brought in $19 million in customs duties paid on goods and equipment imported in 1982, and its total annual expenditure in recent years has been in the vicinity of $100 million (two thirds of which went in salaries). It is interesting to compare these amounts with the funds made available to the various local investment and development schemes: a combined total of $2.65 million in 1982.

Even though its supporting services were reduced in 1976, CEP remains the crux of a political problem to which all the economic and social aspects of the life of the Territory are related. It is indeed easy to understand how maintaining aid and, at the same time granting wider political autonomy might be the counterpart of activities that public opinion (local as well as national, regional and international) views with some misgivings.

These facts need to be borne in mind if, in this particular instance, we wish to heed the excellent advice given by Keefe *et al.* (1976) and take the naturalness out of "natural"

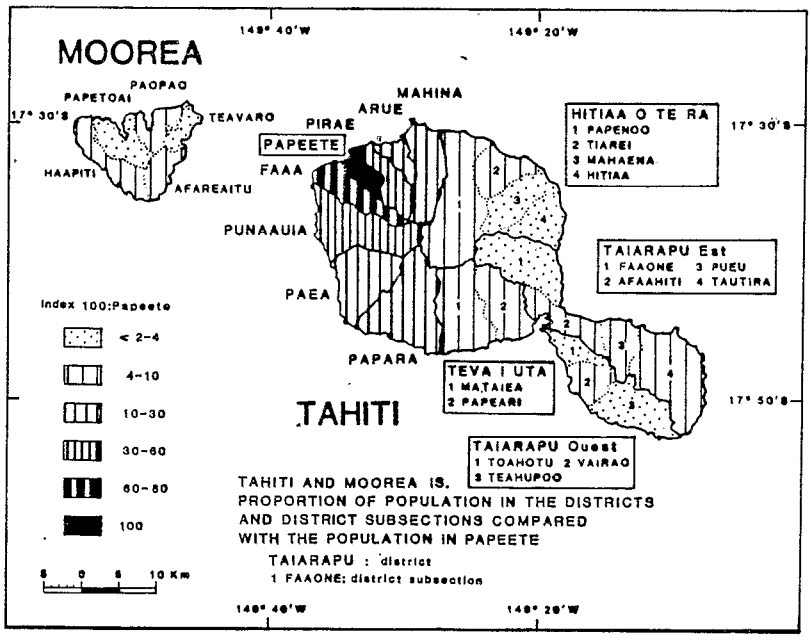
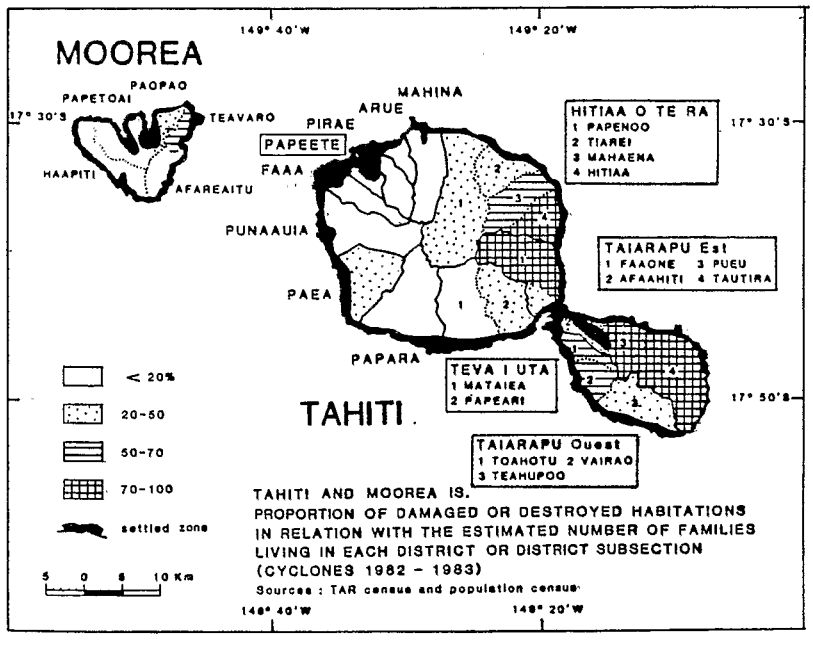


Fig. 7(a). Relative population density in Moorea and Tahiti islands in comparison with Papeete.

Fig. 7(b). Proportion of damaged or destroyed housing with respect to the estimated number of families.



disasters.

While there is no doubt as to the direct physical causes of the 1982—1983 cyclones, their effects were profoundly modified by the political, economic and social context in which they occurred.

The magnitude of the damage done was of course partly due to an unusual and dramatic succession of atmospheric phenomena, but it may also be explained by lowered public awareness of a low-frequency hazard in a region where each of the widely scattered tiny islands has only the slightest chance of experiencing a direct hit. The lack of preparedness is illustrated by widespread non-observance of basic safety rules in the building trade (Fig. 8), vague regulations which are either ill-adapted to the actual hazard or simply disregarded (as in the case of telephone and electricity networks for instance), the absence of collective shelters on islands or sites recognized to be highly vulnerable, the inadequacy of vital installations such as water reservoirs, meteorological and telecommunications buildings, emergency reserves of food and medical supplies. The disproportionate magnitude of the damage resulting from the lack of preventive measures also reflected the peculiar nature of the local economy. However marked social inequalities may still be, the Territory, thanks to the financial resources generated by CEP and to the advantages associated with its present status, boasts a GNP per head of $4,100, which is far higher than that of most of the other island states or territories in the South Pacific. This has given rise to generalization of consumer habits and lifestyles involving the use of costly materials, installations and commodities (see Fig. 9), but which did not make the country any better prepared for the cyclone hazard. Concrete houses were frequently destroyed for example, on the atolls as well as in Tahiti (Fig. 10). The atolls and the remotest island settlements are now equipped with sophisticated installations (electric power, telephone, video systems) which the cyclones showed extremely vulnerable. Full development of the small remote islands is part of a general policy aimed at arresting the decline of their traditional activities and the migration of their population to the urban area of Tahiti. The rapid growth of Papeete and its power of attraction are also indirectly to blame for the severity of the damage sustained by the islands' coconut plantations. The resulting neglect of regeneration and proper maintenance no doubt increase their vulnerability. One should also bear in mind the part played by the system of traditional land tenure that probably causes a lack of incentive.

While the high density of housing in exposed sites may in some cases be considered as resulting from this system, real estate speculation and the rising cost of building land associated with urban growth certainly reinforced the tradition of coastal settlement. Sea oriented tourism further intensified this trend. High-risk settlements, on the shore or close to rivers prone to flash floods (Figs. 11 and 12), were only able to spring up because of loose regulations. In this respect, much damage could have been avoided or reduced. It would be interesting to make an in-depth study of individual and group behaviour during and after the cyclones in relation to the degree of urbanization, underemployment, current questioning of traditional values, and group rivalry illustrated by competition for local political power at various levels.

Many examples suggest that these factors played a significant role during and immediately after the cyclones

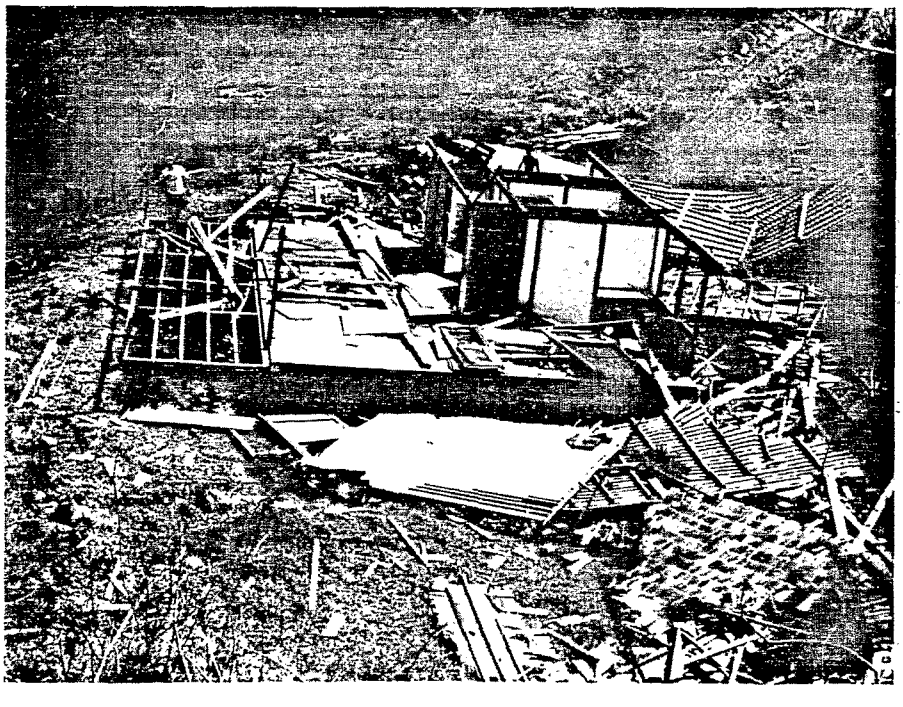


Fig. 8. Housing ill-adapted to the cyclone hazard: effects of cyclone Veena.

Fig. 9. What are the priorities? — A roofless house and a hi-fi system drying out in Tahiti after cyclone Veena.

and that they are still hampering the rehabilitation process. The Territory's particular political structure indeed affords central metropolitan and local authorities numerous opportunities for dispute and encroachment.

Notwithstanding a certain amount of improvization resulting from "exceptional" circumstances involved, rehabilitation may now be well under way and its financial requirements secured. Improvement of prevention and preparedness ought to be on a par with this effort, but unfortunately the heightened awareness of the risk

Fig. 10. Concrete house on Tuamotu atoll destroyed by wind and sea in cyclone Orama.

observable after the cyclone strikes seemed already to be waning in September 1983.

Very few practical measures had been taken to adapt the infrastructures and to improve zoning of settlements. The building of the public shelters had not begun. Local newspapers were fanning the latent concern that subsists in the population by journalistic highlighting of reports on the regional hydroclimatic imbalance, but no real programme of education and conscience-raising for preparedness had been launched.

The role of the regional climatic background

The cyclones of the 1982—1983 summer underscored the reality of a latent cyclone hazard in all the archipelagoes forming French Polynesia, and the even greater vulnerability of the low islands on account of the associated hurricane tide. The climatic and oceanic disequilibrium prevailing in the tropical latitudes of the Pacific since the end of 1982 was most marked during the first quarter of 1983. It may well, at the time, have created the thermal conditions conducive to the development of cyclonic depressions in the central part of the Pacific, but it has diminished since (Rougerie, 1983).

In August 1983, the positive deviation from the seasonal mean of the surface water (0 to 60 m) temperature was still 1 °C. In the Marquesas area, the atmospheric pressure, which had been below mean values for one year, was back to normal. The equatorial westward current had also resumed.

Finally, numerous sea birds, which had left places such as Christmas island (2 °N—158 °W) when the equatorial upwelling disappeared, were gradually coming back to their usual feeding grounds, and this seems to be an additional indication of the return of normal hydroclimatic conditions.

If this trend persists, one can reasonably expect French Polynesia, especially its central and eastern parts, to enjoy a cyclone-free summer in 1983—1984.

In the western part (Society Islands), however, vigilance should not be relaxed because of the statistically higher frequency of the risk between the Cook Islands and the Austral (or Tubuai) group. An active prevention and preparedness policy, based on enforcement of appropriate regulations and general education of the people, should be implemented concurrently with the rehabilitation programmes.

CONCLUSION

Weather forecasting and warning systems, and the special civil defence organization for emergencies, generally performed well during the 1982—1983 cyclones in French Polynesia and undoubtedly helped to reduce the cost in human lives of a series of events that reminded the population and the authorities of the permanence of the cyclone hazard.

These capabilities however only constitute a small part of the general organization that any country located in a cyclone-prone area should possess. In the case of French Polynesia, not only do a number of external factors enhance the potential consequences of the hazard, but the vast area covered by the Territory and the geographical scattering of its island groups make the task of organizing the appropriate response exceedingly complex. The major difficulty lies in the special vulnerability of a large part of the coastal settlements including, in particular, the city area

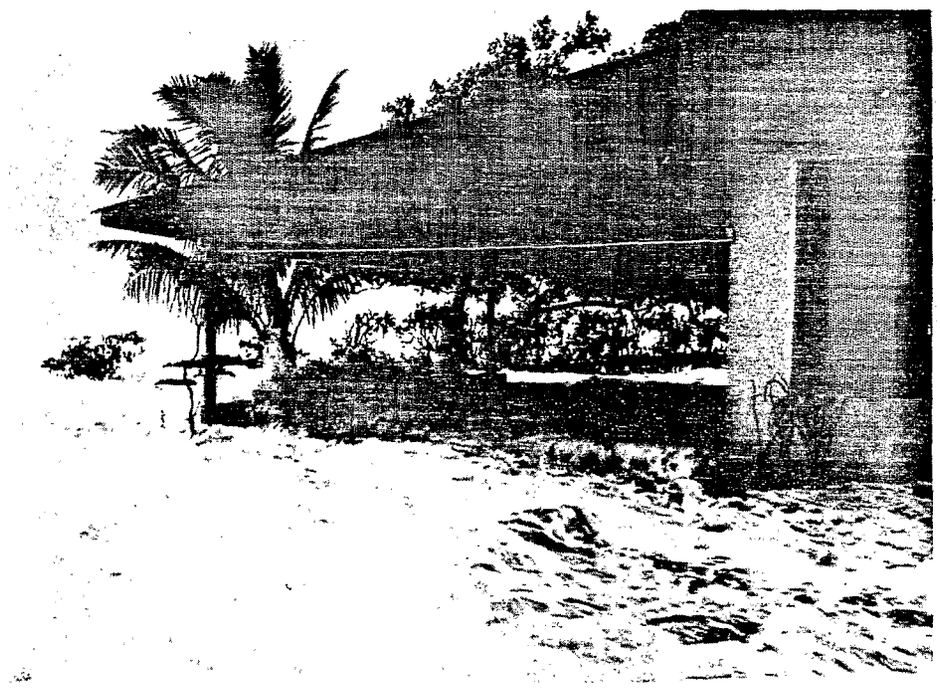


Fig. 11. Storm surge floods a house in a vulnerable location on Tahiti's east coast.

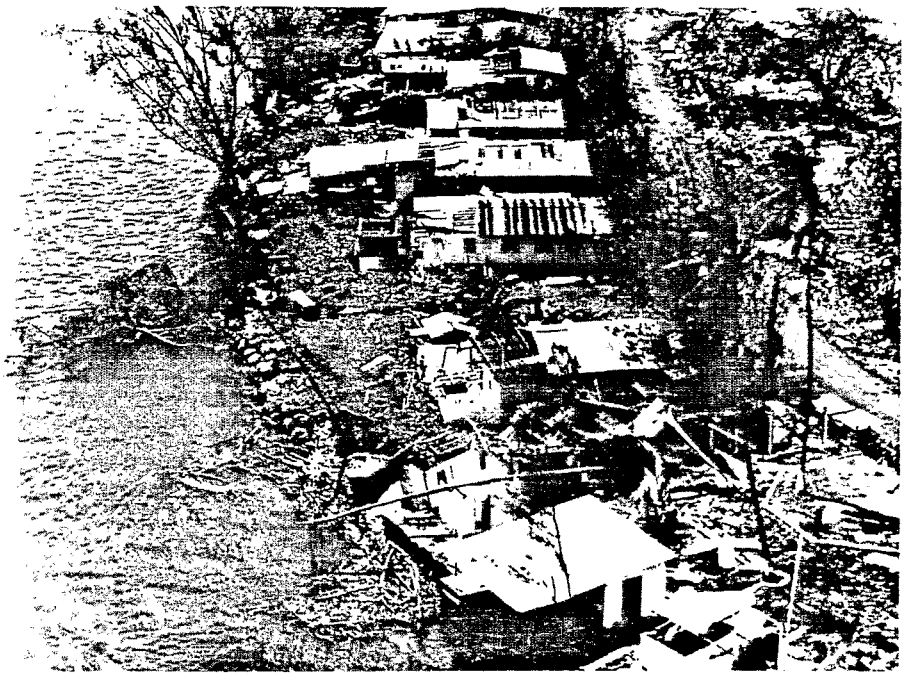


Fig. 12. Partially damaged houses after cyclone Veena, on a hazardous coastal location common in Tahiti.

of Papeete, its harbour and its international airport.

The cyclone hazard is shared, under comparable conditions, by many South Pacific countries. Hence the importance, for French Polynesia, of being included in a regional organization whose establishment was recently considered, and which would coordinate disaster preparedness strategies in the area.*

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