DISASTER PREPAREDNESS AND DISASTER EXPERIENCE IN FRENCH POLYNESIA

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FOREWORD

This report is a supplement to Disaster Preparedness and Disaster Experience in the South Pacific, published in 1982. In keeping with the original terms of reference for the Pacific Islands Development Program's Disaster Preparedness Project that was mandated by the Standing Committee of the Pacific Islands Conference, PIDP is publishing this report to provide regional governments with additional information about disaster preparedness in the countries and territories of the region.

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I. FRENCH POLYNESIA COUNTRY PROFILE

GEOGRAPHY

Area	Less than 4,000 km^2
Land Distribution	See Table 1

Table 1

Administrative Subdivisions	Number of Inhabited Islands	Area of Inhabited Islands	Total Surface Area	Total Population	Population Density (Persons/km^2 of Inhabited Land)
Windward Islands	5	1,172*	1,209	101,392	86.5
Leeward Islands	9	366	398	16,311	44.5
Marquesas Islands	10	823	997	5,419	6.6
Austral Islands	6	143	145	5,208	36.4
Tuamotu-Gambier	84	856	910	9,052	10.6
	114	3,360	3,659	137,382	41.0

*including Tahiti with 1,039 sq.kms.

Geographical Type

Over 120 French Polynesian Islands are scattered across more than four million square kilometers of water (over 2,000 kms. NS and EW). They are grouped into five archipelagos, with the Windward and Leeward Groups forming what are popularly known as the Society Islands.

Between island groups, ocean depths reach more than 2,000 meters. While the islands all have a common volcanic origin, they are nevertheless divided into two major categories according to their age and to the differences in their present-day topography:

1. the "high" or volcanic islands, smaller in number but larger in terms of surface area (Society, Marquesas, and Austral Islands), formed by protrusions of underwater volcanoes;

2. the "low" or oceanic islands and atolls, consisting solely of coral formations deposited on submerged volcanic structures.

Population

The population of the Territory is extremely unevenly distributed. According to the last census taken in 1977, nearly three-quarters of the population of the Territory was concentrated in the Windward group within the Society Islands. Tahiti alone accounted for nearly 70 percent of the total population. While the commune (local governmental unit) of Papeete per se represented barely 17 percent of the total (the "metropolitan area" of Papeete in the broadest sense of the term, including the communes of Pirae and Arue to the east and Faaa to the southwest), represented over 42 percent of the total population of the Territory. If the other suburban communes comprising the "greater Papeete metropolitan area" (Marina and Punaauia) are included, the share leaps immediately to over 52 percent.

Society Islands as a whole: 85.6 percent of the population
Marquesas Islands: 4 percent
Austral Islands: 4 percent
Tuamotu-Gambier Islands: 6.4 percent of the population

GOVERNMENT

Political Status

As defined by Law 77-772 of July 12, 1977, French Polynesia is a French overseas Territory with its own legal status and some administrative and financial autonomy, as provided by Article 72 of the French Constitution.

Government Structure

The Territory is represented in the French Parliament and the Economic and Social Council by two deputies, one senator, and one economic and social councilman. It is governed by its own

elected representatives, who are responsible for managing local affairs. The High Commissioner is the chief representative of the French Government in Polynesia, vested with sufficient powers for such purpose, and is head of the Government Council. The Territory's major government institutions include:

1. The Government Council, with the High Commissioner as its President, a Vice President, and six delegates in charge of the following government departments:
. Infrastructure and Territorial Planning
. Youth and Education
. Industry and Economy
. Taxation, Finance, and Rural Economy
. Health and Social Services
. Tourism and Fisheries

The territorial representatives to the French Parliament may not be Government Council delegates. The Government Council formulates policy for all territorial government departments on matters falling within its sphere of competence and prepares budget proposals for submission to the Territorial Assembly.

2. The Territorial Assembly, with 28 members elected by direct universal suffrage, in turn elects the delegates to the Government Council by voting for a list of candidates from among its own membership or otherwise, who are elected by majority vote.

The Territorial Assembly, which may delegate certain matters submitted for its consideration to a standing committee elected from among its own membership, may censor Government Council decision, in which case a new Government Council is promptly elected.

3. The Economic and Social Council, with

a President plus 29 members who may not be elected representatives and whose composition is determined in a Government Council decision with the advice of the Territorial Assembly, issues opinions on economic, social, or cultural projects submitted for its consideration.

The following functions are retained by the French National Government:

- Foreign Affairs
- Immigration and Alien Registration
- Overseas Communications
- Currency, Treasury, Credit, Exchange Control, and Foreign Commerce
- Defense (including civil defense)
- Citizenship (Bureau of Vital Statistics)
- Justice and the Judicial System (Criminal Law, Criminal Procedure)
- Civil Service
- Administration of Communes and Local Communities
- Secondary and Higher Education (the Territory may organize its own research services)
- Radio and Television

The High Commissioner, appointed by the French President through an Executive Order, is assisted in his tasks by a Secretary General. He enacts laws and decrees, oversees their enforcement, determines government revenues, issues orders for nonmilitary expenditures, maintains public law and order, ensures the legitimacy of all territorial government acts, and may proclaim a state of emergency.

Acting on instructions received from the French Government, the High Commissioner (Article 68 of the Constitution) may negotiate cultural, commercial, and technical agreements of direct interest to the Territory with governments of other member states of the South Pacific Commission, subject to consultation with the Government Council.

Both the Territorial Assembly and the Government Council may be dissolved by order of the Council of Ministers, in which case new elections must be held within a period of three months for the purpose of forming a new Territorial Assembly.

Local Government

French Polynesia is divided into five administrative subdivisions representing the different archipelagos, each of which is governed by an executive officer or chef de subdivision.

The subdivisions are, in turn, divided into communes, the smallest units of local government; the communes are governed by a mayor and municipal councilman elected by the public-at-large. Created in 1972, the communes of French Polynesia are distributed as follows:

Windward Islands:	13
Leeward Islands:	7
Marquesas Islands:	6
Tuamotu-Gambier Islands:	17
Austral Islands:	5
	48

Size of Police and Military Forces

As of July 1982, the combined strength of the Armed Forces and Police was approximately 7,000 people.

Total Government Expenditure

ECPF$46850 (US$368m) in 1981
ECPF$36966 (US$290.5M) in 1980

The above expenditures can be broken down as follows in Table 2:

Table 2

	1980	1981
Nonmilitary		
Pensions	2,170.4	2,655.7
Operating Expenses	10,444.3	12,500.2
Capital Expenditures	378.3	604.2
Total (millions of CFP*)	12,993	15,760.1
Military		
Operating Expenses	10,274.2	12,135.5
Capital Expenditures	992.8	1,272.7
Total	11,267	13,408.3
GRAND TOTAL (millions of CFP*)	24,260	29,168
	(US$190.6m)	(US$228.6 m)

*CFP = Pacific francs

ECONOMY

Gross Domestic Product and Per Capita GDP

In 1976 (the last year for which territorial accounting records are available), the GDP was 51,727 million Pacific francs (US$406.4 million), up 15 percent as compared with 1975.

The small share of the GDP attributed to agriculture and local industry (21%) as opposed to the predominance of the service (47%) and public sectors (32%) is noteworthy. The Pacific Experimentation Center (CEP) assures over 42 percent of all government expenditures, of which more than two-thirds are financed through transfers of funds from metropolitan France. The importance of government expenditures, 70 percent of which are financed by metropolitan France, in satisfying domestic demand is preponderant. Per capita GDP in 1976 was 368,000 Pacific francs ($2,900 at 1982 U.S. exchange rates, as compared with $4,471 in continental France.)

Table 3: Imports (in millions of Pacific francs)

	1980	1981
Major Suppliers	42,030 (US$330m)	54,843 (US$431m)
	1980	1981
France	20,016	25,512
United States	8,795	11,425
Other EEC Countries	4,038	5,456
New Zealand	2,160	2,974
Singapore	2,204	2,824
Japan	1,495	2,038
Australia	1,356	1,860

Major Products (1981):

Foodstuffs	9,410.3 million FCPF (US$74m)
Beverages	756.9
Tobacco	383.4
Fuels	6,877.6
Building materials	4,093.7
Machinery, vehicles, and transportation equipment	16,512.7

Per capita imports of foodstuffs in 1981: 67,216 Pacific francs ($528)

Table 4: Exports (in millions of Pacific francs)

	1980	1981
	2,339.8 (US$78.4m)	2,861.3 (US$22.5m)
Major Products:		
Total local products including:	750.9	1,014.2
Copra oil	562.8	518.8
Cultured pearls	101.9	404.8
"Monoi" (oil extracted from Tahitian Tiare plant)	—	26.7
Vanilla	13.9	10.4
Fresh fruits	6.5	5.6
Mother-of-pearl (shells)	8.2	2.6
"Trocas"	5.6	9.2
Others	1,641.0	1,902.8
Including other raw materials	51.8	62.7
Major Markets (1981):		
France	1,821.6	
Italy	355.2	
Other EEC Countries	45.1	
Other European Countries	96.1	
Japan	199.9	
United States	133.5	
New Caledonia	96.5	
New Zealand	25.1	
Australia	3.3	
	2,776.3	

Sixty-two percent of the Territory's exports are to EEC countries. Japan purchases 49 percent of the Terriroty's pearls with 82 percent of its mother-of-pearl (shells) also exported there. Italy purchases 68 percent of its coconut oil. Exports from French Polynesia in 1979, 1980, and 1981 comprised only 6 percent, 5.6 percent, and 5.2 percent, respectively, of total imports.

Subsistence Agriculture

The percentage of the Territory's total economically active population employed in the agricultural sector declined from 55.4 percent in 1956 to 43.6 percent in 1962, dropping to 16.9 percent by the year 1977.

It is virtually impossible to quantify traditional food production with any degree of accuracy because most traditional crops are grown for consumption by the producer and his family. Only a small portion of such crops are marketed (primarily taro, "Fei" bananas, and potatoes). Changes in eating habits have recently stimulated a sudden drop in sales of traditional food crops (which declined by over 40% in a span of five years). Approximately one-third of all agricultural workers are engaged in the production of cash fruit and vegetable crops, primarily on Tahiti and the Society Islands. The percentage of farm workers engaged in the production of any given crop varies from one island group to another according to the speculative activities practiced in each particular area. For example, 70 to 80 percent of the farm population on the Tuamotu-Gambier Islands produces copra, while approximately half of all farmers on the Austral Islands grow coffee. Foodstuffs (farm crops and animal products) account for approximately 80 percent of the total value of all products sold through commercial marketing channels and are used to satisfy demand generated by the large population center of Papeete on Tahiti. The major sources of supply are Tahiti itself (supplying 80% of the fruits and over 82% of the vegetables) and, to a lesser extent, Moorea (pineapples) and the Leeward Islands (Huahine: watermelons and other types of melons). The share represented by various foodstuffs as a percentage of all crops and animal products distributed through

commercial marketing channels in 1981 was as follows:

Vegetables	33.4%
Fruits	4.9%
Traditional food crops	3.2%

With animal products representing 26.9 percent of all commercially marketed products of agriculture, the Territory has been able to cover 100 percent of the domestic demand for eggs since 1975 and 86 percent of the local demand for pork products. The Windward Islands supply 95 percent of all commercially sold products, which represents 50 percent of all stock slaughtered for meat. By 1981, only 6 percent of the local consumer demand for beef was covered by domestic suppliers. Nearly two-thirds of all government-inspected slaughter operations are performed on the islands of Tahiti and Moorea. The percentage of local demand covered by domestic livestock operations is declining steadily. Over half of all livestock is raised on the Society Islands, with most of the remaining stock raised on the Marquesas Islands in uncontrolled herds.

Cash Crop Agriculture

The percentage of total cash income generated by the production of commercial or "cash" crops is as follows:

Copra	22.9%
Horticulture	6.9%
Coffee	0.5%
Vanilla	0.4%

Copra (16,000 tons), with its generally subsidized producer prices, is grown primarily on the Tuamotu-Gambier Islands (58.2%) and the Marquesas Islands (15.8%). The Leeward Islands account for 21.5 percent of all copra production, with subsistence farming of this crop in the more remote island groups possibly reaching significant proportions.

Cultivation of ornamental plants has developed appreciably over the past several years, with Anthuriums and Tahitian Tiares (for the extraction of "monoi" oil) accounting for a significant share of such production. Half of all surface areas devoted to the cultivation of these plants is concentrated on Tahiti. Anthurium sales represent one third of the total value derived from this form of production.

Coffee is produced principally in the Austral Islands and secondarily in the Society Islands other than Tahiti. Over 72 percent of the 51.5 tons produced in 1981 was grown on the Austral Islands, with the remainder produced by Moorea and Tahaa. Forced to compete with imported coffee from New Caledonia and with instant coffees from the Ivory Coast, sales of local coffee have been poor (with inventories reaching 70 tons in 1981), with a consequent decline in domestic production.

Vanilla still remains the speciality of the Society Islands. The 13.9 ton harvest of raw vanilla in 1981 came from Tahaa (6.5 tons), Raiatea (4.6 tons), Huahine (2.0 tons), and Tahiti (0.8 tons), representing the equivalent of 3.6 tons of processed vanilla. After a sudden drop in production followed by a leveling off, vanilla production seems to have recovered as a result of the rise in market prices since 1980.

Since 1966, the Rural Economy Department has been involved in a series of reforestation projects throughout the Territory, establishing new protected and productive forest areas on over 5,506 hectares of land, nearly half of which were planted with Caribbean pines. At least three-fifths of these reforested areas lie on the Society Islands, with one thousand hectares of reforested areas on the island of Tahiti, 70 percent in

	Caribbean pines, and a more or less equivalent area on the Marquesas Islands.
Foreign Aid	

Table 5: Foreign Aid (millions of dollars)

Bilateral Aid (Official Development Assistance)	1978	1979	1980
Development Assistance Committee: Net funds	90.6	143.9	159.4
Net ODA funds from all sources combined	90.6	143.9	159.4

Source: 1981 Review. Development Cooperation - Development Assistance Committee. Organization for Economic Cooperation and Development (OECD).

COMMUNICATIONS

Newspapers	Two daily French-language papers, La Depeche de Tahiti (circulating 9,000 papers a day since April 29, 1964) and Les Nouvelles de Tahiti (circulating 6,000 papers a day since April 26, 1957). One weekly publication Le Journal des Petites Annonces (in business since December 1980, has a circulation of 5,000).
Commentaries	One weekly publication Te vea hepetoma a ia mana te nunua (circulating 2,500 copies a week since June 1980). One monthly publication Ia Mana (with a circulation of 2,500 since June 1980).
Religious Publications	Three monthly publications, Bethel-Info (published since November 1979, with a circulation of 800); Notre lien (publishing since November 5, 1966 with a circulation of 1,000); and Te vea Katorika (publishing since April 13, 1962 with a circulation of 1,600).

One bimonthly publication Le Semeur Tahitien (publishing since October 15, 1959 with a circulation of 1,600).

Other Periodicals

One weekly publication Tahiti Rama (publishing since August 20, 1971 with a circulation of 1,400).

Two bimonthly publications, Scope (publishing since February 14, 1978 with a circulation of 1,000) and Lettre de la Chambre de Commerce et d'Industrie (publishing since January 19, 1981 with a circulation of 1,000).

Six quarterly publications, Bulletin de la Societe des Etudes Oceaniennes (circulating 1,000 copies since 1926); Une ecole pour etre heureux (circulating 500 copies since June of 1980); Ensemble (publishing since September 1980 with a circulation of 1,000); Faaui (publishing since June 1980 with a circulation of 1,500); Ohipa (publishing since July 1980 with a circulation of 1,000) and Omore (publishing since November of 1978 with a circulation of 3,000).

Two annual publications, Pomarescope (putting out 500 copies a year since September 1979) and Revue du Comite de la Croix Rouge en Polynesie Francaise (publishing since March 29, 1977 with a circulation of 2,000).

Telecommunications

All civilian telecommunications services linking French Polynesia to the outside world are provided by the General Radio Communications Network (RGR), an agency of the French Ministry of Postal Service and Telecommunications attached to the Bureau of Overseas Telecommunications Networks. RGR services are compatible with local telecommunications systems operated by the Bureau of Postal Service and Telecommunications.

There is regular, fully-automatic telephone, telegraph, and telex service

linking French Polynesia to continental France, as well as to other foreign countries.

The RGR also provides point-to-point and telegraph service, as well as data links for various clients (such as the airlines) and carries daily televised news programs to the islands from metropolitan France.

These services are all operated through the PAPENOO satellite communications station in Tahiti, opened in 1978, using the Intelsat geostationary satellite above the Pacific Ocean. Unlike New Caledonia, whose communication services are all routed through a common "Indian" and "Pacific" Ocean relay point, communications originating in French Polynesia are relayed via the United States. In the event of the severance of one of these links, essential services are restored through an emergency link between Tahiti and New Caledonia. Circuits are established with California (the Jamesburg Station) through the Intelsat satellite over the Pacific Ocean and continue overland to the East Coast of the United States and from there to France via the TAT 6 submarine cable.

In 1982, there were a total of over 100 telephone and telex circuits as compared with a mere 30 or so in 1978, all on a SCPC (Single Channel per Carrier) transmission basis. The two 250-watt transmitters used in 1978 have since been replaced by four 3.4-kilowatt transmitters. A hertzian beam using a passive relay (Super Mahina) connects the station to the Fare Ute terminal. The circuits are then placed at the disposal of the Bureau of Postal Service and Telecommunications. Television broadcasts from Paris are relayed through Singapore and Noumea.

In 1982, there were nearly 15,000 telephones in all of French Polynesia (trunk lines) with over 12,000 in the Greater Papeete area alone and another 1,000 or so scattered over the island of Tahiti, representing, together with Moorea (with 456 lines), over 95 percent of all existing telephone connections.

Beyond the Windward Islands, there are small-scale telephone systems in Uturoa (Raiatea), with 316 lines, Fare (Huahine), with 43 lines, and Vaitape (Bora-Bora), with 64 lines. Up to the present, these small automatic local systems have been manually trunked through the Uturoa relay, but full-scale automation of the Society Islands system, like that of Tahiti and Moorea, was scheduled for completion by January of 1983, at which point automatic telephone service would be available to over 85 percent of the general population of French Polynesia.

Other local systems are found on the Marquesas Islands: Taiohae (Nuku Hiva) with 98 lines and Atuona (Hiva Hoa) with 85 lines, as well as on the Austral Islands: Mataura (Tubuai) with 40 lines and Rurutu with 50 lines.

Telephone service within the archipelagoes and between Tahiti and other islands without a local telephone system (or locations simply not connected to the existing network) is replaced by telegraph service or radio links. Service within the Tuamotu-Gambier Island group is provided through Rangiroa for the western half of the archipelago and through Hao for the easternmost islands.

Service on all these islands is available either between 7:00 A.M. and 6:00 P.M. or between 6:00 A.M. and 10:00 P.M. Service number to Papeete is available in an emergency or disaster through the Bureau of Postal Services and Telecommunications

on a round-the-clock audiofrequency from the Super Mahina receiving center on Tahiti. This same center also establishes communication with private radio operators on islands or islets with no other form of communication service, as in the case of certain pearl farms on the Tuamotu Islands. In 1982, 47 first-class licenses were issued to private radiotelephone operators.

There is also the radio system operated by the French Polynesian Police, with all stations connected to Police Headquarters in Papeete, as well as another network allowing all subdivision offices to communicate directly with the Office of the High Commissioner.

These recent and ongoing improvements in telephone and radiotelephone service are expected to result in an extremely rapid increase in the volume of communications.

Radio and Television

According to the 1977 census, nearly all (99.94%) full-time residences within the Territory were equipped with a transistor radio, and over 60 percent had a television set, with the distribution by ethnic origin of the population (expressed as a percentage of all homes) as follows:

Ethnic Group	Radio	Television
Maori	99.92	47.23
Halfcaste	99.97	71.45
Asian	100.00	85.53
European	100.00	82.70
Other	100.00	72.27

The daily broadcasts of Radio Tahiti, a Region III French Government station, are received by all the islands on short- and medium-wave, and on FM as far as Bora-Bora. The Papeete-based station broadcasts between the hours of 6:00 A.M. and 10:00 P.M. in both French and Tahitian. Tahitian-language programs are broadcast daily from 6:00 to 7:00 A.M.,

11:00 A.M. to 12:00 noon and again from 5:00 to 10:00 P.M. There is also a special daily bilingual program on which personal messages from different parts of the islands are transmitted by the police. Inasmuch as the island people often listen to the radio, this particular program is an extremely important part of their lives, particularly for those living on islands other than Tahiti.

The role of television is equally important in areas with daily television broadcasts (from 5:00 to 11:00 P.M.). Outside of Tahiti, these televised broadcasts are received on a direct line (line of sight) as far away as Bora-Bora (a distance of 250 kilometers as the crow flies).

Cinema

As of 1982, French Polynesia had a total of ten public theaters or drive-ins, distributed as follows: eight in Papeete, one in Uturoa (Raiatea, Leeward Islands) and one in Rangiroa (Western Tuamotu).

Weather Service

Aside from daily radio and television reports supplemented by special weather bulletins in the event of the threat of a tropical storm and by special fishermen and small craft warnings, there is no regular, automatic weather information service. However, there is a special number to call where such information will be dispensed on demand by a Weather Bureau employee.

TRANSPORTATION

Roads (as of September 1980)

Since the creation of the French Polynesian communes in 1972, all roads within the Territory have been grouped into one of three categories:
. Territorial roads (built and maintained by the Territory);
. Communal roads (public thoroughfares in communes and major towns and villages,

communal access roads to public facilities such as schools, government offices, stadiums, and reservoirs);
. Private roads (system of roads providing access to private estates or homes in undeveloped areas).
Territorial roads on the high islands, particularly on Tahiti and Moorea, encircle the island providing access to public facilities of general interest (such as major tourist attractions, television relays, public lands, etc.). On the low islands, in addition to the foregoing types of territorial roads, if and when they exist, the road linking the island's major population center to the airfield and/or main wharf is also considered a territorial road.

On Tahiti, all territorial roads are covered by multiple layers or thick coats of basalt. The same is true of Moorea (hot-laid) with the exception of a single five-kilometer stretch of road crossing an area with land tenure problems, where the road is paved with coral. Virtually all territorial roads on the Tuamotu-Gambier and Austral Islands are also paved with coral. The territorial roads of the Marquesas Islands are carved from volcanic rock and are all unpaved.

In the absence of a more recent survey of the existing road network, the latest estimate (1980) by the Department of Public Works contained the following facts and figures as shown in Table 6:

Table 6

	Paved Roads	Unpaved Roads		Total
		Coral/ Basalt	Gravel Tracks	
Territorial Roads	300	300	200	800 km
Communal Roads	60	40	50	150*
	360	340	250	950

*including 37 km of paved city streets in Papeete and 40 km of access roads to coconut plantations on the Tuamotu Islands.

Vehicles

The 1977 census reported that 49.86 percent of all household owned a single vehicle, with the percentage varying from 23.14 to as high as 86.17 percent, according to social position and occupational group. The vehicle count by the Bureau of Mines as of September 1, 1982 (including the usual provisions for vehicles withdrawn from use and not reported as such) was as follows:

Light vehicles	27,900
Light commercial vehicles	14,800
Trucks and buses	1,670

Out of a total of 60,000 two-wheeled vehicles registered since 1964, it is more than likely that fewer than 30,00 are still in service.

Ports

Papeete's good anchorage, complete with a watering place, was quickly discovered by European sailors, resulting in the development of a small population center, which became the capital of the Pomar dynasty. Its role as capital of the islands was subsequently consolidated at the time of Tahiti's annexation by France in 1843.

The original, rather primitive port facilities have gradually been replaced by a series of new piers, with the steamship pier built in 1938/39 and the Fare Ute oil dock completed in 1957. In 1962, the creation of the Autonomous Port of Papeete, a territorial government facility, marked the beginning of a new era of expansion coinciding with the creation of the Pacific Experimentation Center. Expansion of the embankments and facilities at Motu Uta was completed in 1966, with the superstructure, hangars, and industrial installations completed in 1972. The port facilities are currently being expanded eastward, with completion scheduled for 1990. The new oil storage area is already completed. These facilities are expected to double port capacity.

Papeete Harbor

As the only fully equipped port in all of French Polynesia, Papeete Harbor has taken on an increasingly important role as a result of its proximity to Faaa International Airport and the presence of neighboring military installations. The configuration of the ocean floor, far too deep for ships to moor outside the reef, marks the outer boundaries of the port facility built around a well-sheltered 160-hectare anchorage lying between the barrier reef and the mainland, accessible through a channel with minimum depth of 11.30 meters and a working width of 110 meters. The harbor can accommodate a total of six large vessels simultaneously and has a layby basin within the anchorage for ships waiting to dock in the harbor proper. The harbor's berthing facilities include:

- a 450 x 10.5m ocean liner pier (3,150m berths);
- a 233 x 9m steamship pier (2 berths);
- an oil dock with five mooring posts connected to shore by concrete footbridges; Draft 10m (storage depot capacity 45,000m^3);

- a 290 x 6m coastal trading pier (inter-island service);
- Moorea dock (100 x 2.5m);
- a 100 x 5.5m deep-sea fishing pier;
- a 200m coastal fishing pier;
- a 360m marina (for craft with gross registered tonnage of up to 100 tons).

The ocean liner pier has six hangars with total surface area of 13,000 square meters. The coastal trading pier is used primarily for the unloading of copra stored in sheds at the nearby oil mill.

There is also a military transit pier used for the storage of materials and equipment en route to military installations on Moruroa, Hao, and Fangataufa. The facilities also include a repair dock operated by the DCAN (Bureau of Naval Construction and Weaponry) with modern shops and equipment, as well as a 3,000 ton floating dock. There is another pier in Fare Ute (the Navy pier) restricted to use by Naval warships.

The hauling slip managed by the Autonomous Port has a 600 ton launching cradle and two transfers (500 and 200 tons) for the repair of nonmilitary vessels. All work is performed by private firms. Shipbuilding is limited to small fishing craft (less than 25 meters).

The port employs 180 stevedores. The Navigation and Harbor Police Service, responsible for pilotage, towing, and maneuvering, is equipped with one 1,200 H.P. tug and three launches with 450, 250, and 200 H.P. engines. Military tugs (four 400 H.P. push-boats, two 750 H.P. and one 250 H.P. tow boats) are also available in case of need.

Lighterage service is ensured by four companies using shipboard and lighterage company equipment (traveling cranes,

including a 50 ton crane, trucks, and fork lifts of up to 30 tons). The progress of work is extremely rapid.

In addition to the piers and depots placed at the disposal of shipping lines and lighterage companies by the Autonomous Port, there is also a series of large-capacity cold-storage facilities, including a 17,000m^3 cold store for fish alongside the dock, all operated by a single private firm. Another firm operates a 7,000,^{3} capacity storage depot in the port area. All major piers have public utilities (water, electricity, and telephone service). The oil dock has its own reinforced security system and is equipped with a marigraph connected to the international network for the study and detection of tidal waves.

Tahiti has another anchorage in Vairao on the island's southern coast where larger vessels may ride at anchor. Ships enter the anchorage, which is sheltered from the prevailing winds, through a 200 meter wide, 29 meter deep channel to anchor in a good holding ground 30 meters deep. Passengers are taken by launch to a 60m x 2.5m pier.

Other Facilities

Windward Islands -
Moorea: small-scale berthing facilities (20 x 3m) for service between Tahiti and Afareaitu, Vaiare, Paopao, and Papetoai;
Maiao: dock for speedboats and whaleboats;
Tetiaroa: inaccessible atoll, no facilities;
Mehetia: no facilities, uninhabited.

Leeward Islands -
Raiatea: 150 x 9m pier for schooners (small- and medium-size freighters providing inter-island service) and large freighters (Uturoa);
Huahine (Fare): old, improved 64 x 6m pier.

Bora-Bora -
Farepiti: decrepit pier for vessels with 9m draft, in need of repair dating from the Second World War;
Vaitape: 39 x 6m pier with no clearance or storage facilities.

Tahaa -
Tapuamu: 87 x 5m pier under construction (1981) for tuna clippers (3m draft)
Maupiti: New berthing facilities in good condition but relatively inaccessible, for vessels with a 2.5m draft.

Tuamotu-Gambier Islands -
Aside from Hao and Moruroa, whose only port facilities are restricted to military use, seven of the northern Tuamotu and Gambier Islands (Mangareva) have harbor facilities for certain coasters, (all relatively inaccessible as a result of narrow channels and strong currents) and piers of up to 20 meters in length.

Navigable channels and whaleboat piers:
- Rangiroa
- Tikehau
- Ahi
- Manihi
- Takaroa

Schooner piers and haulage slips:
- Fakarava
- Mangareva

Elsewhere in the island group, there are a wharf, a harbor for whaleboats, an opening into the lagoon, an unimproved channel, and on certain islands, a total lack of any harbor facilities whatsoever.

Marquesas Islands -
Nuku-hiva: a 50 x 4m schooner pier in Taiohae (completed in early 1979), a beaching area for landing craft transport (LCT), and a coastal or trading pier under construction in Haaopu Bay for

service between Taiohae and the airfield in Nuku-a-Taha.
Hiva-Oa (Atuona): up to 1980, the island had only a small outdated berth and LCT beaching area or landing.

Since 1980, the schooner pier has been rebuilt, enlarged (75m), and sheltered from the swell by a new dike. Buildings are not yet completed. Cost of facilities is 1.6 million U.S. dollars.

Ua Pou, Ua Huka, Fatu Hiva, Tahuata, and Hiva Oa and Nuku-Hiva valleys are inaccessible by land: small facilities are accessible only by sea in calm weather. Landing is by whaleboat and canoe.

Austral Islands -
Tubuai: an 84 x 4.5m schooner pier was constructed in 1980 along with a landing. Buildings and additional berthing facilities were constructed in 1981.
Raivavae: old 40m schooner pier and landing.

There are no other berthing facilities for schooners elsewhere on the Austral Islands. Landings exist, however, on Rimatara, Rurutu, and Rapa.

The renovation of the inter-island fleet of vessels, combined with the increase in unit vessel capacity, has made current restoration work and improvements of existing port facilities absolutely essential. At present, only Tahiti, Bora-Bora, Hao, Moruroa, and Raiatea have facilities capable of accommodating large freighters (with drafts of 8-10m), and only Papeete actually receives such vessels, since the facilities on Moruroa and Hao are restricted to military vessels. The pier at Bora-Bora is in extremely poor condition and freight traffic at Uturoa (Raiatea) is far too light to warrant its being used as a port of call.

Vessels able to dock at a pier are unloaded by crane. In other cases, they are generally unloaded through the use of whaleboats, with such unloading operations that are much more precarious when the ships are anchored outside the lagoon. Service by landing craft transport (LCT) requires use of an improved ramp or landing. In some cases, the craft are landed directly on the beach or on the fringing reef.

Future plans call for a network of standardized port facilities, with one major port in each archipelago, from which smaller vessels would provide service between different islands within the archipelago.

All major ports include:
- an 80 x 5m (draft) pier
- a LCT landing
- a dock for speedboats and tuna clippers
- a slipway for small craft
- hangar and storage facilities
- a harbormasters office.

The secondary facilities include:
- a 30 x 3m (draft) pier
- an LCT landing
- a dock for speedboats and whaleboats
- a slipway for small craft.

A slipway of less than 100 tons is scheduled for construction in Taiohae (on Nuku Hiva in the Marquesas Islands) and in Uturoa (on Raiatea, Leeward Islands).

Shipping

International Service

Traffic in and out of Papeete Harbor in 1979 was distributed as follows:

A. Passengers	
Outbound	41,093
Inbound	26,635
Passengers in Transit	33,363
Total (A)	101,091

B. Freight (in tons)	
Imports	
Misc. Goods	248,994
Petroleum Products	233,199
Fish Products	2,355
Subtotal	484,548
Exports	21,395
Inter-island trade	88,778
Total (B)	594,721
Containers (units)	8,930

C. Traffic (units)	
Inbound	
Civilian Vessels	
Steamers	17
Freighters	172
Oil/Methane Tankers	31
Fishing Craft	120
Pleasure Craft	589
Coasters, Local Fleet	728
Others	14
Total	1,671
Military Vessels	251
Total (C)	1,922

. Gross Registered Tonnage: 2,773,786 tons

In 1982, the 17 shipping companies making regular calls at Papeete Harbor and linking French Polynesia to the outside world were represented by eight different shipping agents.

To the aforesaid freighter, oil and methane tanker traffic must also be added 10 to 15 oceanliners traveling between North America and Australia along various routes spanning the Pacific Islands, particularly between the months of December and March, as well as the additional traffic generated by fishing craft (heading to Asia, Puerto Rico, etc.) and pleasure craft.

Commercial Lines

- Northern and Western Europe	Compagnie Generale Maritime (CGM)	2 per month
	Nedllyod	1 per month
	Colombus	1 or 2 per month
	Polish Ocean Line	1 per month
	Bank Line	1 per month
- Asia, Japan, Singapore	Balihai Service	1 per month
	Mobil (Tanker)	1 per month
	Kyowa Shipping	1 per month
	Total (Tanker)	1 per month
- Australia	Gazpac Shipping	1 or 2 per month
	Gazocean	1 or 2 per month
	Karlander	1 per month
- New Zealand	Shipping Corp. of N.Z.	1 per month
	CTM Tahiti Line	1 per month
- North America	Polynesian Line	1 per month
	Pacific Island Transport Line	1 per month
- Samoa	Marlex (Tanker)	1/6 wks.-2 mos.

Domestic

All heavy cargo must necessarily be moved by sea. Furthermore, the long distances separating the different island groups of French Polynesia only serve to highlight the importance of inter-island service by sea.

Until only recently, all service originated out of Papeete, the Territory's largest port in terms of tonnage handled (6,000,000 tons), the only nonmilitary international harbor and the home port for the entire local fleet. Table 7 shows the quantity and distribution by major product of the inter-island traffic moved by sea in 1981:

Table 7

Inbound Traffic from the Archipelagos

Copra	14,524	Passenger Traffic:	8,605
Fish	1,314		
Other products	6,089		
	21,927 tons		

Outbound Traffic to Other Islands and Archipelagos

Foodstuffs	12,869	Passenger Traffic:	13,861
Building materials	17,363		
Petroleum products	17,423		
Other products	14,366		
	62,021 tons		

Traffic reported by Moorea in 1981 was as follows:

	Freight Traffic	Passenger Traffic
Inbound:	5,592	51,234
Outbound:	33,962	58,411

Of the 2,096 vessels entering Papeete Harbor that same year, 40 percent belonged to the local fleet. The port's relatively heavy passenger traffic is noteworthy and, in fact, is due to the high cost of air travel. Inter-island travel by sea is still a rather risky venture. Records subsequent to 1930 (Deleplancque, 1982) show a total of 56 vessels stranded on reefs, the loss of six ships, twelve vessels missing at sea, and five vessels shipwrecked while anchored in an anchorage. Facilities are still primitive and, until only recently, the inter-island fleet of vessels was old and obsolete, consisting of schooners and coasters (small- and medium-size freighters, some with wooden hulls).

In an effort to keep customer charges at modest levels, ship owners and operators receive government subsidies, in return for which they must meet certain obligations relative to service regularity and route.

The shipowning business has changed completely since 1977, with inter-island ferry service given public utility status by the territorial authorities. All persons issued operator's licenses must sign and adhere to a series of conditions with regard to service and route. There is a ceiling on freight charges. The territorial authorities are responsible for transporting certain products such as copra, with shipowners simultaneously receiving grants to enable them to modernize their fleets. This policy, combined with the Territory's efforts to develop and thus prevent a general exodus from the outlying archipelagos, has resulted in the rapid replacement of old, outdated vessels, with the value of the inter-island fleet tripling over the past two years, accompanied by an increase in average deadweight capacity from 250 to 400 tons and an appreciable increase in engine power. The fleet now includes four vessels with dead weight capacity of over 1,000 tons as compared with the previous maximum weight of 870 tons. The old fleet of government vessels has also been replaced and currently includes a 1,055 ton craft designed for use in the event of the accidental immobilization of a private vessel, as well as a 500 ton landing craft.

However, out of 19 commercial vessels operated on regular routes by private companies in 1981, ten coasters still had a net tonnage of under 100 tons, including seven with tonnage under 50 tons.

Government vessels (particularly those of Public Works, consisting of five LCT and

two schooners, are used to transport heavy vehicles and equipment employed in public works projects and to carry large groups traveling together (religious organizations, student groups, etc). By 1982, there were four vessels providing regular service to and from the Leeward Islands, ten vessels serving the western Tuamotu Islands, six vessels serving the eastern Tuamotu Islands, four serving the central Tuamotu Islands, one for the Gambier Islands, two for the Austral Islands, and five vessels serving the Marquesas Islands. All of the archipelagos together are theoretically served by five vessels.

The status of service in the different archipelagos in 1981 was as follows:

Windward Islands:
- Moorea: daily service
- Maiao: once a month, with the exception of charters and government service.

Leeward Islands:
- Two runs a week by coastal vessels except for Maupiti and Tahaa and the villages on Raiatea with the exception of Uturoa.

Tuamotu-Gambier Islands: In 1980, only three vessels made a regular circuit of this island group, operating primarily between the Marquesas Islands and Tahiti for the collection of copra. In general, most of the atolls, scattered over more than 1600 kilometers of ocean, are served by small vessels with dead weight capacities of less than 300 tons on somewhat arbitrary routes with long turnaround times. However, efforts are currently underway to improve service to these locations.

Marquesas Islands: In 1980, regular service to the Marquesas Islands, which lie 1400 kilometers northeast of Tahiti,

was provided by three schooners with dead weight capacities ranging from 300 to 800 tons. Government vessels carry passengers as well as materials and equipment to and from islands bypassed by the schooners and into valleys inaccessible by land. In 1981, the bulk of such service was ensured by a single schooner permanently assigned to the island group.

Austral Islands: In 1980, a single schooner provided monthly service to all the Austral Islands with the exception of Rapa (where the schooner called once every three months), with such service supplemented by government vessels as in the case of the Marquesas Islands.

In addition to the privately owned commercial vessels and government craft operating throughout the islands, French Navy craft stationed in Polynesia may be asked to call at islands without regular ferry service, to assist with emergency evacuations, to carry student or other groups, to perform search and rescue operations at sea, and to help transport oil supplies.

The distribution of oil to the islands of French Polynesia poses a rather special problem, with oil oftentimes carried by schooner and LCT in bulk, in 200-liter barrels or tanks, without any special precautionary measures taken in connection.

Consequently, the current plan is to build special oil depots on certain islands, to be supplied by a tanker with deadweight capacity of 1500 to 2000 tons operated by the territorial authorities, from where the oil would then be redistributed. The islands targeted for such depots are Moorea, Bora-Bora, Huahine, Rangiroa, Hiva-Oa, and Nuku-Hiva.

The project is part of a plan for the reorganization of the Territory's port facilities recommended by the Department of Public Works, which establishes a "hierarchy" of port facilities for the different archipelagos based on the guidelines presented earlier in this chapter relative to major and secondary port facilities.

Society Islands: (Windward Islands-Leeward Islands)
- major ports: Tahiti, Raiatea
- full-scale secondary ports (as needed): Bora-Bora, Huahine, Tahaa, Moorea
- secondary ports (coastal service): Maupiti
- minimal facilities: Maiao

Tuamotu-Gambier Islands:
- major ports: Rangiroa, Makemo, Hao, Mangareva
- secondary ports: Apataki, Manihi, Anaa

Marquesas Islands:
- major ports: Hiva Oa, Nuku Hiva
- secondary port: Ua Pou
- minimal facilities: Ua Huka, Tahuata, Fatu Hiva

Austral Islands:
- major ports: Rurutu, Tubuai
- secondary ports: Rapa, Raivavae
- minimal facilities: Rimatara

Airports

The Faa international airport, opened in July of 1961, is an all-weather facility. Its 3415 x 45m runway is supplemented by two 60m extensions used as occasional taxiways. The airport can accommodate all types of aircraft. It is equipped with an instrument landing system (with the guidance and landing system installed in 1961 and the distance measuring equipment installed in 1972) and is operated by SETIL (Societe d'Equipement de Tahiti et des Iles.)

Airlines

International

In 1981, a total of eight different airlines operated international flights to and from French Polynesia.

Table 8

Airlines	Flights Arrival/Departure	Average Load Factor (%)
UTA	630	80.5
Air New Zealand	430	62.6
Lan Chile	233	59.9
Quantas	204	69.4
Polynesian Air	104	30.3
SPIA	102	44.5
Air Pacific	80	35.6
Air Tungaru	62	30.1
	1845	

All of these flights accounted for 241,900 passengers.

Another 24 nonscheduled international flights carrying 1,521 can be added to this total. UTA alone carried 142,201 passengers and 2,639 tons of freight out of a total of 4,742 tons (ANZ: 1877 tons; Qantas: 1182 tons.)

The following table (9) shows the frequency and destinations of all regularly scheduled international flights as of July 1982:

Table 9

	Craft	Weekly Frequency
Papeete/Auckland	B 747	2
Papeete/Auckland/Noumea	DC 10	1
Papeete/Rarotonga/Nadi/Auckland	B 737	1
Papeete/Noumea/Sydney/Paris	B 747	1
Papeete/Sydney/Melbourne	B 747	3
Papeete/Honolulu	B 707	1
Papeete/Los Angeles	B 747	4
	DC 10	3
Papeete/Easter Island/Santiago	B 707	2
Papeete/Rarotonga/Niue/Apia	B 737	1
Papeete/Pago Pago/Nadi	BAC 111	1

Domestic

Out of a total of 447,595 passengers carried on domestic flights in 1981, 242,729 flew between Papeete and Moorea. The total number of domestic flights was 35,141, of which 27,341 were between Papeete and Moorea, accounting for over three-quarters of all passenger flights. Freight traffic was equal to 523 tons, virtually all of which was transported on flights between Papeete and Moorea. There are two domestic airlines, Air Tahiti, primarily serving Moorea but also offering service to the Leeward Islands and other archipelagos, and Air Polynesia, with service to all parts of the Territory, including flights between Tahiti and Moorea.

Air Tahiti has service to 15 of the Tuamotu-Gambier Islands, to Rurutu and Tubuai in the Austral Islands, as well as to Nuku Hiva and Hiva Hoa in the Marquesas. Air Polynesia flies to 20 of the Tuamotu-Gambier Islands, as well as to the same islands as Air Tahiti in the other archipelagos from Papeete-Faaa, and also operates inter-island flights within the different archipelagos.

Thus, the distribution of domestic air traffic in 1981 was in Table 10:

Table 10

French Government-operated Airfields	Flights (A + D)	Passengers (%)	Avg Load Factor (%)
Tahiti/Faaa	35,141	447,595	69.5
Bora-Bora (Leew.)	4,073	97,097	60.7
Raiatea (Leew.)	4,688	66,608	64.1
Rangiroa (T-G)	1,705	22,213	57.1
Territorial Airfields			
Moorea (Wind.)	27,267	242,141	69.2
Huahine (Leew.)	3,696	42,291	69.3
Manihi (T-G)	394	6,882	43.5
Nukua Taha (Marguesos)	1,076	4,649	66.8
Tubuai (Austral)	332	5,391	39.3
Rurutu (A)	452	4,443	55.1
Other Secondary Airfields			
Anaa (T-G)	246	1,171	66.0
Makemo (T-G)	201	791	33.3
Mataiva (T-G)	307	1,815	54.5
Maupiti (Leew.)	854	5,736	56.5
Takapoto (T-G)	214	765	26.9
Tikehau (T-G)	330	2,251	21.0
Totegegie (T-G)	58	1,292	55.0

The frequency of service to islands with airport facilities in the different archipelagos is presented in Table 11. Last, the airfield in Faaa reported the operation of 4,370 military and government flights in 1981, as follows:

Moorea	410
Rangiroa	98
Raiatea	66
Huahine	60
Bora-Bora	40

Table 11: Air fields of French Polynesia

1	2	3		4	5	6			
Airfields		USE				runway, take-off direction			
		Main	Secondary			(a) Orientation	(b) Length and Width	(c) Capacity	(d)
POLYNESIA									
ANAA	C	—	—	1	I	14/32	1500x30	10	PS
APATAKI	D	—	—	1	—	12/30	840x30	5,7	PS
ARATIKA	D	—	—	3	—	09/27	760x20	5,7	NR
ARUTUA	D	—	—	3	—	08/26	680x15	5,7	NR
BORA-BORA/ Motu mute	B	TA	—	1	1	11/29	1500x22	5,7	PS
FAKARAVA	D	—	—	1	—	05/23	1000x30	5,7	PS
FANGATAU	D	—	—	1	—	07/25	900x30	5,7	PS
FANGATAUFA	-	—	—	2	—	—	2000	-	—
HAO	-	—	—	2	I	12/30	3380x45	-	PS
HIKUERU	D	—	—	3	—	10/28	800x20	-	NR
HIVA-OA/ATUONA	D	—	—	3	—	02/20	1125x18	5,7	PS
HUAHINE/FARE	C	—	—	1	I	07/25	1500x20	10/20/40	PS
KAUKURA	D	—	—	1	—	02/20	700x30	5,7	PS
MAKEMO	C	—	—	1	I	11/29	1500x30	10	PS
MANIHI	D	—	—	1	I	05/23	1200x30	10	PS
MANGAREVA/ TOTEGEGIE	C	—	—	1	—	12/30	2000x30	11	PS
MARUTEA-SUD	D	—	—	3	I	06/24	1350x20	-	NR
MATAIVA	D	—	—	3	—	01/19	970x30	5,7	NR
MAUPITI	D	—	—	1	—	08/26	815x20	5,7	PS
MOOREA-TEMAE	D	—	—	1	I	12/30	880x20	12	PS
MURUROA	-	—	—	2	—	08/26	2400x45	-	—
NAPUKA	D	—	—	1	I	10/28	900x30	-	PS
NUKU A TAHA	C	—	—	1	—	06/24	1700x20	-	PS

1	2	3		4	5	6			
Airfields		USE				runway, take-off direction			
		Main	Secondary			(a) Orientation	(b) Length and Width	(c) Capacity	(d)
NUKUTAVAKE	D	--	--	1	--	07/25	850x30	5,7	NR
PUKA-PUKA	D	--	--	1	--	10/28	900x30	10	NR
PUKARUA	D	--	--	1	--	12/30	900x30	10	NR
RAIATEA/UTUROA	C	TA	--	1	I	07/25	1400x30	10	PS
RANGIROA	B	TA	--	1	I	10/28	2100x30	-	PS
REAO	D	--	--	1	I	11/29	900x30	5,7	PS
RURUTU	C	--	--	1	I	09/27	1500x30	10	PS
TAHITI-FAAA	A	TA	AN/AA	1	I	04/22	3415x45	20/40/72	PS
TAKAPOTO	D	--	--	1	I	07/25	900x30	5,7	PS
TATAKOTO	D	--	--	1	--	08/26	900x30	5,7	PS
TETIAROA	C	--	--	3	--	07/25	660x20	5,7	NR
TIKEHAU	D	--	--	1	--	06/24	1200x30	5,7	PS
TUBAI/MATAURA	C	--	--	1	I	03/21	1500x30	10	PS
TUPAI	-	--	--	-	--	11/02	750x12	-	PS
UA-HUKA	D	--	--	3	I	09/27	755x20	2,6	PS
UA-POU	D	--	--	3	--	14/32	833/20	2,6	PS

Source: Civil Aviation Service, Bureau of Aviation Facilities and Infrastructure, Faaa.

ABBREVIATIONS AND SYMBOLS, BY COLUMNS

1. Official airport name
2. Class
3. Use: TA = Air Transportation
   AA = Air Force
   AN = Naval Air
4. Classification of the airport according to its usage:
   1 - open to public air traffic
   2 - reserved exclusively for government use
   3 - approved for restricted use
5. Landing systems:
   I - Instrument Landing System
   1,2,3 - Precision approach category lighting system

6. Runway, strip, or direction of take-off including:
   a. alignment
   b. dimensions: length and width. (The dimensions of grass areas are measured along lighted center lines.)
   c. load bearing capacity: expressed by three figures representing the number of tons per single wheel/per dual wheel/per tandem wheel in that order
   d. type: PS = unmetalled airstrip
      NR = unpaved runway

Table 12: Domestic air service

CONNECTIONS	AIRCRAFT	DAYS PER WEEK
A. ILE DE LA SOCIETE:		
Papeete/Huahine		7/7(1)
Papeete/Raiatea	FOKKER 27	7/7(1)
Papeete/Bora-Bora		7/7(1)
Raiatea/Maupiti	BRITTEN NORMAN	5/7
Bora-Bora/Maupiti		5/7
Papeete/Moorea	TWIN OTTER	7/7(1)
B. TUAMOTU NORD:		
Papeete/Rangiroa		4/7
Papeete/Rangiroa/Tikehau	FOKKER 27	1/7
Papeete/Rangiroa/Manihi		3/7
Papeete/Apataki/Aruatua/Takapoto		1/7
Papeete/Apataki/Takapoto	TWIN OTTER	1/7
Papeete/Mataiva/Tikehau		1/7
Papeete/Kaukura/Apataki/Fakarava		1/7
C. TUAMOTU EST - GAMBIER:		
Papeete/Anaa/Makemo/Hao	FOKKER 27	1/7
Papeete/Apataki/Napuka/Puka-Puka/ Fangatau/Hao/Nukutavake/Reao/ Pukarua/Takakoto/Hao/Anaa/ Papeete	TWIN OTTER	1/30
Papeete/Hao/Gambier	FOKKER 27	1/15
D. MARQUISES:		
Papeete/Nuku-Hiva	FOKKER 27	1/7
Nuku-Hiva/Hiva-Oa		4/7
Nuku-Hiva/Ua-Pou	BRITTEN NORMAN	4/7
Nuku-Hiva/Uuka		4/7
E. AUSTRALES:		
Papeete/Rurutu/Tubuai	FOKKER 27	1/7

(1) Several flights a day.
Source: Civil Aviation Service, Air Transportation Division

RELATIONS WITH OTHER COUNTRIES

Consulates (Honorary Consuls):

Federal Republic of Germany
Austria
Chile
Denmark
Finland
Italy
Monaco
Norway
Netherlands
Sweden (Honorary Vice-Consul)

MEMBERSHIP IN REGIONAL AND INTERNATIONAL ORGANIZATIONS

French Polynesia is a de facto member of all regional and international organizations joined by France and particularly of the South Pacific Commission.

II. FRENCH POLYNESIA DISASTER EXPERIENCE PROFILE: DISASTER TYPES AND HISTORY

OVERVIEW

French Polynesia's history of natural disasters[1] demonstrates the very real danger posed by tropical disturbances, which represent the most common type of risk and a serious threat to the low-lying islands despite the rarity and relatively moderate intensity of tropical disturbances. To the danger of their reaching the intensity of a depression or cyclone and to the torrential rains, which may or may not be associated with these storm systems, we must also add the risk of tsunamis.

Tropical Depressions and Cyclones

Tropical depressions and cyclone[2] liable to strike the islands generally move in a southeast direction. Winds rarely reach or surpass an average of 120 km/hour and usually last less than 24 hours, although accompanying storm tides (see below) could last several days. It is the effect of the storm tides associated with these tropical disturbances, more so than the winds, that represents a serious threat to the low islands, all of which are extremely vulnerable to the force of the sea.

Although data on depressions and cyclones prior to World War II are sketchy, the monthly distribution of storms is given for the periods before and after the war as follows:

	1831-1940	1941-1981 (all types)
November	-	2
December	3	4
January	4	9
February	6	5
March	1	8
April	-	1
August	1	-
	15 (109 yrs)	29 (40 years)

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1 This section and the section on "Preparedness and Rehabilitation" were prepared based on information supplied by the Civil Defense Service (Captain J. Duplessier), the Weather Service (Mr. A. Theron), the Department of Territorial Planning (Mr. F. Dupuy), the Equipment Department (Messierus A. Ellacott, Deleplancque, Villot, Bury, and Pierson), the Department of Rural Economy (Mr. D. Drakni), and the Geophysics Laboratory (Mr. J. Talandier).

2 Moderate tropical depression: Average winds 62-87 km/hr
Strong tropical depression: Average winds 88-116 km/hr
Tropical cyclone: Winds over 116 km/hr

Improvements in observation and recording methods, particularly since 1966, help explain the increase in the number of such phenomena reported in the area over the years:

1941/1965 (25 years): 10
1966/1981 (16 years): 19

Several times a century the island groups of French Polynesia are exposed to being more or less directly hit by tropical storms accompanied by average winds of 100 to 120 km/hr lasting up to 24 hours and storm tides oftentimes lasting two or more days, with the exception of the northernmost Marquesas Islands.

Studies of the paths taken by previous storms have, nevertheless, enabled the Weather Service to identify certain high- and low-risk areas. To the south, there is a risk of such phenomena striking once every two or three years within a corridor running from the southern Cook Islands to the Austral Islands and surrounding areas. Farther north, the risk factor is four to eight storms per century within a somewhat wider corridor running from the northern Cook Islands to the Gambier Islands and including the entire Tuamotu archipelago. Beyond these corridors, the risk falls to one to three storms per century within the area bounded by the Line Islands and the southern Marquesas. Finally, the risk for nearly all the Marquesas Islands beginning with Hiva Oa - Ua Pou is extremely low, or a maximum of one or so storms per century. Within the aforesaid corridors, the risk increases moving in a northwest to southeast direction over the area encompassing the French Polynesian islands.

Storm Tides

Storm tides are caused by a series of phenomena associated with tropical depressions and cyclones simultaneously involving meteorological as well as oceanographic factors and pose a particularly serious threat to coastal flatlands unprotected by reefs and to the low Polynesian islands (atolls with altitudes ranging from 0.5 to ten or so meters above sea level), including:

. a heavy swell preceding the depression or cyclone, resulting in a slow but steady elevation in the level of the sea; and

. the cyclone proper, accompanied by an abrupt rise in sea level, referred to as the storm surge (formerly known as a tidal wave);

The straighter the path taken by the eye of the tropical depression, the larger its diameter and the longer the distance over which it freely propagates, the more settled and slower-moving the storm surges. In French Polynesia, these surges strike the islands from the west and particularly from the north.

When these phenomena coincide with a spring tide, their force is further intensified. Likewise, the contour of the shoreline and ocean floor, with certain conditions more propitious than others to the breaking of waves (along with the position and orientation of the coastline) can, in turn, either intensify or diminish their force. One of the side effects of the agitation and disturbance by these storm systems of coral deposits on the ocean floor around the islands could be a revival of the ciguatera problem (fish poisoning; Bagnis 1979).

STORMS AND HURRICANES

Recorded Storms and Hurricanes, 1800-1939

1831 December 21-2 -- tropical cyclone (?): Leeward Islands, no further details.

1843 December 21 -- tropical cyclone (?): Leeward Islands, strong northeastern/southwestern winds; homes along the coast damaged by waves; trees downed in Huahine, Raiatea (four deaths), Tahaa, Maupiti, and Bora-Bora where the seas flooded coastal areas, penetrating deep inland.

1856 January 22 -- tropical depression (?): Trees blown down by wind; storm surges in Papeete; minimum pressure recorded 751.8 m/m.

1865 February 2 -- tropical depression or cyclone (?): Society Islands (Leeward Islands), Austral Islands, Tahiti; damage to the districts of Mataiea, Paea, and Punaa-Uia (coastal plantations and homes); storm surges carrying sand; destruction of dwellings along the coast of Tubuai (Austral Islands).

1877 January 18-19 -- tropical cyclone (?): Society Islands and Tuamotu

1878 February 6-7 -- tropical cyclone: Western Tuamotu Islands; moving north-northwest/south-southeast; extremely violent storm; damage caused by the force of the wind and sea; 117 deaths; extensive damage to plantations, homes, and vessels; minimum pressure recorded in Papeete 754.6 m/m.

1879 December 11-12 -- tropical depression (?): Tahiti; damage caused by rain and flooding.

1883 February -- tropical depression (?): storm tides.

1883 February 8 -- tropical depression (?): storm tides.

1889 March 16 -- tropical depression (?): storm tides; heavy damage to Tahiti.

1901 December 22 -- tropical depression or cyclone: northeast direction; strong winds, torrential rains, 1-meter storm surge; continuous swell; coastal damage (Papeete piers) and trees blown down by the wind; minimum pressure 744 m/m.

1903 January 14-15 -- tropical cyclone: path similar to that of the tropical cyclone of 1878 but farther east; struck the central Tuamotu Islands claiming 517 lives, 2 schooners, and 83 cutters; villages were destroyed primarily as a result of the inundation of atolls by storm tides; Hikueru, Marokau, Makemo, Ravahere, Takume, Rairoa, and Napuka were hardest hit by the storm; minimum pressure

of 753.2 m/m recorded in Papeete.

1905 March 23-26 -- tropical cyclone: followed two tropical depressions and moved north-northeast/south-southwest, with the eye of the cyclone passing just off Manihi, northern Tuamou (claiming 4 lives in Arutua), Apataki, Kaukura, and eastern Tahiti; minimum pressure 735 m/m in Takaroa, 732 m/m in Napuka, 750.4 m/m in Papeete; strong winds; relatively low storm tides; four schooners wrecked; 4 deaths; 32 cutters and 175 homes destroyed.

1906 February 7-8 -- tropical cyclone: moving in a northwest direction; initial speed less than 10 km/hr, picking up speed between Anaa and the Gambier Islands; minimum pressure 736.1 m/m, 736 m/m, and 744 m/m recorded on the 8th in Papeete, Tikehau, and Hikueru, respectively; Tahiti was damaged by storm tides; two deaths; low pressure of 715 m/m recorded on the 8th around 3:00 pm west of Anaa (by the schoonor "Papeete"); Papeete struck by storm surges measuring 2.75m above mean sea level; 2.5 meter storm surge tides occurred in Tikehau; there was extensive damage to the Tuamotu Islands, primarily from storm tides, claiming over 150 lives.

1915 February 4 -- minimum low pressure of 751.4 m/m in Tahiti.

1919 January 31 -- minimum low pressure of 747.2 m/m in Tahiti. Storm tides in Papeete.

1920 January 23 -- minimum low pressure of 749.4 m/m.

1921 December 30 -- minimum low pressure of 751.7 m/m.

1924 December 11 -- minimum low pressure of 751.3 m/m.

1926 January 1-3 -- tropical depression (?): several lives claimed by a landslide in Papara district; minimum low pressure of 752.2 m/m.

1933 August 23-26 -- tropical depression (?): traveling depression moving west-northwest/east-southeast; small diameter; rapidly moving (30-32 km/hr before finally dissipating); damage to the Austral Islands hit by a 1 to 1.5-meter storm surge; trees downed; many homes destroyed; minimum low pressure of 757.9 m/m recorded at Papeete fewer than 350 miles from the direct path of the storm; this unusual cool season "tropical" depression was initially caused by an unexpected rush of cold air from the south polar front (Giovanelli, 1940).

1935 February 6-12 -- tropical depression: on the 5th and 6th south of the Society Islands traveling east to west, followed by a strong tropical depression or tropical cyclone developing northeast of the Cook Islands, traveling northeast/southwest and then changing course and moving northwest/southeast; minimum low pressure of 997.1 mb (747.9 m/m) recorded in Uturoa on the 6th; no information on damage to French Polynesia.

1937 February 25-27 -- tropical depression: developing southeast of the Cook Isands; traveling in a northwest/southeast direction, hitting the Austral Islands, strong winds and storm tides of 0.75 to 1.00 meter recorded at Tubai; minimum low of 745.4 m/m.

Recorded Storms, 1940-1969

1940 February 6-8 -- moderate tropical depression: approaching the

islands from the northwest; minimum low pressure of 751.1 m/m in Papeete and 750.6 m/m in Rurutu; winds gusting to 90 km/hr.

1940 December 29-31 -- strong tropical depression: Northern Tahiti; east/northeast winds of over 90 km/hr.

1941 January 16-18 -- strong tropical depression: Western Tahiti; damage caused by winds and high seas at Uturoa and Bora-Bora (reporting winds of over 95 km/hr.); one schooner shipwrecked.

1947 February 15-17 -- moderate tropical depression: some damage to Tahiti (winds up to 85 km/hr).

1955 January 4-7 -- moderate tropical depression: developing off the Leeward Islands, traveling in a southerly direction toward the Cook Islands, with winds up to 75 km/hr in Mopelia.

1955 March 10-12 -- strong tropical depression: developing south of the Society Islands, gaining strength before crossing the Austral Islands; average winds of 90 km/hr gusting to 100 km in Rurutu; very heavy seas.

1956 November 18-21 -- moderate tropical depression: developing off the southern Cook Islands, passing just north of the Austral Islands on the 20th and approaching Rapa on the 21st; winds gusting to 75 km/hr in Rurutu.

1958 January 19-21 -- moderate tropical depression: developing north of Huahine, moving in a southeast direction with winds of 70 km/hr gusting to over 80 km/hr in Makatea; extremely heavy swell.

1959 January 26-28 -- strong tropical depression: hitting first the western Society Islands and then Rurutu; average winds of 90 km/hr gusting to 115 km/hr in Bora-Bora.

1960 January 9 -- moderate tropical depression: Northwest Tuamotu Islands and Society Islands; winds gusting to 100 km/hr in Makatea.

1960 February 6-8 -- moderate tropical depression: Society and northern Tuamotu Islands; average winds of 80 km/hr gusting to nearly 100 km/hr in Makatea; heavy swell.

1961 March 9-13 -- moderate tropical depression: Society and northern Tuamotu Islands; average winds of over 75 km/hr gusting to over 100 km/hr in Bora-Bora.

1966 January 29-31 -- moderate tropical depression: developing northeast of the southern Cook Islands, passing east of the Austral Islands (Rapa); average winds of 75 km/hr.

1966 December 1-4 -- moderate tropical depression: developing to the north and passing over the Austral Islands, with winds of 60 km/hr reported at Tubuai.

1967 December 16-20 -- tropical cyclone: first appearing off the Ellice Islands, crossing the southern Cook Islands and passing southwest of Rimatara; winds estimated at 160 km/hr; the accompanying storm surge provoked a rise in the water levels of open lagoons to the west and southwest.

1968 March 3-7 -- moderate tropical depression: developing off the Leeward Islands, passing close to Hereheretue (with winds gusting to 75 km/hr) then crossing the Austral Islands (with gusts of 70 km/hr in Tubuai).

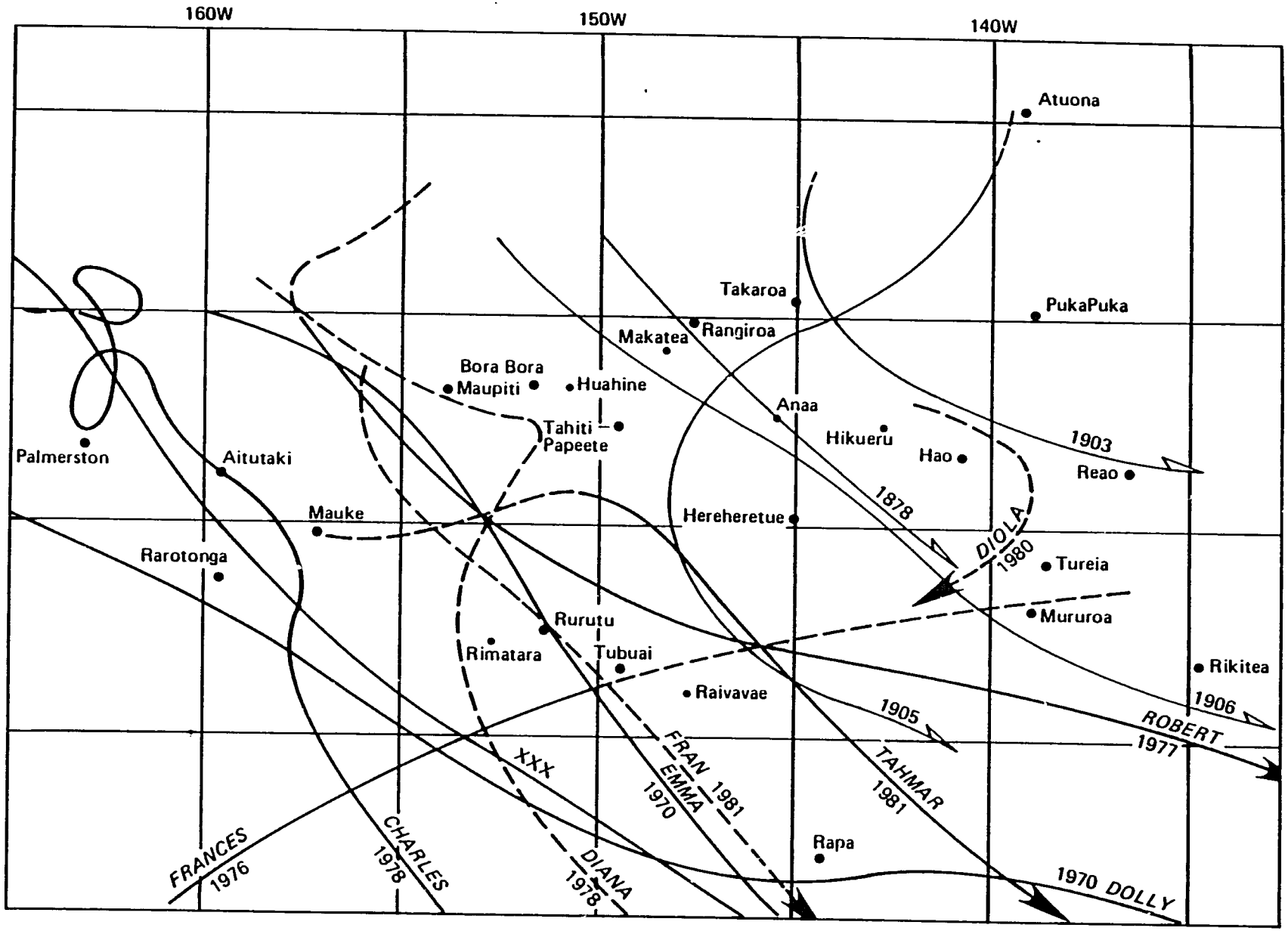

Figure 1: Paths of Cyclones

Paths of cyclones (———) and strong tropical lows (– – – –) that have crossed the territory or neighboring areas from 1966 to 1981.
Estimated paths of cyclones at the beginning of the century (———).

Source: Services Météorologiques de Polynésie Française.

Recent Storms

1970 January 21-25 -- moderate tropical depression: some average winds of 60 km/hr gusting to 75 km/hr in Hereheretue.

1970 February 20-24 -- tropical cyclone "Dolly": developing west of Vanuatu, passing southwest of the Austral Islands and south of Rapa; coastal damage from the heavy swell.

1970 February 28-March 5 -- tropical cyclone "Emma": developing north of the southern Cook Islands, moving in a south/southeast direction, skirting Mopelia, Rurutu, Tubuai, and Rapa; three-meter storm surge in Bora-Bora and a one-meter storm surge reported in Tahiti; maximum winds of 120 km/hr in Mopelia, 160 km/hr in Tubuai, with winds estimated at 170 km/hr in Rurutu; severe damage to homes and buildings throughout the Austral Islands, as well as to certain port facilities (Tubuai); one serious injury; lighter damage reported by the Society Islands.

1971 December 16-19 -- strong tropical depression: path similar to that of tropical cyclone "Emma"; winds gusting to 90-95 km/hr in Tubuai.

1974 March 16 -- moderate tropical depression "Stella": short-lived; passing quickly between the leeward and southern Cook Islands.

1976 February 2-6 -- strong tropical depression/cyclone, "Frances"; developing north of the Gambier Islands, moving west/southwest, gradually gaining in intensity; gusts of 105 km/hr in Moruroa; no storm tides.

1977 April 15-20 -- strong tropical depression "Robert": developing south of the Line Islands, traveling in a west-northwest/east-southeast direction, passing west of Mopelia, north of the Austral Islands and south of the Gambier Islands; tracked only by satellite; moderately strong winds (up to 65 km/hr); no damage reported to the islands, but ships reported extremely rough seas.

1977 December 6-10 -- moderate tropical depression "Tessa": developing southeast of Penrhyn (northern Cook Islands), passing between Takaroa and Pukapuka (northern Tuamotu Islands); average maximum winds of 70 km/hr.

1978 February 16-20 -- strong tropical depression "Diana": developing northwest of the Leeward Islands; originally moving in a southeast direction (passing south of Mopelia), then changing course and moving west, then southwest (passing west of Rimatara), and finally in a southeasterly direction; extensive damage reported to the Leeward Islands; average winds approaching 90 km/hr, gusting to 110-115 km/hr in Mopelia.

1978 February 16-27 -- tropical cyclone "Charles": developing west of the southern Cook Islands, deepening, and moving first southeast and then south, passing west of the Austral Islands without causing any damage.

1980 November 27-29 -- tropical cyclone "Diola": developing in the center of the Tuamotu Islands, moving east/southeast, then southeast, north and finally southwest; strong winds (118 km/hr in Reao, 115 km/hr in Moruroa, 98 km/hr in Tureia); extensive physical damage to the atolls

from storm tides; minimum low pressure of 1000 mb (750 m/m); winds heightened by strong tradewinds south of the 20° parallel.

1981 January 12-17 -- strong tropical depression: developing southwest of Mopelia, moving south/southeast to south, passing over the Austral Islands at Rimatara and skirting Rapa; no appreciable damage. Maximum winds of 105 km/hr at Rapa; minimum pressure of 996 mb (747 m/m).

1981 March 5-8 -- moderate tropical depression: developing south of Mopelia, passing through the central Austral Islands causing light damage and interrupting naval communications.

1981 March 9-13 -- strong tropical depression/cyclone "Tahmar": developing off the southern Cook Islands, moving east/northeast and deepening before veering southeast; skirting Tahiti to the south, then passing between the Tuamotu and Gambier Islands, with winds reaching 100 km/hr at Mopelia and locally strong winds likely over 100 km/hr in Raivavae; extensive physical damage from rain and wind in the Society Islands and from storm tides on the southern Tuamotu Islands (Anaa, Hereheretue).

1981 March 17-24 -- strong tropical depression/cyclone "Fran": developing between the Leeward Islands and an area south of the northern Cook Islands, moving in a south/southeasterly direction and deepening. Passing over Rurutu and skirting Tubuai; minimum low pressure of 986 mb (739.5 m/m) recorded at Rurutu; locally strong winds of over 130 km/hr reported in the Austral Islands; flood damage to the low-lying districts of Papeete on Tahiti; damage from accompanying winds, rain and storm tides in Rarutu, with trees downed, over 50 percent of the crops destroyed and numerous buildings, homes, and port facilities damaged; minor damage to Tubuai and Rapa.

OTHER TYPES OF DISASTERS

Tsunamis

Taking the form of gravity waves with long wavelength propagated along the entire "wall" of water, tsunamis are triggered by major quakes occurring in marginal or epicontinental subduction areas of the Pacific. Their trans-ocean propagation is quite rapid (500 to 800 km/hr), in the form of a wave train with long wavelength. While wave amplitude will rarely exceed 2 meters in the open sea, the arrival of the wave system in shallow waters creates highly accentuated variations in level, where the corresponding decrease in propagation speed and wavelength translates into a significant increase in amplitude or wave height based on the principle of energy concentration.

Propagation

Ocean Depth	Wave Height (m)	Speed (km/hr)	Wave Length (km)
5000	1	800	267
20	4	55	18.3
2	7	34	11.4

The energy of the tsunami is concentrated by shallow water and concave shorelines indented into a succession of small bays and inlets. In the case of French Polynesia, despite the unfavorable position of its island groups that span the central portion of the Pacific in the direct path of these wave trains, the danger posed by the tsunami is mitigated to a certain extent by:

- the existence of barrier reefs,
- the steeply sloping sea-bed in coastal areas, and
- the rounded, convex coastlines of the Territory's smaller islands.

These physical features help reflect and disperse the energy of the tsunami, usually making it somewhat less destructive. Thus, with the exception of those striking the Marquesas Islands, whose numerous bays and valleys open directly into the ocean unprotected by barrier reefs, tsunamis will generally cause an elevation of the level of the sea, without producing any breakers.

The tsunamis posing the most serious threat to French Polynesia are those developing off the Tonga/Kermadec Islands (Talandier, 1979).

Of all the circumpacific quakes generating destructive tsunamis since the year 1940, the quake of April 1, 1946 in the Aleutian Islands appears to have caused the most serious damage to French Polynesia and particularly to the Marquesas Islands, where high waves caused extensive coastal damage and claimed numerous lives.

The potential risk associated with tsunamis can and should be evaluated on the basis of the morphological characteristics of the various island groups according to the classification system devised by Talandier (1979). The high islands protected by barrier reefs (most of the Society Islands, as well as Tubuai and the Gambier Islands) are the least vulnerable. The absence of a barrier reef and the relatively gentle slope of the sea-bed in the coastal areas of Tahiti make a portion of the northern shore relatively vulnerable to damage by a tsunami. The highest waves (over 3 meters) ever recorded were those of the tsunami of May 1960 (produced by an earthquake in Chile). The communes of Mahina, Tiarei, and particularly Papenoo are particularly exposed. On the other hand, Papeete Harbor appears relatively

well protected. However, even higher waves than those of 1960 produced by the April 1946 earthquake in the Aleutian Islands damaged the harbor area.

On the other islands, the risk is minimized by the general configuration of the shoreline, the presence of a fringing reef at a distance of at least 2000 meters from the coast, and the steeply sloping sea-bed (with slopes of 15^{o} and above). The depth of the water in the bays of Moorea is offset by their narrow widths.

Certain points along the coast of Tubuai appear relatively vulnerable. On the Gambier Islands, despite the steeply sloping sea-bed in coastal areas off the islands, the western and southern shores of Mangareva are completely exposed, although villages in these areas are relatively well sheltered. However, according to Talandier (1979), the southern sector, from where dangerous waves could easily strike the islands, is not tsunami-prone.

The only high islands without barrier reefs are the Marquesas, where the relatively steeply sloping sea-bed in coastal areas (with slopes ranging from 12 to 20^{o}) is paralleled by an irregular shoreline indented into a succession of open, exposed bays. Wave heights of 3 to 5 meters were observed this area during the tsunamis of May 1960 (produced by the earthquake in Chile), where damage was extensive if nowhere near that reported for Hawaii as a result of a tsunami generated by the 1960 quake. Wave heights of over 10 meters were recorded in Ua Uka associated with the tsunami of 1946, claiming two lives. The coastal plains of Ua Uka and Nuku Hiva were flooded for several hundred meters inland, with sea waters penetrating several kilometers into the island's river beds. In the opinion of J. Talandier, an in-depth study of the devastating effects of this phenomenon is warranted.

Despite the vulnerable nature of the atolls (the Tuamotu Islands and the western Leeward Islands) lying barely above sea level, there is very little effect on the gravity wave system of the tsunami due to the steep slope of the ocean floor over the first 1000 meters from shore (27 to 45^{o}). The wave heights of tsunamis observed on these islands are no higher than in the open sea, resulting in slow, systematic flooding, along with a riptide in island openings or passes to the sea. The more open the atoll to the sea, the greater the variation in water level in the central lagoon. The southern shores of these islands appear comparatively more vulnerable than other areas.

The seasonally heavy swells regularly striking the atolls from the north and south have caused the people of these areas to forget the specific effects of recent tsunamis whose height does not appear to have ever exceeded 2 meters above the high water level of the sea. No records were made of the variation in water levels in the large, relatively well-sheltered lagoons (of Rangiroa and Hao). According to Talandier (1979), the duration of the positive half-period between successive waves

(8-10 minutes) was probably too short to allow the lagoon to fill between each wave. Although most villages lie near the lagoon and are sheltered by the coral cliffs marking the northern and northeastern shores of the atolls, the possibility of the propagation of tsunamis with much greater energy and wave height than those striking the islands in the past has not been excluded (Talandier 1979). Despite the relatively slow rise in water levels and the absence of breakers, the submersion of their natural barriers could mean serious consequences for the inhabited areas of these islands. This could easily happen in the case of tsunamis developing off the coast of the Tonga/Kermadec Islands produced by strong earthquakes, in which the effect of energy divergence is not that strong.

The coral limestone boulders with dimensions ranging from several meters to several dozen meters and weighing anywhere from one to several dozen tons lying on what are currently the flatlands of the west, north and northeastern portions of Rangiroa and other atolls in the northwest sector of the Tuamotu Island group, could be the mark of an ancient Pre-European contact tsunami most likely originating off the Tonga/Kermadec Islands. There are accounts of coral boulders measuring several meters in diameter and weighing several tons being displaced by the cyclones of 1903, 1905, and 1906 that struck the Tuamotu Islands. However, Talandier bases the above mentioned theory on an oral tradition relating to the destruction of west and southwestern Rangiroa, on geological evidence of the destruction of western Scilly (Leeward Islands), and on archaeological evidence of several sudden, simultaneous abandonments of human settlements in the Marquesas Islands on Huahine, Raitea, and Scilly. These patterns of behavior could be explained by a natural seismic disturbance or meteorological phenomenon (such as a cyclone or tsunami) aggravated by the direct action of the sea.

DESCRIPTION OF TROPICAL CYCLONES

In 1878, 1903, 1905, and 1906, French Polynesia in general and the Tuamotu Islands in particular were struck by a series of cyclones claiming numerous lives on various atolls. The Polynesian people still have a vivid memory of these disasters. Although the relief of high islands have offered greater security to residents in extreme situations such as severe cyclones, atolls have become veritable death traps. Curiously enough, while current-day forecasting and early detection systems warn inhabitants of low islands and atolls of impending storms, no specific measures have been taken to improve their safety in the face of storm surge liable to occur with tropical cyclones having similar intensity and paths as those causing such havoc and destruction in the past.

February 6, 1878

There is little information available on the origin and characteristics of this particular cyclone, which appears to have

done greatest damage to the western Tuamotu Islands, traveling as it did in a northwest-southeasterly direction.

The islands hardest hit by the cyclone were as follows, from northwest to southeast:

Rangiroa: The cyclone apparently skirted the atoll late in the day on the 6th. Villages along the northern shore, sheltered by a ridge along the lagoon, were soon flooded by rising waters in the central lagoon, apparently caused by storm tides penetrating the lagoon through the island's southern passes to the sea. Several buildings and vessels, including a number of schooners, were destroyed. Most of the small islets were already under water by 7:00 p.m. Only Mutufara, where most of the people fled to safety, was partially spared. Thus, the storm claimed few victims.

Kaukura: The western half of the atoll was inundated on the 6th by a storm surge striking the island from the northwest. Of the 200 workers harvesting copra in the north (Morutua), 117, who had taken shelter in boats anchored in the lagoon, were carried out to sea and drowned. The remaining inhabitants escaped death by taking refuge on the highest point of the island (approximately 5 meters above sea level), which was also flooded for a short time.

Anaa: All low-lying portions of the island were completely inundated. The entire village of Tuuhora was destroyed, with the sole exception of the church. The atmospheric pressure recorded on the aneroid barometer read 724.7 m/m on the 7th at 2:00 p.m.

Coconut plantations on all the islands were totally devastated. A schooner, which had left Bora-Bora on the 5th heading for Papeete, was ship-wrecked on the 7th. The crew finally reached Raiatea after 18 days in a canoe.

January 15, 1903

This cyclone struck the entire Tuamotu archipelago, claiming 517 lives, destroying 83 cutters, and causing the wreck of two schooners.

The cyclone was traveling from west to east at over 30 km/hr, with an active diameter measuring over 220 kilometers.

The minimum barometric pressures recorded were 734 m/m on the 13th at 4:00 p.m. and 739 m/m on the 15th, also at 4:00 p.m. (ships logs). The islands hardest hit were Fakarava, Hikuera (377 deaths), Marokau, Hao, Napuka, Makemo, Aketu, Raroia, Takume, Rangiroa, and to a lesser extent, Makatea, Motutunga, Tahanea,

Niau, Fakahina, Fangatau, Taenga, Nihiru, Amanu, Ravahere, and Hauehi.

On Fakarava, by the 13th, with winds from the east and extremely rough seas, the level of the lagoon had already risen approximately 1 meter. By the 14th, the village of Rotoava was already flooded by storm tides, with waves carrying debris as far as the inner lagoon. The villagers took shelter in a schooner secured by three anchors facing into the wind. The village on the island's southeastern shore was completely destroyed by the 15th. Nearly all the coconut palms still standing by that time had been stripped of their leaves and obviously of their fruit as well.

On Hikueru, with strong winds blowing from the east, the first homes in the village of Okerekere were flooded by waves on the 14th, with the entire village under water by the 15th. The local authorities led the villagers to a somewhat sheltered 100-meter rise that was still above water but that, at one point on the 16th, was also covered by 0.5m of water as the sea met the waters of the lagoon. On the small islets to the east where pearl fishermen had set up temporary camps, everything was washed away on the 16th. The only survivors were those able to climb the few coconut trees that had not been blown over by the wind, with this same survival technique used on other atolls and on the occasion of other cyclones. Most of the victims claimed by the storm were in these camps. The village of Okerekere was totally destroyed; 15 cutters and 71 canoes were lost, along with thousands of coconut palms. Eyewitnesses report how quickly the storm tides penetrated inland, with the islets trembling under the shock of the pounding waves. There were absolutely no supplies for an entire week after the disaster, and survivors existed on a few canned goods and coconuts discovered among the debris until the first boat could reach the area.

On Marokau, with the winds blowing in from the east, the first homes lying 150 meters from shore were struck by sea waves on the 13th. Beginning in the morning hours of the 14th, destruction of the village was complete within a mere 48 hours. Some of the villagers swam the lagoon to a somewhat higher islet lying 2 kilometers to the west. The number of victims increased to 96, with several persons buried in the ruins of the church and numerous others swept away by waves or killed as the coconut palms into which they had climbed for safety were knocked over by the strong winds and heavy seas.

The village on Hao was totally destroyed, with its frame houses torn from their foundations and dismantled and its traditional huts swept away by the storm. Five persons lost their lives. Panic reigned. Twelve persons died on Napuka, with the village on

the western shore of the island razed to the ground. Twelve lives and numerous vessels were lost on Raroia. The village on Takume was destroyed on the 15th and 16th. Chunks of coral 3-4 x 2-3 meters in size and weighing as much as 4 and 5 tons were wrenched from the reef and deposited along the coast.

As many as three-quarters of the coconut palms on all the islands were downed by the storm, with much of the arable land wrenched from the earth and carried away, exposing the underlying coral rock.

March 20-27, 1905

Developing north of the Marquesas Islands, the cyclone was accompanied by torrential rains causing rivers to overflow their banks; strong gusty winds and storm tides pounded the islands from the 23rd to the 27th. The cyclone seems to have gathered strength as it moved in a southerly direction, striking the Tuamotu Islands from the east and crossing the archipelago at a speed of nearly 20 km/hr, with an active diameter of over 200 km between Tikehau and Fakarava, before reaching Tahiti. The storm hit Napuka, Takaroa, Arutua, Apataki, and Tahiti in that order between the 23rd and the 25th. Four persons lost their lives in a shipwreck. Four schooners and 32 cutters were lost in the Tuamotu Islands, where 175 homes were destroyed. In Tahiti, storm tides caused extensive damage to the island's eastern shore. The minimum barometric pressures recorded were 732 m/m off Napuka (by a ship) on the 23rd and 750 m/m in Papeete on the 25th.

As in the case of previous storms, the danger on the lower islands and atolls was heightened by the temporary concentration of the island population in certain locations that were not necessarily well situated from the safety point of view (pearl diving, copra harvests, etc.) The flooding of the islets by the simultaneous elevation of the levels of the sea and central lagoon led to the same survival patterns, with islanders attempting to swim out to vessels still afloat in the lagoon or to other islets still above water, escaping to higher elevations and eventually climbing trees. These same phenomena were reported on Arutua and Fakarava.

February 7-8, 1906

The initial depression apparently developed in the southern Line Islands near Flint Islands. It skirted the Tuamotu Islands on the south and headed toward the Gambier Islands, causing damage to these islands, as well as to the Society Islands.

The cyclone was apparently traveling at a speed of over 35 km/hr and had an extremely large active diameter (possibly as large as

650 kilometers). The minimum barometric pressures reported were 736 m/m, recorded in Papeete on the 8th at 8:00 a.m., and 744 m/m, also recorded on the 8th at 8:00 p.m. in Hikueru.

The cyclone claimed 121 lives on the Tuamotu Islands and two victims in Tahiti where 327 homes were destroyed in Papeete alone. Two schooners were shipwrecked, with most of their crews missing. A 2,200-ton vessel was stranded on the reef at Takaroa.

In the Tuamotu Islands, villages on Anaa, Faaite, Fakarava, Hikueru, Hereheretue, Makatea, Motutunga, Raroia, Takume, and Tikehau were leveled. The extensive damage to the islands of Hao, Katiu, Hauehi, Manihi, Nihihu, and Rangiroa was caused by the combined force of the wind and sea.

The atoll of Anaa, the most severely damaged by the cyclone, was totally inundated, with waves from the storm surge as high as 8 meters. Ninety-five deaths were reported in the villages of Tuuhora (34), Temarie (15), Tekahora (45) and Tamatahoa (1), all of which were struck by the storm surge from the north. The village on Faaite was destroyed by late afternoon on February 8th. The records show 5 deaths, including the missionary, who fell from the coconut palm where he had taken shelter and drowned. With much of the soil washed away by the storm, the bodies had to be buried under leaves, mats, and coral boulders.

The village on Hikueru was flooded and destroyed on the 8th. Seven people were reported killed.

The village on the western shore of Takaroa was flooded by the sea. The villagers, who had been diving from small islets on the opposite shore and who took refuge on the most sheltered points of the island, were spared. A 2200-ton British three-master ran aground on the reef, where 10 sailors drowned trying to reach shore.

Perched in the tops of trees, people of Tikehau waited 10 hours for the waters to subside.

On Rangiroa, where an entire village was inundated and destroyed and 11 cutters lost to the storm, the heavy seas tore chunks of coral from the outer edge of the reef measuring "several hundred cubic meters." These rolled onto the western shore of the atoll.

The executive officer on Fakarava reported an unusual swell breaking on the northern coast of the island on February 5th, just as in 1905, which began worrying the islanders. He described the Cyclone's rapid passage over the island on the morning of the 8th. Several eyewitnesses reported the waters in the lagoon rising by

as much as 2 meters above their normal level. Despite extensive damage, no lives were lost.

In Mangareva (Rikitea), the storm raged throughout the night of the 9th, causing extensive damage to homes and totally destroying the island's breadfruit crop, its main source of food. The people took refuge on a rise on the island and thus escaped death.

In the Society Islands, the winds and particularly the storm tides caused extensive damage to buildings and crops along the coast.

In Tahiti, storm tides penetrated 200 meters into the city from the piers in the harbor area. The city's seafront area was totally inundated and extensively damaged along with the entire harbor area. The quarantine station on the islet of Motu Uta lying within the sheltered anchorage, the hauling slip, and corresponding outbuildings, several government buildings in the harbor area, several hundred meters of seafront, and the walls of the main wharf and pier were all destroyed. Total municipal and French National Government losses were estimated at close to 0.6 million gold francs, with private-sector losses (including businesses) calculated at 1.7 million gold francs.

Elsewhere, the eastern shore of the island and particularly the Taiarapu peninsula, including the districts of Afaahiti, Pueu, and Tautira, were hard hit by the storm. Three-quarters of the village of Tautira was destroyed as the sea advanced as much as 150 meters inland from shore, and residents were forced to flee to the nearest rise.

The path of the cyclone seems to have taken it closest to Raiatea during the night of the 7th where, while there was extensive damage to crops and homes, no deaths were reported.

On Bora-Bora, floodwaters inundated the village of Vaitape to a height that the older villagers claimed had not been seen since the storm of 1843. Twenty-four homes were destroyed. Damage to trees and crops was extensive, with residents again forced to flee to the hills. Although the storm claimed no human lives, losses were estimated at 20,000 gold francs by the chief of police.

The scene on Huahine was the same, with the village inundated by the sea and with extensive damage to homes, trees, and crops.

March 9-13, 1981

A trough of low pressure pointing west to east between longitudes 180° and 160° W and west-northwest/east-southeast, east of longitude 160° developed between the second and seventh of March.

Tropical storm "Tahmar," named a posteriori by the French Polynesian Weather Service on its own rather than within the framework of WMO conventions, developed on March 7th and 8th on the edge of this low-pressure area.

It began moving east/southeast, veering east/northeast, deepening and passing south of Tahiti (180-200 km) late in the afternoon. It then continued moving southeast, reaching the status of a tropical cyclone, passing between Hereheretue and Raivavae, northeast of Rapa on March 12th.

The minimum barometric pressure recorded in Tahiti/Faaa was 998.6 mb on March 10th, with a low of 998 mb recorded at Hereheretue on March 11th. The barometric pressure at the storm center was estimated at 990 mb, although it could have been even lower.

The average and maximum winds reported were 53 to 75 km/hr and 100 km/hr, respectively, in the Leeward Islands, 60 to 80 km/hr in Tahiti/Faaa (sheltered by Moorea), and 46 to 65 km/hr in the Tuamotu Islands, with gusts of 70 to 98 km/hour. Average winds in the Austral Islands reached a high of 55 km/hr, with gusts of over 90 km/hr reported on Tubuai and Rapa and of over 100 km/hr on Raivavae.

The strong northwestern current already affecting Polynesia became even stronger ahead of the zone of influence of the storm. Storm tides hit the Society Islands and the western Tuamotu Islands (with waves heights of 5 to 7 meters).

Rains, associated with precipitation from the low pressure area out of which the storm developed, were heavy. The Windward Islands recorded the heaviest rainfall. The resulting damage was due to the combined force of the rain, wind, and sea. Runoff over the already well saturated soils resulted in the water cutting deep gulleys into the land, with general flooding reported along the riverbanks of the Society Islands. The damage was aggravated by a second period of heavy rains on March 14th and 15th, with strong winds and flooding causing heavy damage to public utilities (power and telephone lines) and homes. Storm tides were responsible for the damage reported on the southwestern Tuamotu Islands (homes and island infrastructure).

Local authorities were alerted beginning on March 10th at 3:00 a.m. local time, with the first general warning to the public-at-large broadcast by Radio Tahiti at 6:20 a.m. local time. Between Tuesday, March 10th and Thursday, March 12th, a total of six public information bulletins plus three regular daily bulletins were broadcast to the Polynesian people in addition to special bulletins for pilots and navigators. During the morning and

afternoon hours of the 10th, a total of 150 individual requests for storm information were taken by telephone.

March 20-23, 1981

Developing from a low-pressure area hovering for several days just northwest of Mopelia (west of the Leeward Islands), the storm began moving southeast and began deepening beginning on the 18th, reaching the status of a strong tropical depression by the 20th, with winds gusting to 110 km/hr in Mopelia. It continued moving slowly southeast, picking up speed on the 21st (traveling at a speed of approximately 15 to 28 km/hr). The center of the storm passed over Rurutu in the Austral Islands the morning of the 22nd, where observers reported a low pressure of 986 mb (739.5 m/m), winds of 80 to 100 km/hr out of the northwest and then the southwest, followed by a lull.

In the vicinity of Tubuai, the strongest winds reported on the 22nd reached 130 km/hr. The minimum pressure recorded was 992 mb (744 m/m).

Heavy rainfall in the Society Islands caused flooding in the low-lying districts of Papeete and along the north and west coasts of Tahiti.

On Rurutu, 21 roofs were blown off private homes, 1 pier was totally destroyed, and several trees were downed by the storm. Fifty percent of the coffee and banana crop was ruined. Storm tides caused locally heavy damage along the coast. Light damage was reported on Tubuai and Rapa.

The civilian and military authorities were alerted in the afternoon hours of March 20th. Broadcasts on the 21st announced that the storm would hit the Austral Islands on the 22nd. Beginning at 6:00 a.m. local time on the 22nd, special storm warnings were broadcast in Tahitian over the radio to the general population.

April 14, 1983

"Cyclone 'Veena' struck the French Polynesian islands on 14 April with winds up to 150 kph, leaving one dead, 50 injured and 5,000 homeless. Moorea and Tetisora islands were worst hit. Initial estimate of damage to crops, property and water supplies was put at $21 million. This was the fifth major cyclone to hit the region within two months."

Source: UNDRO News. July/August 1983:15. Geneva, Switzerland: UNDRO

III. FRENCH POLYNESIA PREPAREDNESS AND REHABILITATION PROFILE

ORGANIZATION AND PLANNING OF RESCUE OPERATIONS IN THE EVENT OF A DISASTER

Operations and Responsibilities

Just as in metropolitan France, the recently inaugurated Territorial Civil Defense Service for French Polynesia: ORSEC is responsible for "directing and coordinating the efforts of all agencies responsible for implementing preventive measures and emergency operations to safeguard property and save human lives in the event of a disaster or catastrophe, as well as under all other circumstances requiring some form of civil defense action."

Thus, the role of this Service is twofold:

1. In times of peace:

   a. to take preventive measures designed to prevent the possibility of an accident or disaster actually occurring;

   b. to mitigate the effects of accidents or disasters after they occur using all available civil defense resources and manpower and, if necessary, with assistance from other government agencies or private institutions.

2. In times of war:

   To protect the civilian population through civil defense operations.

   More specifically, in peacetime, in addition to its inherent administrative and technical responsibilities, the Territorial Civil Defense Service is also responsible for:

   - staff briefing and training of rescue workers,
   - protecting public facilities and classified installations,
   - making forecasts,
   - studying potential risks by zone,
   - drawing up ORSEC and other emergency plans and supporting documents,
   - coordinating major civil defense operations,
   - planning emergency measures,
   - overall organization of fire and rescue services,
   - establishing warning systems, and
   - preparing emergency shelter plans.

The ORSEC Plan:

Created under Decree 5923 of December 17, 1975, French Polynesia's first

ORSEC Plan (like the emergency plans in effect throughout the departments of metropolitan France) defines the responsibilities of all government authorities liable to intervene in the event of an emergency occurring within territorial borders.

Placed under the direction and control of the High Commissioner, as a territorial regulation, the ORSEC Plan provides for the full-scale launching of the following general course of action that is duly adapted to prevailing local conditions, as established by the Ministerial Order of February 5, 1952, in the event of the need for some form of government intervention within the Territory, with the exception of maritime operations and government intervention in airport facilities.

ORSEC PLAN

Warning and Rescue Procedure

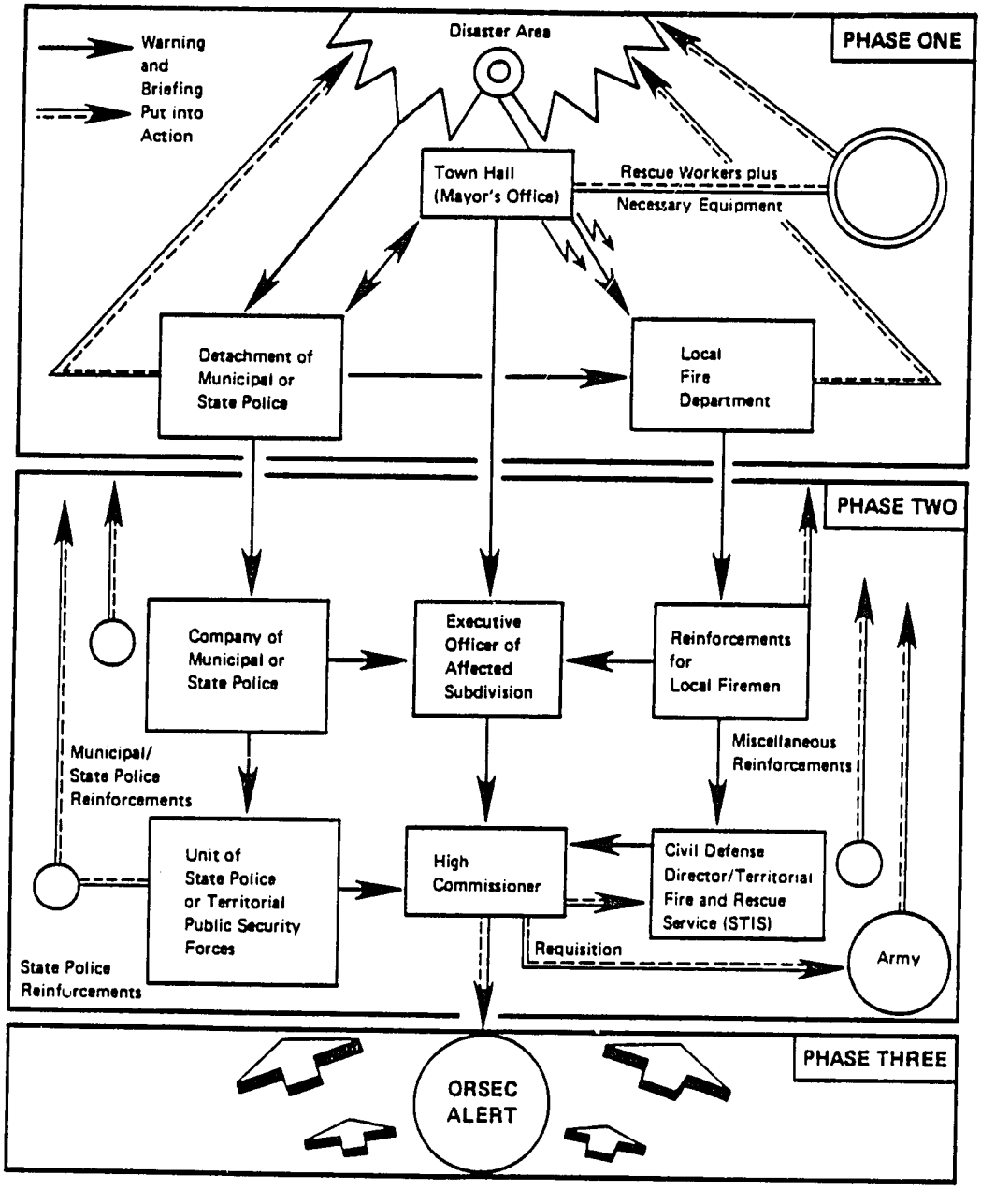

Figure 2: ORSEC PLAN--Warning and Rescue Procedure

ORSEC PLAN

High-level Linkages

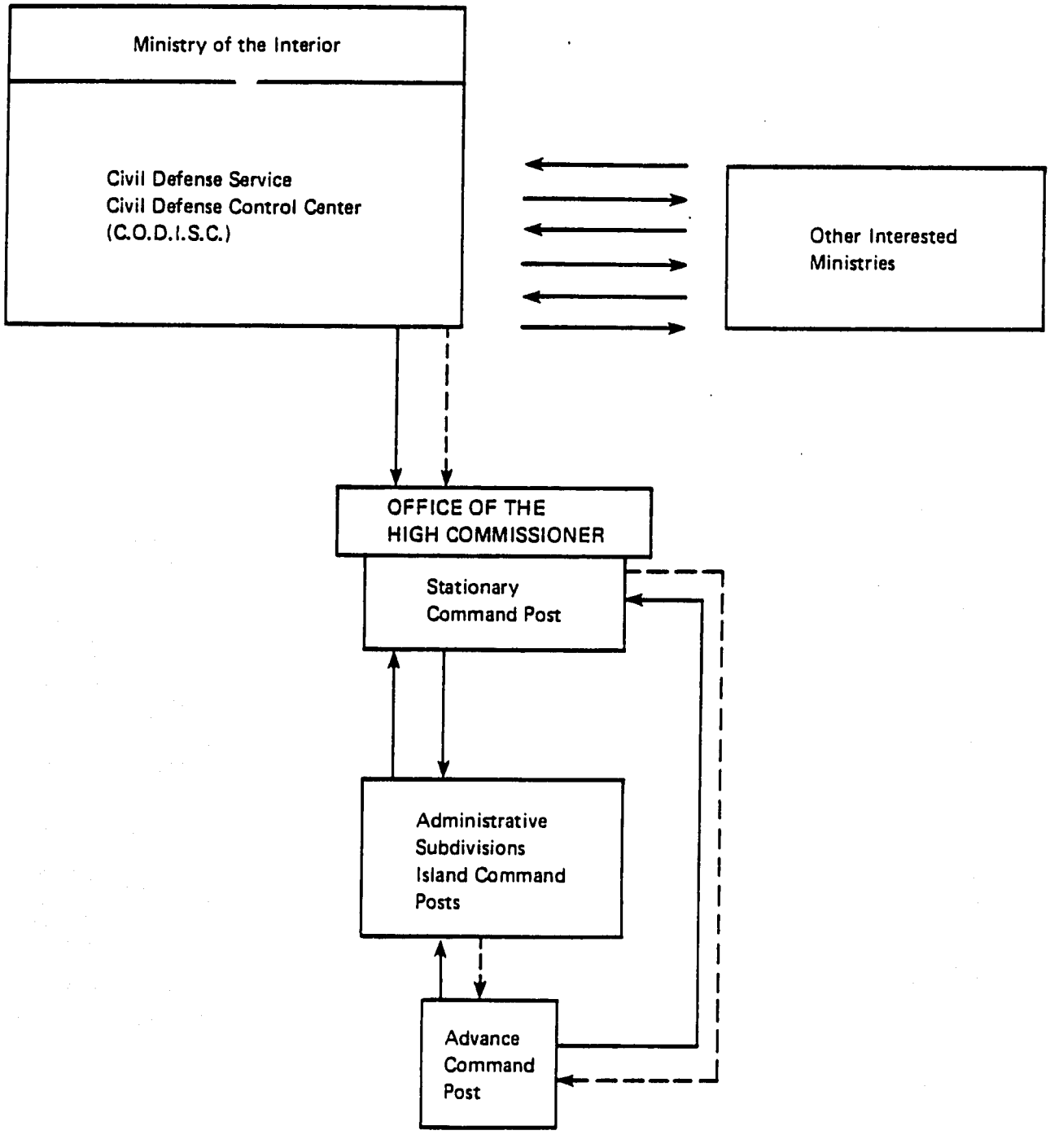

Figure 3: ORSEC PLAN—High-Level Linkages

SPECIAL PROVISIONS RELATIVE TO DIFFERENT CIVIL DEFENSE SERVICES

Traffic Police

Responsibility: The main responsibility for this service lies with the Urban Police Commissioner if the ORSEC Plan goes into effect within the commune of Papeete and with the Commander of the State Police Unit in all other cases.

Tasks: The major tasks of this service are:

- to demarcate and take full control of a buffer zone surrounding the disaster site;
- to maintain public law and order, protect property, and execute requisitions;
- to identify and retrieve the bodies of victims;
- to report back to the command organization; and
- to direct traffic

Available Resources and Manpower:

- urban police force,
- State police,
- municipal police, and
- temporary transfers of military personnel and equipment.

Medical Care and Self-Help

Responsibility: The main responsibility for this service lies with the Territory's Public Health Commissioner.

Tasks: The primary task of this service is to send out emergency medical teams to disaster sites to administer first aid to disaster victims. Its other tasks include:

- alerting hospitals and other health facilities;
- conducting medical evacuations in cooperation with the military staff assigned to the Office of the High Commissioner;
- coordinating the efforts of all territorial, military, and private hospitals; and
- coordinating supplies of medicine and blood.

Available Resources and Manpower: public health and military resources and personnel. Private ambulances may be requisitioned as needed.

Transportation - Public Works:

Public Works Department

Responsibility: lies with the Head of the Territorial Public Works Department.

Tasks:

- to provide necessary transportation other than medical and arrange all corresponding logistics;
- to evaluate the emergency public works required to control the disaster, provide proper equipment, and oversee its use (particularly heavy equipment); and
- to procure all necessary special tools and equipment that may be required given the circumstances.

Available Resources and Manpower: Public Works personnel and equipment, plus any and all other resources requisitioned from the public or private sectors. Available military personnel and equipment may also be requested under certain circumstances.

Emergency/Rescue Services

Responsibility: The responsibility for these services normally lies with the Civil Defense Director in his capacity as Head of the Territorial Fire and Rescue Service (STIS). In practice however, such responsibility is delegated to the Papeete Fire Chief.

Tasks:

- to determine the make-up and volume of appropriate intervention based on the nature of the disaster and on the emergency and rescue resources available within the territory, and
- to launch a comprehensive rescue operation and coordinate individual efforts.

Available Resources and Manpower: To supplement the resources available within the communes of Tahiti, Moorea, and the Leeward Islands, the Head of the Emergency and Rescue Service relies on requisitions and on temporary loans of personnel and equipment, turning first, in the event of need, to existing emergency services including:

- municipal government services, even those without a fire and rescue unit,
- the Papeete Fire Department,
- the Pirae Fire Department,
- the Punaauia Fire Department,

- the Faaa Fire Department,
- the naval fire brigade,
- the Civil Aviation Service fire-fighting unit,
- the Autonomous Port of Papeete rescue service,
- the military forces,
- A.P.P.C. rescue workers, and
- all other organizations capable of lending assistance.

DISASTER RELIEF AND COMPENSATION SERVICES

In the event of a disaster triggering the ORSEC Plan, the chief executive of the affected subdivision must report the extent of all damage and losses suffered by stricken communes to the High Commissioner.

The High Commissioner, in his dual role as representative of the French National Government and President of the French Polynesian Government Council, in turn makes two separate appeals:

- the first, addressed to the Ministry of the Interior and Decentralization,
- the second, directed at a special session of the Government Council.

Both appeals have the common goal of instituting some form of emergency relief that provides immediate physical aid to disaster victims and is subsequently followed by financial compensation and reconstruction of distressed areas.

WARNING SYSTEMS

Regional and International

The French Polynesian Weather Service receives tropical storm warnings from San Francisco, Honolulu, and Nadi over special Weather Service or Civil Aviaton Service telegraph lines.

Polynesia has no specific role per se within the international warning network and, in fact, is included within the area of responsibility of Nadi. However, bulletins on tropical storms of direct concern to the Territory issued by the Tahiti/Faaa Analysis and Forecasting Center are transmitted to all Pacific area authorities responsible for obtaining international meteorological assistance. Special Navy bulletins are transmitted through the Naval Broadcasting Center in Tahiti by Radio Mahina.

French Polynesia

- Early Detection of Tropical Storms:

Thanks to its state-of-the-art equipment capable of receiving photographs

from the geostationary satellite GOES W and from NOAA 7, a nonsynchronous satellite, the Tahiti/Faaa Weather Forecasting Service is able to detect cyclones of direct concern to the Territory as soon as they develop.

Preliminary Phases

As soon as a cyclonic storm appears capable of affecting the Territory because of its formation and development within territorial borders or because it appears to be heading toward the area from a distant location, a preliminary warning is immediately transmitted to the executive officer attached to the Office of the High Commissioner in charge of civil defense by the Head of the Weather Service, after consulting with the Director of the Civil Aviation Service.

As soon as the risk materializes, warnings are issued to all concerned authorities, including the Police, the Armed Forces, the Departments of Equipment and Health, the heads of all administrative subdivisions liable to be affected by the storm, and the Mayor's Offices. At the same time, the storm is reported in weather bulletins broadcast on the radio and television, as well as in special Navy and Air Force advisories for sailors and pilots.

Finally, as soon as it is certain that a particular area within the Territory will be hit by the storm, the High Commissioner calls for a general warning to be issued to the area's inhabitants and determines the security measures to be implemented based on the expected severity of the storm.

Warning Phase

Pilots and sailors are warned of impending storms through the special bulletins referred to above, in the section dealing with regional and international warning systems.

The most effective media for use in warning the Polynesian people are radio and television. Consequently, special bilingual bulletins are broadcast to the general population indicating the progress and severity of the storm, accompanied by advice and recommmendations by concerned government authorities on various types of security measures to be taken in preparation for the storm. At the same time, the state Police transmits information and instructions back and forth over its own broadcasting network. The Armed Forces establishes a maximum of air, land, and sea communications. Naturally, regular radio-telephone service by the Postal and Telecommunications Bureau is available on a round-the-clock basis, with priority to high-ranking government officials.

All communications are coordinated under the direction and control of the High Commissioner, who may decide at this point to set the islands' ORSEC Plan in motion.

Tahitian System

The plan outlined above for French Polynesia is identical to that for Tahiti with the sole exception of the radio-telephone service operated by the Postal and Telecommunications Bureau which, in the case of Tahiti, is a telephone system.

Tsunami Forecasting

The Pacific Tsunami Warning System, with its center in Honolulu, was created as an aftermath of the havoc caused by the 1946 tsunami that struck Hilo, Hawaii. Using data generated by seismological and marigraphic stations in 17 countries throughout the Pacific, including French Polynesia, the Pacific Tsunami Warning Center (PTWC) transmits reports of possible danger followed, if applicable, by special warnings in the event of the occurrance anywhere in the Pacific of surface quakes with magnitude over MS 7-5.

Annex "A" to the ORSEC Plan deals with the threat of tsunamis in French Polynesia. The Tahitian Geophysics Laboratory in Pamatai (LDG) is responsible for evaluating the risk and determining if and when warnings should be issued. The laboratory supplements the information provided by the PTWC by data from the Polynesian seismological and marigraphic network to enable it, in the event of a severe earthquake, to determine when a warning should be issued based on its study of the characteristics of the T waves, compressional waves that are somewhat different from the gravity waves of the tsunami and are propagated 7 to 8 times more rapidly.

In the event of a strong quake occurring anywhere within a 10,000-kilometer radius of Tahiti, the following course of action is immediately set in motion:

1. The major LDG stations (Pamatai on Tahiti, Tiputa on Rangiroa, Otepa on Hao, Rikitea, and Tubuai) are equipped with automatic alarm systems triggered by the seismic waves (P) produced by a strong quake. The alarm warns the resident geophysicist at the Pamatai Laboratory and all station operators. The latter transmit the data obtained from their seismographs by radio if such information is not automatically retransmitted by telemeter (as in the case of the five stations on Tahiti and the four on Rangiroa with graphic and magnetic recordings made at the Pamatai Laboratory.)

2. Using the aforesaid data, the geophysicist evaluates the characteristics of the quake: epicenter, seismic focus, magnitude (mB and MS.)

3. Based on this data and on the intensity of a seismic phase (T waves) directly related to the quantity of energy released into the ocean, the

geophysicist then determines whether conditions are right for the formation of a tsunami.

4. Inasmuch as tsunamis propagate much more slowly than even the slowest propagating seismic sea waves (T waves), forecasts based on this method of detection allow sufficient time for issuing appropriate warnings before the tidal waves can reach shore, provided the epicenter is far enough away. The "lead" time is approximately 2 to 3 hours at a distance of 3,000 kilometers from the epicenter (the distance separating the Tonga/Kermadec Islands from Tahiti), as much as 10 hours over a distance of 9,500 kilometers (the distance from Japan and the Kuril Islands), and approximately 9 to 10 hours in the case of the Aleutian Islands and South America.

This method has been getting good results ever since it was first implemented in 1964. It prevents false alarms and minimizes the time required for issuing an alert. Warning can be issued immediately upon arrival of the T waves, which is absolutely essential for Polynesia if it is to effectively forecast tsunamis developing off the Tonga/Kermadec Islands at a distance of only 2,200 to 3,000 kilometers from Tahiti. Data on seismic sea waves, on the location of the epicenter of the earthquake, and to a somewhat lesser extent, on the wave amplitude of the tsunami, are transmitted back and forth between the Geophysics Laboratory and the PTWC in Honolulu. The islands of French Polynesia are, in effect, the first land masses intercepting a tsunami originating off the Tonga/Kermadec Islands and South America. On the other hand, tsunamis from most other tsunami-prone areas of the Pacific will strike Hawaii before reaching Tahiti.

EFFORTS TO MINIMIZE RISKS

. Land Use and Urban Planning:

There are no natural disaster-prone areas declared unsuitable for construction either in the urban development plan for Papeete or in any other duly approved general development plans.

. Building Codes:

Urban Development Plan for Papeete, Chapter I, Article 15H:

"All structures, regardless of their intended use, must be built in such manner that the ground floor lies at least +1.00 meter above the high-water level in the lagoon. Likewise, the ground floor of all buildings must lie at least 0.30 meter above natural ground level or above the level of any embankments to prevent damage in the event of flooding."

The first provision is intended primarily as a protective measure in the event of exceptionally high tides, since it is obvious that a one-meter

clearance is insufficient protection against either a tsunami or the storm waves associated with a tropical cyclone.

Territorial Planning Code, Title III, Chapter I, Article 161:

"No structures may be erected...on land exposed to landslides, cave-ins, collapse or erosion, on swampland or in floodplains without specific measures being taken as protection against such potential threats."

This is the only allusion in the Code to any requirement attempting to mitigate the effects of potential natural disasters.

In addition to the foregoing provisions, certain data extracted from the last population census of 1977 with reference to housing provide a number of interesting details in this same respect. As of the date of the census, 54 percent of all buildings (with 51.6% in urban areas and 48.4% in rural areas) had wooden walls, 84 percent were covered with sheet metal (82% of all dwellings in Papeete), and 60 percent of all private homes were built on concrete slabs. Only 1.6 percent of all dwellings had walls constructed of plant materials other than wood and 2.8 percent had roofs also made of plant material.

Infrastructure

In addition to repairing the islands' system of territorial roads, the Territory's government is also responsible for maintaining its waterways. Thus, the Department of Public Works cleans and clears waterways on the high islands along those stretches where flooding could threaten communities and infrastructure along the river banks. However, no preventive maintenance is performed on stone foundations.

Since 1978, there has been a systematic flood control program focusing on the embankment and canalization of downstream courses of island rivers, with the first attempts at canalization actually beginning somewhat earlier. Territorial investments over a three year period in embanking rivers and protecting shorelines are distributed as follows (with all figures in millions of Pacific francs):

	1980	1981	1982
Tahiti	514	200	177
Moorea	15	25.5	12
Leeward Islands	14	35	18
Austral Islands	—	19	8
Marquesas Islands	6	26	20
	549	305.5	235
	(U.S.$4.2m)	(U.S.$2.3m)	(U.S.$1.8m)

To further illustrate this point, tropical depressions and torrential rains striking the territory over the past few years have triggered release of the following sums under the concept of disaster relief to rebuild roads and associated engineering structures: 120 million Pacific francs in 1978 (including 22 million for the commune of Mahina) for the Windward Islands and over 30 million for the Leeward Islands. Flood damage in 1981 made it necessary to appropriate another 33.4 million Pacific francs in disaster relief funds.

Insurance

There is no insurance system and particularly no crop insurance providing protection against natural disasters.

Public Education and Information

There is no specific systematic program to educate and inform the public other than suggestions and instructions accompanying warnings of an impending disaster.

Legislation

Other than the aforementioned provisions in territorial building codes, there are no legal texts attempt to mitigate the effects of potential natural disasters.

PROVISION FOR THE NEED AND COST OF DISASTER PREPAREDNESS IN PLANNING AND BUDGETING ACTIVITIES

The need for disaster preparedness is recognized by government agencies other than the Civil Defense Service per se. The Public Works Department, for example, performs hydrologic studies of Tahiti to enable it to better evaluate the threat of flooding and thereby calculate suitable dimensions for flood protection and other engineering structures.

The Territory's budget includes a special provision for disaster relief in its Chapter 46.51, Relief, Article 60 "Public Assistance to Disaster Victims."

Damage Appraisal and Forms of Relief

The following procedures were instituted on the occasion of recent disasters:

. Crop Damage: comparison of estimates prepared by farmers and Rural Economy Department specialists. Municipal governments are responsible for obtaining individual statements from disaster victims.

The Government Council is responsible both for final determinations relative to compensation and for management of corresponding funds.

. Building Damage: An estimate is prepared by a Public Works Department adjuster, with the procedure for victim compensation the same as that outlined above.

A special provision within the territorial budget enables local government officials to respond to the needs of disaster victims on extremely short notice. The Central Government may also make funds available for disaster relief or for other similar types of emergencies.

There seems to be no hard and fast rule for sharing the cost of emergency public assistance, relief, and reconstruction between the Territorial and Central Governments.

If an appeal for community support seems to be necessary in the event of a major disaster, the Government Council may authorize a call for public contributions to supplement official government funds earmarked for the relief of disaster victims.

Finally, as is common in other areas of the world, French Polynesia's numerous, well-organized charitable organizations and private foundations are willing and able to assist the local authorities in official efforts to help the victims of natural disasters.

The present profile was prepared on the basis of information supplied by the Territorial Statistics Institute (Mr. Baudchon, Mrs. N. Millaud), the Department of Economic Affairs (Mr. Savole), and the Department of Public Works (Mr. A. Ellacott), the Civil Aviation Service (Air Transportation Division--Mr. Mottard), the Papeete Harbormaster's Office (Mr. H. Vernaudon), and the General Radiocommunications Network (Mr. I.E. Le Vert).

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APPENDIX: THE CYCLONES OF 1982-1983 IN FRENCH POLYNESIA*

Between December 1982 and April 1983 the archipelagoes that compose the Territory of French Polynesia were hit by a strong tropical storm and five tropical cyclones, which caused extensive material damage and 15 fatalities. (See figure A1.) This disastrous series is of special interest because, at first glance, it appears highly exceptional: not since the beginning of the century have these island groups been struck by any really destructive cyclones.

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 well may have facilitated cyclogenesis (NOAA--UNDRO, 1983). The reasons for these anomalies, which could be useful for long-term weather forecasting, are not yet clear, despite the rapid progress of knowledge about the interactions between the ocean and the atmosphere.

The Cyclones during the Summer of 1982-1983

The most striking feature in by Table A1 is the comparatively small number of human casualties--15 deaths and 46 injuries. This may be due to the following factors:

- improved forecasting, warning systems, and telecommunications (people were told to take emergency measures for safety from 10 to 26 hours, depending on their location, before the actual strike);
- the lack of fortuitous population concentrations in risky locations and temporary settlements, as occured on the atolls in 1878 and 1903;
- the rapid succession of the cyclones, which caused people to take precautionary measures in spite of their unfamiliarity with the risks of the situation.

Two-thirds (8) of the deaths were caused by ships being wrecked or by people being swept off ships (2). Four of the five other deaths were caused by collapsing buildings or falling trees; the remaining death was due to electrocution. Most of the injuries were caused by flying debris, falling trees, or collapsing buildings.

The Cost of the Cyclones

The total cost of the direct damage sustained was estimated to be between 100 and 115 million dollars. By comparison, French Polynesia's total budget was 157 million dollars in 1982.

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*This appendix is a summary of Dupon, J.F., 1984. Where the exception confirms the rule: the cyclones of 1982-1983 in French Polynesia. Disasters, 8(1):34-47.

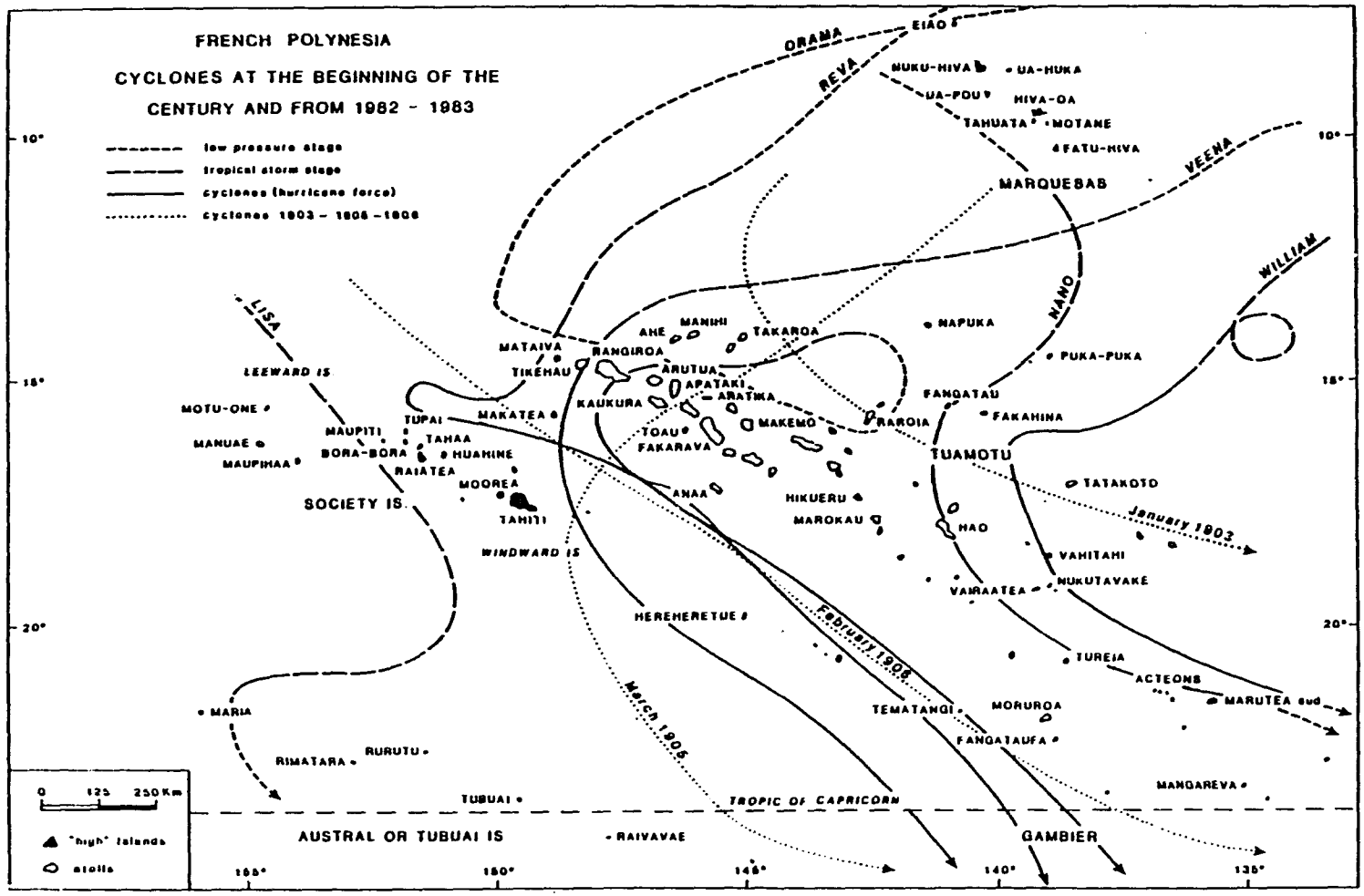

FRENCH POLYNESIA
CYCLONES AT THE BEGINNING OF THE CENTURY AND FROM 1982 - 1983
low pressure stage
tropical storm stage
cyclones (hurricane force)
cyclones 1903 - 1905 - 1906
ORAMA
REVA
VEENA
WILLIAM
NANO
LISA
EIAO
NUKU-HIVA
UA-HUKA
UA-POU
HIVA-OA
TAHUATA
MOTANE
FATU-HIVA
MARQUESAS
NAPUKA
PUKA-PUKA
MANIHI
AHE
TAKAROA
MATAIVA
RANGIROA
TIKEHAU
ARUTUA
APATAKI
ARATIKA
KAUKURA
MAKATEA
FANGATAU
FAKAHINA
RAROIA
MAKEMO
TOAU
FAKARAVA
TUAMOTU
TATAKOTO
HAO
HIKUERU
MAROKAU
ANAA
LEEWARD IS
MOTU-ONE
MANUAE
MAUPIHAA
MAUPITI
TUPAI
TAHAA
BORA-BORA
HUAHINE
RAIATEA
MOOREA
TAHITI
SOCIETY IS
WINDWARD IS
VAHITAHI
NUKUTAVAKE
VAIRAATEA
HEREHERETUE
TUREIA
ACTEONS
MARUTEA sud
MORUROA
TEMATANGI
FANGATAUFA
MANGAREVA
GAMBIER
MARIA
RIMATARA
RURUTU
TUBUAI
RAIVAVAE
AUSTRAL OR TUBUAI IS
TROPIC OF CAPRICORN
January 1903
February 1906
March 1905
0 125 250 Km
"high" islands
atolls
10°
15°
20°
155°
150°
145°
140°
135°

Figure A1

Table A1. Characteristics of the 1982-1983 Cyclones

Cyclones	Minimum atmospheric pressure at center (a)	Wind instant maximum speed	Marquesas	Tuamotu				Society		Austral	Deaths	Injured	Storm surge	Floods	Wind
				W	C	E	G	WI	LI						
12-12/12 TS LISA	985	112-119						*	*		2	2		Tahiti °	
20-27/01 TC NANO	980	150	*			*	*					6	°	Marquesas °	°
22-27/02 TC ORAMA	950	180		*				*			6	3	°		
6-14/03 TC REVA	955	180		*	*			*	*		5	2	°		
7-13/04 TC VEENA	950	200		*				*			1	28	°	Tahiti °	
15-21/04 TC WILLIAM	965	120				*	*				1	5	°		
TOTAL	(millibars)	(Km/h)									15	46 (b)			

(a) estimated
(b) 20 of whom had minor injuries
WI : Winward Islands
LI : Leeward Islands
W : West
C : Center
E : East
G : Gambier group
* : affected archipelagoes or parts of
° : damage caused by...

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

The total direct damage to productive sectors of the economy, infrastructure, transport systems, and communication networks (excluding housing, personal belongings, public buildings, and coconut plantations) amounted to nearly 32 million dollars. 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 has been taken into account.

The breakdown of damage to productive sectors is as follows:

- agriculture, livestock, forestry: nearly 5 million dollars
- fisheries and pearl farming: nearly 3 million dollars (2.5 million in the Tuamotu group alone)
- handicraft and industry: nearly 1.5 million dollars, more than half of which was to electric power plants in a rather undiversified sector
- tourism and the hotel trade: nearly 5.2 million dollars, 3.9 of which was to officially registered hotels that are located mainly in the Society Islands
- business activities: more than 3 million dollars

The total of all these sums amounts to over 17 million dollars. The total cost of damage to the infrastructure (road systems, harbor and airport facilities, bridges, transport systems, and telecommunications networks) amounted to nearly 15 million dollars. More than three-quarters of this sum will be spent on the repair of these infrastructures and on building collective shelters on the Tuamotu atolls.

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 difficult to evaluate with any accuracy.

French Polynesia possesses about 50,000 hectares of coconut plantations, many of which are old and poorly cared for. Most are located in the Tuamotu islands. Wastage of nuts and loss of cyclone-felled trees is estimated to have decreased by one-half the total production anticipated for 1983. More than two-thirds of the losses occurred in the Tuamotu Archipelago. Production was expected to return to normal levels in the leeward group of the Society Islands in 1984 and to reduce the deficit by more than one-half. But the secondary effects of the shaking that the

palms received and the injuries to roots and leaves are likely to be felt for five or six more years.

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

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

The local tourist bureau awaited with great concern the reaction of the main tourist sources (North America and Western Europe) to the negative image of Tahiti created by this unexpected series of cyclones. For several months the bureau's apprehensions turned out to be justified.

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 some extent responsible for this situation: an economic slump aggravated unemployment and local elections (for the designation of the districts' local councils and mayors) coincided with discussions between the local and the French governments to define a new status of extended autonomy to the territory. Under the present setup, the local (territorial) government has to either set apart funds from its own resources or create new resources by raising levies or loans for all economic rehabilitation operations. The central (French) government provides funds for emergency relief, notably to help those individuals who lost all or part of their personal belongings. A total of 6.9 million dollars was earmarked for such direct assistance.

To coordinate relief and reconstruction, the local government established a Territorial Agency for Rehabilitation (TAR). The remedial operations undertaken by TAR, the repair of general public infrastructures, and the rebuilding of community facilities will entail a total outlay of between 48 and 69 million dollars. The Government of French Polynesia raised the funds partly from its own budgetary resources, partly from a levy of a special 0.5 percent tax (of CIF value) on imported goods (except for essential foodstuffs), and partly from loans.

The levy is expected to produce 10 million dollars. Loans from local banks (16 million dollars) and from the French Government's financial institution, known as the Central Fund for Economic Cooperation (24 million dollars at 4 percent interest), provided the bulk of the money.

Reconstruction of Dwellings

The damage to the houses of the well-to-do was as common, although not as serious, as the damage to vulnerable dwellings made of light,

European-type materials such as wood, panels, and sheet iron. In fact, traditional materials and building techniques have now virtually disappeared from French Polynesia. As the cyclones drew near, few preventive attempts to strengthen structures were made. Those few efforts that were made were done in an ineffectual or dangerous manner. Self-built housing is predominant in these islands; and even when houses are erected by tradespeople, basic safety rules are often either incompletely applied or totally disregarded in the construction process. Hence ignorance, lack of concern, and irresponsibility might account to a great extent for the high degree of damage to housing. The surveys made after the cyclones by town planning and housing authorities suggested that at least 80 percent of the housing destruction resulted from structural defects or faulty building practices.

A TAR survey showed that, of a total of 3,522 dwellings destroyed or damaged in Tahiti and the neighboring island of Moorea, 493 had lost only their roofing and 933, their entire roof including the frame. The complete destruction of 1,218 houses was due in many cases to the inadequate size of the structural elements or the absence of any proper structure at all. On the coastlines of the "high" islands and in the inhabited parts of the atolls, the impact of the wind was compounded by the storm tide.

Reconstruction programs had to tackle two apparently incompatible tasks at the same time: rehousing the many homeless families as quickly as possible and initiating an adequate prevention policy. For the low-lying islands, the construction of collective shelters was the preferred solution because of the high additional costs that would have ben entailed if individual houses in highly vulnerable sites had to be built on a large scale.

Collective shelters are to be erected in the Tuamotu group and on the inhabited atolls with permanent populations ranging from 10 to 1,000 people. These shelters will be multipurpose and equipped for daily use as a town hall, hospital, or radio room. 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 perpetuated in many cases by slipshod repairs and makeshift rebuilding. New building regulations are to be adopted for public buildings, making them capable of withstanding wind speeds of over 200 km/h, but they will be difficult to enforce in the case of 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 program had been completed. 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.

In the Leeward Islands as in the Marquesas, homeless families (numbering 823 and 78, respectively) were sent the materials they needed to repair or rebuild their dwellings.

For the completely destroyed dwellings, TAR designed an extendible 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 adopted gradually. A model house was erected in every district, and TAR technicians trained instructors (usually selected from district council workers) to help people build their new homes. The amount of assistance given varied with the work force available in each family.

For the families living in the partly destroyed dwellings in Tahiti and Moorea, TAR provided free materials and technical assistance. TAR was 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 percent of the 1,218 totally destroyed houses. The total cost of this aid program eventually will exceed 11.7 million dollars, three-quarters of which will be spent on new buildings and the rest on repairs.

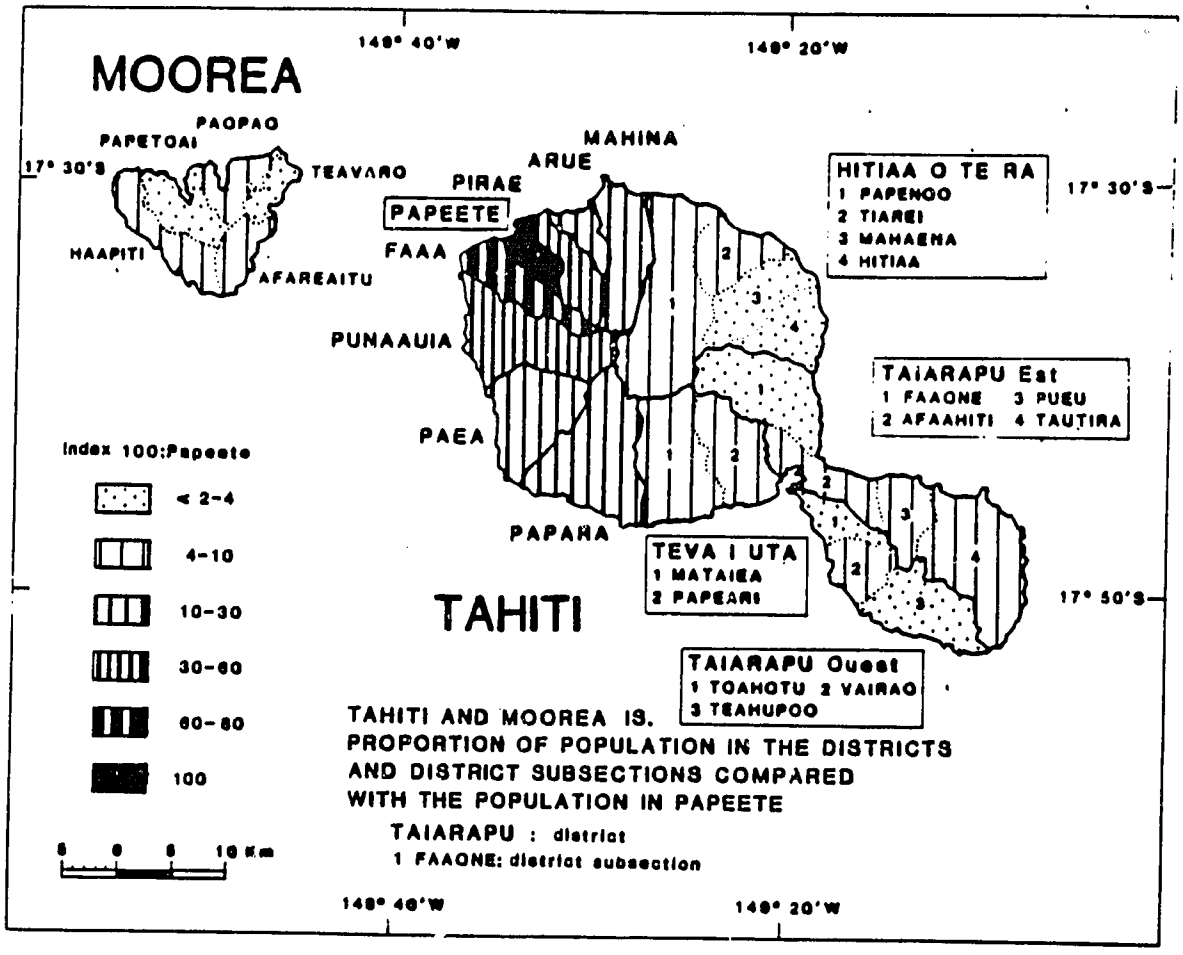
By August 1983 approximately one-third of the families who had their houses partly destroyed and who met TAR's eligibility requirements had received assistance. Almost one-quarter of the new houses were ready to be constructed and distribution of building materials to families was about to begin.

The distribution of damage to housing in Tahiti and Moorea in relation to population size is shown in figures A2 and A3.

Rehabilitation in the Productive Sectors

As of in September 1983 the local authorities intended to allocate between 5 and 9 million dollars through TAR for the rehabilitation of the productive sectors.

In the agricultural sector, TAR was to give priority assistance to the some 2,000 farmers and stock breeders who declared damage or loss of their production instruments (for example, machinery and buildings), which were to be reimbursed at a 80 percent rate, and production losses, which were to be reimbursed at a 50 percent rate.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2 AFAAHITI 4 TAUTIRA
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1 MATAIEA
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TAIARAPU Ouest
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3 TEAHUPOO
Index 100:Papeete
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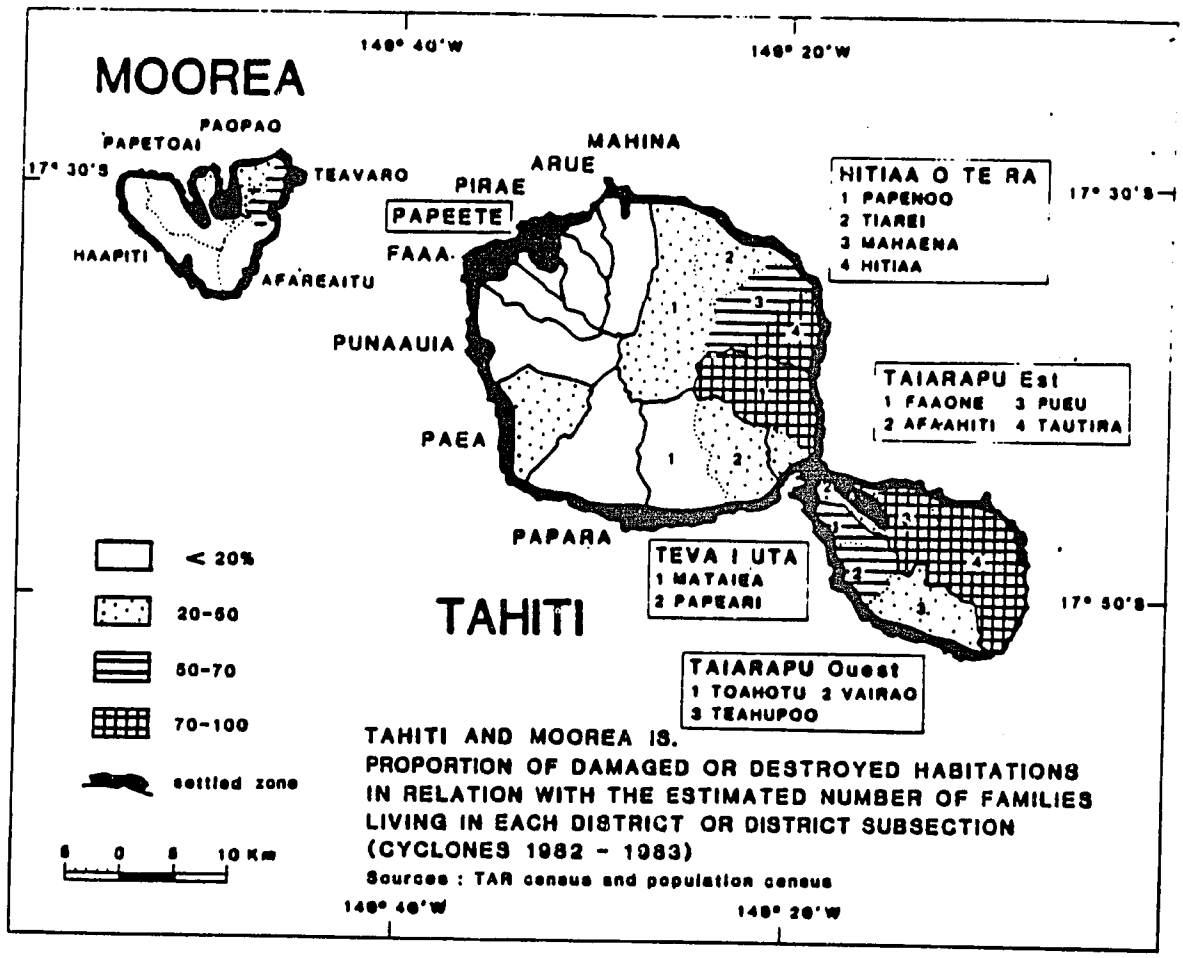
TAHITI AND MOOREA IS.
PROPORTION OF POPULATION IN THE DISTRICTS
AND DISTRICT SUBSECTIONS COMPARED
WITH THE POPULATION IN PAPEETE
TAIARAPU : district
1 FAAONE: district subsection

Figure A2


MOOREA
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2 AFAAHITI 4 TAUTIRA
TEVA I UTA
1 MATAIEA
2 PAPEARI
TAIARAPU Ouest
1 TOAHOTU 2 VAIRAO
3 TEAHUPOO
TAHITI
< 20%
20-50
50-70
70-100
settled zone
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TAHITI AND MOOREA IS.
PROPORTION OF DAMAGED OR DESTROYED HABITATIONS
IN RELATION WITH THE ESTIMATED NUMBER OF FAMILIES
LIVING IN EACH DISTRICT OR DISTRICT SUBSECTION
(CYCLONES 1982 - 1983)
Sources : TAR census and population census

Figure A3

Approximately 20 percent of the individual files approved for assistance had been processed at the end of August 1983. The total cost involved should reach 2.3 million dollars. In addition, TAR will contribute to the rehabilitation of coconut plantations by expanding a regeneration program that was already in progress before the cyclones struck. The dual purpose of the program 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's funding should be about 1.4 million dollars, two-thirds of this sum to be spent in the Tuamotus. Remedial action will focus on rehabilitation of the fishing fleet (160 boards were totally destroyed or lost and 100 suffered at least 50 percent damage), replacement of fishing gear and rebuilding of fishtraps, and provision of new equipment such as cold storage facilities. For pearl farming, only the small privately owned or cooperative ventures will receive assistance from TAR. The bulk of the funds will go into the fishing boat program.

Rehabilitation of the tourist sector will absorb less than one million dollars. TAR will provide assistance for buildings only. The French Government and the special local development schemes established during the last ten years will give some assistance for the replacement of fittings and furnishings lost or damaged in hotels.

The Future of the Rehabilitation Policy

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

Demand should be stimulated and unemployment should 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, brought about mainly a decrease in private spending.

But, because in recent years services and administration accounted for about 80 percent of the GDP, it is difficult to see how rehabilitation could stimulate the badly damaged productive sectors sufficiently to propel the territory toward economic self-reliance. The CEP (Centre d'Experimentations du Pacifique, the nuclear testing agency) alone brought in 19 million dollars 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 dollars (two-thirds of which went to 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 dollars in 1982.

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, due partly to an unusual and dramatic succession of atmospheric phenomena, but it may also be explained by lowered public awareness of a low-frequency risk in a region where each of the widely scattered and tiny islands has only the slightest chance of experiencing a direct hit. The lack of preparedness is illustrated by widespread nonobservance of basic safety rules in the building trade, vague regulations (which are either ill-adapted to the actual risk 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, and emergency reserves of food and medical supplies.

Notwithstanding a certain amount of improvization resulting from the exceptional circumstances involved, rehabilitation was well under way, and its financial requirements were secured after six months. Improvement of prevention and preparedness ought to be on a par with this effort, but unfortunately the heightened awareness of the risk observable after the strikes already seemed to be waning by September 1983.

Local newspapers were fanning the latent concern that subsists in the population by the journalistic highlighting of reports on the regional hydroclimatic imbalance, but no real program of education and conscience raising for preparedness had been launched.

Conclusion

Weather forecasting and warning systems, and the special civil defense organization for emergency situations, 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, constitute only a small part of the general organization that any country located in a cyclone-prone area should possess. In the case of French Polynesia, external factors enhance the potential consequences of the risk; moreover, 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 of Papeete, its harbor, and its international airport.

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