

# A STRATEGY FOR THE DEVELOPMENT OF REMOTE SENSING APPLICATIONS AND G. I. S USES IN FRENCH POLYNESIA

F. CHENON (1), L. LOUBERSAC (2), H. VARET (1)

(1) Service de la Mer et de l'Aquaculture/Station Polynésienne de Télédétection BP 601 Papeete - Tahiti

(2) IFREMER/Station Polynésienne de Télédétection BP 601 Papeete - Tahiti

Abstract : Once the specific geographical context of French Polynesia and its needs about the use of results of Remote Sensing and Geographic Information have been presented and situated, the strategy used and developed by both the Territory and IFREMER in partnership, is introduced. It comprises four parts and tries by involving directly the consumers to make known the use of data of high technology tool represented by Space Remote Sensing and Geographic Information Systems. Several types of the products are proposed and regional extrapolation plans are offered consequently.

Presented at the AIDAB/ESCAP meeting on Remote Sensing and Geographic Information Systems for the Pacific. SUVA, FIJI, 18 - 22 march 1991.

## I/ Introduction and base-context

French Polynesia as most of insular States and Territories of South Pacific has a specific geography. It is made of 118 islands and three main types of domains can be noticed :

- an emerged part (approximately 4,000 s.q. km),
- lagoons and reefs (more than 10,000 s.q. km),
- the open sea (EEZ of 4,500,000 s.q. km).

The first domain consists of more or less new volcanic structures (high islands) or old and submerged volcanic ones (atolls).

- In the first case, the relief is well-cut (altitudes are often over 1,000 m) and slopes are generally sharp. The living space is poor and the density of the population is high. For these reasons, the use of this living space generates opposition between town planning, agriculture environmental protection, road network, industrial and energy developments, etc.).

- In the second case, the areas at stake are poor, relief is rather nonexistent or trivial. These areas are divided into islets, varying of size, more or less accessible where there are villages and plantations of coconut-trees, the only traditional resource.

The second domain corresponds to either high islands or atolls lagoons and reefs.

- In the first case, the lagoons are narrow and generally of small size. Because of the high density of permanent population which settled in the flat part of the coast then on the next high plains and the seasonal touristic population also settled near the coasts, these lagoons are areas subject to an overexploited use (traditional fishing activities, exploitation of coral sand, tourism, sailing, coastal development, ....) aggravated, in some areas, by a constant degradation of the environment due to the concentration of urban and industrial effluents, sewage, suspended sediments from the erosion of high plains under urban pressure...

In the second case, the lagoons have large surfaces (more than 1,000 s.q. km in Rangiroa). They communicate or not with the open sea through passes or *hoa*. These large lagoons are often characterized by the presence of numerous coral pinnacles which are very productive. The local population finds in them two types of resources :

- fish which is sold and exported to the consumers centers (Tahiti),

- mothers of pearl and black pearls which represent the first exportation in value of the Territory.

A potential resource which is not yet exploited (phosphates) is interesting for some inhabitants of the lagoons. On the other hand, the recent development of pearl farming activities, which proved to be profitable, leads to a rush for virgin lagoonal areas (more than 600 applications for maritime concessions in 1990, SMA sources) which raised the question of administrative and technical management of these areas in more than thirty atolls.

The third domain finally corresponds to the vastness of the sea that surrounds the five archipelagoes of French Polynesia where the depths are variable but generally very important. The potential resources of the Exclusive Economical Zone, either mineral or living, are apparently important but generally scattered.

In addition to these three specific geographical areas, the distance between each island and group of islands needs to be noticed. This remoteness, in addition to the difficulty of communication, complicates all efforts of planning and rational management of areas and resources.

The vision of the geographical conditions that have been precedently studied and the difficult task of applying the means of conventional observation (in situ measurement, aerial surveys, sea campaigns), the basic cartography of the three geographical zones studied before remains incomplete and out of date. This penalized the emerged islands and lagoons areas from which the essential of the Territory wealth is extracted. This is the case of several islands like Marquesas and Austral and almost all atolls of Tuamotu-Gambier.

Consequently, it appears that :

- in French Polynesia, there is no standard geographic data base and easy manipulation (digital data),

- there is no integrated tools that deals with the geographic information studied before that will allow people who care about development and planning, exploiters and managers of the resource to make decisions on objective basis and criteria.

Besides, the means of investigation that deal with these three zones are different as the various scales of observation are :

emerged islands	from 1/1,000 - 1/5,000 to 1/250,000
lagoons	from 1/10,000 - 1/25,000 to 1/250,000
EEZ	from 1/100,000 to 1/1,000,000 and less

However, it appears that a geographic information about the three fields can be associated with the major scales. This is particularly necessary, for example at scale 1/50,000, for the two groups of emerged islands and lagoons which cannot be disassociated. As a matter of fact it is easy to understand that the constraints applied to the planning and management of lands or lagoons are mutual.

The Space Remote Sensing of high and low resolution seems to be able to provide, in addition to the conventional methods of investigation, standard geographic information about the emerged parts, lagoons and open sea which is reproducible, up-to-date, easy to handle, repetitive and used for :

- the creation of a basic cartography (images-maps),
  - the setting-up of data bases,
  - the creation of geographic information systems
- useful for the management of natural areas and its resources.

That is the reason why, in addition to the projects already established or in progress in French Polynesia (topographic, hydrographic maps, cadastral datas, evaluations of resources of the EEZ, etc.) a programme of elaboration and handy geographical information from the Remote Sensing tool to be set up has been decided in accordance with the strategy hereafter mentioned.

## II/ A strategy for the development/Remote Sensing applications and Geographic Information Systems used in French Polynesia

The strategy consists of four main steps :

Step 1 : Creating in French Polynesia a tool and a necessary critical human resource

To this purpose and from the beginning, the Territory of French Polynesia (Ministry of the Sea, Energy, Equipment, Post Office and Telecommunications) has associated itself with IFREMER which had a long-lasting experience about research and development in Space Remote Sensing and production of final results. This association allowed in 1988 the creation of the Polynesian Remote Sensing Station SPT equipped with computers, digital image processing, digital cartography, restitution and necessary softwares means (LOUBERSAC 1990). Within the framework of this partnership, the financial means are in joint ownership with IFREMER and the Territory of French Polynesia. The staff is composed of 50 % of local scientists and technicians who have been trained in Universities and technical colleges in France and have learned the complementary necessary technical training through IFREMER.

Step 2 : Getting tuned in and manage to analyze the problems that have not been solved in the Territory and in the South Pacific.

In order to facilitate contacts between the potential demand and its effects and the answers to be proposed, the Polynesian Remote Sensing Station is ruled by two committees :

- a Technical Committee, which meets about every three months and is open to any representative of a technical or administrative service or of private interests. It assesses the demands and completions in progress and proposes projects and programmes.
- an IFREMER-Territory Steering Committee which submits to the political authorities the project and programme appraisals and proposes action schemes in the frame of middle term plans.

In addition to these committees, promotion and information operations have been enforced in the Territory :

- writing of an information note about the activities of the Polynesian Remote Sensing Station through the quarterly brochure "SPT Infos" ;
- making of posters destined to the general public and presenting the islands of French Polynesia photographed from space, of booklets, some of them translated into Tahitian, etc.
- publication of articles in the media (newspapers, television),

as well as overseas :

- organization in late 1990, in collaboration with ORSTOM and the Territories of French Polynesia and New Caledonia, of international days "Pix-Iles 90" devoted to remote sensing and island environments in the Pacific : integrated approaches (MORGAN 1991).

### Step 3 : Launching pilot projects and demonstration projects

In compliance with the analysis of the priority needs in French Polynesia, many pilot projects have been launched in direct association with the organisms in need :

- basic cartography (image-maps or "spacemaps"),
- digital elevation models
- availability of digital geographic data,
- development of specific tools (GIS)

Besides, considering that many countries in South Pacific, just as French Polynesia, experiment problems in similar fields, some pilot projects have been initiated overseas (Cook islands, Fidji, Tonga, SOPAC, etc.)

### Step 4 : Easing the access of the needing bodies to the know-how, the data and the systems so that the final user is directly involved and therefore, to bring about transfers

This stage of the work is, to us, vital. In effect, it appears too often that the use of remote sensing or the handling of geographic data are mostly done by specialists. Our philosophy consists in wanting both to let the final user (administrative or technical service or private body) determine with the SPT the list of his needs, and to initiate him to the tool, the methods and techniques so that he can take care of them entirely. This phase therefore requires many travels between our agents and the final user service's employees, all of them working together in spite of the potential institutional barriers (different organisms or administrations) in a real project structure.

### III. Examples of achievements and projects under way

#### 3.1 cartography of atolls (Tuamotu archipelago) :

As we already mentioned it, this cartography is very incomplete. The implementation of the previous strategy has generated the first association between the Hydrographic and Oceanographic Service of the French Navy (MOP : Oceanographic Mission in the Pacific) and the SPT, enabling :

- to set up files for the preparation of hydrographic campaigns (SHOM/MOP-SPT 1990),
- to develop interactive application programmes (softwares) which can be directly used by the agents of the MOP at the SPT,
- to conceive then create image-maps said of "Pacific" standard (FOURGASSIE 1990) which correspond to standards adapted to the needs, environments and economic context of the islands. Effectively, it would not be realistic to undertake a costly cartography on this region following the conventional hydrographic and topographic standards.

The training effect generated by the dynamic required for this achievement has made that, presently, other partners involved by the same type of product participate in its creation by bringing their own set of themes : for instance, the Technical Service of Town Planning (CHAMPOMIER 1990) for the making of village maps and the toponymy survey ; the Tourism Office ; the Rural Economy Service ; the Sea and Aquafarming Office, etc.

#### 3.2 Working out a Geographic Information System (SIGMA Poe Rava) of assistance for the administrative and technical management of pearl-farming

Given the needs caused by the disorderly occupancy of the atoll lagoons and their conquest after the development of the mother-of-pearl and pearl aquafarming, the Sea and Aquafarming Service (SMA) which, in collaboration with the State Property Service, is responsible for controlling the pearl-farming activities and managing the maritime concessions, has joined with the SPT to firstly make image-maps of assistance for the ground inventory work. As their collaboration developed, they created the methods, software and systems which presently form a Geographic Information System (CHENON and al 1990), an absolute decision tool available for both territorial administrative and technical services, allowing an improved management of the lagoon spaces now based on objective criteria. It appears extremely important to us to emphasize the fact that the Geographic Information System

elaborated presently causes a calling into question of the actual legislation in French Polynesia about the maritime concession management ; it is not well adapted to the situation because it is not based on administrative and technical documents that are reliable, reproducible and hardly questionable such as those provided by the GIS SIGMA Poe Rava.

### 3.3 Digital Elevation models :

Firstly, we studied the problems of planning and managing the land spaces in the islands. Many users have required a Digital Elevation Models (Environment Commission, Town Planning Service, Plan Office, Equipment Service, Rural Economy Office) on two scale levels :

- at 1/50,000 or equivalent for the creation of global planning schemes ;
- at 1/5,000 or equivalent for cadastral survey works.

As a first stage, the SPT joined with ORSTOM Montpellier (DEPRAETERE 1990) to participate in the development and the integration into these computer devices of softwares for the making of Digital Elevation Models and by-products (slope, orientation, illumination, summits and valleys detection, catchment areas, draining off and other maps).

As a second stage, the SPT initiated the creation of a three dimensional model-making of the island of AITUTAKI (Cook Islands) and its lagoon (ANDREFOUET and al 1990), and then of the bay of Taiohae, Nuku Hiva, in the Marquesas archipelago, in the framework of the General Scheme of Planning and management of French Polynesia (SAGE).

Presently, a project is under way in a partnership with the French National Geographic Institute (IGN), the Plan Office and the Town Planning Service for the making of the Digital Elevation Model (DEM) of the island of Tahiti at the scale of 1/40,000 through the digitalization of contour lines, and for the making from the SPOT stereoscopic couples of the DEM in Ua Huka, Fatu Hiva, Tahuata and Rapa, non cartographed islands of the Marquesas and Austral archipelagoes.



### 3.4 Cartography of meteo-oceanic parameters and development of a open-sea fishing flotilla :

Presently in French Polynesia, the developing local industrial tuna fishery is responsible for the exploitation of fishing zones located in the South of the Austral islands and in the North of the Marquesas. There is a conjunction between the development of this flotilla (18 tuna boats anticipated), the setting up of a satellite reception station (GOES) in the Meteorological Service at the Airport of Faaa (BOSSARON 1990), the integration of softwares allowing to cartography the sea surface thermal fields from space data at the SPT (GOHIN 1990), the creation of a halieutic research group combined between ORSTOM and IFREMER and the existence of two territorial services in charge of the management and development of fisheries that are the Sea and Aquafarming Service (SMA) and the Corporation for the Development of Aquafarming and Marine Activities (EVAAM). It has generated a debate about a survey programme for the meteo-oceanic environment parameters in relation with the pelagic resources so as to undertake fundamental research such as the fishing assistance and the management of the exploitable potential. Such a programme would be integrated into the global evaluation undertaking of the Exclusive Economic Zone of French Polynesia which presently is under study and could be used, in the frame of a regional cooperation, to help South Pacific countries (willing to do so) to start an exploitation of the pelagic resources of their own economic zone and to have a better management of that potential.

### Conclusions and prospects :

We have presented the basis of the strategy implemented in French Polynesia in the frame of a partnership between the Territory and IFREMER so as to develop a rational utilization of the remote sensing tool and so that the authorities in charge notably of the planning and -management of the resources and environment can have the use of optimized decision tools. This strategy aims at bringing the results and findings of high technology (satellite observation, image processing, data-base and Geographic Information Systems) to the more users possible in the Territory with their own participation, both to lower the costs and for the advantage of the whole Polynesian community.

We also wish in French Polynesia we could actively participate in the necessary global effort, overall in the coastal zones, the lagoons and reefs to make a complete and up to date geographic information available and usable in South Pacific. This part of the

world remains one of the last regions where this information, at the dawn of the XXI<sup>st</sup> century still is disparate, incomplete and often expired. It is vital and urgent to do something in compliance with the ideas developed by Dr H.L. THUNG (THUNG 1990), and it seems necessary to launch a wide-range programme of map-making and disposal of numerical geographic data, notably resulting from space data, about the reefs, lagoons and littorals of South Pacific countries.

At last, we would like to actively take part in the attempt of making this geographic information as compatible as possible from island to island, State to Territory and Territory to State. We deeply believe that this information, which relates to a common inheritance, can be gradually placed at everyone's disposal in South Pacific so that we can all talk about the same thing.

## Bibliography :

ANDREFOUET S., CHENON F., LOUBERSAC L., VARET H., WIBAUX B. 1990. Modélisation bathymétrique d'un lagon d'atoll, application à la modélisation tridimensionnelle d'une île et de son lagon. Actes du colloque "Pix'îles 90" Remote Sensing and insular environments in the Pacific : integrated approaches. Noumea - Tahiti 19-24 novembre 1990. (in press)

BOSSARON G., LASBLEIZ R. 1990. Projet SIRUS : Implantation d'une station de réception GOES à l'aéroport de Faaa. In Actes du colloque "Pix'îles 90" Remote Sensing and insular environments in the Pacific : integrated approaches. Noumea-Tahiti 19-24 novembre 1990. (in press)

CHAMPOMIER R. 1990. Une méthode simple d'élaboration de mosaïques photographiques MTU des îles basses à partir d'un fond SPOT panchromatique de niveau 2A. Poster presented at the international workshop "Pix'îles 90" Remote Sensing and insular environments in the Pacific : integrated approaches. Noumea-Tahiti 19-24 novembre 1990. (in press)

CHENON F., VARET H., LOUBERSAC L., GRAND S., HAUTI A. 1990. "SIGMA Poe Rava : un système d'information géographique pour la gestion de l'aquaculture perlière aux Tuamotu Gambier. In Actes du colloque "Pix'île 90" Remote Sensing and insular environments in the Pacific : integrated approaches. Noumea-Tahiti 19-24 novembre 1990. (in press)

DEPRAETERE C. 1990. Notices OVNIH, méthodes et guide des utilisateurs vol 4, 5, 6. Laboratoire d'Hydrologie de l'ORSTOM Montpellier.

FOURGASSIE A. 1990. La spatiocarte marine : une solution pour la cartographie des atolls polynésiens. In Actes du colloque "Pix'îles 90" Remote Sensing and insular environments in the Pacific : integrated approaches. Noumea-Tahiti 19-24 novembre 1990. (in press)

LOUBERSAC L. 1990. La Station Polynésienne de Télédétection : statuts et moyens. In Actes du colloque de "Pix'îles 90" Remote Sensing and insular environments in the Pacific : integrated approaches. Noumea-Tahiti 19-24 novembre 1990. (in press)

GOHIN F. 1990. Synthèse d'images du satellite NOAA pour la cartographie des champs thermiques de surface de la mer. In Actes du colloque "Pix'îles 90" Remote Sensing and insular environments in the Pacific : integrated approaches. Noumea-Tahiti 19-24 novembre 1990. (in press)

MORGAN G. 1990. International workshop "Pix'îles 90" Noumea, New Calédonia 19-21 Novembre and Papeete, French Polynesia 22-24 Novembre 1990. International Journal of Remote Sensing. (in press)

SHOM/MOP - SPT 1990. Les dossiers de préparation des campagnes hydrographiques aux Tuamotu Gambier. Poster presented at the international workshop "Pix'îles 90" Remote Sensing and insular environments in the Pacific : integrated approaches. Noumea - Tahiti 19-24 novembre 1990. (in press)

THUNG H.L. 1990. Integrated use of remote sensing in the Pacific. Note proposed at the international workshop "Pix'îles 90". Remote Sensing and insular environments in the Pacific : integrated approaches. Noumea-Tahiti 19-24 novembre 1990. (in press)