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REMOTE SENSING AND INSULAR ENVIRONMENTS ; THE USE OF REMOTE SENSING IN FRENCH POLYNESIA : STATUS AND TRENDS

TELEDETECTION ET MILIEUX INSULAIRES : L'UTILISATION DE LA TELEDETECTION EN POLYNESIE FRANCAISE, BILAN ET PERSPECTIVES

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ABSTRACT

Once the geographic context specific to the French Polynesia archipelago has been presented the necessities and interest in delivering a standardized geographic information to serve management and economic development tools are underlined. For such goals the strategy set up in French Polynesia in partnership between the State and the Territory is depicted. This strategy aims at identifying human resources, spreading the required information, launching demonstration projects, involving the final user in the definition of the product and facilitating the transfers of know-how. Some of the realization achieved and in progress are presented : atolls mapping, GIS elaboration for administrative and technical management of pearl culture activities, three dimension representations of relief, cartography of meteorological parameters and assistance to fisheries.

It is concluded on the basis of the results achieved in French Polynesia, that there is a great interest in launching a wide programme including the supply of the basic geographic information which is generally poor in the South Pacific and the elaboration of derived tools to help managing the activities, resources and environment.

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## RESUME

Après une présentation succincte du contexte géographique spécifique aux archipels tropicaux du type de celui représenté par la Polynésie française, on argumente l'intérêt de la mise à disposition d'une information géographique standardisée à l'origine de la mise en forme d'outils de planification des activités et de décision en matière de développement économique. A cette fin on explicite la stratégie mise en place en Polynésie française dans le cadre d'un partenariat établi entre l'Etat et le Territoire. Cette stratégie vise à créer les ressources humaines nécessaires, à transmettre le plus largement possible les informations requises, à lancer des projets de démonstration, à impliquer directement l'utilisateur dans la conception du produit qu'il requiert et faciliter ainsi les transferts. On présente ensuite succinctement plusieurs réalisations effectuées : cartographie des atolls, élaboration d'un GIS d'aide à la gestion administrative et technique de la perliculture, représentation tridimensionnelle du relief, cartographie des paramètres météo-océaniques et aide à la pêche.

On conclue, sur la base des résultats acquis en Polynésie française, sur l'intérêt du lancement d'un vaste programme de mise à disposition de l'information géographique de base le plus souvent déficiente dans le Pacifique et d'élaboration d'outils de planification des activités qui en seraient dérivés.

## INTRODUCTION

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).
- An open sea (EEZ of 4 500 000 s.q. km).

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

- In the first case, high islands, the relief is well-cut (altitudes are often over 1 000m) and slopes are generally sharp (colour fig. P1A). The living space is poor and the density of the population is high. For these reasons, the use of this rare living space generates opposition between town planning, agriculture, environmental protection, road network, industrial and energy developments, etc.).

- In the second case, atoll, the areas at stake are poor, relief is rather nonexistent or trivial (colour fig. P1B).

These areas are divided into islets varying of size more or less accessible where there are villages and plantations of coconut-tree, the only traditional resource.

The second domain, lagoon and reef, corresponds to either high islands lagoons or atolls lagoons.

- In the first case, high islands, the lagoons are narrow and generally of small size, colour fig. P1C. Because of the high density of permanent population which settled in the flat part of the coast then on the next high plains and because of the seasonal touristic population also settled near the coasts, these lagoons are areas subject to an over-exploited use (traditional fish activities, exploitation of coral sand, tourism, boating, 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 construction...

In the second case, atoll, the lagoons have large surfaces, colour fig. P1D (more than 1 000 s.q.km in Rangiroa). They communicate or not with the open sea through passes or hoas. These large lagoons are often characterized by the presence of numerous coral pinacles where marine life concentrates. 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 exploited at the present moment (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 within the nine first months of 1990, SMA sources) which raised the question of administration and technical management of these areas in more than thirty atolls.

The third domain finally open-sea corresponds to the vastness of the sea that surrounds the five archipelagoes of French Polynesia and while the variable depths are 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 measures, aerial surveys, sea campaigns, render the map-making base of the three geographical zones studied before incomplete and out of date. This penalized the emerged islands and lagoons areas from which the essential of the Territory wealth is presently extracted. This is the case of several islands like Marquesas and Australes and almost of all atolls of Tuamotu-Gambier.

Consequently, it appears that :

- In French Polynesia, there is no standard geographic data base with easy manipulation (digital data).

- There is no integrated tools that deal with the geographic information studied before which will allow the people who care about development, planning and exploiters and managers of the resource to take decisions on objective bases and criteria.

Besides, the various scales concerning the three domains studied : emerged islands, lagoons and open-sea are different : as the means of investigation that deal with these three zones are.

Emerged lands	from 1/1 000 - 1/5 000 to 1/250 000
Lagoons	from 1/10 000 - 1/25 000 to 1/250 000
ZEE	from 1/100 000 to 1/1 000 000 and less

However, it appears that a geographic information about the three fields should be associated. This is particularly necessary for example at scale 1/50 000 for the two groups of emerged islands and lagoons which cannot be disassociated because the compulsory measures about planning and management cannot be taken into account for lands or lagoons without considering the points that apply to the other.

The aerospace Remote Sensing of high and low resolution seems to be able to provide at large and medium scales about the emerged parts and lagoons and at small scales for the open sea, in addition to the conventional methods of investigation, a standard geographic information, which is reproducible, up to date, digital, easy to handle and repetitive and would be used for :

- The creation of cartographic models (image-maps),
- The setting-up of essential data bases,
- creation of Geographic Information Systems useful for management of natural areas and its resources.

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

**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 : To create 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, of Energy, Equipment, the 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 equipped with computing system, 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 local staff has been trained in Universities and technical colleges in France and it has learned the complementary necessary technical training through IFREMER.

**Step 2 : To get tuned in, to analyse and to manage the problems that have not been resolved in the Territory and in the South Pacific.**

In order to facilitate contacts between the potential demand 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 programs.

- 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 :

- Writting of an quarterly information note about the activities of the Polynesian Remote Sensing Station through the 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 (newspaper, 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 devoted to the workshop "PIX'ILES 90", remote sensing and island environments in the Pacific : integrated approaches.

### **Step 3 : To launch pilot 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 map-making ("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 : To facilitate 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 utilization of remote sensing or the handling of geographic data are mostly done by specialists and that the transfer of know-how is not performed. 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 this 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.

## **EXAMPLES OF ACHIEVEMENTS AND PROJECTS UNDER WAY**

### Cartography of atolls (Tuamotu archipelago)

As we already mentioned it, this map-making 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, (see the poster dedicated to these activities SHOM/MOP - SPT 1990).

- To develop interactive application program (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 realist to undertake 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.

#### 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 aquafarming, the Sea and Aquafarming Service (SMA) (HAUTI, 1990) 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 which would be presented during this workshop (CHENON and al., 1990), a decision tool available for both territorial technical services and pearl aquaculture farmers, 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 which 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.

## Digital Elevation models

Firstly, we studied the problems of planning and managing the land spaces in the islands. Many users have required 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 cadatral survey works.

As a first stage, the SPT joined with ORSTOM Montpellier (DEPRAETERE, 1990) to participate in the development and the integration into these micro-computer devices of softwares for the making of Digital Elevation Models and by-products (slope, orientation, 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 which will be presented during the workshop (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 of French Polynesia (SAGE).

## Cartography of meteo-oceanic parameters and development of 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 a flotilla (18 tuna boats anticipated), the setting up of a satellite reception station (GOES) in the Meteorological Service at the Airport of Faaa, project to be presented during the workshop (BOSSARON, 1990), the integration of softwares allowing to map the sea surface thermal fields from space data at the SPT, also presented during this PIX'ILES workshop, (GOHIN, 1990), the creation of an 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 as fishing assistance and management of the exploitable potential. Such a program 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 better management of that potential.



## CONCLUSION

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-bases 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.

The achievement of such objectives, whether they result from the research findings and their applications as from the implementation of advanced technologies, has to cope with various difficulties which are progressively ironed out by the strategy herein exposed. Those difficulties are :

- An information problem. The tool and its potential are poorly known in this area because of a prior scientific and technical education such as that acquired by some other asiatic, african and latino-american tropical countries thanks to the experiments lead on the basis of LANDSAT data in the 70's and 80's.

- A communication problem. This affects the communication toward the decision-makers who are to be persuaded to use an advanced technology and maintain a high level of research as well as that destined to the final users who want to have a product directly and easily digestible and applicable to their situation.

- A training problem, notably from the local technician who want to understand but are somehow affraid of the tool's high technical level.

- An adaptation problem of the products to the concrete difficulties met in the islands for example, the problem of the management of marine concession which are somehow similar in nature to those encountered in the coastal and sea space of developed countries but which expression is different and hard to obtain.

- A problem in the implementation of the tool within the local conditions where the fragility of the computer systems and the maintenance are issues which may be crippling.

If in one hand it has been essential to ensure the needed technological boom which is on going here to bring the potential users to the tool together right at the beginning. On the other hand we also wish in French Polynesia we would actively participate in the necessary global effort, mostly in coastal zones, lagoons and reefs, to set up a complete standardized and up to date geographic information available

and usable in the South Pacific. This part of the world remains one of the last region where the information at the dawn of the 21th century is still disparate, uncomplete and often expired. It is vital and urgent to do something in compliance for example with the ideas underlined by Dr. H.L. THUNG (THUNG, 1990) who unfortunately had to cancel his participation to this meeting, and it seems necessary to launch a wide range programme of cartography and disposal of digital geographic information, notably resulting from aerospace data, about the reefs, lagoons and coasts of the South Pacific countries.

At last, we would like to take an active 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 put at the disposal of everyone in the region so that we can all talk about the same thing.

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P1



P1A : Sharp relief and slopes  
in Tahiti mountains  
(source OPATTI)

P1



P1B : Flat islets Mani-  
hi isalnds, Tuamotu  
(source OPATTI)

P1



P1C : Narrow lagoon in  
Tahiti island  
(source OPATTI)

P1



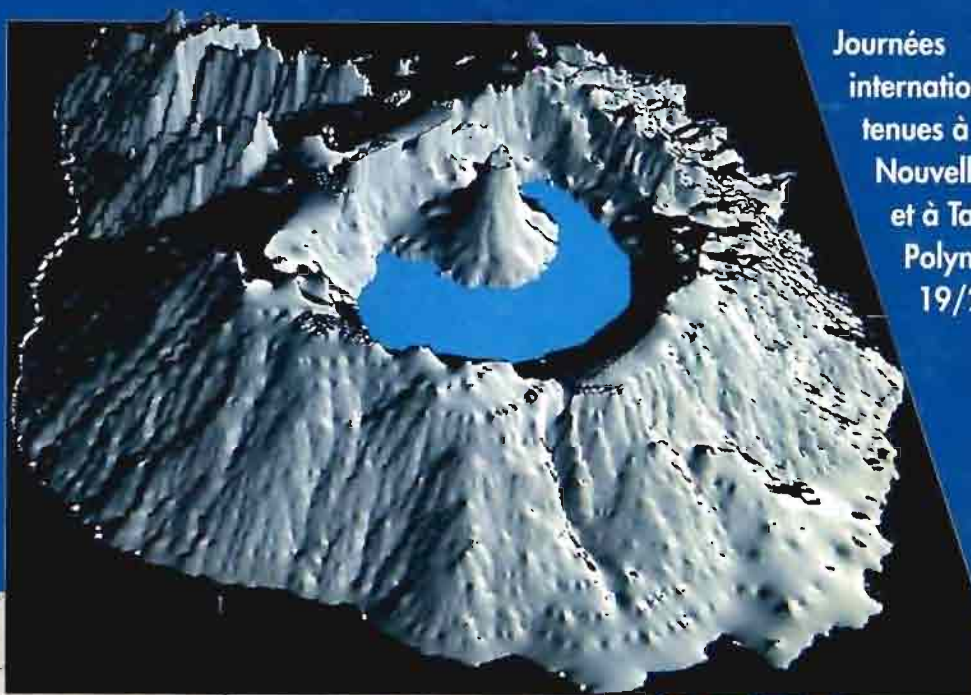
P1D : Wide lagoon in a  
Tuamotu atoll  
(source S.P.T.)

# "PIX'ILES 90"

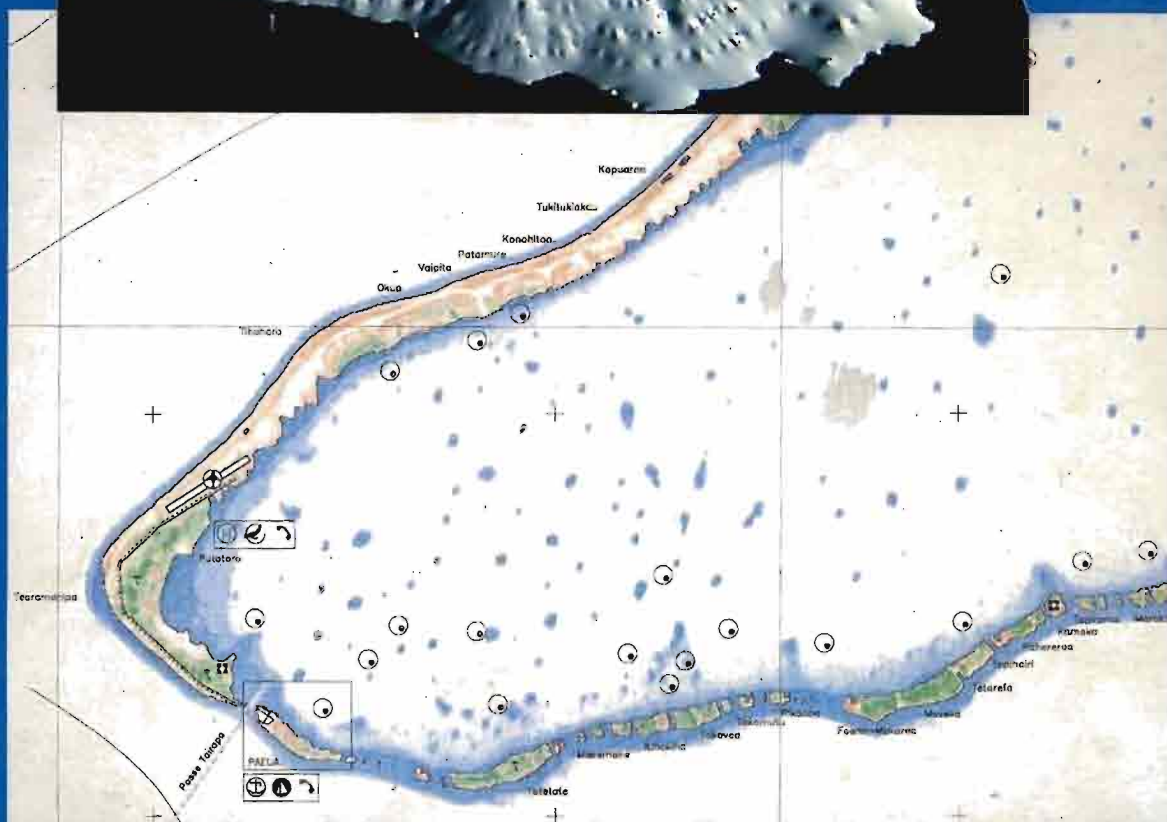
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