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**Coastal and coral reefs studies in New Caledonia, using SPOT Images,  
for environment and management monitoring.**

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**ABSTRACT**

Remote sensing laboratory LATICAL has been set up two years ago in ORSTOM Research Institute settled in New Caledonia. The main satellite imagery processing system encompass a SUN computer, a high resolution color monitor SEPIMAGE and an electrostatic color plotter VERSATEC. This equipment allows the processing of any satellites data types (LANDSAT, SPOT, CZCS, SEASAT...).

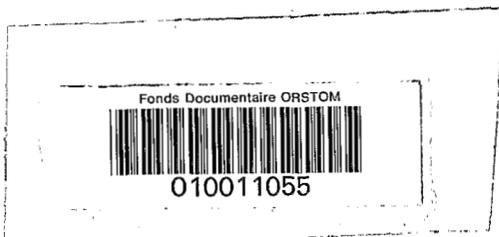
In one run, an image size of 2048 lines and 2048 pixels can be processed.

The LATICAL capabilities are presented through two cartographic studies related with remote sensing applications to coastal zone and coral reefs environment. The first study is dealing with mangroves identification in New Caledonia. The main topics were :

- to cartography the areas occupied by the mangroves along about 130 coastline kilometers ;
- to separate the theme mangroves into three density level sub-areas ;
- to evaluate the surface of each sub-area ;
- to mosaïc the four SPOT Images involved in the study.

The second study give an example of which information can be extracted from a coral reef SPOT Image for the following purposes :

- thematic cartography for shallow biotopes identification ;
- living coral assessment through a density related index calculated from radiometry signatures.



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## INTRODUCTION

The remote sensing laboratory LATICAL has been set up two years ago in ORSTOM facilities of NOUMEA, New Caledonia. ORSTOM is a french multidisciplinary research Institute, conducting finalized and basic research programmes in the intertropical zone. NOUMEA Center is one of the main ORSTOM branches spread in over fourty countries.

### LATICAL 's Team and Equipment

A team of four peoples (a research worker and three informatician engineers) are currently involved in remote sensing projects. Generally a project is conducted in close collaboration between the scientist(s) knowing parts of the terrain and people(s) from LATICAL for an optimal solution of the objective to be reached.

The main hardware equipment is composed of :

- a 3/160 computer SUN station
- a CCT tape reader (1600 and 6250 bpi)
- a high resolution color monitor  
SEPIMAGE (2048x2048x24 bits)
- an electrostatic color plotter VERSATEC

The equipment is linked to the other SUN stations with an Ethernet connection.

### Satellite data used at LATICAL

The software developed with LATICAL facilities enables all types of digitized data to be processed but the need of precise cartography for environmental purposes expressed at ORSTOM focus the projects mainly towards high resolution data like SPOT data. Nevertheless, other sensors were used such as : CZCS from NIMBUS 7 for productivity study of the open sea and altimetry data from SEASAT for the detection of unknown seamounts.

Through two examples dealing with coastal zone and coral reef thematic cartography, the performance of high resolution satellite images are demonstrated.

## 1. THEMATIC AND QUANTITATIVE CARTOGRAPHY OF MANGROVES

### 1.1 The area of research

Mangroves, acting as an interface between land masses and marine environment, play a triple role of protection, nutrition and fertilization of the coastal environment and the resident species. Mangroves are often extensive, difficult to penetrate and may change rather rapidly under natural or human impacts ; consequently, mangroves are pieces of choice for remote sensing technology.

New Caledonia is surrounded by a large lagoon limited by a ring of barrier reefs ; the main island called "Grande Terre" extending up to 400 km long is a mountain chain ; this morphology delineates a shoreline comprising many bays and areas suitable for mangroves.

The mangroves mapping described below encompass a lagoon portion of about 130 Km along the southwestern coast of New Caledonia (figure 1).

### 1.2 Data and processing

The coastal zone under study needed four SPOT scenes to be processed. Each scene covers about 3600 Km<sup>2</sup> and was acquired on CCT, with multispectral mode (i.e : with three bands : yellow-green, visible red and near infra-red). The spatial resolution gives a pixel size of 20m and the preprocessing level is 1B (only radiometric and geometric system corrections). The rectification of the images was performed in LATICAL, according to the UTM cartographic projection, giving a location accuracy of 50m.

The objectives of the project were :

- to locate the mangroves areas ;
- to share these areas into three mangrove density levels (high, mean, low) ;
- to estimate (in ha) the surface of each main mangroves sites ;
- to divide this surface between the density dependent sub-areas.

To achieve these objectives, the principal processing steps are listed below :

- stretching and equalizing the spectral dynamic of each SPOT scene ;
- supervised classification of the pixels after identification of each specific spectral signature given by mangroves of different density levels. The classification was fitted to the "ground truth" by using a dozen of control plots observed in the field
- incrustation of the mangroves themes into a false color image giving the location background ;
- mosaicing the four scenes in one image ;
- dressing the image with text, drawing and figures to get the final product.

### 1.3 Results

The final map shows essentially the coastal zone where mangroves are scattered in the bays. An example is given in figure 2, near NOUMEA peninsula.

Each mangroves entity is identified by a rectangular box and related to pertinent quantitative informations. These study, being still in progress, provides an important cartographic document for further topics such as :

- morphology of mangroves in relation with coastal features and currents ;
- length of interface between mangroves and lagoon waters ; a parameter which could play a determinant role for fish larvae survival.
- surfaces of the habitat occupied by exploited marine species, such as mud crabs (*Scylla serrata*), for the estimation of the biomass.

## 2. THEMATIC AND QUANTITATIVE CARTOGRAPHY OF A CORAL REEF

### 2.1 The area of research

The conservation of coral reefs is a matter of particular concern to tropical island countries. The declining "health" of coral reefs is often reported both in the Pacific and the Indian Oceans. An appropriate mapping of coral reefs is then needed for the assessment of living corals.

An attempt in such a fields is carried out in New Caledonia. The reef under study is a portion of the barrier reef, south of NOUMEA, called KUE. This coral reef is continuous and limited by two passes and measures 18 km in length (figure 1).

### 2.2 Data and processing

The SPOT data processing is close to that used in the mangroves example but, in this case, all the pixels of the reef have to be classified for a whole biotopes mapping with a special attention to the living corals areas. For the achievement of this purpose, some knowledge of the ground was obtained through diving in four locations on the reef.

Each visited point was exactly positioned with an hand-held Magellan GPS NAV 1000. The aim of such an exact positioning was to locate the areas covered with living corals. The different density coverages were clustered into three density levels : high (>70%), medium (between 30 and 70%), low (<30%). These percentages, evaluated by eyes, are just indicative.

The supervised classification used in the processing is based on the statistical analysis of the bi-dimensional histogram performed with the green and red channels of SPOT. The infra-red band is too strongly absorbed by the water to be efficiently used in the classification.

The histogram analysis brought clearly a relationship between living corals density and the level of the signature in the two channels. This relationship is linear between surface and 5 meters depth and can be determined by regression analysis ; for deeper areas, a log-transformation of first channel is needed.

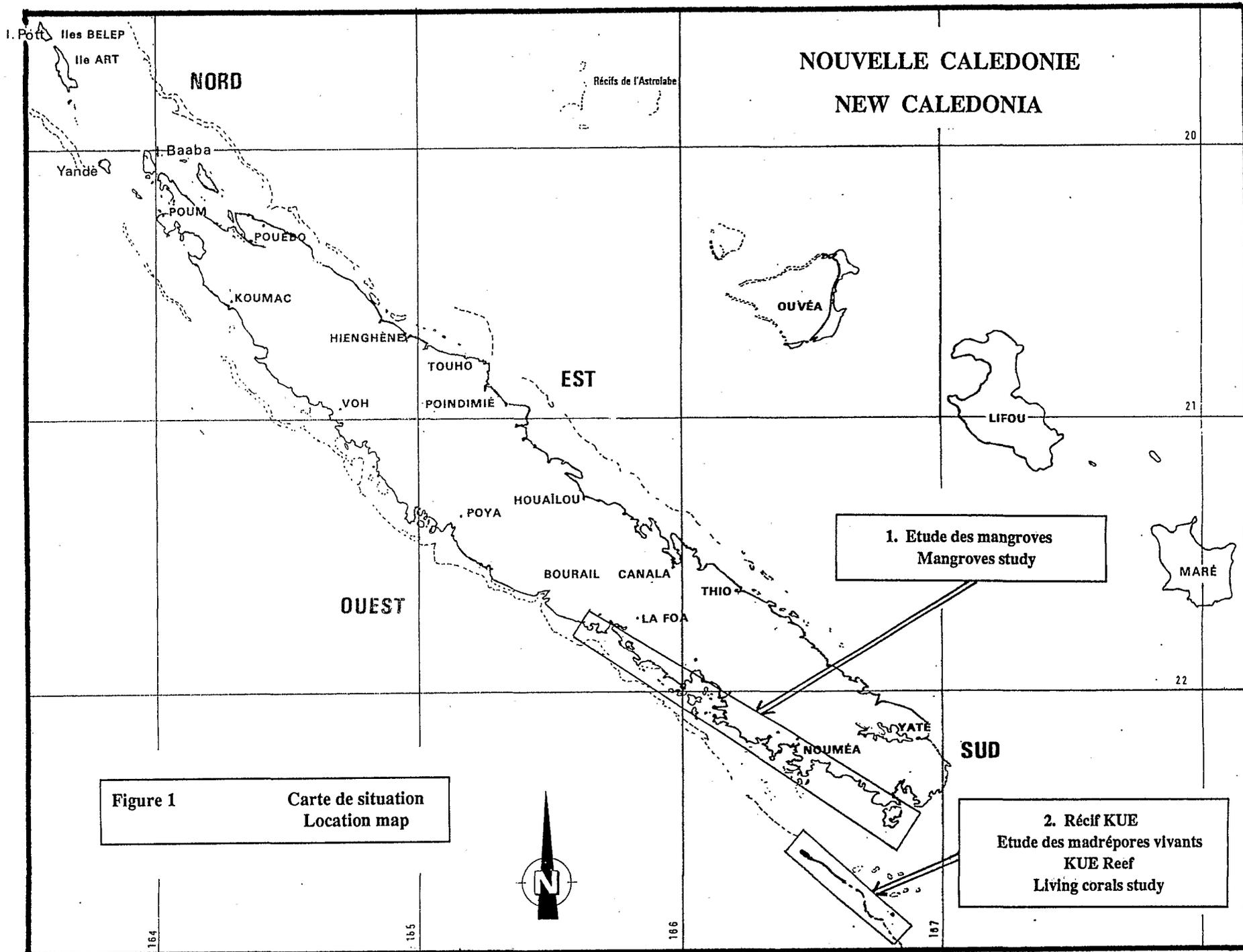
The mathematical formulation of the relationship needs more control points, especially with other reefs, to be used as a realistic "living coral index".

### **2.3 Results :**

The thematic map of KUE is presented in figure 3. The living coral areas are shown but also the reef flat, composed of rubbles or flagstone, and the sandy areas. Estimation of the surface occupied by each theme is also provided. It can be noted that high density living coral areas are small and scarce. Comparison with others reef of the barrier will be very useful to determine the "health" condition of KUE reef.

### **CONCLUSION**

The two above examples are dealing with very fragile marine environment zones which are of most importance for all tropical island nations. Remote sensing and processing of high resolution satellite data may provide, in many cases, a quick knowledge of the quantitative extension and health status of these resources bearing areas.



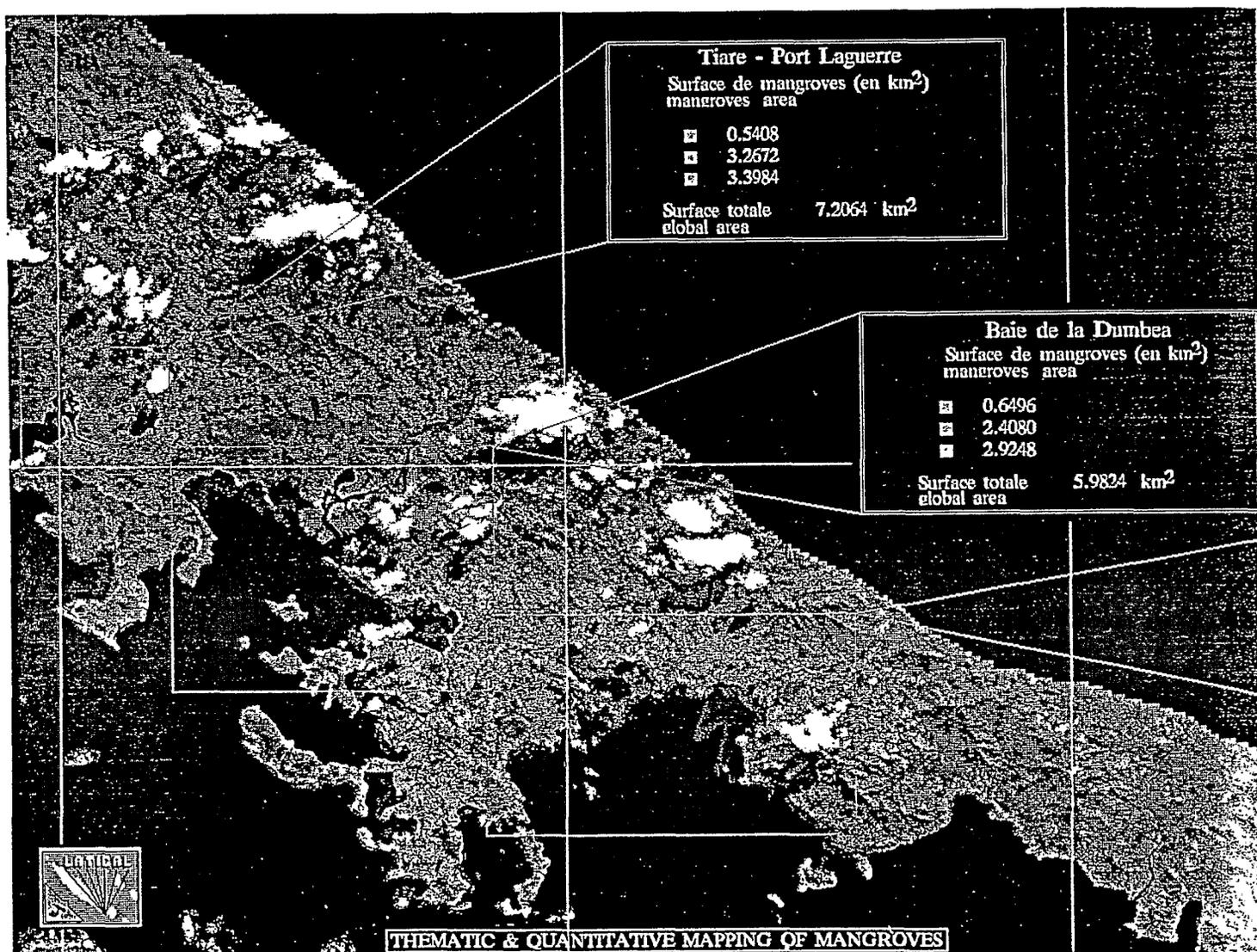
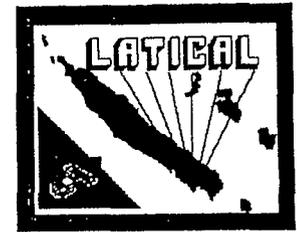


Figure 2

Carte thematique du recif de KUE (Nouvelle Caledonie)

Thematic map of KUE reef (New Caledonia)



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SPOT 1  
KJ 415-395  
Date 17/07/87  
HRV2  
R16.1

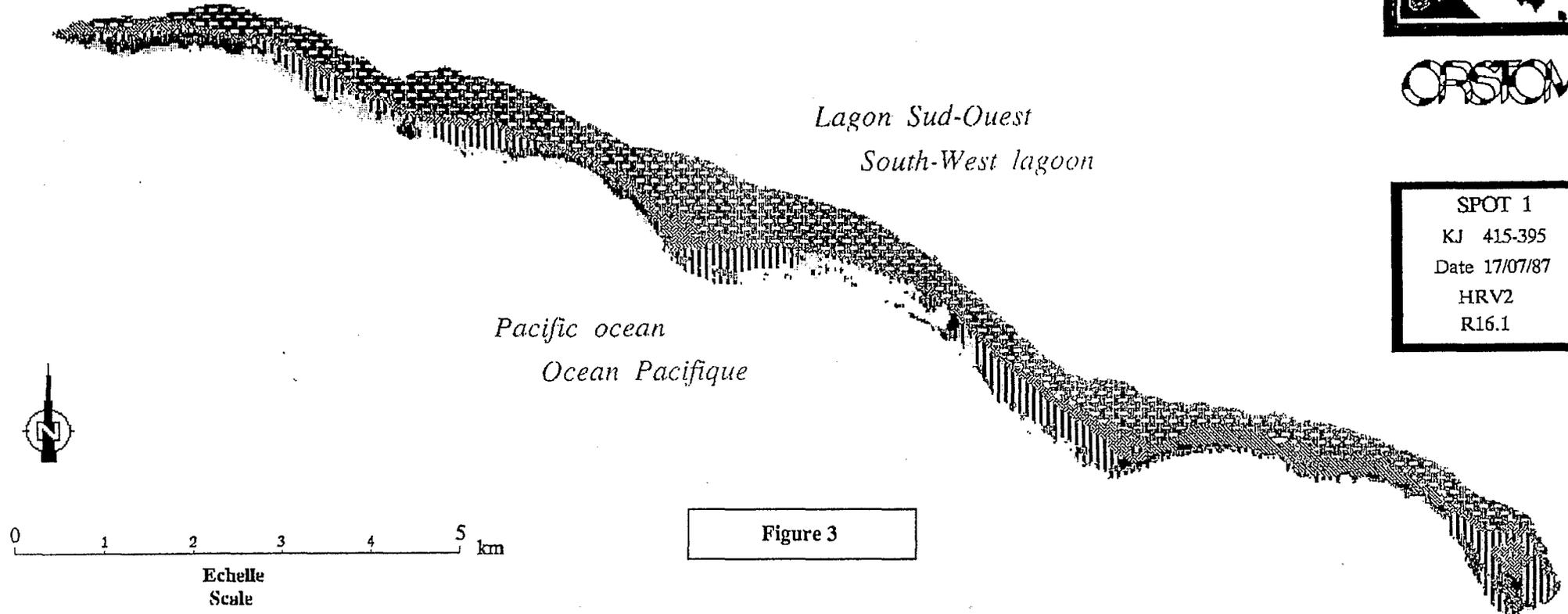
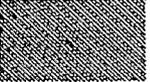
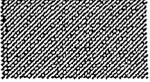
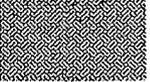


Figure 3

	Madrepores vivants, haute densite (>70%) Living corals, high density	21.4 ha		Chenaux coralliens (pente interne) Coral grooves (inner slope)	71.4 ha		sable superficiel Shallow sandy areas	22.9 ha
	Madrepores vivants, moyenne densite (>30% et <70%) Living corals, medium density	111.4 ha		Debris coralliens Rubble reef flat	113 ha		Sable profond Deep sandy areas	635.8 ha
	Madrepores vivants, faible densite (<30%) Living corals, low density	164.5 ha		Dalle caverneuse concretionnee Reef flat flagstone	201.8 ha		Eaux profondes Deep waters	