

Special Report

SURVEYING FRENCH GUIANA'S COASTLINE CLOSE UP

SPOT 5 imagery is providing telling insight into French Guiana's constantly shifting shoreline. For the first time ever, government agencies can now draw on an accurate set of data detailing the unique dynamic processes shaping the country's coastal regions. Nevantropic is the company leading this innovative project.



Source E. Prost

Anse du Châton bay, Cayenne, in 1993 (left) and today (right). The proliferation of the mangrove shows how quickly the landscape can change.



Source O. Pionier

The new SEAS¹ satellite receiving station operating in French Guiana since 2006 acquires imagery directly from the SPOT and Envisat satellites in Cayenne. Whether for monitoring fishing vessels or territorial surveillance, space-based Earth observation is a unique tool supporting French Guiana's economic and technological develop-

1) *Surveillance de l'Environnement Amazonien assistée par Satellites haute résolution - High-resolution satellite monitoring of the Amazonian environment*

ment. It is now helping scientists to study phenomena that are well known yet still poorly understood. French Guiana's shifting shoreline, which Nevantropic and Spot Image studied from March to August 2007 chiefly using SPOT 5 imagery, is a case in point.

Like nowhere else in the world

French Guiana's shoreline exhibits quite unique features that are being constantly reshaped by dynamic littoral processes. Suspended materials are transported along the coast from the Amazon, the world's largest river that discharges between 1.1 and 1.3 billion tonnes of suspended sediments every year at a rate of about 200,000 cubic metres per second. Twenty percent of this total migrates westwards along French Guiana's coastline at an average rate of 1.5 kilometres a year. Almost all of these sediments end up in the Orinoco delta,

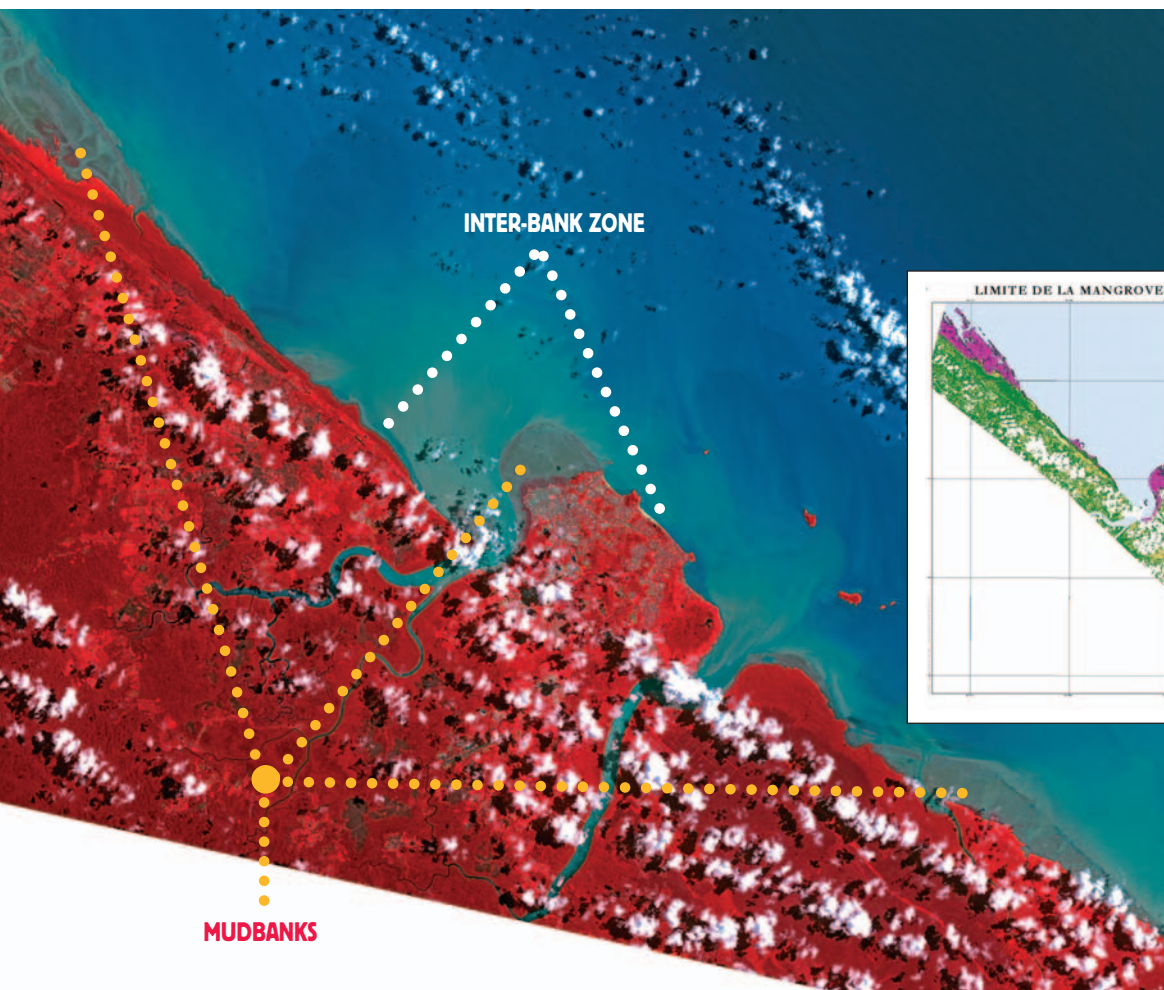
forming mudbanks along the shore that hinder navigation. The action of the currents, tradewinds and swell also causes erosion and accumulation of mudbanks soon colonized by mangrove. These highly complex mechanisms—in areas that are hard to get to and therefore hard to study—are found nowhere else in the world. What is more, they are significantly reshaping the shoreline. French Guiana's coastline consists largely of mangroves on unstable and perpetually shifting soils. The sometimes colossal effects of erosion mean that the shoreline's profile changes very quickly. Put another way, the fast-changing coastal landscape threatens to derail land planning and impact the region's economy. Will territories be here today and gone tomorrow? What will happen to the sandy beaches? And what new land will be available for development in the future?

Compiling a clearer picture of the coastline

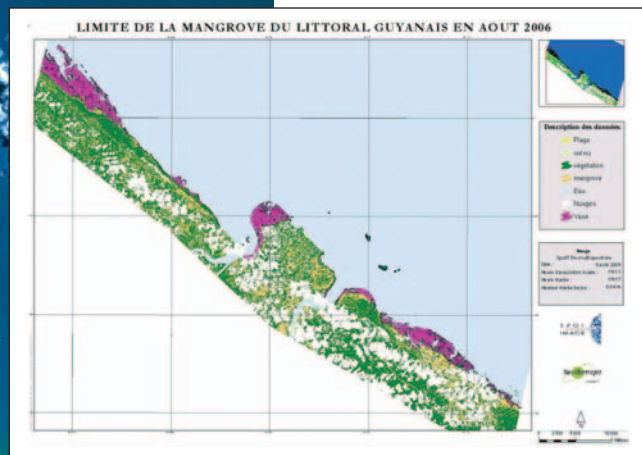
The shoreline study is pursuing a dual objective. First, it is seeking to provide French Guiana's naval and naval aviation command (COMAR) with an

NEV@NTROPIC OPTIMIZES SATELLITE IMAGERY

■ Nevantropic is an innovative young company based in French Guiana. It operates the SEAS satellite receiving station and provides environmental Web-based services. Specialized in extracting information using remote sensing, Nevantropic develops and exploits information services from data received at the station for environmental protection, resource management, defence and fundamental research. These Web-based services operate in real time and meet OGC international geospatial standards.



Shoreline map compiled from SPOT 5 imagery



Source Nevantropic

ANALYSIS OF MUDBANK INTERTIDAL ZONE
9 August 2006

Local acquisition time: 11.13 a.m.
Local low tide: 11.37 a.m.

accurate map of the shoreline to aid coastal navigation and make it easier to reach river mouths and estuaries sometimes hidden by vegetation. Satellite image-based maps of the coastline will assist COMAR field personnel in their duties. Second, the study intends to define a reproducible methodology for monitoring coastal change. Many public agencies and authorities need effective and reliable decision-support tools to assess risks to human activities posed by silting or erosion. Consequently, the ultimate objective of this project is to generate a map of the coastline, updated every six months from SPOT 5 data. The ability to identify coastal features by segmentation and to characterize the shoreline will yield vital data for managing, protecting and monitoring French Guiana's coast. Public agencies and local authorities have pinpointed more effective coastal management as a key issue, driven by growing pressure on urban and peri-urban areas and the need to protect important

industrial zones like the Guiana Space Centre, the Mana ricefields or economic hubs like the commercial ports of Cayenne and Kourou.

Successful study shows promise

Stretching for more than 300 kilometres from the Oyapock in the east to the Maroni in the west, French

Guiana's coastline is mostly low lying, swampy, bordered by mangrove forest along its sea front and indented by wide estuaries. Satellite imagery was used to study one-fifth of this coastline—roughly 60 kilometres—because of its very strong coastal dynamics.



SCIENTISTS TEAM TOGETHER

- Emmanuel Prost has worked with some highly expert teams like the ESPACE environmental expertise and spatial information unit. This unit comprises scientists and technicians from France's IRD development research institute and other agencies, and is pursuing two lines of research—in Earth observation and integrated approaches to environments and societies—to refine and develop operational spatial analysis methods. Emmanuel Prost has also worked with the EPOC joint research unit operated by the University of Bordeaux 1 and the French national scientific research centre CNRS. EPOC's main mission covers international fundamental research in coastal oceanography, paleoclimatology and the continental-ocean interface. CNRS researcher Jean-Marie Froidefond, an expert in optical remote sensing, provided in-situ signatures of different soil types in French Guiana that he knows well.

COASTAL CHANGE BETWEEN 2003 AND 2006 IS CLEARLY HIGHLIGHTED BY SATELLITE IMAGERY.



► Remire beach 2003



► Remire beach 2006

Shifting of sandbanks westward threatens turtles for which Remire beach is a globally important nesting site.



► Cayenne mudbank 2003



► Cayenne mudbank 2006



Without getting into detail, the study looked at a test region covering Mana, Kourou, Sinnamary and Cayenne, using archive data between 2003 and 2007. Six SPOT 5 scenes were thresholded, classified and vectorized using ENVI 4.3 and ERDAS IMAGINE 9.1 image processing software and an ArcGis 8.3 geographic information system. Most effort focused on interpreting SPOT 5 satellite data, matching spectral signatures with image segments, analysing coastal morphology and dynamics, and generating finely detailed maps.

This work confirmed certain assumptions like the movement of mudbanks—in fact, we now know they move as much as 1.5 kilometres per year. Sandy beaches were also closely

studied. Some of these beaches are nesting sites for leatherback turtle, the largest living sea turtle, and oliveback loggerhead turtle, one of the smallest. Gaining a clearer picture of how the shoreline is changing also helps to better organize and plan protection of these threatened species. What this project has achieved is to reaffirm the value of remote sensing for studying a coastline as complex as French Guiana's. Matching parameters of features in the intertidal zone to spectral parameters in satellite imagery yields good-quality maps with rich content. But given the region's frequent cloud cover and especially active coastal dynamics, maps will almost certainly have to be updated every six months. The study results have been presented

on several occasions in French Guiana, attracting keen interest. Indeed, the methodology could be employed within the framework of PROCLAM², in particular by Brazilian researchers looking for an effective tool to map the shores of the Amazon River. It looks like the use of satellite imagery for coastal monitoring has only just begun. ■

2) *Programme de Cartographie des Littoraux Amazoniens - Amazon coastal mapping programme*

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