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FROM SATELLITE IMAGE TO MARINE SPATIOCHART AT SHOM

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BACKGROUND AND OBJECTIVES

To fulfil its missions regarding navigational safety and expertise in marine environment, the French national hydrographic service (SHOM) developed a rigorous image processing to produce digital marine "spatiocharts" that depict the coastal topography, the seabed nature and bathymetry of shallow waters.

Qualified digital spatiocharts for cartographic and GIS systems

The SHOM's digital spatiochart is a database (on dvd-rom) made of vectorial and raster cartographic layers. All cartographic and GIS systems can read those digital spatiocharts.

A rigorous process and strong experience at SHOM

The production of a marine spatiochart from calculations on satellite images is a complex process, requiring strong qualified knowledge in remote sensing, image processing, geodesy, cartography and hydrography. Since 1986, SHOM carried out research, developed its rigorous process, improved its tools and skills.

APPROACH & METHODS

Images acquisition (step 1)

The remote-sensing images used by SHOM are from diverse satellites whose different characteristics cover all the needs in coastal mapping.

Spatiopreparation (step 2)

SHOM surveys a "spatiopreparation" on the field to provide geodetic and bathymetric measurements to calibrate its image processings.

Geometric rectification (step 3)

SHOM uses the orbitographic parameters (provided by the satellite) and the geodetic field measurements to modelize and rectify the distortions of the raw image.

Pre-processing (step 4)

To check the quality of the images and characteristics of detected "objects" some image processes are run :

Building Masks (step 5)

Masks are extracted from the pre-processing results : land area, inter-tidal area, clouds and their shadows.

Calculating the model of bathymetry (step 6)

To modelize depth from a satellite image, at least some sunlight must be reaching the bottom and then being reflected back trough the water towards the satellite. Water absorbs light, such absorption increasing with the wavelength until the light is almost totally absorbed in the near-infrared (NIR). So to extract depth contours several wavelength are useful, with visible Blue going deepest, visible Green less deep, visible Red less deep and NIR not deep at all.

SHOM uses the visible Green and Red bands of SPOT satellite.

Bathymetry is calculated in clear shallow waters, and off the cloudy mask. The model used at SHOM is based on Lyzenga model:

$Z = A * \ln(R1 - R1inf) + B * \ln(R2 - R2inf) + C$

where :

Z	The calculated depth of the pixel ;
R1, R2	The radiometry of the pixel in the visible Green and Red bands ;
R1inf, R2inf	The radiometry, in the visible Green and Red bands, over a deep-water zone (where the radiometry is free from bottom effects) ;
A, B, C	The calibration coefficients of the model. Sixty or more sounding

measurements allow accurate calculation of these coefficients and thus calibration of the model from “ground truth”.

RESULTS

Quality of the model to map bathymetry

The quality of the model depends on the clearness, homogeneity and reflectivity of the water and the bottom surface. The experiments at the remote sensing department of SHOM show that :

• The model is quite good till 15 m then it regularly worsens till 20 or 25 m. Beyond, the reflected light is too weak to be processed ;

• The model is coherent on flat and moderate slope bottom. The quality decreases on strong slope and coral pinnacles (because this slope does not reflect correctly the light towards the satellite, and the absorption by coral) ; Those pinnacles being dangerous for safety of navigation, SHOM enlarges and heightens them on spatiocharts ;

• In turbid area, the bathymetric model is wrong (for instance, in atoll passes, the currents generate turbidity that disturbs the calculation of bathymetric model) ;

• Over a homogeneous atoll, such as Ouvea in New Caledonia, the relative error is lower than 10% for depth between [5-20] metres but increases for depth between [0-5] metres. This increase is due to the slope, to correlation of the visible Green band with the Red one and to a more heterogeneous feature bottom.

Building of the digital spatiochart and quality control (step 7)

All image processing results are vectorized and merged as a thematic map, the digital spatiochart, in a GIS system. All the objects of each layer are controlled and qualified. This new map is ready to be read by the client/user in his system with his own information layers. At SHOM, the cartographic department uses digital spatiocharts to improve quality of existing nautical charts or to publish new ones.

CONCLUSION AND FUTURE PLANS

A new era for cartography ... digital spatiocharts in GIS systems

The processing of satellite images in area of clear water provides an efficient and relatively inexpensive method of completing a partial or old chart. It is helpful information in huge areas where the data is scarce and expensive to collect.

Despite its limits, the bathymetric model allows SHOM to map the geomorphology of the clear shallow waters by discovering new dangers. SHOM digital marine spatiochart shows numerous cartographic informations about coastal topography and underwater dangers (for the safety of navigation), positioning them with an absolute planimetric accuracy better than 20 m. The new developing techniques in remote sensing combined with the huge possibilities of GIS system open the digital updating cartography world. In this context, the SHOM digital marine spatiochart is a useful decision aide tool for all the littoral managers.

The poster will explain the process to build SHOM digital marine spatiochart.