

IN EARLY 2008, TAHAL CONSULTING ENGINEERS LTD. OF TEL AVIV, ISRAEL, BEGAN PREPARING THE NATIONAL MASTER PLAN FOR ANGOLA'S COASTAL ZONE FOR THE GOVERNMENT OF ANGOLA. THE OVERALL OBJECTIVE OF THE UNDERTAKING WAS TO ESTABLISH A COMPREHENSIVE, SUSTAINABLE PLAN FOR THE COUNTRY'S COASTAL STRIP, TAKING INTO ACCOUNT BOTH DEVELOPMENT NEEDS AND THE IMPORTANCE OF CONSERVING NATURAL RESOURCES AND TRADITIONAL ACTIVITIES FOR THE BENEFIT OF PRESENT AND FUTURE GENERATIONS.

A national master plan for Angola's

Motivation for current land-use mapping

The planning products include proposals for regulating uses and activities in the coastal region, optimal scatter of residential areas and population, urban renewal and expansion, establishment of a transport system along the coast, and judicious distribution of recreational and tourist activities. Development is also oriented toward preserving natural resources, conserving rare species and ecological corridors, preventing or reducing nuisances, and maintaining quality of life for residents along the coast.

With its rich natural resources and breathtaking landscapes, Angola is considered one of the most beautiful countries on the African continent. Along its shores lie a dozen towns, interspersed with tens of smaller townships and villages. Today, more than half of the country's population is concentrated along the seashore and migration towards the coastal areas, which began during the war years, is a continuing trend—a fact that explains the somewhat chaotic settlement pattern.

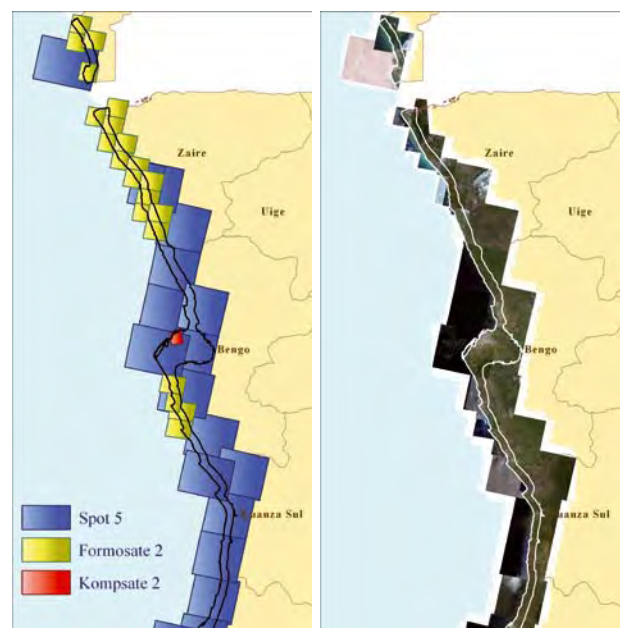
Although signs of increased development are seen in all walks of life, the field of mapping and spatial quantification required to constantly update information on the status quo is still in its infancy. Since knowledge of the present situation is of the utmost importance for planning future changes, TAHAL has completed mapping assignments for the coastal zone master plan on budget and to a tight schedule.

A land-use map of the project area has been prepared. This map includes a description of both natural and man-made land cover, as well as an outline of the data-collection methodology and map compilation tools. The current land-use map serves as the main planning tool and a benchmark for future changes.

The coastline area

Angola's coastline stretches for about 1,980 kilometres (including the northern Cabinda District) from the Congolese border in the north to the Namibian border in the south. Determination of mapping boundaries with respect to both the existing situation and the proposed programme was influenced by physical, administrative, economic and social considerations.

SPOT imagery coverage of Angola's coastal strip





ANGOLA



Angola was a Portuguese colony until 1974. Since receiving independence, the country has witnessed a number of upheavals, including a brutal civil war that lasted until 2002. Signs of the war are still evident in the population, the infrastructure and the economy. Now, however, Angola is undergoing a process of reconciliation, unification and healing, and it currently stands at the threshold of a period of accelerated development.

COASTAL ZONE

The project area for planning purposes was defined as a 10.5-km-wide strip along the entire coastline—extending 10 km inland and 500 metres out to sea—for a total mapping area of 20,300 sq.km.

Land cover in the area of interest varies from dunes in the south to wetlands in the north, urban areas to small rural villages, exposed bedrock to dense woods, and agricultural fields to deserted lands.

Selecting mapping sources

Satellite images covering the coastal zone of Angola over a distance of at least 10 km inland from the coastline to the east and 500 metres into the sea to the west were purchased from Spot Image through PAIMEX Israel. Throughout most of the coastal strip the imagery actually covered a much larger area (up to 20-30 km from the coastline), serving as a suitable background for the planning area.

Although satellite imagery was the principal source of information for the purposes of the study, other sources were also used, such as ESRI World Data, the FAO database, old local maps, U.S. NGA marine charts, field survey data and diagonal aerial photos.

To meet planning needs and with a view to analysing the existing situation, a comprehensive search was conducted of available images to identify those suitable for the project. Images were selected with great care to ensure the required currency, resolution, coverage of the project area—the coastal strip and hinterland—cloud cover (0-10%) and lack of haze. Multispectral images were processed to give natural colours. All images were dated no earlier than 2007-2008.

TAHAL requested that the satellite images be supplied as orthophotos in GeoTIFF format and adapted to 1:50 000-scale mapping (not less than 2.5-metre pixel resolution).

The search found that more than 70% of the project area was covered by SPOT 5 archive imagery. SPOT 5's 2.5-metre resolution was well suited to manual analysis up to a scale of 1:7 500, allowing emphasis of geomorphological features as well as urban land-use patterns and categories, such as residential, public and industrial buildings, airports and open areas—crop land, natural woods and forests, and sand and rock cover. Natural and man-made features such as roads, railways and rivers can also be mapped at this resolution.

Given the tight schedule and the fact that no image cover was available for 30% of the project area, the Taiwanese FORMOSAT-2 satellite (2-metre pixel size) was tasked with the assistance of Spot Image. FORMOSAT-2 is the only high-resolution satellite with a daily revisit capability.

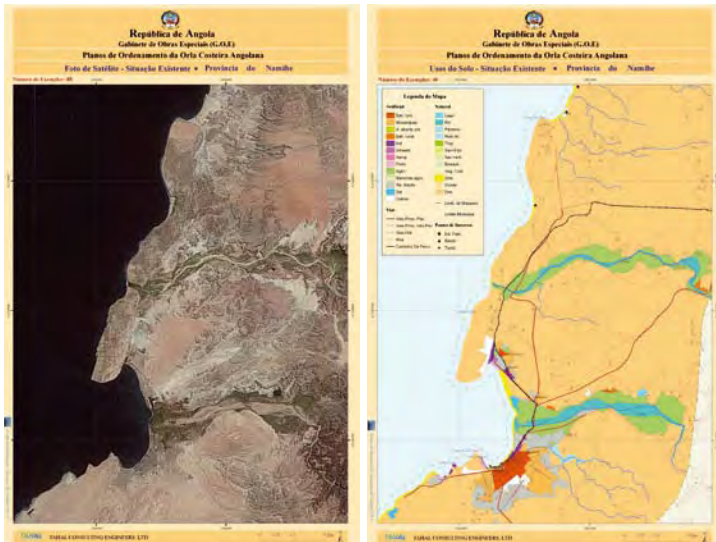
The complex urban patterns in the capital city of Luanda called for acquisition of Korean KOMPSAT-2 satellite imagery with a 1-metre pixel size for a larger mapping scale of 1:5 000.

SPOT imagery metadata in the project GIS database

Properties of selected metadata	
Product	SPOT 5
Number	000007
Acquisition date	2007-02-02
Acquisition time	00:25:47
Gain	2148
Cloud cover (%)	0.000000
Scene corner setting	00000000
Angle of satellite	90.000
Depth of scan along the track	50.000

Geographic coordinates of scene	
Latitude of center	-8.237
Longitude of center	12.887
Latitude of SW corner	-8.237
Longitude of SW corner	12.887
Latitude of NE corner	-8.237
Longitude of NE corner	12.887
Latitude of SE corner	-8.237
Longitude of SE corner	12.887





ANGOLA COASTAL ATLAS
SPOT imagery next to land-use analysis
10/11/2009

tries, agriculture, roads, etc.) as well as natural cover (tropical vegetation, rivers, sandy beaches, savannas, sand dunes, exposed rocks, etc.). Altogether, more than 20 significant surface cover types were identified and presented as land-use categories, as exemplified below.

Angola coastal atlas

The mapping products were published in the form of an atlas of Angola's coastal zone, showing the raw satellite image next to the interpreted surface as a land-use map. Diagonal aerial photos were linked to the 2D images to obtain more visual aspects of points of interest along the coastline. ■

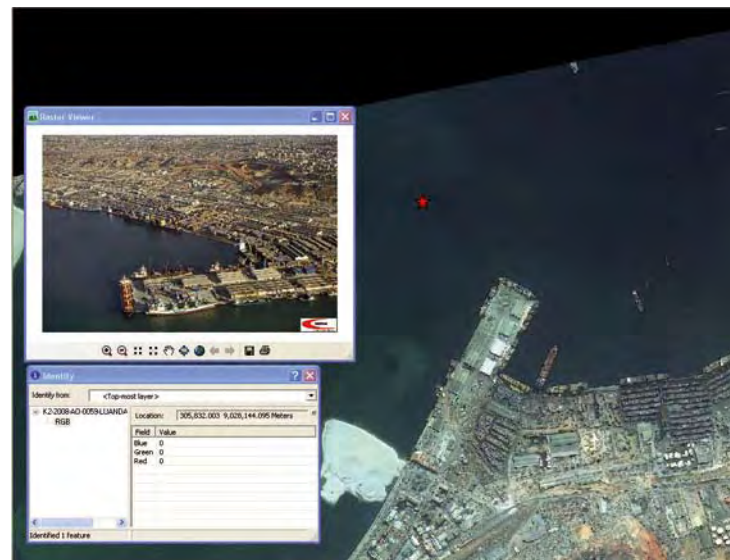
- ▶ To facilitate ongoing work by the different teams, all the available images were stitched into a mosaic using ERDAS software to form a single continuous file. Images were managed according to polygonal information layers, with a metadata bank documented for each image, including information such as year and month in which the image was taken, resolution and ID number at Spot Image.

Software and methodology

Spatial mapping and analysis were done on an ESRI platform with ArcGIS 9.2 software, which supports progressive data management, spatial querying, statistical calculations, performance of intersections between layers and high-quality visualization.

TAHAL's professional team engaged in land-use manual analysis included experts in urban planning, transportation, architecture, geology, geomorphology and sociology, as well as GIS specialists who processed the data.

The mapping methodology incorporated technology, planning concepts and disciplines. Surface analysis based on satellite images included many aspects of anthropogenic activities and facilities (urban and rural built-up areas, indus-



Diagonal aerial photos geolinked to SPOT imagery

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LAND-USE MANUAL ANALYSIS CATEGORIES

