EVALUATION OF THE GEOGRAPHIC INFORMATION POTENTIAL
OF SPOT5 IMAGES

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ABSTRACT:

The objective of this thematic study is to evaluate the potential of SPOT5 images various modes for the extraction of planimetric features. Two kinds of analyses have been carried on. The first analysis deals with updating and/or checking of existing maps or databases in developed countries, typically IGN France products such as BDTopo® and BDOrtho® (IGN).

The second analysis deals with updating or producing base maps or databases in developing countries, 1: 50,000 topographic maps being typically targeted over the vast sparsely populated areas around the world.

Two test sites have been selected. First test site is the town of Pamiers, located in the south-west of France. Second test site is Ouagadougou, capital of Burkina Faso. A side product of this second study is a 1 :20,000 scale image map produced over the whole city.

The suitability of HRG acquisition modes has been analysed for the above mentioned mapping requirements, in terms of scale and type of landscape : urban, suburban or rural. Of course, 2.5m Colour images show the best cartographic potential, but 2.5m Black & White or 5m colour images may turn out to be sufficient for some cartographic applications, especially in sparsely populated areas.

Moreover, stereoscopic interpretation using 2.5m stereo pairs in urban areas still brings further information.

SPOT 5 clearly appears as a wonderful tool for mapping purposes, allowing the production of Geographic Information with a content and a geometric accuracy that are compliant with 1: 25,000 topomap standards. Hundred thousand Sqkm can be covered within short time delays and at a reasonable price per square kilometre, when compared with metric satellites.

1. OBJECTIVE

The objective of this study is to evaluate the potential of SPOT5 in its various image modes, for the extraction of planimetric features in the following contexts:

- Updating and/or checking existing maps or databases in developed countries, typically IGN France products such as BD Topo®, the topographic database, and BD Ortho®, the orthophoto database sampled at 0.5 m.
- Updating or producing base maps or cartographic databases in developing countries, 1:50,000 topographic maps being typically targeted over the vast sparsely populated areas around the world.

For a description of Spot 5 mission see (Fratter 2001) and for in-flight commissioning results, dedicated to location model calibration, see (Bouillon 2003).

2. TEST SITES AND DATA SETS

2.1 Datasets

2.1.1 Pamiers dataset

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<th>HMX</th>
<th>HM</th>
<th>HI</th>
<th>HRS</th>
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<td>1° 7°</td>
<td>1° 7°</td>
<td>23° 28°</td>
<td>1° 7°</td>
</tr>
</tbody>
</table>

Table 1 – Images interpreted for Pamiers

Pamiers is a small town located in the south-west of France. The study area is 170 km2 wide (Fig 1). Several SPOT5 images have been acquired in June 2002, as synthesised in Table 1. IGN reference products are available in both vector and raster format : BD Topo® and BD Ortho®.

Figure 1 : Pamiers area

2.1.2 Ouagadougou dataset

Images covering the whole 300 km² urban area of Ouagadougou were acquired on July 9th, 2002. Panchromatic images sampled at 2.5m and 5 m as well as multispectral 10m SPOT5 images were available. A pan sharpened THX images has been processed.

Previous work using simulated image had been conducted. It stands as a reference.
2.2 Image pre-processing

Whatever the area and the image, preprocessing common to all images included:
- Geometric modelization and orthorectification using best available DTM.
- Image enhancement: global stretching and filtering

Optional preprocessing consists of:
- Pan sharpening: merging of Panchromatic and Multispectral modes (HM+HX or THR+HX)
- Pseudo-natural colours transformation of 2.5m resolution pan-sharpened images.

3. QUANTITATIVE ANALYSIS ON PAMIERS SITE

3.1 Methodology

The following linear features were interpreted, grouped by layer and subject to length calculation:
- Primary road network: motorways and national roads.
- Secondary road network
- Tracks and paths
- Railroads
- Primary hydrographic network: width > 7m and surfaced objects.
- Secondary hydrographic network

Other interpretation features have been taken into account, such as stations, tollgates, stadiums, cemeteries, golf, significant or isolated buildings, cisterns, water towers... They didn't lead to any quantitative evaluation.

All images have been submitted to two photo-interpreters. They both work with the same drawing software and carried visual interpretations in monoscopy. The images have been interpreted in the following order:
- HRS images 5m square re-sampled images
- HX images: 10m multispectral without SWIR
- HM images: 5m panchro image
- HMX: 5m Pan sharpened image, HM & HX
- THR images: 2.5m panchro image
- THX: 2.5m pan sharpened image, THR & HX

The BD Ortho® reference provides aerial orthophoto sampled at 0.5 m. Aerial images have been interpreted in the same way.

One interpretation per image mode and per interpreter has been generated, comparing, if necessary, multitemporal images of the same type. All interpretations have been done using the same drawing software.

3.2 Results

The cumulated lengths in the reference and on the study area, for each layer are:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Reference Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary road network</td>
<td>24.5 km</td>
</tr>
<tr>
<td>Secondary road network</td>
<td>343.0 km</td>
</tr>
<tr>
<td>Primary hydrographic network</td>
<td>22.1 km</td>
</tr>
<tr>
<td>Secondary hydrographic network</td>
<td>345.7 km</td>
</tr>
<tr>
<td>Railroads</td>
<td>11.7 km</td>
</tr>
<tr>
<td>Tracks, path</td>
<td>299.6 km</td>
</tr>
</tbody>
</table>

Table 2: Interpreted features cumulative length

Quantitative comparison of linear features detected, with IGN Topographic database reference data, BD Topo®, has been performed after averaging the results obtained by the two interpreters.

The following quality statistics were determined and are presented below. Note that for readability purpose:
- Y axis scale is optimised for each graph.
- Data which values are close to 0 for each mode are not represented.

For each layer, quality criteria according to the interpretation are defined as follow (total = 100%):
- Recognized objects: number of objects correctly interpreted compared to number of objects interpreted in the layer (Fig 3).
- Over-detection: Objects without existence in the reference: they are missing in the reference (Fig 4).
- Confusion: objects wrongly interpreted; they belong to another layer of the reference (Fig 5).
Quality criteria according to the reference data and for each layer are defined as follow (total = 100%):

- Recognized objects: objects interpreted in the corresponding layer compared to the number of objects in the reference; it measures the interpretation exhaustiveness (Fig 6)
- Missing objects: omission errors, forgotten objects (Fig 7)
- Objects wrongly interpreted: belonging to another layer (Fig 8).

Statistics results by layer show:
- A correct interpretation of the primary road and hydrographic networks, as well as the railways;
- For urban mapping, the 2.5 m image is mandatory for network interpretation;
- Colour images are needed for optimal interpretation of built-up areas, mainly because of the red colour of the roofs in this region;
- 5 m pan sharpened: some omissions, but interpreted individual houses are all correctly positioned;
- 2.5 m B/W, fewer missing objects, but some well-interpreted houses are displaced.
- Colour « Modes » are better than B&W for hydrographic features and especially surface water.
- Whatever the mode, secondary hydrographic features, tracks and paths are difficult to assess. We encounter omissions, over-detections, confusions. We noticed that such features are also difficult to assess on orthophotos sampled at 0.5m.

Finally, the viewing angle seems widely irrelevant.
4. QUANTITATIVE ANALYSIS ON OUAGADOUGOU SITE

On Ouagadougou, a qualitative comparison of the different modes has been performed on 10, 5 and 2.5m colour images as well as 5 and 2.5m panchromatic images.

All the networks, road, hydrographic and railroad, have been interpreted on a 2.5m pan sharpened orthoimage, using existing old 1:50,000 topomaps as a reference. An image map at scale 1:20,000 has been achieved over the whole city, in cooperation with the Burkina Survey Dept (IGB) for data verification on the ground and for toponymy. This spacemap has been produced in 3 versions, with different image background : 2.5m panchro [Fig 10], 2.5m in false colours [Fig 11], 2.5m in pseudo-natural colours.

Main qualitative results are :

- 2.5m is required in urban areas for :
  - discrimination of housing patterns, especially in the suburbs.
  - fine networks interpretation

- A colour mode is mandatory for :
  - discrimination of tracks and paved roads
  - interpretation of vegetation and hydrography

5. CONCLUSIONS

Of course, 2.5m Colour images show the best cartographic potential, but 2.5m Black & White or 5m colour images may turn to be sufficient for some cartographic applications, especially in sparsely populated areas.

Moreover, stereoscopic interpretation, under investigation at the moment, using 2.5m stereo pairs in urban areas still brings further information.

SPOT 5 clearly appears as an excellent tool for mapping purposes, allowing the production of Geographic Information with a content and a geometric accuracy that are compliant with 1: 25,000 topomap standards. Hundred thousand Sqkm can be covered within short time delays and at a reasonable price per Sqkm, when compared with the actual capabilities and costs of metric satellite images.

6. REFERENCES


Breton E. Pre-flight and In-flight Calibration of SPOT 5 HRG and HRS Cameras. Proceedings of ISPRS Commission 1 Mid-Term Symposium, Denver, CO, November 10-15, 2002