

# SPOT 5 APPLICATION VALORISATION PROGRAM CONCLUSIONS

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**KEY WORDS:** Performance, Application, Interpretation, Quality, User, Value-added, Decision support, Accuracy, Geometric

**ABSTRACT:** The SPOT program has been in operation for fifteen years, and is guaranteed to continue with the successful launch and commissioning of SPOT 5 satellite in 2002. The data provided have successfully met all the quality standards required.

Thanks to its improved 5-metre and 2.5-metre resolution and wide imaging swath covering 60 km by 60 km or 60 km by 120 km in twin-instrument mode, SPOT 5 holds the ideal balance between high resolution and wide-area coverage. It enlarges quite extensively the scope of potential applications to be addressed by the SPOT constellation.

CNES and Spot Image have launched in 2003 the SPOT 5 Application Valorisation Program (SAVP), aiming at testing and performing evaluation studies of the SPOT 5 data by a limited number of key users worldwide for operational applications.

CNES and Spot Image propose a synthesis of the main results of SAVP studies: medium-scale topographic mapping in Philippines, cadastral mapping in Guatemala, land-use mapping for urban planning in Spain, improvement of census cartography in South Africa, geological hazard identification and risk assessment for humanitarian aid in Nicaragua, boreal forest resources monitoring in Sweden, agri-environmental measures control in Germany, three-dimension visualisation products for flight simulation in France.

Finally, CNES and Spot Image make a statement of the performance of SPOT 5 imagery for the generation of the value-added products, in terms of geometric accuracy and quality of the derived information.

## 1. INTRODUCTION

The SPOT 5 satellite was successfully launched by the Ariane 42P rocket on May 4<sup>th</sup>, 2002. The commissioning of this new sensor was pronounced on July 12<sup>th</sup>, 2002 and the data provided since the launch has successfully met all the quality standards required.

With SPOT 5, CNES and Spot Image offer to the world-wide user community a unique tool. The unrivaled imaging capability of the SPOT satellite series is now combined to the Very High ground resolution to allow the coverage of very large geographic areas, in a short period of time, with very high resolution/large scale imagery. Thanks to its improved 2.5-metre and 5-metre resolution and wide imaging swath covering 60 km by 60 km or 60 km by 120 km in twin-instrument mode, SPOT 5 enlarges quite extensively the scope of potential applications to be addressed by the SPOT satellites.

In addition to several initiatives conducted to evaluate the quality and information content of SPOT 5 imagery, CNES and Spot Image have decided to confirm the potential of SPOT 5 for applications through the SPOT 5 Application Valorization Program (SAVP).

This program aimed at providing, to a very limited number of selected key users world-wide, the possibility to test and evaluate the SPOT data for operational applications. The Principal Investigators were limited to a number of eight worldwide, representative of the key SPOT 5 applications and of various geographic conditions. They all had a sound expertise in remote sensing, specifically in SPOT 1-4 imagery. The PI selected have had access to a free SPOT 5 data set on a site of their choice. They had to commit themselves to perform an evaluation study of this data set for their operational application.

## 2. DESCRIPTION OF SPOT 5 APPLICATION VALORIZATION PROGRAM

During the SPOT 5 in orbit performance assessment in 2002, a number of thematic evaluations were performed using the very first SPOT 5 images. They demonstrated that enhanced resolution (2.5 m) combined to 60x60 km<sup>2</sup> coverage, multispectral information (including SWIR channel), and HRS Digital Elevation Model constitute a significant advance from thematic point of view.

All these technical characteristics render the SPOT system particularly well suited for applications requiring geographical information at medium-scale (1:25,000) such as cartography, urban planning, natural disasters prevention, forestry.

### 2.1 Selected applications and teams

The SAVP was designed to go further into the applications benefiting particularly from SPOT 5 enhancements.

The first SAVP domain is obviously *Cartography and Land Use/Land Cover mapping*.

Results of in-orbit performance evaluation showed that SPOT 5 2,5m color products are well suitable for generating or updating medium-scale cartographic databases, or for generating topographic maps at scales of 1:50,000 up or 1:25,000. Other related applications are LU/LC maps providing information on peri-urban areas at scale 1:10,000. Such information is of great interest for urban planning, monitoring of urban/rural fringe of large cities, updating of census maps, etc. Four SAVP studies have been selected in this thematic domain:

1. Topographic mapping at scale 1:25,000; study performed by PASCO corporation (Japan) on Manila site (Philippines)
2. Cadastral mapping; study performed by UTJ-PROTIERRA (Guatemala) on Izabal site (Guatemala)
3. Urban sprawl monitoring for urban planning; study performed by Universitat politecnica de Catalunya (Spain) on Barcelona site (Spain)

4. Improvement of census cartography; study performed by GeoTerraImage (South Africa) on Pretoria site (South Africa)

The second SAVP domain is related to *Natural Disaster Management*.

Earth Observation is more and more frequently used through the International Charter "Space and Major Disasters". Improved SPOT 5 resolution is the key element improving significantly satellite images capability to provide civil security with useful information. One SAVP study is dedicated to this topic :

5. Geological hazard identification and risk assessment for humanitarian aid; study performed by UNOPS/UNOSAT (Switzerland) on Matagalpa site (Nicaragua)

The third SAVP domain addresses *Renewable Resources (Agriculture and Forestry)*.

In such a large domain, *Forestry* is definitely the one that highly benefits from 2.5 m resolution combined to multispectral information. Indeed, previous SPOT images at 20 and 10 m resolution were already used for mapping and monitoring forest cuttings, but could not be used for precise forest management. In *Agriculture*, benefits linked to resolution improvement are obvious for crop monitoring in smaller parcels, and for very specific topics such as control of European aids related to crop surfaces, trees counting, or any linear units. Two SAVP studies have been selected for this domain :

6. Boreal forest monitoring; study performed by Metria Miljöanalys (Sweden) on Nässjö site (Sweden)
7. Agri-environmental measures control; study performed by the JRC Ispra (Italy) on the Baden-Württemberg Zwie site (Germany)

The last SAVP domain addresses *Three-Dimensional Visualisation*. This domain of higher interest both for civilian and defence applications, and exploits the full range of SPOT 5 products : 2.5 m imagery and HRS DEM.

One SAVP study has been selected for addressing this new way of visualising satellite images:

8. Three-dimension visualisation products for landing approach simulation; study performed by the French Air Force on Toulouse-Francazal site (France).

## 2.2 Technical objectives

Technical objectives aimed at by SAVP partners can be split into two main orientations: exploitation of images through visual expertise and automatic (or semi-automatic) processing techniques improvement.

The majority of SAVP partners uses mainly human interpretation for extracting information from satellite images. Their objective in the framework of SAVP was to assess the information content of SPOT 5 as compared to previous SPOT and/or to metric aerial photography, and to assess which enhancement filters may help experts to analyse the images.

A smaller number of SAVP partners are interested in automatic or semi-automatic processing, in order to be able to process quickly and self-consistently a whole SPOT image, guaranteeing that the same methodology was used on every pixel.

Of course, several partners combine both approaches (visual interpretation and automatic processing), and have performed tests and evaluations in the two areas.

## 2.3 SPOT 5 products acquisition and production

Nearly 30 SPOT 5 products were tested through the SAVP. Most of the investigators got a multi-resolution SPOT 5 dataset including the 10 m colour, the 5 m black and white (B&W) resolution and the 2.5 m B&W resolution products.

The 2.5 m colour resolution product was produced and tested in the frame of six investigations upon the eight ones, demonstrating a great interest of the users for this new product for many applications.

All SPOT 5 products were acquired through normal priority programming services.

Some difficulties due to meteorological conditions combined with the schedule of realisation of the SAVP were encountered in two areas above the eight ones.

In northern Europe in the winter season, no SPOT 5 image was available because of bad weather conditions for the agricultural test in Baden-Württemberg area.

In the case of Guatemala, the area was very difficult to cover, and the radiometric quality of the resulting image was medium because of the presence of clouds and haze. The programming of a SPOT 5 stereopair was unsuccessful for the coverage of the sub-areas of interest, due to the presence of clouds. A Digital Elevation Model extracted from SRTM sources was finally used for the orthorectification.

On the contrary, in Manila, Philippines, a SPOT-5 2.5 m resolution stereopair was finally acquired in October 2003 despite of difficult meteorological conditions.

A similar satisfying result was also obtained in Nicaragua despite of unfavourable meteorological conditions.

## 3. RESULTS AND PERFORMANCES OF SPOT 5

### 3.1 Cartography, Cadastre, Land Use/Land Cover mapping

Thanks to the DORIS instrument, which allows to locate the spacecraft very precisely on its orbit, the absolute location accuracy of SPOT 5 images is better than 50 m RMS, without any ground control point.

The absolute location accuracy of SPOT 5 orthoimages, rectified on the basis of the digital elevation model issued from the SPOT 5 High Resolution Stereoscopic (HRS) instrument, is 15 m RMS in planimetry without any ground control point.

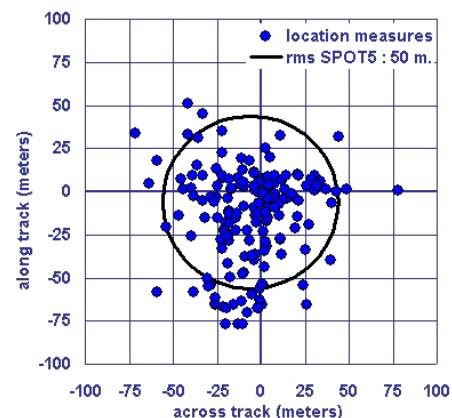


Fig. 1 : SPOT 5 location performances without any ground control point - 2002

### 3.1.1 Cartography

It has been largely proved through SAVP investigations the geometric quality of SPOT 5 2.5 m resolution products is consistent with international 1:25,000 scale cartographic and topographic mapping standards.

The investigation conducted by PASCO clearly demonstrates that horizontal accuracy and vertical accuracy of the well-controlled 2.5 resolution panchromatic SPOT 5 imagery by space triangulation are enough to create or update the 1:25,000-scale topographic maps by three-dimensional plotting or ortho images (Kakiuchi, H., Onaka, M., Asai, M., and Itoh, F., 2004). In this case, interpretation availability of the SPOT 5 imagery was also sufficiently high for the 1:25,000 level maps. However it is a little difficult to interpret some features like narrow roads, single rivers, vegetation, etc. by only the SPOT 5 imagery. Therefore, the field identification is needed as well as for the plotting by the aerial photographs.

Other thematic studies have confirmed the potential of the various SPOT 5 imaging modes for the extraction of planimetric features, according to mapping requirements of developed and developing countries.

In the years 2002 and 2003, it was shown by the Kingdom Center of Remote Sensing (CRTS) in cooperation with Spot Image, an also by the National Bureau of Surveying and Mapping of China through a test in the Sichuan province, that the geometric accuracy of SPOT 5 HRG images is even consistent with the geometry of the standard 1:10,000 scale topomaps. The National Bureau of Surveying and Mapping of China is one of the main SPOT 5 data consumers worldwide.

The suitability of SPOT 5 HRG images was analysed in France and in Burkina Faso, in view to generate or update medium-scale topomaps (Lasselín, D., Sempere, J.P., and Cantou, J.Ph., 2003).

All studies lead to the conclusion that 2.5 m colour images show the best cartographic potential at 1:50,000 and 1:25,000 scales in terms of interpretation of features, but 2.5 m black-and-white or 5 m colour images may be sufficient for some cartographic applications, especially in sparsely populated areas. The use of SPOT 5 data increases the task of field work with respect to the use of aerial photos. Nevertheless, the cost-effectiveness of SPOT 5 data combined with field work has been proved.

### 3.1.2 Cadastre, parcel boundary interpretation and area estimation in rural areas

In Guatemala, the SAVP investigation by UTJ-PROTIERRA lead to the conclusion that SPOT 5 imagery brings a significant support to cartography where planning cadastral activities are prepared with outdated topographical maps (Corlazzoli, M., and Fernandez, O.L., 2004). Comparisons between data from total stations – GPS measurements and orthoimage identification for different types of parcels were evaluated. Good results were obtained for large and medium extensions, up to the 1:10,000 scale for the identification process of properties, although it presented its limits for identifying accurately small parcels, peri-urban and urban estates. SPOT 5 orthoimage is considered an interesting alternative input for indirect methodology for latifundium and medium estate with low topographical variation. However for small properties, urban cadastre and building identification, it was recommended to use traditional surveying methods.

Other tests of parcel boundary interpretation were implemented all over the world. One of them took place in Sweden in 2003, in the frame of Control with Remote Sensing (CwRS), as a component of the European Union's programme of Monitoring Agriculture by Remote Sensing (MARS-PAC). It was based on the comparison of the results of interpretation from airborne orthorectified images with 1m resolution and from SPOT 5 orthorectified images with 2.5-m resolution, by the same operator (Forsgren, J., 2003). The conclusion was that SPOT 5 data could be an option for the area estimation in most of the cases, as they seem to fulfill the requirements in the CwRS in Sweden. The advantages with SPOT 5 orthoimages are the cost and coverage aspects.

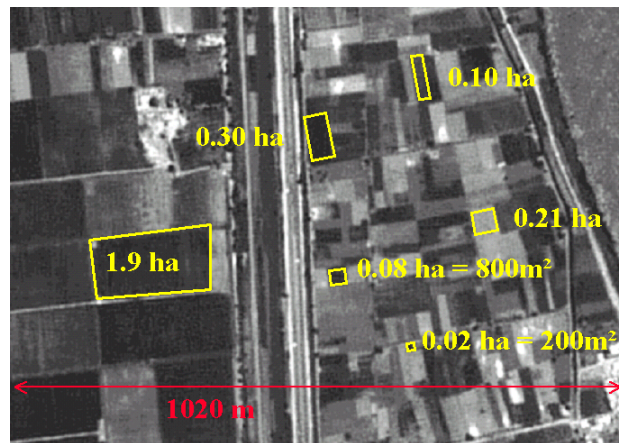


Fig. 2 : Example of identification of small parcels on a SPOT 5 2.5-m resolution panchromatic image in rural areas  
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### 3.1.3 Urban planning

UPC/CPSV addressed urban planning issue on Barcelona site (Roca, J., Burns, M. C., and Carreras, J. M., 2004). SPOT 5 images have been used for two main goals: identification and measurement of urban growth between 1995 and 2003 from a strictly morphological perspective, and assessment of SPOT 5 characteristics for urban planning activities from an operational perspective.

In order to guarantee self-consistent results on the whole area, a methodology based on automatic classification was developed, even if such processing produces results less detailed than visual analysis. It appeared that a big advantage of SPOT 5 data comes from its large coverage (60 x 60 km) which permits to cover the entire 495 km<sup>2</sup> of Metropolitan Area of Barcelona (MAB) in one time. Such precise, homogeneous and exhaustive geographical information is ideal for urban planning on a large metropolitan area.

In addition, the result of the visual assessment performed by urban planners showed that 2.5 m color SPOT 5 images contained a wealth of information, very easily accessible by simply superimposing the earlier and later images. It is possible to determine at a glance the areas where development pressures have been most strongly experienced (industrial redevelopment, new commercial developments, infrastructure improvement or investment).

This SAVP investigation on Barcelona example shows clearly the benefits of SPOT 5 imagery in the domain of town and country planning. This is consistent with the results of previous studies, conducted in the frame of in-orbit performance

evaluation by SCOT on Toulouse area, France (Galaup, M., and Dupuy, S., 2003) with a slightly different approach.

An automatic method was developed, taking full advantage of urban objects responses and spatial distribution. Processing steps have been conducted with eCognition, commercial software which follows an object-oriented concept and where it is possible to define rules between objects. This region-based method produces results more detailed than pixel-based classification used on Barcelona, but requires a very deep expertise both in e-Cognition utilisation and logical rules to be applied.

SPOT 5's improved resolution and spectral sensing capability make it possible to elaborate thematic information layers using automatic image processing methods, consistent with the needs of urban planners.

#### **3.1.4 Urban monitoring for population census**

The results of GeoTerraImage investigation show that SPOT 5 has an advantage for census applications compared to lower resolutions, especially when attempting to classify or quantify urban change (Ferreira, F., 2004).

Imagery was evaluated in the three following applications : urban change detection, urban structural classification and detail of imagery to allow counts of buildings.

All the mapping is based on visual interpretation and heads up digitizing of urban changes. Visual interpretation uses the human eye and brain to consider context, shape, proximity and texture to identify features on satellite imagery.

The classification of the change area according to the urban structural classes showed that medium resolution sensors such as Landsat are not adequate for this procedure. Although some structures could be recognised and identified from Landsat, it is not possible to classify all structures. SPOT 5 Colour (10m) and B&W (5m) could classify all the classes except the low cost housing, which is a class of dense, but very small houses. The SPOT 5 merge of Colour (10m) and B&W (5m), Colour (10m) merge with B&W (2.5m), and B&W (2,5m) could clearly classify all classes.

The final stage to perform building counts in order to quantify urban growth indicated that only SPOT Colour (10m) merged with B&W (2.5m) and B&W (2,5m) could distinguish buildings in all structural classes with confidence.

It is now possible to use only one set of imagery to perform three procedures, while previously it required two or three data sets and the same amount of workflow procedures. The subsequent reduction manpower and costs required for processing and mapping, creates strong advantages for Statistics South Africa. The possibility to acquire data on a closer date of acquisition to census date through programming services, and the uniform image coverage for areas where population are concentrated, are also strong assets for SPOT 5 imagery.

#### **3.2 Natural disasters management**

The investigation conducted by UNOSAT was made in close collaboration with the Laboratoire de Géologie de l'Ingénieur et de l'Environnement (GEOLEP) of the Swiss Federal Institute of Technology (EPFL) (Retière, A., Senegas, O., Parriaux, A., Haerberlin, Y., and Turberg, P., 2004). It aimed at testing the suitability and potential of SPOT-5 data in combination with digital elevation models (DEMs), topographic maps and a geological GIS database for the generation of vulnerability

maps related to landslides, mud flows and debris flows in the Matagalpa area, Nicaragua.

SPOT 5 imagery appeared to be an effective tool for the visual evaluation of landslides and to a lesser extent mud and debris flow. A false color 2.5 m SPOT-5 color image, best enhanced with a DEM, allows to delimit hazard areas at a scales consistent with the 1:25,000 scale up to the 1:10,000, and to create a comprehensive inventory map. Some parameters, such as the rate of vegetation disturbance might even yield a qualitative monitoring of the activity. However, the recognition depends to a great extent on the ability and experience of the interpreter. This tool usefully complements traditional surveying methods based on aerial photography.

For risk susceptibility maps (which sectors are potentially risk areas for each natural hazard type), the integration of SPOT 5 products is less straightforward and needs to be combined with the use of DEMs and classified slope maps.

Since 2000, many other successful rapid mapping services have been provided through the International Charter "Space and Major Disasters". SPOT 5 data were tested in particular during the dramatic flash floods which severely affected the Southern part of France in September 2002. (Yésou, H., Clandillon, S., Allenbach, B., Bestault, C., De Fraipont, P., Inlgalda, J., Favard, J.C., 2003).

Thanks to the constellation, 6 SPOT images, were acquired between the 10th and 11th, plus on the 14th two SPOT 5 scenes in multispectral, 10m, and 2.5m. Furthermore, two pairs of SPOT 5 XS and 2.5m, 2002 summertime data, were taken as reference data.

It was shown that based on the SWIR channel it was possible to monitor the soil water content decreasing over 5 days allowing in fact to map the flash flood extent one or more days after the event.

The SPOT-5 2.5 m natural colour product, was used as a reference image, associated with the flood extent, generated much interest within the rescue services because of their very high detail and their updated information compared to existing topographic maps, allowing to identify new built areas which were affected by the floods.

Compared to former actions, this Charter action highlighted the benefits of the SPOT 5 VHR as well as the SWIR channel and also the SPOT constellation's potential as images from three SPOT satellites were used for rapid damage mapping.

#### **3.3 Agriculture and Forestry**

##### **3.3.1 Agriculture**

In the frame of the European Union's MARS-PAC programme, Spot Image has supplied SPOT products every year covering 60 sites in the 15 member states over the past 10 years.

Among the satellite data provided in the frame of the 2003 MARS PAC campaign, 430 SPOT (including 54 SPOT 5) products were provided to the European Community, i.e. more than 63% of the total number of products including radar and VHR optical images. Thanks to this project, the EU obtains every year a direct inventory of utilized agricultural areas and main annual crops.

In the frame of the SAVP, JRC has led a study on the use of SPOT 5 data to control area based agri-environmental measures over "extensive fruit orchards" in Baden-Württemberg test site, southern Germany (Baruth, B., Aastrand,

P., de Roeck, E., and Leo, O., 2004). For such control, VHR satellite images were required to count the number of trees, to measure the declared area and to draw conclusions concerning the age by interpreting the treetops.

The test has been performed over 551 parcels. A SPOT 5 2.5 m resolution and a QuickBird 60 cm resolution panchromatic images were visually compared to an orthorectified airborne image of May 2001, with 2 m resolution.

This comparison showed that the SPOT 5 2.5 m panchromatic data is sufficient for a definitive tree counting if the trees are clearly separated, which is generally the case for this type of extensive orchards. But tree counting is no longer possible when the trees are rather close to each other and their tree crowns seem to fuse together.

In some complex situations (around 20% of the declared fruit orchards), such as fruit orchards near buildings or tree rows, a blur effect leads to non-interpretable situations both on the ortho-photo and on the SPOT 5 image. In these cases, either a better resolution is required (i.e. QuickBird imagery) or field inspection, as foreseen by the general control with Remote sensing methodology, has to be done. Another complementary strategy recommended is to systematically check the eligibility of the orchards on the basis of very high resolution satellite imagery, when the farmer applies for the first time to the AEM.

The use of SPOT 5 data is finally recommended for a regional fraud detection approach, providing an element for the selection of the sample to be controlled (risk analysis). In this case a classification of SPOT 5 data could be very efficient to check for a huge number of parcels, the compliance with some specific and visible commitments such as autumn green cover or crop rotation. The interest of such approach is increased by the fact that these commitments are dynamic and outside the main cropping season. They are consequently already poorly controlled by traditional inspections.

### 3.3.2 Forestry

Forest monitoring is one of the thematic domain where benefits linked to SPOT 5 enhanced resolution and unchanged multispectral information content (specifically SWIR and NIR channels) are the most salient.

The SAVP study performed by METRIA on boreal forest demonstrates that, compared to Landsat-7 or SPOT-4 images, additional forestry features can be detected, identified and mapped in SPOT-5 2.5 m colour images (Rosengren, M. G., and Willén, E., 2004.).

Information brought by SWIR channel is of highest interest for foresters as it is correlated to density, timber volume and tree height in coniferous forests. Therefore METRIA developed a merging technique producing four enhanced multispectral channels at 2.5 m resolution, including SWIR. Such 2.5 m colour image permits to detect the presence of seed trees left on new clear-cut area. Line patterns resulting from thinning by harvester machines could also be easily identified on 2.5 m or 5m colour images.

Very precise clear-cut mapping (minimum size mapped: 0.5 ha) could be reached using change detection between SWIR channels acquired at two dates (SPOT 5 and Landsat-7 SWIR bands). Within these clear-cut areas, it is possible to generate a seed trees map, by thresholding the SPOT 5 original 10 m resolution SWIR channel. Stratification and planning of field

visits will benefit from this result, as in field validation gave good results.

In Sweden the main limit is meteorological conditions. SPOT 5 alone cannot meet the need for yearly nation-wide cloud-free coverage. Nevertheless, it can be noted that in 2003, Spot Image delivered more than 200 scenes on Swedish forests, confirming its excellent acquisition capability.

Another study performed by SERTIT on a French forest (Haguenau, Alsacian forest), demonstrated the relevance of SPOT 5 images for forest mapping (Clandillon, S., Yesou, H., and Meyer, C., 2003).

After the December 1999 storm, a large part of Haguenau forest was devastated. In 2002, SERTIT tested the use of SPOT 5 data to update the damage maps and evaluated their usefulness in forest management, in relation with forestry end-users.

Damage zones were mapped accurately by comparing SPOT 5 10-m colour image before (simulated image) and after the storm. Results for forest parcels were very close to those obtained by the French National Forestry Office (ONF), working at a scale of about 1:10,000. In comparison with a similar data set acquired by SPOT 4, detection errors using SPOT 5 data were reduced by half.

In addition, SPOT 5 data were assessed for their potential in forest management. Regenerated areas, young coniferous stands, paths, firebreaks and forest works can be clearly identified on 2.5 m data. Forestry professionals such as forest owners, state and private administrators, and foresters very well received these results.

### 3.4 3-Dimensional visualisation

This SAVP investigation by the French Air Force, validates the concept of a flight simulation system dedicated to the pilot's familiarization with the natural environment that they will face in their future missions (Hernoust, F., and Cancès, M., 2004).

The tested 3D-visualisation solution integrated a system light and easy to maintain and to operate by a pilot with no exterior assistance, and a SPOT 5 3D-database, on a limited area around an airport, allowing multi-scale and multi-resolution display, from 10 to 2.5 m resolution.

Experimented pilots and trainees have been briefed on the main controls of the tool, and then they have flown freely over the database. The interest was proved through the first evaluations.

Cost is undoubtedly a key factor underlying increased use of SPOT 5 imagery, eventually merged with aerial images, and enriched by aeronautical data into flight simulators or simpler but realistic visualization systems.

Among the operational users of SPOT 5, the US Air Force (USAF) has validated the use of SPOT imagery in mission planning. SPOT 5 data are used in the F-16 flight simulator at Luke Air Force Base, Arizona. Customers who have turned to SPOT include Lockheed Martin, CAE, Flight Safety International, Frasca International, Multigen Paradigm, Terrex and BAE Systems.

## 4. CONCLUSIONS

SAVP results (and current amount of Spot Image sales and repartition between Spot 2-4-5!) demonstrate that Spot5 is a real success, due to its 2.5 m resolution combined to unchanged

geographical coverage 60x60 km<sup>2</sup> and to unchanged multispectral richness including SWIR channel.

The key product seems to be the 2.5 m color orthoimage, although the 2.5 m B&W and the 5m color orthoimages may be enough according to the application.

The other major improvements are the absolute precision location, and the HRS instrument, which open new perspectives in the production of highly accurate digital elevation models with 15 m horizontal accuracy and 10m vertical accuracy, and orthorectified images with the same horizontal accuracy.

Spot 5 clearly appears as a wonderful tool for cartography and cadastre on rural areas, allowing the production of geographic information with a content and a geometric accuracy that are compliant with 1: 25,000 topomap standards, and consistent with the 1 : 10 000 scale geometry. Hundreds of thousands of km<sup>2</sup> can be covered within a short time and at a reasonable price per km<sup>2</sup>, when compared with metric satellites.

For urban monitoring, planning and population census, the 2.5 m color images, allow urban change detection, urban structural classification and even count of buildings or identification of isolated settlements, at 1 : 10 000 scale. The natural color products seems of very high interest for communication purposes, and the 60 km swath is a strong asset for big metropolitan areas.

In risks and disasters mapping services, the 2.5 m resolution is again a decisive advantage, more particularly on urban areas, resulting in a very strong demand for constitution of an archive of Spot-5 2.5m color images on the major urban areas with potential risk. Such archive would be of highest interest in case of crisis as it would give a 1:10.000 map of status "before crisis".

For agriculture and forestry, the SWIR band and the 2.5 m resolution combined with the geographical coverage, together with the high programming capabilities, are the main assets of SPOT 5 images. It is now possible to count individual fruit trees, to identify precisely agricultural fields boundaries. Crop monitoring and agricultural statistics are improved in a smaller parcel environment with the multispectral information at 10 m resolution. A few concrete examples of benefits in forestry is a precise identification of forest stands, the characterization of regenerated areas, the estimation of the density of seed trees, etc... through SWIR analysis at 10 m and 2.5 m.

For 3D-visualization applications, the main asset of SPOT 5 consist in the provision at low cost of different layers of natural-colour orthoimages at resolutions of 10 metres, 5 metres and 2.5 metres, coregistered and centred on an airport. The Reference3D product, very-high-quality DEM issued from the SPOT 5 HRS instrument, is another major advantage of this multi-resolution orthoimages offering. Indeed, flight simulation gets real with SPOT 5.

## 5. ACKNOWLEDGEMENTS

Spot Image and CNES thank the eight investigators for their active and useful participation to this SAVP.

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