

# BELGIAN CITIES SEEN FROM SPACE

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## ABSTRACT

The *City promotion* project aims at arousing the awareness and the possible use of the Very High Resolution (VHR) satellite images in the public agencies and the education sector. This project is presently financed by the Belgian federal Office for Scientific, Technical and Cultural affairs (OSTC). In this purpose, a poster has been prepared showing the three main towns in Belgium – Brussels, Ghent and Liège – and a website has been devoted to the project. The core of the cities is represented by satellite maps at 1: 5000 scale. Ikonos panchromatic and multispectral images are merged together in order to obtain coloured images at 1 m resolution able to render the urban fabric of these old cities. Moreover small excerpts at enlarged scale (1:3000) show typical places and buildings in panchromatic mode. The excerpt selected on the famous Brussels “Grand Place” is used to illustrate the fusion process between the panchromatic (1 m) and the multispectral (4 m) images. Two small scale insets present the regional context of these three towns thanks to a natural colour composite made of Landsat 7 ETM+ images on the one hand, and a classical physical map on the other hand. Various exploitations in the classroom of this poster, and others of the same kind, are suggested on the related website (<http://www.geo.ulg.ac.be/eduweb>).

## 1 INTRODUCTION

The *City promotion* project aims at arousing the awareness and the possible use of the *very high resolution* (VHR) satellite images in the public agencies and the education sector. A poster and a website have been completed to present three Belgian cities: Liège, Brussels and Ghent. Such high resolution is very useful for urban mapping at scale up to 1:5 000. The fusion of the panchromatic and multispectral channels offers colour images with 1 m resolution. This project is funded by the Belgian federal Office for Scientific, Technical and Cultural affairs (OSTC) that promotes the use of satellite remote sensing in Belgium and others countries.

Presently VHR images are mainly used in land and country planning administration (Binard & Nadasdi, 1998 ; Donnay et al., 2002, Binard & al., 2001) for updating existing information in a more efficient way. Furthermore, VHR images will also be used in agricultural and economical ministry, e.g. for the refinement of the statistical sector division for the Belgian census (Binard et al., 2000). In the educational sector, VHR can be used in order to make easier the reading and understanding of the city fabric. For example, on the contrary to observations done from the ground, the relative size of the sights or the presence of vegetation inside the city blocks can easily be observed on VHR images recorder from space. In the same way, students can draw up a list of the smallest detectable objects from space (vehicles, details in sport and leisure resorts, etc.) or a list of historical relics.

## 2 TECHNICAL ASPECTS

The Ikonos imagery offers 4 m spatial resolution in multispectral mode and 1 m in panchromatic mode. The blue, green, red and near infrared channels are available in the multispectral mode, while the 1 m very high resolution (VHR) is only available in grey levels – panchromatic. However it is possible to combine the last with the multispectral channels in order to obtain coloured images with 1 m resolution. Such integration is proposed by *Space Imaging* but at a quite expensive price.

Nevertheless many fusion methods have been published, which allow the self production of data fusion from the raw data channels. In this respect, the laboratory Surfaces at the Department of Geomatics of the University of Liège proposes a genuine algorithm based on the computation of the local mean and variance. This method, so-called LMVM – local mean and variance matching – was firstly tested with scanned Russian Kosmos digital photographs and SPOT XS or Landast TM images (de Béthune et al., 1998).

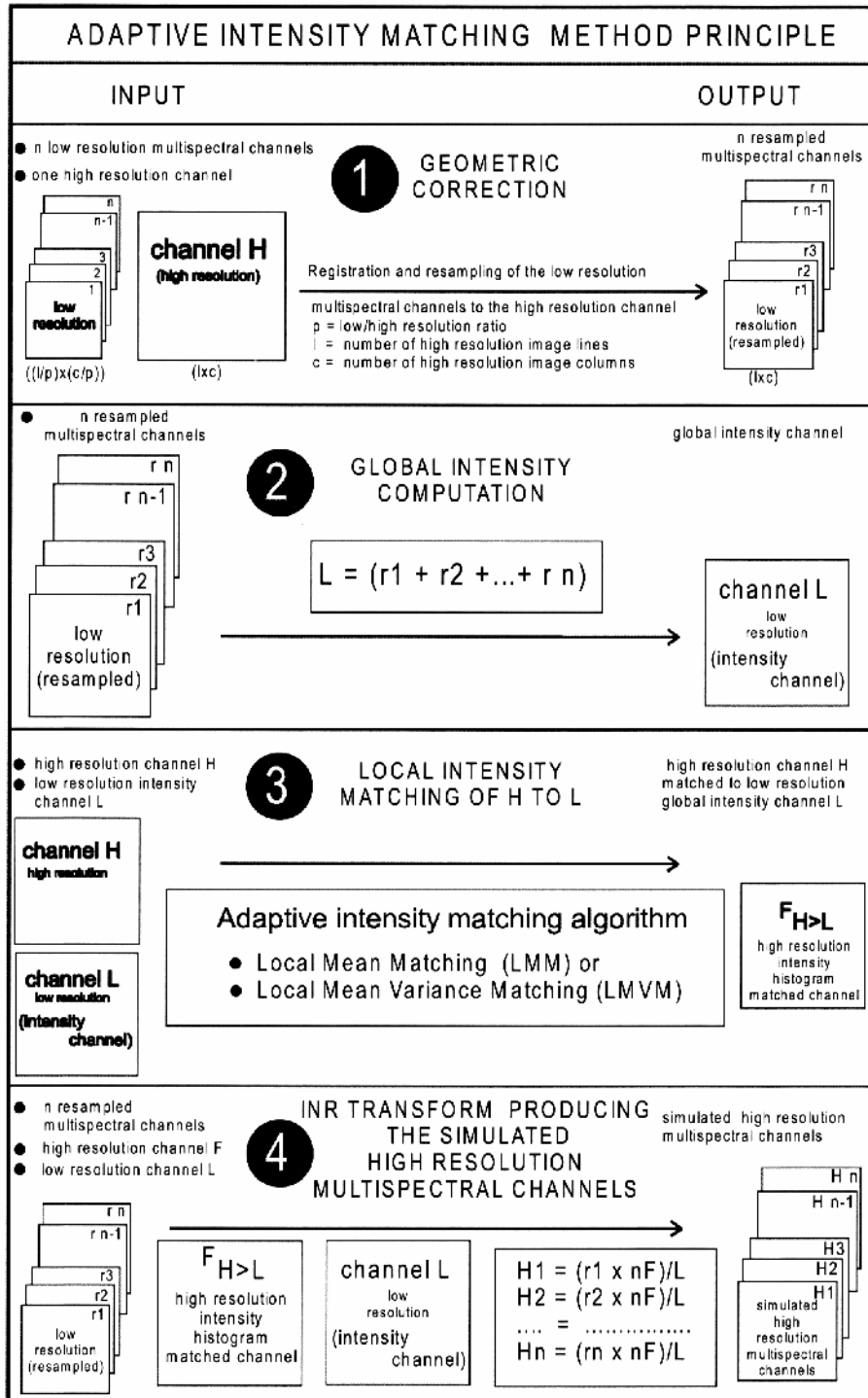


Figure 1. The LMVM methodology applied to merge different spatial resolutions channels.

The complete flowchart of the fusion process is presented in the figure 1. The size of the convolution window can be adjusted in order to tune the merging process and to control the level of panchromatic data integration.

The figure 2 presents a comparison of the input channels and the merged result (left: 1 m panchromatic; centre: colour composite illustrating the realization of the fusion process; right: true colour composite made from 4 m multispectral channels). This image of the centre of Brussels shows the well-known “Grand Place”, with the tower of the town hall, clearly visible in white on the three pictures but dramatically sharpened in the merged central picture thanks to the supply of the panchromatic data.

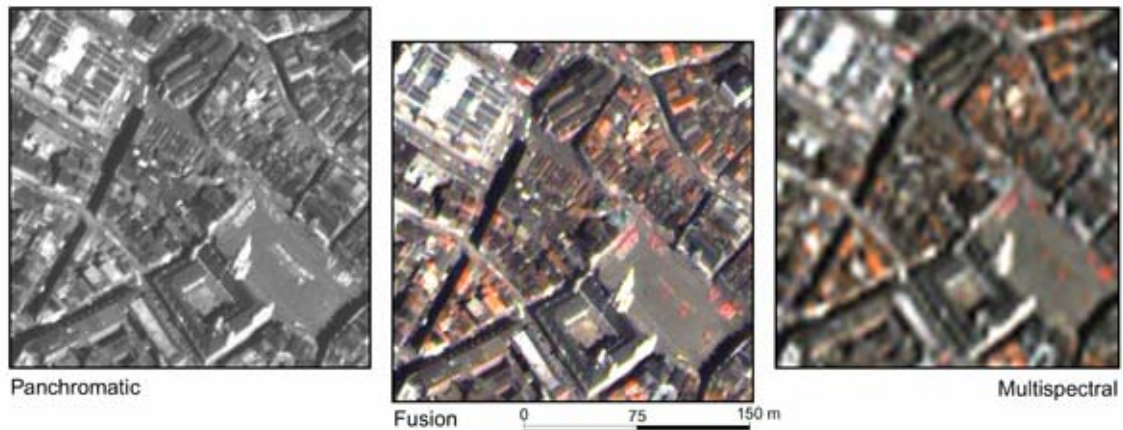


Figure 2. The *Ikonos* image fusion.

### 3 POSTER

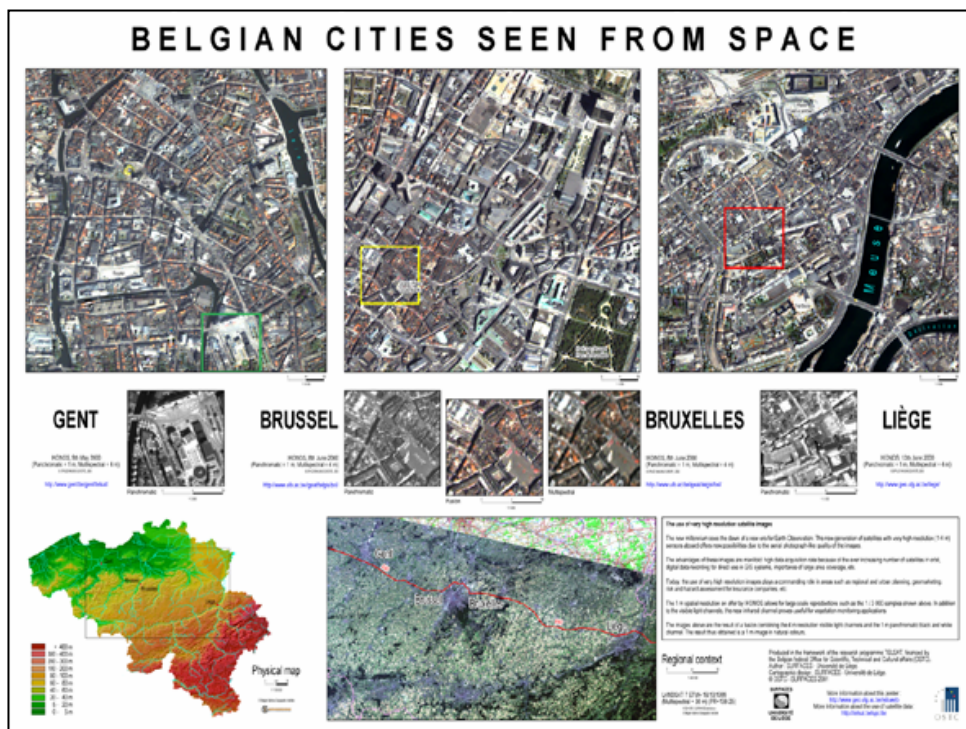


Figure 3. The poster of the *City promotion* project.

The two maps appearing at the bottom – left and centre – of the poster (figure 3) show several important Belgian cities in their regional context. The first map is a relief map at the scale of 1:1 350 000, while the second one is a true colour composite made of Landsat 7 ETM+ images at the 1:600 000 scale. The motorway E40 linking the three cities of Ghent (West), Brussels (centre) and Liège (East) is underlined by a red line.

On the top of the poster, the city-cores of Brussels, Ghent and Liège are represented by three satellite maps at 1:5000 scale constituted by colour composites of IKONOS images. Below each of these images, three excerpts, enlarged at 1:3 000 scale, show typical places and buildings in panchromatic mode. These excerpts are located by coloured squares in the main images. For Brussels, in the centre of the poster, the merging process explained in section 2 is illustrated by the figure 2. Text general information about the main uses of VHR images is given in the bottom - right part of the poster.

#### 4 WEBSITE

Related to this poster, a website was realized – the “City promotion” website – available in four languages (French, English, Dutch and German) at the following address:

<http://www.geo.ulg.ac.be/eduweb/city-promotion/> (figure 4).



Figure 4. Home page of the website.



Figure 5. Example of satellite image with thematic layers superimposed.

This realization is part of a larger project called *EduWeb* and grouping a collection of websites devoted to the promotion of satellite imagery. All these sites can be attempted from <http://www.geo.ulg.ac.be/eduweb/>.

Such media offers dynamic presentation facilities which are not available with a standard poster. The same three cities – Liège, Brussels and Ghent – are illustrated on this website with VHR Ikonos imagery. The site contains four main topics: three of them are dedicated respectively to the three cities, while the fourth shows the cities in the Belgian and European contexts. The three cities are examined in their historical dimension, thanks to ancient maps and various satellite images. The Belgian context is addressed by several small scale physical maps, such as the elevation contour maps elaborated by the National Geographic Institute. Similarly, the illustration of the European context makes use of various maps and lower resolution satellite images such as SPOT XS and Landsat TM. Such a smaller scale and lower resolution suggest different thematic approaches: morphology of the cities and their evolution in time and space; natural regions and landscapes; communications; relief, etc. In this



connection, North-Western Europe viewed at night from space constitutes an interesting image which comes from the DMSPP archives – Defence Meteorological Satellite Program (<http://www.ngdc.noaa.gov/dmsp>). This clearly shows the geography and the intensity of public and private lighting, giving a coarse indication about the distribution and the density of population (figure 6). It also provides a view of the urban structure and hierarchy of this part of Europe. More particularly, Belgium is characterised by close spots corresponding to the cities of Brussels, Antwerp, Ghent, Liège and Charleroi. The towns are connected by ribbons of urban settlement along the banks of the Scheldt and the Meuse, which also correspond to the major communication ways (waterways, motorway and railway) (Figure 7).

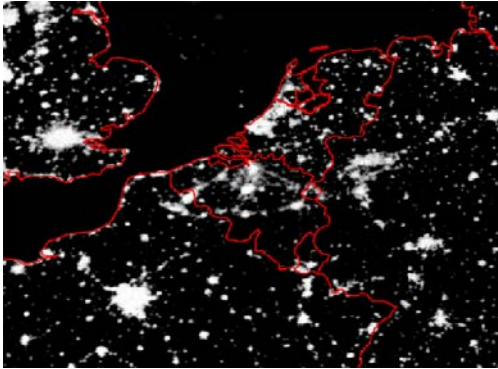


Figure 6. Belgium and neighbours at night.

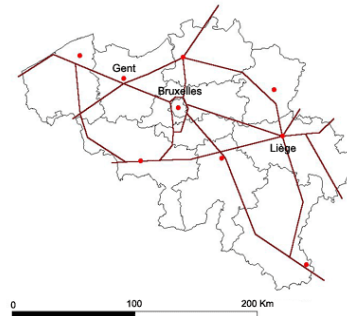


Figure 7. The motorway network.

Every city is studied and illustrated according to different themes, facilitated by the superimposition of interactive map and image layers (figure 5). For instance, the growth of the built-up areas, from the beginning of the nineteenth century up to now, combines information taken from old maps and urban foot-print obtained by a land-use classification of the satellite images. The green areas, easily recognizable on the true colours composite are compared with the NIR channel, in order to illustrate the usefulness of this waveband in the study of the vegetation phenomenon. All past and present communication ways, including railway, main roads, watercourses and bridges, as well as former medieval walls of the city can be incorporated at time in the visualization. They help for understanding the urban structure of the respective cities.

Finally, a last section of the site is devoted to various applications of remote sensing, exploiting different spatial and multispectral sensor capabilities and describing their utilities. As regards, thermal and other infrared wavebands from Landsat ETM+ point out the high reflectance characterising the vigorous chlorophyll activity of green areas, making easier the delineation of the large alluvial plains and the contacts between green areas, built-up areas and water bodies. Similar delineations are spatially refined inside the cities thanks to the higher resolution of the near infrared Ikonos channel.

Small excerpts (500 x 500 m) from many satellite images featuring the *EDUSAT* website can be freely downloaded (Muller, 1995-2001). Excerpts centred on the location mouse-pointed by the web visitor on the quicklook is transmitted instantaneously at full resolution to the visitor's email. This website also offers a large collection of educational data sets (e.g. EDUSPOT and SPOT DEMO image series), including the mosaic of 16 SPOT-XS scenes covering Belgium, from which excerpts can be selected according to the list of 3 624 municipalities in Belgium, and downloaded in direct access and at full resolution.

## 5 CONCLUSIONS

This educational project was presented in many national institutions and workshops. The poster is freely distributed in the tourism offices of the three concerned cities and widely to the geography teachers of secondary schools.

## ACKNOWLEDGEMENTS

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