The Satellite Images Ikonos 2 Used in Analysis of Urban Zones

Iosif VOROVENCII, Assoc. Prof. PhD. Eng. Ec – University "Transilvania" of Brasov, Romania, icatop@yahoo.com

***Abstract**: The satellite images are important source of data which can be used in different applications inclusively in analysis of urban zones. The most indicate are satellite images with high spatial resolution like Ikonos 2 accessible to civilian sector. In this way, the images, georeferencied in national system "Stereographic 70", can be used to monitor the changes from a certain interval, to systematization of the localities and in design studies. Also, the images can be used in building cadastre and in municipal networks cadastre to follow the dynamic of buildings and to point out the direction of networks. The use of these images in geographic information systems can be creating the data base very efficient which can be used by municipality. In this way, in this paper was analysed an image Ikonos 2 from different points of view like visual interpretation and classification for point out the advantages and disadvantages of this records.*

***Keywords**: urban zones, satellite image, building cadastre, spatial resolution, supervised classification, geographic information systems.*

1. General Aspects

Because satellite remote sensing techniques, together with satellites that take images are always changing spatial resolution and the methods used for data processing, they can offer irreplaceable cartographic products as multispectral images merged with the panchromatic which become the applications for systematic property and settlements utilities cadastre. Merged images can be combined with existing cartographic data which allow visual interpretation of urban characteristics. This can be applied for maps in which information, compared with the classical map, is richer and it is not represented by the graphic but by the characteristics of details at the date of registration (texture, colour, relief, etc.). Also, the classification of images content from urban areas can have as a result thematic maps of land use and the characteristics of the category of use for a period of time which shows the degree of urban development.

Satellite images along with other information sources may be used to describe the physical reality of the urban areas taking into account *the employment of land, accessibility, distribution and extent of green spaces, the link between construction*, etc. In this direction, to play the complexity of the urban environment can be used satellite images of the type Landsat 7 ETM +, SPOT and Aster at a *global* or *regional scale* or images of high spatial resolution of the Ikonos 2 type, Quickbird, Orbview, Geoeye to a *local scale*. In general, the last images are given in all applications of systematization of villages (inside and outside) due to their very high spatial resolution.

2. Methods and materials

In this paper it was used Ikonos 2 satellite image taken on city of Brasov in 2005. The image was recorded in four bands: in panchromatic with spatial resolution of one meter and in multispectral (red, green and blue) with the resolution of four meters. Cartographic materials used are the plans with curves at 1:5000 scale and the cadastral plans of the city of Brasov at a 1:1000 scale.

The image was processed with the remote Erdas Imagine 8.6 and cadastral plans were made vectors using AutoCad Land R3. Registration Ikonos 2 and cadastral plans were georeferencied in the "Stereography 70" projection system to ensure a common basis for the overlaps. Screenshots were made using the ScreenHunter 5.1 Pro.

The methods used were visual interpretation and those specific for remote sensing satellite.

3. Results

The Ikonos 2 image was radiometric processed in order to decrease the effects of the atmosphere during the takeover, thus ensuring the integrity of spectral data used in processing.

The research aimed to establish some direct criteria for employment of between field and highlighting the opportunities that satellite images of very high spatial resolution Ikonos 2 offer in identifying details of the built city.

Visual interpretation can be considered as a first step in image analysis. It identifies and establishes the urban environment quality by indicators defined by the interurban scale, which were built using variables that describe the quality of the environment. These indicators are developed using *vegetation-environment-construction association* of urban forms and *nature's material*. Variables used to construct these indicators relate *to employment land*, obtained using satellite images and *access to infrastructure* (green spaces, road car, train stations), expressed as distance and defined by the network of access roads and nature of the transport system.

The choice of variables related to employment of soil requires the recognition of urban details that must be taken into account in the needs of users. As such, the objective is not to identify all details of the urban city, but the use of specific indicators of urban environment. In this way there were taken into account the following details:

- *urban vegetation* (morphology, stratification, distribution, density).
- *constructions* (morphology, height) that determine the spatial organization of cities depending on which can be distinguish four types of *urban tissue*. The nature of the roof material can be, in certain cases, the only thing that leads to knowledge of the details and provides a leading indicator to differentiate people. For example, in Brasov a roof tile is generally characteristic for individual buildings (especially in the old city), a concrete roof is characteristic for blocks or pavilions and "gravel" roofs are representative for large assemblies buildings.
- *road* and *rail networks* (width routes, flow).
- *industrial areas* which are, as their type, sources of air pollution, noise and potential risk technology. Such targets cover in Brasov's built quite large areas where can be found large buildings such as industrial halls.

Classification of Ikonos satellite image 2 content was an objective of this paper which sought details of the spectral behaviour in urban areas for their use in systematic town activities. The content of Ikonos 2 image was classified into 6 classes considered to be

representative for the city of Brasov, namely: *green areas*, *blocks* (concrete), *construction* (houses), *roads* and *parking lots* (asphalt), *industrial halls* and *shadow*. In the classification of the content of image it was used the *supervised classification* called the "*maximum likelihood*" in order to create more samples for each class of information after which they have been united. Further these samples were verified in terms of spectral, creating the reflectation spectral curves. It was calculated the spectral distinction and the matrix of errors (Table 1). Classification was done by six successive reiterations.

On the basis of classification were prepared *thematic maps* in which the classes of information are shown in different colours. For some applications the identification of details must be exhaustive (vegetation, buildings) and for others it is useful only to identify areas (industrial areas) (fig. 1).

Table 1. Matrix of errors

Classes of information	Green spaces	Blocks (concrete)	Constructions (Houses)	Streets, parking lots (asphalt)	Industrial halls	Shadow	Total
Green spaces	396	0	0	0	0	0	396
Blocks (concrete)	0	171	0	2	0	0	173
Constructions (Houses)	0	0	96	0	0	0	96
Streets, parking lots (asphalt)	0	0	0	119	4	0	123
Industrial halls	0	0	0	5	215	0	220
Shadow	0	0	0	0	1	88	89
Total	396	171	96	126	220	88	1097

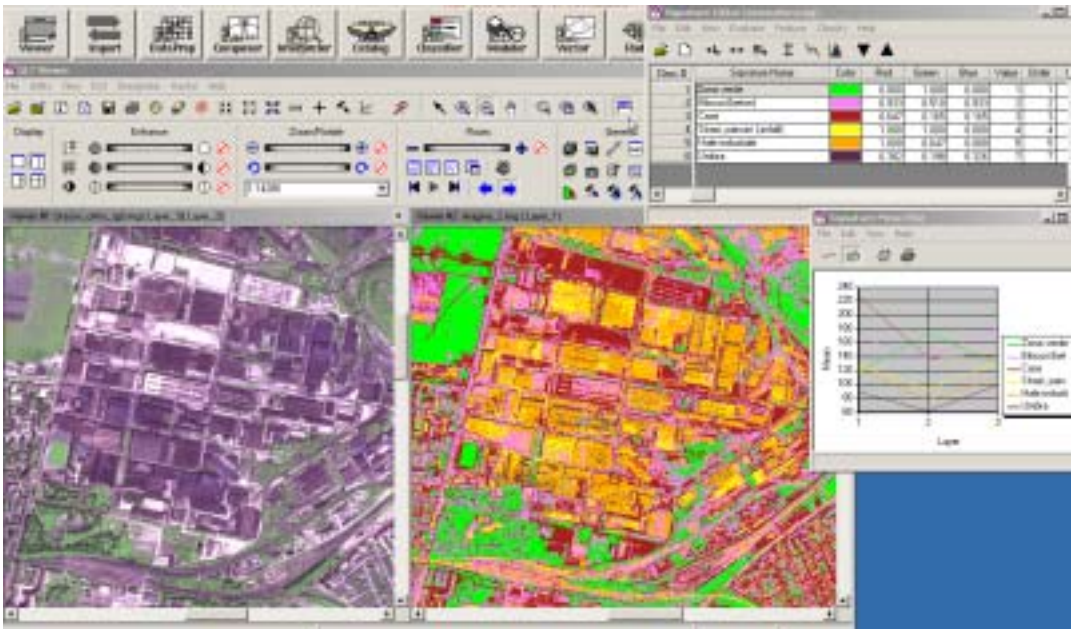

Fig. 1. Ungraded Ikonos image (left) and classified image (right).
Industrial Area.

Following completion supervised classification was found that urban areas are hardly classified due to heterogeneous nature of urban features. Moreover, the classification is more difficult as the spatial resolution of images grows due to increased level of detail of objects and spectral interval in which pixels are located. In this case the problem was the difficulty of

separation of classes such as streets and buildings. In most cases, roofs of buildings are in various materials i.e. metal, concrete, tile and other and have similar spectral behaviour of the material constituting the roads (asphalt and concrete). The result is that the limits of roads and buildings are not distinct in the classified image (fig. 2).

The establishment of density of buildings and inventory of plots are two operations that can be achieved in good conditions after Ikonos images 2 reasons for which there were used two methods to assess the density of buildings. One consisted of using a window of 100 x 100 pixels, called the *analysis window*, which moves transversely on the image and provides a central pixel value based on the percentage of built area within its perimeter. This method makes it possible to view the density of buildings in a continuous manner. A second method involves estimating the density of buildings on each cadastral parcel based on the percentage of built area (fig. 3).

Fig. 2. Classification of Ikonos 2 image in which constructions are recorded.

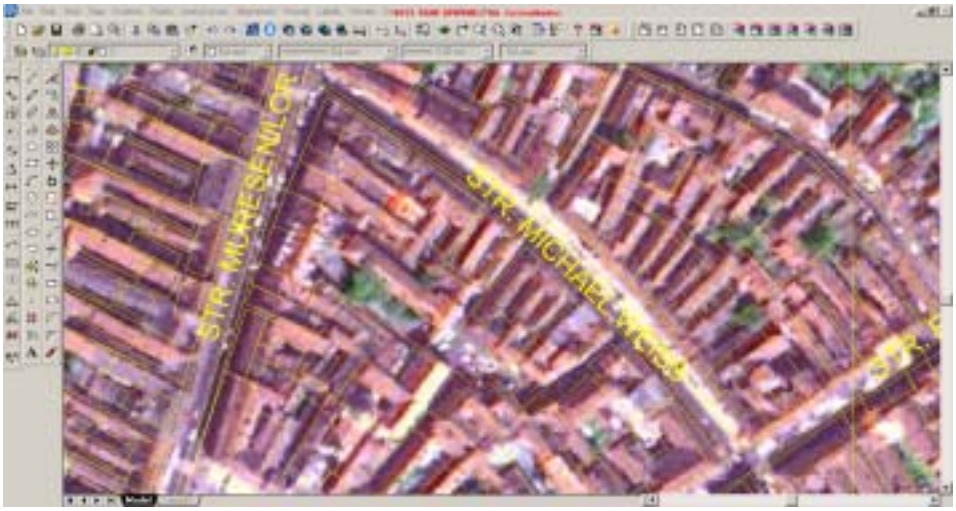

Fig. 3. Estimating the density of buildings on Ikonos satellite image 2.

In the field studies it was shown that when comparing inventory based on satellite images with a similar inventory based on cadastral information harvested by classical way it is obtained an accuracy of about 85% which is not sufficient for certain applications.

Tracking changes in urban areas occurred in a given period of time, taking into account the dynamics of construction in recent years, can be successfully achieved by Ikonos images 2. In this sense, the new construction can be pursued and by confrontation with urban area projects can be established if the law was respected. Also, verification can be made quickly without requiring movement in land which is efficiency and timeliness.

Integration of satellite images of high spatial resolution Ikonos 2 in database mayoralty alongside other data relating to systematic localities is a great advantage due to the rapid access and insurance of a raster view and not of a graphic one. Images from databases can be used in the *raster format* for *vector* layers overlap so that they provide an overview (raster and vector), offering the possibility to be kept in a separate layer in ArcGIS (ArcView, ArcInfo) (fig. 4). Achieving such a database allows immediate updates and by replacing the satellite images at certain time intervals the dynamic of systematic towns can be analyzed.

Fig. 4. Vector overlapping layer over Ikonos satellite image 2

4. Conclusions

To obtain some acceptable results on classification, so that the satellite images of very high spatial resolution to *represent a high potential for systematic localities*, are linked to meeting certain *conditions*. *Firstly*, the movements caused by high angles of inclination compromise both visual interpretation and any overlap with existing data. Geometric corrections and couples of stereoscopic images of very high spatial resolution are needed to obtain raised results. *Secondly*, visual interpretation involves consuming a large amount of time for interpretation of large surfaces. In this sense, automatic classification is much more economical but less accurate. *Third*, if one plots the inventory built with buildings images of very high spatial resolution on large surfaces than the images should be taken over the entire surface and regularly updated. These conditions are not met because the current acquisition cost is prohibitive. A single Ikonos image provides only a limited view for observation of each region in good condition.

In terms of classification of content satellite Ikonos 2 images it has been found to be particularly difficult to distinguish certain details due to the similar spectral behaviour of the materials from which they are made. This is the case of differentiating low road streets and

construction (concrete road) through the use of GIS software which is based on achieving the spectral behaviour when creating the classification without taking into account traits. In the classified image were raised structures, particularly the network of roads and street structure due to their specific form.

Therefore, traditional techniques of processing the images taken in urban areas, due to very high spatial frequency when they are based on the observation of spectral details, do not always lead to the best results. In order to solve these issues on classification, along with other special techniques may be used data from other sources such as thematic maps, topographic, etc. Also, digital surface model can be an important aid to separate the classes of information from a classified image. Hypsometric information can be combined in the classification so that it can achieve the best results in the separation of classes with similar spectral behaviour.

5. References

1. *Bussios, N., Tsolakichy, Y., Tsakiri-Strati, M., Goergoula, O. – Integrated High Resolution Satellite Image, GPS and Cartographic Data in Urban Studies. Municipality of Thessaloniki;*
2. *Herold, M., Scepan, J., Muller, A., Gunther, S. – Object – oriented mapping and analysis of urban land use/cover using Ikonos data – Proceedings of 22nd EARSEL Symposium Geoinformation for European – wide integration, Prague, 2002;*
3. *Kansu, O., Gazioglu, S. – The Availability of the Satellite Image Data in Digital Cadastral Map Production – Shaping the Change XXIII FIG Congres, Munich, Germany, Octomber 8-13, 2006;*
4. *Krauß, T., Lehner, M., Reinartz, P. – Modeling of urban areas from high resolution stereo satellite images – IPI workshop Hannover 29.05 – 01.06.2007 Land Cover and Change Detection II Commission III, WG III/4, 2007;*
5. *Tanbenbock, H., Esch, T., Roth, A. – An Urban Calssification approach based on an object – oriented analysis of high resolution satellite imagery for a spatial structuring within urban areas. 1st EARSU Workshop of the SIG Urban Remote Sensing Humboldt – Universitat zu Berlin, 2-3 March, 2006;*
6. *Tim Van de Voorde, Binard, M., Tom Op't Eyndt – Inventoring urban areas with Very High Resolution Satellite Images – 5th AGILE Conference on Geographical Information Science, Palma (Balearic Islands, Spain) April 25th – 27th, 2002;*
7. *Vorovencii, I. – Cercetări privind posibilitățile de utilizare a imaginilor satelitare în lucrările de amenajarea pădurilor. Teză de doctorat. Universitatea "Transilvania" din Braşov, 294 p, 2005.*