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ACCURACY ASSESSMENT OF AN OBJECT-ORIENTED CLASSIFICATION FOR TRANSPORT AND INDUSTRIAL INFRASTRUCTURE, RESIDENTIAL BUILDINGS, AND WATER BODIES BASED ON A QUICKBIRD IMAGE

Vassil Vassilev

Bulgarian Academy of Sciences - Space Research Institute
e-mail: vassilev_vas@yahoo.com

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Abstract: *A methodology for cartography and accuracy assessment of an object-oriented classification for three different Land use classes based on extraction of thematic information from very high resolution multi spectral Quickbird image acquired on 31.05.2008 is presented in this paper. The proposed methodology includes several work stages and it has been applied on a highly fragmented urban and agricultural land of the Novi Iskur Region, Municipality of Sofia, Bulgaria. The area studied is slightly above 130 km^2. A land use classification scheme for the area studied was created for the three classes: transport and industrial infrastructure, residential buildings and water bodies, depending on the differences in their spectral reflectance and texture. Automatic identification of the land use classes based on the multi spectral image was applied using the Feature Analyst 4.2. Extension Tool of ArcGIS software. Their accuracy assessment was calculated using ERDAS Imagine software which shows overall accuracy of 94%. Upon evaluating the distribution of these classes it can be concluded that the area features agriculture-orientated development. A large scale land use map is composed bases on the final result. The methodology developed offers an opportunity for quick and objective extraction of thematic information from multi spectral images to support urban planning of a relatively large territory. This allows to take adequate planning decisions and to conduct a regional policy which ensures sustainable development of the environment.*

ОЦЕНКА НА ТОЧНОСТТА НА ОБЕКТНО-ОРИЕНТИРАНА КЛАСИФИКАЦИЯ ЗА КЛАСОВЕТЕ ТРАНСПОРТНА И ИНДУСТРИАЛНА ИНФРАСТРУКТУРА, ЖИЛИЩНИ СГРАДИ И ВОДНИ ОБЕКТИ ПО МНОГОКАНАЛНО ИЗОБРАЖЕНИЕ НА QUICKBIRD

Васил Василев

Институт за космически изследвания – Българска академия на науките
e-mail: vassilev_vas@yahoo.com

Ключови думи: *QuickBird; Анализ на изображения; Едромащабно картографиране; Градско планиране; Обектно-ориентирана класификация*

Резюме: *В доклада е представена методика за картографиране и оценка на точността на обектно-ориентирана класификация на три различни класове земеползване чрез извличане на тематична информация от изображение със свръх висока пространствена разделителна способностна от QuickBird, заснето на 31.05.2008г. Предложената методика включва няколко работни етапа и е апробирана върху силно фрагментирана градска и земеделска територия за район Нови Искър, Столична община, България. Изследваната територия е малко над 130 км^2. Създадена е класификационна схема за три класа земеползване: транспортна и индустриална инфраструктура, жилищни сгради и водни обекти, в засисимост от техните отражателни и текстурни различия. Приложено е автоматично идентифициране на класовете земеползване върху многоканално изображение чрез Feature Analyst 4.2. Extension Tool в ГИС. Тяхната оценка на точността е изчислена чрез ERDAS Imagine, който показва обща точност от 94%. След анализа на разпределението на тези класове може да се направи заключението, че територията има аграрна ориентация. Въз основа на резултата от изследването е изготвена едромащабна карта на земеползването. Предложената методика дава възможност за бързо и обективно извличане на тематична информация от*

многоканални изображения с цел подпомагане на градското планиране на относително голяма територия. Това позволява да се вземат правилните решения при планирането и да се проведе правилна регионална политика, която да осигури устойчивото развитие на природата.

I. Introduction

Urban environment is one of the most challenging areas for remote sensing analysis due to the high spatial and spectral diversity of surface materials, and spectral confusions among different land-use/cover types and the large number of mixed pixels [Lu and Weng, 2006]. Improvement of the accuracy of urban land-use/cover classifications is very important and different approaches have been proposed to solve the mixed-pixel problem in traditional per-pixel classifiers, including development of object-oriented [Thomas et al., 2003] and object-based [Baatz and Schape, 2000; Definiens Imaging, 2002] classifications.

A methodology for cartography and accuracy assessment of an object-oriented classification for the distribution of three very informative land use classes on an urban territory based on extraction of thematic information from very high resolution multi spectral image is presented in this paper. A land use classification scheme was created for the three classes: transport and industrial infrastructure, residential homes and water bodies, depending on the differences in their spectral reflectance and texture. The methodology is an attempt to combine the capabilities of Automatic identification of the land use classes in the Feature Analyst 4.2. Extension Tool of ArcGIS software and accuracy assessment tool in ERDAS Imagine software. It was shown that such approach enables to perform accurate and objective analysis of the territory that could be useful for regional policy, construction processes and the conservation of water resources. Such assessment of the territory is one of the main criteria used in the landscape and urban planning to control and take decisions on sustainable development of urban territories and for its relationship with ecological and environmental issues as well.

II. Methodology

The proposed methodology includes several work stages: 1) Selection of an appropriate satellite image; 2) Selection of methodology for assessing the distribution of the three selected land use classes on the territory using the information gathered in the geodatabase; 3) Selection of a method for automatic land use identification on the multi spectral satellite image; 4) Conducting land use classifications and evaluating its accuracy; 5) Accomplishment of Visual computer aided interpretation of the classified satellite image; 6) Conducting a field check of the results; 7) Composing a large scale land use map on the base of land use classification for the three classes and 8) Importing the results in the geodatabase.

III. Results and Discussion

The methodology has been applied on a highly fragmented urban and agricultural territory of Novi Iskar, municipality of Sofia, Bulgaria. A multispectral Quickbird image acquired on 31.05.2008 has been chosen. Additionally, a panchromatic image was used to increase the visual interpretation with its 0.61 meters spatial resolution compared with the 2.44 meters spatial resolution of the multi spectral image. Digital Elevation Model (DEM) with 40-meter cell size and Rational Polynomial Coefficients (RPC) geometric correction model in ERDAS IMAGINE were used for orthorectifying the QuickBird image (from Digital Globe). Ground control points selected from orthophoto images with 0.5 meter resolution were used for adjusting the RPC coefficient values. The RPC model uses cubic polynomials for transformation from ground surface coordinates to image coordinates.

A land use classification scheme for the studied area was created using the information in the geodatabase including shape files, ground truth data and initial visual interpretation of the image. For this purpose the first field check was conducted, ground control points (GCP) were taken with GPS for some typical training sets for the studied land use classes, and test regions were evaluated as area of interest for the object-oriented classification using the Feature Analyst Extension Tool in ArcGIS.

Automatic identification of the land use classes on the multispectral image were selected using visual interpretation and ground truth data gathered in previous stages of the work process. The training sets for the object-oriented classification were digitalized using a visual interpretation of the image in different band combinations, as well as in-situ information. Visual interpretation of the image was also used to identify the differenced of the land use classes in hue, shape, size, structure, texture, shade, associations between them as the most common combinations of bands was 4, 3 and 2 and 3, 2 and 1. The panchromatic image was used to support the visual interpretation of the multispectral image. Two to five training sets were digitalized for each class in ArcGIS software. For the class

Residential homes the training sets were much more than for the other two classes because of the specifics of the land use class and the need of a large group of training examples. In this paper ArcGIS FEATURE ANALYST 4.2. tool extension was used to conduct object-oriented classification on the territory. The key benefits of this ArcGIS extension are that it allows selection of a learning model for the classification. A hierarchical learning for adaptive feature extraction to identify objects in complex and cluttered scenes iteratively improves classification. This ArcGIS extension also provide the possibility for extraction of wall-to-wall features and has the necessary image processing tools for vector and raster conversion.

The land use classification was made using different options available in the ArcGIS FEATURE ANALYST 4.2. extension tool. The tool extension gives an opportunity to select feature selector depending on the features you are trying to classify, as well as to select the type of band data to use (reflectance, texture, elevation or discrete class values). The Input presentation option provides additional information about the area surrounding the rooftop.

A large scale land use map is composed on the base of land use object-oriented classification (Fig. 1) as follows: Residential homes, Transport and industrial infrastructure, and Water bodies. The statistical method Majority from Focal statistic in ArcGIS 9.2 software was applied with the purpose of additional cleaning of the mixed pixels on the map.

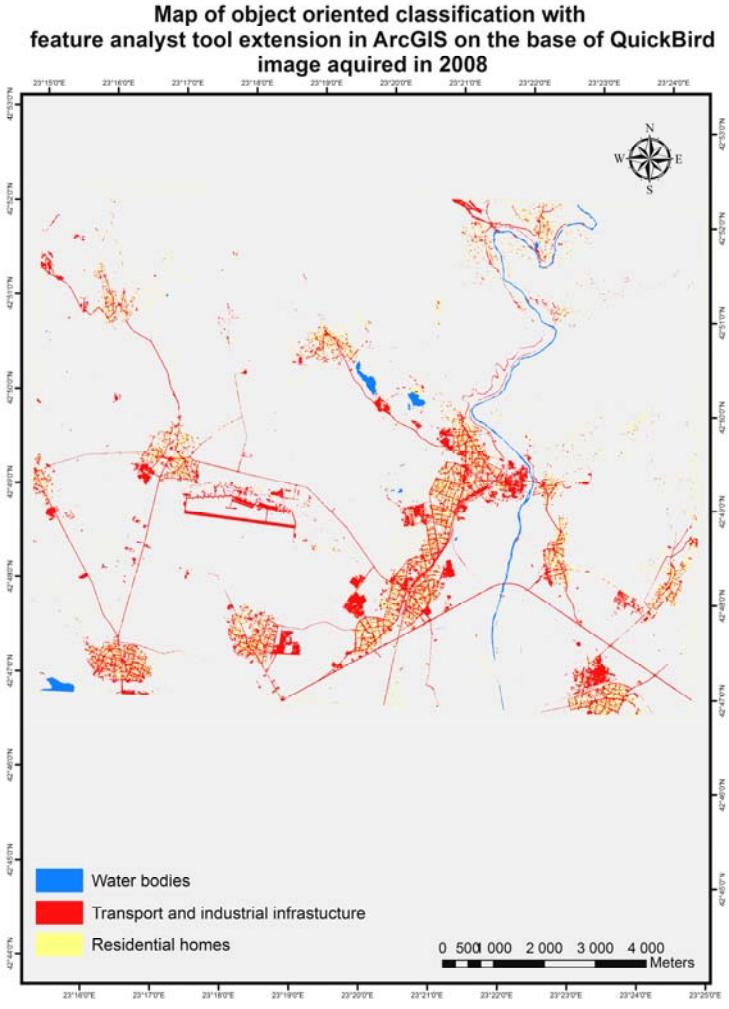

Fig. 1.

The accuracy assessment of the resulted classification was done using ERDAS Imagine software. The land use classification was converted in image (img.) file and after that imported in ERDAS Imagine for calculating it's accuracy by using accuracy assessment option. Two hundred 200 randomly distributed points on the image were used. Some of the points were positioned in the edge of the area of interest, so these points were left out of the actual points which accuracy was evaluated. This is one of the downsides of choosing the randomly distributed points, but using that option the subjective factor of

placing the points yourself was eliminated. Therefore, the actual points used were 188. The accuracy report shows overall accuracy of 94.15% and Overall Kappa Statistics of 0.9335. The Water bodies' class shows producer and users' accuracy of 100%, while Residential homes class show producer accuracy of 100% and users' accuracy of 87.50%. The class that has been appointed as the difficult one for determining is Transport and industrial infrastructure with producer accuracy of 83.33% and users' accuracy of 87.50%. A Visual computer aided interpretation of the classification was performed and some specific areas were appointed for a field check to evaluate their difficulty in the classification process.

A field check (Fig.2) of the results was conducted in order to compare the accomplished results from the accuracy report with the actual situation on the field. The purpose of the field check was to get the real picture of the quality of the work and to evaluate the methodology presented in this paper. It can be concluded that the class Water bodies is the most accurate class from the three classes studied. This can be explained with the fact that water by itself can easily be distinguished by spectral and textural analysis. The other two land use classes, Residential homes and Transport and industrial infrastructure are more difficult to accurately be separated by spectral and even texture analysis. This can be explained for the Residential homes class by the types of roofs that the different buildings have, for example, residential and cottages in the forested area that are build-up with very different in structure and origin materials and with one- and two-storied buildings with courtyards and farmyards that are predominated. The class Transport and industrial infrastructure, on the other hand, has even more complicated problem. There are different ground surfaces from paved roads, cabbie roads to black roads, and the industrial buildings have also very different roofs from bricks to laminated iron and etc. This makes very difficult to recognize them as one single class in the classification process. However, despite the difficulties that were encountered, overall it was established from the field checks that all land use classes were well distinguished and represent the real distribution of the classes in the study area. Finally, the thematic data obtained have been integrated into the geodatabase.

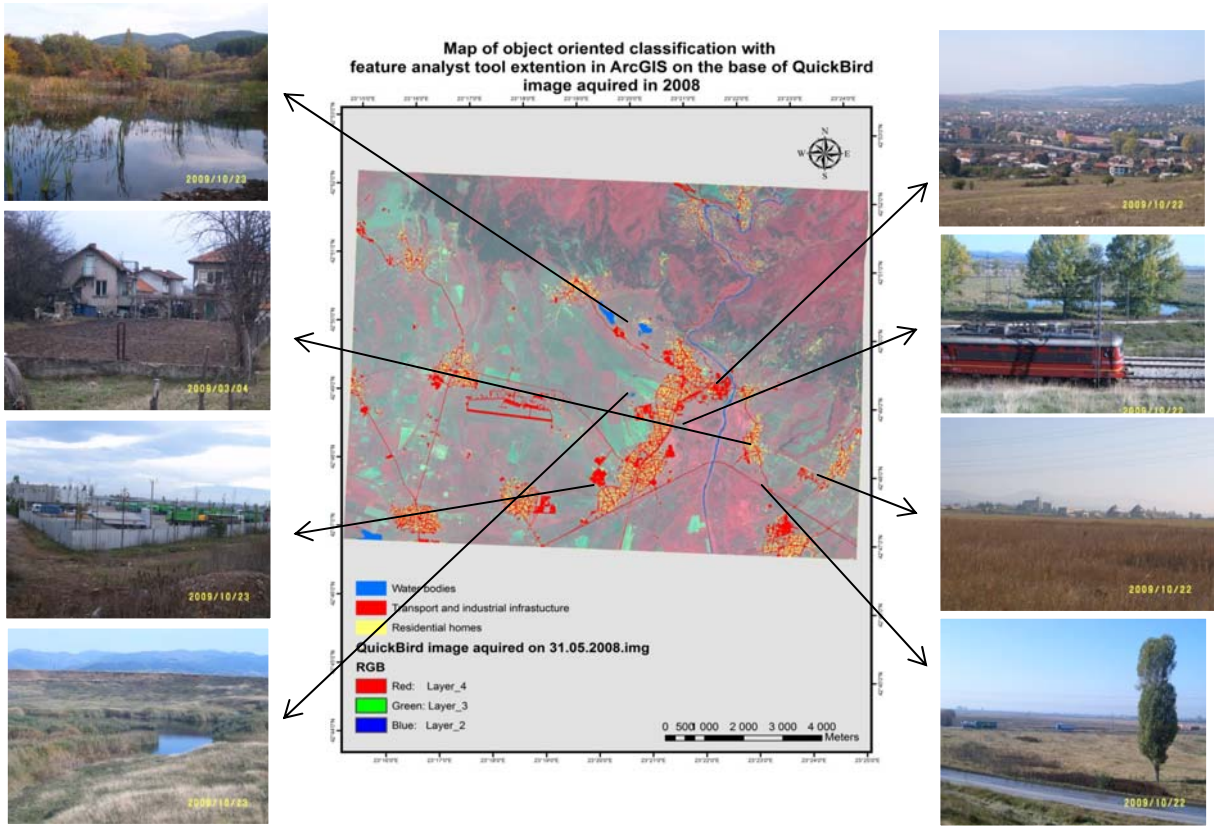

Fig. 2.

The methodology developed proposes an opportunity for quick and objective extraction of thematic information from multi spectral images in order to assess the urban planning and the congestion of buildings at a specific area, using satellite images. This allows to take the right decisions

in planning, and to conduct a regional policy which ensures a sustainable development of the environment.

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