THE UTILIZATION OF VERY HIGH RESOLUTION SATELLITE IMAGERY AS A SOURCE OF INFORMATION IN CARTOGRAPHIC ANALYSES OF QUALITY OF URBAN GREEN AREA

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Protection of green areas is nowadays one of the most important aims of urban development. The recent sources of remote sensing data carry great capacity of information about the state of urban landscape. In the paper the test of possibility of profitable using QuickBird images and classification methods of validation will be presented. Possibility of exploration of QuickBird image has been tested in order to assess the degree of importance of south ‘wedge of urban green’ in Poznan. Results of classification were verified on the ground in order to increase the quality of analyses. As an effect, the map of state of landscape of the area of the green area has been obtained. This map is a part of the set which illustrates the initial conditions for revalorization of this terrain.

In the work, the range of remote sensing project will be presented on the example of quality analyses of natural and changed space situated along the Varta River in Poznan. The advantage of segmentation and fuzzy logic methods will be pointed out as a useful elements of classification process. Results of classification as a part of complex cartographic analyses conducted within the project will be presented.

1. INTRODUCTION

Management of city space needs sometimes preparation of detailed thematic map. In context of idea of sustainable development urban green sites are subject of special concern. Design of their protection often designates these areas for public as parks, gardens or natural landscape spaces. The subject of such elaboration is so called ‘south green wedge’ of Poznan, which was the component of pioneer ecological solution elaborated in 1930th by W. Czarnecki (1932), the great Polish architect of that times. Figure 1 shows Czarnecki’s design of city plan, where urban green spaces formed a cross with vertical direction along Varta River, and horizontal one, compatible with dominant direction of winds. Such schema guaranties excellent ventilation of the town and conservation of soil-climate conditions, good for growth of vegetables.

![Figure 1. The sketch of urban green preservation in Poznan of early XXth Century. Red ellipse points out the area of interest](image-url)
Despite of changes made during last years, those schema is still accepted in current master plan of Poznan development. Figures 2a and b are fragments of Master Plan. Unfortunately, immoderate speed of changes, which we see now, makes real hazard for its preservation without doubts of its degradation and enable keeping good conditions for vegetation in the further.

Figure 2. Drawings from current Master Plan of Poznan, Poland showing (a) two categories of south green wedge, and (b) classes of land uses: forest, trees and bushes, parks and gardens

An important factor that can abstain from degradation of urban vegetation may be the design of revitalization of Poznan south wedge of green, directed on growth of tourist-recreation attractiveness (Wyczalek, 2005). Map of state of cultural landscape of the area of interest is initial source of information for analyses.

Existing urban maps do not show natural objects in details, and contain rather cadastral data, utilities, streets, buildings and other man made phenomena. Therefore it was decided to use VHR satellite image as a source of thematic data. Registration of terrain details with resolution of 1x1 m gives hope, that proper stage of detailed thematic map in a scale 1:2000 will be achieved. Following parts of the work were planned: (i) assessment of usefulness of QuickBird image; (ii) image and map transformation to common reference frame; (iii) data preparation for image classification; (iv) object-based classification; (v) thematic map preparation. Mentioned stages will be presented in this paper.

2. THE RANGE OF ELABORATION

The area of interest is south complex of urban green that is remainder of wilderness old forests, the rest of which forms National Park of Wielkopolska, located 10 km south of Poznan. In the middle is located Lubon city, and line of transeuropean highway A2 passes along its North border. Analyzed part of mentioned area has a form of about 1 km wide and 4 km long belt, which lies on the west side of Varta River in north of the highway, up to the first crossing street in the town. In the south part of the belt we can see old forest with remainders of water supply and settler ponds. Next there is an oak forest with several old lakes, and next – grassland with bushes. Northern part of the area is partly gardened. Left border of the area draws a street connected highway with downtown. From time to time needs are formulated to build over this terrain.

Following classes of objects define the cartographic model for analyses of urban green in order to its revitalization.

<table>
<thead>
<tr>
<th>1. The group of natural objects:</th>
<th>2. Changed objects:</th>
<th>3. Artificial forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 – natural water (river, lakes)</td>
<td>2.1 – unnatural water ponds</td>
<td>3.1 – streets</td>
</tr>
<tr>
<td>1.2 – flooded river banks</td>
<td>2.2 – parks</td>
<td>3.2 – train</td>
</tr>
<tr>
<td>1.3 – forests</td>
<td>2.3 – gardens</td>
<td>3.3 – buildings</td>
</tr>
<tr>
<td>1.4 – trees and bushes</td>
<td>2.4 – high vegetation (trees) along streets</td>
<td>3.4 – places and</td>
</tr>
<tr>
<td>1.5 – open area</td>
<td>2.5 – low vegetation (grass, bushes)</td>
<td>parking lots</td>
</tr>
</tbody>
</table>
A number of objects are visible on maps of described terrain, particularly on municipality map which is conducted in vector form as a layer of Poznan Information System. In full domain and degree of reality there are visible artificial anthropogenic forms, external boundaries of natural landscape complexes and also boundaries of parks, gardens and green alongside streets. It was assumed, that these elements can be collected from the map. Remaining elements need to be surveyed. Because of big area of elaboration, photogrammetric method based on satellite images of very high resolution (VHRS) was chosen. For interpretation of this image necessary terrain information was gained as teaching data. Moreover, unreadable or uncertain places were surveyed at site. The map of state of green landscape containing mentioned objects have been elaborated.

3. PHOTOGRAMMETRIC ELABORATION

3.1. Assessment of Quick Bird image

QuickBird imagery has been gained as a source of data for classification. The satellite is next space vehicle after IKONOS, which provide very detailed images of earth surface, with full geometric resolution 0.6 x 0.6 m. The image is composed from panchromatic canal (pixel size from 0.61 m) and three or four spectral canals (from 2.44 m). Images from this source are accessible since 2002 year. Late in 2003 year first publications appeared with fairly estimations of their quality (Oki et al., 2003). The estimation carried out in this project concerned possibility of recognition and geometric location of natural objects in urban environment.

Analyzed image has been collected 1.06.2003, 9.45 GMT with camera directed at 7° to the West. The subject of elaboration was a composition PAN+RGB fused with PanSharpening method and transformed to resolution 0.6 x 0.6 m. The scene includes the west part of the town with suburbs and surroundings. Interested green area is situated in South-East part of the scene. Orthorectification of the image has been omitted because of not high difference within study area (between 53 and 63 m). In this way we avoided degradation of radiometric quality.

The image characterizes with readable texture and sharp differences between lighted places and shadows. Roads and pavement, as well as horizontal marks are distinctly visible. Also the color of the roofs, its edges and chimneys are readable. Comparing the image to the map in 1:2000 scale and orthophotomap in the same scale we can notice its 2-3 times worst geometric quality. For the need of landscape study estimation of described fragment of image was done comparing to cartographic model. Figure 3 shows features corresponding to the description of the model.

![Figure 3. QuickBird image (RGB PanSharpened) of objects taking part of the model of urban green wedge. Numbers correspond to class hierarchy described above. Quality of image is degraded during preparation for publishing.](image-url)

Histograms of base parameters of color composites R, G and brightness for selected features are illustrated on figure 4. All base elements of landscape are good readable despite of very close radiometric parameters. Especially, differences between various types of vegetables are not big. In order to extract the most individual features of analyzed object
classes, it was stated, that classification of image must allow for masking of fragments of terrain and contain elements of fuzzy set theory. Object-base classification fulfills such needs.

3.2. Classification of the image

The program eCognition (www.definiens-imaging.com) has been chosen as a tool for object classification. The initial step of object-base classification is hierarchical segmentation based on radiometric parameters and shape features, with using accessible thematic information. An analyst determines sizes of segments that should correspond to expected sizes of objects. Hierarchical approach allows it for different levels of class hierarchy. As parameter of segmentation in eCognition the ratio between color and shape features may be used, and also proportion between compactness and smoothness of segments.

In our solution the base segment size has been established as equal to 25 pixels, that corresponds to a circle of 3.5 m diameter or a square of 3x3 m what on given image. Middle level, which groups pixels into objects, is build of 150 pixel sized segments, and level of complex shapes is segmented by grouping each 500 pixels. Ratio of color to shape was set as 0.9 to 0.1, and relation between compactness and smoothness as 0.2 to 0.8.

Landscape features obtained from an image at lower segmentation level include tree clusters, their shadows, and also fragments of water bodies and areas covered by other objects. It was difficult to mark out some few coniferous trees among great number of deciduous ones. The middle level contains separate groups of trees and bushes as well as open places and water reservoirs. The highest level in segments hierarchy consists of complexes of trees, openings and water.

To classify objects within eCognition maximum likelihood method is used, allowing fuzzy rules, hierarchical structure of features and their inheritance. Therefore, as main features to characterize objects, RGB values and deviations were used, and also neighborhood of objects on each hierarchy level and between them. The mosaic of features have been gained, which characterizes them with big diversity. This mosaic was used to cartographic presentation.

Gardens appear to be the most difficult area for classification. It was good reason to do several tests and attempts in order to differentiate dense and sparse trees, vegetables and cultivated places there.
4. CONCLUSIONS

It was stated, that the use of very high resolution satellite images in classification of natural forms within urban green areas fulfill the needs. Classification using object-based algorithm gives results, which are very useful for purposes of revitalization of large green areas within the city. Assessment of classification quality at the area of gardens using...
comparison of land cover maps certifies efficiency of the method. Results of described work were used to create a layer of thematic map, which will be used in decision making process concerned revitalization of the area.

Maps presented in this paper show different ways to achieve information about various features forming image of gardens. The map obtained using classification seemed to better show real situation than those elaborated using terrain works and statistical calculations.

The map of land cover features for entire area will be presented in the poster. It covers whole area, containing forests, trees and bushes, grass and so on.

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![Thematic map of various types of vegetation on the area of urban gardens. The map was elaborated using hierarchical object-based classification of QuickBird image](image)

Figure 6. Thematic map of various types of vegetation on the area of urban gardens. The map was elaborated using hierarchical object-based classification of QuickBird image
Figure 7. Thematic map of percentage of area covered by tree crowns comparing to entire areas of each individual garden. The map was elaborated by multiplication of number of trees by mean area of a tree crown.

References


