



## SPECIFICATION OF THE STRUCTURE OF LAND IN HARD-TO-RICH AREAS OF THE REPUBLIC OF IRAQ ON REMOTE SENSING DATA

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### Summary

The paper discusses the problem of using QuickBird space images to provide land cadastral surveys and regulations regarding the protection and rational use of land under specific conditions: hard-to-rich areas, limited funds, time and staff for the inspection and monitoring of large territories. Legal, technical and technological questions concerning the use of QuickBird images and geoinformation technologies for the specified purposes are analysed in the work.

### Keywords

space images • QuickBird • land monitoring • land protection • geoinformation system

### 1. Introduction

Remote sensing data (RSD), in particular space images, are used to solve various issues: from updating cartographic materials, territorial management, environmental monitoring to forest management, archaeological research, and assessment of the consequences of emergencies. The importance of space imagery materials is determined by the technical parameters of satellite systems and it includes imaging in the visible spectrum, infrared, multispectral and hyperspectral imaging, radar and stereo imaging for creation digital terrain models. Although the accuracy of space images is inferior to ground-based geodetic surveys or detailed aerial images, they have a number of undeniable advantages: efficiency, coverage of large areas in a short period, repeatability of imaging and affordable price. Modern materials of space imagery are supplied in digital form, and their processing is completely computerized. The territory of Iraq has suffered from the military actions of the United States and other NATO countries. In addition to humanitarian disaster, devastating socioeconomic consequences of the war there are large problems in the land use.

First of all, as a result of military operations, agriculture, forestry, transport infrastructure, irrigation systems and other categories of land suffer damages.

As during and after the military conflict, it becomes important to make a land-use assessment of the territory (to determine the damage, to reveal the destroyed lands, partially broken, clogged, etc.).

However, such territories are not always available not only during hostilities, but also after their termination. There are many mines, unexploded shells, cartridges in the areas of armed conflict. While there is a process of demining, stripping the territory, it is possible and necessary to start preparatory work for the assessment of damage.

Application of modern geographic information systems (GIS) using high-spatial resolution space materials significantly reduces the time and material and financial resources, to carry out work promptly and at a fixed time. This is due to the prompt delivery of images, high detail, and the availability of prices.

Objects of the research were the neighbourhoods of the cities of Baghdad, Kirkuk, Irbil in Iraq. There were used synthesized RGB QuickBird-1 space images obtained in September 2014 and topographic cartographic materials of scale 1 : 10000 – 1 : 100000 in the capacity of plan and cartographic basis.

## 2. Specification of the composition of land in hard-to-reach areas of the Republic of Iraq

In spite of limited means, time and staff, in the Republic of Iraq land cadastral works, rational use of land and arrangement of land composition in hard-to-access large areas is an urgent task. When approaching this problem, it is helpful to use space imagery, the most important advantage of which is the possibility of collecting information for hard-to-reach areas, or for territories where ground surveys are impossible or unsafe for some reasons: areas of military operations, natural disasters, sparsely populated areas or hard natural climatic conditions or relief. But in such areas, we have to solve the tasks of land management, cadastral or land-based nature.

Clarification of the composition of land on the basis of space images must be preceded by accomplishment of the following tasks:

- study of the main features and technical characteristics of modern high-resolution remote sensing data,
- analysis of legal, technical and technological issues related to the use of high-resolution remote sensing data,
- empirical study on using QuickBird space imagery for land cadastral works,
- study of technological aspects of the use of QuickBird space images to clarify the composition of lands in hard-to-reach areas (in the case of Iraq).

The aim of the paper is to analyse the possibilities of interpretation of space images of the territory of Iraq with the purpose of updating topographic maps.

The modern methodology of using remote sensing data is based on the rules set out in XCCXXYY. According to them, all processing and almost all the use of RSD is digitised by computers, all data derived from the interpretation of remote sensing data are prepared for use as part of spatial databases of geoinformation systems. In

the process of using RSD, a wide variety of other data types organized in the form of GIS databases are also involved: field survey data, various maps, other remote sensing data, geophysical and geochemical fields characterizing certain natural environments. Work with remote sensing data is not done with individual images, but with a virtual mosaic of many frames. Methods of automation of thematic processing, automation of interpretation are not considered as methods of obtaining the final result, the main and final decisions are most often accepted by a person.

The possibilities of using QuickBird space imagery for land management and land cadastral works are determined by the geodetic accuracy of the interpretation that they provide. Cartographic evaluation of these images was carried out by, e.g., Oliynyk et al. [2005] and Karpinsky et al. [2007]. The authors came to the conclusion that the resolution and accuracy of QuickBird images can provide maps with a scale of 1 : 5000. At the same time, their nominal resolution (viewing at 100% increase) corresponds approximately to the scale of 1 : 2000, but comfortable conditions for working behind the computer screen during interpretation are 1 : 1000.

Space images can significantly supplement and correct maps of land areas on the territory of the farms of the districts. The methodology for drawing up such maps of land resources using QuickBird space images, using ERDAS Imagine software is described in the publications of Gotynyan and Aristov [2007] and Lashchanov [2005], as well as on the site of the organization Priroda [[www.pryroda.gov.ua](http://www.pryroda.gov.ua)].

Our work is devoted to the unresolved parts of the general problem associated with the allocation of land contours and recreational and park infrastructure, landscaping, hydrography and transport network, residential and household buildings on maps of the territory of the Republic of Iraq with the purpose of drawing them on maps and assessing damage to agriculture or landscape.

The goal of the study is to determine if land-use assessment (identifying the scope of damage, places where lands are destroyed, partially devastated, clogged, etc.) in certain regions of the Republic of Iraq is possible by means of RSD.

Remote sensing data for the territories of the Republic of Iraq is quite informative. Figures 1–2 show the various categories of land in the city of Baghdad, demonstrating the possibilities of their interpretation on the QuickBird space images.

Vectorization of the borders of sites, of irrigation canals and transport infrastructure was carried out for Baghdad and its environs.

Also, space images were used to develop the master plan of the city of Suleymaniyah using GIS (ArcGIS) (Figure 3).

### 3. Conclusions

The practical importance of the work consists in the possibility of solving a number of problems of thematic mapping of territories, as well as issues concerning land administration and monitoring and rational land use in the conditions of limited time for collecting information, the vastness of territories and a small number of personnel, or other limiting factors (e.g. limited accessibility).



Source: authors' study

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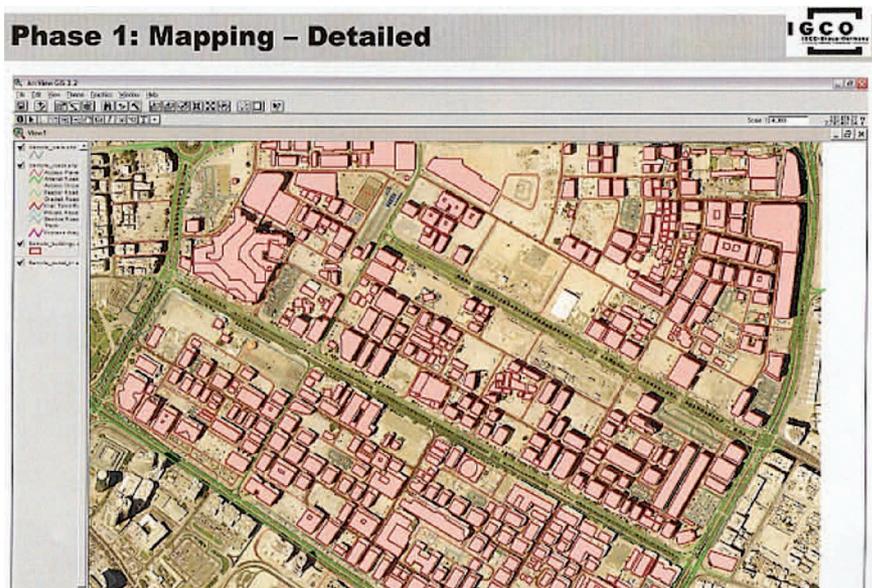
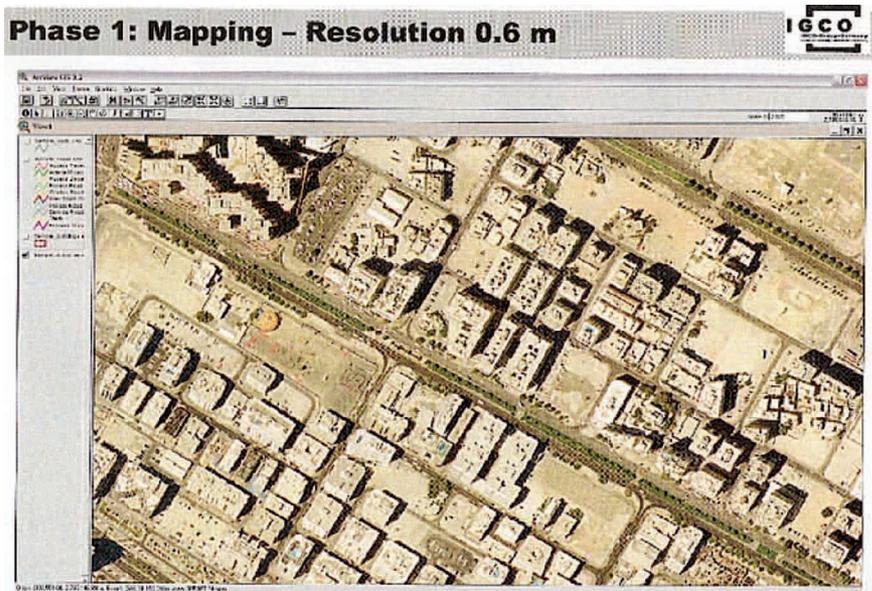
**Fig. 1.** Vectorization of the boundaries of the lands of settlements, persimmon gardens, rivers and transport infrastructure (Baghdad)



Source: authors' study

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**Fig. 2.** The vectorization of irrigation canals and transport infrastructure on agricultural lands (suburb of Baghdad) near the village of Kala-Hasan al-Suheil



Source: authors' study

Fig. 3. Using QuickBird satellite imagery in the development of the general plan of the city of Sulaimaniya

The study allowed to outline contours of lands and objects of recreational and park infrastructure, landscaping, hydrography and transport network, contours of agricultural land, fields under different crops, irrigation system objects, residential and household buildings, perennial fruit plantations (persimmon groves), show agricultural land damaged by military operations (defensive fortifications, transport network), their area and damage to agriculture or landscapes, forestry of mountain slopes, development of new residential towns in the form of cottage buildings on agricultural lands, etc.

The implemented work allows us to state the following:

1. The use of high-resolution remote sensing data, including QuickBird satellite imagery, allows digital terrain mapping at a scale of 1 : 5000.
2. QuickBird space images are suitable for planning and mapping land cadastral works at a scale of 1 : 5000 as the most up-to-date and operational cartographic basis.
3. QuickBird space images allow effectively monitor the use and protection of land in the development of minerals in a superficial way.
4. The use of QuickBird space-based images is particularly effective in difficult terrains or with limited resources, time and staff for surveying and monitoring large areas.

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