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***Research Article***

# CREATION OF AN AUTOMATED SYSTEM OF THE STATE FOREST CADASTER IN UZBEKISTAN

***Bakhtiyor Tokhtaevich Kurbanov and Utkir Khotamovich Imomkulov**
*National Center of State Cadasters, Geodesy and Cartography (NCSCGC), State Committee of The Republic of Uzbekistan on Land Resources, Geodesy, Cartography and State Cadaster, Bunyodkor Avenue-28, 100097, Tashkent city, Republic of Uzbekistan*
**Author for Correspondence*

## ABSTRACT
In Uzbekistan, work was carried out to develop the National Geographic Information System of the Republic of Uzbekistan. It is an integral part of the "Electronic Government" system, which provides for the creation of a satellite geodetic network, a unified computerized system of state cadasters, etc. The purpose of the system is to provide management bodies and consumers with the necessary information and resource base for the rational use and protection of natural resources, the integrated development of the regions of the republic. This work is devoted to the development of an automated system of the State Forest Cadaster as an integral part of the Unified System of State Cadasters. Research conducted on the basis of the ArcGIS software package.

***Keywords:*** *Monitoring of Environment, GIS technology, Remote Sensing, Cadaster, Forest Inventory*

## INTRODUCTION
The unified computerized system of state cadasters (USSC) is an open system and includes more than 20 industry cadasters. The USSC is called upon to integrate heterogeneous information coming from various industry sources (ministries and departments), process it in a single information environment and give it out to persons making managerial decisions in a form convenient for them (Kurbanov *et al.*, 2005; Kurbanov *et al.*, 2015). An important component of the UGSS is the integrated system of the State Forest Cadaster of Uzbekistan.

The integrated system of the State Forest Cadaster is a set of data systematized on a single geographical information basis. It contains the necessary and reliable information about the natural, economic and legal status of the lands of the forest fund of the Republic of Uzbekistan, their location and size of plots, their assessment, etc. It is compiled on the basis of forest management data for the organization of rational use of forests, forestry development planning, etc. The State Forestry Cadaster contains information on environmental, economic and other quantitative and qualitative characteristics of the forest fund. The automated system of the State Forest Cadaster is a complex multi-factor system. For the successful implementation of the system, it is advisable to use modern information technology and remote sensing materials (Kurbanov 2005*a*; Kurbanov 2005*b*; Kurbanov *et al.*, 2013). The data of the state forest cadaster are used in managing the development of territories, managing forestry, organizing its maintenance, assessing the ecological condition of the territory, transferring forest lands to non-forest lands for purposes not related to forestry and using the forest fund, and when transferring forest fund lands to lands of other categories, assessment of the economic activity of persons engaged in forestry, etc.

## MATERIALS AND METHODS
### *The use of remote sensing materials to analyze the state of vegetation and forests*
The State Forest Cadaster is maintained by the State Committee of the Republic of Uzbekistan on Forestry. The creation of an automated system of the State Forest Cadaster was carried out at the National Center for State Cadasters, Geodesy and Cartography (NCSCGC).

Analysis of the global market for geographic information products showed that today ArcGIS is the most suitable software product for creating and maintaining automated cadastral systems, including an

automated system of state forest cadaster. This software combines a developed interface for maintaining a cartographic database in combination with a semantic database. ArcGIS enables processing, orthorectification, automated decryption and the use of high-resolution satellite imagery (Kurbanov *et al.*, 2018; Kurbanov and Halmatov, 2012). The most important qualities of the data used in the decision-making process are their relevance, completeness, reliability and objectivity. Remote sensing data, primarily satellite imagery of high and ultra-high resolution, have all these qualities. Space imagery materials contain a continuous field of information over the entire coverage and all the individual features of each object of the forest fund. Remote sensing allows you to get the most relevant and reliable information about the state of forests, their characteristics, which is especially important for conducting a situational analysis in order to develop optimal solutions. Along with statistical materials, remote sensing data is the main information base on which the integrated automated system of the State Forest Cadaster (ASSFC) is built. Modern high-resolution images and software products for their spectral processing make it possible to assess not only the ecological state of the forests as a whole, but also each tree individually. Recently developed new image acquisition and processing systems provide information on the structure of forests, their biophysical parameters and ecological status. The use of spectral information in the form of images in conjunction with the data of field observations allows extrapolation to obtain information about objects that have not been field observations with great accuracy (Boriah 2010; Iisaka 2000; Lopatin, 2002). For this reason, an important block of ASSFC is the block for the use and high-precision processing of remote sensing materials of medium, high and ultra-high resolution, taking into account relief effects.

When decrypting high-resolution satellite images with the aim of more detailed classification of the species and condition of forests, agricultural crops and pasture vegetation, experiments on automatic classification were carried out. The classification used satellite images QuickBird. The technology of sub-pixel classification was tested by the ERDAS Imagine Subpixel Classifier module (Zhuraev *et al.*, 2013; Kurbanov and Askarkhodzhaev, 2018; Coppin *et al.*, 2004; Kurbanov *et al.*, 2014).

In this case, four spectral ranges were involved for analysis: red, green, blue, and near infrared. The experiments showed that the use of a layer with a near infrared spectrum significantly improves the decryption procedure, increasing the gradation of the state of the vegetation cover in the study area, including trees. An example of automated decoding of space images of Quick Bird, including the near infrared layer (Figure 1 and Figure 2), is presented. The bottom image shows the result of automated decryption using four channels. Areas with a very good state of vegetation are highlighted in blue. Areas with an extremely unsatisfactory state of the vegetation cover, including trees, are highlighted in red.

**Figure 1: Space image of QuickBird (Kamchik pass)**

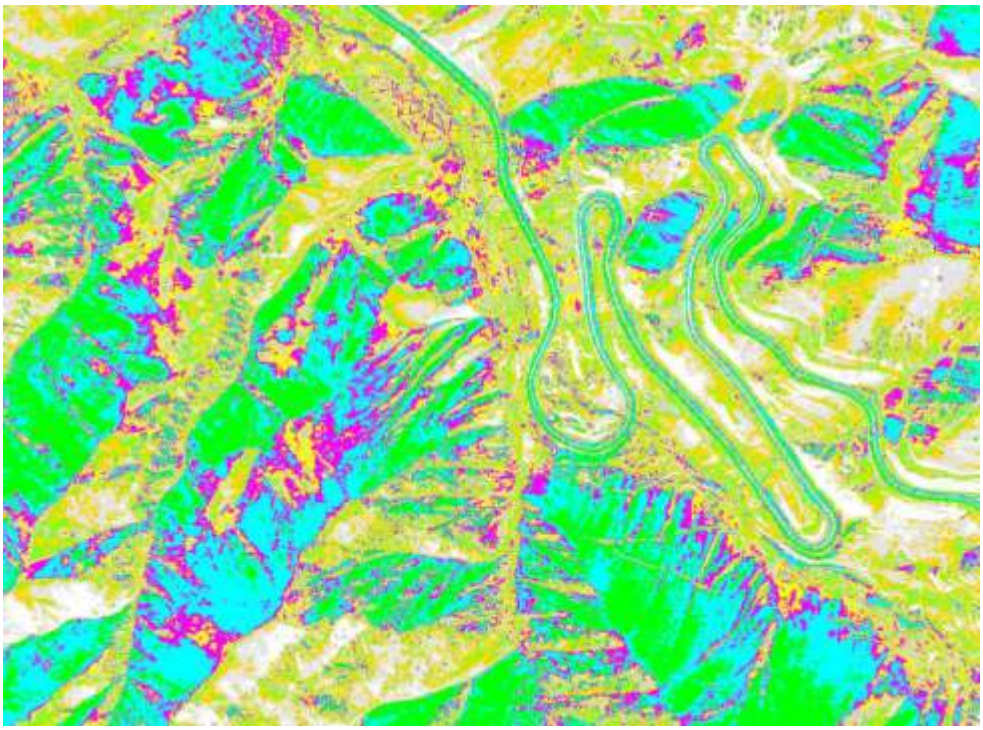

**Figure 2: An example of automated decoding of a QuickBird satellite image, including the near infrared layer**

***Development of an automated system of the State Forestry Cadastre***
***Development of a database of attribute information***

The State Committee of the Republic of Uzbekistan on Land Resources, Geodesy, Cartography and the State Cadastre, which was entrusted with the creation and maintenance of an automated Unified System of State Cadastres (USSC), has purchased more than 100 licenses for ArcGIS software. Licenses purchased with varying degrees of software use. For this reason, this project was developed in the ArcGIS environment and in this work, the main attention is paid to the use of this particular software (Kurbanov and Halmatov 2012).

The specialized forestry Abu Ali ibn Sino, located in the Namangan region and characterized by saturated forests with a wide species composition of forests, was chosen as the object for developing the model.

Since all information regarding the state of forest lands and their parameters flows to State Committee of the Republic of Uzbekistan on Forestry, the collection of necessary information was carried out there. Reporting cadastral data (tabular and cartographic) was collected. Based on the tables, a relational database was developed in the DBMS ACCESS and/or SQL SERVER environment. The database exactly corresponds to the information structure of the cadastral book. With one exception, namely, in the database there are no fields with total data, because they can be easily calculated.

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In developing the structure of the database of semantic information (DB) and its maintenance, the following tasks are also solved:

• the ability to establish and maintain communication between cartographic objects and semantic database records;
• input and correction of information;
• maintaining classifiers and reference books, including documentation of finished classifiers and reference books;
• the ability to access classifiers and directories from the procedures for maintaining a database of semantic information and a cartographic database.
• ensuring the protection of information from unauthorized access.

***Development of a database of cartographic information.***

Cartographic information reflects the location and configuration of those accounting units for which cartographic reference is appropriate (sections of the territory, linear sections of communications, point features). It is represented by a set of electronic maps (plans), on which the territory of the entire facility or its individual parts is depicted on an appropriate scale. Attribute data of the thematic layers of the GIS of the State Forest Cadaster are compiled in strict accordance with the cadastral book of the State Forest Cadaster.

When designing, developing and maintaining a cartographic database, the following tasks were solved:

- provided the ability to enter data from various sources;
- registration and automatic error correction;
- the presence of developed interactive graphic editing tools;
- work with remote sensing materials;
- automatic formation of topological structure, etc.

The unit for the formation and withdrawal of cadastral, reporting, analytical and presentation materials performs the following main functions:

- formation and output of tabular and text documents;
- formation and output of cards and schemes, etc.;

***Geographic Information Database Architecture***

The specific method of communication between database information, cartographic information, and Earth remote sensing materials is determined by the software used to maintain the forest inventory. The methods of communication between database information, cartographic information, and Earth remote sensing materials have been correctly solved in the ArcGIS environment. This is one of the main reasons why the ArcGIS software package was used to develop an automated system of the State Forest Cadaster.

The architecture of the geoinformation database of the automated GIS of the State Forest Cadaster was developed in the MS Visio environment. During the development of the model, they were repelled from the main thematic layers:

• Thematic layer “Forestry departments”;
• Thematic layer “Forest quarters”;
• Thematic layer “Forest lands”;
• Thematic layer “Non-forest lands”.

Based on this model, an automated geographic information system of the State Forest Cadaster was built. The geoinformation database in the ArcGIS environment in the format (* .gdb) as well as other attribute information databases are developed on the basis of a DBMS (Microsoft SQL Server).

***User Friendly Development***

An important component of the system is the development of computer programs and a user-friendly interface for interaction with other automated cadastral systems of USSC. The analysis showed that the C # programming language is the most suitable for solving the tasks set in the project. Interactive graphical editing tools were developed on the recommendation of the State Committee for Forestry - the main user of an automated system - in the state language. Interactive tools are formed on the platform of Microsoft Visual Studio C # and .NET. An example of a dialog box for editing forestry facilities is presented (Figure 3). Other blocks have also been developed in the form of windows of developed interactive

graphical editing tools that allow, based on the GIS application, to fully manipulate, edit, process the data of the objects of the State Forest Cadastre, to obtain the necessary information using the information retrieval system, etc.

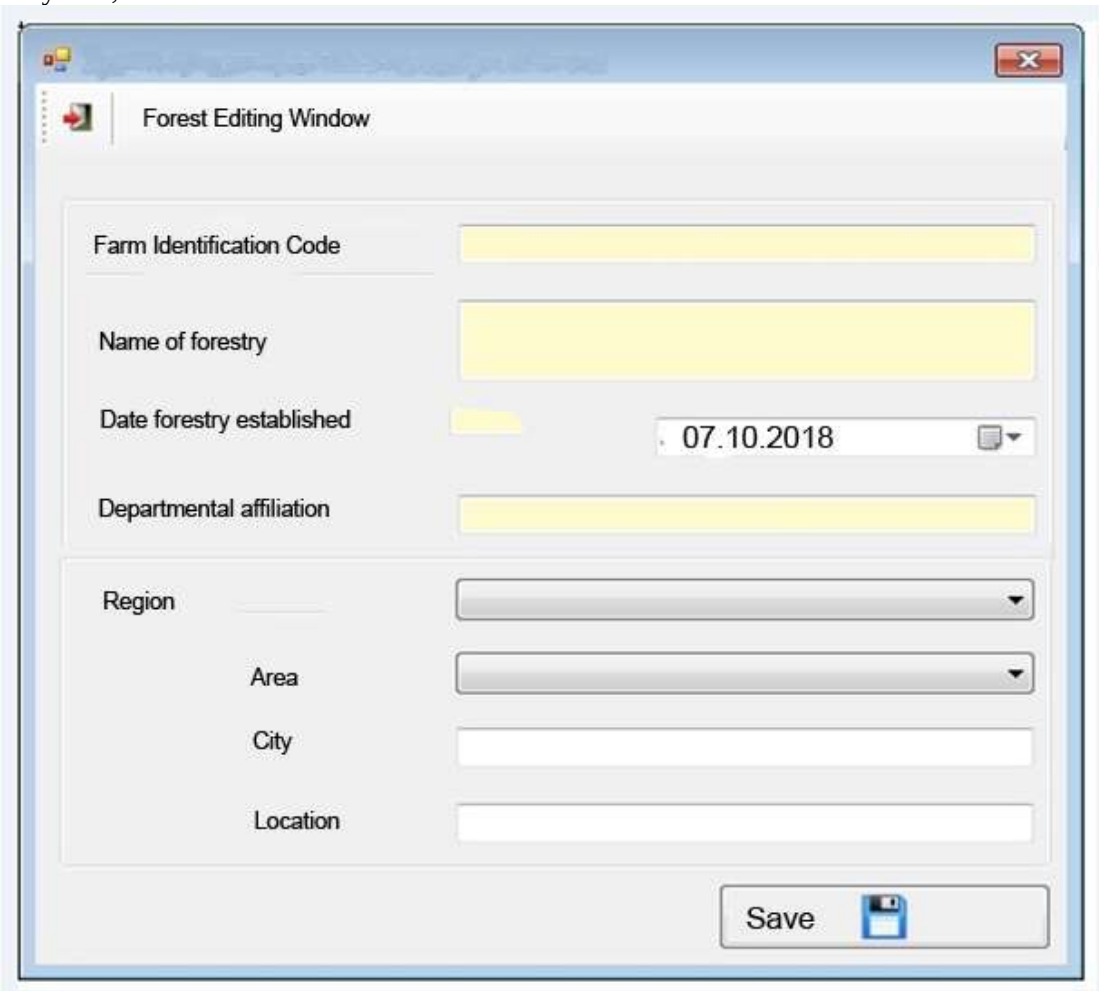


**Figure 3: Dialog box for editing forestry facilities**

***Development of an information retrieval system***

Using a search engine, a user for a given query can get links to documents matching this query.
The search engine consists of three components:
-1- search robot;
-2- system index;
-3- a program that (a) processes a user's request, (b) finds documents matching the query criteria in the index, and (c) displays a list of documents found in descending order of relevance. Documents can represent both attributive and cartographic information.
The information retrieval system (IRS) primarily includes information from the forest cadastral book - regulatory, legal documents. It is implemented as a database or as a textual IRS, where the details of documents, information about their location and, if necessary, annotations or abstracts are entered.
Description of documents, attributive materials and information about the object can also be combined with cartographic information.
An example of searching for an object with identification number 003: 0001: 008 using the information retrieval system and the issuance of attribute information tied to this object is shown (Figure 4).

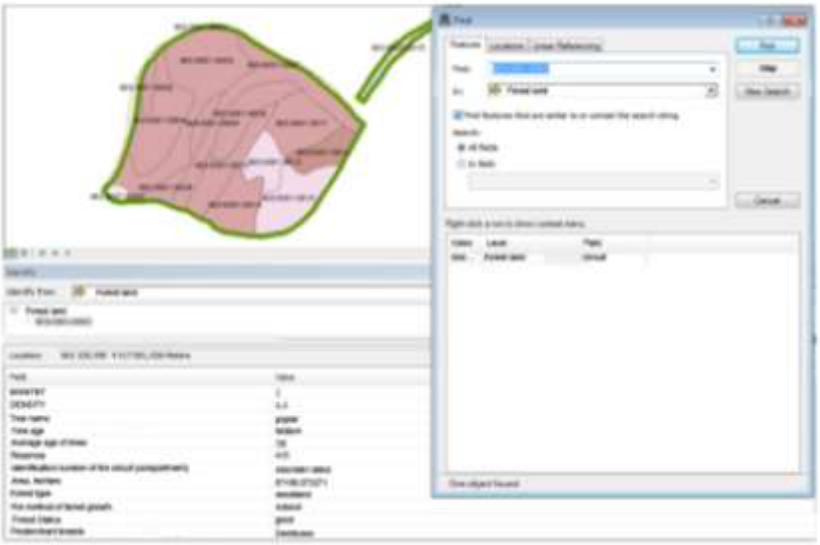

**Figure 4: Search for a graphic with the identification number 003: 0001: 008 using the information retrieval system**

## DISCUSSION

The model of the automated system of the State Forest Cadaster developed and described above has now been transferred to trial operation in State Committee of the Republic of Uzbekistan on Forestry and to the information database preparation department

In the process of trial operation of the model, according to the recommendations of the State Forest Cadaster of Uzbekistan information database preparation department, a number of improvements were made. In particular, the attributive database has undergone changes in comparison with the previously developed one. These changes were made in accordance with the recommendations of the UN Commission on the Environment.

The general view of the forest branch "Gulistan" of the specialized forestry Abu Ali ibn Sino and its attribute data is presented (Figure 5).

**Figure 5: General view of the forest branch "Gulistan" of the specialized forestry Abu Ali ibn Sino and its attribute data**

## Conclusion

In the process of project implementation, the following main results were obtained:

• The main blocks and nodes of the automated GIS of the State Forest Cadaster have been developed;
• By agreement with the State Forestry Committee of the Republic of Uzbekistan, a modified database structure and the connection of semantic information with cartographic information have been developed
• By agreement with the State Committee of the Republic of Uzbekistan on Forestry, the composition of the thematic layers of the GIS of the State Forest Cadaster has been determined;
• The attributive data of the thematic layers of the GIS of the State Forest Cadaster, their organizational form, and recommendations for their completion were developed;
• Based on the developed user-friendly interface, an information-search system has been created that provides the search for both attributive and graphic information;
• Based on the above work, a model of automated GIS of the State Forest Cadaster was developed. The model was tested at the State Committee of the Republic of Uzbekistan for Forestry, and its employees were trained in the operation of the automated system of the State Forest Cadaster. Based on the recommendations received, the model was transferred to the State Committee of the Republic of Uzbekistan for Forestry.

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