STORING, PROCESSING AND VISUALIZATION OF ARCHAEOLOGICAL INFORMATION USING GIS: A CASE STUDY - KABIYUK ARCHAEOLOGICAL SITE

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ABSTRACT

Today non-destructive archaeological methods are essential for the archaeological research. Developing such methods based of Remote Sensing and GIS solve many problems in the field of archaeology especially important for precise and detailed documenting of the archaeological site. The geodatabase is probably the most compact and conveniening way for storing, processing and analyzing data. The purpose of this paper is to present a combination of remote sensing data integrated with GIS technologies, focusing on the geodatabase creation and data processing for the non-destructive survey of the archaeological site "Kabiyuk". It serve as a tool for performing of spatial analysis, documenting and storing the results of the archaeological surveys, and planning of future archaeological surveys and studies

Keywords: GIS, remote sensing, geodatabase, non-destructive methods in archaeology

INTRODUCTION

The current paper presents results of a research project for archaeological site Kabiyuk, aiming at elaboration of complex multidisciplinary approach for studying large areas of archeological sites with use predominantly non-destructive methods The main accent of the project is put on the use of non-destructive methods - aerospace methods and technologies, geophysical methods and geographic information systems for investigation of archaeological sites and their combination with the classical archeological methods. The non-destructive component is significant part of the project and comprise the survey of the Kabiyuk archaeological site through satellite and aerial remote sensing methods and geophysical prospection combined with archaeological terrain surveys, which will serve to identify the locations where classical archaeological methods (drilling and excavation) will be applied by the archeological team [1].

The project "NHAR Kabiyuk: Complex interdisciplinary study of one of the non-capital royal residences (Aul) of the First Bulgarian Kingdom" marks a new stage in the development of the archaeological research in Bulgaria. This is the first archaeological project aimed to explore the whole area of Kabiyuk and the first project in Bulgaria focused entirely on the leading role of methods for non-destructive survey.

The aim of this paper is to present the remote sensing part of the project, focusing on the geodatabase creation and data processing for the non-destructive survey of the archaeological site "Kabiyuk".

STUDY AREA

The archaeological site "Kabiyuk" is located approximately 12 km northeast from Shoumen town, Northeast Bulgaria (Fig. 1). Kabiyuk is important Early Medieval archaeological site, one of the non-capital royal residences (Aul) of the First Bulgarian Kingdom with an area of 5.7 sq. km. Its earthen rampart is the second biggest one after the fortification of the First Bulgarian Capital – Pliska. In 2011 the Kabiyuk archaeological site was announced as a National Historical and Archaeological Reserve.

The archaeological site was discovered during the field observations and excavations made by K. Shkorpil in the end of XIX century and the beginning of the XX century [2]. According to the literature during the years the site was explored sporadically and only separate structures were studies [3], [4], [5], [6] and [7].

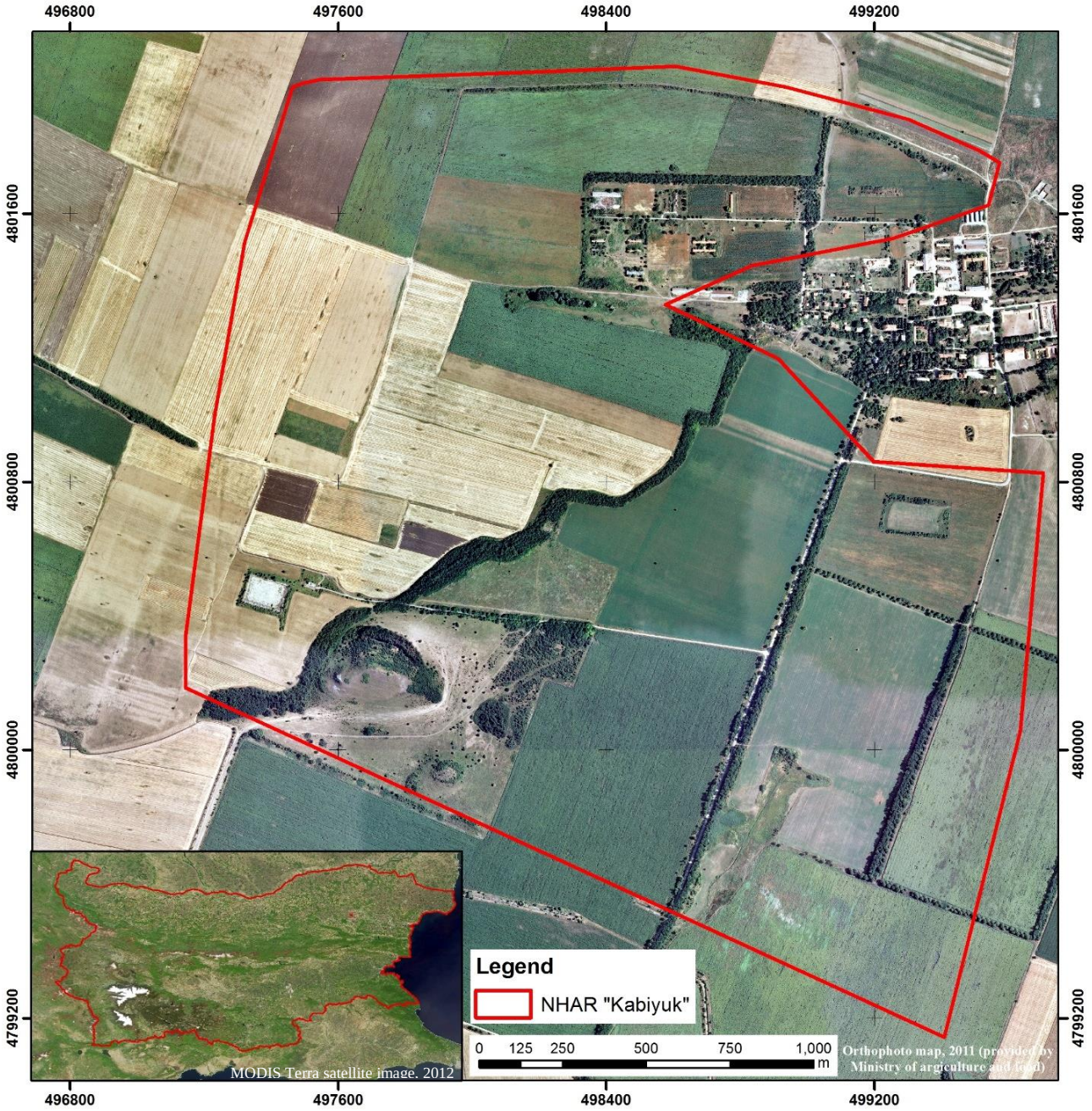

Fig. 1. Location of Kabiyuk archaeological site

GEODATABASE - DATA STORING, PROCESSING AND VISUALIZATION FOR ARCHAEOLOGICAL SITE "KABIYUK"

A geo-database model of NHAR "Kabiyuk" containing remotely sensed and ground-based data was designed. The main objective of the geo-database is to support the non-destructive survey of

archaeological site Kabiyuk, documentation and preservation of the results from archaeological surveys, and usage in the planning of further studies of the site The Kabiyuk geodatabase has been built using ArcGIS 9.2 ESRI software product and the data included in it cover the time period from 2002 to 2013.It includes remote sensing data for different years - 2002, 2006, 2009, 2011, as well as data from the field archaeological survey (Fig. 2).

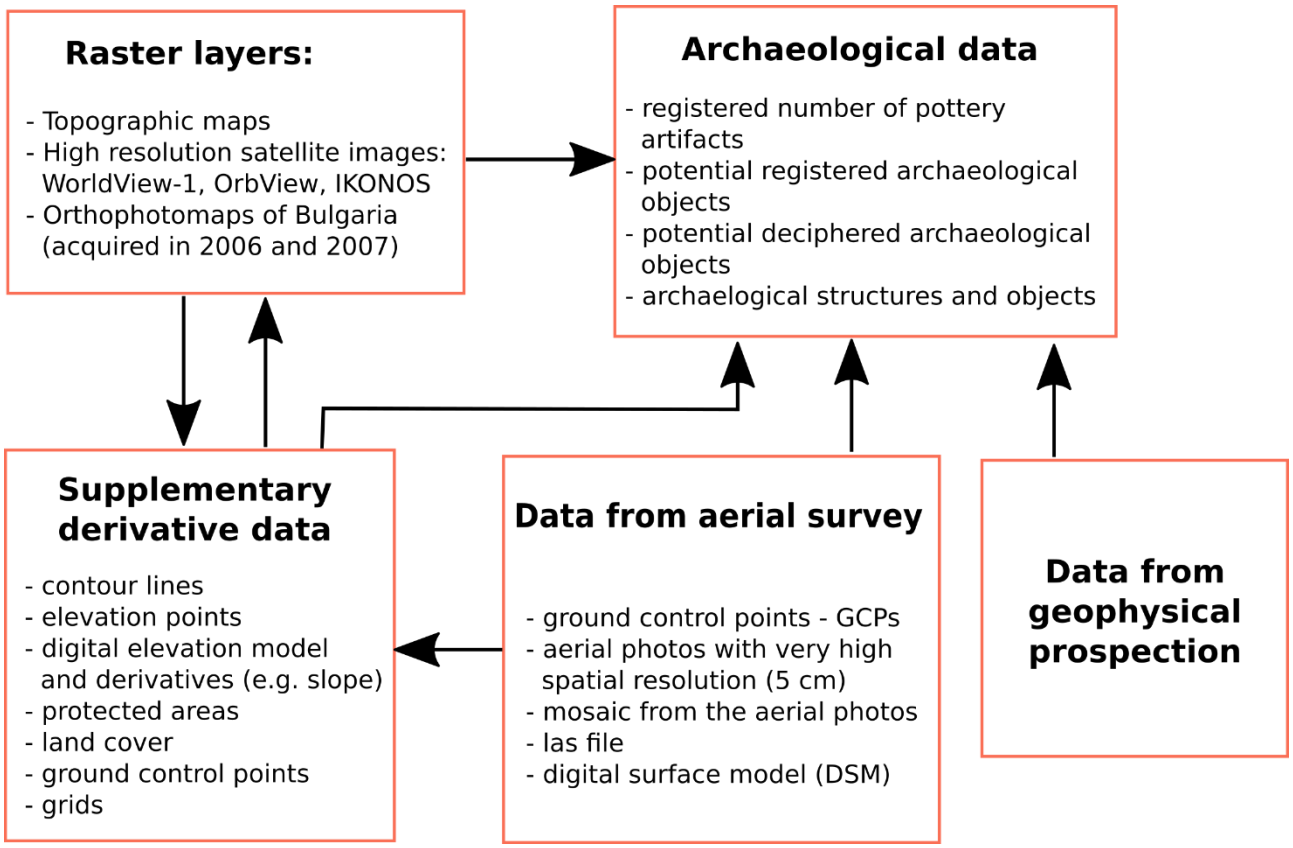

Fig. 2. Geodatabase scheme - overview

During the project implementation the created geodatabase was supplemented and updated regularly with new information and thematic layers from the archaeological surveys and the interpretation and analysis of the remote sensing data. Large scale topographic maps (scale 1:5000, coordinate system 1970) of the study area were georeferenced in UTM, WGS 84 and were added to the geodatabase. Overview of the structure of the geodatabase is shown on fig.3

The raster data *for the Kabiyuk archaeological site:*

- Georeferenced and orthorectified high resolution satellite images form the satellites WorldView-1, OrbView and IKONOS. The WorldView-1 satellite image for the territory of NHAR "Kabiyuk" purchased by NAIM-BAS in 2010 under project TC01/0444 "Old Bulgarian capitals Pliska, Veliki Preslav and their surroundings". The OrbView satellite images are freely available and two chosen panchromatic images for Kabiyuk are acquired in May 2006. Based on a thorough review an IKONOS satellite image acquired in March 2002 for the study area were ordered, orthorectified and added into the geodatabase.
- Orthophotomaps from aerial survey on the territory of Bulgaria in 2006 and 2011 with spatial resolution 0.50 m and 0.40 m respectively. The data are provided for use in research projects

by the Ministry of Agriculture and Food of Republic of Bulgaria. The orthophoto maps are acquired during the summer months, which makes it difficult to decipher them for the archaeological purposes, but provides detailed information on current land cover in the study area, which is important for the planning of the archaeological field survey.

- Aerial photos with very high spatial resolution - 1880 aerial photos with 5 cm spatial resolution for the territory of NHAR "Kabiyuk". The aerial scanning has been made with 70% longitudinal and transverse overlap of the images which allows a detailed digital surface model (DSM) to be generated.

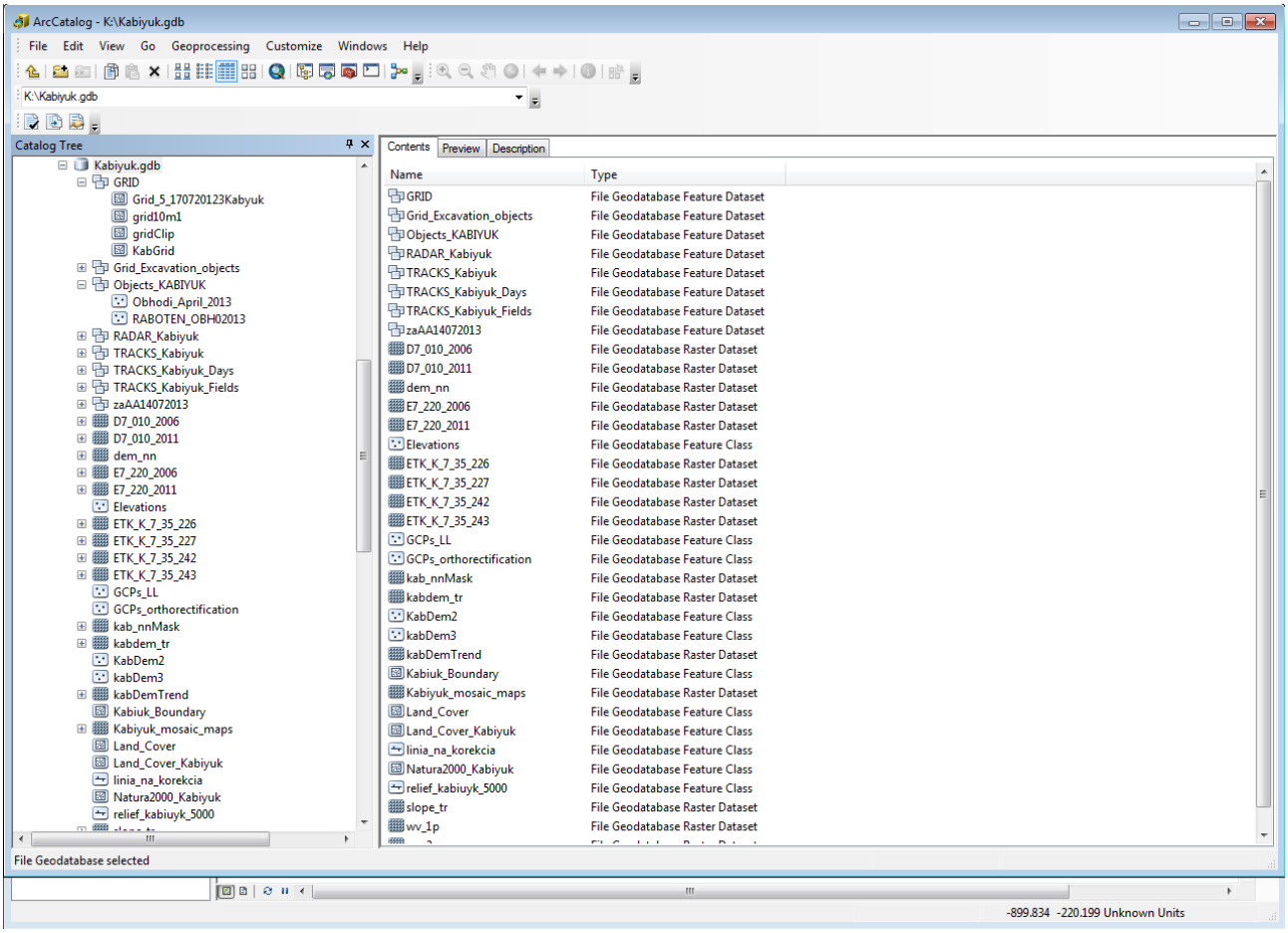

Fig. 2 – Overview of the file geodatabase of NHAR "Kabiyuk"

Archaeological data *in vector data format*

As a part of the non-destructive survey of the archaeological site "Kabiyuk" were conducted archaeological field surveys with the arcaeolgical team from NIAM-BAS in April and November 2013 and approximately 70% of the study area has been explored. The methodology for archaeological field survey including the preparation process for it has been presented partially at the Digital Heritage 2013 Congress in Marseille [8]. As a result of the field surveys were registered several vector data containing archaeological information. The thematic layers contain information about the number of registered pottery fragments, artifacts and registered potential archaeological

site. As an example of the collected information during the archaeological field survey presented a map with the locations of the registered numbers of pottery artifacts on fig. 4.

Fig. 4. Visualization of the locations of the registered numbers of pottery artifacts during the conducted archaeological surveys

Data processing

The preliminarily data processing include the transformation of all data for the study area into unified coordinate system – UTM, WGS84, зона 35N and through georeferencing, orthorectification and projection of all remote sensing data, topographic maps and vector data. The orthorectification of the satellite images has been made using ground control points measured with high-precision dual-frequency GNSS receiver X91 with controller. The ground control points are distributed throughout the NHAR "Kabiuk" as well as beyond its borders in order to achieve high accuracy of the orthorectification of the satellite images. Photo documentation and a description of the measurement parameters were performed for each ground control point and this information is added to the geodatabase.

Computer-aided visual deciphering and interpretation of remote sensing data has been carried out as a result of it several thematic layers containing information about the basic land cover types has been generated. These data are needed for the planning and conduction of the archaeological field excavations, which methodology has been described presented and published at the Digital Heritage 2013 conference [8]. The method of computer-aided visual deciphering and interpretation has been applied for identification of potential site distinguished on the satellite images and aerial photos.

CONCLUSION

The project "NHAR Kabiyuk: Complex interdisciplinary study of one of the non-capital royal residences (Aul) of the First Bulgarian Kingdom" is unique for Bulgarian archaeology and not only. For the first time an integrated methodology for non-destructive archaeological research was applied in a project. This methodology is developed as complete preliminary stage of the archaeological research combining data preparation and analysis, terrain research methods and successive data analysis in one methodology. This expands vastly the possibilities for archaeological research, its planning, documenting the discoveries and storing the information in a detailed and convenient form for future research.

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