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LAND USE CHANGE OF THE *KUTINA PYRAMIDS* NATURAL LANDMARK AREA

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Abstract: *In relation with the high industrialization rate during the recent decades and the active anthropogenic activity, adequate land use and land use change turns to be a problem of extreme importance concerning the sustainable development of any territory. The report presents a study on land use change in the region of the Kutina drainage basin, a territory where intensive coal-mining took place which had direct impact on the Kutina Pyramids natural landmark located in the area. The registered land use change was obtained based on visual interpretation and deciphering of aerial photos of the Golemiya Dol sub-catchments area, a part of the Kutina drainage basin, where the natural landmark is located for two time periods – prior to the start of the lignite coal mining activity and after its termination and the performance of partial reclamation activities. Significant land use change is observed on the examined territory. Before the start of the mining activity, the territory was occupied mainly by arable land, meadows, and barren (denudated) land – rocks and soils, with a very low percentage of available forests. Nowadays, a great part of the Golemiya Dol sub-catchments area is occupied by (coniferous or deciduous) forests and pastures.*

Introduction

As a result of the high industrialization rate in the last decades and the active anthropogenic activity, adequate land use complying with preservation of the environment is becoming an increasingly topical issue. Land use and its changes are an essential input into decision-making for implementing appropriate policy and effective planning of each territory.

The purpose of the study is a large-scale mapping of the land use change on a natural landmark in a stage of degradation on catchments mapping level using GIS and remote sensing methods in addition to existing topographic maps and fieldwork[*]. Remote sensing methods and GIS technologies make it possible to identify the areas with strongest land use changes and determine their spatial parameters.

The study area, the Kutina catchments area, is located in the northwest part of the Metropolitan Municipality. The major emphasis is placed on land use changes of the Kutina Pyramids natural landmark area, located in the Kutina's sub-catchments called Golemiya Dol (Fig.1). The area of the Golemiya Dol is 1.93 km^2. The Kutina Pyramids was awarded the status of a natural landmark in 1962. They represent a group of earth pillars in a stage of accelerated destruction, as a result of the anthropogenic activity and lignite coal excavation, carried out in its immediate vicinity (Kanev, G. et al, 2006). The study area is chosen because of the dynamic changes that have taken place in it during the last 60 years, especially the development of the Kutina mining site.

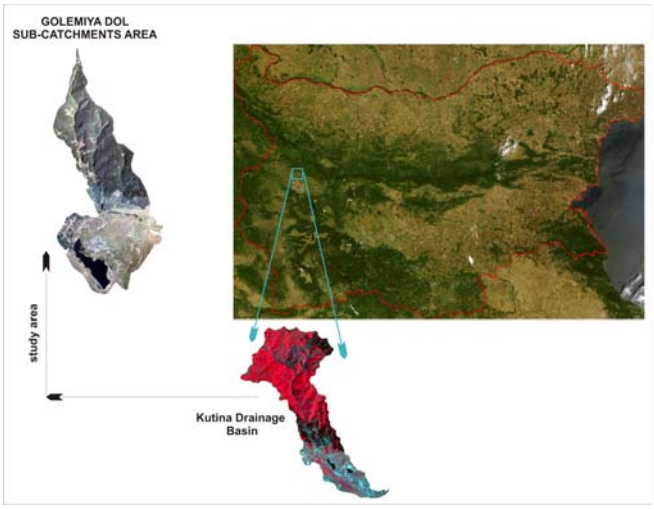

Fig. 1

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Methods

The basic methods used for creating a geodatabase aimed at land use mapping and land use change detection is geoinformation technologies which include GIS and remote sensing techniques. The methods used in the study include 9 major stages (Fig. 2).

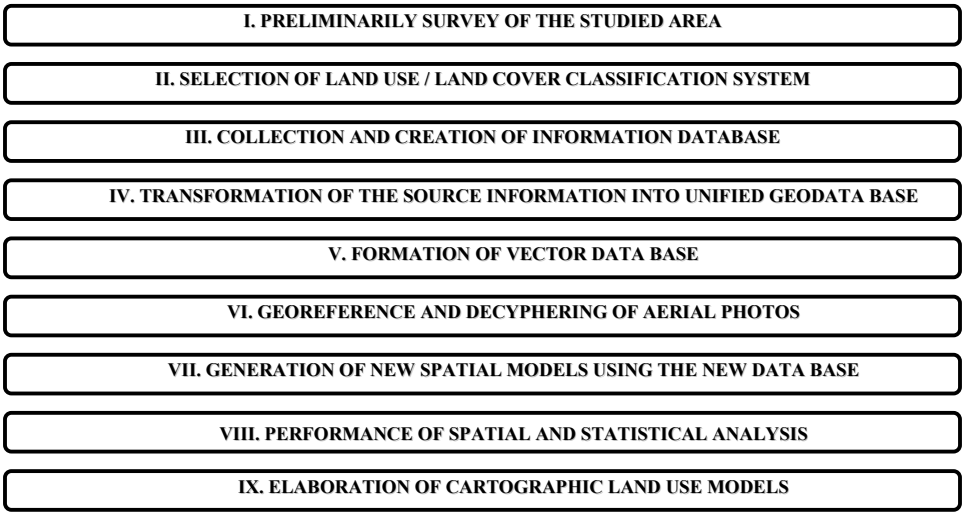

Fig. 2. Working stages

One of the most important steps is the selection of land use/land cover classification system. The presented land cover/land use classification is based on the USGS land cover/land use classification system (Anderson, J. 1972, 1976) and is adapted for the territory of Bulgaria (Table 1).

Table 1. Land cover / land use classification

No	LEVEL I	LEVEL II
1	BUILD-UP LAND	RESIDENTIAL
		SUMMER-HOUSES' AREAS
		INDUSTRIAL
		TRANSPORTATION, INFRASTRUCTURE AND UTILITIES
		AGRICULTURAL BUILD-UP LAND
2	AGRICULTURAL LAND	CROPLAND
		PASTURES
		PERMANENT PLANTS (ORCHARD, VINEYARDS)
		OTHER AGRICULTURAL LAND
3	VEGETATED LAND	MEADOW
		SHRUB
		MIXED VEGETATED LAND
4	FOREST LAND	DECIDUOUS FOREST
		CONIFEROUS FOREST
		MIXED FOREST
5	WATER AREAS	STREAMS / RIVERS
		CANALS
		LAKES
		RESERVOIRS
6	BARREN LAND	BARE SOIL / ROCKS

Database organization

The geodatabase created for the purpose includes archive panchromatic and coloured aerial photographs, large-scale topographic maps, data from terrain studies and GPS measurements, photos, thematic maps and other department databases. Based on the created database and the defined land use/land cover classification system, a number of thematic cartographic models, tables, and graphs were produced. The data are divided into three groups depending on the way they were obtained – input information, derived data and output results (Fig.3). The output results are presented

in the form of assessment maps, graphs and tables. The created personal geodatabase comprises the following geodatabase elements – feature dataset, raster datasets, attribute data (tables) and additional elements, such as graphs and diagrams (Table 2).

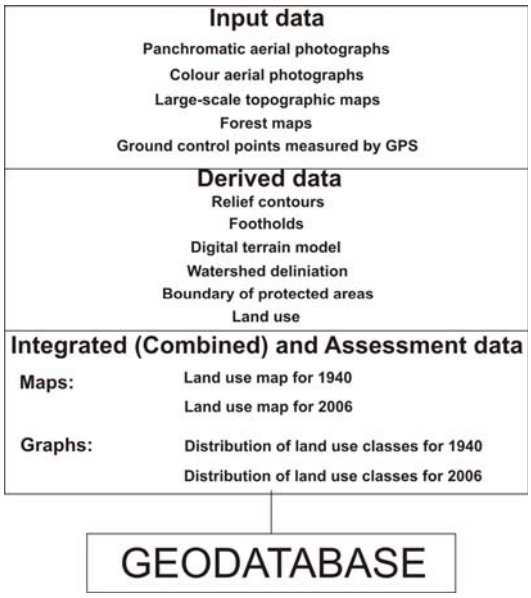

Fig. 3. Data types

Table 2. Geodatabase elements

GEODATABASE ELEMENTS	TYPE OF LAYER
Feature dataset	
Ground control points measured by GPS	Feature - point
Relief contours	Feature - line
Footholds	Feature - point
Boundary of protected areas (based on data from maps of the State Forestry, Sofia - Novi Iskur Forestry)	Feature - polygon
Land use – 1940, 2006	Feature - polygon
Attribute data (tables)	
Ground control points measured by GPS	Feature - point
Relief contours	Feature - line
Footholds	Feature - point
Boundary of protected areas (based on data from maps of the State Forestry, Sofia - Novi Iskur Forestry)	Feature - polygon
Land use – 1940, 2006	Feature - polygon
Raster dataset	
Digital terrain model	Raster
Panchromatic aerial photographs - 1940	Raster
Coloured aerial photographs - 2006	Raster
Large-scale topographic maps	Raster
Forest maps	Raster
Additional elements – graphs and diagrams	
Distribution of land use classes - 1940	Chart
Distribution of land use classes - 2006	Chart

Results

The changes of land use classes during a 65-year period on the territory of the Golemiya Dol's sub-catchments were investigated.

There are two temporal stages:

- before the exploration period – 1940;
- after the exploration period – 2006.

Maps of land use for 1940 and 2006 were created as a result of deciphering and interpretation of aerial photos for the abovementioned years. The land use changes of the studied area during this 65-year period are quite significant.

In the period before mining activity began, the territory of the Golemiya Dol was occupied mainly by cropland and meadows, amounting respectively to 39.9% and 21.9% (Fig. 4a). Vast areas were occupied by barren land – a total of 22.5%. The percentage of forest land for this time period is insignificant – less than 5% (Fig. 4a). According to bibliographic (literary) sources, the Golemiya Dol's catchments were woodless, with many erosion incisions and gullies, and the lower part of the drainage basin was a low land with slight slopes (Bozhinov, Iv., 1954).

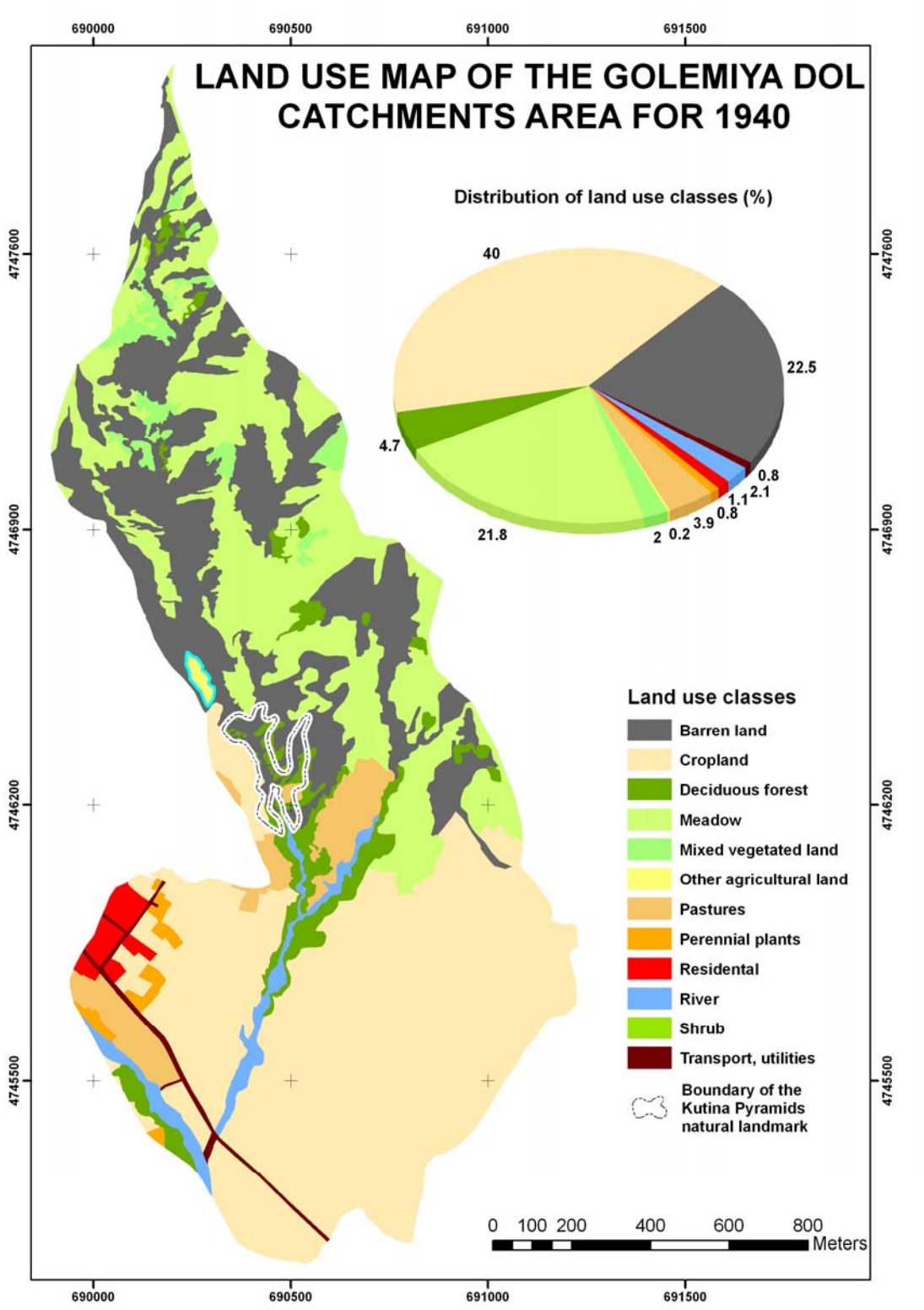

Fig. 4a

During the exploration period the terrain was transformed many times. Mining activity was terminated in 1972, to be followed by a reclamation period.

Nowadays, a great part of the Golemiya Dol's catchments area is occupied by forest land (deciduous and coniferous forests) and pastures. Their percentage distribution is respectively 44.9% for forest land as a whole, with predominance of coniferous forests, and 39.8% for the pastures (Fig. 4b). The percentage of barren land has decreased over the time period to 1.2% as a result of the intensive forestation actions after the 50^{ies} of the previous century. Anthropogenic activity has generated some new land use classes, such as lakes, which occupy abandoned excavations, summer-house' areas and coniferous forests.

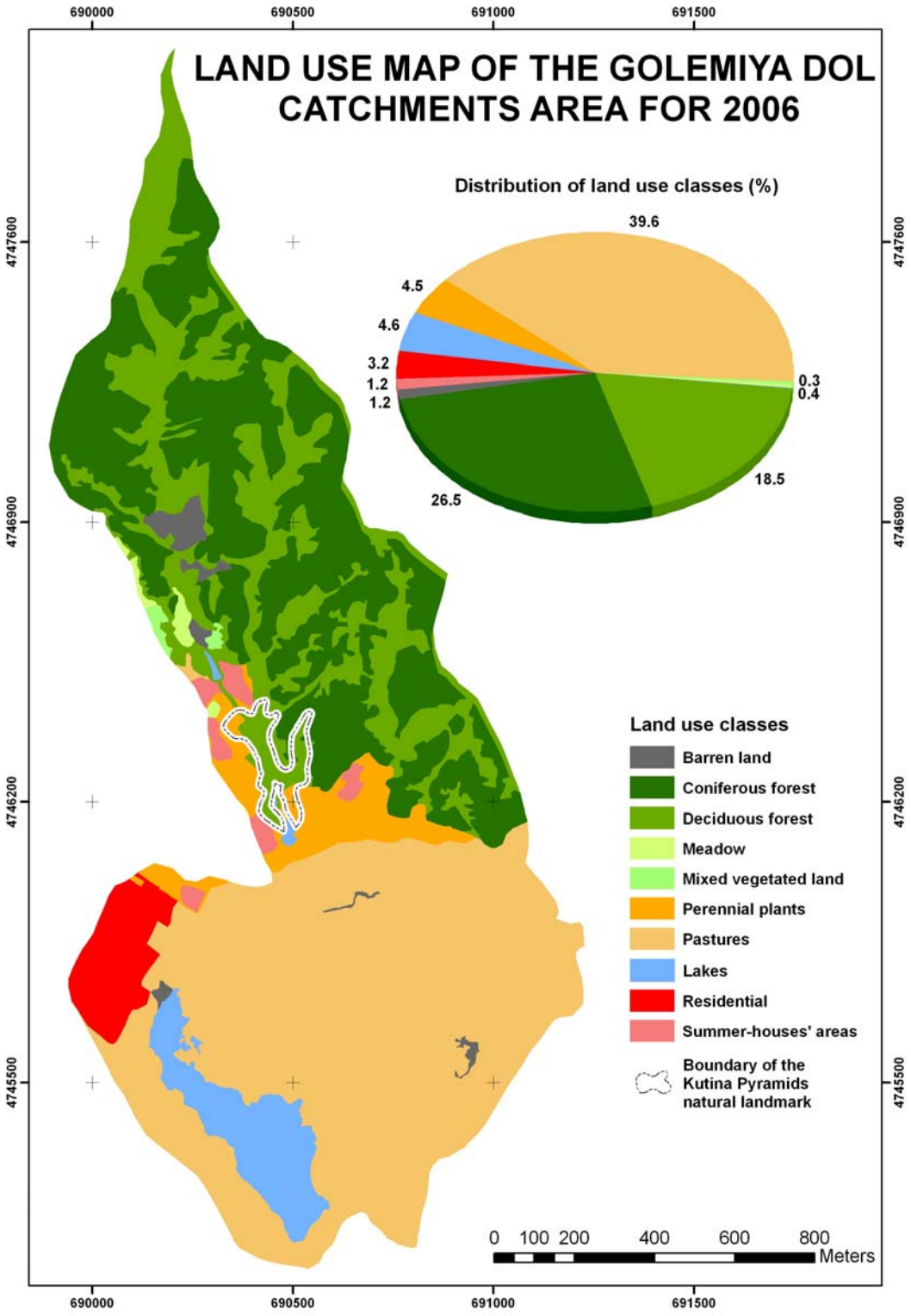

Fig. 4b

The land cover/land use changes undergone by the *Kutina Pyramids* natural landmark are shown in Fig. 5a and 5b. The main land cover/land use class which in 1940 occupied more than 50% of the protected area was barren land. Nowadays, these areas are entirely covered by forest land, where deciduous forest increased to 75 % while 4% of the territory is afforested with coniferous species.

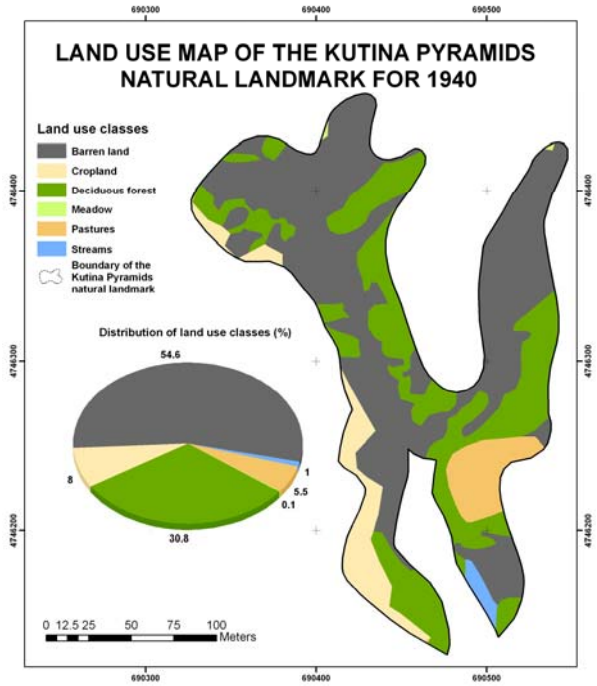

Fig. 5a

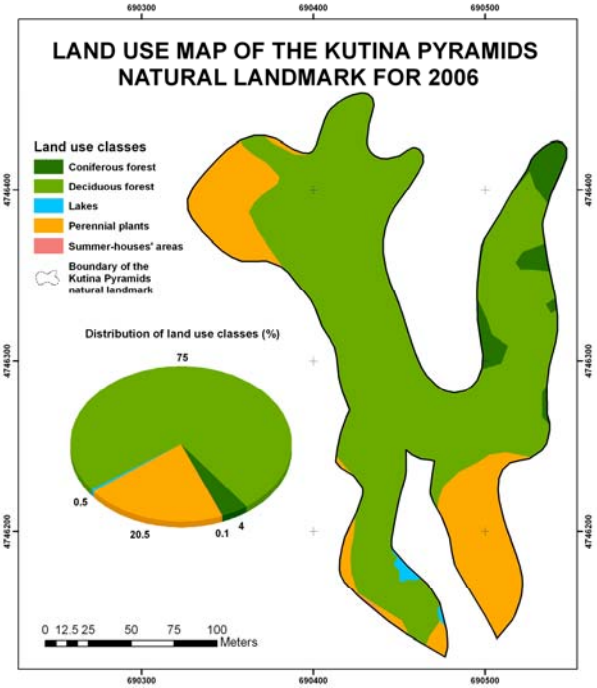

Fig. 5b

The observed land cover/land use changes of the Golemiya Dol's catchments area and especially the protected area of the Kutina Pyramids are a result of the anthropogenic activity during the last decades and the intensive development of mining activity, which is the main reason for their accelerated destruction (Kanev, G. at al, 2006).

Conclusion

The created geodatabase is used as an information source to elaborate a series of thematic and assessment maps of land use change and to determine the spatial parameters of land use change. It provides for quick retrieval of unbiased information on land use change whereas land use maps may be used in land use planning, which will help the local self-governing bodies and the natives to make everything possible for the natural landmark's conservation and preservation and the territory's sustainable development.

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