верке в Microsoft Excel остался неизменным, что говорит о том, что код программы написан корректно. Полученный результат подтверждает надежность предложенного метода и говорит о возможности использования его в учебном и производственном процессе.

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THE APPLICATION OF DIFFERENCE IMAGE TECHNIQUE FOR CHANGE DETECTION ON THE TERRITORY OF MEZIN NATIONAL NATURE PARK

The article deals with results of instrumental comparison of satellite images taken at two different times to identify and systematize changes of underlying surface (terrain, land use, buildings, etc.) that have occurred on the territory of Mezin National Natural Park over 18 years (1989–2007).
Keywords: National Nature Park, map of changes, satellite imagery, GIS.

О. О. Волковая, М. О. Балинська, О. С. Третьяков
ВИКОРИСТАННЯ МЕТОДИКИ ПОБУДОВИ РІЗНИЦЕВИХ ЗОБРАЖЕНЬ ДЛЯ ВИЯВЛЕННЯ ЗМІН НА ТЕРИТОРІЇ МЕЗИНСЬКОГО НАЦІОНАЛЬНОГО ПРИРОДНОГО ПАРКУ
У статті розглянуто результати інструментального порівняння двох різночасових космічних знімків з метою виявлення та систематизації змін підстильної поверхні (ландшафту, землекористування, забудови і тощо), які сталися на території Мезинського національного природного парку за 18 років (1989–2007 р. р.).
Ключові слова: національний природний парк, карта змін, супутникові знімки, ГІС.

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ПРИМЕНЕНИЕ МЕТОДИКИ ПОСТРОЕНИЯ РАЗНОСТНЫХ ИЗОБРАЖЕНИЙ ДЛЯ ВЫЯВЛЕНИЯ ИЗМЕНЕНИЙ НА ТЕРРИТОРИИ МЕЗИНСКОГО НАЦИОНАЛЬНОГО ПРИРОДНОГО ПАРКА
В статье рассмотрены результаты инструментального сравнения двух разновременных космических снимков с целью выявления и систематизации изменений подстилающей поверхности (ландшафта, землепользования, застройки и т. д.), которые произошли на территории Мезинского национального природного парка за 18 лет (1989–2007 гг.).
Ключевые слова: национальный природный парк, карта изменений, спутниковые снимки, ГИС.

Introduction. Nowadays national nature parks (NNP) are considered as network elements of territories especially protected for long-term ecological monitoring and recognized as standards of the background of the natural environment. Unlike other protected sites, NNP perform a wide range of functions: protection of natural and cultural heritage, recreation of the population, search for ways of sustainable development of the territory. Moreover, they are the most common forms of protection areas in the world practice. But at the same time, the problem of preserving the unique nature of these territories is exacerbating. This is influenced by both intensive operation and pollution of natural resources and indifference, pragmatic attitude of people to nature.

The significant sizes of the protected areas

(6,05% of total area of our country) require more and more expenditures of funds, equipment and considerable volumes of observers. This leads to financial and organizational problems.

In conditions of significant and diverse load on the NNP territory, high dynamics of situation, especially in their buffer zones, is often observed. Ground observations are bulky, relatively slow, so do not manage to process such changes.

Recently, world has witnessed a growth in popularity of use of remote research methods, particularly for tracking the trends and scales of human activity. Compared to traditional methods of research, the use of satellite images is faster and less expensive, focused primarily on operational monitoring.

The goals and the objectives of the research.

The aim of this work was to identify and systematize the natural and anthropogenic changes of underlying surface (landscape, land use, buildings, etc.) in the Mezin National Nature Park by instrumental comparison of satellite images taken at two different times.

To achieve this purpose following tasks were solved:

• collection and processing of the initial information on the territory of Mezin NNP;

• exploration the possibilities of construction and analysis of difference images;

• construction of difference images with the help of the Imagine DeltaCue module of the ERDAS Imagine software system;

• study of changes that have taken place on the territory of Mezin NPP, their classification and scale determination;

• construction of anthropogenic and natural changes map of the Mezin NPP territory.

The following raw materials were used for the study:

• Landsat 5 Thematic Mapper (TM) space satellite system image of the Mezin NNP territory (dated 1989);

• Landsat 5 TM space satellite system image of the Mezin NNP territory (dated 2007);

• data on regulations that were received from Law of Ukraine «On Natural Reserve Fund of Ukraine» [2];

• additional materials (data about physical and geographical processes and economic activities that took place on the territory of NNP).

By qualitative decoding of satellite image landscape structure of the territory had been defined, which was then matched with the literature descriptions, primarily from the fundamental monograph «Physical and geographical zoning of Ukraine» [6] and thematic series «Nature of Ukrainian SSR», particularly in volume «Landscapes» [5]. Images of the NNP territory also were compared with text descriptions and graphic sketches [3]. Data on construction and use of difference images were obtained from electronic and text sources [4, 8 ,10].

In the course of the construction of difference images and analysis of changes on the territory of research ERDAS Imagine software package was used, software module Imagine DeltaCue in particular.

Presenting main material.

Difference images methods.

The primary purpose of difference images creation is a visual representation of sites on the earth surface, which for some period of time had undergone some changes under the influence of anthropogenic factors or natural disasters. Difference image is a bitmap created by special processing of two satellite images, obtained through some time interval.

With the help of the Imagine DeltaCue software difference image was created from two initial images. On that image land areas that had changed and therefore had changed their spectral reflective characteristics have a significant contrast in comparison with areas that had not changed and had not changed their reflective characteristics. To create a difference image two or more digital satellite images, obtained through some time interval have to be used [8]. Following steps had been carried out to create a difference image of NNP:

• Gathering images into stack. As a result, on the base of spectral zonal images multilayered image was created. It could be displayed in different spectral combinations for the best visualization of the researched objects.

• Excluding zero values of images histograms to obtain more contrast and more informative image.

• Adding a vector layer with the Mezin NNP boundary to the computer images and cropping pictures to this boundary.

• Aligning (equalization or linearization) of histograms of two images. This phase of the research was necessary to take into account and compensate such factors as different height of the sun, varying degrees of surface moisture,

and others. Thus, the different height of the sun was related to the fact that the survey had been conducted on different days of the year (June 2, 1989 and May 27, 2007) and at different times (8:16 and 8:36 in 1989 and 2007 respectively). Different degree of moisture affects the reflectivity of objects of area. Thus, we had converted histograms of images to the common standard.

• Search for areas of histograms, where there are significant differences from the reference level of brightness.

• Filling pixel with colors, depending on the distance from the reference brightness level (the darker became pixel on the image in 2007, the more its color was closer to red visible spectrum, the lighter — the closer to purple).

Since histograms equalization step, all further steps were performed automatically by the module Imagine DeltaCue.

Images of the Landsat 5 TM satellite provided information about the object in 7 channel spectral range. Variations in the displaying a combination of different channels allowed to conduct multifaceted analysis of changes (Fig. 1).

Study area description.

Mezin NNP is situated in Korop district in Chernihiv region. The park was created according to the Decree of the President of Ukraine № 122/2006 «On creation of the Mezin National Nature Park» of February 10th, 2006 for the purpose of preservation and revival of typical and unique natural complexes of Novgorod-Siverski Polissya. It is allocated mainly on the right bank of the Desna River in its lower current. The NNP is subordinated to the Ministry of Environmental Protection of Ukraine. The park covers 31035,2 hectares. Only one-third of the territory (8543,9 hectares) is transmitted to constant use [7].

The results of methods application.

During the time period from 1989 to 2007 on the territory of Mezin NNP a number of significant changes had been observed. The resolution of images enables to analyze changes in fairly large scale and generally meets the conditions set in the course of research. Thus, it was impossible to examine the development of roads, small streams; it was difficult to trace the emergence of small buildings. These shortcomings could be completely made up by comparing with the images of higher resolution (which, unfortunately, we didn't own) or in the field research. But major changes, such as deforestation, changes in vegetation, were quite noticeable. In the analysis we started precisely from them. After a comprehensive review of research areas, we noticed that these changes were associated primarily with the appearance or disappearance of objects, their quantitative characteristics. Qualitative characteristics had changed only for agricultural fields.

Carrying out the analysis of images we have concluded that the changes that have occurred on

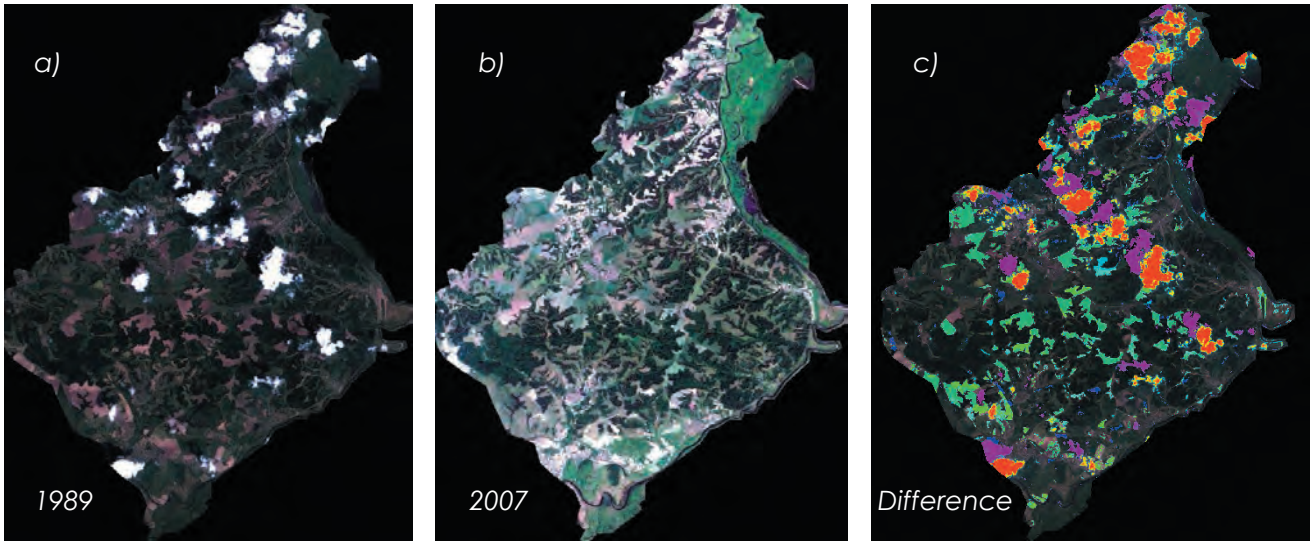

Fig. 1. a — image of 1989; b — image of 2007; c — difference image.
On the difference image with saturated red, yellow and green colors are shown areas, brightness of which had significantly decreased in 2007 compared with 1989; purple and blue — the brightness of which significantly increased.
Band combination: 3, 2, 1 (RGB).

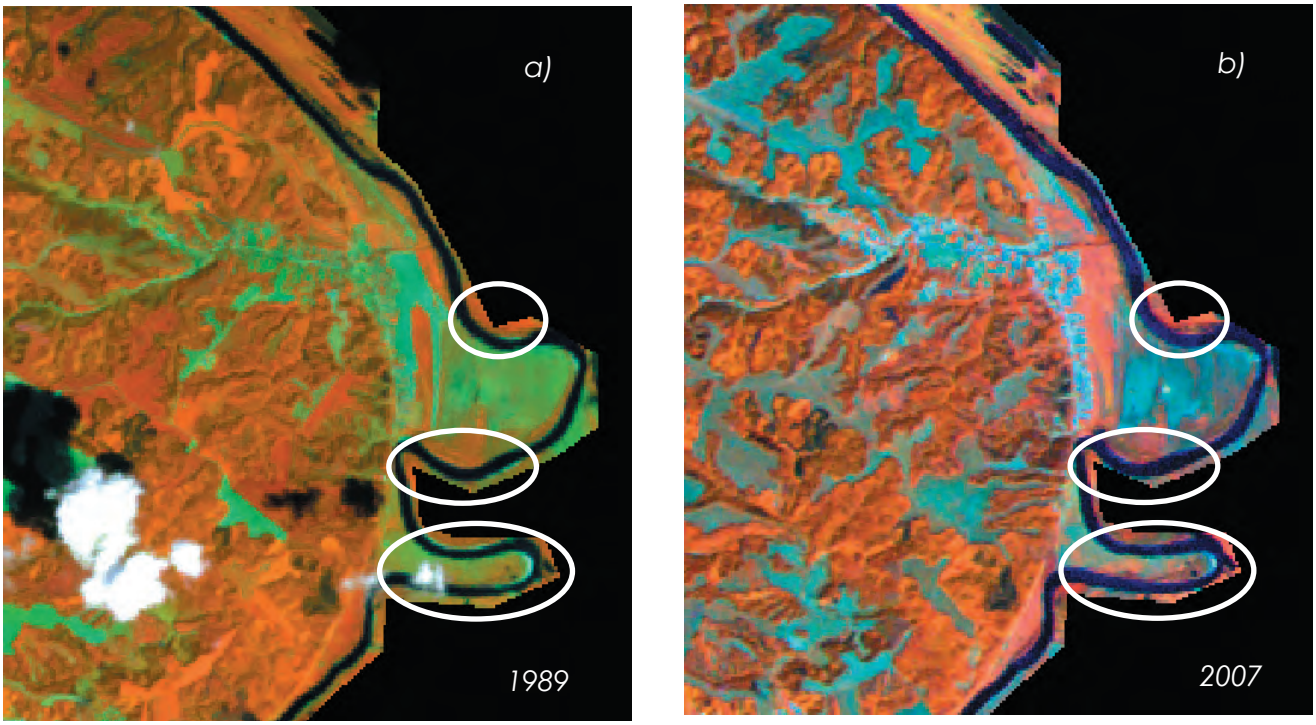

Fig. 2. The development of meanders of the Desna river.
Areas that have experienced the greatest changes are marked with red outline.
Band combination: 4, 5, 3 (RGB).

the territory of Mezin NNP could be divided into:

- changes in hydrological network;
- changes in land use;
- changes in forest plantations.

Changes in the hydrological network.

The development of meanders. In the first place we precisely considered secondary meanders (meanders of the river channel). The development of meanders was connected with the characteristics of the watercourse. The smaller were the size and speed of the watercourse, the greater was the curvature of meanders and smaller — the width of wandering belt. Eventually, meanders increases, as long as the watercourse will not meet an insurmountable obstacle (firmer rock) on the way or will be smoothed due to «interrupt» of isthmus between two meanders.

Changes of width and sizes of watercourses were associated with both turbulence flow and water content of the river, which may vary depending on the supply of water (drying of tributaries, construction of engineering structures, increase or decrease in precipitation, etc.). The content of insoluble particles (silting of coast) was also important.

The emergence of new water facilities or disappearance of old could be associated with both human activities (this primarily was related to reservoirs, ponds and channels) and with natural factors (e. g. an exit of groundwater to the surface, waterlogging).

Hydrological network of Mezin NNP is presented by Desna River and its tributaries, oxbows in floodplain of the river and several reservoirs. Comparing two images we have concluded that the change of the river Desna was

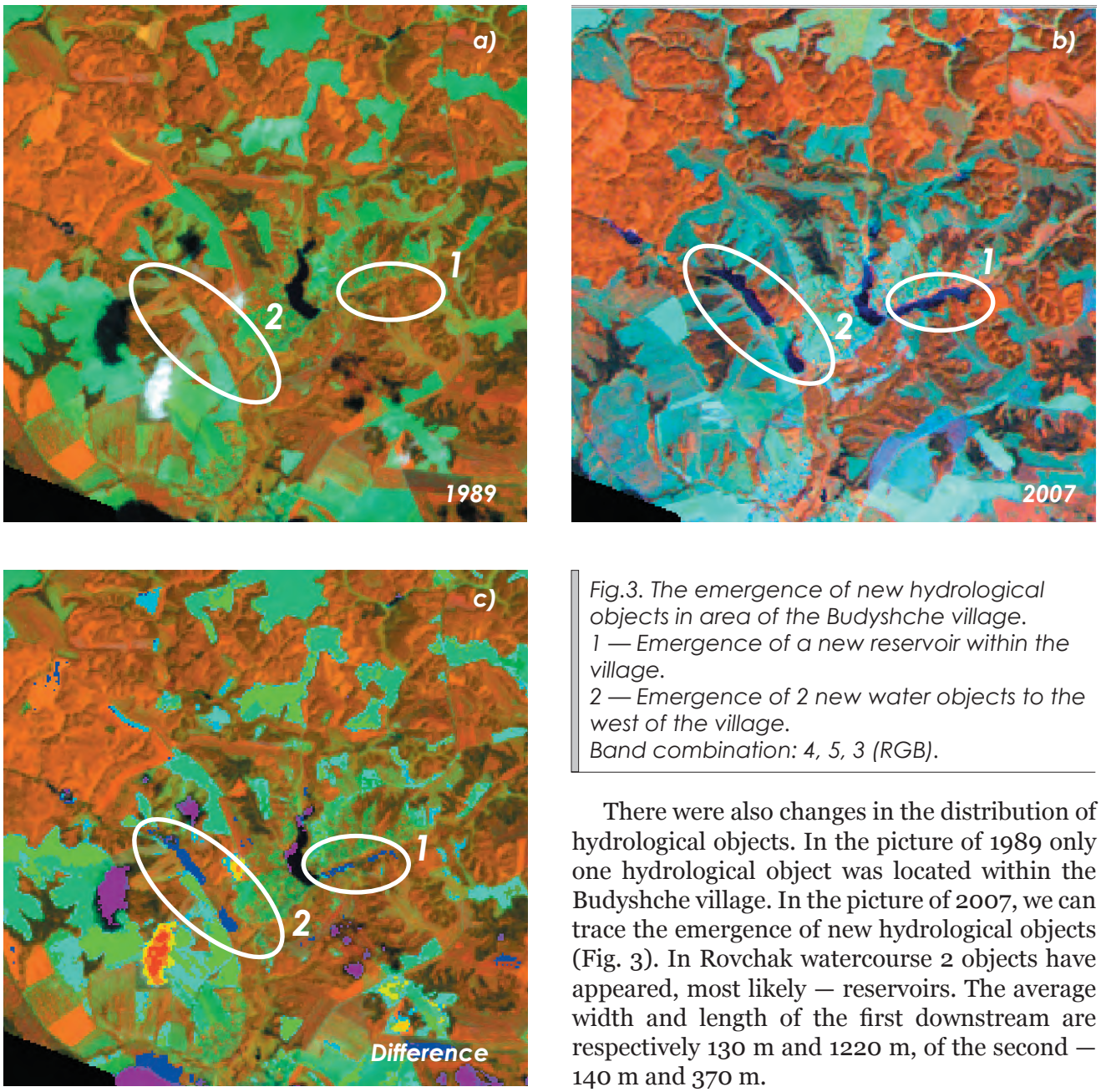

Fig.3. The emergence of new hydrological objects in area of the Budyshche village.
1 — Emergence of a new reservoir within the village.
2 — Emergence of 2 new water objects to the west of the village.
Band combination: 4, 5, 3 (RGB).

primarily associated with an increase in meander of the river.

For example, in the southern part of the park the river makes three distinct curves. Comparing images we identified that these curves had slightly increased (Fig. 2). The most noticeable change was in the first downstream — left bank was undermined by approximately 30 meters, about the same was an increase of riverine sandbank near the right bank.

Changes in water courses of tributaries of the Desna were not analyzed due to small resolution of images. On the image small rivers were hard to discern. It did not allow drawing conclusions about changes in trajectory of movement, width, length and depth.

There were also changes in the distribution of hydrological objects. In the picture of 1989 only one hydrological object was located within the Budyshche village. In the picture of 2007, we can trace the emergence of new hydrological objects (Fig. 3). In Rovchak watercourse 2 objects have appeared, most likely — reservoirs. The average width and length of the first downstream are respectively 130 m and 1220 m, of the second — 140 m and 370 m.

There was an overall increase in size and number of oxbow lakes on the territory of the Desna River floodplain. The width of the lake in the northeastern edge of the park increased for more than 100 m.

The analysis of changes in the hydrological network enabled to assess the condition of the park, to forecast changes in the future, to draw conclusions about water supply of the district and so on.

Changes in land use.

Buildings. Each settlement is undergoing continuous development, new buildings are built and old disappear. An unauthorized construction, which is quite common in our country, was actual within the study.

Agricultural activity. These changes are

Fig. 4. Changes in buildings of village Vyshenky.
1 — The appearance of new buildings to the north of the village.
2 — Fields sharing to the southwest of the village.
Band combination: 3, 2, 1 (RGB).

associated with variations in cultivated crops and fields distribution (sharing, mastering of new natural areas for the purposes of agricultural activity, etc.).

On the territory of Mezin NNP there were 16 settlements, seven centers of rural councils belonging to Korop district in Chernihiv region were among them.

In the northern part of the village Vyshenky new buildings were noticeable on the image of 2007 (Fig. 4). Also in the southwestern part of the village a sharing of field was conducted. There were new buildings in the woods near the northeastern edge of the village.

Within the village Radychiv an increase in the use of natural lands in all (except the eastern) directions was noticeable. Buildings in the woods emerged too.

Changes in forest plantations.

The most common reason of reduction of the forests area is deforestation without sufficient planting of new trees. In addition, forests are destroyed due to natural causes (e.g. fires, hurricanes, floods, invasions of pests) and anthropogenic factors, which are primarily connected with damage made by humanity to the environment (acid rain, industrial pollution of air, soil, flooding due to the construction of hydrological structures, etc.).

In general over 18 years forest area on the territory of the national park had not undergone significant changes that could be captured in the analysis of satellite images. Well notable was the emergence of a clearing in the northern part of the park (Fig. 5). Its width was about 60 meters, length within the image — about 970 m. Considering the fact, that land clearing was straight, one could conclude that the clearing arose as a result of cutting down the forest.

In addition there were changes related to reforestation (old overgrown glades, new plantings).

More changes of underlying surface are viewed on the map of anthropogenic and natural changes on the territory of NNP (Fig. 6).

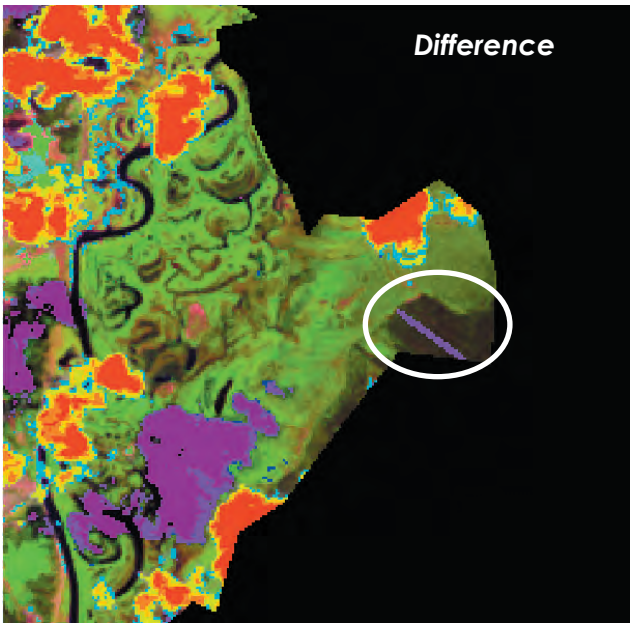

Fig. 5. Felling of the forest.
Band combination: 5, 4, 3 (RGB).

Conclusions. The use of difference images as a way of human activity detection and monitoring as well as defining the extent of environment transformation as a result of impact of factors of the various origins is a quite promising direction. In addition, materials obtained during the analysis of satellite and difference images may be used for the preparation of activities plans of nature users, in the process of ecological expertise and related public hearings, for independent public control of observance of its interests in the field of traditional nature use and for solving a number of other problems. They acquire a great importance in the course of topographic monitoring, when planning «fragmented» renovation of cartographic materials of various scales, instead of using continuous shooting. Materials analysis can also be used for educational purposes as a visual material.

During the analysis, we concluded that significant changes occurred on the territory of Mezin NNP in the period from 1989 to 2007. During the research a classification of changes that have occurred on the territory of Mezin NNP was conducted, according to which the changes were divided into changes in the hydrological network, changes in land use and changes in forest plantations; the reasons that might cause these changes were examined. We also have held a linking of these changes directly to the territory of studies, examined the most significant examples of these changes.

The largest changes on the park territory were observed in the hydrological network: the emergence of reservoirs, the disappearance of hydrological objects and the meanders development of the Desna River. Also important were the changes in buildings (the appearance of new buildings) and forest (the emergence of large cuttings), they determine the need for additional security measures and made it possible to assess the extent of human impact on the park. The obtained data made it possible to draw conclusions about the population compliance with legal regulations, predict the development of the park in the future.

Reviewer: Doctor of Technical Sciences (hab.), Professor Igor Chervanyov

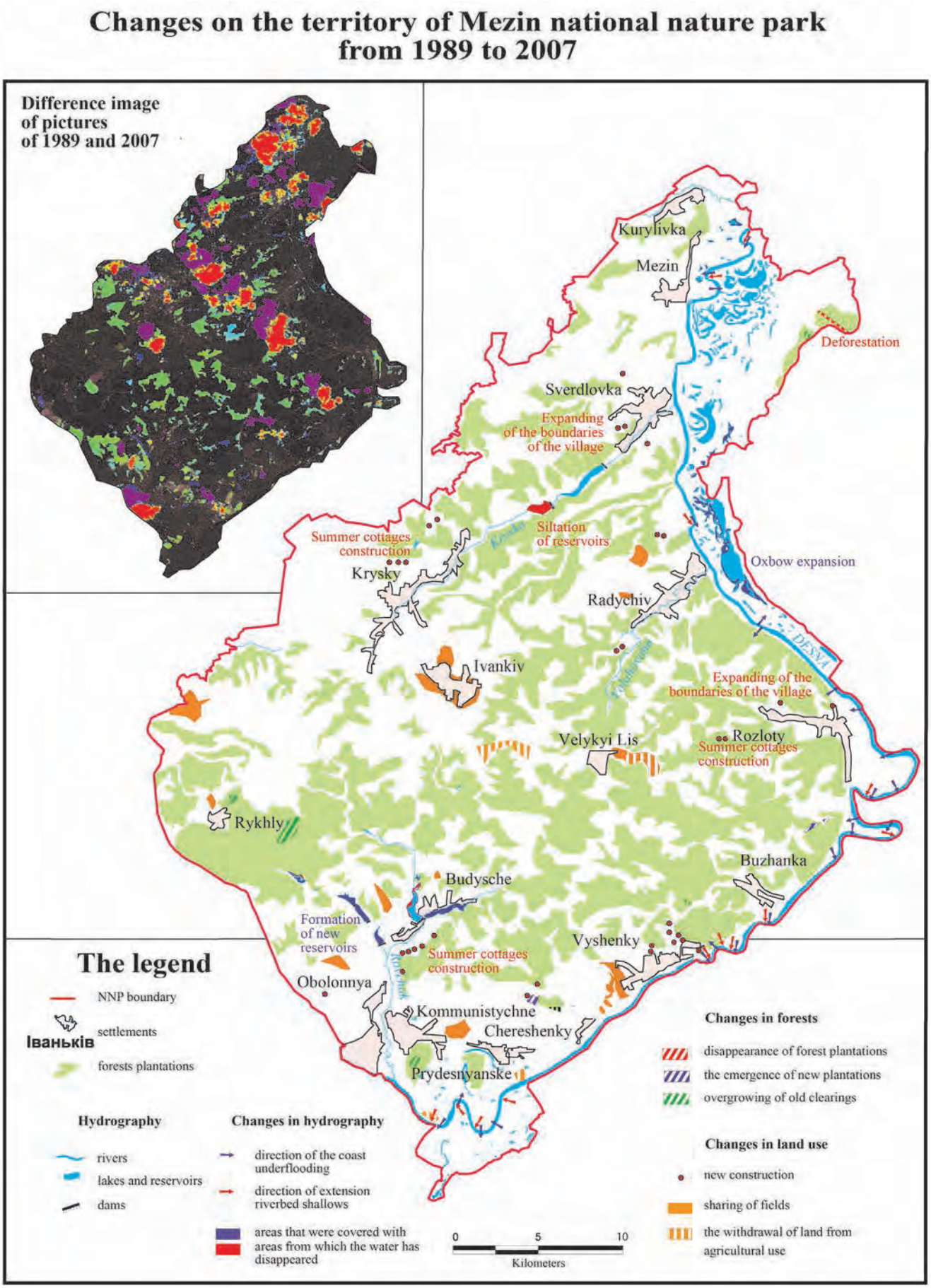

Fig. 6. The resulting map of natural and anthropogenic changes on the territory of NNP.

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ПРЕДСТАВЛЕНИЕ УСЛОВИЙ ГОРОДСКОЙ СРЕДЫ В ИНФОРМАЦИОННЫХ РЕСУРСАХ ЗДРАВООХРАНЕНИЯ НА МУНИЦИПАЛЬНОМ УРОВНЕ

Обозначены проблемы систематизации и анализа данных о факторах общественного здоровья на муниципальном уровне. Предложена методика создания информационно-аналитической системы, представляющей особенности городской среды на уровне первичных ареалов сбора медико-статистической информации. Представлены оценочные карты условий городской среды как факторов распределения общественного здоровья.
Ключевые слова: здоровье городского населения, комфортность городской среды, факторы общественного здоровья, информационно-аналитические системы, ГИС.

Є. Л. Ковальова, А. П. Ужакіна, Б. В. Трішкін
ВІДОБРАЖЕННЯ УМОВ МІСЬКОГО СЕРЕДОВИЩА В ІНФОРМАЦІЙНИХ РЕСУРСАХ З ОХОРОНИ ЗДОРОВ'Я НА МУНІЦИПАЛЬНОМУ РІВНІ
Відзначено проблеми систематизації і аналізу даних щодо факторів суспільного здоров'я на муніципальному рівні. Запропоновано методику створення інформаційно-аналітичної системи, що відображає особливості міського середовища на рівні первинних ареалів збирання медико-статистичної інформації. Представлено оціночні карти умов міського середовища як факторів розподілу суспільного здоров'я.
Ключові слова: здоров'я міського населення, комфортність міського середовища, фактори суспільного здоров'я, інформаційно-аналітичні системи, ГІС.

E. L. Kovaleva, A. P. Uzhakina, B. V. Trihkin
REPRESENTATION OF URBAN ENVIRONMENT CONDITIONS IN THE HEALTH INFORMATION RESOURCES AT THE MUNICIPAL LEVEL
The problems of systematization and analysis of the public health factors data at the municipal level are identified. The technique of information-analytical system (IAS) creation, representing features of the urban environment at the level of the primary areas of medical-statistical information collection, is proposed. The estimation maps of the urban environment conditions as factors of the public health distribution are presented.
Keywords: urban health, comfort of the urban environment, factors of public health, information-analytical systems, GIS.