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Investigation of forest cover dynamics in Carpathian National Nature Park, using remote sensing and GIS

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Annotation: Використовуючи супутникові знімки Landsat, програму QGIS та вегетаційний індекс MSR було досліджено лісовий покрив ділянки Карпатського національного природного парку. Отримані результати за період 1993-2017 рік вказують на задовільний стан та позитивну динаміку лісової складової обраної території.

Keywords: remote sensing, GIS, MSR, forestry, forest cover dynamic;

Ключові слова: дистанційне зондування землі, ГІС, динаміка лісового покриття, вегетаційний індекс MSR.

Forest management in Carpathian region is not sustainable. Massive illegal deforestation have commenced critical situation in total exposure of all forest areas in Ukrainian Carpathian Mountains (Борейко та Левина, 2016). Actual information about forest biotopes is needed for effective decision making processes at local and governmental levels. In particular, it's important for protected areas management.

Objective of this study was to make an assessment of forest dynamic of selected parts of Carpathian National Nature Park (CNNP) using remote sensing data and corresponding methodology. CNNP is one of the largest reserved area with forest biotopes in Ukraine. It has total area 51570.80 hectares, which include 38340.46 hectares of forests and 13230.33 hectares for other types of land. Pilot area for assessment (5.3 km^2) was selected near the western part of the village Dzembronya (Verkhovyna district of Ivano-Frankivsk region). As a criterion for choosing this territory, the presence of the characteristic signs of cutting was considered. Analysis of parameters indicating the state of vegetation during relatively long period (1993-2017) should answer the question whether human interventions were sufficient for the forest cover dynamics.

Geographical coordinates of the study area are following: the northern peak is $48^{\circ}7'40.59'' \text{ N } 24^{\circ}38'43.87'' \text{ E}$, the western peak is $48^{\circ}7'9.67'' \text{ N } 24^{\circ}37'16.80'' \text{ E}$, eastern peak – $48^{\circ}6'22.52'' \text{ N } 24^{\circ}39'26.48'' \text{ E}$, southern peak – $48^{\circ}5'50.44'' \text{ N } 24^{\circ}38'11.06'' \text{ E}$. Predefined area was explored using the Google Earth program. There were searches of territories within and near the CNNP, which have traces of cutting; were created vector masks of research areas.

During the study, satellite images of the Landsat family (4, 5, 7, 8) were used for the period

from 1993 to 2017, and vegetation index MSR calculated using the formula in QGIS raster calculator:

$$MSR = \frac{\left(\frac{NIR}{RED} - 1\right)}{\sqrt{\left(\frac{NIR}{RED} + 1\right)}}$$

where NIR is a near-infrared spectral channel, RED is a red spectral channel. Resolution of shots at 30 m² is sufficient for this type of research. The vegetation index MSR was chosen because of its less sensitivity to noise (as to compare to NDVI) (Skianis et al., 2007), minimized exposure from open soil and insolation angle, increased sensitivity to the expression of biophysical vegetation and better contrast. Photos were processed for June, July and August of each year. Main reasons are the same period of vegetation, as well as the availability of investigated areas in the pictures (with an average of 1-2 photos per month, some of them unsuitable for research due to excessive cloudiness).

As a result of the analysis of satellite images, the positive dynamics of the forest cover was revealed (Fig. 1). A number of fluctuations in the signal and the value of the vegetation index were observed, presumably caused by especially high temperature and precipitation peaks. There is also a noticeable redistribution during the investigated period between diluent and dense forest cover. We assume that this is due to the maturation of the forest, since older trees have more powerful crowns and larger biomass per unit area, which makes a significant contribution to the signal. Also, traces of older deforestation periodically become more visible, most likely due to the drying of the grass cover and the lack of moisture for groupings of bushes and trees.

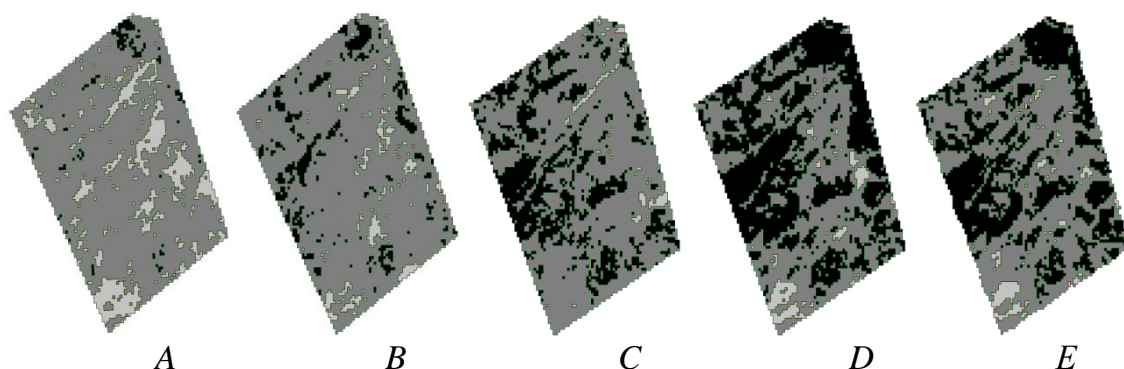


Fig. 1. Carpathian National Nature Park, the study area. Distribution of forest cover in time. The black is the dense forest, darker grey – rarefied, lighter grey – open ground.

A – 3 July 1993; B – 14 July 2006; C – 6 Aug 2011; D – 11 June 2014; E – 3 June 2017

As a result, the state of the forest cover of the explored territory of Carpathian National Nature Park can be called as satisfactory. During the preliminary study, illegal felling as well as objects such as waste landfills in the reserve area were not found within the study period, only traces of old deforestation. If such phenomena took place, then they did not have a significant effect and were not reflected on the smallest studied cells. The analyzed dynamics of forest cover for the years 1993-2017, with few exceptions, has a positive tendency for development and indicates the absence of the expressed negative influence of human activity or extreme natural phenomena.

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A projected botanical reserve "Zolota Lypa" (Ternopil region, Ukraine)

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Annotation: Проектований ботанічний заказник місцевого значення «Золота липа» площею 48,2 га пропонуємо створити в околицях села Посухів, Бережанського району, Тернопільської області з метою охорони видів, що занесені до Червоної книги України: *Orchis militaris*, *Anacamptis morio*, *Adonis vernalis*. Проектований об'єкт природно-заповідного фонду «Золота липа» є важливим не тільки для охорони видів, а й для збереження лучно-степових біотопів, які зазнають постійного антропогенного пресингу.

Keywords: conservation of nature, botanical reserve, Ternopil region;

Ключові слова: охорона природи, ботанічний заказник, Тернопільська область.

Currently, biodiversity conservation is one of the main scientific direction and it is possible only with a comprehensive protection of habitats. One of the main goal of phytosoology is the inventory and protection of rare species in areas that have not been studied to date. The western part of Ternopil region is one of the less researched, as well as the Berezhany district whose "reserve index" is only 5.91 % (Ecoternopil, 2019).

Three species included in Red Data Book of Ukraine was find on meadow-steppe slopes near Posukhiv village (Berezhany district, Ternopil region): spring pheasant's eye, military orchid and green-winged orchid (Cipa, 2019). *Orchis militaris* L. is eurasian palearctic species on the southern border of the area and has vulnerable conservation categories sensu Red Data Book. *Anacamptis morio* (L.) R. M. Bateman, Pridgeon et M. W. Chase (syn. *Orchis morio* L.) is also vulnerable species on western border of the area. *Adonis vernalis* L. is eurosiberian forest steppe species with Not Evaluated conservation categories (Дідух, 2009).

The *Orchis* population has almost tripled in the last three years, especially through the activities of wild boars (Гапоненко 2014). The lower part of slope was plowed in 2017 and this activity was continued in 2019 on the other part of the slope with *Anacamptis morio* and *Orchis militaris*. That is why in order to further conserve the populations of these species, it is proposed to create a botanical reserve "Zolota Lypa" (according to Article 25 of the Law of Ukraine on the Nature Reserve Fund). Reserve will be located on the right bank of the Zolota Lypa River with an area of 48.2 ha.

The main objective is conservation of rare species and support the ecological balance in the region. The regime of protection of the reserve will be governed by Article 26 of the Law on the Nature Reserve Fund of Ukraine (Verkhovna Rada of Ukraine, 2019). We propose environmental knowledge and education among young people, and for scientific research in the area as well for spreading.

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