Retrospective and geographical features of forestry use of lands in Podilski Tovtry

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Abstract. Forest cover is an important component of the landscape and is responsible for the conservation of other components. Forests of the Podolian Upland are distinguished by a high natural resource potential and a significant risk of manifestation of unfavorable natural processes. The aim of our research is to study the forest cover of Podilski Tovtry and analyze the dynamics of its changes for the period from 1880 to the present. Forestry nature management in Tovtry is second only to agriculture in terms of the area of occupied land. Forests of the reef zone and adjacent territories within the Ternopil oblast are part of the Ternopil forestry enterprise and the Medobory Nature Reserve. Within the study area, forests of a relatively large area are confined to the summit surface and slopes of the main ridge. Our research has established that in the period from 1880 to 1930, there was a significant decrease in forest cover practically throughout the entire study area, which is associated with both the need for firewood and agrarian overpopulation and the desire to expand the arable land. A direct relationship was found between the decrease in forest cover and the approach to villages and hamlets. After the Second World War and until the present, there have been no significant changes in forest cover. In some areas, even an increase in forested areas was found. Active forest expansion was observed at the beginning of the two thousandth years amid a decline in agricultural production.

1. Problem statement

The forest cover is an important component of the landscape, it is responsible for the preservation of its other components such as relief, soil, surface and ground water, fauna, etc. The ecological impact of forest ecosystems on the state of the natural environment in general, on the nature, pace and direction of exogenous processes, human living conditions, etc. is enormous.

Given the important ecological stabilization and economic functions of the forest, the processes associated with a decrease in the area and deterioration in the quality of plantations require study. Timely identification and justification of the harmful effects of deforestation and the development of measures to improve the situation will contribute to the formation of a favorable geoecological situation in the territory. The forests of the territories of the Podolian Upland, which have long been mastered by humanity, are of particular ecological and geographical importance. They are distinguished by a high natural resource potential and a significant risk of unfavorable natural processes.
2. Materials and research methods
The study of forestry land use and the ecological role of the forest is the subject of research by many domestic and foreign scientists. S. Hensiruk [1] studied the features of forestry as a branch of nature management in different regions of Ukraine. The study of forest management on the territory of the Podilski Tovtry is devoted to the publications of such scientists as K. Moskaliuk [2], V. Bondarenko [3]. They concern mainly the territory of the Medobory Nature Reserve and reveal one aspect, namely the possibility of reproducing and preserving autochthonous forest stands in protected areas where intensive economic activity used to take place. The current state and dynamics of the forest cover of Podilski Tovtry remain insufficiently explored. This is especially true of the territories northwest of the Medobory Nature Reserve.

Beech stands have recently received special attention from researchers. Their study on the territory of Ukraine is devoted to the publications of H. Krynytskyi with co-authors [4] and S. Myklysh, Yu. Myklysh, etc. [5]. They considered the region of Podilski Tovtry as the extreme eastern area of natural growth of Fagus silvatica L. The monograph by N. Tekalo, M. Matusiak et al. [6] and a short article by O. Mudrak et al. [7] are devoted to the ecological features of reforestation and afforestation in Podillia. The Tovtry in both studies are part of a much larger region. Some aspects of the territorial features of the use of forest fund lands within Tovtry were studied by B. Havryshok, M. Syvyj [8].

The purpose of our research is to study the forest cover of the Podilski Tovtry reef zone and analyze the dynamics of its changes over the period from 1880 to our time. According to the purpose, the following tasks were formulated: select multi-temporal topographic maps of the study region; divide the sheets of maps into squares with a side of 2 km (registration areas) and determine the forest cover of each of them; determine the change in forest cover over the period from 1880 to the present and build an appropriate cartogram; trace current trends in the development of forest cover; develop recommendations for the development of forestry in the region.

3. Results and discussion
Forests in the study area are unevenly distributed. Their distribution depends on the physical and geographical conditions, primarily the relief, geological structure, climate, as well as the economic use of the territory. Forest management of natural resources in Tovtry is second only to agriculture in terms of the area of occupied land. The forests of the reef zone and adjacent territories within the Ternopil oblast are part of the Ternopil forestry establishment (Mshanets, Zbarazh and Skalat forestry) and Medobory Nature Reserve.

V. Shafer [9], analyzing the flora of the region, divided Medobory into northern and southern parts, drawing a border between them approximately between the Vikno and Krasne massifs of the reserve. He qualified the forests of the northern part as Podillia oak forests, noted their change and the presence of only minor forest areas with initial signs. Oak remained the dominant species. The forests of the southern part of Medobory according to Shafer are forests of the Central European type. By the beginning of the 20th century, there were practically no older and primary forest stands left. V. Bondarenko and co-authors [3] note that the wide distribution of the hornbeam in the Podillia oak forests was the result of patronage for this species in forestry as a fast-growing and unpretentious breed.

To analyze the forest cover of Tovtry and the surrounding area, we have built the corresponding maps. Forest cover is calculated for the land use areas of territorial communities as a percentage of the areas occupied by forests to the total area. The highest forest cover is characteristic of the Tovtry Ridge itself and the territories to the northeast of it.

In particular, within Vikno, Krasne, Sadzhivky, Rashtivtsi of the starostynsky districts of the Hrymailiv united territorial community, it exceeds 40 percent and Horodnytsya, Postolivka (Husiatyn united territorial community), Reniv, Hai-za-Rudkoiu (Zaliztsi united territorial...
community) is 30-40 percent. The least forested areas are in the vicinity of the villages of Kretivtsi, Stryivka, Maksymivka, Halushchentsi, Zelene, Okhrymivtsi, etc. and the town of Skalat, whose forest cover is less than one percent.

The forest cover of the northwestern part of Tovtry and the surrounding area has been affected by a complex combination of natural and anthropogenic factors for at least two centuries. During the last century, the role of human activity in the transformation of vegetation has increased markedly. In this regard, we consider it appropriate to identify the long-term dynamics of the region’s forest cover.

To trace the dynamics of the forest cover of the study area, multi-temporal maps were used (1880, 1930, 2020) [10], [11]. For the convenience of calculations, the entire territory is divided into accounting areas with an area of 4 km², which coincides with the squares of the map grid at a scale of 1:100 000. Such cartometric studies were carried out on each of the three time slices. Based on their results, forest cover cartograms were constructed for 1880, 1930 and 2020. After that, the change in forest cover for the period 1880 - 2020 was determined by calculating the difference in the values of this indicator for each accounting area. Punsons of modern settlements were superimposed on the last site, which made it possible to reveal a relationship between a decrease in forest cover and proximity to settlements (figure 1).

In addition to cartometric studies, a visual analysis of the maps was carried out according to the indicated time slices and modern satellite images obtained from the Google Earth system. This allowed us to trace the change in the configuration of forest tracts, to analyze the current trends in the expansion of forests on lands that are not involved in agricultural production.

In the middle of the XVII century H. Boplan wrote In Ukraine and Podillia, villages are surrounded by forests with hiding places, where in summer people hide from predatory Tatars [12]. Deforestation proceeded slowly and met the needs of the subsistence economy of local residents. The intensification of this process was impossible due to the constant threat of nomad attacks. The modern picture is fundamentally different from that described by H. Boplan. Forests are located in separate islands between massifs of arable land and occupy mainly territories unsuitable for agriculture.

The great need for firewood and building material, along with agrarian overpopulation, led to the destruction of forests at the end of the 19th and early 20th centuries, which is clearly seen when comparing multi-temporal topographic maps. For example, a significant area was cut down in the northeast of the Malynnyk forest massif in the vicinity of Novosilka (formerly Novosilka Skalatska). During the period from 1880 to the present, the forest area has decreased by 2.6 km². In the late 1920s, a grange of the same name appeared on this territory. The last one was destroyed during the Soviet Union time and at present this territory is arable land on the slopes of the beam (figure 2).

During the same period, the area of forests in the vicinity of the city of Zbarazh has significantly decreased. The forest area Zbarazh Forest was completely cut down and separate farms appeared in its place, and a railway ran through the forest area to the west of the village of Zaluzhzhaia. To the east of Ihrovytsia, at the foot and on the slope of Mount Zembova, there was the forest area Obrozivka, which was the western continuation of the currently existing forest tract Dubivtsi. Its area in 1880 was about 1.7 km². By 1930, the forest was completely cut down, and only the toponym remained on the map. Subsequent changes in this area were not significant and were mainly associated with a change in configuration and a slight increase in the forest area in the Dubivtsi and Pozharnytsia tracts (figure 3).

A significant decrease in forest cover has also occurred in the territories that are now part of the main massif of the Medobory Nature Reserve. The forest area between the villages of Ostapie and Turivka (the Mantiava tract) has decreased by approximately 2.7 km² for the period from 1880 to the present due to cutting down areas in the area of Mount Nazarova, where the Palamarka grange arose, as well as on the northern and eastern outskirts of the forest. A
Figure 1. Changes in the forest cover of Podilski Tovtry and adjacent territories over the period from 1880 to the present (calculated for the area of the accounting plot; reduced on a scale of 1:100,000).

little south of the specified period of time, about 3.2 km² of forest on the slopes of Mount Monastyrnykha was destroyed, and a village of the same name arose in its place. In general, from the end of the 19th to the end of the 20th century, the area of the forest massif north of the village of Krasne decreased by more than 6 km². The forest area between Krasne and Lychkivtsi also decreased by more than 5.5 km², mainly due to cutting-down to the east of the villages of Krasne and Sazhivka, north of the village of Lychkivtsi, as well as to the east of Mount Yantsova, where in the 1930s the Bilitovka grange appeared on the site of the forest, and after the Second World War a military training ground functioned.

According to I. Kaplun [13], about a hundred years ago, the northern part of the Podilski Tovtry was almost completely afforested, as evidenced by gray podzolics soils on loess loams.
As a result of economic activity, part of the forests was destroyed, only the names of individual settlements such as the Chornyi Lis, Dubivtsi, Zarubyntsi remained. We can partly agree with this statement. Of course, once these lands were under the forest. However, our cartometric studies of multi-temporal maps convincingly prove that the forest cover of the northern part of Tovtry has indeed decreased compared to 1880. Nonetheless the analysis of the Austro-Hungarian maps does not give any grounds to assert that the northern part of the Podilski Tovtry was almost completely forested 100 years ago. In the vicinity of the village of Dubivtsi, the area of individual forests even slightly increased, as a result of which the forest tracts of Pozharnytsia and Dubivtsi formed a single forest massif.

As of 1880, the territories northwest of Zbarazh were distinguished by the greatest forest cover. Forests in this territory covered not only Tovtry, but also the nearby plains. At the same time, forests were represented by separate massifs of different areas. The usual forest cover of accounting plots in this area is below 30 percent. Its higher rates (35–70 percent) were characteristic of the territories near the villages of Mshanets, Mylno, Ivanchany. To the southeast of Zbarazh, a clear confinement of forest tracts to Tovtry Ridge was observed. The only exception is the area between Zbarazh and Maksymivka, where Tovtry is low and treeless, and to the east of them was the Lubianky forest. The forest cover of the ride gradually grew from the villages of Maksymivka and Hory-Stryiovetski towards the southeast. Its maximum values (70 - 100 percent) were south of the village of Krasne. When comparing the forest cover as of 1880 and 1930, we see a decrease in this indicator within individual accounting areas, while maintaining common features in the distribution of forests. A decrease in forest cover and an expansion of treeless territories are observed to the north of the village Hai–Roztotski, west of Zbarazh, etc.

On the maps of 1930, as a result of deforestation on the plains, in the section Mala Berezovytysia – Zbarazh, one can quite clearly trace the connection between the extent of Tovtry and the forest cover of the territory. Analysis of the maps revealed a decrease in the area of the Chornyi forest by 3.3 km² (from 12.3 to 9.04 km²). At the same time, the configuration of the massif has also undergone changes. Cut down and plowed areas, to which the farms are confined, are deeply cut into the territory of the forest from the east and south-west. The area of the Lubianky forest decreased by 4.9 km² (from 18.8 to 13.92 km²) as a result of cutting and plowing in its estern and southern surroundings. Forest Lypnyk, in 1880, stretching southwest of the village Zarubyntsi to the river Hnizdychna in a continuous massif with an area of 1 km².
Figure 3. Transformation of forest massifs between the villages of Zarubyntsi and Zaluzhzhia. Map fragments: a) 1880; b) 1930; c) 2020.

was cut down until 1930, and three small plots overgrown with shrubs, with a total area of 0.5 km², remained from it.

Ternopil Voivodeship was the only one in Poland that did not have state forests. Within the limits of the voivodeship there were public (gmina), church and private forests. In 1939, by combining private and monastic forests, the Ternopil forestry was formed, assigned to the North-Western Podillia forestry region with hornbeam-oak and beech forests.

On large areas of the study area, a decrease in forest cover is observed. The most active deforestation took place near settlements, as well as in the process of building granges. The maximum reduction in forest cover is -68 percent and -89 percent. Both of these sites are located northeast of the Tovtry Ridge and are associated with the development of settlements. In the first case, the village of Khomivka was formed on the site of the forest, and in the second, the farms building between the villages of Lopushno, Panasivka and Volysia. A significant decrease in forest cover (-57 percent) occurred near the village of Boliazyby, as well as south of Hai-Roztotski, near Zaluzhzhia, Lubianky, Krasne, etc. To the south-east of Maksymivky
Maksymivka, changes in forest cover are quite clearly associated with the Tovtry Ridge, which is due to the absence of forests on the nearby plains as early as 1880. The most significant changes in this segment can be traced between the villages of Krasne, Sadzhivka and Volytsia, near the village of Monastyrykh (-40 percent) and in the north-east of the Malynnyk forest massif (-42 percent). In general, there is a fairly clear connection between the decrease in the forest cover of the territory and its proximity to the settlement, which, obviously, is due to the economic feasibility of agricultural use of land close to the settlement. In some areas of the study area, there was also a certain increase in forest cover. Its most significant growth is observed in the western environs of the Medobory Nature Reserve, which is probably due to the cessation of economic activity in these territories. This phenomenon is negative, because it leads to a decrease in the areas of poaceous forbs and petrophilic steppe vegetation that are valuable from the scientific and economic points of view.

K. Moskaliuk [2] argues that as a result of grazing domestic animals, the territory of the lateral Tovtry is overgrown with weeds and shrubs. It is impossible to agree with this. Rather, on the contrary, by allowing moderate, regulated grazing of animals and hay cutting, it will be possible to stop the expansion of shrubs and weeds. To date, it is impossible to verify any of the claims, due to too few domestic animals left in the population.

Interesting data on the transformation of Medobor landscapes on the territory of the reserve can be found in the article by V. Shymanski [14]. This Polish researcher, studying the site of the discovery of the Zbruch Idol, gives a description of the section of the Zbruch valley near the village of Lychkivtsi based on a photograph of 1882. The descriptions made by him convincingly testify in favor of the expansion of tree and shrub vegetation in areas taken out of agricultural use.

As a result of long-term economic impact, the natural complexes of the Western Podillia, and in particular Tovtry Ridge, have been significantly changed, their original structure has been disturbed, and the mechanisms of self-regulation have been unbalanced. Forests have undergone especially significant changes, namely, in oak forests, native full-membered cenoses of different ages with oak dominance have been largely replaced by derived groups, the ecological potential of which and the possibility of detecting environmental stabilizing functions by them are limited [3].

The analysis of the species composition of forest stands was carried out on the basis of forest plantation plans of the forestry and our own field observations. Therefore, certain patterns have been established in the change in the composition of forest stands in the direction from the northwest to the southeast. Thuswise, the forests of the Mshanets forestry are composed mainly of oak and pine (silviculture) with an admixture of aspen, sweet cherry, etc. In the Zbarazh forestry, forest stands are represented by hornbeam, oak, linden with an admixture of aspen, sweet cherry, ash, acacia (in separate sections). The forests of the Skalat forestry are composed of ash, ulmus, oak, hornbeam with an admixture of sweet cherry, birch, etc. It also has a place of beech growth: Polupanivka beeches (a natural sanctuary of local significance) in the tract named after S. Dovbenka (former Kolodiivka forest) and in the forest Malynnyk. Oak, beech, hornbeam with an admixture of linden, sweet cherry, aspen grow in the forests of the Medobory Nature Reserve. In the reserve, active work is underway to form nominally primary oak-beech stands with an admixture of hornbeam, linden, and sweet cherry.

In each forestry, certain areas are occupied by fir, maple, aspen, etc. At the present stage, larix and pine forest plantations are being created on rocky hill of Tovtry Ridge and other lands. The priority of these crops in forestry is due to their unpretentiousness to conditions and rapid growth.

A number of authors, in particular V. Bondarenko et al. [3] focus on the expansion of modern forest vegetation to adjacent lands, the agricultural use of which has been discontinued for certain reasons. The most actively overgrown meadows adjacent to the forest, fallows, abandoned
estates. In the conditions of Western Podillia, the evidence of forest expansion into nearby fields is the ditches, with which, in the interwar period, and sometimes even earlier, the owners dug their forest plots. Currently, all of them are covered with trees and shrubs. After conducting research at the Medobory Nature Reserve, V. Bondarenko and co-authors [3] found that over the past 70–80 years, the forest has spread beyond the ditch line by 1–9 m. Similar processes were found by us in the forests northwest of Polupanivka (the area named after S. Dovbenka), near Staryi Zbarazha, Oprylivtsi, Ditkivtsi during research in 2010-2013. A repeat inspection of these territories in 2020 did not yield results. All agricultural lands have been redeveloped with modern powerful equipment of agricultural holdings. The natural succession of sections is again stopped by economic activity. We can still observe the expansion of the forest in small areas of the river floodplains Zbruch, Hnizna, Hnyla. But the species composition of these thickets is too specific.

V. Bondarenko and co-authors [3] note that on the land where agricultural land use has ceased, forests spread through the edge, within which microclimatic, biotic, and coenotic conditions are specifically and predominantly favorable for many tree species. On the majority of the edge of the reserve, among other species, hornbeam, tree-like and shrubby willows, blackthorn predominate and grow intensively. The change in phytocenosis occurs in the direction of a composition close to the previous one, its pace and nature are determined by the species composition of the adjacent forest, environmental conditions, the influence of animals, and the direction of the prevailing winds. First of all, the derelict lands are overgrown with photophilous species, the microclimate characteristic of the forest environment is gradually forming, and the pioneer vegetation is being replaced by shade bearing plants [15].

We obtained similar results in 2010-2013 during field observations in the above-mentioned forest massifs. In 2020, in the area named after S. Dovbenka, active expansion of the forest is taking place in the southwestern and southern directions. From the south, between the forest and the Polupanivka quarry, the land allocated for the expansion of the quarry. They are actively overgrown mainly with hornbeam, sweet cherry and willow. At the border of the forest, the trees are quite dense and go to a height of 2 - 4 m. With distance from it, they become lower and less common. In the species composition, the number of hawthorn and other shrubs is growing. To the south-west of the forest, there are steep slopes of the main strand with outcrops of bedrock, on which the expansion of shrubs and woody vegetation into rocky steppe areas is clearly traced. The predominant species here is hawthorn. Pine is also found and rarely sweet cherry. To the east and north-east of the forest, all the lands are plowed, therefore significant expansion is impossible. However, the forest in this direction since the 30s of the XX century “captured” about 1.5 m beyond the moat.

In the vicinity of Staryi Zbarazha, the expansion of the forest to fallow fields and hayfields is not very active in 2010-2013. On the falls mostly individual specimens of hornbeam, willow, and hawthorn sprouted. Since 2019, these falls have been plowed up again. Active expansion of tree and shrub vegetation is observed in the steppe areas near the villages of Staryi Zbarazh, Oprylivtsi, Dubivtsi. These are predominantly forb meadows on humus-carbonate soil, which were used as unproductive pastures and places for spontaneous stone mining. Now the slopes of such hills (for example, Mount Skala in the south of the village of Oprylivtsi) are actively overgrown with hawthorn and other shrubs.

On the northeastern outskirts of Detkovets, the top surface of the Tovtry Ridge is covered with planted pine forest, which is adjoined by several hectares of fallow. On the last one, active overgrowth of self-sowing pine is observed. Pine of all ages and unevenly distributed over the territory. The oldest specimens reach a height of more than 3 m. The adjacent falls on the slopes are not yet overgrown with forest. When analyzing the public cadastral map, we found that these lands have already been given into ownership for private peasant farming, so the expansion of the forest will definitely not go any further. Very soon these plots will be plowed
up and reused for crops.

The priority task should be considered to increase the area of forests to a scientifically substantiated level through the formation of forest cultures on sloping lands adjacent to forests. This requires the development of an appropriate legal framework, because most of the land is private property and the greatest economic effect is brought by their use in agriculture, in particular, when leased to agricultural holdings or farmers. The return on capital in forestry requires a very long time investment and therefore is not at all attractive to land owners. Only the government or separate amalgamated territorial communities can increase the area of forests. This should be done by creating forest corridors (as wide as possible) between existing forest areas, which will contribute to the stabilization of the geo-ecological situation and, in particular, the development of fauna. In order to increase the tourist attractiveness of the existing agro landscapes, it is also advisable to create small forests on the site of abandoned farms and parts of villages, cemeteries and on the slopes of small beams.

Further studies of forest management in this region should be directed to substantiate the optimal ratio of protected and commercial forests, as well as to develop a regulatory and legal framework for the possibility of afforestation of shared and privatized lands, to further develop the problem of restoration.

4. Conclusions
As a result of our research, we found that:

- about 2/3 of the study area is occupied by areas with a forest cover of less than 20 percent;
- forest massifs of a relatively large area are confined to the top surface and slopes of the main ridge and grow mainly on gray and dark gray forest soils. Less common are chernozems carbonated and humus-carbonate soils;
- the species composition changes slightly in the direction from northwest to southeast, however, in general, the dominant species are oak, hornbeam, pine, ash with an admixture of ulmus, sweet cherry, linden and beech;
- in the period from 1880 to 1930, there was a significant decrease in forest cover almost throughout the study area, which is associated both with the need for firewood and with agrarian overpopulation and the desire to expand arable land. On the site of clearings, farms and granges were formed;
- in the period from 1930 to the present day, the forest cover continued to decline, but much more slowly and only in certain areas, while in others it even slightly increased;
- in the late 90s and early 2000s, there was an active expansion of the forest on lands not involved in agricultural production;
- in recent years, most of the areas where the forest was expanding have been uprooted and plowed up again. Unfortunately, it was not profitable to change the status of the lands legally. Agroholdings are interested in maximum arable land.

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