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Mapping of Forest Habitats in Mountainous Areas – a Case Study from Svoge Municipality, Western Bulgaria

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Abstract. The study is focused on the study of forest habitats of Svoge Municipality, situated in the western part of the country. The total area of Svoge Municipality is 868 km^2. 134 relevés were collected during the period of 2015-2019, following the Braun-Blanquet approach and 445 field points were verified, as well. As a result, nine forest habitat types, included in Directive 92/43/EEC, were identified, representing a habitat diverse municipality. They are covering 135.89 km^2 or 15.7% of the total municipality's area. The habitat type of the *Asperulo-Fagetum* beech forests (9130) covers the largest area (57.86 km^2), followed by the habitat type of the Medio-European limestone beech forests of the *Cephalanthero-Fagion* (9150) (31.03 km^2). The dominance by beech forest is typical for the Western Balkan Range where these types of forests expanded due to climatic and anthropogenic factors, which led to the reduction of the belts, dominated by the common hornbeam, the spruce and the fir. Major threats include forest degradation and loss, because of logging activities, pests, presence of invasive species, quarries and illegal household disposing. Measures, including afforestation with local species and forest regeneration, are needed.

Key words: mapping, Natura 2000, Directive 92/43/EEC, vegetation, beech forests.

Introduction

Forests play a vital role in ecosystem functioning. They are a source of food and clean water, they take part in processes such as pollination and erosion prevention, they provide shelter for biodiversity (Powell et al., 2013; Aznar-Sanchez et al., 2018; Acharya et al., 2019; Dodev et al., 2020). Forests are in fact key habitats that have to be studied thoroughly. Their role is indispensable for climate regulation. Local forests have a key role in battle against invasive species. Forest loss and forest degradation restrict their ecosystem role. Therefore, a range of activities for their monitoring, assessment, conservation and restoration have to be organized. This is acknowledged by the EU Biodiversity Strategy for 2030 and the European Commission has published guidelines for dealing, mapping, monitoring and strictly protecting primary and old-growth forests, as well as guidelines on biodiversity-friendly afforestation, reforestation and tree planting (European Commission, 2023 a,b). Much has been done for their mapping in-situ and data is being stored in archives, such as the European Vegetation Archive by Chytrý et al. (2016). Still much has to be accomplished, especially regarding data focused directly on forest protection. As we venture into smaller geographical scale, we find out

that in some places, such as Bulgaria, despite the fact that forests are protected, their management has to be improved in some areas (Chobanova & Popova, 2017). Overall, forests cover around one third of the country's area, meaning that the provision of ecosystem goods and services is guaranteed in some way, but territorial coverage may be expanded. According to the Global Forest Resources Assessment (2015) the total cover of protected native forests in Bulgaria was around 5720 km^2 (5.2% of the territory of Bulgaria) in 2010. A large share of the forests is a part of the Natura 2000 network, protected under Council Directive 92/43/EEC of the European Union. Currently, there are over 230 sites, included in the aforementioned Habitat Directive that are covering over 30% of the country's area.

Habitat research within the present study's territorial scope - Svoge Municipality is still schematic. The present study is focused on the investigation of the forest habitats of this area which may add more data for policy making. Forests in Western Bulgaria have been studied by Tzonev et al. (2006, 2009) and Tashev et al. (2010). Vassilev et al. (2014) and Dimitrov & Petrova (2014) have done an investigation of the Special Protection Area "Ponor", included in the municipality's area, thus the present research's results may be used as a comparison to previous ones. Dyakov (2013) studied successional patterns, stand structure and forest regeneration. Molla et al. (2014) focused on forest fire impacts on soil carbon content in Rila Mountain. Nedkov et al. (2021) developed a methodological approach for ES mapping and assessment.

Materials and Methods

Case study area

Svoge Municipality is situated in Western Bulgaria and it covers a territory of around 868 km^2, making it the second largest in Sofia Province (Fig. 1). The choice of working in an administrative unit was supported by the fact that this would be more useful for local authorities for policy making. The municipality's area is included in the Western Balkan Range, leading to the presence of a mountainous relief - a prerequisite for forest formation. Climate is temperate (Velev, 2010). The municipality is divided by the longest Bulgarian river - Iskar River. Other major rivers are Iskretska River, Batuliyska River and Gabrovnitsa River. Soil diversity includes the presence of Fluvisols, Luvisols, Leptosols, Cambisols (Ninov, 2002).

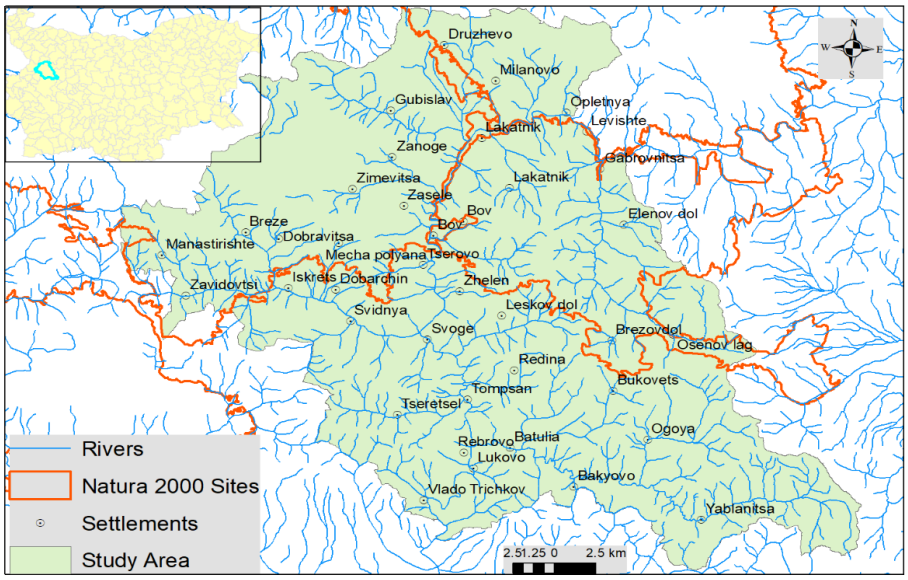

Fig. 1. Map of the study area.

Data and methods

Field data was collected during the years of 2015 and 2019. The vegetation sampling included the collection of 134 relevés, following the Braun-Blanquet approach (1965). The plots were distributed in homogenous and representative areas, 15 by 15 m. All vascular plants were distinguished in each plot and their projective coverage was eva-

luated. Vegetation was classified by the application of JUICE 7.0 (2002) and PC-ORD software packages (1999). GPS coordinates were taken with Juno BS Trimble. The collected information was analyzed afterwards and data was related to the habitats. Habitat mapping was conducted at 1:5000 scale in 2020-2021 and habitat determination was accomplished through the use of Kavrakova et al. (2009) and the Interpretation Manual of European Union Habitats (2013). The ArcGIS 10.8.1 software tools were applied for cutting, merging, deleting and creating polygons. Polygon modifications were also helped by the application of Forestry Data.

Results

Nine forest habitat types, included in Directive 92/43/EEC, were identified (Fig. 2). Statistical data, regarding them is presented in Table 1. The most common habitat is 9130, while 91G0 has the smallest area.

Table 1. Statistical data about the forest habitats in Svoge Municipality.

Habitat type	Number of polygons	Minimum polygon area (km²)	Maximum polygon area (km²)	Total area (km²)	% coverage of the total area
9110	7	0.098	0.29	1.34	0.2%
9130	71	0.08	5.01	57.86	6.7%
9150	67	0.006	4.12	31.03	3.8%
9170	59	0.07	1.795	24.796	2.9%
9180	19	0.08	0.81	5.15	0.6%
91G0	3	0.21	0.28	0.70	0%
91M0	8	0.06	1.11	2.56	0.3%
91W0	23	0.099	1.24	11.01	1.3%
91Z0	4	0.11	0.38	1.08	0.1%

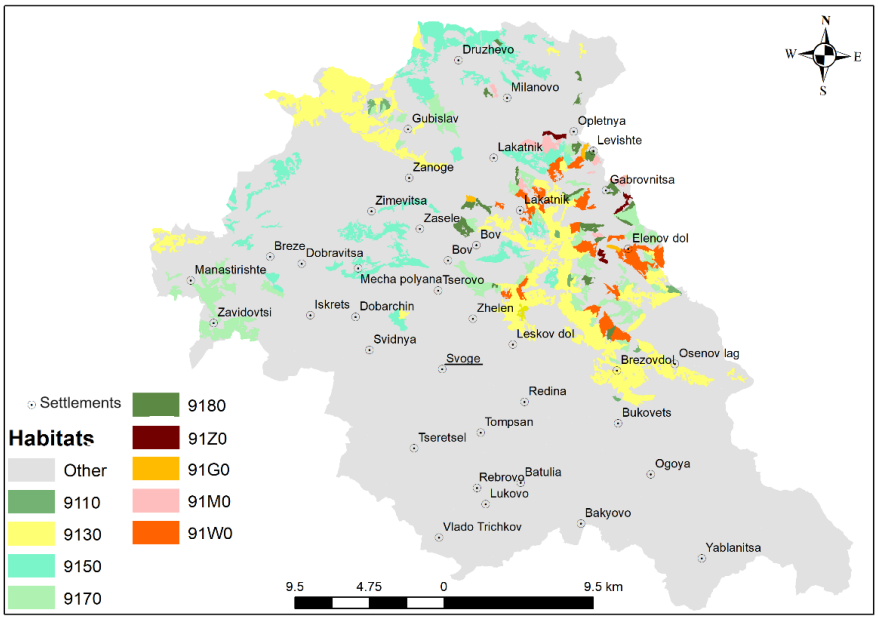

Fig. 2. Forest habitats in Svoge Municipality.

9110 *Luzulo-Fagetum* beech forests

This habitat type is located in the eastern parts of the municipality, but it has a restricted aerial coverage of 1.34 km². This habitat includes mesophyllous beech forests that occur in the upper part of Western Balkan Range. Phytocoenoses have a closed horizontal structure with a total cover of 95-100%. The dominant species is *Fagus sylvatica*. Other typical tree species are *Acer pseudoplatanus, Carpinus betulus* and *Quercus daleschampii*. The shrub layer has a low cover (10-15%) and is formed by *Rubus hirtus, R. idaeus, Corylus*

avellana, Vaccinium myrtillus, V. vitis-ideae, Juniperus sibirica. The herb layer has a cover of 50-70% and the most frequent species are *Luzula luzuloides, Galium odoratum, Mercurialus perennis, Melica uniflora, Cardamine bulbifera*. This vegetation was classified to class *Carpino-Fagetea*, order *Fagetalia sylvaticae* and alliance *Luzulo-Fagion*.

9130 *Asperulo-Fagetum* beech forests

The habitat type is situated in the eastern and south-eastern parts of the case study area. It is the type with the broadest distribution and it covers almost 60 km^2. It includes mesophyllous beech forests with a closed horizontal structure. The total vegetation cover is 95-100%. The dominating species is *Fagus sylvatica. Carpinus betulus* appeares as a subdominant. The shrub layer has a low cover (10-20%) and is formed by the same species from the tree layer along with *Rubus hirtus, R. idaeus, Corylus avellana*. The herb layer has a cover between 25 and 80% with more frequent species like *Galium odoratum, Melica uniflora, Cardamine bulbifera, Aremonia agrimonoides*. This habitat is in contact with *Galio-Carpinetum* oak-hornbeam forests (9170).

9150 Medio-European limestone beech forests of the *Cephalanthero-Fagion*

This habitat type is located in the central, northern and north-western territories. It is characterized by closed horizontal structure 90-100% with *Fagus sylvatica*, as a dominant. Other tree species are *Carpinus betulus, Quercus daleschampii, Tilia cordata, Acer peudoplatanus*. The shrub layer is well-developed and consists of young trees from the aforementioned, as well as *Cornus mas, Euonymus verrucosus, Ligustrum vulgare*. The herb layer has a rich species composition, including some calciphilous species. Other species that were found in the herb layer were *Mercurialis perennis, Melissa melissophylum, Helleborus odorus, Polygonatum odoratum, Cephalanthera lonfigolia* and *Neotia nidus-avis*.

9170 *Galio-Carpinetum* oak-hornbeam forests

This habitat type is located mainly to the west. It includes mixed or monodominant forests, dominated by *Quercus dalechampii* and *Carpinus betulus*. Other tree species are *Fagus sylvatica, Acer pseudoplatanus, A. campestre, Sorbus torminalis*. The total vegetation cover is 95-100% and the tree layer coverage is 90-100%. The shrub layer is formed by the same species of tree layer as well as *Chamaecytisus hirsutus, Euonymus europaeus* and *Corylus avellana*. The herb layer has a cover of 60-80% with uniform species composition and species such as *Poa nemoralis, Festuca heterophylla, Luzula luzuloides, Melica unifl*ora were typical.

9180* *Tilio-Acerion* forests of slopes, screens and ravines

This habitat type is fragmentally distributed on steep slopes in the central and eastern parts of the municipality. The closed horizontal structure is typical for it with a total cover of 85-100%. The most abundant species in the tree layer are *Acer campestre, Tilia platyphyllos, Quercus daleschampii* and *Carpinus betulus*. The shrub layer consists of younger individuals of the same trees and *Ligustrum vulgare, Euonymus europaeus, Coryllus avelana*, as well. The herb layer has a total cover ranging from 40 to 85%.

91G0 *Pannonic woods with *Quercus petraea* and *Carpinus betulus*

This habitat type has a restricted territorial coverage and it is situated only in the central parts of Svoge Municipality. The subdominants in this habitat type were presented by *Carpinus betulus, Quercus cerris* and *Q. daleschampii*. The shrub layer was formed by *Cornus mas, Ligustrum vulgare, Euonymus europaeus, Ulmus minor, Viburnum lantana*. The herb layer had a cover of around 45% and it was represented by *Melica uniflora, Buglossoides purpurocaerulea*, etc.

91M0 Pannonian-Balkanic turkey oak–sessile oak forests

The habitat type is located only to the north. The vertical structure of this habitat type was presented by four layers – trees, shrubs, herbs and cryptogams. The total vegetation cover was 80-100%. The tree layer covered 70-100% and the dominant species were *Quercus cerris* and Q. *frainetto. Q. daleschampii* was found to be a subdominant. The shrub layer had a cover between 10 and 65% and was mainly formed by the same species, discovered in the tree layer, along with *Crataegus monogyna, Rosa canina, Prunus spinosa*. These communities had a well-developed herb layer with highly abundant species such as *Poa nemoralis, Festuca heterophylla, Melica uniflora*.

91WO Moesian beech forests

This habitat type is distributed in the eastern parts of the territory. It includes monodominant beech forests or mixed forests with *Carpinus betulus, Quercus daleschampii* and *Tilia platyphyllus*. Other tree species are *Acer campestre, Quercus cerris, Q. frainetto, Sorbus torminalis*. The shrub layer is formed by the same species of the tree layer and includes also *Corylus avellana, Prunus spinosa, Crataegus monogyna, Ligustrum vulgare, Euonymus verrucosus*. The herb layer is well developed and has a cover of 60-80%. It is represented by the species of *Melica uniflora, Poa nemoralis, Aremonia agremonoides, Euphorbia amygdaloides, Cardamine bulbifera*, etc.

91Z0 Moesian silver lime forests

This habitat type is distributed in the eastern part of study area. The dominant species is *Tilia tomentosa.* The shrub layer is formed by the same species as those of the tree layer, accompanied by *Prunus spinosa, Ligustrum vulgare, Corylus avellana, Euonymus verrucosus, Fraxinus ornus*, as well. The herb layer is rich in species and the most frequent species are *Polygonatum odoratum, Scilla bifolia, Melica uniflora, Poa nemoralis*.

Discussion

Svoge Municipality is a third municipality in the country in which habitat types were studied and mapped, using 1:5000 scale (Grigorov et al., 2023 a,b). Despite this fact and the presence of a number of studies more research is needed to reveal the characteristics of the condition of the forests in the western parts of Bulgaria. Habitats under Council Directive 92/43/EEC and EUNIS habitats were taken into account. The approach, using administrative units, has its pros and cons compared to the approach, that deals with natural boundaries. Among its biggest advantages of the first is that it can be applied directly by policy makers who are responsible for the governance of any municipality.

The research regarding Godech Municipality included 7 EUNIS habitat types, while 8 forest habitat types, included in Directive 92/43/EEC, where investigated in Dragoman Municipality. If compared to the latter, the forest habitats in Svoge Municipality are located in all sections of the administrative unit with the exception of the southern parts. The habitat types of 9110 *Luzulo-Fagetum* beech forests, 91WO Moesian beech forests and 91Z0 Moesian silver lime forests are present in the study area of this research and lack of in Dragoman Municipality which can be explained by the physical characteristics of the area, including its bedrock and geomorphological features. At the same time the habitats of 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) and 91H0* Pannonian woods with *Quercus pubescens* are not featured in Svoge Municipality due to the absence of large areas covered by the pubescent oak, the common alder and the common ash. Drumeva & Lyubenova (2023) studied 91M0 habitats in SCI ''Zapadna Stara Planina i Predbalkan'' from the point of view of natural capital. The authors conclude that 91M0 is a fragmented habitat, which is valid for Svoge Municipality, as well. It is one of the habitats with the most restricted territorial coverage here, thus they cannot be a source of extensive natural capital for this area.

Svoge Municipality is dominated by beech forest, which is typical phenomenon for the Western Balkan Range where these types of forests expanded because of climatic and anthropogenic factors, which led to the reduction of the belts, dominated by the common hornbeam, the spruce and the fir (Filipovich, 1981; Filipovich & Antonov, 1996).

A lot of problems have to be addressed in order to increase the protection of the territory. Forest degradation and loss, because of logging activities, pests, appearance of invasive species, presence of quarries and illegal household disposing are forming some of the major threats for forest habitats in Svoge Municipality. Measures, including afforestation with local species and forest regeneration, are needed.

Overall, the promising results of the current study may be used as a basis for further investigations on this matter. The subject could be introduced in the neighboring and habitat research may be focused on grassland or shrubland territories.

Conclusions

The current research focused on the investigation of forest habitats in Svoge Municipality. Nine habitats, included in Directive 92/43/EEC, were identified. The habitat type of the 9130

Asperulo-Fagetum beech forests has the widest distribution, while the 91G0* Pannonic woods with *Quercus petraea* and *Carpinus betulus* were with the smallest territory. The mapping in a 1:5000 scale provided enough detail. More relevés and terrain verifications are needed to acquire in-depth information. On one hand the focus could have been more on the forest with the broadest distribution (beech forests), but on the other the authors could have put more effort in studying habitats with lesser extent. More data could have been obtained by the application of remote sensing. Despite these limitations, the present research has its positives and may be used by local authorities for policy making.

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