BioRisk 20: 153–163 (2023)
doi: 10.3897/biorisk.20.97534
https://biorisk.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
BioRisk

Forest habitats of Godech Municipality, Western Bulgaria

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Academic editor: K. Danova | Received 14 November 2022 | Accepted 29 December 2022 | Published 15 May 2023

Citation: Grigorov B, Velev N, Assenov A, Nazarov M, Genova B, Vassilev K (2023) Forest habitats of Godech Municipality, Western Bulgaria. In: Chankova S, Danova K, Beltcheva M, Radeva G, Petrova V, Vassilev K (Eds) Actual problems of Ecology. BioRisk 20: 153–163. https://doi.org/10.3897/biorisk.20.97534

Abstract

The current study aims at revealing the forest habitat diversity of Godech Municipality, according to the EUNIS habitat classification. Initial data was collected from the Ministry of Environment and Water and the Forestry Management Plans. Subsequently, 418 vegetation plots (relevés) and 3422 verification points were collected during the fieldwork seasons of 2019 and 2020. The research territory is situated in Western Bulgaria in close proximity to the country's border with the Republic of Serbia. Forests cover a total of 144.85 km^2. Their phytocoenoses are dominated by *Fagus sylvatica* L. (59.22 km^2), *Quercus cerris* L. (14.85 km^2), *Carpinus betulus* L. (4.94 km^2), *Quercus dalechampii* Ten. (2.39 km^2), *Q. frainetto* Ten. (2.99 km^2). There are plantations with *Pinus nigra* J. F. Arnold (20.87 km^2), *P. sylvestris* L. (16.06 km^2) and *Picea abies* H. Karst (11.65 km^2) also. Forests are experiencing some major threats, such as logging, pollution and fires.

Keywords

EUNIS, GIS, habitat mapping, syntaxa, vegetation and habitat diversity

Introduction

The role of forests in the functioning of our planet is indispensable. They hold one of the keys for the reduction of human's ecological footprint. Forests provide a vast array

of ecosystem services (Garcia-Nieto et al. 2013; Aznar-Sanchez et al. 2018; Acharya et al. 2019). The sustainability issue is also tied tightly to a forest's structure and functioning. Many forest habitats in Bulgaria are protected, but poorly managed in general. They are included in the Natura 2000 network and watched over by Council Directive 92/43/EEC of the European Union. Still more research is needed to unveil their full significance for our well-being. More awareness has to be raised for their overall protection, but not only on paper. Despite the lack of governmental acknowledgement of the importance of the forest ecosystem in Bulgaria, we still possess around 30% of forested territory. The authors share the view that forest habitats have to be mapped, complying with all current trends at the perspective of the EUNIS classification, striving for habitat monitoring and protection (Chytrý et al. 2020).

Forests in western Bulgaria have been investigated by a number of scientists (Yordanov 1924; Minchev 1938; Florov 1952; Garelkov 1973; Filipovich 1981; Filipovich and Antonov 1996; Dodev and Popov 2011). Tzonev et al. (2006, 2019), Tashev et al. (2010), Dimitrov and Petrova (2014) played their role in forest habitat research.

The present study represents a continuation of the habitat investigations in Western Bulgaria, based on the EUNIS classification (Grigorov et al. 2022a). Habitats in Godech and Dragoman Municipality have already been studied by Grigorov et al. (2021a, b, 2022a, b). The creation of a habitat map of forests in Godech Municipality, based on the EUNIS classification, will provide more data to policy makers and this is a main aim of the current work.

Methods

Godech Municipality covers ca. 375 km^2 (Fig. 1). The territory is situated in the western part of Bulgaria. It borders the municipalities of Berkovitsa and Varshets to the north, Svoge municipality on the east, Dragoman and Kostinbrod municipalities on the south. The orogenesis has led to the formation of the following mountain ranges: Berkovska Mountain, Ponor Mountain, Vidlich, Vuchibaba and Chepun Mountain. Godech Valley, also known as Zaburge, is located in-between. The highest peak is Srebarna (1931.3 m), situated in Berkovska Mountain. More than 50% of the territory has an elevation between 1000 and 1600 m above sea level. The geological features include carbonate rocks (limestones, dolomitic limestones, dolomites) – a prerequisite for development of the karstification process. Breccias, conglomerates and sandstones are present, as well. Intrusive rocks and alluvial deposits may also be found (Zagorchev et al. 1990). The main river is Nishava with its tributary – Arakul River. The wide variety of geographical conditions has led to the formation of different soil types, such as Cambisols, Luvisols, Alluvisols and vegetation communities.

The fieldwork seasons of 2019 and 2020 were used for collection of 418 relevés following the Braun-Blanquet approach (Braun-Blanquet 1965) and 3422 verification field points (Fig. 1). All data collected in the field was applied in order to build a precise habitat map of the area. All collected relevés contributed to the Balkan Vegetation

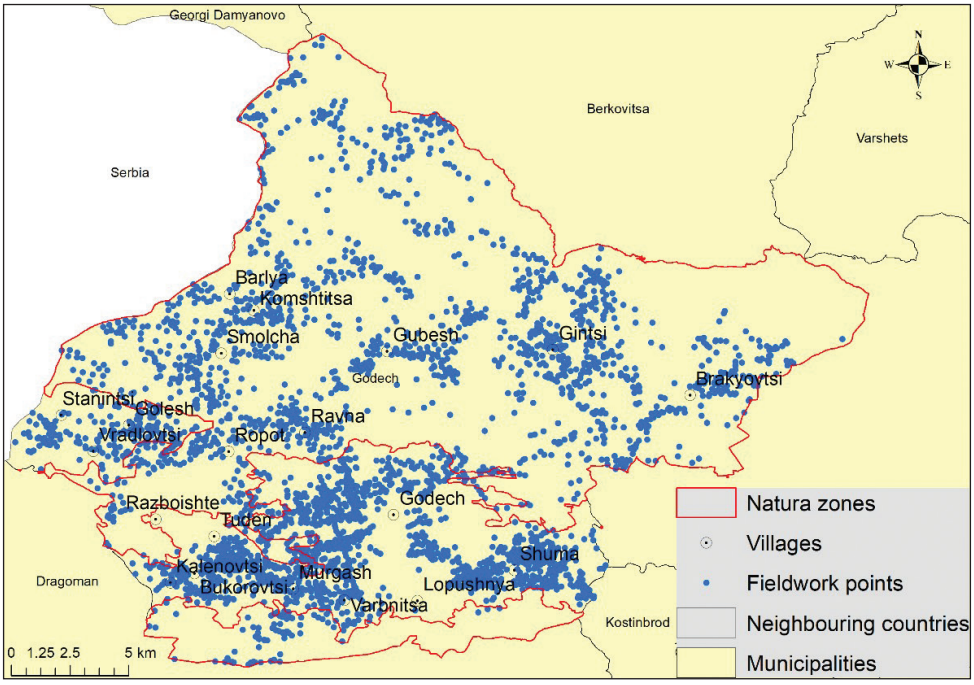

Figure 1. Forest vegetation relevés and verification points collected in Godech Municipality.

Database (Vassilev et al. 2020) and Balkan Dry Grassland Database (Vassilev et al. 2012). All relevés were plotted in homogenous areas of forest communities and were subsequently assigned to relevant habitat types. Habitat types were related subsequently to the revised version of the EUNIS system (Chytrý et al. 2020).

The EUNIS habitat types were determined with the help of the classification expert system EUNIS-ESy (Chytrý et al. 2020) integrated into JUICE 7.1 software (Tichý 2002). All defined habitat groups have had their diagnostic, dominant and constant species determined, following Chytrý et al. (2020). Every semi-natural habitat type was classified to alliance level according to Mucina et al. (2016). Associations were determined based on the expert knowledge and available literature sources for the country (Tzonev et al. 2006, 2019).

Mapping was done using the ArcGIS 10.6 software package. Spatial data was collected in the field using GPS device Juno BS by Trimble and was later laid over the most recent orthophoto images available. The habitat map was created by the help of the "Intersect tool" by combining the layers, containing forestry data from Forestry Management Plans, as well as data about agricultural areas and habitat data from habitat mapping of NATURA 2000 in Bulgaria. Later, the "Cut polygon" tool was used in order to precisely modify the polygon geometry. All polygons were outlined manually using all the field collected data as well as the orthophoto images. The habitat map was elaborated in scale 1:5000.

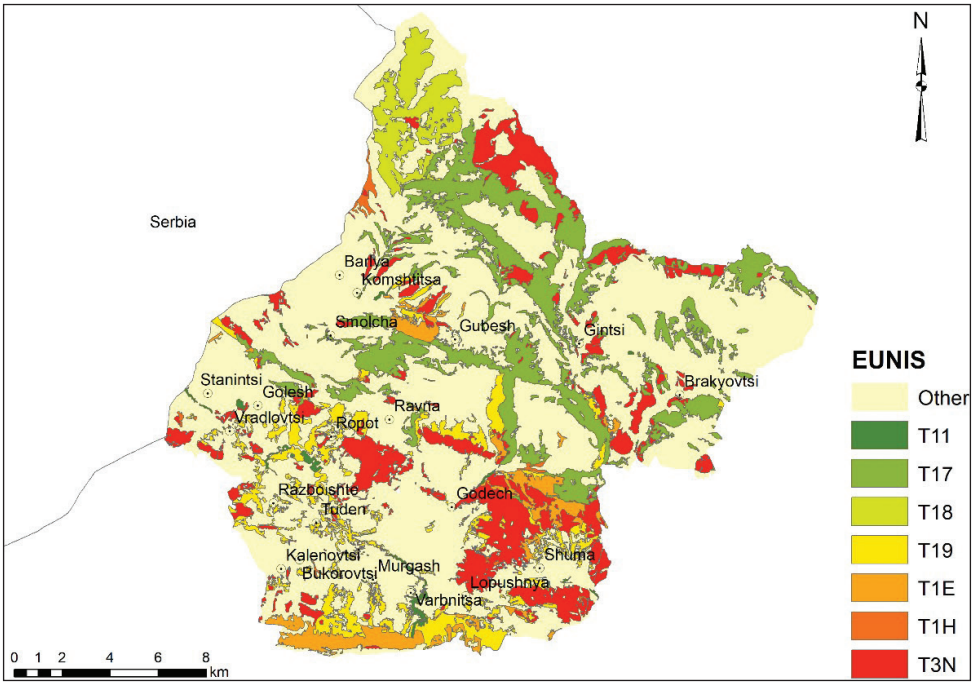

Figure 2. EUNIS forest habitat types in Godech Municipality.

Results

All studied forest types in Godech Municipality were related to 7 EUNIS habitat types (Fig. 2), which cover an area of 144.85 km^2.

T1E Carpinus and Quercus mesic deciduous forest

Abiotic characteristic: This habitat type covered an area of 12.20 km^2. It was located on slopes with humid conditions mainly in the mountains of Chepun, Vuchibaba and Berkovska Mountain predominantly in the hypsometric belts between 600 and 1000 m a.s.l. on slightly inclined slopes (10–15°) predominantly with northern and western components. Limestones, dolomites and marls were present. Soils were averagely deep. This habitat type was presented by 78 polygons (map units). The polygon's area was in the range of 0.0007–2.14 km^2.

Species composition and vegetation structure: T1E habitat type included monodominant or mixed forests with a closed horizontal structure and a total cover of 90–100%. *Carpinus betulus* L. or/and *Quercus petraea* agg. dominated the tree layer, which had a cover of 85–100%. *Fagus sylvatica* L., *Acer campestre* L., *Tilia platyphyllos* Scop., *Quercus cerris* L. and *Sorbus torminalis* Crantz were also present. The shrub layer had a cover of 20–40% and was formed by the same species of the tree layer as well as *Ligustrum vulgare* L. and *Corylus avellana* L. The herb layer also had poor species

composition and the most frequent species were *Festuca heterophylla* Lam., *Melica uniflora* Retz., *Poa nemoralis* L., *Aremonia agrimonoides* (L.) DC. Its cover was about 45–65%. The habitat type falls within class *Carpino-Fagetea*, order *Fagetalia sylvaticae* and the alliances *Carpinion betuli* and *Fagion sylvaticae* s.l. This vegetation represents 9170 *Galio-Carpinetum* oak-hornbeam forests, according to the Habitat Directive.

T1H Broadleaved deciduous plantation of non-site native trees

Abiotic characteristic: This habitat included plantations dispersed throughout the municipality and covered a territory of 1.21 km^2, mainly in Berkovska Mountain at 600–1000 m a.s.l. on slopes with various distribution. The bedrock types were represented mainly by limestone and dolomites and the soils were shallow to moderately deep. This habitat type was presented by 12 polygons. The polygon's area was in the range of 0.00000001–0.70 km^2.

Species composition and vegetation structure: Two tree species dominated the plantations: *Robinia pseudoacacia* L. and *Quercus rubra* L. The total vegetation cover in the studied polygons was 85–95%. *Prunus cerasifera* Ehrh., *Pyrus pyraster* (L.) Burgsd., *Malus domestica* Borkh., *Carpinus betulus* L., *Acer campestre* L., *Quercus cerris* L., *Q. frainetto* Ten., *Q. petraea* agg. were also present in the tree layer. The shrub layer was well-developed and had a cover of 25–50% and was formed by the same species of tree layer as well as *Crataegus monogyna* Jacq., *Prunus spinosa* L., *Euonymus verrucosus* Scopoli, *Rosa canina* L., *Rubus caesius* L., *Fraxinus ornus* L., *Carpinus orientalis* Mill. and *Cornus mas* L. The herb layer of *Robinia pseudoacacia* L. plantations was well-developed with cover 90–100%. *Bromus sterilis* L. was the dominant species. Other common species were *Galium aparine* L., *Myrrhoides nodosa* (L.) Cannon, *Chelidonium majus* L. *Quercus rubra* L. forests had a very poor species composition and the herb layer had a very low cover (up to 10–15%). *Robinia pseudoacacia* L. plantations belong to association *Bromo sterilis-Robinietum*, alliance *Balloto nigrae-Robinion pseudoacaciae*, order *Chelidonio-Robinietalia pseudoacaciae* and class *Robinietea*.

T3N *Coniferous plantation of site-native trees

Abiotic characteristic: This habitat type was distributed in all parts of the municipality and included planted coniferous forests at the hypsometric belts 200–600, 600–1000 and 1000–1600 m a.s.l. on slopes with various distribution. It covered an area of 41.97 km^2. Sedimentary and magmatic rocks were at the basis of shallow to averagely deep Chromic Luvisols and Rendzic Leptosols. This habitat type was presented by 246 polygons. The polygon's area was in the range of 0.0009–5.24 km^2.

Species composition and vegetation structure: The main tree species were *Pinus sylvestris* L., *P. nigra* J. F. Arnold and *Picea abies* H. Karst. The tree layer was well-developed with a cover of 85–100%. The horizontal vegetation structure was closed in the *Pinus sylvestris* L. stands and semi-open in the *Pinus nigra* J. F. Arnold stands. Other typical tree species were: *Fagus sylvatica* L., *Quercus* spp., *Acer pseudoplatanus* L.

The shrub layer of *Pinus nigra* J. F. Arnold and *P. sylvestris* L. plantations included *Rosa canina* L., *Rubus* spp., *Crataegus monogyna* Jacq., *Prunus spinosa* L. *Picea abies* H. Karst plantations, which were found at a higher altitude, included species such as *Vaccinium myrtillus* L., *V. vitis-ideae* L., *Chamaecytisus hirsutus* L., *Juniperus sibirica* Burgsd. The cover of the shrub layer was 60–70%. The herb layer was well-developed for the *Pinus nigra* J. F. Arnold plantations and had a cover of 50–70%. Some species from the neighboring habitats such as *Poa nemoralis* L., *Festuca dalmatica* (Hack.) K. Richt., *F. heterophylla* Lam., *Geum urbanum* L., *Melica uniflora* Retz., *Fragaria viridis* Weston, etc., were also discovered. *Pinus sylvestris* L. and *Picea abies* H. Karst plantations, where the tree and shrub layers form strong shady effect, had a herb layer with a lower total cover – 10–40%. The species composition was poorer and the most frequent species were *Luzula luzuloides* (Lam.) Dandy & Wilmott, *L. sylvatica* (Huds.) Gaudin, *Poa nemoralis* L., *Geum urbanum* L.

T11 Temperate Salix and Populus riparian forest

Abiotic characteristic: This habitat type was discovered along the riverbeds of Nishava, Glutnitsa, Zli dol and Shumska Rivers at lower altitudes on flat terrains. It covered an area of 1.8 km^2. The alluvial deposits, mainly on carbonate rocks, have been a prerequisite for the formation of typical averagely deep alluvisols. The habitat type was presented by 29 polygons. The polygon's area was in the range of 0.0005–0.63 km^2.

Species composition and vegetation structure: The vegetation had a closed horizontal structure with a total cover of 95–100%. The tree layer (cover about 85–95%) was dominated by *Salix fragilis* L. and *Alnus glutinosa* Gaertn., mixed with *Populus tremula* L. and *Salix purpurea* L. in some sites. The shrub layer had a cover of 40–60% and was formed by the same species, as the tree layer, but also included *Cornus sanguinea* L., *Prunus spinosa* L., *Rosa canina* L., *Rubus caesius* L., *Sambucus nigra* L. The herb layer was well-developed with a cover of 30–75%. Typical herb species were *Aegopodium podagraria* L., *Agrostis stolonifera* L., *Urtica dioica* L., *Lysimachia nummularia* L., *etc*. Invasive species, such as *R. pseudoacacia* L., *Amorpha fruticosa* L., *Erigeron annuus* (L.) Pers. and *Conyza canadensis* L. were typical as well. This vegetation represents the habitat type of 91E0*Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*), included in the Habitat Directive.

T17 Fagus forest on non-acid soils

Abiotic characteristic: This habitat type had the widest distribution and covered an area of 51.9 km^2 in the hypsometric belts between 600 and 1000 m a.s.l and 1000–1600 m a.s.l. It was common for slightly inclined slopes (up to 20–25°) with various expositions. It included mainly sedimentary rocks and shallow to moderately deep Cambisols. It was presented by 211 polygons. The polygon's area was in the range of 0.0002–7.54 km^2.

Species composition and vegetation structure: The horizontal vegetation structure was closed with a total cover of 90–100%. The tree layer had a cover of 90–100%.

The dominant species was *Fagus sylvatica* L., accompanied in some stands by *Quercus petraea* agg., *Carpinus betulus* L., *Sorbus* spp., *Tilia* spp. The shrub layer included species from the tree layer as well as *Crataegus monogyna* Jacq., *Corylus avellana* L., *Chamaecytisus hirsutus* L., *Ligustrum vulgare* L., *Carpinus orientalis* Mill. Its cover was 20–35%. The herb layer was species-rich with cover 15–65%. The most frequent species were *Aremonia agrimonoides* (L.) DC, *Mercurialis perennis* L., *Helleborus odorus* L., *Polygonatum odoratum* (Mill.) Druce and some orchid species such as *Dactylorhiza cordigera* (Fr.) Soo, *Cephalantera longifolia* (L.) Fritsch, *Neotia nidus-avis* (L.) Rich. This vegetation was classified to class *Carpino-Fagetea*, order *Fagetalia sylvaticae*, alliance *Cephalanthero-Fagion*. This vegetation represents the habitat type 9150 Medio-European limestone beech forests of the *Cephalanthero-Fagion*, according to the Habitat Directive.

T18 Fagus forest on acid soils

Abiotic characteristic: This habitat covered an area of 12.07 km^2 and was presented by 2 polygons only, located in Berkovska Mountain in the hypsometric belts between 600 and 1000 m a.s.l and 1000–1600 m a.s.l. The terrains were slightly inclined (up to 15°) and the exposition was variable. Soils were shallow to moderately deep and were from the Cambisols group. The bedrock consisted mainly of granodiorites, granites, conglomerates, sandstones, siltstones and limestones.

Species composition and vegetation structure: The phytocoenoses had a closed horizontal structure and total cover 90–100%. *Fagus sylvatica* L. dominated in the tree layer, which had a cover between 75% and 100%. Other tree species were *Acer pseudoplatanus* L., *Quercus petraea* agg. and *Carpinus betulus* L. The shrub layer had a low cover (10–25%) and was formed from the same species as in the tree layer along with *Rubus hirtus* Waldst. & Kit., *Corylus avellana* L. The herb layer was well-developed with a cover of 60–80%. There were stands with a cover of only 10%. Species with higher cover and abundance were *Galium odoratum* (L.) Scop., *Cardamine bulbifera* (L.) Crantz, *Mercurialis perennis* L., *Melica uniflora* Retz., *Luzula luzuloides* (Lam.) Dandy & Wilmott. This vegetation was classified to class *Carpino-Fagetea*, order *Fagetalia sylvaticae*, alliance *Fagion sylvaticae* s.l., associations *Asperulo-Fagetum* and *Festuco drymejae-Fagetum*. This vegetation represents the habitat type 9130 *Asperulo-Fagetum* beech forests, according to the Habitat Directive.

T19 Temperate and submediterranean thermophilous deciduous forest

Abiotic characteristic: This habitat was found on slopes with eastern and southern exposition mainly in the mountains of Vidlich, Vuchibaba and Ponor mainly in the hypsometric belts between 600 and 1000 m a.s.l. on slightly inclined slopes (10–15°) with predominantly eastern and southern components. Soils were shallow to moderately deep, overlaying mainly carbonates. This habitat type was presented by 212 polygons and covered an area of 23.70 km^2. The polygon's area was between 0.001 km^2 and 1.17 km^2.

Species composition and vegetation structure: The vegetation had a semi-open to closed horizontal structure with a tree layer cover of 75–90%. *Quercus cerris* L.,

Q. frainetto Ten. and *Q. pubescens* Willd. were the dominants. They formed mixed stands with *Fraxinus ornus* L., *Carpinus orientalis* Mill., *Ulmus minor* Mill. and *Sorbus torminalis* Crantz. The shrub layer reached 60% cover and included *Crataegus monogyna* Jacq., *Rosa canina* L., *Euonymus verrucosus* Scopoli, *Syringa vulgaris* L., *Chamaecytisus hirsutus* L. The herb layer was species-rich with cover in the range of 60–80%, including many herb and grass species such as *Poa nemoralis* L., *Festuca heterophylla* Lam., *Dactylis glomerata* L., *Galium pseudoaristatum* Schur, *Aremonia agrimonoides* (L.) DC, *Helleborus odorus* L., etc. These vegetation types were classified to class *Quercetea pubescenti*, order *Quercetalia pubescenti-petreae* and alliances *Quercion confertae* and *Quercion petraeo-cerridis*. This vegetation represents the habitat 91M0 Pannonian-Balkanic turkey oak-sessile oak forests and 91H0 *Pannonian woods with *Quercus pubescens*, according to the Habitat Directive.

Discussion

Fagus sylvatica L. forests dominate the forest landscape of Godech Municipality with the two EUNIS types, covering 64.6 km^2 in total, following the typical pattern, started in the Holocene, discussed by Filipovich and Antonov (1996). *Fagus sylvatica* L. participated in the last development phase of the forest vegetation in Stara Planina Mountain. These forests started their expansion 2–3 centuries before the beginning of the New Era due to climate and, more recently, anthropogenic factors. The forest belt in Western Stara Planina Mountain, dominated by *Carpinus betulus* L., once had a larger territorial extend and the same conclusion can be drawn for the coniferous species, mainly from the genera of *Picea* and *Abies* (Filipovich 1981). *Fagus sylvatica*'s timber has been used as a building material for many years. Cleared territories could experience restoration of *Fagus sylvatica* L. forests in areas free of weeds, such as *Urtica* spp., *Pteridium aquilinum* (L.) Kuhn., thriving in direct sunlight. This is an example of interspecies competition. Territories that are more prone to indirect sunlight cannot be invaded by weeds and *Fagus sylvatica* L. thrives there (Florov 1952). The restoration of *Fagus sylvatica* L. forests is more difficult on slopes with southern exposition and stony soils. Forests are restored better at 1000–1300 (1400) m a.s.l. (Garelkov 1973). According to Kumchev (1986) coniferous forests in Stara Planina Mountain will expand their territories by 2080 from 16 389 ha in 1980 to 26 941 ha. Broadleaved forest will decrease from 85 144 ha in 1980 to 74 592 ha by 2080.

The forests of Godech Municipality are presented by seven habitat types. They cover 144.85 km^2 in total, an area divided into 790 polygons, leading to a high rate of vegetation fragmentation. The habitat type with widest distribution is the T17 *Fagus* forest on non-acid soils (51.9 km^2), compared to the T3N Coniferous plantation of site-native trees that dominated the territory of Breznik Municipality (Grigorov et al. 2022a). Godech Municipality is dominated by beech forests which are typical for Bulgaria. Despite the fact that the artificial coniferous plantations are not the most widespread habitat type, they still cover 41.97 km^2, taking them into second place.

On the opposite side is the habitat type of T1H Broadleaved deciduous plantation of non-site native trees, which covers only 1.21 km^2.

There are several major threats to be addressed. Unfortunately, forest degradation, destruction and loss due to logging, fires, pollution, pest invasions, erosion etc., are typical for the study area. Some forest habitat types (T1E, T19) are turning into shrublands, while others (T11) are experiencing almost total damage. A whole new package of measures has to be adopted quickly to stop the negative effects, aiming at forest regeneration, afforestation with native species and ceasing of invasive alien species introduction.

Conclusion

The present study established 7 forest habitat types in Godech Municipality, according to the EUNIS classification. It represents a continuation of the habitat research of this scientific team in Western Bulgaria. It revealed some of the typical forest problems in Bulgaria – forest degradation due to natural and anthropogenic factors. The mapping in a 1:5000 scale proved once again to be desirable for analysis making. More research is needed to reveal the full picture of the forests' condition in the western parts of Bulgaria. The results of the current study may be used as a basis for further investigations on this matter.

Acknowledgements

This investigation was carried out with the financial help of the NSP "Young scientists and postdoctoral students, 2020", and the National Science Fund (Contract ДКОСТ 01/7/19.10.2018).

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