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Research article

Determination of terrestrial EUNIS habitat types of Mount Ganos (Işıklar), Tekirdağ, Türkiye

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Abstract

In this study, it is aimed to determine the terrestrial European Union Nature Information System (EUNIS) habitat types of Mount Ganos (Işıklar) and its surroundings. Field studies were carried out from April to October 2021. Reference areas were determined for Maximum Likelihood (ML) classification during the field studies. To increase the accuracy and obtain the highest possible level of EUNIS habitat types, we used both reference areas observed in the field studies and processed land cover and habitat maps. These are; Landsat Satellite Images classified with ML, Corine Land Cover, and European ecosystem maps. Regarding both biodiversity and social activities, Mount Ganos is among the most significant natural areas in the Tekirdağ district. The northern slopes of the mountain have a rainier and more humid climate than the southern slopes which Mediterranean climate is dominant. The presence of various climate types and the remarkable altitude variations also contribute to the habitat diversity of the Mount Ganos. Many natural areas have been degraded due to anthropogenic effects such as mineral extraction, agricultural, tourism, and urbanization activities in the Mount Ganos region until today. In this study, a total of 9 ecosystems and 29 habitat types were determined for Mount Ganos according to the EUNIS classification. 21 of them were identified at level 3 and 8 of them ranged between 2 and 6 levels. The intensive unmixed crops (I1.1) are the most-covered EUNIS habitat type with 16173.16 hectares. This is followed by low and medium altitude hay meadows (E2.2, 9350.63 ha), Meso- and eutrophic *Quercus*, *Carpinus*, *Fraxinus*, *Acer*, *Tilia*, *Ulmus*, and related woodland (G1.A, 7548.73 ha) and Pseudomaquis (F5.3, 5926.65 ha). With this study, a portrait of the habitat destruction created by humans has also been drawn. The results of this study can be used by decision-makers to conserve the remaining natural habitats on Mount Ganos.

Keywords: *Biodiversity; classification; ecosystem; GIS; land cover*

1. Introduction

Habitat is briefly defined as terrestrial, freshwater, or marine systems where an organism continues its vital activities (Mitchell, 2005; Diehl, 2013; Hall et al., 2013). In addition to terrestrial and marine habitats, there is a proposal to consider airspace as a habitat (Diehl, 2013). Classification of habitats (including natural, semi-natural, and man-made habitats) can be accepted as a practical tool for nature and species conservation. It is also important in generating inventories of natural places; conservation or monitoring studies, and target setting in ecological restorations (Davies et al., 2004; Moss, 2008; Janssen et al., 2016; Chytrý et al., 2020).

European Union Nature Information System (EUNIS) Habitat classification based on hierarchy was designed by the European Topic Center for Biodiversity for the European Environment Agency (EEA) (Davies and Moss, 1998; Davies et al., 2004; Moss, 2008). This classification system includes much

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more detailed habitat definitions relative to Corine Land Cover and Palaearctic Habitat classification since it is based on syntaxonomic units (Moss and Davies, 2002).

Although there are some efforts to determine habitat types in Türkiye by using the EUNIS habitat classification, these efforts covered only limited areas, and they are not adequate relative to Europe EUNIS-based studies (Cakmak and Aytac, 2021). Similar to flora studies, conducting inventories of habitat types is important for conservation, monitoring, and assessment studies. Mount Ganos is one of the hotspot areas in the Thrace region because of its rich species and habitat diversity. So with this study, we also aimed to determine the terrestrial EUNIS habitat types of Mount Ganos and its surroundings, and also to contribute to the classification of habitats in Türkiye.

2. Materials and methods

2.1. Study area

Mount Ganos (Işıklar) is located in the south-eastern part of Tekirdağ province in Türkiye (40°48'06.4"N, 27°18'59.4"E). The study area, which includes Mount Ganos, is within the borders of 3 different districts: Süleymanpaşa in the north, Malkara in the northwest, and Şarköy in the south and southwest. The total terrestrial area of the study area is 52827.23 ha.

2.2. Field studies

Field studies were carried out from April to October in 2021. Reference areas were determined for Maximum Likelihood (ML) classification in the field studies. Plant samples representing reference areas were collected during field studies. The coordinates of the reference areas where the plants were collected were determined by the Magellan 510 GPS device. Identification of plants was carried out in Tekirdağ Namık Kemal University, Plant Morphology and Anatomy Laboratory. Flora of Turkey and the East Aegean Islands (Davis, 1965-1985; Davis et al., 1988; Guner et al., 2000) and Resimli Türkiye Florası (Illustrated Flora of Turkey) (Guner et al., 2018) were used in identification studies.

2.3. Determining EUNIS habitat types

ML classification was performed on Landsat Satellite Images (LSI) (covering April and October 2021) in the ArcMap (version 10.5) tool to determine the main ecosystem types of EUNIS (E, G, H, I, J, etc.) based on reference areas. During the process, we obtained 15 meters resolution satellite images with the help of panchromatic and multispectral bands of the LSI and Pan-Sharpening process. This process and also radiometric and geometric corrections of the LSI were performed with the GRASS GIS software. To increase the accuracy and obtain the highest possible level of EUNIS habitat types we used not only reference areas observed in the field studies, but also ML classification performed LSI, Corine Land Cover (Copernicus Land Monitoring Service, 2022), and European ecosystem map (EEM) provided by European Environment Agency (European Environment Agency, 2022) (100 m resolution).

3. Results and discussion

In this study, a total of 9 ecosystems and 29 habitat types were determined according to the EUNIS classification (Fig. 1). 21 of them were identified at level 3 and 8 of them ranged between 2 and 6 levels (Table 1). The intensive unmixed crops (I1.1) are the most-covered EUNIS habitat type with 16173.16 hectares (ha). This is followed by low and medium altitude hay meadows (E2.2, 9350.63 ha), Meso- and eutrophic *Quercus*, *Carpinus*, *Fraxinus*, *Acer*, *Tilia*, *Ulmus*, and related woodland (G1.A, 7548.73 ha) and Pseudomaquis (F5.3, 5926.65 ha).

In the European ecosystem map (EEM) containing the EUNIS data presented by the European Environment Agency (EEA), habitat types are given only up to level 2 at the European scale (including Türkiye) (European Environment Agency, 2022). There are 18 different level 2 habitat types in and around Mount Ganos in EEM. In addition to these habitat types, we observed 4 new habitat types at level 2 with this study: C2 (as C2.3), D4 (as D4.1), J4 (as J4.5), and J5 (as J5.3). F5 habitat is shown in a very narrow area in the EEM. Contrary, it covers a large part of the southern slopes of Mount Ganos. The area determined as scree (H2) in the EEM was defined by us as permanent non-tidal, smooth-flowing watercourses (C2.3). In this habitat type, it was observed that the river bed was intact and stone sets were built on its edges. It is thought that the Geographical Information Systems (GIS) methods which EEM is based on, evaluate this area as H2 due to the stone set. A part of the southern slopes of Mount Ganos was specified in the EEM as miscellaneous inland habitats with very sparse or no vegetation (H5). However, in the field studies carried out by us in the relevant areas, it was determined that algae, lichens, or bryophytes were not dominant and vascular plants were not very sparse. On the contrary, habitat types in these areas were observed as E1.1, E1.2, and F5.3 where vascular plants were dominant. In addition to these habitats, the H3.2D habitat type which is associated with chasmophytic species such as *Sedum album* L., *Melilotus albus* Desr., *M. spicatus* (Sm.) Breistr., *Senecio vulgaris* L., *Thymus atticus* Celak., *T. sibthorpii* Benth., and *Thymbra spicata* L. was determined. A similar situation applies to the C1 and G2 habitat types given by the EEM. Areas specified as G2 in the EEM were defined as FB and G1.D in field observations. C1 was defined as J5.3.

Permanent non-tidal, smooth-flowing watercourses (C2.3) habitat type was observed in regions with intensive agricultural activities. This includes slow-flowing rivers, streams, brooks, rivulets, and rills which are associated with benthic and meso-eutrophic macrophyte communities (Davies and Moss, 1998; Davies et al., 2004). Considering the nutrition provisioning by fertilization of agricultural fields, the observation of meso-eutrophic (*Groenlandia densa* (L.) Fourr., *Nymphaea alba* L., *Potamogeton natans* L., *P. nodosus* Poir., *P. perfoliatus* L., and *Stuckenia pectinata* (L.) Börner) species in this area confirms this habitat type. Slow-flowing rivers have vegetation rich in submergent species such as *G. densa*, *P. nodosus*, and *N. alba*. Because the flow rate is slow, such habitats have a suitable environment for the development of submergent and free-floating species. However, changing the flow rate in rivers depending on the season or climate can damage this habitat type, which contains emergent-submergent species important for nitrogen removal from water (Albert et al., 2005; Tanaka, 2006; Fayvush and Aleksanyan, 2022). We observed that calcareous seasonal water bodies are formed in some areas with the effect of meso-eutrophic rivers. In these areas, species related to the D4.1 habitat were found such as *Phragmites australis* L., *Glyceria maxima* (Hartm.) Holmb., and *Juncus subnodulosus* Schrank.

Table 1
EUNIS habitat types of Mount Ganos and its surroundings.

EUNIS Habitat Type	EUNIS Habitat Name	Percentage (%)	Area (ha)
	B-Coastal habitats		
B2.2	Unvegetated mobile shingle beaches above the drift line	0.006	3.31
	C-Inland surface waters		
C2.3	Permanent non-tidal, smooth-flowing watercourses	0.064	34.03
	D-Mires, bogs and fens		
D4.1	Rich fens, including eutrophic tall-herb fens and calcareous flushes and soaks	0.009	4.59
	E-Grasslands and lands dominated by forbs, mosses or lichens		
E1.1	Inland sand and rock with open vegetation	0.092	48.45
E2.2	Low and medium altitude hay meadows	17.700	9350.63
	F-Heathland, scrub and tundra		
F5.3	Pseudomaquis	11.219	5926.65
F5.4	*Spartium junceum* fields	0.020	10.36
FB	Shrub plantations	1.636	864.43
	G-Woodland, forest and other wooded land		
G1.11	Riverine *Salix* woodland	0.280	148.07
G1.7	Thermophilous deciduous woodland	4.312	2277.88
G1.712	Sub-Mediterranean *Quercus petraea-Q. robur* woods	0.674	355,86
G1.76	Balkano-Anatolian thermophilous *Quercus* forests	3.840	2028.55
G1.A	Meso- and eutrophic *Quercus, Carpinus, Fraxinus, Acer, Tilia, Ulmus*, and related woodland	14.289	7548.73
G1.A1C3	Moesian oak-hornbeam forests	1.620	855,74
G1.D	Fruit and nut tree orchards	5.104	2696.14
G2.1	Mediterranean evergreen *Quercus* woodland	0.004	2.10
G3.7	Lowland to montane Mediterranean *Pinus* woodland (excluding *Pinus nigra*)	1.977	1044.59
G3.75	*Pinus brutia* forests	0.541	285.78
G3.F12	Native pine plantations	0.964	509.36
G4.B	Mixed Mediterranean *Pinus* - thermophilous *Quercus* woodland	2.468	1303.61
G5.2	Small broadleaved deciduous anthropogenic woodlands	0.749	395.87
G5.5	Small mixed broadleaved and coniferous anthropogenic woodlands	0.258	136.52
	H-Inland unvegetated or sparsely vegetated habitats		
H3.2D	Basic and ultra-basic inland cliffs	0.607	320.59
	I-Regularly or recently cultivated agricultural, horticultural and domestic habitats		
I1.1	Intensive unmixed crops	30.615	16173.16
	J-Constructed, industrial and other artificial habitats		
J1.2	Residential buildings of villages and urban peripheries	0.675	356.53
J2.3	Rural industrial and commercial sites still in active use	0.008	3.99
J3.2	Active opencast mineral extraction sites, including quarries	0.089	46.88
J4.5	Hard-surfaced areas of ports	0.005	2.71
J5.3	Highly artificial non-saline standing waters	0.174	92.12
		Total Area	52827.23

E1.1 habitat type is related to thermophilic vegetation. It was observed in the southern slopes and calcareous areas of Mount Ganos. Species such as *Poa bulbosa* L., *Bromus tectorum* L., and *Cynodon dactylon* (L.) Pers. associated with E1.1 were found. *Sedum album* and *Thymus* species, which can also be seen in the H3.2D habitat type were also observed in E1.1. E1.1 is rich in biodiversity and can be considered on priority status in terms of protection (Cakmak and Aytac, 2020). At low and medium altitude hay meadows (E2.2), species related to this habitat type, such as *Poa pratensis* L., *Alopecurus pratensis* L., *Trifolium dubium* Sibth., *Arrhenatherum elatius* (L.) P.Beauv. ex J.Presl & C.Presl, *Dactylis glomerata* L., *Daucus carota* L., *Galium album* Mill., *Medicago sativa* L., *Orchis coriophora* L., and *O. laxiflora* Lam., were observed. Grass-dominated hay meadows are characterized by their highly diverse vegetation (Rodríguez-Rojo et al., 2017). However, it has decreased significantly since the mid-20th century (Sullivan et al., 2018) due to the damage caused by agricultural activities (especially the disposal of the area for agricultural land) and grazing pressure in Mount Ganos and its surroundings.

F5.3 habitat type associated with sclerophyllous evergreen and deciduous shrubs was determined in the southern part of Mount Ganos. In areas where F5.3 habitat type was determined, *Quercus coccifera* L. was dominant, but also *Juniperus oxycedrus* L., *Carpinus orientalis* Mill., *Pistacia terebinthus* L., *Paliurus spina-christi* P. Mill., and *Quercus pubescens* Willd. were identified. It is thought that a part of the F5.3 in this study area was formed by the degradation of the thermophilic deciduous woodlands (G1.7). Such that, transitional areas can be seen between G1.7 and F5.3 habitats, where *Quercus petraea* (Matt.) Liebl., *Q. robur* L., *Q. frainetto* Ten., and *Q. cerris* L. are found together. In addition to the transition areas, pseudomaquis were also observed in deciduous forests, especially in the northwest of Uçmakdere. On the northern slopes of Mount Ganos, where the effect of the Mediterranean climate decreased, it was observed that *Carpinus orientalis* Mill. was more dominant in pseudomaquis instead of *Quercus coccifera* L.. Čarni et al. (2018) also stated that maquis formations dominated by deciduous species were observed in the regions where the effect of the Mediterranean climate decreased. Along with F5.3, *Spartium junceum* L. dominated F5.4 habitat type was determined near roads on the slopes facing the sea.

Grape fields, which play an important role in the livelihood

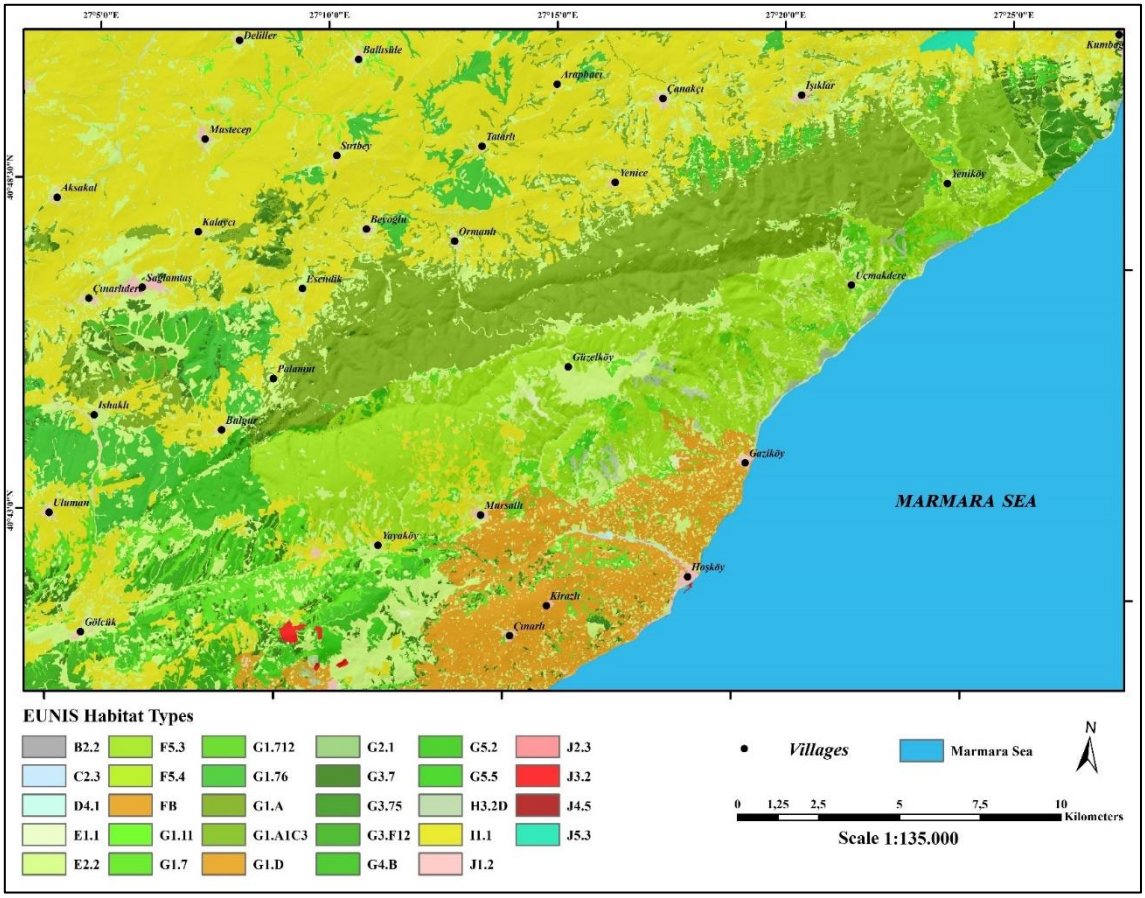

Fig. 1. EUNIS habitat map of Mount Ganos and its surroundings.

of the people of this region, are dense in the south of the study area. It is observed that these areas, which are considered especially wine gardens, have recently been turned into orchards (G1.D) (mostly cherry).

Shrubby *Salix alba* L. and *Populus alba* L. dominated G1.11 constitute 0.280% of the study area. *Urtica dioica* L., which is used by the local people for ethnobotanical purposes (food, health, etc.), was frequently observed in this habitat. G1.11 habitat in the study area is generally used by people for recreational activities. It was determined that this habitat type sustained damage when precipitation is below the season normal or when the stream dries out periodically, especially due to human activities.

G1.7 habitat type (including G1.712 and G1.76) covers 8.83% of the study area. It is dominated by *Quercus* species such as *Q. petraea* (Matt.) Liebl., *Q. robur* L., *Q. frainetto* Ten., and *Q. cerris* Blanco. Also, sometimes accompanied by *Carpinus orientalis* Mill. and *Castanea sativa* Mill.. In addition, thermophile calcicolous plants such as *Limodorum abortivum* (L.) Sw. associated with G1.712 and G1.76, and *Veronica officinalis* L. were also observed. G1.712 is generally found in the southern parts of Mount Ganos. However, G1.76 was found only in the north of Mount Ganos. In this study area, the use of *Quercus* species as wood charcoal by the people and mining activities can be shown as threat factors for this habitat type.

G1.A habitat type consisting of *Acer* L., *Carpinus* L., *Fraxinus* Tourn. ex L., and *Tilia* L. composition, especially dominated by *Quercus* species, was observed on the north-facing slopes of Mount Ganos. In terms of tree vegetation, G1.A is the largest (14.289%) habitat type and covers an area of 7548.73 hectares. There are many hiking routes in the areas where the G1.A habitat type was determined. In addition, the local people in the vicinity harvest the *Tilia tomentosa* Moench throughout the flowering season for extra income. It was observed that sometimes insensible tourism and harvesting activities damage this habitat type. To sustain this habitat type, which is entirely composed of natural trees, it is recommended that authorized institutions follow human activities here and raise awareness of the local people on this issue.

Although the I1.1 habitat type covers 30.615% of the study area, forest vegetation (excluding FB and G1.D habitat types) constitutes 43.196% of the study area. According to the report of the General Directorate of Forestry of Türkiye (2020), the total forest assets of Tekirdağ province are 101174 hectares. The forest assets in the study area constitute almost one-fourth (22819.31 ha) of Tekirdağ. Considering that the total area of Tekirdağ is 634 thousand (study area 52827.23) ha, Mount Ganos is important for the forest assets of Tekirdağ. In addition to forest assets, the study area includes hay meadows (E2.2) rich in plant diversity, especially in the Melen region of Mount Ganos.

Coniferous trees constitute 3.483% (excluding mixed forests with broadleaved trees) of the study area. We observed habitat types that there are G3.75 (only *Pinus brutia* Ten.), G3.7 (*P. brutia* is dominant, but *Ilex aquifolium* L. is present), and G3.F12 (reforestation with *P. brutia*). It was observed that reforestation works were carried out with *Pinus brutia* species, which is naturally distributed in this region as well.

We thought that reforestation works are mostly carried out in areas where G1.7 and F5.3 habitats have been destroyed since short *Quercus coccifera* L. and *Q. petraea* (Matt.) Liebl. were observed in these areas. Most of the areas with G3 habitat type are picnic areas managed by private and municipal enterprises. The most important factors threatening this habitat type are the

high potential of human-induced fires and the conversion of these areas into arable lands.

Most of the habitats determined in this study were evaluated in the LC category in the European Red List of Habitats (Terrestrial and freshwater habitats) (Janssen et al., 2016). Only the Low and medium altitude hay meadows habitat type (E2.2) has been evaluated in the VU, and the lower levels of some habitat types (e.g., E1.1a-j) are in the VU-CR category. The abovementioned study is useful in determining or evaluating the threatened categories of habitats in Europe. However, habitat types in Türkiye were not included in this study. For this reason, there is no data on how accurate it is to consider the threatened categories of habitats according to this study at the scale of Türkiye.

Mount Ganos is among the important natural areas of the Tekirdağ district in terms of both biodiversity and social activities. While the Mediterranean climate is seen on the southern slopes of the mountain, the northern slopes have a rainier and more humid climate compared to the southern parts. The presence of different climate types and the remarkable differences in altitude (for example, the sudden rise to 300-400 meters above sea level) also increase the diversity of habitats in the region. Besides, it is one of the leading tourism activity areas of Tekirdağ. At the same time, mining activities are carried out in some regions of Mount Ganos. Therefore, human pressure on the biodiversity in and around Mount Ganos is high. Determining the EUNIS habitat types may contribute to possible conservation or monitoring studies in this region.

Since the habitat types were determined on a European scale in 1998, studies to identify EUNIS habitat types and threat factors on related habitat types have been common for the last 10 years in Türkiye (Arslan et al., 2012; Mergen and Karacaoglu, 2015; Geven et al., 2016; Ciftci and Hasbenli, 2018; Tezel et al., 2020; Cakmak and Aytac, 2020, 2021).

Türkiye is quite different from Europe in terms of ecology, climate, topography, and biodiversity. Therefore, new habitat types have been defined in Türkiye due to the differences in the existing syntaxonomic units which define EUNIS habitat types (Cakmak and Aytac, 2021). However, probably, these syntaxonomic units may also be associated with existing habitat types. Apart from these differences, EUNIS is almost entirely compatible with Türkiye. Habitats are an important part of ecosystems, and the existence of some species depends on the continuity of their habitats. Especially due to climate change, the risk of species extinction specific to certain habitats is high (Pompe et al., 2010). For this reason, it is important to increase studies on the determination of habitat types and plant communities specific to these habitat types at the scale of Türkiye.

Conservation of specialized habitats may become even more important in comparison to the conservation of a single threatened species. Thus, it can enable the conservation of all species in related habitats.

Conflict of interest: The authors declare that they have no conflict of interests.

Informed consent: The authors declare that this manuscript did not involve human or animal participants and informed consent was not collected.

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