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Research article

Determination and mapping of EUNIS habitat types of Mamak District (Ankara), Turkey

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Abstract: In this paper, habitat diversity was studied for Mamak district, which is one of the extremely active districts of Ankara in terms of a constantly growing urbanization rate. Within the scope of the research, the habitat types of the studied area were determined and mapped in accordance with EUNIS Habitat Classification by using several GIS data (CORINE Land Cover data, forest stand maps, hydrology data, land presence data, open street map data, satellite images), and many field surveys were also conducted. In the study, a total of 43 habitat types were identified. While 29 of those habitats were determined at level 3, 14 of them were at level 4. Besides, it was determined whether those 43 habitats were on the EU Habitat Directive Annex 1 and/or Bern Convention Decision No 4 lists. This research presents the importance of determination of habitat type studies for cities. Besides, it is emphasized in the paper that the necessity of having such studies should become widespread across the country.

Keywords: EUNIS, GIS, habitat classification, habitat mapping, Mamak

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Introduction

European Nature Information System (EUNIS) Habitat Classification is a classification system that, as is the case for species, allows a wider analysis of habitats in relation to pressures on ecological regions, climate, soil and environment, provides a comparison of data with other countries, and defines habitat types in the European Union (EU) scale according to a standardized terminology. The main idea of the development of this classification was to create a common habitat language and habitat hierarchy, just as is the case for species (Moss and Roy, 1998). Indeed, EUNIS has a strict hierarchical classification structure with habitat descriptions and definition keys which are similar to diagnostic keys (Geven et al., 2016).

The effects of habitat destruction are an important threat to biological diversity (Tilman et al. 1994). With increasing environmental problems and changes in habitats, biodiversity loss is expected to continue to increase in the coming years (Süel et al., 2018). Habitat conservation is one of the most efficient and rational ways to prevent and/or halt the biological diversity loss. To do that, primarily, habitats must be identified and mapped with their unique characteristics. Related to this issue, standardization of the determination and classification of habitats at micro and macro scales are of utmost importance for the establishment of both local and global conservation strategies. Moreover, "The European Biodiversity Strategy" and "Strategic Plan for Biodiversity by 2020" urge the EU member countries to map and assess ecosystems and their services with the aim of decelerating the biological diversity loss in the EU by 2020 and of restoring them (Convention on Biological

Diversity, 2010a; 2010b; European Commission, 2011). In the process of being a member of EU, determination and classification of habitats according to EUNIS, which this study is concerned with, will be an obligation for Turkey in the future (Geven et al., 2016). Although there has not been much research in the country in this context so far, the number of researches has started to increase in recent years.

Mamak is one of the extremely active districts of Ankara in the context of constantly growing urbanization and emerging unplanned slum areas (Çakmak and Aytaç, 2018). The reason for choosing this area is that the district has many different land use and habitat types. This study aims to determine both natural and unnatural habitat types in the district according to EUNIS, and to produce habitat map that can provide a basis for management plans and to determine protection priorities at micro and macro scales for ecologists, environmentalists, nature conservationists, administrators and decision-makers. Furthermore, another aim of this study is to identify and map habitat types with the highest possible level of precision by using several GIS data and minimum fieldwork.

Materials and Methods

Study Area

The Mamak district is located in the eastern part of Ankara (32°55'23" E and 39°56'31" N). Neighboring districts are Çankaya (in the south and southwest-west), Altındağ (in the north and northwest) and Elmadağ (in the east) (Figure 1). The total land area of the district is 342 km^2 (Governorship of Ankara, 2019).

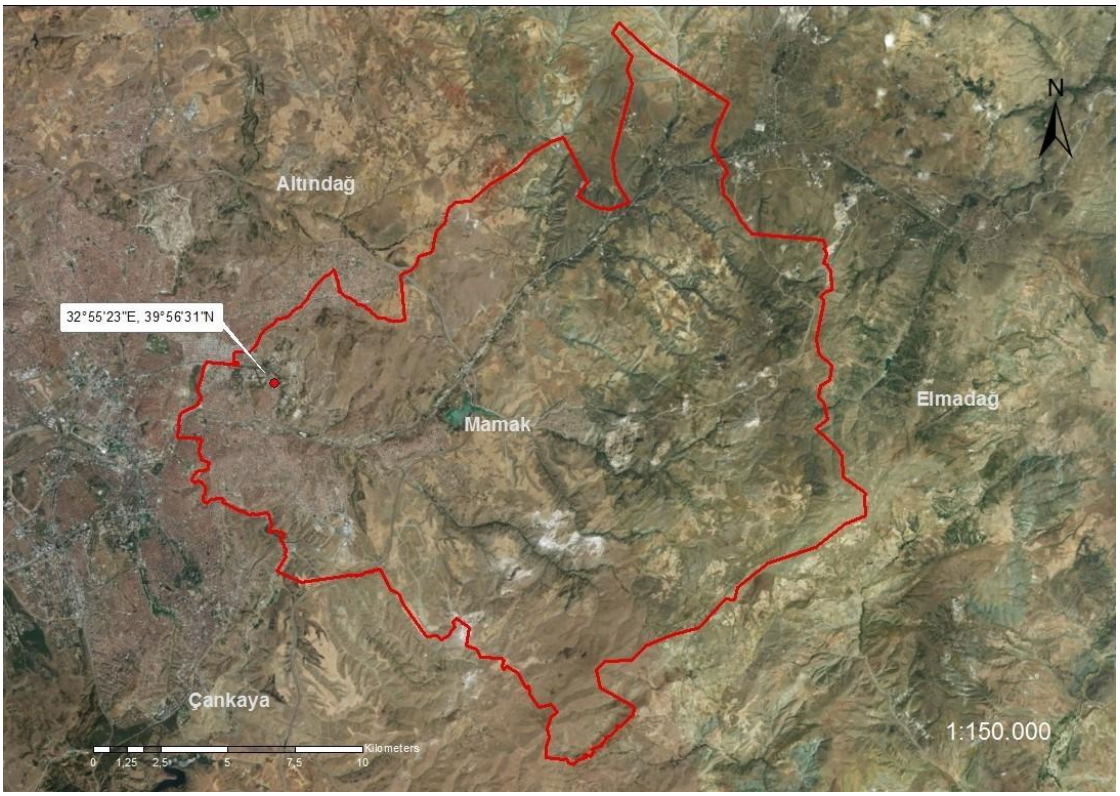

Figure 1. The satellite view of Mamak district (Çakmak and Aytaç, 2018).

Triassic aged Emir, Elmadağ, Ortaköy, Keçikaya formations and Late Pliocene aged Gölbaşı formations are dominant in the study area. Elmadağ Formation comprises agglomerate, calcarenite, limestone, metaconglomerate, metasandstone, sandy limestone and sandstone. Ortaköy Formation consists of agglomerate, calcarenite, diabasis, splite and tuff. Keçikaya Formation consists of only limestone. Finally, Gölbaşı Formation is composed of conglomerate, mudstone and sandstone (Akyürek et al., 1997; Celik et al., 2007).

There are 7 soil types in the district that comprises a total area of 34245.6 hectares (ha). Soil types of the study area respectively are as follows; brown soils (20375.6 ha), brown forest soils without lime (2473.39 ha), brown soils without lime (2296.01 ha), reddish-brown soils (2094.64 ha), brown forest soils (808.628 ha), alluvial soils (356.757 ha), colluvial soils (261.891 ha). Besides, the

district's 5578.71 hectares are covered with other land types and settlements (Figure 2) (Ministry of Food, Agriculture and Livestock, 2015).

The research area is under the influence of the Mediterranean climate. While January is the coldest month with a mean low of –1.9°C, July is the warmest month with a mean high of 31.4°C. Annual precipitation is about 425.7 mm per year, and the highest precipitation occurs in the spring period. While the mean annual temperature is 12.8°C, the mean annual precipitation is 35.5 mm for the period of 1996 - 2015 (20 years) (Figure 3). Extreme winter cold (< 0°C) is usual, and the late frost danger is generally present in the district. In relation to the Mediterranean bioclimatic divisions, the area adjacent to the slightly humid zone with semi-arid cold winter (Turkish State Meteorological Service, 2016).

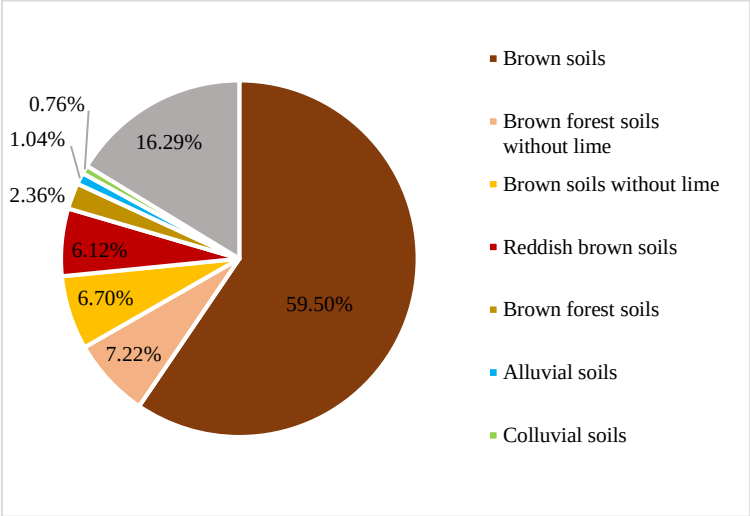

Figure 2. Proportional distribution of major soil groups (Çakmak, 2016).

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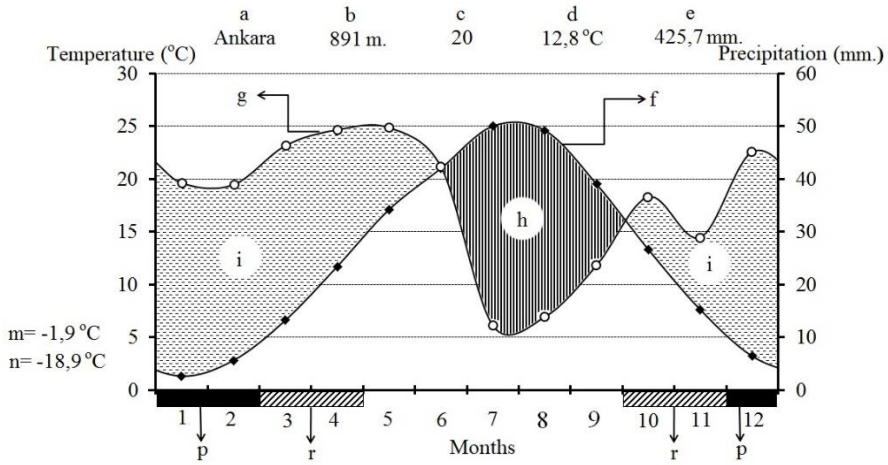

Figure 3. Ombrothermic diagram of the study area a: Name of the meteorological station, b: Altitude of the meteorological station, c: Meteorological observation time (year), d: Average temperature (annual), e: Average precipitation (annual), f: Temperature curve, g: Precipitation curve, h: Drought period, i: Precipitated period, m: The lowest temperature average of the coldest month, n: Absolute minimum temperature, p: Absolute frosty months, r: Probable frosty months (Çakmak, 2016)

Methods

The habitats in the district were determined according to EUNIS Habitat Classification. To identify and determine the habitats, many GIS data [CORINE Land Cover 2018 data (Corine Land Cover, 2018), forest stand maps (General Directorate of Forestry, 2019), hydrology data (General Directorate of State Hydraulic Works, 2019), land presence data (Ministry of Agriculture and Forestry, 2019), and open street map data (Open Street Map, 2019)] were used as base. First, these data were analyzed one by one, and habitat types were identified according to EUNIS. Then, layers were overlapped with one another,

and habitat types were identified again. After the identifying process, some corrections were made on the boundaries of the habitats by using 2019 dated Landsat Satellite Images (Earth Explorer, 2019). On the other hand, several field surveys were conducted in the district to determine the structure of flora, vegetation and ecology of habitats years between 2012-2019. With usage of the data acquired from field observations, the process of identifying the habitats and geometric corrections were finalized.

To identify habitats, "EUNIS Habitat Classification Revised 2004" (Davies et al., 2004) and https://eunis.eea.europa.eu/habitats-code-browser.jsp (EUNIS, 2020) were used. The habitats were mapped by using "ArcGIS ArcMap 10.5". After habitats were mapped, the area of each habitat type was calculated by using the "Calculate Geometry" feature of ArcGIS.

Results

In this study, a total of 43 EUNIS habitat types were determined (Figure 4). While 29 of those habitats were determined at level 3 (%67.44), 14 of them were identified at level 4 (%32.56) (Figure 5, Table 1).

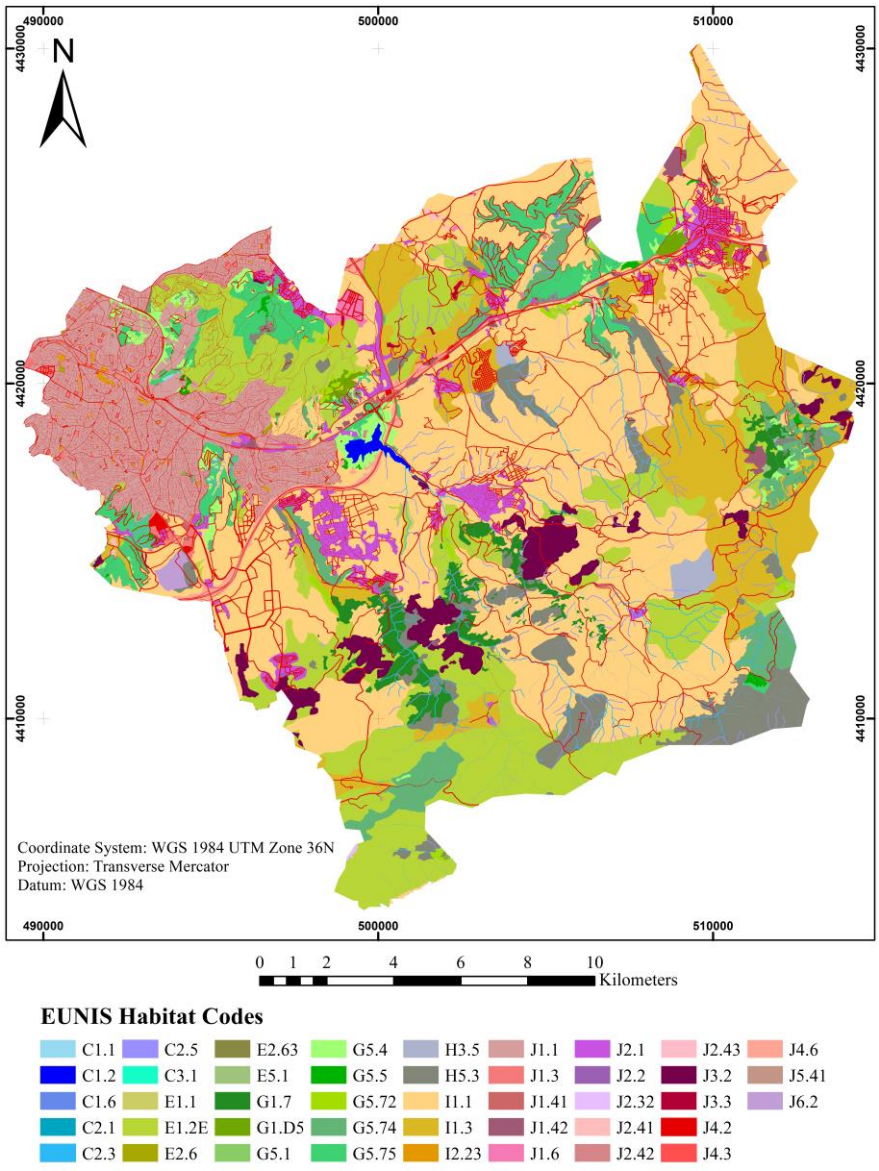

Figure 4. The EUNIS habitat map of the study area.

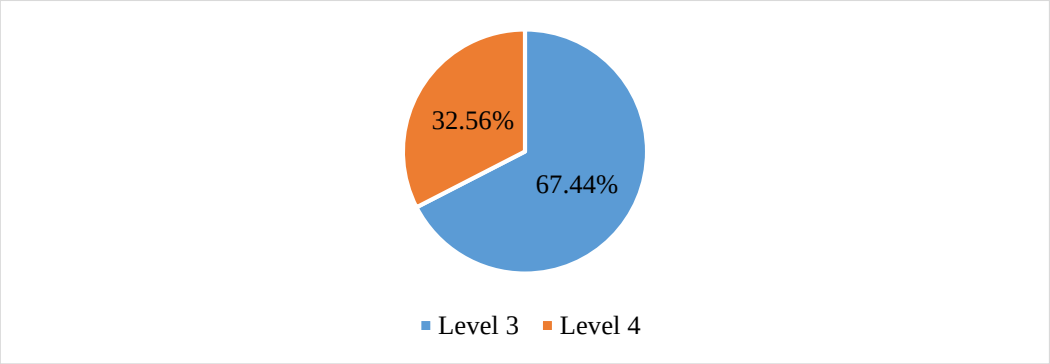

Figure 5. Distribution of habitats to levels.

Table 1. EUNIS habitat types of Mamak district.

No	EUNIS Habitat Codes	EUNIS Habitat Names	Area (ha)
1	C1.1	Permanent oligotrophic lakes, ponds and pools	3.786667
2	C1.2	Permanent mesotrophic lakes, ponds and pools	70.661888
3	C1.6	Temporary lakes, ponds and pools	6.326279
4	C2.1	Springs, spring brooks and geysers	1.773584
5	C2.3	Permanent non-tidal, smooth-flowing watercourses	63.623487
6	C2.5	Temporary running waters	100.171339
7	C3.1	Species-rich helophyte beds	109.815562
8	E1.1	Inland sand and rock with open vegetation	9.2934
9	E1.2E	Irano-Anatolian steppes	5459.374595
10	E2.6	Agriculturally-improved, re-seeded and heavily fertilised grassland, including sports fields and grass lawns	47.390356
11	E2.63	Turf sports fields	5.400744
12	E5.1	Anthropogenic herb stands	5.172907
13	G1.7	Thermophilous deciduous woodland	752.183351
14	G1.D5	Other high-stem orchards	76.392801
15	G5.1	Lines of trees	1.64948
16	G5.4	Small coniferous anthropogenic woodlands	428.751493
17	G5.5	Small mixed broadleaved and coniferous anthropogenic woodlands	65.293209
18	G5.72	Early-stage broadleaved deciduous plantations	137.835621
19	G5.74	Early-stage coniferous plantations	1120.770591
20	G5.75	Early-stage mixed broadleaved and coniferous plantations	1430.505743
21	H3.5	Almost bare rock pavements, including limestone pavements	172.748843
22	H5.3	Sparsely- or un-vegetated habitats on mineral substrates not resulting from recent ice activity	1717.711358
23	I1.1	Intensive unmixed crops	12073.15341
24	I1.3	Arable land with unmixed crops grown by low-intensity agricultural methods	3458.355518
25	I2.23	Small parks and city squares	81.177839
26	J1.1	Residential buildings of city and town centres	2974.559028
27	J1.3	Urban and suburban public buildings	134.603073
28	J1.41	Urban and suburban commercial units	32.669802
29	J1.42	Urban and suburban factories	144.80222
30	J1.6	Urban and suburban construction and demolition sites	69.269255
31	J2.1	Scattered residential buildings	1098.476748
32	J2.2	Rural public buildings	4.515413
33	J2.32	Rural industrial sites	5.932243
34	J2.41	Agricultural buildings (not isolated)	43.957788
35	J2.42	Isolated agricultural buildings	14.063811
36	J2.43	Greenhouses	2.834584
37	J3.2	Active opencast mineral extraction sites, including quarries	869.390666
38	J3.3	Recently abandoned above-ground spaces of extractive industrial sites	21.463077
39	J4.2	Road networks	1052.673822
40	J4.3	Rail networks	41.759237
41	J4.6	Pavements and recreation areas	257.300269
42	J5.41	Non-saline water channels with completely man-made substrate	6.546794
43	J6.2	Household waste and landfill sites	71.623204

Some habitats identified in this study have legal status according to the Annex 1 (EU Habitat Directive) and Decision No: 4 (Bern Convention) lists. While 7 out of 43 habitats are included only in the EU Habitat Directive Annex 1 list, 1 out of the 43 habitats is included only in the Bern Convention Decision No: 4 list. Besides, 2 out of the 43 habitats are common in both lists at the same time. Finally, 33 of the 43 habitats which were determined in this study are not included in these two lists (Table 2, Figure 7).

Table 2. Habitats' legal status according to EU legislation lists.

EUNIS Habitat Type	EU Habitats Directive Annex I	Bern Convention Resolution 4	EUNIS Habitat Type	EU Habitats Directive Annex I	Bern Convention Resolution 4	EUNIS Habitat Type	EU Habitats Directive Annex I	Bern Convention Resolution 4
C1.1	+	+	G5.4	-	-	J2.1	-	-
C1.2	+	-	G5.5	-	-	J2.2	-	-
C1.6	+	-	G5.72	-	-	J2.32	-	-
C2.1	+	-	G5.74	-	-	J2.41	-	-
C2.3	+	-	G5.75	-	-	J2.42	-	-
C2.5	+	-	H3.5	+	-	J2.43	-	-
C3.1	-	-	H5.3	-	-	J3.2	-	-
E1.1	+	-	I1.1	-	-	J3.3	-	-
E1.2E	-	+	I1.3	-	-	J4.2	-	-
E2.6	-	-	I2.23	-	-	J4.3	-	-
E2.63	-	-	J1.1	-	-	J4.6	-	-
E5.1	-	-	J1.3	-	-	J5.41	-	-
G1.7	+	+	J1.41	-	-	J6.2	-	-
G1.D5	-	-	J1.42	-	-			
G5.1	-	-	J1.6	-	-			

+ : Included, - : Not included.

Discussion

In the study area, 43 EUNIS habitat types were determined. Despite the fast-developing and continuously urbanizing nature of the district (Çakmak and Aytaç, 2018), it can be said that the study area still has a rich habitat diversity. The most dominant habitat types in the district are I1.1 (12073.15 ha, %35.26), E1.2E (5459.38 ha, %15.94) and I1.3 (3458.36 ha, %10.1). These 3 habitats (arable lands and steppes) cover a large part of the research area (%61.29). This is because the study area is located in the Central Anatolian Region, and the region's characteristic vegetation type is basically steppe (Vural et al., 2007). On the other hand, habitats which cover the narrowest area are J2.43 (2.83 ha, %0.01), C2.1 (1.77 ha, %0.01) and G5.1 (1.65 ha, %0.005).

In the district, there are 6 main ecosystem types (C, E, G, H, I, J) according to EUNIS (Figure 6). The main ecosystem types of the research area respectively are as follows; I (15612.69 ha), J (6846.44 ha), E (5526.63 ha), G (4013.38 ha), H (1890.46 ha) and C (356.16 ha). I habitats (regularly or recently cultivated agricultural, horticultural and domestic habitats) cover almost half of the district. In terms of the main ecosystem types, the second rank is occupied by J habitats (constructed, industrial and other artificial habitats) with nearly %20 of the district. The main reason why both I and J habitats cover such large areas is the human impact. According to Çakmak and Aytaç (2018), Mamak is an extremely active district in the context of constantly growing urbanization. While E habitats (grasslands and lands dominated by forbs, mosses or lichens) are the ones that cover the largest area (%16.14), H (inland unvegetated or sparsely vegetated habitats) (%5.52) and C (inland surface waters) (%1.04) habitats cover the narrowest area among natural habitats. The main reason for this is that the research area is located in the Central Anatolian Region, which is included in the Irano-Turanian phytogeographic region, and steppe vegetation is dominant in this region (Vural et al., 2007). Besides, the fact that the study area is in an arid region is the reason why wetlands cover small areas. Similarly, results of another research (Çakmak and Can, 2020) shows that wetlands are very scarce in the district. G habitats (woodland, forest and other wooded land) cover more than %10 of the district. Most of the forests in the research area are plantations and not natural (excluding *Quercus* woodlands). Trees in plantation forests are at early stage, and there is not much canopy cover yet in these woodlands.

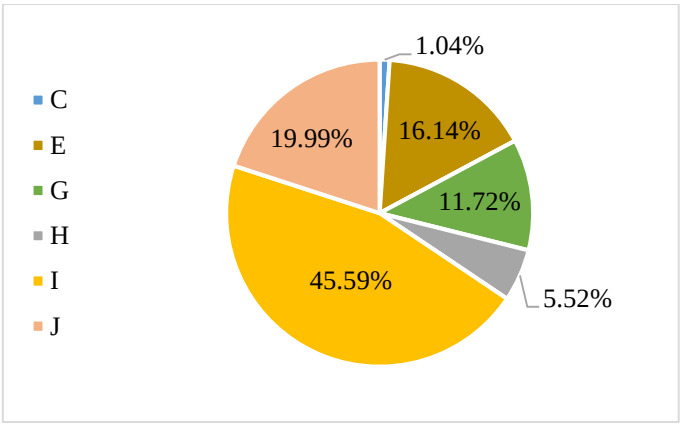

Figure 6. Distribution of main ecosystem types in the study area.

Legal instruments are important tools for nature conservation (Rodgers, 2013). There are also several regulations and international conventions related to habitat conservation. While 33 out of 43 habitats which are determined in this study aren't included in any lists, 10 habitats are included in two important legal instruments (EU Habitat Directive and Bern Convention). Because these two habitats are included in both EU Habitat Directive Annex 1 and Bern Convention Resolution 4, C1.1 and G1.7 will have the priority when determining the habitats with high priority for conservation for the study area. That's because wetlands and forests are very important ecosystems for the earth and they are under threat because of global climate change issue (Salinger, 2004; Erwin, 2009). Additionally, wetlands (C habitats) cover small areas in the district. In relation to that, other C habitats (C1.2, C1.6, C2.1, C2.3, C2.5), which are included in EU Habitat Directive Annex 1, may be evaluated as a priority in terms of conservation because of global climate change threat. On the other hand, E1.1, E1.2E and H3.5 may also be evaluated as a priority in terms of conservation. That's because steppic charactered E1.1 and E1.2E, and rocky charactered H3.5 habitats are rich areas in terms of biodiversity and possible hosts to endemic and new species (Vural and Adıgüzel, 2006; Sarı and Acar, 2015).

When the habitat types in this study are compared with only Mamak part of the Ankara study in which 24 habitat types were determined (Eker et al., 2015), it can be seen that only 2 habitats (E1.2E and J1.6) sort together at level 3 and level 4. However, when habitat types in both studies were compared at level 2, they sort together, and this study has 7 more different habitat types than Mamak part of the Ankara study has (Table 3). The reason for this is thought to be the differences in materials used in both studies (GIS data etc.).

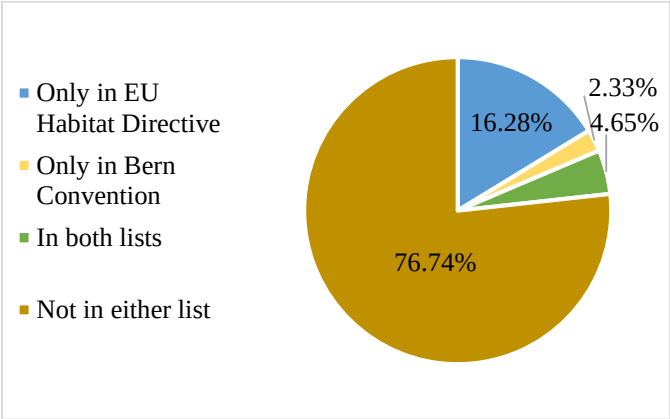

Figure 7. Habitats' legal status according to EU legislation lists.

Habitat types in this study were compared with only Mamak part of the "Ecosystem types of Europe" study (Weiss and Banko, 2018) at level 2, and results showed that %77.78 of habitats in both studies were matched perfectly one another (Table 3). G3 and G4, two of different habitats, were not identified in this study. Because the forests with the character of G3 and G4 habitats are not natural in the district, they were identified under G5. On the other hand, E4 and FB, other two of different habitats, were not also identified in this study. The reason for this is thought to be the differences in materials used in both studies (different dated and resolution satellite images, etc.).

When the habitat types in this research are compared with another research, which was conducted in Kahramankazan district (Seyfe, 2019), it can be seen that both studies have many similarities in terms of habitat types despite the fact that two research areas have many different environmental conditions (bedrock, soil types, elevation, etc.) (Table 3).

Identifying and mapping habitats are two important actions that concern habitat conservation strategies. However, because the boundaries between habitats cannot be determined genetically as for species, they are very difficult to define analytically (Moss, 2008). Within one of the aims of this study, habitat types are identified and mapped by using several GIS data and with non-intensive fieldwork. This research has shown that even studies conducted in the same or nearby areas are not exactly similar in terms of habitat types. One of the reasons for this might be the differences in the experience level of the researchers in these studies. Another reason for this could

be also the differences in materials (different GIS data use as basis) and methods (different techniques use) of these studies. The accuracy rate of the determination of habitats is highly depended on the accuracy of the data used. Furthermore, which data type is used where and how is another important point of identifying habitats with high accuracy.

Table 3. Comparison of habitat types with other studies.

EUNIS Habitat Classification of Mamak District (Ankara/Turkey)				**The vascular plant diversity and taxa of Ankara (Turkey) which have priority for conservation (Only Mamak Region)**	**Mapping Europe's ecosystems (Only Mamak Region)**		**Preference and Distribution of Reptile Species of Kazan Hills (Kahramankazan/Ankara) According to EUNIS Habitat Types**	
C1.1	G1.D5	J1.3	J4.3	C1	C1	J1	C1.1	I1.1
C1.2	G5.1	J1.41	J4.6	E1	E1	J2	C1.2	J1.2
C1.6	G5.4	J1.42	J5.41	E1.2E	E2	J3	D5.3	J4.2
C2.1	G5.5	J1.6	J6.2	G5	E4	J4	E1.20	X18
C2.3	G5.72	J2.1		H3	FB	J6	E1.2E	
C2.5	G5.74	J2.2		H5	G1		G1.1	
C3.1	G5.75	J2.32		I1	G3		G1.7	
E1.1	H3.5	J2.41		I2	G4		G1.D	
E1.2E	H5.3	J2.42		J1	G5		G3.5	
E2.6	I1.1	J2.43		J1.6	H3		G4.9	
E2.63	I1.3	J3.2		J2	H5		G4.B	
E5.1	I2.23	J3.3		J3.1	I1		G5.7	
G1.7	J1.1	J4.2		J4	I2		H3.2	

The prepared map of EUNIS habitats shows in detail the habitats' distribution in Mamak district and provides a much more accurate basis for the ecosystem assessment than the maps which are from other available sources such as Corine Land Cover (CLC), etc. Other habitat classification systems (e.g. CLC) are more basic and less detailed systems compared to EUNIS. Since more detailed data are desired in this study, EUNIS was preferred instead of using above-mentioned classifications. Therefore, this study carries grave importance with respect to habitat types which were determined and mapped with such precision, detail and complexity on a district scale for the first time in Turkey. Habitat map can be used by different communities of interest such as development plans, master plans, environment plans, landscape plans, forest management plans, land use planning, etc.

Spatiotemporal changes in habitats can be revealed by reproducing the prepared habitat map once every 5-10 years with the same or more advanced methods. It is possible to make comparisons with the maps reproduced at certain periods in the context of changes in habitats. Some metrics and biodiversity indices will be very useful to evaluate the changes in these maps produced at different times. This will ensure the monitoring of changes of the habitats, and habitat monitoring will support decision-making mechanisms in habitat conservation efforts.

EUNIS is a large-scale and detailed habitat classification system that includes a large number of habitat types. The habitat types in EUNIS are defined according to the EU scale (Moss and Roy, 1998). Not all habitats defined in EUNIS fully match habitats in Turkey. The main reason for this is the differences in phytosociological units together with floristic composition between Turkey and Europe. In EUNIS, there are no habitat types/codes for phytosociological units which are defined only in Turkey but not existed in Europe. Therefore, EUNIS is not sufficient to identify all habitats in Turkey. However, by further researches and integration of endemic phytosociological units of Turkey to EUNIS, this classification will be more usable across Turkey.

This study presents that determination and mapping of habitats are of utmost importance for a variety of communities of interest and habitat conservation strategies. This is why such studies should become widespread across the country.

Ethical Approval

The authors don't declare ethical approval.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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The authors don't declare any fund.

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References

Akyürek B., Duru M., Sütçü Y.F., Papak İ., Şaroğlu F., Pehlivan N., Gönenç O., Granit S., Yaşar T. 1997. Scale 1/100,000 Geological Maps of Turkey: Map Sheet Ankara F-15. MTA Report No. 55, MTA, Ankara.

Çakmak M.H. 2016. The Urban Ecological Characteristics of Mamak (Ankara) District. M.Sc. Thesis, Gazi University, Graduate School of Natural and Applied Sciences, Ankara.

Çakmak M.H., Aytaç Z. 2018. Urban Vascular Flora and Ecological Characteristics of Mamak District (Ankara/Turkey). Biological Diversity and Conservation, 11(2): 123–131.

Çakmak M.H., Can M. 2020. Assessing Regulating Ecosystem Services for Improving the Air Quality of Mamak District (Ankara) (*Accepted Article*). Bilge International Journal of Science and Technology Research, 4(2).

Celik M., Tastekin M., Kayabali K. 2007. An investigation of the surface and groundwater leachate from an old waste disposal site at Mamak, Ankara, Turkey. International Journal of Environment and Pollution, 30(3–4): 548–560. https://doi.org/10.1504/IJEP.2007.014828.

Convention on Biological Diversity 2010a. COP 10 Decision X/2: Strategic Plan for Biodiversity 2011–2020. https://www.cbd.int/decision/cop/?id=12268.

Convention on Biological Diversity 2010b. Strategic Plan for Biodiversity 2011–2020, including Aichi Biodiversity Targets. https://www.cbd.int/sp/.

Corine Land Cover 2018. Maps & Data. Available from: https://land.copernicus.eu/pan-european/corine-land-cover/clc2018, Retrieved 08/08/2019.

Davies C.E., Moss D., Hill M.O. 2004. EUNIS Habitat Classification Revised 2004. European Environment Agency, European Topic Centre on Nature Protection and Biodiversity, 1–307.

Earth Explorer 2019. Landsat Satellite Images. Available from: https://earthexplorer.usgs.gov/, Retrieved 10/08/2019.

Eker İ., Vural M., Aslan S. 2015. Ankara İli'nin Damarlı Bitki Çeşitliliği ve Korumada Öncelikli Taksonları. Bağbahçe Bilim Dergisi, 2(3): 57–114.

Erwin K.L. 2009. Wetlands and Global Climate Change: The Role of Wetland Restoration in a Changing World. Wetlands Ecology and Management, 17: 71–84. https://doi.org/10.1007/s11273-008-9119-1.

EUNIS 2020. EUNIS Habitat Types Hierarchical View. Available from: https://eunis.eea.europa.eu/habitats-code-browser.jsp, Retrieved 05/03/2020.

European Commission 2011. Communication from the Commission to the European Parliament, the Council, The Economic and Social Committee and the Committee of the Regions: Our Life Insurance, Our Natural Capital: An EU Biodiversity Strategy to 2020. COM 2011/244, European Commission, Brussels, 1–17.

General Directorate of Forestry 2019. Forest Stand Map Data. Department of Information Systems, Ankara.

General Directorate of State Hydraulic Works 2019. Hydrology Data. Department of Technology, Ankara.

Geven F., Ozdeniz E., Kurt L., Bolukbasi A., Ozbey B.G., Ozcan A.U., Turan U. 2016. Habitat Classification and Evaluation of the Köyceğiz-Dalyan Special Protected Area (Muğla/Turkey). Rendiconti Lincei. Scienze Fisiche e Naturali, 27: 509–519. https://doi.org/10.1007/s12210-016-0510-1.

Governorship of Ankara 2019. Mamak. Available from: http://www.ankara.gov.tr/mamak, Retrieved 03/03/2020.

Ministry of Agriculture and Forestry 2019. The Presence Data of Ankara Province Land. General Directorate of Agricultural Reform, Ankara.

Ministry of Food, Agriculture and Livestock 2015. The Presence of Ankara Province Land. General Directorate of Agricultural Reform, Ankara, 3–53.

Moss D. 2008. EUNIS Habitat Classification – a Guide for Users. European Topic Centre on Biological Diversity, Paris.

Moss D., Roy D. 1998. Towards a European Habitat Classification: Background Review 1989-1995. Topic Report No. 28, European Topic Centre on Nature Conservation, Belgium.

Open Street Map 2019. Open Street Map Data. Available from: https://www.openstreetmap.org/, Retrieved 03/08/2020.

Rodgers C.P. 2013. The Law of Nature Conservation. Oxford University Press, UK.

Salinger M.J. 2004. The Recent IPCC Assessment of Climate Change and Regions Most Vulnerable to Projected Climate Change. In: Management Strategies in Agriculture and Forestry for Mitigation of Greenhouse Gas Emissions and Adaptation to Climate Variability and Climate Change, Technical note No. 202, Geneva, WMO, 1–15.

Sarı D., Acar C. 2015. Evaluation of the Natural Plant Taxa in Alpine Rocky Habitats in terms of the Functions of Planting Design. Artvin Coruh University Journal of Forestry Faculty, 16(2): 144–163.

Seyfe M. 2019. Preference and Distribution of Reptile Species of Kazan Hills (Kahramankazan/Ankara) According to EUNIS Habitat Types. M.Sc. Thesis, Gazi University, Graduate School of Natural and Applied Sciences, Ankara.

Süel H., Şentürk Ö., Mert A., Özdemir S., Yalçınkaya B. 2018. Habitat Suitability Modeling and Mapping. V. International Multidisciplinary Congress of Eurasia Proceedings July 24-26, 2018, Barcelona, Spain, 536–549.

Tilman D., May R.M., Lehman C.L., Nowak M.A. 1994. Habitat Destruction and the Extinction Debt. Nature, 371: 65–66.

Turkish State Meteorological Service 2016. Climate Data of Ankara. Meteorological Data Processing Department, Ankara.

Vural M., Adıgüzel N. 2006. Türkiye'nin Doğal Yaşam Ortamları: Bozkırlar. In: G. Eken, M. Bozdoğan, S. İsfendiyaroğlu, D.T. Kılıç, Y. Lise (Eds). Türkiye'nin Önemli Doğa Alanları, Ankara, Doğa Derneği, 28–30.

Vural M., Yaman M., Şahin B. 2007. Vegetation of Buyukhemit Deresi (Delice-Kirikkale) and its Surroundings. Ekoloji, 16(64): 53–62.

Weiss M., Banko G. 2018. Ecosystem Type Map v3.1 – Terrestrial and Marine Ecosystems. Technical Paper 11/2018, ETC/BD, France.