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Evaluation of basic soil characteristics of Turkish forests using GIS

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Abstract: Riparian forests (or floodplain forests) are rare ecosystems with a variety of habitats resulting from the temporal and spatial variation in the relationship between the water level of rivers and the geomorphological characteristics of floodplains. Turkey is one of the countries with floodplain forest ecosystem characteristics. These forests, protected under various status are significant for biodiversity. Although many studies have been carried out on the forest cover, vegetation, landscape characteristics and tourism potential of Turkey's floodplain forests, little research has been carried out on the basic soil characteristics. However, it is very important to explain the basic soil properties for evaluating the existing floodplain forest ecosystem in a sustainable way. The aim of this study was to evaluate the basic soil properties of Turkey's riparian forests using GIS. In this context, firstly, 9 floodplain forests reported in the literature and their boundaries were identified. These were Acarlar, Hacıosman (Meşeligöl), Hendek-Süleymaniye, İğneada, Karacabey, Köyceğiz, Sarıkum, Sinop-Aksaz and Yörükler (Galeriç) floodplain forests. The basic soil characteristics within the boundaries of these flooded forests were described using GIS techniques. The basic soil properties were extracted from the data of the National Soil Information System provided by the General Directorate of Agricultural Research and Policies. According to the results of the study, alluvial soils are generally widespread in the flooded forests connected to river systems. When evaluated in terms of land use, the largest class of floodplain forests is woodland. When evaluated in terms of land capability class, class II, III and VII soils are the areas that generally characterize the flooded forests.

Keywords: Alluvial forest, GIS, soil, land use, land capability class.

Türkiye'nin subasar ormanlarının temel toprak özelliklerinin CBS ile değerlendirilmesi

Öz: Subasar (longoz) ormanlar (veya taşkın yatağı ormanları), akarsuların su seviyesi ve taşkın yataklarının jeomorfolojik özellikleri arasındaki ilişkinin zamansal ve mekânsal değişikliği sonucunda ortaya çıkan çeşitli habitatların bulunduğu nadir ekosistemlerdir. Türkiye'de subasar ormanların görüldüğü ekosistem özelliklere sahip olan ülkelerden birisidir. Farklı statülerde koruma altına alınmış olan bu ormanlar, biyoçeşitlilik açısından önemlidir. Daha önce Türkiye'nin subasar ormanlarının genellikle orman varlığı, bitki örtüsü, peyzaj özellikleri ve turizm potansiyeline yönelik çok çeşitli çalışmalar yapılmasına rağmen temel toprak özellikleri konusunda çok sınırlı sayıda araştırma yapılmıştır. Ancak mevcut subasar orman ekosisteminin sürdürülebilir bir şekilde değerlendirilmesi için temel toprak özelliklerinin açıklanması oldukça önemlidir. Bu çalışmada Türkiye'nin subasar ormanlarının temel toprak özelliklerinin CBS ile değerlendirilmesi amaçlanmıştır. Bu bağlamda öncelikle Türkiye'deki literatürde bahsedilen 9 subasar ormanı ve sınırları belirlenmiştir. Bunlar Acarlar, Hacıosman (Meşeligöl), Hendek-Süleymaniye, İğneada, Karacabey, Köyceğiz, Sarıkum, Sinop-Aksaz ve Yörükler (Galeriç) subasar ormanlarıdır. Bu subasar ormanların sınırları dahilinde temel toprak özellikleri CBS teknikleri kullanılarak açıklanmıştır. Temel toprak özellikleri, Tarımsal Araştırmalar ve Politikalar Genel Müdürlüğü tarafından paylaşıma açılan Ülkesel Toprak Bilgi Sistemi verilerinden çekilmiştir. Çalışma sonuçlarına göre akarsu sistemleri ile bağlantılı olan subasar ormanlarda genel olarak alüvyal toprakların en geniş sahada yayılış gösterdiği anlaşılmıştır. Arazi kullanımı açısından değerlendirildiğinde subasar ormanları oluşturan en geniş sınıf orman alanlarıdır. Arazi kabiliyet sınıfı bakımından değerlendirildiğinde ise II, III ve VII. Sınıf araziler subasar ormanları genel olarak karakterize eden alanlardır.

Anahtar kelimeler: Subasar orman, CBS, toprak, arazi kullanımı, arazi kabiliyet sınıfı

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1. Introduction

Oceans, lakes, rivers, ponds and other water bodies, which constitute or influence the formation of natural resources worldwide, form different ecosystems in the geography in which they are located. Ecosystems where the ground is wet or saturated with water and where water-loving plants dominate are called wetlands. Wetlands are home to more plant species than their surroundings, as well as being a habitat for endemic species and various creatures. These characteristics make wetlands an inclusive upper class (Çiçek, 2004; Ramsar, 2005; Wetlands Convention Communication Database, 2024). According to Ramsar, the Convention on Wetlands, a wetland is any natural or artificial reedbed, wet meadow, swamp, peat bog, lake or marine area, saturated and mobile, fresh, alkaline or saline, with a water depth of less than 6 meters. These subclasses with different characteristics form different types of ecosystems within themselves and are home to many species (Hasançavuşoğlu, 2018; Yeler et al. 2023; Solak & Yılmaz, 2021). These are wetlands that are the habitat of primitive plants such as liverwort (Sarıoğlu & Keçeli, 2018). However, they are ecologically important structures in producing oxygen, absorbing nutrients, creating microclimates, filtering pollution, influencing global climate change and in the groundwater recharge/discharge cycle (Bani & Elmas 2022). Therefore, it is necessary to protect important wetlands (Toker & Sunar 2018).

Turkey has different types of wetlands of which some have been protected under different status, but all the components of floodplain forests have not been sufficiently studied (Çiçek, 2004). Although scientific studies have been carried out on the existence of forests, vegetation, landscape features and tourism potential, studies on the soil, which is one of the most basic elements of the ecosystem, have been insufficient. Since floodplain forests have a higher plant diversity compared to other forests, soil properties are very important both to explain this diversity and to ensure its sustainability (Gallardo, 2003; Parolin et al., 2004; Heger et al., 2021). In this study we mapped the soil properties of floodplain forests in Turkey using Geographic Information Systems (GIS) from the National Soil Information System data provided by the General Directorate of Agricultural Research and Policies to assess the soil properties of floodplain forests in general (TAPGM, 2017). Floodplain forests are one of the most fragile ecosystems of the Middle Belt, which are currently 9 in Turkey. Although Efe (2004) mentions the existence of various floodplain forests, these ecosystems have disappeared after being destroyed by humans.

Floodplain forests are located downstream of large streams and rivers (Gallardo, 2003). As all floodplains are associated with one or more rivers, alluvial soils are common to all floodplains. The alluvial soils that accumulate in the downstream part have flat and almost flat slope characteristics. They have normal permeability, are well drained, have no salinity and alkalinity problems and are suitable for dryland and irrigated agriculture (Bozyiğit, 2020; Table 1). This part, which corresponds to the briquette part of the material carried by the river, is very fertile and, together with water, is the basic element of the micro-scale floodplain ecosystem. Soil, which is an element of floodplain forests worthy of research as much as aboveground resources, is important because it allows different types of tree groups to grow depending on its quality (Tuncer & Kaya, 2010). Due to their ecological, biological, environmental and economic importance, floodplain forests play multiple functional roles in the natural landscape (Bozkaya et al., 2014). Floodplain forests, which are similar to the mangrove forests of the tropical belt but with certain differences, are very important forest resources in the Middle Belt. Turkey has part of the largest floodplain forest ecosystem in the middle belt. Changes in the regime of the rivers that feed the floodplain forests are a constant problem for the floodplain forests. At the same time, the fact that these forests are established on the bottom lands and their soils are fertile, leaves the ecosystem with another problem such as land use demand (Yeni, 2004).

2. Material and Method

The list of flooded forests included in the study was obtained through a literature review (Çiçek, 2004). The locations and boundaries of the flooded forests that have survived to date were compiled from scientific studies (Bahadır and Özlü, 2014; Sürmen, 2018; Hasançavuşoğlu, 2018; Karaduman, 2019; Özdemir, 2019; Akyiğit, 2020; Ürker, 2020; Ürker and Yorulmaz, 2020; Bani and Elmas, 2022). The boundary data of the obtained floodplain forests were digitized in ArcGIS PRO 3.0. The soil data and land use land cover data of the floodplain forests were obtained from the General Directorate of Agricultural Research and Policies (TAPGM, 2017). The floodplain forests examined were

İğneada, Acarlar, Hendek-Süleymaniye, Sarıkum, Sinop-Aksaz, Yörükler, Hacıosman, Karacabey, Köyceğiz floodplains.

3. Results and Discussion

Among the flooded forests, the flooded forests of Acarlar, Hacıosman (Meşeligöl), İğneada, Sarıkum, Sinop-Aksaz and Yörükler (Galeriç) are located on the Black Sea coast, while the remaining three are located on the Marmara coast. Karacabey on the coast of Marmara Sea, Hendek-Süleymaniye is located within the provincial border of Sakarya and is not on the sea coast, and finally Köyceğiz floodplains are located in the Aegean region and have shown tolerance to climate change. Despite its tolerance to climate change and summer drought, the Köyceğiz floodplain has been severely affected by anthropogenic destruction. As the remaining small patches of forest are not visible on the map, they have been transferred to the map within an inclusive area. The numbered maps are 1. İğneada, 2. Acarlar, 3. Hendek-Süleymaniye, 4. Sarıkum, 5. Sinop-Aksaz, 6. Yörükler, 7. Hacıosman, 8. Karacabey, 9. Köyceğiz floodplains (Figure 1). The soils of the floodplain forests in Turkey are divided into major soil groups, which are upper categories, according to their pedogenetic characteristics. The distribution of the soil groups identified by letters in Table 1 is shown in Figure 2. Red-brown Mediterranean soils, which are found only around the Köyceğiz floodplain, are present in areas where the continental semi-arid climate prevails (Atalay, 2016). Hydromorphic alluvial soils, which have excessive soil moisture in the degree of wetness, have a structure that prevents drainage and have high moisture retention rates because they are formed in flat, low slope and depression areas (Horasan, 2014). As slope debris, calcareous brown forest soils are present in some floodplains, red yellow podzolic soils in Sinop-Aksaz and Sarıkum floodplains, and calcareous brown forest soils in our floodplain forests.

3.1. List of flooded forests according to land use capability class

The list of flooded forests according to land capability classification is given in Table 2. In general, flat, nearly flat, deep and fertile lands with fertile soils that can be cultivated and lands with excessive slope, stony structure, swamp and other unfavorable soil characteristics, which are not suitable for cultivation, are present in all floodplain forests in Turkey (Özşahin & Eroğlu, 2018).

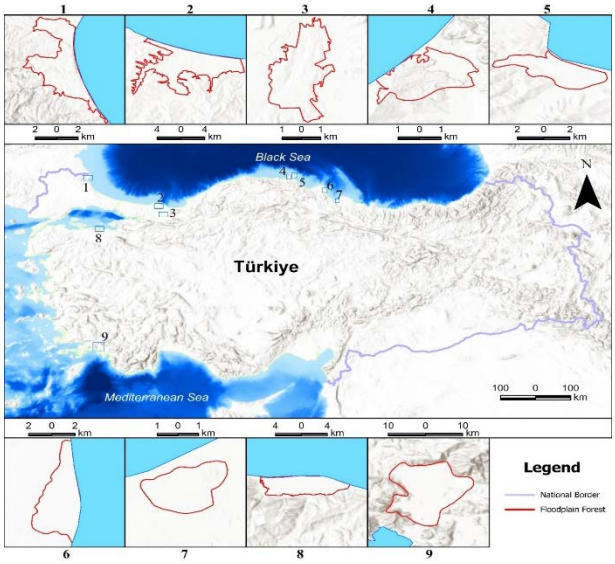

Figure 1. General combination ability of popcorn genotypes according to tester lines.

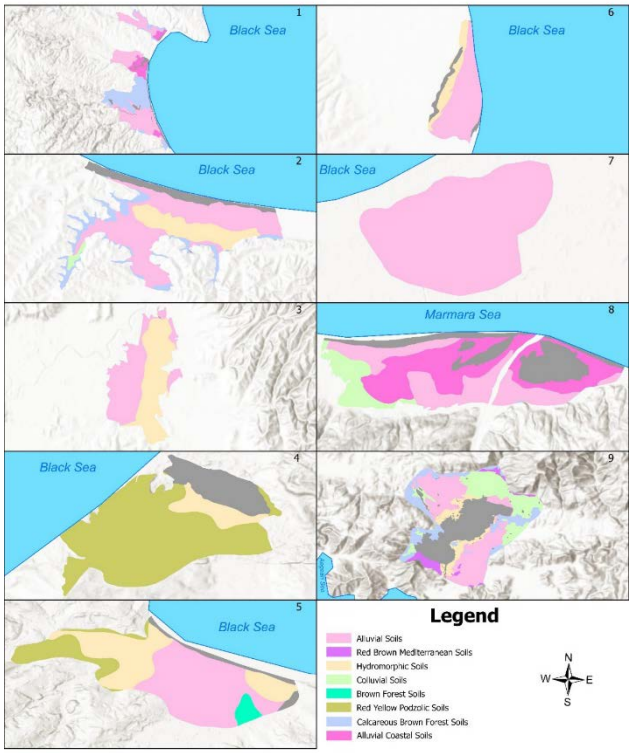

Figure 2. Map of large soil groups of the study area (TAPGM, 2017).

Table 1. List of large soil groups found in flooded forests

	Sand
A	Alluvial Soils
E	Red Brown Mediterranean Soils
H	Hydromorphic Alluvial Soils
K	Colluvial Soils
M	Brown Forest Soils
P	Red Yellow Podzolic Soils
N	Calcareous Brown Forest Soils
S	Alluvial Coastal Soils

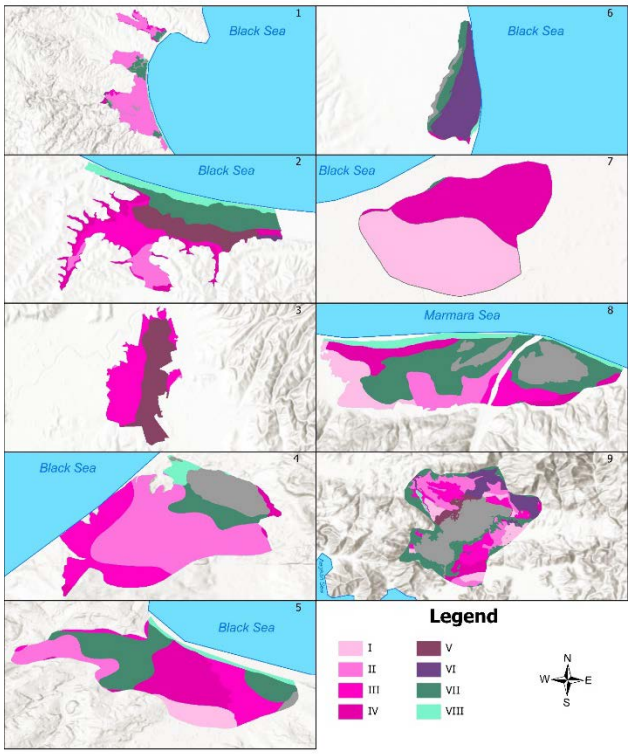

Figure 3. LULUC map of the study area (TAPGM, 2017).

Table 2. Land Capability Classification

	Land suitable for cultivation	Land not suitable for cultivation
1	II, III, IV	V, VI, VII, VIII
2	I, IV	VII
3	II, III	V, VI
4	II, III, IV	VI, VII, VIII
5	I, II, III, IV	VII, VIII
6	I, II, III, IV	V, VI, VII, VIII
7	II, III, IV	VII, VIII
8	I, II, III, IV	VII, VIII
9	IV	VI, VII, VIII

4. Conclusion

Zonal, azonal and intrazonal soil types are observed in the study areas. For the safety of the alluvial forests and their surroundings, which are rich in soil diversity, planning and agriculture should be carried out in ccordance with the identified soils. The surrounding areas of floodplain forests should be closed to settlement and soil pollution should be prevented. The water resources of these wetlands, which are very suitable for endemic plants, should be protected. Hydroelectric dams should not be built on the rivers that feed the floodplain forests, and the sustainability of these oxygen-rich forests should be ensured. Even if there are areas in the study area that can be cultivated according to the land's capacity, the most appropriate solution is to limit the use of these areas with observation, scientific studies and educational programs. As these forests are also one of the stopping points for bird migration, natural life can also be damaged by human activities.

Another advantage of flooded forests is that they store carbon. This characteristic makes floodplain forests one of the most productive areas. This is because soil organic carbon levels are high in forests with active river connections. The formation of hydromorphic features close to the mineral soil surface is a sign that soils store high levels of organic carbon. In this respect, it is important to protect the soils of alluvial forests, which will be a legacy for future generations.

On the other hand, floodplain forests that are mentioned in the literature but have lost their quality and natural resources can be studied and better protection methods can be developed for existing floodplain forests.

Conflict of interest

The authors declare no conflicts of interest.

Authorship contribution statement

H.S: Control, research design, and writing process. M.Ö: Research and writing process.

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