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Agro-Ecological Zones and Land Use Planning at the Kuzgun Dam Irrigation Area

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ABSTRACT: Soils are a major source which restricts the agricultural production because of the limited and non-producible properties. So, it is very important to be evaluated in a manner appropriate to the characteristics of farm lands. This study was undertaken to prepare the agro-ecological zones and the land use planning of farmlands, on the irrigation area of the Kuzgun Dam which is constructed by State Hydraulic Works in Erzurum. Factors affecting crop production (climate, soil texture, salinity, alkalinity, permeability, groundwater level, erosion grade, soil profile depth, land slope, farmer preferences) in research area were considered and multiple query was made. As a result of the query, it was obtained that soil profile depth and slope of the land will play dominant role for crop pattern and the others will have low-impact. Probable land use forms of the farm lands were estimated base on dominant factors according to the geographic information system (GIS) method, and some suggestions were presented for the crop production. As a result of this study, cereals, forage crops, natural pasture and afforestation areas were identified in the fields with production limitations for Kuzgun Dam irrigation area. In areas without production limitations in terms of soil properties, two factors, climate and farmer preference, were effective.

Key words: Agro-ecological zone, land use planning, Kuzgun Dam, GIS

Kuzgun Barajı Sulama Alanında Agro-Ekolojik Sınırlar ve Arazi Kullanım Planlaması

ÖZET: Toprak, sonlu ve yenilenemez özelliğinden dolayı tarımsal üretimi kısıtlayan en önemli kaynaktır. Bu nedenle tarım topraklarının özelliklerine uygun bir şekilde değerlendirilmesi önem taşımaktadır. Bu çalışmada, Erzurum ilinde Devlet Su İşleri tarafından sulamaya açılan Kuzgun Barajı sulama alanı tarım topraklarının kullanım açısından planlanması amaçlanmıştır. Araştırma alanında bitkisel üretimi etkileyen faktörler (iklim, toprak bünyesi, toprak tuzluluğu, alkalilik, geçirimlilik, yeraltı su düzeyi, erozyon derecesi, profil derinliği, arazi eğimi, üretici tercihleri) dikkate alınarak çoklu sorgulamalar yapılmıştır. Sorgulamalar ışığında söz konusu alanda "toprak profil derinliği" ve "arazi eğimi"nin bitkisel üretim deseninde başat rol oynayacağı, diğer faktörlerin etkilerinin düşük olduğu tespit edilmiştir. Etkili faktörler esas alınarak agro-ekolojik sınırlar ve olası arazi kullanım şekilleri coğrafi bilgi sistemi (CBS) yöntemi ile belirlenmiştir. Çalışma sonucunda Kuzgun Barajı sulama alanı için üretim sınırlaması olan alanlar ile bu alanlarda hububat, yem bitkileri, doğal mera ve ağaçlandırma alanları tespit edilmiştir. Toprak özellikleri açısından üretim sınırlaması olmayan alanlarda ise iklim ve üretici tercihi olmak üzere iki faktörün etkili olduğu sonucuna varılmıştır.

Anahtar kelimeler: Agro-ekolojik sınır, arazi kullanım planlaması, Kuzgun Barajı, CBS

INTRODUCTION

As with all natural resources of production, the concept of sustainable land management is the protection and or development of natural environmental components, the transfer of the benefits of natural resources to next generations and to foresee a stable income and life assurance. At first every kind of production is expected to increase, especially nutrition necessitates the effective use of natural resources.

Because the soil is one of the most important nonrenewable resources for production; it cannot be reused for reasons such as misuse, erosion, desertification and pollution, or it can be brought back to its former status with serious investments.

Sustainable agricultural development just went from being a choice, are becoming mandatory for a global solidarity and agreement (Kuşlu and Yağanoğlu, 2007).

In developing countries, agro-ecological zones are increasingly taking into account while doing agricultural investments (Özel *et al*., 1999; Quiroz *et al*. 1999; Raji, 2003). In the study of agro-ecological boundaries; land resources inventory, agro-ecological zone maps, land suitability, land suitability classes, determination of potential production capacity, potential land productivity, output, such as land-use planning is provided (Quiroz *et al*. 1999; Umezaki *et al*., 2002; Genç and Bostancı, 2007; Reis, 2007). As an output of agro-ecological boundary studies, land-use planning is appropriate in Turkey and in the world. Protection of rural life and determination of agricultural production areas and shapes in Peru (Quiroz *et al*. 1999), determination of the existing land cover and land-use planning in China (Umezaki *et al*., 2002), classification of land use in a region opened to irrigation in Nigeria (Raji, 2003), change the type of land use in Vietnam from 1968 to 2003 are examples of its application in the world (Binh *et al*., 2005). There are also many similar studies in Turkey. For example; the effect of the newly opened

residential areas on farmland in Bursa city (Aksoy *et al*., 1997), determination of crop production in the boundaries of Samsun province (Özel *et al*., 1999), changes in the use of agricultural land at Torbalı district in the province of İzmir (Küçükyılmaz, 2003), change of vegetation and land use pattern of the TROIA National Park (Genç and Bostancı, 2007), change of land covers in the province of Rize from 1976 up to 2000 (Reis, 2007) can be mentioned chronologically.

Agriculture related investments are highly intensified in the developing regions of our country like in Ege, Akdeniz and Güneydoğu Anadolu regions. Among the cities of the Eastern Anatolian region, irrigation investments are in Erzurum which is one of the most important cities in the region and are mainly located in the plains of Pasinler and Erzurum. The Project in Erzurum, is aimed to irrigate approximately 50 000 hectares of dry agricultural land in Erzurum plains. The construction of the first part of the Daphan irrigation project was completed among to 1991-1998 years, and a total of 9908 ha area was opened for irrigation. The second part of the project includes 12 039 ha area and its construction was completed in the first half of 2014 (GDSHW, 2014).

Geographic Information Systems (GIS) is a tool used to manage geographic based data according to the user's requirement by storing, managing and correlating large scale and diverse data (Fisher, 2003; Özgül, 2003).

In this study, agro-ecological zones and the agricultural land use planning of the irrigable land from the Kuzgun Dam, which is part of the Erzurum Project was determined with the help of Geographic Information Systems (GIS).

MATERIALS AND METHODS

Kuzgun Dam is a water storage structure and was built between 1985-1998 to be used for irrigation, energy production and flood control in the Serçeme valley. Kuzgun dam is located in the Fırat basin between 39° 49′ and 40° 15′ north latitudes and between 39° 52′ and 40° 42′ east longitudes. This dam irrigates 49 901 ha (Figure 1). Looking at the topography of the project area, it is mountainous and rugged while it is flat to a certain width and length in the middle. The plains in Erzurum are located between elevations of 1680-1930 m (GDSHW, 2014).

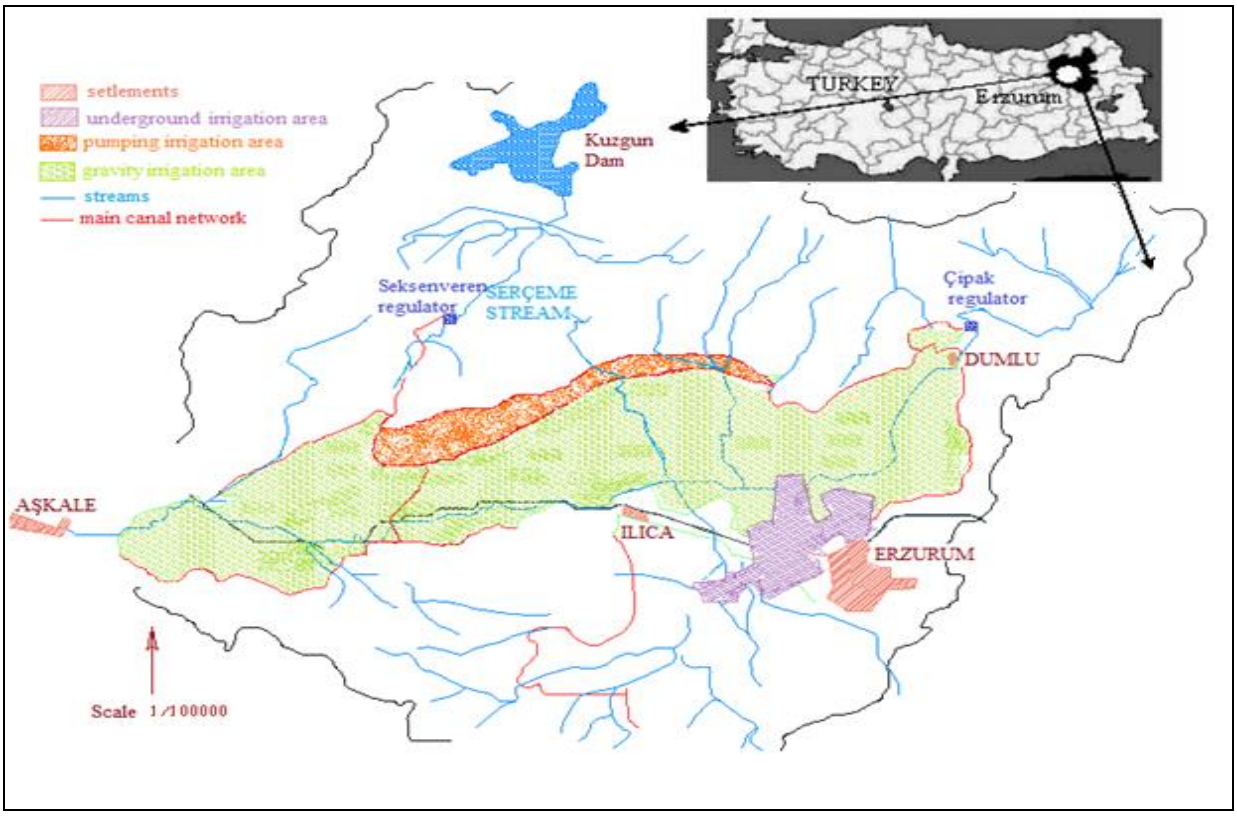


Figure 1. Map of the study area: Kuzgun Dam and irrigation system

Average precipitation and average temperature values of the research area are presented in Fig. 2. The climate of the research area is hot and dry in summer and very cold and snowy in winter. The temperature difference between night and day is high. The annual average temperature was 5.7 °C for many years (1926-2016). The coldest month is January with an average of - 9.1 °C on, and the hottest month is August with an average of 19.5 °C. The average annual precipitation was 432 mm, with the highest rainfall observed in the month of May with 73.1 mm, and the lowest in August with 17.5 mm. 47.97% (207.6 mm) of annual rainfall falls in the plants vegetation period of from May,1 up to October, 20. The relative humidity value was the lowest in August by 47%, the highest is in December and January by 76% and the average annual relative humidity is 64% (TSMS, 2016).

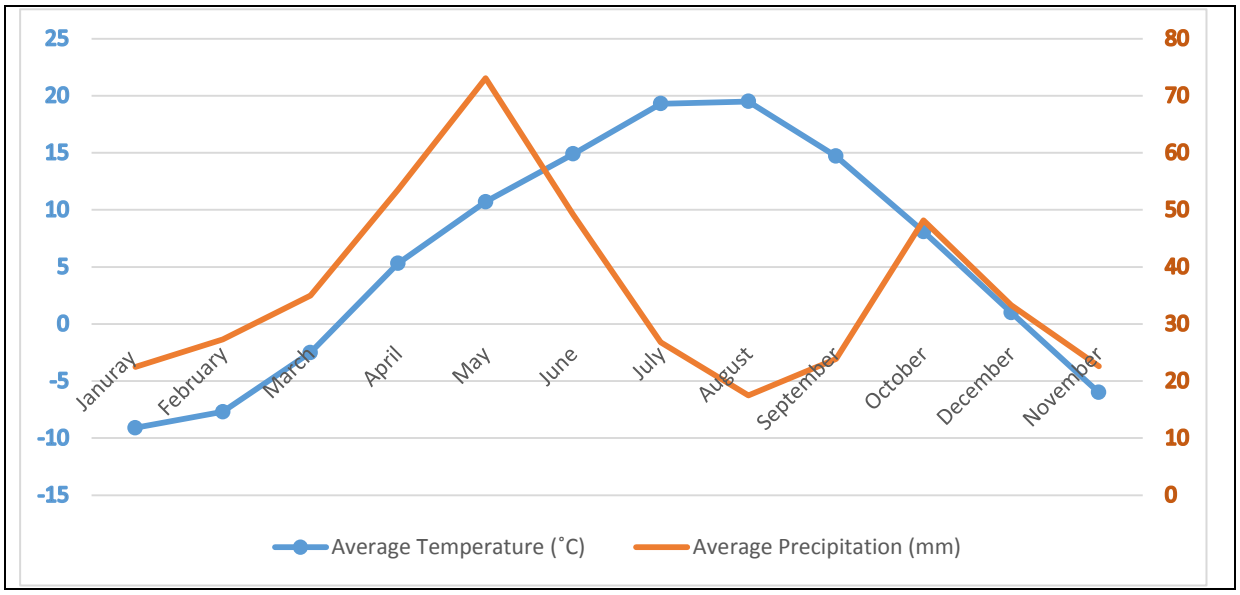


Figure 2. The average monthly temperature and precipitation data of the research area for many years (1926-2016).

A survey was planned to understand the possible reasons of the land use and irrigation. For this purpose, a sampling design was created by using the following formula (Bender *et al*. 1982; Cicek and Erkan 1996).

$$n = \frac{N * \sigma^2}{(N-1) * D^2 + \sigma^2}$$

Where; n is sample size, N is total number of the families in research site, σ2 is the population variance, t is a value from the Student's table, D is the maximum error of the estimation.

The samples were chosen randomly among the villages where lands are suitable for irrigation. Sample size (n) was determined as of 218 for an interview.

According to the land capability classification, 29 879 ha (87.12%) of Erzurum plain area is grouped as irrigable I., II. and III. class. The 1817 hectares (5.42%) is considered as temporarily non-irrigable land class V. for reasons such as groundwater, flood, salinity alkalinity, permeability and insufficient topography and 1831 ha (5.46%) area has been identified as non-irrigable land. In some areas of the plain, soil profile is having quite shallow depth (Akgül, 1992, 1994; Şahin, 1994; Özbek, 2003; Kuşlu, 2004).

For the research, Erzurum Project Situation Plan at a scale of 1/25 000, Property Map prepared by General Directorate of State Hydraulic Works (GDSHW) at a scale of 1/5000 and the Erzurum Province Land Capability Classification Map prepared by General Directorate of Rural Services (GDRS) at a scale of 1/100000 were used (GDRS, 2000; GDSHW, 1979). The maps were scanned and transferred to a computer based software CAD (Computer Aided Design Drafting) and screen digitization and Affine transformation was done in NETCAD 5.2 program that is a window compatible for maps and related applications. NETCAD 5.2 program was also used for the analysis of the obtained raster (maps), non-graphical (the results of the interview), graphical (maps and spatial files prepared in NETCAD 5.2), numerical and alphanumerical data by GIS method (Özel *et al.*, 1999; Fischer, 2003; Genç and Bostancı, 2007; Özgül, 2003).

In the creation and analysis of the database, the factors like topography (slope), soil profile group, top soil structure, permeability and similar properties that limit irrigation are taken into account.

RESULTS AND DISCUSSION

Since the water distribution system cannot be carried out at the same time as the land consolidation project at Kuzgun Dam irrigation area, the utilization rate of in-field development services remained low. In general, total irrigation efficiency can be defined as the ratio of irrigation water needed to the amount of water discharged from the source. According to the results obtained from the research, irrigated area opened to irrigation from Kuzgun Dam has been approximately 35%. Only a small part of the water derived through the area opened to irrigation can be used for irrigation purposes. The irrigation rates operated by GDSHW and Daphan Irrigation Association are 23% and 59% respectively (Kızıloğlu *et al*., 2012).

In the irrigated area of the research, grain cultivation has been carried out traditionally, partly potatoes, sugar beets and sunflower farming have also started. However, complete product diversification has not yet been done. In the areas that not yet been irrigated, cereal growing is common and forage crops mostly vetch and sainfoin are cultivated.

In the area of research, there are considerable percent of meadows and pastures. Because of this reason, livestock is one of the main occupations. One of the most prominent features of the region is that it is close to a big market in the center of Erzurum (Kuşlu, 2004; Kızıloğlu *et al*., 2012).

The start of irrigation caused very little change in production. Farmers locally engaged in agriculture in the region are generally farming crops with low income yields and as they do not have an effective settled established irrigation culture, they are have difficulty in accepting new knowledge and methods. The current plant pattern and cultivation rates on the plain are shown in Table 1. In agricultural enterprises, planting in autumn is a widely used form of production because of getting more yields. Production planning is very important for the effective use of resources.

Table 1. Plant pattern in research area

Cultivated Plant Species	Rate (%)
Cereals	27.34
Beans (fresh)	0.09
Chickpea	0.16
Vegetable	0.89
Sugar beet	7.73
Sunflower	0.32
Arboriculture	0.41
Potato	1.03
Forage crops	58.98
Meadow	3.06

At some parts of the lands in the irrigation area of Kuzgun Dam were having inadequate depth of soil profile. Some of cultivation and irrigation practices in shallow soils cause soil erosion. The digitized map of profile depth prepared in the NETCAD 5.2 is given in Figure 3.

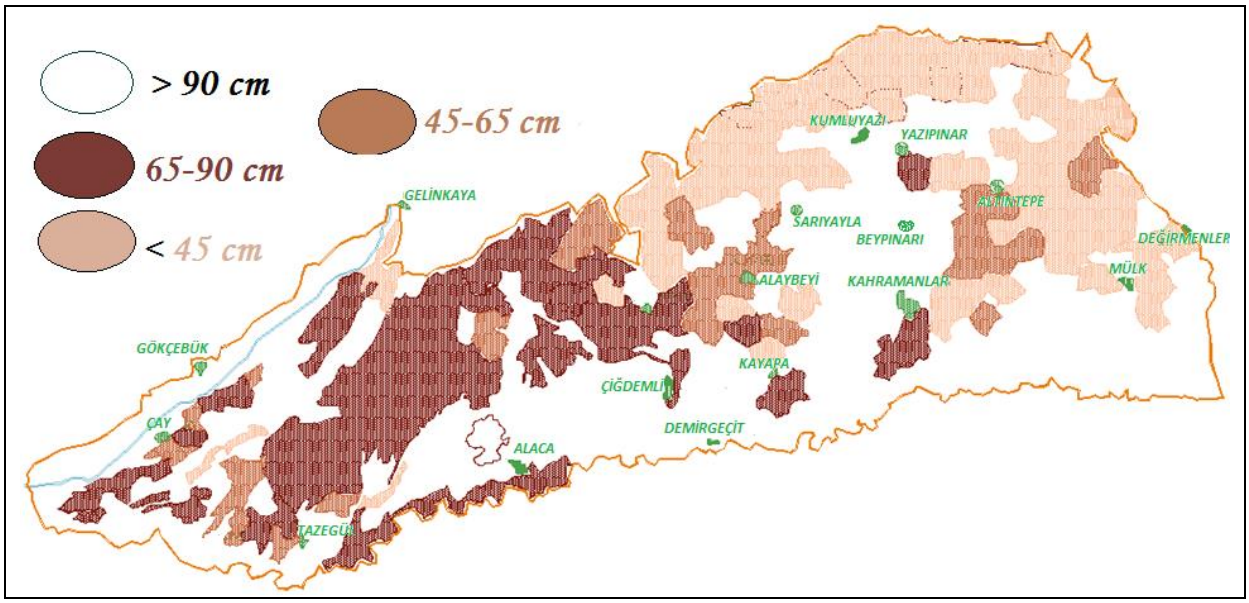


Figure 3. Distribution of soil profile depth in Kuzgun Dam irrigation area

In some part of the study area, the soil was found to have a slope problem leading to factors that restricts irrigation. In the sloppy land of the region, traditional irrigation methods are mostly used. The digitized map of slope classes prepared in the NETCAD 5.2 is given in Figure 4.

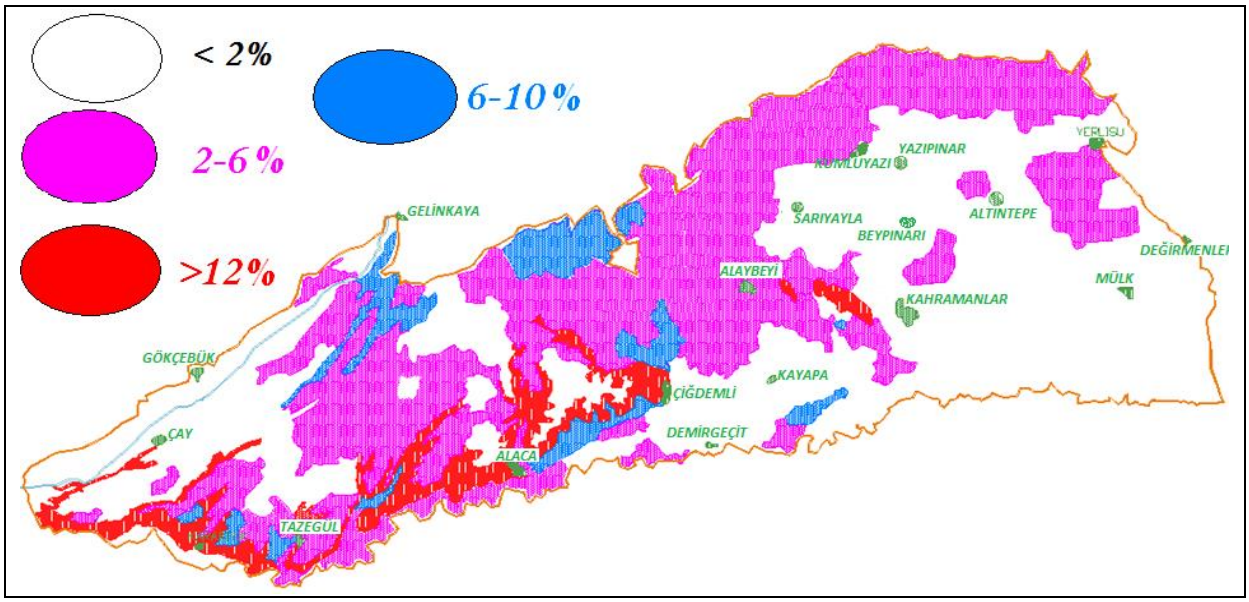
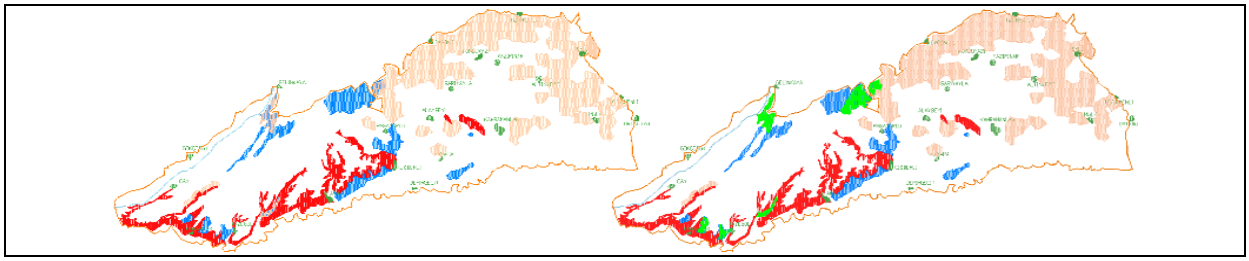
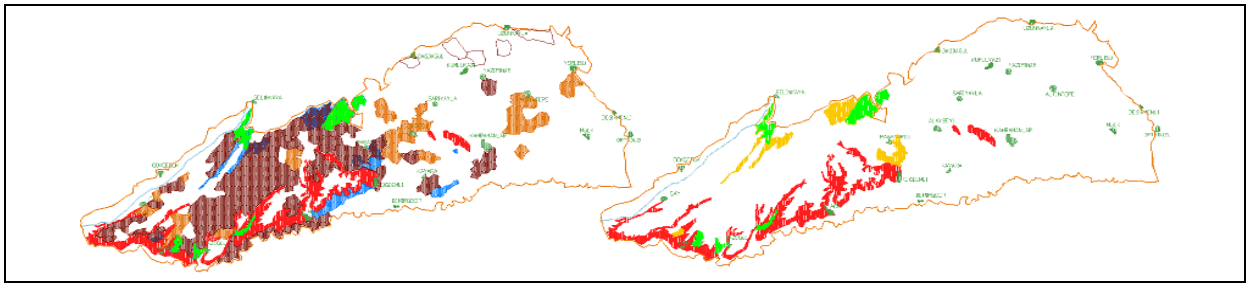


Figure 4. Distribution of land slope classes at Kuzgun Dam irrigation area

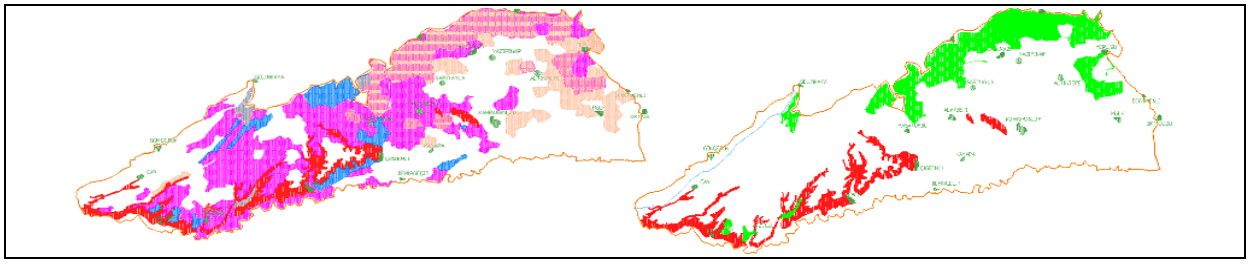
In addition to the limitations of land slope and soil profile which are important for irrigation and cultivation agriculture, the agro-ecological zones prepared by evaluating the profile depth and slope classes are shown in Figure 5. According to the results of spatial analysis; some agricultural zones have been determined as high slope class and shallow profile depth zones (a), high slope class and limited profile depth zones (b, c), limited slope class and limited profile depth zones (d, e).



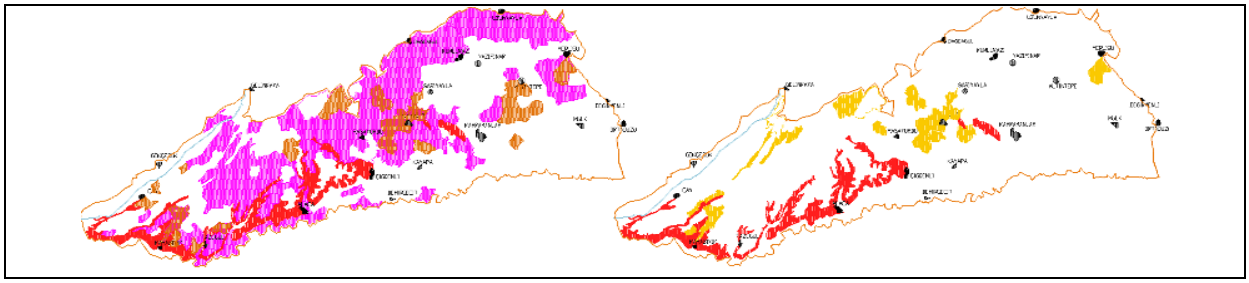
(a)



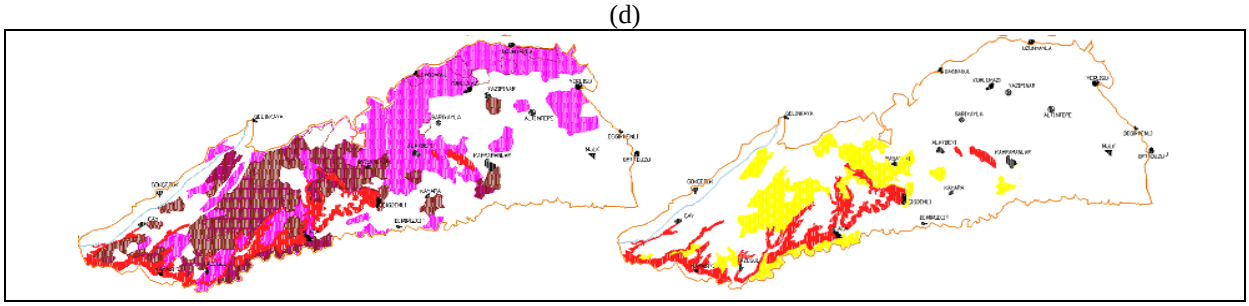
(b)



(c)



(d)



(e)

Figure 5. The results of the spatial analysis and agricultural zones

The thematic map that shows the possible land use planning in the irrigation area of Kuzgun Dam made by the GIS method considering soil permeability and the top soil profile group is shown in Figure 6.

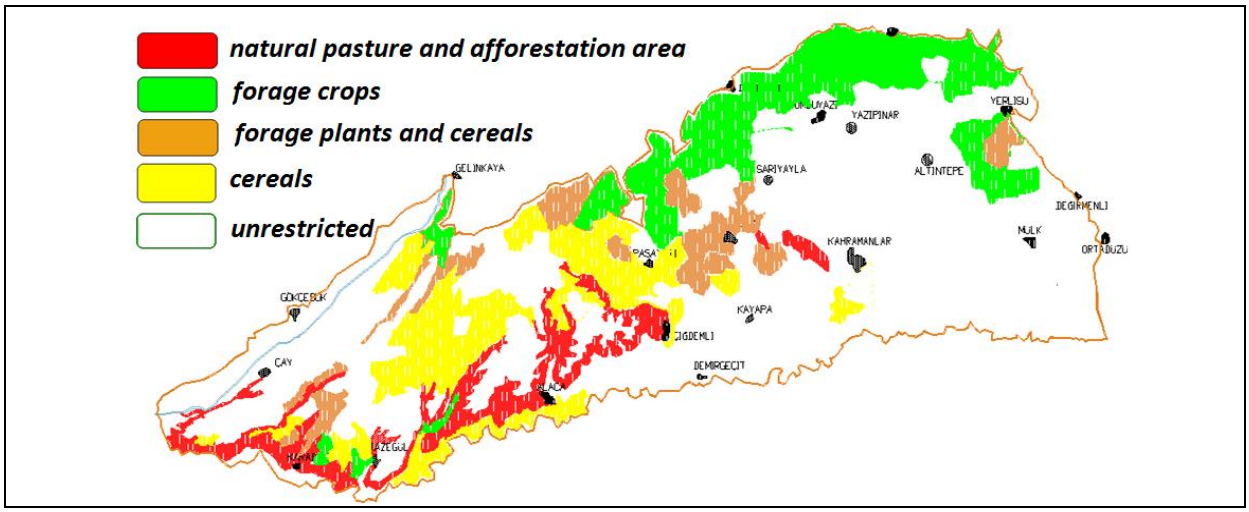


Figure 6. The thematic map of the possible land use planning in the research area

CONCLUSIONS

There are basic limited-irrigation zones in some parts of the Kuzgun Dam irrigation area resulting from topography, and in some parts due to inadequate depth of top soil profile. Due to the fact that the initial cost of pressurized irrigation systems is expensive, gravity irrigation is widely used in the agricultural practices of the region. Development of irrigation technology and surface irrigation should be avoided in lands with steep slopes and shallow soil depth characteristics. Since pressurized irrigation systems have a low operating cost and are easy to use, as well as having high efficiency, the amount of water applied to the unit area is low compared to surface irrigation systems

In the area of research, to make more effective for the dairy cattle breeding, which has already attracted attention in an agricultural production and for this purpose, the creation of artificial grassland which is formed by the mixture of plants with frequent root and trunk development should be assessed both in terms of prevention of soil erosion and the provision of green forage that are needed.

In order to avoid problems like excessive irrigation, erosion and salinity which are observed with the opening of irrigated farmland in our country, soil and topographical land use planning is required. Land consolidation must be done in collaboration with the irrigation systems in order to remove the infrastructure shortage.

REFERENCES

Akgül, M., 1992. Daphan Ovası Topraklarının Sınıflandırılması ve Haritalandırılması. Atatürk Üniversitesi Fen Bilimleri Enstitüsü (Doktora Tezi), Erzurum.

Akgül, M., 1994. Daphan Ovası topraklarının arazi kullanım yetenek sınıflaması. Atatürk Üniv. Ziraat Fak. Derg., 25 (1): 14- 29.

Aksoy, E., Çullu, M. A., Ergün, H., 1997. Bursa ilinde doğal kaynaklardaki olumsuz değişimlerin belirlenmesinde uzaktan algılama ve coğrafik bilgi sistemi teknikleri uygulamaları. III. Uzaktan Algılama ve Türkiye'deki Uygulamaları Semineri, 16-18 Mayıs, Bildiriler, V-22, Harita Genel Komutanlığı Matbaası, Ankara.

Bender, F.E., Douglass, L.W., Kramer, A., 1982. Statistical Methods For Food and Agriculture. AVI Publishing, Westport, CT

Binh, T. N. K. D., Vromant, N., Hung, N. T., Hens, L., Boon, E. K., 2005. Land cover changes between 1968 and 2003 In Cai Nuoc, Ca Mau Peninsula, Vietnam. Environment, Development and Sustainability, 7: 519-536.

Çiçek, A., Erkan, O., 1996. Tarım Ekonomisinde Araştırma ve Örnekleme Yöntemleri (The Methods of Research and Sampling in Agricultural Economics). Gaziosmanpasa University, Faculty of Agriculture Publication:12, The Series of Lesson Notes:6, Tokat (In Turkish)

Fischer, M. M., 2003. GIS and Network Analysis. In Handbook 5 Transport Geography and Spatial Systems. Hensher D., Button K., Haynes K. and Stopher P. (eds.); Pergamon.

Genç, L., Bostancı, Y. B., 2007. TROIA Milli Parkı arazi kullanım ve bitki örtüsü değişiminin uzaktan algılama ve coğrafi bilgi sistemleri yardımıyla belirlenmesi. Tekirdağ Ziraat Fak. Derg., 4(1): 27-41.

GDRS, 2000. Erzurum İli Verimlilik Envanteri ve Gübre İhtiyaç Raporu. KHGM, Araştırma Etüd ve Proje Dairesi Başkanlığı, Ankara.

GDSHW, 1979. Erzurum Projesi Yapılabilirlik Raporu. DSİ VIII. Bölge Müdürlüğü, Erzurum.

GDSHW, 2014. http://www2.dsi.gov.tr/bolge/dsi8/isletme.htm#sulama (02 Ekim 2014).

Kızıloğlu, F. M., Şahin, Ü., Kuşlu,Y., 2012. Erzurum Tarım Raporu. TMMOB Ziraat Mühendisleri Odası Erzurum Şubesi, Erzurum.

Kuşlu, Y., 2004. Kuzgun Barajı Sulama Alanında Arazi Toplulaştırma Potansiyelinin Belirlenmesi. Atatürk Üniversitesi Fen Bilimleri Enstitüsü, (Doktora Tezi), Erzurum.

Kuşlu, Y., Yağanoğlu A. V., 2007. Kuzgun Barajı sulama alanında yapısal durumun belirlenmesi. Atatürk Üniversitesi Ziraat Fakültesi Dergisi 38 (1); 71-81.

Küçükyılmaz, N., 2003. İzmir–Torbalı Yöresi Sanayi ve Kent Gelişiminin Tarım Arazileri Üzerine Baskısının Coğrafi Bilgi Sistemi (GIS) Kullanılarak Araştırılması. Ege Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, İzmir.

Quiroz, R., Zorogastua, P., Baigorria, G., Barreda, C., Valdivia, R., Cruz, M., Reinoso, J., 1999. Toward A Dynamic Definition of Agroecological Zones Using Modern Information Technology Tools, CIP Program Report 1999-2000, 361-370. http://www.fao.org/WAIRDOCS/TAC/Y4953E/y4953e0a.htm.

Özbek, A. K., 2003. Daphan Ovası topraklarının sulu arazi tasnif standartlarına göre sınıflandırılması ve toprak koruma önlemlerinin seçimi. Atatürk Üniv. Ziraat Fak. Derg. 34 (2): 125-134.

Özel, M. E., Yıldırım, H., Ağdağ, M. İ., Alparslan, E., Torun, M., Aydöner, C., Elitaş, S., Dağcı, M., Erkan, B., Dok, M., Duran, H., 1999. Agro-ecological zoning by use of satellite remote sensing and GIS. Third Turkish-German Joins Geodetic Days, 1-4 June 1999, Istanbul.

Özgül, M., 2003. Uzaktan algılama ve coğrafi bilgi sistemleri ile arazi kullanım haritalarının hazırlanması. Atatürk Üniv. Ziraat Fak. Derg. 34 (3): 293-297.

Raji, B. A., 2003. Agricultural Landuse Planning and Management in Kadawa Irrigation Schema, Kano State, Department of Soil Science, Faculty of Agriculture, Institute for Agricultural Research, Ahmedu Bello University, Zaria, Nigeria.

Reis, S., 2007. Rize ilinin arazi örtüsündeki zamansal değişimin (1976-200) uzaktan algılama ve coğrafi bilgi sistemi ile belirlenmesi. Ulusal Coğrafi Bilgi Sistemleri Kongresi. TMMOB Harita ve Kadastro Mühendisleri Odası . 30 Ekim-2 Kasım, KTÜ, Trabzon.

TSMS, 2016. http://www.dmi.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx?m=ERZURUM (Erişim tarihi:15.06.2017).

Şahin, Ü., 1994. Kuzgun Barajı Daphan Ovası Sulama Sahası Topraklarının Sulama Yönünden İncelenmesi Üzerine Bir Araştırma. Atatürk Üniversitesi Fen Bilimleri Enstitüsü (Doktora Tezi)., Erzurum.

Umezaki, M., Pahari, K., Jiang, W., 2002. Land Use of the Li-Speaking People in a mountainous area of Hainan Island, China: impact of national nature reserve established in 1986, Asian Conference on Remote Sensing, Birendra International Convention Centre in Kathmandu, Nepal.