

Evaluation of the Land and Water Resources of the Middle Black Sea Region from an Agricultural Perspective

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ABSTRACT: A rational use of land and water resources is essential in attaining agricultural production growth. This calls for studies to determine the existing soil and water resources in quantity and quality and improve these resources for solving problems. Although there is an increase in the total size of land cleared for irrigated agriculture each year in the Middle Black Sea Region, where significant problems prevail in terms of land and water resources, the existing water resources in the region cannot be benefited satisfactorily and a desired irrigation has not been achieved so far. For the development of the agricultural aspects of the region, necessary investments to develop water resources should be implemented. The socio-economic structure of the region could be improved through implementing sustainable projects regarding land and water resources primarily. Investigating and reviewing studies conducted on land and water resources of the Middle Black Sea Region, the problems encountered and solution options, this study presents preliminary information for future research.

Keywords: Land and water potential, the Middle Black Sea Region



Orta Karadeniz Bölgesi Toprak ve Su Kaynaklarının Tarımsal Açından Değerlendirilmesi

ÖZET: Tarımsal üretimin artırılmasında toprak ve su kaynaklarının rasyonel biçimde kullanımı zorunludur. Bunun için mevcut toprak ve su kaynaklarının nitelik ve nicelik olarak belirlenmesi, sorunların çözümü için bu kaynakların geliştirilmesi üzerinde çalışılmalıdır. Toprak ve su kaynakları yönünde önemli sorunların bulunduğu Orta Karadeniz Bölgesinde sulu tarıma açılan alanlar her yıl artmasına karşın mevcut su kaynaklarından yeterli ölçüde yararlanılamamakta, istenilen şekilde sulama yapılamamaktadır. Bölgenin tarımsal yönden kalkınması için su kaynaklarının geliştirilmesi konusunda gerekli yatırımlar yapılmalıdır. Toprak ve su kaynaklarına ilişkin sürdürülebilir projelerin öncelikle ele alınmasıyla bölgenin sosyo-ekonomik yapısı düzeltilebilecektir. Orta Karadeniz Bölgesinin toprak ve su kaynaklarına ilişkin yapılan çalışmalar ile karşılaşılan sorunlar ve çözüm olanaklarının incelendiği bu çalışmada gelecekte yapılacak yeni çalışmalara ön bilgi olması bakımından gerekli bilgiler verilmiştir.

Anahtar kelimeler: Toprak ve su potansiyeli, Orta Karadeniz Bölgesi

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INTRODUCTION

The average annual rainfall in Turkey is about 643 mm and it corresponds to an average of 501 billion m³ of water in a year. 274 billion m³ of this water returns to atmosphere by vaporization, 69 billion m³ feeds groundwater and 153 billion m³ flows into seas and closed basin lakes. 28 billion m³ of the 69 billion m³ of water feeding groundwater joins surface water through springs. In addition, an average of 7 billion m³ of water flows into our country from neighboring countries annually. Therefore, the gross surface water potential of our country adds up to 193 billion m³. When 41 billion m³ of water feeding the groundwater is also considered, the renewable water potential of our country mounts up to a total of 234 billion m³ grossly. However, under current technical and economical conditions, the potential of surface water that can be consumed for various purposes is totally 98 billion m³ per year in average. 95 billion m³ of this total comes from domestic rivers and streams and 3 billion m³ from rivers flowing through our country from neighboring countries. Together with the groundwater potential determined to be 14 billion m³, the average total consumable ground and surface water potential of our country is 112 billion m³ per year. 44 billion m³ of this total is used (Anonymous, 2011a; Calis, 2011).

27.3% of the land in Turkey is used for dry farming, 5.6% for irrigated farming, 3.1% for horticulture and for specific product farming, 27.6% for grassland and 29.8% for forest-heath. The total size of cultivable land is 28.0 million ha; however, the fact that arable land is 26.6 million ha and that the unused 5.0 million ha land is used for grassland, forest-heath and settlement indicates that the amount of land used for farming is actually 21.8 million ha.

Turkey is not rich enough in terms of land resources. It can be seen that the amount of land that needs to be preserved makes up about one fourth of our country and the amount of arable land for several purposes has remained only 6.5% (Anonim, 2007a). The area of Turkey is 78 million hectares and the total size of agricultural lands is about one third of this area; that is, 28 million hectares. For optimum efficiency, 93 % of the arable lands needs irrigation. According to studies, given the potential sources of groundwater and surface water, the economically irrigable area is 8.5 million hectares. The full development of land-water resources

in Turkey is projected to be completed in 2030. It is planned that 65% of the water potential will be used for irrigation, 23% for drinking and domestic use, and 12% for industrial purposes. The amount of water reserved for agriculture in 2000 was 75% of the total consumption, whereas it is estimated to be 65% in 2030 (Volkan et al., 2001).

The Middle Black Sea Region stretches from Melet Stream to the east of Sinop province. The land shapes are less complicated than those of the Eastern and Western Black Sea Regions. Mountains have lower elevations and they have a retracted layout. As a result of this, agricultural areas have been highly developed. The Region stretches south more than the Eastern Black Sea Region and it is also home to Samsun, Ordu, Tokat, Amasya and Corum provinces.

The Middle Black Sea Region has a significant agricultural production level and it can be considered as rich in water potential. The average annual rainfall in the region is about 602 mm, which is 643 mm in Turkey general. The low rainfall during plant growing period increases the importance of irrigation more. Irrigation facilities call for expensive investments. Though there are a lot of investments made for this purpose, the irrigation problems have not been resolved fully, yet. Therefore, the water in already operated irrigation networks should be used more effectively and economically. This study aimed at evaluating the land and water sources and the studies carried out for the Middle Black Sea Region. In addition, the problems were investigated and solution options were proposed.

The Potential of Land-Water Resources and the Size of Irrigated Lands

Climate: The Middle Black Sea Region (Figure 1) is dominated by terrestrial climate type. The average annual temperature is about 13.5 °C, humidity 67.4 % and rainfall 602 mm. Due to the layout of the mountains in the region, which shows an inland extension, there is a decrease in the amount of rainfall. The annual rainfall decreases as much as 700 mm and it increases through the west over 1000 mm (Table 1). The province is dominated by a transition climate between Black Sea Region climate and terrestrial climate. It generally has a temperate climate. The city exhibits the characteristics of the Black Sea Region climate, which has hot summers and warm and wet winters. The hottest months are July and August (Anonymous, 2010a).



Figure 1. The Middle Black Sea Region

Land Assets: The land asset of the region is 4 462 598 ha and it makes up nearly 5.7 % of the total area of Turkey. Because the climate is appropriate and the city is under the influence of the Black Sea Region characteristics, 1 892 474 ha of this land asset is used as agricultural land (Table 2). 449 892 ha (10 %) of the land is grassland-meadow and 1 471 892 ha (33 %) is forest-heath. The fallow land is 24 255 ha (5 %). When the available land asset in region is examined, it can be seen that agricultural lands cover the biggest area, followed by lands reserved for forest and heath respec-

tively. While the proportions of agricultural lands and forest-heath lands in the region are higher than those of country average (35.6 % and 29.8 %), the proportion of grassland-meadow is less than that of country general (30.2 %) (Erdal, 1997; Yavuz, 2005; Haktanır et al., 2000; Anonymous, 2007b; Anonymous, 2007c; Anonymous, 2010b; Anonymous, 2010c; Anonymous, 2010d).

Lands are classified into eight categories in terms of their capacity of use. Category I, II, III and IV lands are appropriate for tillage. On the other hand, category V, VI and VII lands, which are not suitable for tillage, are only appropriate for use as grassland or meadow. Category VIII lands can be used for collecting water or as shelter for natural life. According to land capacity classification, 295 550 ha of the total lands is category I land (6,7 %), 334 134 ha is category II (7,6 %), 403 443 ha is category III (9,1 %), 496 525 ha is category IV (11 %), and 2 184 ha is category V (0,5 %) (Table 3). Category I-IV lands are used for farming. Category V-VIII lands are forests and grassland-meadows. However, though they are not suitable for farming, some of the category V-VIII lands are used for agricultural purposes and this reduces the efficiency and causes erosion. A large part of these lands can be brought in production. It can be seen that the lands unsuitable for tillage are more than those suitable for tillage.

Table 1. Meteorological d

Meteorological Elements	Samsun	Ordu	Tokat	Amasya	Corum
Average Temperature (°C)	14.4	14.1	12.3	13.6	11.3
Average Relative Humidity (%)	71.8	72.0	62.0	60.0	74.0
Average rainfall (mm)	693.9	1018.3	440.7	445.0	633.8
Average wind speed (m s ⁻¹)	1.5	1.7	1.7	1.8	1.7
Sunshine duration (h)	5.4	4.3	6.1	5.44	6.2

Table 2. Land assets (ha)

Land type	Provinces				
	Samsun	Ordu	Tokat	Amasya	Corum
Agricultural land	455 324	184 358	381 209	252 029	619 554
Grassland-meadow	33 721	80 395	124 405	65 992	145 379
Forest-heath	358 107	157 583	387 060	203 934	365 208
Other	110 748	233 964	107 344	47 145	148 239
Total	957 900	656 300	1 000 018	570 100	1 278 380

Table 3. The distribution of land use capacity categories in terms of provinces in the Middle Black Sea Reg

Provinces	Category I	Category II	Category III	Category IV	Category V	Category VI	Category VII	Category VIII
Samsun	42 079	115 574	99 253	135 994	349	47 300	49 884	11 251
Ordu	1 300	7 600	23 200	67 500	0	102 600	394 200	3 000
Tokat	75 766	65 417	94 101	75 852	1 631	144 695	522 933	10 122
Amasya	46 272	47 588	43 940	86 477	0	87 023	245 801	10 242
Corum	130 133	97 955	142 949	130 702	204	205 17	557 823	14 738

Most of the lands suitable for tillage in the Middle Black Sea Region are in Corum and Ordu provinces. Plains cover nearly 16.7 % of the region. The main plains in the region are Sungurlu, Irmak, Corum Osmancık, Hüseyin, Kazova, Turhal, Erbaa, Niksar, Artova, Zile, Carsamba, Bafra, Geldigen, Suluova, Merzifon, and Gumus plains (Erdal, 1997; Anonymous, 2007b; Anonymous, 2007c; Anonymous, 2010b; Anonymous, 2010c; Candemir and Özdemir, 2010; Anonymous, 2011b; Anonymous, 2011c).

Water Resources: The most important water resources of the Middle Black Sea Region are surface water resources and the region is rich in rivers and streams. The 519 km long Yesilirmak River and the 1355 km long Kizilirmak River and its tributaries are the most important stream resources in the region. These two rivers pass through the city and then reach and flow into the Black Sea. In addition, there are numerous large and small streams in the city. However, these streams have an irregular flow rate. They draw a wide arc in the city of Samsun and create Bafra Delta. They create the biggest delta of Turkey over the area, where they flow into the Black Sea. The area of this delta is 560 km² and the length is 30 km. The maximum, minimum and average flow rates of the Yesilirmak River measured so far are 1.914 m³ s⁻¹, 1,83 m³ s⁻¹ and 121 m³ s⁻¹ respectively. The total annual flow, on the other hand, is 5 707x10⁶ m³ (Anonymous, 2005a). The important tributaries of the Yesilirmak River are Kozanlı (468 km), Cekerek (331 km), and Kelkit (373 km).

The average flow rate of the Kizilirmak River is 188.08 m³ s⁻¹ and its maximum and minimum flow rates, the output of 20 year-long observations, are 1.673 m³ s⁻¹ and 18.4 m³ s⁻¹ respectively. Delice (426 km), Devrez (211 km) and Gökirmak (1355 km) are important tributaries of the Kizilirmak (Anonymous, 2005b). The Kizilirmak River basin has a rainfall area of 78 170 km². Its average annual flow is 6,48 km². It also has an average annual flow rate of 2.6 l s⁻¹ km⁻². On the other hand, the Yesilirmak River basin has a rainfall area of 36 114 km². Its average annual flow is 5.80 km² and it has an average annual flow rate of 2.6 l s⁻¹ km⁻².

The region has groundwater (898 hm m⁻³) and surface water (19308 hm m⁻³) potentials, therefore total water potential is 20 206 hm m⁻³. The surface area of water in the region is 37 460 ha. The natural lakes in the area are Liman (270 ha), Ladik (1000 ha), and Simentit

Lake (870 ha) in Samsun, Borabay (4,5 ha) in Amasya city, and Gaga (6,9 ha), and Ulugol (8 ha) in Ordu city. In addition, there are some other lakes in the region such as Zinav and Gollukoy, Kaz Lake, Gokgol, Eymir Lake, Karagoz, Duttibi, Cernek, Uzun Lake, and Tombul, Akcagol, Akarcık, and Dumanlı. Apart from these, there are some artificial lakes in the region such as Altinkaya (11831 ha), Derbent (1650 ha), Derinoz (88 ha), Hasan Uğurlu (2266 ha), Ondokuzmayıs (147 ha), Suat Uğurlu (970 ha), Vezirkopru (230 ha), and Cakmak (628 ha) dam lakes in Samsun; Topcam dam lake (309 ha) in Ordu; Yedikir (593 ha), Sarayozu (89 ha), and Derinoz (80 ha) dam lakes in Amasya; Alaca (80 ha), Hatap (102 ha), Kochisar (1200 ha), Obruk (5021 ha), Yenihayat (135 ha) and Corum (56 ha) dam lakes in Corum; Bedirkale (135000 ha), Kızık (55700 ha), Dutluca (52500 ha), Artova (32900 ha), Kızık (18000 ha), Buyukakoz (13700 ha), Uluoz (12600 ha), Akbelen (11400 ha), Almus (3130 ha), Guzelce (2 ha), Boztepe (187 ha), Belpınar (173 ha), Alpu (1 ha), Atakoy (50 ha), and Kokluce dam lakes in Tokat (Anonymous, 2005a).

The 33 dam lakes in the region have a total body size of 35.56 hm³ and 54359 ha of irrigation area. In addition, there are 48 ponds constructed by DSI (Public Water Affairs Dept.) and 166 by Special Provincial Administration for irrigational purposes. They supply 23 077 ha land with water and have 88.54 hm³ storage capacity. The hydroelectric power potential of the Middle Black Sea Region is 8998 GWh year⁻¹ supplied by an installed 3 249 MW power (Anonymous, 2005a; Anonymous, 2005b; Anonymous, 2010e; Anonymous, 2011b).

Irrigable Land Assets: 13.9 % of the lands in Middle Black Sea Region have irrigation facilities. The area of economically irrigable land in the region is 767 498 ha 30 % of the irrigation is provided by DSI (Public Water Affairs), 29 % by Special Provincial Administration and 41 % by the efforts of local people. The overall land in the region studied by DSI is 904 933 ha. 460 583 ha of the lands is suitable for irrigation. In addition, it has been determined that 768 499 ha is economically irrigable and the required water resources have been found.

The number of settlements with irrigation possibilities is 1559 and the total area of irrigable land is 404 418 ha 139 of the irrigation facilities were built

by government and 605 were built by people in the region. There are 299 229 farms in the region and 92 254 of them (159 076 ha) have irrigation facilities. 24 347 of the farms (46 247 ha) benefiting from irrigation facilities use wells, 14 221 (15 527 ha) get water from springs, 42 299 (44 330 ha) from streams, 1931 from lakes (3 305 ha), 8066 from ponds (20 574 ha), 5247 from dam lakes (11 827 ha), and 2 642 from other sources (Anonymous, 2001; Anonymous, 2007b; Anonymous, 2007c; Anonymous, 2010b; Anonymous, 2010c; Candemir and Ozdemir, 2010).

With the development of agricultural techniques, as a result of studies carried out by land development services of Special Provincial Administration and DSI on irrigation networks, there have been notable increases in yields, especially in recent years. Due to irregular precipitation regime in the region, the amount of rainfall during plant growth period cannot meet water requirements of plants. Despite the presence of sufficient amount of irrigable land in the province, since rainfall and surface water resources have not been able to keep up with water requirements for irrigation, groundwater resources have been introduced. DSI and Rural Affairs Department carry out studies and projects to provide rest of the lands with irrigation facilities.

The Characteristics of Farming Lands: Although the different topography, climate, geological differences of the Middle Black Sea Region and the variety in vegetation have brought about the formation of soils with various characteristics, there are also land types deprived of soil cover in the region.

617 269 ha of the lands in the region has brown forest soil. 125 869 ha consists of non-calcareous brown forest soil, 81 625 ha chestnut brown soil, 59 508 ha alluvial soil, 32 439 ha colluvial soil, 10 329 ha brown soil, 4 615 ha gray-brown podzolic soil, 228 ha hydromorphic soil, and 38 ha involves red-yellow podzolic soil. Alluvial soils are abundant in the Kizilirmak River and the Yesilirmak River deltas and river floors. Brown forest soil covers a large area in the region (The total is 1 899 288 ha in Tokat, Amasya and Corum provinces). Alluvial soil that makes up the majority of first-class farmlands is moist and rich in organic matter. These soils have formed in plains such as Amasya, Turhal, Zile, Corum, Tokat, Almus, Omala Suluova and Kazova as a result of the accumulated material carried by the rivers such as Kizilirmak, Cekerek, Cat, and Ye-

silirmak. In addition, colluvial soil covering an area of 126 658 ha is found along the Kizilirmak, Cekerek and Cat Rivers. These soils are not suitable for agriculture, however they can gain value after their drainage problem is resolved (Anonymous, 1997; Anonymous, 2000; Anonymous, 2001; Anonymous 2005c; Anonymous, 2007b; Anonymous, 2010b; Anonymous, 2010c).

When the structural distributions of the soils are examined, more than 60 % of them can be seen to have clay-loam characteristics (Amasya, Corum, Tokat). In addition to having slightly alkaline content ranging from 70 to 80 %, these soils also consist of about 50 % organic matter. Most of the soils in the region have a medium texture and soil reactions are neutral or slightly alkaline. Their salt content is low and they have medium or high organic matter content. It can be seen that the richest soils in the region in terms of organic matter are under forest cover and the poorest ones are formed on the young alluvial deposits. The main material in soils with high lime content is limestone, and it is greenschist in soils with low lime content (Durak, 1986; Anonymous, 2000; Anonymous, 2005a). Most of the bottom lands in the region are used for agriculture. Meadow has not grown on soils formed on materials deposited near streams and pit areas due to high groundwater.

There is no erosion in these areas whose slope ranges between 0 and 2 %. The bottom lands extend through waterway basins of the Yesilirmak, Kelkit, and Cekerek Rivers. The alluvial soil brought from different regions has mixed physical, chemical, and mineralogical properties. Particle size distributions of these materials vary according to physiographic units of their origin where they come from.

Problems and Solution Options: Irrigation investments in the Middle Black Sea Region are carried out by farmers and government agencies, and they have continued to increase in recent years. 295 550 ha of first class land among the arable lands in the region is suitable for growing all kinds of plants and some parts of this land lacking irrigation need water for getting better and more product. Given the developments in irrigation technologies today, it is obvious that more lands should be irrigated. On the other hand, the lands considered not suitable for irrigation due to their negative features such as sloping surface and soil depth are likely to be irrigated using new technologies. The fact that the farms

in the region have small pieces of lands in irregular and scattered parcels causes difficulties in the planning and construction of irrigation projects, as well as preventing the effective use of water distribution and desired irrigation methods. Most of the farmers lack enough knowledge about modern irrigation methods and they cannot be trained efficiently by relevant institutions; consequently, it is not known exactly which irrigation method will be used, how, when and how much water is to be supplied. Flooding method, one of the surface irrigation methods in the region, is more common than border and furrow irrigation methods; therefore, due to excess irrigation, this method causes an increase in surface flow and deep infiltration losses, lower irrigation efficiency, excessive water consumption, washing away of nutrients, higher groundwater elevations, salinity and drainage problems (Kanber and Unlu, 2008). Instead of flooding method commonly used among the surface irrigation methods, water application efficiency should be enhanced by using border and furrow irrigation methods by considering soil structure, infiltration rate and plant variety on flat and leveled areas. On the other hand, the areas where sprinkle and drip irrigation methods are applied have widened recently.

There have been declines in the region in terms of irrigation efficiency. Therefore, measures are needed to improve efficiency. On-farm development services should be handled as a whole, where necessary, and they should be implemented. Irrigated lands should be plowed with proper plows and the land should not be allowed to have tillage pan formations. In order to increase irrigation efficiency, plant, soil and topography relations should be examined meticulously; the water should be distributed in a planned way; topographic abnormalities should be eliminated and appropriate irrigation methods should be applied. In addition, the development of water-saving networks should be given priority. Due to favorable topography and alluvial soils they have, the majority of plains have irrigation facilities. However, over-irrigation in these facilities cause drainage problems. This reveals that people lack adequate knowledge about irrigation. For this reason, studies are needed for training the farmers as well. In addition, opening irrigation and drainage facilities, and service roads in the irrigation areas before their constructions have been completed as projected, and failing to administer a desired maintenance and repair of canals bring about increasing water losses and ground-

water problem. Drainage problem observed in the majority of the irrigated farmlands and part of dry farming lands is a condition that should be eliminated. Apart from controlling high level groundwater through drainage systems constructed for this purpose, the problems arising from drainage deficiency will also be solved. These areas, where salinity and alkalinity damage is an important problem, should be studied well and toxic matter should be washed away from soil profile.

Major investments are carried out by cooperatives in the region, where most of the farms are in the form of small family-run businesses. Operated by DSI (Public Water Affairs Dept.) until now, irrigation operation has been taken over by irrigation unions to gain more productivity. There are 181 irrigation cooperatives in the region (Anonymous, 2005c). The most important deficiency limiting agricultural development in terms of organization is that farmers are not prone to have a common organization. Particularly, the tendency to be organized in the form of cooperatives by small land owners has not taken enough attention. Management of irrigation facilities by the state is expensive and problems are encountered when providing services considering the changing conditions. Handing over the facilities to those benefiting from the system will ensure the participation of farmers to operating expenses and management of the system. The irrigation facilities in the region should be passed on organizations which are good at administering irrigation. Moreover, the members and the administrators of the irrigation cooperative should be trained on the issue. Irrigation organizations and particularly irrigation unions should have a democratic and transparent structure and the participation of farmers to the unions should be ensured. From time to time, floods are experienced due to excessive rainfall, lack of infrastructure and streams needing improvement. Given the climatic conditions in the region, while there are problems in obtaining water for irrigation and households during dry seasons, the floods during rainy season cause the loss of fertile soils in addition to life and property losses. The farmlands in these areas should be protected with moats and ditches or walls. It is of great importance to store water in certain periods for use when needed. This will help both meet water need and prevent floods and soil loss. It will be better to implement basin improvement studies aiming to control the water and design water storage constructions based on the results obtained from studies. The time of

rainfall in the region does not generally fit the time and months when plants need water. It is possible to meet the water needs of the plants at the right time, amount and quality through the construction of water storage facilities. The groundwater and surface water potential in the region will be boosted by the new ponds to be constructed.

In some of the projects transforming the lands into irrigated farming, small farms are in majority and their lands are over-fragmented and scattered. In irrigation areas where road network is inadequate and farmers do not allow neighboring farmers to pass through their lands, land consolidation should be given priority. It will be beneficial to achieve land consolidation before the irrigation starts in parts of the lands where the current projects haven't been completed yet. Before beginning the construction of irrigation projects, consolidation criteria should be applied at the project design stage and consolidation should be achieved at this stage.

Due to the increase in industrialization in the region particularly in the last 20 years, industry and settlement areas have started to be established on fertile and irrigable first class lands. With the spread of urbanization on these fertile lands, agricultural lands have narrowed and the efficiency of the existing lands has decreased. In addition, the use of the soils in mining sector such as sand, lime, bricks, and tiles brings about the loss of natural resources in a way where recycling is impossible. The misuse of farmlands, unauthorized opening of sand and stone quarries cause important problems. For example, taking soil from farmlands in Erbaa plain to meet the raw material need in soil industry and later ignoring to improve these lands has resulted in unwanted consequences.

Some of the category V-VIII lands in the region are used for agricultural purposes, though not suitable for farming. This decreases the productivity and causes erosion. A large part of these lands can be converted into farming lands. Industrialization should be taken away from alluvial areas to sloppy areas and the loss of category I and II farmlands should be prevented in this way. The lands in the region should be used according to their capacities, and optimum farm sizes should be determined considering the ecological conditions. Failing to achieve these conditions and other problems such as some legal issues in land ownership

and constant shrinkage of the lands due to inheritance from generation to generation cause water and wind erosion in some lands. To eliminate the wind erosion in farmlands, crop rotation, protective and soil-enhancing vegetation cover, plant residue and stubble mulching, application of green and artificial fertilizers, leveling curve and strip farming, tilling the soil with appropriate equipment, protective tree curtains and meadow improvement are among the measures to be taken.

Erosion is widespread in the lands of the region. Areas unaffected by this problem or those least affected are lands mostly consisting of base lands formed by alluvial soils. On the slopes of the Black Sea Mountains overlooking the Central Anatolia and in areas where the natural cover is damaged, erosion damages reach critical extents. Erosion particularly affects the Yesilirmak and Kizilirmak deltas, which are agricultural centers. For example, it was determined from the measurements carried out in the Yesilirmak River basin that the amount of average annual carried soil was 1521 ton km⁻² and the amount of carried soil in a year was 54.9 million tons (Gunay, 1995).

In areas and plains where there is no overgrazing and forests are not damaged, erosion problem does not exist. In mountainous lands except for those mentioned, soil losses up to the level of severe erosion occur due to overgrazing. The fallow-wheat farming system applied accelerates erosion. Due to some reasons such as increase in the amount of land in the region opened to tillage farming, failing to take measures against erosion in farming lands, widespread application of fallow system in agricultural activities, and soil sensitivity to erosion, lands where overgrazing is practiced suffer from erosion to a great extent.

In the majority of the lands in the region, particularly in 59 508 ha, where alluvial soil around the Yesilirmak valley is located, the level of ground water is high enough to damage the plant growth in the majority of the year. Due to flat land and high groundwater level in areas where drainage is deficient, there is a salinity problem because salt is washed away in higher lands and accumulate in hollow parts of the flat lands and low quality water is used. In areas where there is a drainage problem, both salinity and sodicity are observed. The main reasons for the appearance of these problems are as follows: the storage of alluvial material in the sea or nearby, and the flat land and high level groundwater

prevent the salt on the surface soils from being washed; the salt washed away from higher areas accumulate in the holes of flat areas; the irrigation water used is low quality; and enough drainage is not found (Anonymous, 1997; Anonymous, 2005a).

With the transition to modern agriculture and acceleration of industrialization, soil contamination has also emerged as an environmental problem. There did not use to be soil pollution due to inadequate power and energy resources used in the past, underdeveloped industry and a small population. As in other agricultural production areas in the region, there is an ever increasing use of fertilizers and pesticides. In particular, the use of both chemical fertilizer and pesticides is intensive in the Yesilirmak and Kizilirmak River Deltas. The part of the Yesilirmak River within the boundaries of Samsun province is affected by agricultural applications negatively.

Today, technological developments are as important factors as labor, capital and natural resource in productivity growth. The foundation of technological developments is scientific studies and research. For this purpose, the efforts of the research institutions in the province should be brought at a desired level. The research institutions should investigate the decrease in irrigation ratings, the physical properties of the soils in the region in terms of irrigation. They should conduct studies to determine water consumptions of plants and techniques to use the water efficiently. In order to increase the irrigation ratings, the ecological, economic and social structure of the region should be taken into account during the planning stage. An efficient production plan with a high implementation possibility should be put into practice. A better soil study should be conducted to implement a more rational use of water potential. Plants suitable for local conditions should be selected and basic data about water consumption of plants and irrigation efficiency should be determined.

RESULTS

The use of soil and water resources ignorantly and unconsciously is one of the leading problems of agriculture. These resources should be used most appropriately. The unplanned and unbalanced use of these resources causes countries to experience hard times socially and economically. The development of

soil and water resources is one of the economic functions of nations. It can also be considered as social and economic guaranty of societal order. With the development of soil and water resources, and conservation of natural resources, the existence of life and property is ensured. It also provides food and employment for the growing population and raw material for the industry. The Middle Black Sea Region has considerable problems regarding soil and water resources. Therefore, the socio-economic structure of the region can be improved by giving priority to sustainable projects related with soil and water resources. Utilization of the existing potentials of the lands is essential to agricultural production and sustainability of natural resources. Therefore, the existing land resources should be determined in the first place. The Yesilirmak and Kizilirmak Deltas are among the important agricultural centers. However, the misuse of these lands and particularly erosion pose a threat to the sustainability of these important agricultural centers.

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