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Chapter 1

Strategies to Enhance Sustainability of Land Resources in Arid Regions

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Additional information is available at the end of the chapter

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Abstract

The ability to effectively maintain the functions of the ecosystem is closely related to the assessment of land resources within a conservation-utilization balance. Land degradation is one of the most significant environmental treats on arid region ecosystems in terms of the use of these resources. In this chapter, the aim was to attract the attention to land degradation processes in Turkey and analyze the current conditions in the context of policy-science interaction by performing the strengths, weaknesses, opportunities and threats (SWOT) analysis and develop the effective strategies for sustainable use of land resources. Thus, anthropogenic effects on sustainability of land resources and its relation with drought and productivity, and insufficient legal regulations were analyzed for developing strategies to enhance sustainability of land resources. Results showed that Turkey is at the point of breaking for sustainability of its natural resources. Insufficient topographic and soil conditions, administrative problems and negatively changing climatic conditions made the condition adverse. Therefore, the significant strategies were defined for sustainable resource management under the integrated approach from ecological, economic, political and sociological perspectives. In this context, assessments have been made in order to prevent weaknesses and possible threats to the sustainable use of this resource.

Keywords: land degradation, sustainability of land resources, SWOT, Turkey

1. Introduction

At the historical development of human beings, we see that many civilizations had been established from the hunter-gatherer system (the Neolithic period) to the premodern 9000 period that had caused the great pressures on natural resources [1]. It is known that human activities such as overgrazing, deforestation, wrong or inappropriate land uses/conversions

and poor agricultural management practices are common causes of land degradation, but extreme climatic events also accelerate this process. It is reported that today 1.5 billion people worldwide are affected by land degradation processes [2]. Especially in arid and semiarid ecosystems, land degradation is one of the most significant environmental treats. The major problems encountered in terms of sustainable land management in these ecosystems are mentioned as the salinity, desertification and drought and soil erosion. However, these problems are defined in different forms in different sources. The result is the same for humans who base their life on agricultural bases. This is the gradual decline of the fertility capacity of the soil. At this point, it is extremely important that the soil, which is one of the main resources for living beings to survive on earth, is sustainable. Today, land resources in terms of soil and water are limited to meet the needs of future generations as we completely depend on these resources. In the world, it is estimated that 12 million hectares of land are degraded annually (corresponding to 23 ha per minute), which corresponds to 20 million tons of grain due to the results of drought and desertification. In the economical aspect, annual cost of land degradation is estimated to be about US$300 billion. This includes losses to both agricultural production and other ecosystem services [3].

To combat land degradation processes, many strategies have been defined by both governments and intergovernmental platforms under several titles such as United Nations Sustainable Development Goals (SDGs), Food and Agriculture Organization of the United Nations (FAO), Global Soil Partnership and Land Degradation Neutral World. In particular, Goal 2 (end hunger), Goal 3 (good health and well-being), Goal 12 (responsible consumption and production) and Goal 15 (life on land) of the Sustainable Development Goals (SDGs) that are planned to be reached for the period covering 2015–2030 include measures and policies related to the use of land and water resources [2]. Of course, the applied agricultural policies have direct and very important effects on land use. The subsidies, incentives and taxes imposed by governments have great implications for which crops are grown and where land is well managed. Inappropriate land management practices applied in marginal areas and fragile ecosystems that are sensitive to climatic, topographic and soil conditions cause the rapid deterioration of land resources. But, land resources are limited and demands for different land-use types especially in the developing countries are greater than the available land resources and these demands become more pressing on natural resources [4]. And so, the only way to protect and sustain soil and water resources from negative effects of erosion, salinity and desertification and other land degradation types in fragile ecosystems is to prepare and enforce appropriate land-use plans. Because of that, sustainable resource management can only be successful if it is based on appropriate land uses. In summary, sustainable promotion of soil and land management is necessary for the provision of healthy food and the environment. Within the scope of this chapter, the aim is to attract attention to land degradation processes in arid and semiarid regions (mostly focused on Turkey's conditions), to analyze the conditions in terms of policy-science interaction by performing situation analysis (SWOT) and develop the effective strategies for sustainable use of land resources under arid and semiarid Turkey conditions.

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2. Definition to the causes and results of land degradation in arid and semiarid regions: current situation in Turkey

As mentioned above, land degradation is one of the major environmental problems worldwide and has become particularly severe in the last decades in Turkey [5]. It causes the significant reduction of the ecosystem functionality with unfavorable effects on biodiversity, desertification and water resource quality [6–9]. FAO [10] figured that the main causes of land degradation are the deforestation, population growth, urban expansion, pollution and waste disposal, climate change and unsustainable land management practices, and their results led to discovering significant problems especially in the arid ecosystems having great water scarcity to survive ecosystem services at the optimal conditions. These problems are defined as biodiversity loss, salinization and sodification, nutrient imbalance, compaction, sealing, pollution, acidification, erosion and loss of soil organic carbon. As a result, water scarcity, food and nutrition insecurity, rapid climate change, poverty and social insecurity, migration and reduction of the ecosystem services are basically affecting our lives.

The rate of land degradation processes is closely related to the interactions between climate, soil, land use and topography. Today, Turkey is classified as degraded in terms of soil according to the degradation map [11]. In this context, it was stated that a large part of Turkey is rated highly susceptible to desertification in terms of climate, soils, topography and land cover status [12], although no region could be classified as "desert" in the country based on the general evaluation of the 1965–2007 period using the Aridity Index [13]. Ninety percent of Turkey's total land area is climatologically classified as arid and semiarid regions; especially, Aksaray, Cihanbeyli, Ereğli (Konya), Iğdır, Karaman, Karapınar, Konya, Nallıhan and Niğde stand out in the semiarid-very arid border. In general, Thrace, Central Anatolia, the interior of the Central Black Sea and eastern Anatolia are regions where arid and semiarid areas spread [13].

Other significant studies related to the long-term variability of climatic conditions over the rainfall regions of Turkey mostly indicated that annual and seasonal precipitation totals have been in the decreasing trends for many stations in Turkey, particularly at those in the Aegean and Mediterranean regions and South-eastern Anatolia and the continental interiors of Turkey that have significant potential to be arid lands in future. And it is estimated that these regions will become more sensitive to desertification in the future with anthropogenic effects such as forest fires, land conversion, urbanization, pollution, etc. [13–20]. Considering the variation of rainfall erosivity values, a trend analysis for the Mediterranean part of Turkey was performed (**Figure 1**) [21]. And, the obtained results showed that rainfall erosivity values statistically increased in the period of 1993–2004. Not surprisingly, increasing rainfall intensities led to increase in flooding and water erosion risk in several parts of Turkey [22, 23]. This situation is not only specific to the Mediterranean region but also to the whole of arid areas. Although there is a decrease in the amount of rainfall with global warming, climate change scenarios state that rainfall intensities in dry areas significantly tend to increase [24]. Another potential threat is the degradation of soil moisture balance and the depletion of groundwater levels throughout the country as a result of reduced winter precipitations [17].

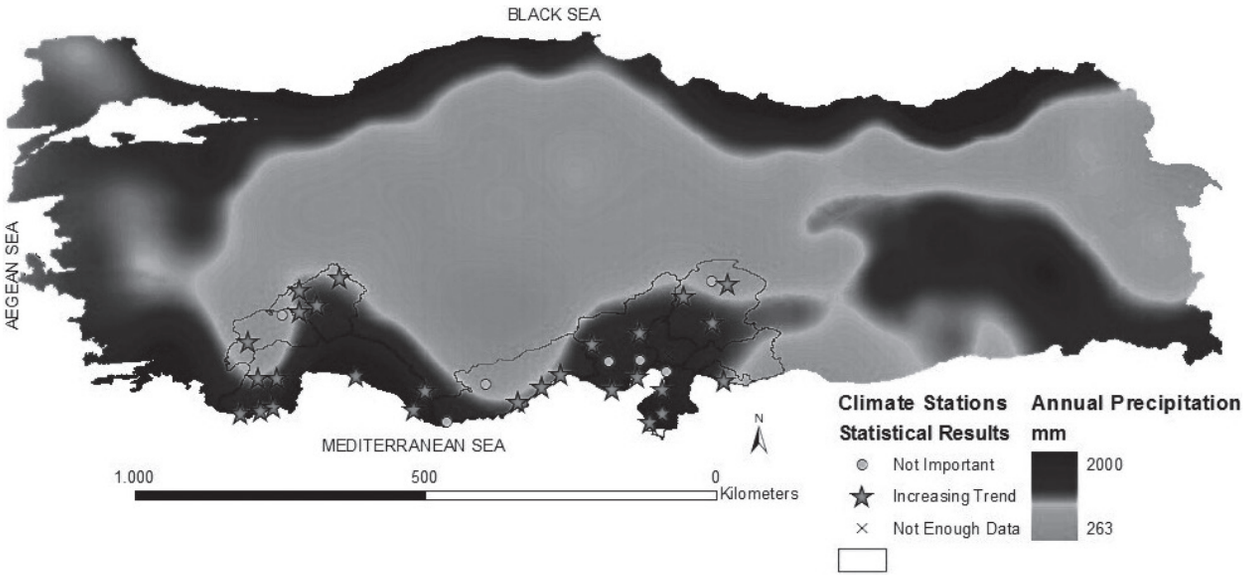

Figure 1. Trend analysis result for rainfall erosivity values in the Mediterranean part of Turkey.

At the basis of all these problems are actually anthropogenic effects. People in fragile ecosystems promote land degradation processes due to land-use conversions by farming in fragile soils and applying poor crop management techniques. And, those facilities have significant effects on salinization and nutrient exploitation in terms of degraded natural soil and water interactions. [25]. Another drastic effect on resource management of land-use transformations in these ecosystems could be mentioned as the mineralization of soil organic carbon (SOC) by cultivation activities. These changes under the Mediterranean climate conditions have been closely examined by various researchers [26–28]. And, the effects of these conversions on land resources, global warming and soil are being discussed frequently in recent times [29]. As reported, three main reasons of the global increase of CO_2 and other greenhouse gas emissions, resulting in global warming, are fossil fuel combustion, cement manufacturing and land-use changes [30]. It is known that the conversion from natural to agricultural ecosystems, tillage and soil degradation with erosion and other processes in the world resulted in a reduction of about 60% of carbon stock in the soil from the beginning of agriculture 10,000 years ago [31–33]. It is an important fact that the effect of agriculture on greenhouse gas emissions is increasing day by day in terms of CO_2 equivalent (**Figure 2**) [34]. In addition to inappropriate mechanization techniques, exploitation of grassland and forest areas in fragile ecosystems, especially for agricultural activities, is triggering this situation.

Soil organic carbon (SOC) is the significant parameter to evaluate land-use conversions' effects on vulnerability of soil erodibility. This unsuitable land-use changes cause the decomposition of aggregates as a result of organic matter being oxidized [5, 35, 36]. In this context, a comprehensive investigation on the effects of changes in land-use type on some soil properties was performed in a Mediterranean plateau and searched for land-use effects for three adjacent land-use types including the cultivated lands, which have been converted from pastures for 12 years, fragmented forests and unaltered pasture lands [29]. Results indicated that cultivation of the pastures caused the degradation of soil physical properties and increased the soil susceptibility to the erosion under the limited soil depth conditions in the southern Mediterranean

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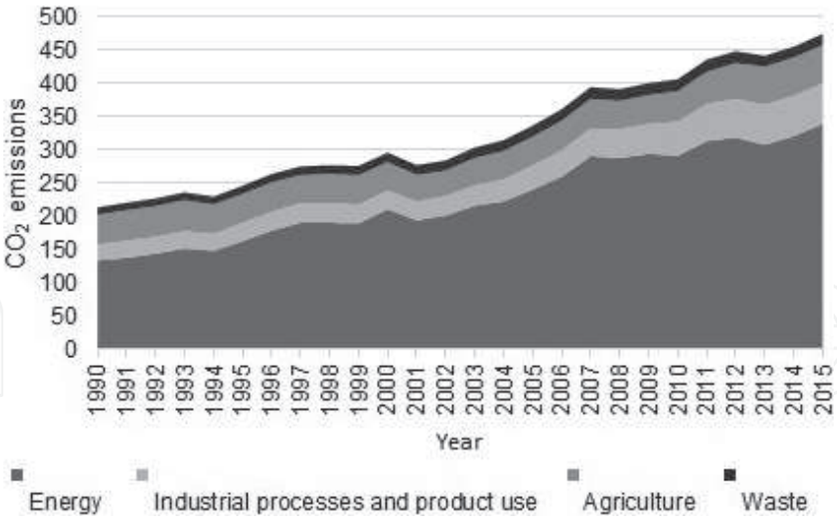

Figure 2. Greenhouse gas emissions according to the sectors in Turkey [34].

highlands [29]. Similarly, land-use transformation effects on soil erodibility in the Central Anatolian conditions were investigated [37]. And, findings showed that soil organic matter content, hydraulic conductivity and soil erodibility value statistically changed with changing land use, and soils of the recreational land and cropland were more sensitive to water erosion than those of the woodland, grassland and plantation usage. More recently, the changes in aggregate-associated and labile soil organic C and N fractions were evaluated after conversion of a natural forest to grassland and cropland in northern Turkey [38]. And, the results showed that long-term conversion of forest to grassland and cropland significantly decreased microbial biomass C, mineralizable C and physically protected soil organic C. Recently, it was reported that 70% of SOM was lost from agricultural soils due to cultivation practices; however, there is no definite information about dehumidification ratios [39]. Moreover, when evaluated in terms of the levels of organic matter in Turkey, it is less than 1% in two-thirds of soils [40–42].

Not surprisingly, the lower organic matter contents make the soil more susceptible to erosive forces in these fragile arid and semiarid ecosystems. In addition to that, considering the topographical conditions, the country generally has a mountainous topography with higher slope degrees and shallower soil profile depth. With 47.98% of the total land having 'steepness of slope' greater than 20% and 62.15% of land, the slope greater than 12% was not suitable for machinery agricultural activities. It also accelerated the soil erosion risk [43]. Today, 16.4 million hectares of the 27.7 million hectares of agricultural land soil erosion is the major problem in Turkey. If an overall assessment of the erosion potentials of Turkey's soil is to be made, it can be said that more than 75% of the land is at risk of erosion at different levels [44, 45]. It was reported that suspended sediment yield was 155 ton y^{-1} km^{-2} or 119 m^3 y^{-1} km^{-2} based on the detailed river observation in Turkey [43, 46], considering that the soil formation rate is naturally 1 mm within 200–400 years [47]. In this way, the soil formation rate was calculated as "0.025 mm y^{-1}, 0.025 m^3 ha^{-1} y^{-1} or 0.0325 ton ha^{-1} y^{-1} if taking into consideration the upper limit of soil formation rate for arid and semiarid conditions of Turkey. Accordingly, the rate of soil loss was estimated approximately 48 times higher than the rate of soil formation in Turkey [43]. It is also well known that for agricultural purposes the breaking of the natural soil formation rates 40 times and for other reasons, such as breaking with up to 100 times more soil losses occurred in worldwide [47, 48].

Other significant problems encountered in arid and semiarid regions in Turkey are drought, salinity and desertification due to lack of precipitation, high evapotranspiration rates and unsuitable land management practices [49]. Today, agricultural sector is one of the most important users of water resources in Turkey. Annually, we are economically using 44 billion cubic meters of 112 billion cubic meters of water resources, and 74% of this water is only being used for agricultural activities [50]. Excessive and unsuitable use of both surface and subsurface waters for agricultural purposes led to significant changes in the quantity and quality of water resources. In the world, 60 million hectares, which account for about 20% of the world's irrigated areas, are facing serious salinity problem. And, more than 50% of these areas are located in India, China, USA and Pakistan. Turkey is also affected by irrigation-derived salinity at considerable levels. Today, 1.5 million hectares of soils have salinity problem due to improper management of irrigation and inadequate drainage in Turkey [2]. As a result of unsustainable agricultural practices, a considerable amount of agricultural land is put out of production each year. This situation results in reducing agricultural productivity and limiting agricultural production areas [49]. Thus, it is estimated that increased salinization of arable land will led to a land loss of 50% in 2050 [51]. At the beginning of the causes that increase the activity of salinity in these regions is the drought. In Turkey, on average, a moderate drought every 6 years and a most severe drought every 18 years are observed. For this reason, World Meteorological Organization (WMO) listed Turkey among the 76 countries that have the risk of drought [50, 52].

According to the drought predictions, the tendency of meteorological drought in our country to turn into agricultural drought is rather high [53]. This is in our country that uses 74% of total water for agricultural purposes; the fact that agricultural drought is one of the most important limiting factors for the agriculture sector in terms of having enough moisture in the soil during the plant development periods for agricultural production [50]. According to the 2020, 2050 and 2080 projections in Turkey, a decrease in production rates of the grains such as wheat, barley, rye and oat by 4.9, 8.3 and 13.8 per percent, respectively, due to climate change and drought is estimated [54]. Considering that 80% of the 24 million hectares of agricultural land is rainfed, it is clear that if necessary measures are not taken, agricultural production will be adversely affected in the future from the climate change processes. As a result, the sustainability of land resources in semiarid and arid ecosystems, such as Turkey that has high sensitivity to land degradation in terms of climate, soil and topographic conditions, is directly related to the effective implementation of sustainable land management practices. And, it can be achieved on the condition that the science-policy interface is actively formed.

3. Measures and strategies at a national scale and its potential and actual effects on sustainability

Successful land resource management requires action to be taken at the level of individuals, governments and even intergovernmental organizations. In this context, sustainability of the collaboration and interactions in the science-policy interface, improvement of the existing sources of information in terms of databases of land resources and the adaptation of the legal

regulations under the sustainable land management approach are significant issues to reach the desired targets.

Related to the subject, revised soil charter [55] defined the responsibilities under the three main groups, which are individuals and private organizations, government and intergovernmental organizations, to overcome degradation process and build restoration of degraded areas. The success of national scale works related to land resource sustainability is closely linked to the actions and strategies that governments will implement. For that, 10 significant actions to be realized by governments are defined [55]. Among them, the last three actions (VIII, IX and X) emphasize the need to develop the land and soil information systems to combat climate change and land degradation processes in terms of sustainability of land resources effectively.

To more effectively and sustainably combat desertification and erosion throughout Turkey, both national and international projects have to been seriously implemented. National Soil Erosion Map by USLE/RUSLE algorithm (Universal Soil Loss Equation – Revised Universal Soil Loss Equation) [56] is one of the most important attempts by General Directorate of Combating Desertification and Erosion bureau. In this context, constantly updated 'Erosion Monitoring System' is preparing for monitoring studies and creating data archive in the web [57]. It is aimed to gather available information throughout the country related to applied or planned soil conservation practices. It is supported with web-available system for applying different scenarios to estimate its effects on soil loss ratios [12]. Another important monitoring system is created for the problem of desertification. For that, a risk map has been established by determining the vulnerability classes of desertification-sensitive arid and semiarid lands of Turkey [57]. Studies at national scale are also being conducted in the same way to evaluate the risk of wind erosion and take effective precautions against to it.

In addition to this, considerable steps have been taken with the efforts to increase the presence of forests and the improvement of the existence of damaged forests. Over the last 37 years, total forest area has increased by 1.3 million hectares with afforestation projects. For future projections, it is aimed to increase the total forest area from 27 to 30% by 2023 by Ministry of Forestry and Water Affairs. Afforestation of degraded soils by converting into forests or other perennial land uses has a large potential of soil organic carbon sequestration. It will enhance the carbon accumulation in soil organic matter [32].

Other significant projects on management of limited land resources in Turkey are related to watershed managements, soil and water resource monitoring facilities, drought, desertification, snowslide, flood and landslide control and monitoring systems, rehabilitation of degraded areas in the context of Land Degradation Neutrality approach have been progressed by Ministry of Forestry and Water Affairs.

The Ministry of Food, Agriculture and Livestock, which is also responsible for combating climate change in Turkey, has various projects, strategies and policies related to agriculture as follows [58–61]:

- *Land Consolidation Strategy* aims to increase the efficiency and reduce the energy usage by reaching the optimum size of the enterprises. In Turkey, 5.1 million hectares of land

consolidation work have been completed, and it is continuing at 1.9 million hectares area by the end of 2015. Land consolidation studies for 14 million hectares of land are planned to be completed by 2023.

- *Organic Farming Activities* aim to increase soil fertility in natural terms in the long term considering ecological conditions, to prevent soil and genetic resource erosion, to protect water quantity and quality, to use renewable energy resources and to help save energy.
- *Good Agricultural Practices* aim to ensure that agricultural production is done for sustaining the environment, human and animal health, protection of natural resources, supplying the traceability and sustainability in the ecosystem.
- Environmentally Protected Agricultural Land Conservation Program (ÇATAK) aims to give support payments for farmers who prefer ecofriendly agricultural techniques and cultural practices. Grant support is provided for the conversion of in-field irrigation systems to closed and pressurized systems within the framework of the Program for Supporting Modern Irrigation Methods to Support Water Saving and the Support Program for Rural Development Investments.
- *Drought Management* supports Agricultural Drought Provincial Crisis Centers in 81 cities that were established and the provincial agricultural drought strategies and action plans for the years 2013–2017 were prepared and put into effect in order to reduce the expected drought more frequently due to climate change.
- *Agricultural Insurance Applications* are being done for floods, hurricanes, etc., which are increasing in number due to climate changes. They aim to compensate for the risks arising from meteorological disasters. Through the Risk Management strategy in agriculture, it is aimed to ensure the sustainability of production by ensuring the products of the producers exposed to such risks.

And several agricultural Research & Development studies pursue to reduce the energy use in agriculture, sustainable resource use, development and improvement of drought-tolerant plants, improvement of methods and tools in irrigated areas in dry periods and development of land processing methods and tools providing carbon capture in the soil. The others related to some information technologies carried out in our country within the scope of action plans to be taken by governments are "land use land use conversion and forest (LULUCF)," "determination of the problematic agricultural areas," "agricultural monitoring and information system project (TARBİL)," "farming registration system" and "rural database project." All of these projects aim at the formation and development of reliable information systems related to soil and land-use strategies.

Recently, the significant project that stands out in crop/soil management is the "National Agriculture Project" that has been started by the Ministry of Food, Agriculture and Livestock in 2017. Its original aim is to promote sustainable agriculture by considering the existing ecological and economic conditions and the needs of Turkey. In this context, 21 products that are important in terms of human nutrition, health and animal production, which are strategically and locally important in our country (wheat, barley, rye, rice, Dane corn, triticale, oats, lentils, chickpeas, dry beans, cotton, soybean, oil sunflower, canola, Aspir, tea, hazelnut, olive oil,

potatoes, onion and forage plants), will be supported on 941 agricultural areas and planned production will be passed. To define the supported product on a specific area, a decision support system has been established that includes more than 1 billion data taking into consideration long-term output statistics, the crop rotation, climate, soil and topography conditions, water restriction data (current water potential and vegetation water consumption), present legal regulations on soil conservation and public and academic proposals. Within the scope of this project, "fertilizer usage guidelines" was prepared for total 941 agricultural basins to prevent from being contaminated with excessive fertilization and increased productivity. And, 211 large plains have been identified and their boundaries have been determined in order to ensure effective protection of agricultural land. It is planned that these 211 large agricultural basins will be declared as a protected area by the decision of the Council of Ministers and protected effectively. New arrangements have been made in order to bring unused agricultural lands for various reasons (property issue, immigration, abandonment of farming, etc.) to agricultural production and the economy of the country. Irrigation and land consolidation projects will be applied in the scope of this project. Thus, it is aimed at increasing the production capacities of the soil by adaptation of modern production/irrigation techniques within the soil and water resource conversation approach.

However, discussions about the legal, technical, socioeconomic and environmental dimensions of sustainable land and soil management in Turkey clearly showed that land-use planning for industrialization, urbanization, transportation and tourism, etc., with the contribution of the gaps in the legal regulations creates a serious pressure on our land resources, the soil functions are deteriorated and it causes the subsurface and above-ground ecosystem services to disappear. In particular, the concept of "public good" in the law on soil conservation and land use has been brought to lead to the use of an instrument for the conversion of qualified agricultural lands to another uses.

In addition, databases already used in land-use plans have lost their validity. There is an increasing demand for detailed soil surveys in Turkey by scientists and technicians working on projects of sustainable soil and water management. Soil classes should be updated. It was produced within the 1938 Soil taxonomy named as the old American classification system [62], and semidetailed maps made 30 years ago need to be updated nationwide at 1/25: 000 scale to meet today's needs. The information-based land-use planning period, which includes soil series and important phases, should be urgently passed. A more systematic case assessment on land resource sustainability in Turkey is shared below with the help of SWOT analysis.

4. Situation analysis, SWOT: soil and water resources and sustainability in Turkey

Strengths, Weaknesses, Opportunities And Threats (SWOT) analysis is defined as the strategic planning method used to summarize the key elements of your strategic environments [63]. In fact, it is thought as the first step in the strategic planning and it helps planners to identify the strategies of achieving goals by concentrating on the key subjects [64]. The SWOT analysis matrix was explained by [65] as shown in **Table 1**. Where the questions are to be asked in the analysis to reach the planned targets are expressed clearly.

	Strengths	Weaknesses
Opportunities	How do I use these strengths to take advantage of these opportunities?	How do I overcome the weaknesses that prevent me from taking advantage of these opportunities?
Threats	How do I use my strengths to reduce the impact of threats?	How do I address the weaknesses that will make these threats a reality?

Table 1. SWOT analysis matrix [65].

The method, commonly used for several business enterprises, has recently been widely used in sustainable planning of environmental resources in terms of changing demands and declining resources. For example, it was used to assess the rural tourism potential in Turkey [66]. Groundwater resource potentials were also evaluated in the Zakynthos Island in terms of sustainability with the help of SWOT analysis technique [67]. In addition, for more appropriate conservation and utilization of natural resource, this analysis technique could significantly be

Objective: strengths, weaknesses, opportunities and threats (SWOT) analysis for "land resources and sustainability in Turkey"			
External factors		**Internal factors**	
Strengths (S)	**Weaknesses (W)**	**Opportunities (O)**	**Threats (T)**
S_1: Abundance of natural resources all over the country compared to the most severe arid regions in the World S_2: The existence of legal regulations, e.g., laws and regulations related to the soil and water protection, land-use planning, natural resource protection and rural development S_3: The existence of action plans to combat erosion, climate change, desertification and protect biodiversity S_4: Adopt and approve all international conventions of environmental and biological diversity by governmental and public organizations S_5: The existence of strong academicals, technical and administrative infrastructure	W_1: Sensitivity for climate change and land degradation processes in terms of severe soil erosion, salinization, drought and desertification rates especially in semiarid and arid regions W_2: The shortcomings of the law and governmental regulations for sustainable land management strategies W_3: Lack of reliable data on soil and water resources to protect the sustainable use of these resources W_4: Increasing pollution rates of soil and water resources due to agricultural, industrial activities and energy requirements W_5: Unprevented land conversions due to political pressures and gaps in the legal regulations W_6: Lack of coordination and integration efforts between public, academic, private, governmental and nongovernmental organizations for sustainable planning of natural and human resources	O_1: A very young farmer population that can better understand and accept environmental issues O_2: Increased supports for farmers who especially implant the best management practices O_3: Opportunities to access the international funds for environmental protection O_4: Increasing public interest for the nature-friendly production methods O_5: The development of nature-friendly new production technologies O_6: The development of existing policies based on the protection-use balance with the aid of contribution of new information technologies due to the necessity of harmonization process in the EU and international obligations	T_1: Predictions that the temperatures will increase and the irregularities in the precipitation regimes T_2: The risk of deterioration in soil quality due to the applied national agricultural policies T_3: The risk of increasing anthropogenic pressures on land resources T_4: The possible environmental risks to be encountered in the absence of science-policy coordination in legal regulations T_5: Placement of the perception that the unsuitable land conversions can be made to provide energy production and raw material T_6: Increase in immigration rates and social-economic and cultural problems caused by the reduction of natural resources

Objective: strengths, weaknesses, opportunities and threats (SWOT) analysis for "land resources and sustainability in Turkey"			
External factors		**Internal factors**	
Strengths (S)	**Weaknesses (W)**	**Opportunities (O)**	**Threats (T)**
Strategies (WT)			
WT_1: Reforming environmental, agricultural and industrial policies to establish sustainable resource use			
WT_2: Updating databases used in monitoring climate change and land degradation processes			
WT_3: Preparing updated land-use plans in accordance with the needs of the ecosystem, taking into account the science-policy balance			
WT_4: Planning and implementing research, experiments and extension studies related to the defining suitable land-use types for the ecological conditions of the selected region			
WT_5: The application of dissuasive punishment to land users exceeding pollutant limit values by periodically measuring the runoffs in terms of transported sediment-associated pollutants and water quality in the microwatershed scale			
WT_6: Supplying an acceptable level of farm income by reducing income variability for reducing the pressure on especially marginal lands			

Table 2. SWOT analysis for soil and water resources and sustainability in Turkey.

used [68] for village planning. Similarly, significant strategies were proposed for sustainable farming system management based on farmers' needs by conducting SWOT analysis in rural areas of Shadervan district, Shouahtar Township, Iran [64]. Under the fragile arid and semiarid climate conditions, it is vital to make strategic planning to manage land resources in sustainable manner. As a first step for long-term effective planning in Turkey conditions, SWOT analysis was performed to draw the situation including the strengths, weaknesses, opportunities and threats as the internal and external effects on developing strategies on sustainability as given in **Table 2**.

5. Strategies to maintain the conservation-utilization balance for sustainability in arid regions

In light of the performed SWOT analysis for "Land resources and Sustainability in Turkey," six threats and six weaknesses were identified, and to overcome their effects, six significant strategies were recommended as outlined below.

5.1. Strategy WT_1

Unfortunately, it has been assessed that the soil and water resources in our country cannot be protected by effective and comprehensive legislation. And so, reforms are needed in the existing legislation, taking into account the conservation-use balance in relation to the protection of natural resources [$W_{2\text{-}5} - T_{2\text{-}4\text{-}6}$].

5.2. Strategy WT_2

National scale studies such as monitoring and assessments of soil degradation types, e.g., desertification, erosion and effects of climate change and global warming on sustainable land

management have been largely based on unreliable datasets, and so, they need to be updated for effective planning and monitoring of land resources. In order to do that, comprehensive soil survey and mapping studies should be carried out. In addition, species especially in arid regions should be identified for preventing biodiversity losses, and necessary measures should be taken for sustainability [$W_{1-3} - T_{1-6}$].

5.3. Strategy WT_3

It should be followed after the activities specified in Strategy 2. It is very important to keep up the conservation-use balance in the land-use plan, which is prepared with updated data. But, land-use planning in practice should be an integral part due to that land-use planning only for agricultural purposes is not sufficient for solving problems. District and regional planning and then land-use planning at the entire country level should be done. In the planning phase, it is necessary to include specialists working in the fields of law, economics and society, and landowners in order to effectively implement the plans besides natural resource specialists on the planning team [$W_{5-6} - T_{2-3-5-6}$].

5.4. Strategy WT_4

It suggests that research and experiments should be carried out to find most suitable land-use types in the region that are planned to be proposed primarily in land-use plans and that the results obtained in the determination of region specific uses should be objectively introduced to the people of the region and should be tested for validity of suitability by taking into account long-term forecasts and forecasts of climate change and the sensitivity of land resources to these changes. Unintended use of agricultural areas should be prevented. For that, breakup of agricultural lands, especially nonagricultural use of irrigated agricultural land, and agriculture in unfavorable agricultural land will be prevented and land consolidation services will be accelerated [$W_1 - T_{1-6}$].

5.5. Strategy WT_5

Various pollutants sourced by industrial facilities or excessive consumption of fertilizers or chemicals have the ability of easily transporting in the soil-water air cycle and affecting the ecosystem services negatively. In this context, it is proposed to establish mobile-test centers throughout the country to monitor pollution in soil and water resources and to apply effective punishments to those within the basin scale where limit values are exceeded as a result of periodically planned measurements. And, spread of the good agricultural practice techniques, establishment of modern irrigation and drainage systems in order to prevent soil salinization, planning and implementation of budgeting for drought and salinity-resistant species determination studies and identification of potential rehabilitation sites should be performed especially in the degraded arid and semiarid areas of Turkey. Proper fertilization and soil conservation strategies must be introduced. The content of soil organic matter in arid and semiarid regions should be increased with the use of animal fertilizers together with the application of stubble and green fertilizer usage techniques. Cultural and technical

measures (such as fertilization, seeding and soil and water conservation measures) must be taken with pasture management to protect natural grassland areas where rainfall is insufficient or unevenly distributed. In areas having higher potential for rehabilitation, measures to prevent land degradation should be planned and enforced. Biological fighting methods should be preferred in combating harm [$W_{4\text{-}5\text{-}6} - T_{2\text{-}3}$].

5.6. Strategy WT_6

The topographic and climatic conditions of Turkey limit the width of the suitable land in rural areas. Besides, the land is very fragmented in the way of inheritance, which leads farmers to use marginal lands for agricultural facilities, and it causes the land degradation process in terms of deforestation, land conversions, etc. These activities shortly give irreversible damage to areas where high slopes, shallow soil profiles and inadequate vegetation coverage are the key properties for degradation. For this reason, it is extremely important to supply an acceptable level of farm income to the farmers. In this context, rural development must be realized in agriculture. For that, agricultural income should be increased steadily, the standard of living should be increased and resources should be used more effectively and economically. Thus, the way to be followed is the regional planning of production patterns with high profit margins based on the conservation-use balance of natural resources in order to reduce the pressure on land resources considerably [$W_6 - T_{3\text{-}6}$].

6. Conclusion

In Turkey, the effects of land degradation are considered to be mostly experienced in the inner and central Anatolia regions where the arid and semiarid areas dominate. Intensive deforestation, industrialization and rapid population growth in coastal regions have been defined as the significant threats for accelerating the impacts of climate change throughout the country and limiting the sustainability of natural resources with the aid of topographical and climatic insufficiencies. In this context, first, current situation of land degradation processes and its causes and results in Turkey were discussed and then the measures and strategies enforced in the national scale were summarized. Under the light of current situation, SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis was performed to recommend the strategies for overcoming the weakness and possible treats on sustainable land resource management. These strategies were mainly explained under the headings of deficiencies in legal regulations in Turkey: the necessity of making comprehensive land-use plans not only at the agricultural purposes but also at the regional and national scale, renewal of insufficient and unreliable databases of natural resources in terms of monitoring land degradation and climate change processes, supplying of the coordination and integration among governmental, academic, private, nongovernmental organizations and land users and dissemination of environmentally sound management practices. Finally, it is concluded that sustainable resource management must be ecologically, economically, politically and socially integrated in fragile ecosystems such as Turkey.

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