

Suggestions on Preventing Deforestation and Erosion due to Global Climate Change in Türkiye

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Abstract: The rapid increase in the world's population from the past to the present has led to an increase in the demand for natural resources, resulting in the deterioration of the forest ecosystem and the emergence of many problems such as global warming. During this period, the changes brought by the industrial revolution have caused an increase in the amount of carbon dioxide (CO₂) released into the atmosphere by adversely affecting the ecological balance. The role of forest ecosystems will increase in order to eliminate the negativities caused by the continuous increase in the amount of carbon dioxide (CO₂) in the atmosphere and climate change. Within terrestrial ecosystems, soil and vegetation hold and store carbon. Forests, meadows, pastures and agricultural areas constitute the part kept in vegetation. Some of the most important factors affecting the amount and duration of carbon sequestered in terrestrial ecosystems are climate, vegetation type, soil properties, erosion, bedrock and land use changes. As a matter of fact, these changes in land use have triggered desertification, dryness and erosion along with soil losses. In particular, soils transported by erosion are a great loss for nature and cause disruption of the ecological balance. Therefore, in order to maintain this balance, the natural species in the region should be protected and a forest ecosystem consisting of natural species should be created. In this case, we need to understand forest ecosystems very well and to correctly identify the silvicultural interventions that can be applied. In this study, it was aimed to create a road map for silvicultural interventions that can be applied by evaluating carbon losses in areas where desertification, drought and erosion occur in Türkiye. In addition, in line with this road map, general recommendations that are thought to be useful in preventing and combating carbon losses are given.

Keywords: Carbon sequestration, Carbon storage, Erosion, Desertification, Drought, Forest ecosystem, Silviculture.

1. INTRODUCTION

Soil, which constitutes the top and thinnest layer of the earth's surface (Mutlu et al., 2021), is used by humans as production material. In fact, soil is defined as a dynamic entity in terrestrial ecosystems that contains a wide range of living organisms, contains a certain amount of water and air, lives and sustains (Celilov & Dengiz, 2019; Ünal, 2011). In particular, soil is one of the most important carbon sequestrators of terrestrial ecosystems. The largest reserves of terrestrial carbon are found in soil. Therefore, organic carbon is stored under the soil for a long time (Yılmaz & Dengiz, 2021). However, soil is constantly undergoing erosion, transportation and accumulation processes under the influence of different edaphic and ecological conditions (Yalçınkaya et al., 2022; Görcelioğlu, 1976). The situations in which these processes occur are defined as erosion (Karaoğlu, 2016). As a matter of fact, erosion is the phenomenon of transportation and accumulation of soil particles to another place by natural factors such as water and wind (Issaka & Ashraf, 2017; Aykır & Fıçıcı, 2022).

Erosion is increasing as a result of factors such as destruction of natural vegetation, industrialization, urbanization, improper land use, climate change and overuse of pastures (Ikiel et al., 2020). In addition, the rapidly increasing human population in recent years has deteriorated the quality and natural regulatory properties of soil, water and air resources. This situation causes land degradation and desertification in nature, which has a dynamic and complex structure (Dengiz et al., 2023). Desertification is defined as land degradation that causes almost irreversible loss of biological productivity in arid and semi-arid regions (Mutlu et al., 2013; ÇEM, 2013a). Drought, on the other hand, is a natural phenomenon in

which significant hydrological imbalances occur when precipitation is below normal levels and/or irregular, and consequently the natural productivity of land is adversely affected.

Türkiye's topographical structure, climate, geographical location, soil characteristics, erosion and changes in land use affect the amount and duration of carbon. Especially with the effect of climate change, the ecological balance is adversely affected and the amount of carbon dioxide released into the atmosphere increases. The role of forest ecosystems will increase in order to eliminate the negativities caused by the continuous increase in the amount of carbon dioxide (CO₂) in the atmosphere and climate change. One of the most effective ways to prevent these negativities is to ensure that carbon remains in the "soil". Combating desertification, halting biodiversity loss and stabilizing land degradation are considered as critical steps for carbon to be stored in the soil.

Türkiye, which is located in an arid and semi-arid climate zone and faces serious desertification and erosion problems, should determine comprehensive policies and strategies on soil conservation, development of soil resources, combating desertification and erosion, avalanche and landslide control, afforestation, elimination of salinization, and implement them with a large number of projects. This study aims to create a road map for silvicultural interventions that can be applied by evaluating carbon losses in areas where desertification, drought and erosion occur in Türkiye.

2. EROSION PREVENTION STUDIES IN TÜRKİYE

Türkiye is one of the countries in the world where the severity of erosion is high (Balabanlı et al., 2005). The most important reason for this is that it has high and rugged terrain in terms of landforms (Hatipoğlu, 2020; Tunç & Schröder, 2010). Especially with the increase in anthropogenic impacts, the severity of erosion increases. Erosion severity is directly proportional to the slope of the land (Özşahin, 2011; Kanar & Dengiz, 2015; Aykır & Fıçıcı, 2022).

With erosion, the organic matter in the soil is transported (Cebel & Akgül, 2011). As a result, soil fertility decreases. The lifespan of dams is shortened with the transported soil, floods and overflows occur. For this reason, erosion control measures should be taken against erosion problems. In Türkiye, a number of measures have been taken since 1946 to protect soil fertility and prevent erosion (ÇEM, 2013b). These are;

- Afforestation and erosion control works
- Rehabilitation of degraded forest areas
- Rehabilitation of pasture areas.

Until the end of 2012, afforestation activities were carried out on 1,070,435 hectares for erosion control in Türkiye. In addition, afforestation works have been carried out on 2 million 420 thousand hectares of land through watershed rehabilitation projects, increasing forest areas and erosion control works carried out in recent years (ÇEM, 2013b).

However, some institutions and organizations in Türkiye have carried out successful studies on erosion prevention. Today, these efforts have prevented erosion, but artificial forests have been established because plant species suitable for the existing ecosystem were not selected (ÇEM, 2005). These are:

- Windbreaks in Konya Karapınar region (Figure 1)
- Watershed Rehabilitation Studies in Eastern Anatolia Region
- Adana Akyatan-Ağyatan Dune Afforestation Works (Figure 2).

The most important erosion study carried out in Türkiye is the Wind Erosion Risk Assessment study in Konya and Karapınar district with the Renewed Wind Erosion Equation at Regional Scale (YREE/RWEQ) supported by TÜBİTAK (Erpul et al. 2012). The importance of this study is that it is the first systematic regional wind erosion study conducted in our country. The findings obtained from this study have provided extremely important data and approaches for basin and regional scale erosion studies.



Figure 1. Konya Karapınar Dune afforestation area (Çat, 2021).



Figure 2. Adana Akyatan Dune afforestation area (T. C. Çevre, Şehircilik ve İklim Değişikliği Bakanlığı, n.d.).

The General Directorate of Forestry carried out a study in the Adana Akyatan sand dune area starting in 1972 and ending in 1985. First of all, non-living windbreaks (reed, oleander, myrtle plants) were created to prevent wind erosion. After the dunes were stabilized, Cypriot acacia was planted in the area, eucalyptus, pistachio pine, coastal pine, and individually mountain cypress and acacia were planted on the plains called warehouses. As a result, wind erosion was prevented and a productive forest plant was established (T.C. Orman Genel Müdürlüğü, n.d.).

Yılmaz and Gül (2012) stated that natural pasture areas should be reclaimed in his study conducted in Çankırı region. He suggested the use of plant species suitable for the region within the scope of reclamation measures. In order for these areas to be used as pasture, he suggested that they should be reclaimed from species belonging to the families Wheataceae (Gramineae), Leguminosae (Leguminosae), Chenopodiace, Compositae, Solanaceae, Euphorbiaceae, Scrophulariaceae.

In the study conducted by Göktürk et al. (2004) in Artvin-Çoruh Valley, soil erosion has reached serious dimensions. In order to ensure the continuity of soil and vegetation cover, afforestation works on an average of 380.8 ha and erosion control works on 1009.2 ha were planned between 1992-2003. As a result of the study, 35.4% and 104.5% of these were realized.

In his study, Pekal (2009) evaluated the afforestation activities carried out for erosion control purposes in Sümbüllü and Salkımlı regions in the Çoruh valley of Artvin Province. In Salkımlı and Sümbüllü regions, experimental studies were carried out in the planting of pistachio pine seedlings (1+0 years old), Taurus cedar seedlings (1+0 years old) and bare-rooted false acacia seedlings (1+0 years old). As a result of the study, it was envisaged to use species such as oak, hawthorn, blackthorn, cotoneaster and wigwam, which grow naturally in the Artvin region, in the afforestations where erosion control is carried out.

Yalçinkaya et al. (2022) carried out an erosion control study with afforestation in the Atatürk Dam basin. In 2053.93 ha area, the afforestation area was given protection status. Within the scope of afforestation, ground cover plants were used as well as pine species. As a result of the study, they determined that ground cover plants should not be used due to possible forest fires and single species plantations should be included.

Kaba (2019) evaluated 431,200 false acacia saplings, 94,860 common birch saplings, 65,370 spindle saplings and 157,300 yellow pine saplings planted between 2012-2014 in the afforestation study conducted for erosion control in Ağrı Province. As a result of the evaluation, he stated that the use of species such as rosehip, hawthorn, maple, poplar and willow in afforestation works for erosion control will ensure the continuity of the genetic diversity and populations of these species.

3. DESERTIFICATION AND DROUGHT PREVENTION STUDIES IN TÜRKİYE

Türkiye's geographical location, topography, climate and soil conditions increase the impact of drought and desertification. Drought and desertification, especially with the impact of climate change, is one of the most important global and regional environmental issues that must be taken seriously (Türkeş, 2012a). The damages caused by the factors that constitute desertification are not seen in our country. However, in Türkiye, situations such as desertification in agricultural lands, degradation of species diversity in forest areas, wrong land uses, destruction of pasture areas will increase the risk of desertification and drought with the effect of climate change. In this context, many local, regional, national and international studies are being carried out in Türkiye to combat desertification and mitigate the effects of drought.

In his study, Türkeş (2012b) made evaluations and recommendations according to Türkiye's tendency to be affected by desertification and drought. These recommendations are

- Türkiye has insufficient water resources in terms of its climate characteristics. For this reason, he emphasized that water policies should be established to increase water resources in order to prevent drought.
- The impact of aridification should be reduced by preventing forest fires.
- Water resources in Türkiye and their potential impacts on drought and desertification should be continuously monitored and evaluated.
- Considering that forests are carbon sinks, the principle of sustainable forestry should be adopted.

Gül et al. (2019) carried out afforestation works to prevent desertification in arid and semi-arid areas. In the study area, the desertification risk ranged between 1.69 (low risk) and 4.87 (medium risk) in the parts where afforestation works were carried out between 1998-2008, and between 2.07 (low risk) and 5.25 (medium risk) in the parts where afforestation works were carried out between 2009-2015. As a result of the study, it was stated that desertification risk values will be minimized by protecting and increasing herbaceous and woody plants.

In order to monitor desertification, the Ministry of Forestry and Water Affairs and the General Directorate of Combating Desertification and Erosion (GDEM) developed the Basin Monitoring and Evaluation System (HDIS). With this system, a GIS-based desertification model was created and Türkiye Desertification Risk Map was made (Dengiz & Oztas, 2020) (Figure 3).

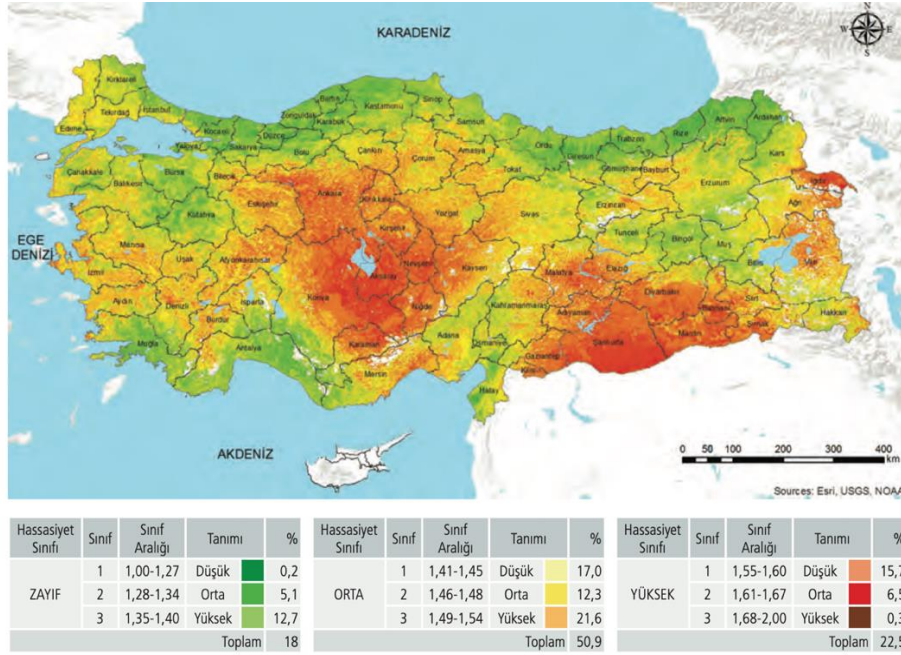


Figure 3. Desertification Risk Map of Türkiye (ÇEM, 2019).

Since 1946, Türkiye has carried out many successful efforts to combat desertification, erosion and drought (ÇEM, 2019). In this context;

- 8.9 million hectares of afforestation and erosion control work as of the end of 2018
- Rehabilitation of 2,899,912 hectares of degraded areas in the period 1998-2016,
- In the period 1962-2018, pasture improvement activities were carried out on 250,443 hectares.

In order for Türkiye to combat and successfully manage drought, desertification and erosion, it is necessary to formulate the necessary strategies and strengthen the capacities of relevant institutions.

4. CONCLUSION

Forest ecosystems are important components of global climate change and carbon exchange in the atmosphere. As it is known, forests play an important role in mitigating the impact of climate change by sequestering carbon as they are potentially net carbon sinks. In this study, carbon losses in areas where desertification, drought and erosion occur in Türkiye were evaluated and a road map was created for silvicultural interventions that can be applied. In addition, in line with this road map, general recommendations that are thought to be useful in preventing and combating carbon losses are given. These recommendations are

- In Türkiye, billions of tons of soil are transported by water and soil erosion. The amount of organic carbon in these eroded soils is also decreasing. Therefore, carbon pools need to be expanded.
- Silvicultural interventions such as afforestation of vacant and open areas and rehabilitation of hollow closed areas will directly expand carbon pools.
- Silvicultural interventions should be carried out in a timely manner and in accordance with its nature.
- Reforestation of hollow closed forest areas and forest openings should be accelerated. This strategy is at the forefront of all strategies, mainly because it implies a net increase in carbon.
- In areas with erosion, desertification and drought, natural species should be protected and a forest ecosystem consisting of natural species should be created.

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