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In which biome is the most degradation happening? The case of croplands, rangelands, forests, and irrigation water in Tunisia

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Abstract

This study estimated the quantities and monetary values of ecosystem services (ESS) lost due to in/inadequate action to control agricultural resource degradation in Tunisia. We used a combination of GIS, remote sensing, and data from publications and official statistics to generate estimates of total and percentage of crop lands, rangelands, and forests falling in one of three (low, moderate, and severe) degradation classes and the corresponding biomass yield (ton/ha). We used a combination of market and non-market valuation methods to estimate the value of ESS lost due to inaction. The estimates are provided for each biome x province combination.

Using extremely conservative assumptions, we estimated that in/inadequate action is causing Tunisia to lose at least 1.97 million tons of potential production of different food crops, 209 thousand tons of forest biomass, and 2.5 million tons of forage from rangelands, and at least 736 million cubic meters of irrigation water annually. In addition, Tunisia is losing at least 141.68 million tons of soil which is also associated with the release of at least 779 thousand tons of carbon into the atmosphere. Rangelands constitute 73.51% of the total national soil erosion out of which 67.7% is happening in the five Southern provinces where erosion rates as high as 52t/ha are recorded.

The monetary value of all the ecosystem services that Tunisia is losing annually in all biomes is estimated to be at least $2.17 billion (4.65% of GDP). The main cost of in/inadequate action in the country in monetary terms is related to crop lands which constitute 53.98% of this loss followed by irrigation water, and rangelands which contribute 28.19% and 12.09% of total cost of inaction, respectively. These estimates have generated much discussion among high officials in Tunisia on the need to solicit funds to control land degradation, especially in rangelands.

Introduction

Desertification induced by land degradation affects most of the dryland areas of the Tunisia and has the knock-on effect of contributing to climate change by releasing soil carbon into the atmosphere. The drylands of Tunisia, which are already challenging areas for food production are also experiencing loss of biodiversity and ecosystem services that support agrifood systems (Rosendahl, 2022). The impacts of degradation of agricultural resources in Tunisia is evident not only in terms of the growing difficulty for farmers to produce food, but also in terms of the

growing gap between food demand and supply, leading to the country's growing dependence on imports, as well as the consistently increasing food prices which historically even led to popular uprisings. Loss of land productivity due to desertification and weather shocks is also a contributing factor to food and feed shortage and conflicts which are the major causes of forced migration of people, predominantly the youth, from dryland areas. Left unchecked, these challenges are expected to increase with time and put the inhabitants, particularly the farming communities, at greater risk.

Few studies were carried out in the past to estimate the extent and monetary value of resource degradation in the country. For example, a World Bank study covering all sectors (including agriculture, tourism, manufacturing, and transport) estimated the cost of environmental degradation in Tunisia in 1999 to be 2.1% of GDP (Sarraf et al., 2004). Another study was also conducted only for the Medninne province (Sghaier and Belgacem, 2011) which estimated the cost of land degradation in the province to be 36.4 million Tunisian Dinars. A more recent study (GIZ, 2023) covering the provinces of Béja, Siliana, Kairouan, and Kasserine (representing about 14% of the total national area) estimated that, at discount factors of 7% and 10%, every dollar invested to control land degradation will bring back 14 and 12 dollars, respectively – indicating that combating land degradation is not only a worthy effort in terms of its environmental benefits, but also a financially viable endeavour. On a positive note, Daly-Hassen (2017) reported that the country has made good progress in carrying out afforestation in many parts of the country leading to positive outcomes.

All the past studies are either old and hence less relevant, limited in terms of their geographic and agricultural biome coverage, and are lumpsum with no disaggregation by province and biome – making them less useful for policy makers. This study aimed at providing credible estimates of the costs of inaction in terms of the quantities and values of ecosystem services lost due to failure to intervene to control land degradation. The study covered the whole country, with disaggregation at provincial levels, and included the four main agricultural biomes, namely, crop lands, rangelands, forests, and water.

Methods

Most economic valuations of land degradation are based on comparisons with a counterfactual that refers to a scenario with no-land degradation. This implicitly assumes that after the interventions, land will be restored to 100% of its potential (Quillérou et al., 2016). We argue that these assumptions are not realistic as it is difficult, if not impossible, to know the land attributes if degradation would not have taken place (the counterfactual). Interventions may not restore land to its original state and, hence, the benefits of action and the costs of inaction may be overestimated.

In this study, we follow Gregersen et al. (1995) to classify the total value of land resource into two broad categories: Use and non-use values. Use values are further classified into direct and indirect use-values. Direct use values are again classified into consumptive and non-consumptive use-values. Consumptive use-values include ecosystem service values that are produced on the land for immediate consumption (such as grain and straw on crop fields, wood and timber on forest lands, hay and leafy biomass from pastures, etc.). Non-consumptive use-values refer to recreational, educational and research values. Indirect use values are classified into the following four categories: (i) Watershed, soil protection, and nutrient recycling; (ii) gas (carbon dioxide and oxygen) exchange, carbon storage and climate stabilization; (iii) habitat and protection of biodiversity and species; and (iv) aesthetic, cultural and spiritual values. As the Aralkum desert is far away from human settlements, for the on-site valuation, we focus only on the non-use values of land and trees, with focus on their potential to serve as a carbon sink. In general, non-use values of natural resource or environmental assets are classified into three broad categories: (i) Option values (values of the option of not using it in the present time); (ii) existential values (values of its mere existence); and (iii) bequest values (the amount of the ability to bequeath it to future generations). Following Yigezu et al. (2020), we use a combination of market and non-market valuation methods to monetize the ecosystem services lost and have used area weights to aggregate province-level estimates to generate national level estimates.

Results

The results showed that inaction to control degradation in natural capital in the agriculture sector (croplands, pasturelands, forests, and water) in Tunisia is causing the country to lose substantial amounts of ecosystem services (ESS). Using extremely conservative assumptions, we estimated that Tunisia is annually losing at least 1.97 million tons of potential production of different crops (cereals, legumes, vegetables, fruits, and others), which represents 22.41% of current production and the associated crop residues. Degradation also causes the loss of 209.25 thousand tons of forest biomass (0.53% of total forest biomass stock), and 2.5 million tons of forage (equivalent to 28.03% of current forage supply) from natural pastures. Moreover, due to inaction or inadequate action to conserve water and reduce losses, the country is losing at least 736 million cubic meters of irrigation water (28.78% of total irrigation water supply from surface and ground water sources). In addition, the country is losing 147 million cubic meters of rainwater (11.98% of total precipitation) due to surface runoff. Tunisia is also losing at least 141.68 million tons of soil (i.e., 13.14 ton/ha or 0.94% of total soil stock) every year due to erosion on crop, pasture, and forest lands, which is also associated with the release of at least 779 thousand tons of carbon into the atmosphere. This does not include the amount of soil eroded from the other land use types including urbanization, infrastructure, abandoned agricultural lands, etc. and the associated carbon emission. In addition to these losses, the country is suffering different kinds of harm (including health, infrastructure damages, extreme weather, water quality deterioration, soil salinity, etc.) related to degradation of the natural capitals in the agriculture, forest, and water sectors, some of which are not addressed and hence no detailed estimation is provided in this report.

The monetary value of all the ecosystem services that Tunisia is losing annually in all biomes is estimated to be at least $2.17 billion (4.65% of GDP). The main cost of inaction in the country in monetary terms is related to crop lands which constitute 53.98% of this loss followed by irrigation water, and rangelands which contribute 28.19% and 12.09% of total cost of inaction, respectively. Direct use values (including crop and biomass, forage, and forest biomass lost constitute 80.87% of the total loss while indirect use, including the value of soil eroded and the associated soil carbon emissions, constitute about 15.15%.

Discussion

It is noteworthy that despite the low current level of forage biomass production in the rangelands, the biomass loss in rangelands accounts for about 54% of total which is higher than the 36.6% share of rangelands in total agricultural land. Rangelands, especially those in Southern Tunisia, also constitute most of the areas with the highest erosion rates per unit area which go as high as 52t/ha. Only the five Southern provinces constitute about 82% of the total national soil erosion. Rangelands constitute 73.51% of total national soil erosion out of which 67.7% (i.e., 91.8% of total erosion in rangelands) is happening in the five Southern provinces which constitute 66.8% of total national rangeland area. This calls for concerted efforts between national and international research organization, the relevant departments within in the Ministry of Agriculture, national and international development organizations, and financing institutions in the voluntary carbon market to join forces in identifying packages of policy, institutional, and technological innovations that are believed to be effective in combatting resource degradation in each biome for each province. These packages will need to be refined through a series of consultations with panels of experts. Such efforts should give the utmost priority to rangelands where the extent of land degradation in the form of soil erosion is the highest.

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