ENJEUX SCIENCES

DESERTIFICATION AND CLIMATE CHANGE

ARE THEY PART OF THE SAME FIGHT?

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it increases the density of aerosols in the lower atmosphere, which reflects some of the sun's rays back into the atmosphere. But these dust particles also amplify the greenhouse effect through their infrared emissions. Although solar radiation interception by suspended dust lowers the warming of the ground surface, this does not reduce the greenhouse effect.

Soil organic matter and atmospheric CO_2 concentration

Soil is one of the main carbon reservoirs: it holds two to three times more carbon than the atmosphere. Carbon is stored in soil in the form of organic compounds produced by plant photosynthesis. As such, vegetation abundance and the size of this reservoir are correlated. However, the amount of carbon stored also depends on another key factor: the type of soil. Soils in dry regions have little organic matter due to their very sandy texture. Even so, these soils account for almost 30% of the organic carbon stocks in the world's soils. If soil degradation continues at a similar rate as today, by 2030 there will be almost a billion hectares (9,750,000 km^2) of degraded land, which will contribute to rising atmospheric CO_2 concentrations and thus to greenhouse warming. Soils in dryland areas are also very rich in inorganic carbon (carbonates). Documenting the extent to which they are involved in CO_2 emissions is a research priority.

In sum, desertification can have complex and interconnected consequences on the atmosphere and climate, particularly on rainfall, by increasing the albedo and the CO_2 source function of the land.

WHAT ARE THE ECONOMIC EFFECTS OF DESERTIFICATION?

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Assessing the costs of desertification comes with a number of challenges, not least of which involves determining the situation to which the current condition is being compared. First, a list of impacts linked to desertification must be agreed upon. This list varies depending on the regions under consideration and the way in which they are used by human societies. The economic costs must also be determined. These costs may relate to productive, residential or even recreational activities, both private and public, and whether or not they can be measured in monetary terms.

At the Rio Summit in 1992, the first global economic assessment of desertification (Dregne and Chou, 1992) was used as an argument for the decision to create a specific treaty on desertification in drylands. The economic assessment of natural capital could be useful in decision-making and public action to support sustainability.

In line with the official definition of desertification in the UNCCD, this initial assessment is limited to countries with arid, semi-arid and dry sub-humid regions. It is based on the results of studies (mainly in Australia and the United States) carried out at the research-project scale. This assessment measures in monetary terms the per-hectare productivity losses associated with land degradation for three main types of land use: irrigated agriculture, rain-fed agriculture and livestock farming. It is based on an estimate, by country and then worldwide, of irrigated agricultural land, rain-fed agricultural land and grazing land affected by desertification. The authors put the annual losses due to desertification at a total of USD 42 billion (at 1990 exchange rates). In this assessment, only agricultural uses are considered, and so the estimated losses correspond solely to the provisioning ecosystem service for food.

In the 2000s, a number of national assessments were carried out, particularly in Africa. They include new calculations associated with land desertification: the loss of wood, non-timber forest products and biodiversity as well as indirect costs such as the silting up of dams due to wind erosion and even some social costs.

In 2005, the Millennium Ecosystem Assessment established a new framework for the economic assessment of ecosystems and the services they provide, known simply as "ecosystem services". This framework was used for the second global assessment of land degradation, published in 2016 (Nkonya et al., 2016). This assessment applies to the entire surface of the Earth. It is based on land mapping – not by land use, but rather the observation and measurement of changes in biophysical characteristics in the main terrestrial biomes and major ecosystems. To do this, economic values were assigned to the main terrestrial biomes, based on several hundred regional studies compiled by The Economics of Ecosystems and Biodiversity (TEEB) initiative. By mapping changes in vegetation cover or the transition from one biome to another, researchers can estimate the per-hectare economic losses relating to these changes or conversions on the basis of the values calculated for each biome. Examples of such changes include the degradation of vegetation cover, conversion from a natural area to a grazed or cultivated area, or an area that has become unusable for plant and food production. This assessment also takes into account the issue of degraded areas used for crop and livestock farming. To this end, specific bioeconomic modelling was developed for land with no change in use (or occupation) in order to estimate the annual value of the observed productivity losses. In this global assessment, recommended by the Millennium Ecosystem Assessment, the total value of degradation corresponds to the sum of these two main methods of calculation, and adds together the loss of areas where change is under way and the loss of areas still used for crop and livestock farming. The results indicate a total annual cost of land degradation of USD 297 billion for the 2001–2009 period. Losses linked to provisioning services (crops and livestock) account for only 38% of this amount.

Although the two assessments carried out in 1992 and 2016 (Dregne and Chou, 1992; Nkonya et al., 2016) rely on different conceptual frameworks (food use in one case, ecosystem services and the total economic value of these services in the other), they combine per-hectare monetary estimates with a mapping assessment of the areas occupied and affected by land degradation. Despite obvious limitations, mainly linked to the extrapolation of regional data to national and global scales, they are objective assessments of the economic losses related to desertification. That said, they are clearly focused on the food use of land, as opposed to a quality-based vision regarding natural and cultivated ecosystems.

Stakeholders' perceptions can also be used to gain deeper insights into the value they place on the various non-market services that land provides. While a financial approach based on variations in production and induced productivity as well as on production losses is feasible for market provisioning services, estimating the value of non-market services linked to land requires reporting-based methods. An experiment was conducted in Burkina Faso in a region where anti-erosion and agroecological structures (stone lines, zaï holes, semi-circular bunds, gabions, etc.) had been implemented. The aim was to estimate the value of the non-market services provided by these structures, based on producers' perceptions. The findings are shown in the table below. First, the absence of agroecological infrastructure ("business as usual") results in a significant loss of utility per hectare for producers, estimated at almost a year's minimum income (at the local level). This calculation method shows the value placed on these types of developments. In consultation with local producers, each priority non-market service is assessed in monetary terms on a per-hectare basis according to their perceptions. The grand total of the non-commercial provisioning services of water, additional straw for the animals, trees (for biodiversity) and local solidarity (mutual aid is essential to maintaining these infrastructures) amounts to XOF 110,000 (around EUR 160) per hectare per year, or more than three months' minimum wage. As a point of reference, the minimum monthly wage in Burkina Faso in 2020 was XOF 33,130.

Assessments of this kind are important tools for guiding decisions on funding actions to combat land degradation, and more generally for making a case backed up with figures to public decision makers.

Table 1. Illustration of the methods used to assign a value to the effects of land degradation (adapted from Traoré and Requier-Desjardins, 2019).

Service	Calculation method	Value in XOF/year/ha
Harvest increase	Cost–benefit analysis on a representative sample CBA	52,250 (1)
Straw increase	Choice experiment method Evaluation of producers' willingness to pay on a self-reported basis WTP	27,400
Water	Choice experiment method Evaluation of producers' willingness to pay on a self-reported basis WTP	36,100
Biodiversity	Choice experiment method Evaluation of producers' willingness to pay on a self-reported basis WTP	16,800
Mutual aid	Choice experiment method Evaluation of producers' willingness to pay on a self-reported basis WTP	29,700
Total		162,250
Business as usual with no new developments		–330,303

(1) This amount was calculated by multiplying the surplus by the average price of cereals in 2018 (250 × XOF 209 = XOF 52,250).
CBA: cost–benefit analysis; WTP: willingness to pay

HOW DOES DESERTIFICATION MAKE POPULATIONS VULNERABLE AND WHAT ARE THE REPERCUSSIONS?

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Analysing the links between land degradation and population vulnerability requires an approach that accounts for the complexity of the specific situation, particularly with regard to three issues:

1. What are the demographic, socioeconomic and environmental changes that trigger the dynamics of desertification?
2. How does land degradation specifically affect rural populations and exacerbate inequalities?