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On-Site and Off-Site Effects of Land Degradation in Albania

Gazmend Zeneli[1*], Semiha Loca[2], Abdulla Diku[3], Albana Lila[4]

[1] *Lecturer, Faculty of Economics and Applied Sciences, University "Marin Barleti", Tirana, Albania*
[2] *Associate Professor, Faculty of Economics and Applied Sciences, University "Marin Barleti", Tirana, Albania*
[3] *Ph.D Student, DIAVA Consulting, Tirana, Albania*
[4] *Ph.D Student, Raiffeisen Bank Tirana, Albania*

**Corresponding author: Faculty of Economics and Applied Sciences, University "Marin Barleti", Tirana, Albania. Tel: +355 69 206 2086. Fax: +355 424 30212, Email: gzeneli2000@gmail.com*

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Background: This paper is devoted to preliminary assessment of the economic cost of land degradation in Albania resulting from unsustainable land use, based on comparing the costs of action for dealing with land degradation versus the costs of inaction.
Materials and Methods: The causes of land degradation are divided into proximate and underlying ones, which interact with each other to result in different levels of land degradation. The economic impacts of land degradation on soil uses are valued according to their typology and their different impacts have been classified spatially into on-site and off-site effects, distinguished according to the economic values that are affected.
Results: The results showed that the on-site costs of soil degradation are significant, but are not be a major concern in the short run. However, on the local scale, impacts will be more substantial for the affected areas. The off-site costs of soil degradation are substantial, however. In some cases, they may exceed the on-site costs, despite the fact that a large part of the off-site costs could not be quantified. **Discussion and Conclusions:** Some of these issues, especially the conservation of water resources and their sustainable management to reduce sedimentation in rivers and dams, and flood risk reduction, call for immediate conservation measures.

Keywords: *Cost, Economic assessment, Environmental impact, Land use, Sustainability*

1. Background

Land degradation seriously impairs food security (13), biodiversity (33), and economic development (3, 18, 34), especially in lower income countries, where land users are highly dependent on the quality of natural resources endowments (19, 31). Moreover, capital constraints restrict land users' access to expensive inputs such as fertilizer that could compensate to some extent for the deteriorative effects of land degradation (32). Land degradation encompasses the whole environment but includes individual factors concerning soils, water resources, forests, grasslands, croplands and biodiversity (12). As the problem of land degradation is complex, the existing definitions of land degradation and the methods for its assessment are varied and sometimes conflicting. One of the more comprehensive definitions of land degradation identifies it as the "reduction in the capacity of the land to provide ecosystem goods and services over a period of time" (27). The emphasis on land, rather than soil, broadens the focus to include natural resources, such as climate, water, landforms and vegetation. The productivity of grassland and forest resources, in addition to that of cropland, is embodied in this definition (37). Over the years, the emphasis has also shifted towards the impact of land degradation on the provision of ecosystem goods and services (40). More attention is also now being paid to incorporating socio-economic factors and not only physical determinants of land degradation.

Land degradation in Albania is considered as one of the biggest problem in last two decades. The root causes that have contributed to this phenomenon are numerous and a complete analysis of each of them will enable the necessary corrective measures to be addressed in the short, medium and long terms.

Based on earlier studies,erosion washes away 1.2 million tons of organic carbon, 100,000 tons of nitrate salts, 60,000 tons of phosphates, and 16,000 tons of potassium saltsin Albania every year (42, 43, 45).

Attempts have been made to prepare a system of modelling soil erosion dynamics for mountainous areas in Albania (16). The model uses existing soil maps, land use maps, a digital elevation model, and interpolated climate data and estimates the erosion rate. The erosion maps clearly show that Albania is a country where the potential for erosion is severe. In three spots the annual erosion rate is more than 100 t ha^{-1} (16). There is remarkable soil loss in the whole territory, but it is especially significant in three main regions, which are located in the north, in the central part of the country and in the south (21). Countrywide average soil loss rate is 31.5 t $ha^{-1}y^{-1}$, which is far above the tolerable limit of 10 t $ha^{-1}y^{-1}$. Extremely high soil loss rates (60-130 t $ha^{-1}y^{-1}$) were calculated for the mixed agricultural land and the orchards/vineyards located on high slopes. This results in an enormous total soil loss (82 Mio t y^{-1}) from the total agricultural sector. The mixed lands (especially the seminatural- areas), the grasslands and the sparsely vegetated zones probably used as intensive pastures are affected by overgrazing, which leads to high erosion rates (21). Despite the huge total soil loss (90.5 Mio tons per year) generated in the country, only *ca.* 55 Mio tons suspended sediment is transported by the rivers into the seas annually (21).

Forests provide a buffer to filter water and to hold soil in place. Data on the country's forest surface shows a decrease of approximately 13,000 hectares of forest area during the period 1990-2010 (22), which has been under the effect of erosion and nutrient losses. Areas of coniferous and mixed forests, together with mountainous agricultural land, appear to be the land types most at risk of erosion (17).

Winter months appear to be the most risky, but with all months contributing substantially to the annual erosion rate (i.e. between 4 and 12 % each). A recent study found out that cold months were the most erosive, with average erosion rates reaching the maximum in November and December, i.e. 2.62 and 2.36 t ha^{-1}, respectively, while the annual rate was estimated at 10.25 t $ha^{-1}y^{-1}$ (44).

Although there are few studies dealing with the economic cost of soil degradation (4, 5), none of them assessed the financial cost of land degradation. The main task of this paper is a preliminary assessment of the economic cost to Albania of land degradation resulting from un-sustainable land use. The main focuses are the socio-economic and biophysical aspects and identification of the key drivers and causes for such forms of land use.

2. Materials and Methods

In orderto assess the impacts and costs of land degradation on a larger scale, there is a need to take a broad and integrative approach, which includes both the capital stocks and flows that affect human well-being, as well as the linkages to external effects and livelihoods that are not based on the terrestrial surface. This is because the immediate effects of land degradation are directly evident in the supply of ecosystem services, and thus the impacts on well-being (38).

One way of approaching the extent of land degradation is by conducting a cost–benefit analysis of the current land management type and alternative options. The ELD (Economics of Land Degradation) Initiative has developed such a methodology, based on the 6 + 1 steps action plan established by the United Nations Convention to Combat Desertification (UNCCD) Global Mechanism (11). It is intended to allow the estimation of the overall benefits of addressing land degradation and implementing ecosystem restoration. Such estimates will enable businesses and policy makers to test the economic implication of land management decisions, based on a scenario-driven, net economic benefit decision making frame-work (11). The 6 + 1 steps are designed to ensure that a thorough and applicable knowledge base is established for the valuation and subsequent cost–benefit analyses that are the bases of the decision making process.

The methodology used in the study follows the approaches proposed by von Braun *et al*. (40) and is based on the comparative evaluation of the cost of action and the cost of inaction.The causes of land degradation are divided into proximate and underlying, which interact with each other to result in different levels of land degradation. The level of land degradation determines its outcomes or effects - whether on-site or offsite - on the provision of ecosystem services and the benefits humans derive from those services.

The total cost of degradation in the time period t can be expressed as the sum of these five cost components, as expressed in the formula (1):

$$C_t = \sum_i (PC_{it} + RC_{it} + SC_{it} + DC_{it} + NC_{it}) \quad (1)$$

WhereC represents the total cost. The subscripts (t) and (i) indicate the time period and the type of soil degradation, respectively.

The private damage costs (PC) and the social damage costs (RC) constitute the *damage costs* of land degradation. By contrast, the on-site mitigation and repair costs (SC) together with the off-site defensive expenditure (DC) sum up to the *damage avoidance cost*.

The non-user costs (NC) can fall into either category. If added up horizontally, the private on-site costs (PC) and the mitigation and repair costs (RC) give the on-site costs of land degradation. The sum of off-site, social costs (SC), defensive costs (DC) and non-user costs (NC) yields the off-site costs of land degradation; in economic terms also referred to as the external effects.

This means that each of the five cost categories has to be calculated and summed for each of the different degradation types. It is important to note that mitigation costs should not be confused with an analysis of possible policy responses: here, mitigation cost are merely used as a proxy, based on the argument that the costs of mitigation are potentially considerably less than the impacts of soil degradation. However, in most cases, mitigation measures will not address degradation as such, but rather aim to limit its impacts.

3. Results

The impact of land degradation on land uses is valuedin economic terms according to the typology of the economic impact. The different impacts can be classified spatially into on-site and off-site effects, distinguished according to the economic values that are affected; they may also be grouped causality as direct and indirect impacts. On-site effects of land degradation describe the impacts that can be directly experienced by farmers, such as declining yields. Off-site effects—as externalities—are effects that do not occur on the degrading land itself (41). To assess the extent of land and soil degradation in Albania, a number of studies have been evaluated. The extent and the economic cost of land degradation and soil degradation identified by all of these studies varied and are hardly comparable between them.

3.1. Economic Cost of on -site impact of Land Degradation in Albania

Agriculture in Albania employs 47.8% of the population and uses about 24.31% of the land. Agricultural land refers to the share of land area that is arableunder permanent crops, or under permanent pastures. Agriculture contributes to 18.9% of the country's GDP (23). However, it is limited primarily to small family operations and subsistence farming because of lack of modern equipment, unclear property rights, and the prevalence of small and inefficient plots of land. The main agricultural crops products in Albania are wheat, maize, potatoes, vegetables, tobacco, fruits, and aromatic plants.

The direct on-farm impacts of land degradation on agricultural production can be experienced by farmers through declining yields, which are a result of the changes in soil properties. Calculation of economic losses was performed by using the replacement and lost production methods. Economic losses from the erosion and compaction in the agricultural area in Albania are at least 125.2 Mio EUR per year and the plant nutrient losses due to the water erosion are 70 tons or 88.8 Mio EUR.

Crop yield is the measurement often used for a cereal, grain or legume and is normally measured in metric tons per hectare. Despite favorable climate conditions, the yield of main field crops is relatively low, partly because the high severity of land degradation. Agricultural production is sensitive to land degradation because it depends, for its production process, on heat for energy and on water.

The economic losses related only to soil compaction are calculated for some importantcultivated plants that can be impacted from soil compaction. The relative loss yield factors due to the soil compaction which present the rate between optimal yield of the crops and actual yield are calculated that vary from 1,17 for maize to 1,20 for wheat. These values are used also for the other crops according to the similarity on plant root penetration in soil.

Data on the country's forest surface area shows a decrease of approximately 13,000 hectares of forest area during the period 1990-2010 (22). Because of lack of investment in the forest sector, this area (13,000 ha) has suffered from erosion and nutrient losses. In calculating the cost of economic losses, three main elements are considered, respectively: Cost for planting of the lost forest area (13,000 ha); the cost of missing value of the potential rent of forest area (13,000 ha); and the cost of the value of the lost timber (18). Considering the three above-analysed elements, the total on- site cost of the deforestation of 13,000 ha will be ca 52 Mio EUR, for a period of 20 years, or 2.6 Mio EUR $year^{-1}$.

Taken together, the on-site private cost on mitigation and repair the damage (RC) is estimated to be about: 134 Mio EUR.

3.2. Economic Cost of off -site impact of Land Degradation in Albania

The energy sector is one of most important sectors of the Albanian economy.Energy security is a critical concern in Albania which relieson hydropower (HPP) for about 90% of its electricity production. While renewable energy resources such as hydropower play a fundamental role in moving the world towards a low-carbon economy, they can also be vulnerable to climatic conditions (10). In the absence of data, two main indicators have been used in the evaluation of the risk and losses from the energy sector as impacted from land degradation, respectively: a) the quantities of the sediment deposited in the reservoirs of HPPs and the cost of rehabilitation and cleaning; and b) the damages related to the reduction of water reserves as a result of the land erosion.

Reliable sources for the evaluation and calculation of the deposits of the sediments on the reservoirs of HPP in Albania are missing. The most reliable assessment was carried out by the CNVP (8) on the sediments filling of the reservoir of one of HPP in the Mati River Cascade. The results showed that the capacity of hydropower reservoir had been reduced by about 31.5% with a cost of ca 3.7 Mio EUR.

Trap efficiency method of estimating reservoir sedimentation (7), widely used all over the world, has been employed in this study. This method developed the curve with the relation between trap efficiency and reservoir capacity-inflow (C/I) ratio. Based on calculation, as results of filling with sediments, the reduced lifespan and efficiency of this power plant, has a cost of 15.7 Mio EUR.

Off-site social cost (SC) resulting from flooding and landslide, based on the estimation of studies for the flooding of Vjosa and Buna river basins are at the range of 110 Mio EUR. In addition, the economic cost of intervention for protection against flooding in Shkoder region is estimated at the range of from 55 to 155 Mio EUR.To date, there are no reliable studies on off-site defence cost (DC), for the protection of the land from landslide or soil conservation in Albania on national level.

One specific issue, unlike in many other countries, is the high amount of abandoned land. The agricultural land in Albania is estimated to be about 487500 ha while the arable land used for crop production is estimated to be about 408000 ha (21). Alcantara *et al.* (1) found that 13% of Albania's agricultural land to be abandoned. Their MODIS-based estimates of abandonment were in general conservative when compared to case studies that were based on 30-m resolution Landsat images such as the one from Müller and Sikor (26) who reported an abandonment rate of 27%. Earlier, Deininger *et al.* (9) reported that some 10% of productive land (by 18% of producers) was uncultivated for reasons otherthan crop rotation at the time of their survey; most of it had been abandoned for at least 5years. Agricultural abandonment in Albania is strongly mediated by both the biogeophysical environment and transportation infrastructure (25). However, direct comparisons are challenging, because the time periods and abandonment definitions used vary among these studies. Even using conservative estimates (an abandonment rate of 13%), the abandoned agricultural land in Albania covers an area of ca. 64 000 ha. It should be mentioned that the terrain for the most part in these areas is extremely steep and rocky, quite unsuited to economies of scale (46). Some of these areas have been deforested in 1960s as part of the regime's twin campaigns to promote regional equality and to extend the arable land area as much as possible. The non-users cost (NC) as a result of land abandonment, when erosion is more active, can be calculated based on the yield of the agricultural land. Based on expert opinion, on considering an average yield of 2400kg/ha for cereals (these soils are considered of low fertility, therefore a reduced yield of crops can be obtained), in an area of 64000 ha, the potential economic losses by land abandonment can be estimated at about 48 Mio EUR/year.

These numbers should be regarded as conservative estimates, as many impacts could not be quantified at all. Hence the values reported as upper bounds in the above paragraph do not provide the upper bound for all impacts of land degradation, but merely the upper bound for those aspects of land degradation that were quantified in monetary terms in this study.

4. Discussion

Land degradation is extensive, covering approximately 23% of the globe's terrestrial area, increasing at an annual rate of 5–10 Mio ha, and affecting about 1.5 billion people globally (28). The annual costs of land degradation at the global level were found to equal about US$300 billion (28).The analysis of the cost of land degradation across the type of ecosystem services shows that 54 % of the cost is due to the losses in regulating, supporting and cultural services (for example, carbon sequestration), which are considered as global public goods. Thus, the major share of the costs of land degradation affects the entire global community (29).

Characterizing and measuring land degradation has long been recognized as a challenging task. Quillérou and Thomas (30) identified two potential pragmatic ways for policymakers to estimate the total economic value of land services at national level. The first approach consists in estimating the value of ecosystem services separately then aggregating them. The second approach would consist in applying choice modeling to all types of services at the same time. The main challenge is to quantify these impacts and provide the economic agents with answers as to the real losses caused by erosion. Here a simplifying approach to collapse the multivariate phenomena of land degradation into a single spatially varying number is presented. This classification (on-site and off-site) is used in evaluating the economic cost of land degradation in Albania.

Land degradation is a major challenge for agricultural and rural development in Albania. Our research findings indicate that the costs of land degradation in Albania are substantial; reaching about US$0.45 billion annually resulting from the loss of valuable land ecosystem services due to land use and land cover changes. These costs are comparable to those found in Senegal (US$0.412 billion annually) (35), but lower than those found in Uzbekistan (US$0.85 billion annually) (2), in Ethiopia (estimated to be about US$4.3 billion) (15), in Tanzania (US$2.3 billion) (20), in Nigeria (US$0.75 billion) (24), etc. However, the sizes of the countries are not comparable.

The private on-site costs of land degradation are significant, but will not be a major concern in the short run. However, on the local scale, impacts will be more substantial for the affected areas.The indirect offsite economic costs, e.g. relating to the sedimentation in water bodies and disruption of transport are also important, but estimates of their magnitude vary even more widely, plus the lack of market prices for many of these impacts making effective comparisons difficult.Off-site costs are generally covered by society: as externalities, they are not reflected in the decision-making framework of soil owners and users.

The cost of taking action against land degradation is much lower than the cost of inaction, however. The actions against land degradation include investment in restoration of degraded lands and prevention of land degradation through stricter regulation of agricultural expansion into forests and other higher value biomes (6). They also include reforestation and other restoration efforts; protection wetlands and restoration of degraded wetlands. The excessive use of agrochemicals also requires action to regulate their potential off-site effects.

Because of the discrepancies in the data, it was difficult through economic simulations to show the differences in the returns from actions to address land degradation compared to taking no action. However, in many case study countries and sub-regions, the returns from each dollar of investments into land rehabilitation were found to reach up to 5 dollars over the same period (27).

5. Conclusion

Characterizing and measuring land degradation has long been recognized as a challenging task. Here a simplifying approach to collate the multivariate phenomena of land degradation into a single spatially varying number is presented. We used this simplification as a proxy measure of land degradation to make an estimate of the impact of land degradation on ecosystem function, which is in turn converted into a loss of ecosystem service value.

In order to estimate the total economic value of land services at national level, two potential pragmatic ways for policymakers can be used. The choice between these alternatives depends on which is less costly to implement in practice considering data already available and the country's capacity to obtain reliable national estimates. We recommend also considering the production of a wider and more comprehensive range of services in land ecosystems. Some of these services are valuable for their support to agricultural systems (regulation of water supplies for irrigation, pollination, genetic resources for crop improvement, and so on), but can also provide services that go beyond agricultural production (for example, carbon sequestration, flood control, recreational activities).

Some of these issues concerning land degradation and especially the conservation of water resources and sustainability of water resources management by reducing the sedimentation in rivers and dams from land degradation could be addresses through the Environmental Services Project (ESP).

Conflict of Interest

The authors declare that they have no competing interests.

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اثرات در محل و خارج از محل تخریب زمین در آلبانی

گازمند زنلی[1*]، سمیها لوکا[2]، عبدالله دیکو[3]، آلبانا لیلا[4]

۱- مدرس، دانشکده اقتصاد و علوم کاربردی، دانشگاه Marin Barleti، تیرانا، آلبانی

۲- دانشیار، دانشکده اقتصاد و علوم کاربردی، دانشگاه Marin Barleti، تیرانا، آلبانی

۳- دانشجوی دکتری، مشاوران DIAVA، تیرانا، آلبانی

۴- دانشجوی دکتری، بانک Raiffeisen، تیرانا، آلبانی

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مقدمه: مقاله حاضر به ارزیابی اولیه هزینه اقتصادی تخریب زمین ناشی از استفاده ناپایدار از اراضی، بر اساس مقایسه هزینه‌های اقدام برای مقابله با تخریب زمین و هزینه‌های عدم اقدام در آلبانی پرداخته است.

مواد و روش‌ها: علل تخریب زمین به دو دسته تقریبی و اساسی تقسیم می‌شوند که با یکدیگر در تعامل هستند تا سطوح مختلف تخریب زمین را منجر شوند. تأثیرات اقتصادی تخریب زمین بر استفاده از خاک، بر طبق نوع‌شناسی این اثرات قابل بررسی و ارزشمند است و تاثیرات مختلف آنها به صورت مکانی به اثرات در محل و خارج از محل طبقه‌بندی می‌شوند که بر اساس ارزش‌های اقتصادی متاثر از آن‌ها قابل تمایز هستند.

نتایج: نتایج نشان داد که هزینه‌های تخریب خاک در محل معنی‌دار است، اما نگرانی عمده در کوتاه مدت این هزینه‌ها نیستند. با این حال، در مقیاس محلی، تاثیرات در مناطق آسیب دیده بیشتر خواهد شد. هزینه‌های خارج از محل تخریب خاک قابل توجه است. علی‌رغم این واقعیت که بخش بزرگی از هزینه‌های خارج از محل نمی‌تواند به صورت کمی تعیین شود، این هزینه‌ها در برخی موارد حتی ممکن است از هزینه‌های در محل بیشتر شود.

بحث و نتیجه‌گیری: بعضی از این مسائل، به ویژه حفاظت از منابع آب و مدیریت پایدار آنها برای کاهش رسوب در رودخانه‌ها و سدها و کاهش خطر سیل، نیاز به اقدامات حفاظتی فوری دارند.

کلمات کلیدی: اثرات زیست محیطی، ارزیابی اقتصادی، استفاده از زمین، پایداری، هزینه