

Commentary

Land Resource Depletion, Regional Disparities, and the Claim for a Renewed ‘Sustainability Thinking’ under Early Desertification Conditions

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Abstract: The present contribution discusses recent findings in environmental issues dealing with desertification risk and regional disparities in the Mediterranean basin. By focusing on key socioeconomic factors underlying land and soil degradation (population growth, urban sprawl, coastalization, agricultural intensification, and land abandonment), this commentary highlights the intimate linkage between socioeconomic processes, rural poverty, and territorial disparities based on complex dynamics of demographic and economic factors. The increasing complexity in the spatial distribution of land vulnerable to degradation has also been pointed out with special reference to post-war Italy, a Mediterranean country considered as particularly affected in the UNCCD Annex IV, as the results of non-linear biophysical and socioeconomic dynamics. The lack in multi-target and multi-scale policies approaching land degradation and territorial disparities together is finally discussed as an original contribution to the study of Mediterranean desertification.

Keywords: desertification; territorial disparities; land degradation; Mediterranean basin



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1. Introduction

In developed countries, drastic changes in societies and economic structures, reflecting what is frequently interpreted as a transition from modernity to a ‘post-modern’ phase, were observed over the last years. These processes involve changes in the availability of natural resources and the landscape configuration with impacts on environmental quality [1]. As an example, pressures on fragile ecosystems, particularly in the most sensitive and economically disadvantaged areas, and on traditionally polarized territories [2–4], are linked to changes occurring since the Second World War to this date in the structure of the economies of Mediterranean countries. Bio-physical and anthropogenic causes of these changes are attracting growing consideration in the social sciences, disciplines interested in highlighting the effects of ecosystem degradation on population and economic systems, as well as the response of local communities to such changes [5]. Uncertainty and risk are therefore interpreted as key concepts of this interpretive path that concerns, in an integrated way, economic dynamics, social change, and political action [6].

As a social and economic problem at once, environmental degradation appears to be related to our system of production and consumption, which is based on a notion of progress, long predominant, focused on the quantitative expansion of goods produced and their consumption, according to the principle that economic growth would automatically lead to an increase in social welfare. This places at the center of attention a reflection on our own model of development and the need for its rethinking in the direction of the construction of a ‘sustainable human well-being’ [7]. The latter starts from the assumption

that the improvement of living conditions does not depend only on the increasing availability of goods but also on the fair distribution of wealth and the reduction in impacts on the environment, so as to ensure the stability of welfare over time, based on an ethic of intergenerational equity that requires not to compromise the ability of future generations to take advantage of the resources that are now available to current generations [8].

The debate on territorial organization and infrastructuring is also particularly lively in the European context, and in the Mediterranean in particular, generally characterized by shortened accessibility of inland, which negatively affects its development [9]. On the other hand, economic development has also left innumerable marks on the Italian landscape, which has begun to lose the features of diffuse rurality, which had distinguished it in the first half of the last century after World War II [10], becoming progressively urbanized and often highly infrastructured. The phenomena of urban growth and littoralization affect the large urban areas of the Po Valley and the agglomerations—without interruption—of Rome and Naples, as well as the coasts of Puglia and Sicily, the Tuscan-Lazio Maremma, and the entire Adriatic coast from Romagna to Molise. In the same years, the intensive agriculture of monoculture and industrial animal husbandry alternates with high-density industrial settlement, manipulating the typical features of the landscape and creating an ‘entropic’ mosaic of land uses, with a coexistence of urban and rural features that returns indistinct and fragmented territories, reducing that quality which is the base for future growth opportunities. Along with these, those territories, marginal and, at the same time, with a high landscape vocation that have been preserved for years, even during the economic ‘boom’, the characters of rurality and biodiversity are lost, compromised by a weaker recent development but also more widespread and spatially capillary [11].

In this perspective, desertification is today one of the most complex environmental and socio-economic issues that our societies are called to face, with important implications on sustainable development and spatial organization of the territory. If, on one side, the topic has often been at the center of the attention of the media, decision makers, and public opinion, on the other side, it must be noted the cyclical nature of this interest, corresponding to the occurrence of emergency situations mainly linked to drought and water scarcity, phenomena easily (but sometimes erroneously) associated with the climate change theme [12]. Therefore, this interest has focused the attention of the public on the desertification–climate relationship (and, more generally, on the bio-physical factors behind desertification), while overlooking social, economic, cultural, political, and institutional factors. This aspect, highlighted by the most recent dynamics at various scales of observation, asks for appropriate scientific approaches and a more aware and less sensationalistic divulgation [13]. The great array of land degradation processes in the Mediterranean involves monitoring difficulties hampering the identification of effective counteracting actions [14]. However, interest in these problems has been renewed in the last twenty years.

Following European community-funded project experiences, a number of studies have interpreted land degradation as multiple phenomena, highlighting how one or more components of natural capital has deteriorated over time, either quantitatively or qualitatively [15]. In recent years, moreover, there seems to be an increasing interest in a more systematic study, compared with the past, of the socio-economic factors that interact with natural capital (mainly soil and water) and that determine its possible degradation, using both theoretical and empirical approaches [5]. However, despite some scientific contributions, sustainable development, land disparities, and land degradation relationship still appears to be substantially unexplored in the Mediterranean basin [16].

The aim of this paper is to discuss the increasingly topical linkage between land degradation processes, desertification risk, spatial planning, and regional disparities in an environmentally fragile context such as the Mediterranean. The contribution, through a review of the available empirical evidence and a specific focus on Italy, highlights a progressive complexification of the geography of land degradation in the Mediterranean as a result of the joint action of several determinants both bio-physical and socio-economic. This scenario is related to the slow consolidation of territorial disparities in socio-economic

terms, highlighting how the policies at national scale are not yet fully ready to accept the new challenges related to multi-scalarity and joint action on multiple objectives of mitigation and adaptation, which can look at the different dimensions of sustainability. The contribution intends to start from the local territories that become the new starting point to address the issues of sustainable development and desertification in the Mediterranean.

2. Desertification Processes in the Mediterranean Basin

The study of land degradation processes requires a multidisciplinary approach, in view of the multiple and different variables involved, as well as the acquisition of a considerable amount of basic information, sometimes unavailable or incomplete. The degradation of land can evolve, over time, in an ultimate and irreversible phase that is identified as 'desertification'. This term, even if it includes in the etymology the root 'desert', should not be understood as 'generator of deserts', in fact, in Italy, as in many other countries geographically and conceptually far from the real desert areas, it is possible to find situations of desertification. The processes of land degradation (and desertification), unfortunately, begin in a latent form and often become manifest only when it is too late to reverse the irreversible conditions that have been generated [17].

United Nations information sources show that 70% of arable arid land, equal to approx. 30% of the total emerged land, is affected by land degradation phenomena and, therefore, at risk of desertification. Considering the heavy impact on the population, as well as the environment, the problem is particularly serious in developing countries in Africa, Asia, South America, and the Caribbean. However, even structurally strong regions and societies (for example, Europe, the United States, and Australia) are variously affected by the phenomenon whose evolution, although attributable to a combination of different causes, appears unequivocally connected to and reinforced by climatic conditions of aridity and/or drought [18].

For instance, despite lacking extreme climate conditions, the Mediterranean area is particularly exposed to land degradation as seasonal droughts regularly hit the region [19]. However, human causes of land degradation have had a strong impact on soil quality here [20]. Soil degradation in the Mediterranean region affects extensive areas already vulnerable to the exploitation of natural resources, to the point that the implementation of specific soil conservation actions is required as a necessity [21]. This notion has helped creating more awareness on the geographical extent of soil degradation, thus discrediting the misconception that it is a problem affecting only the most economically fragile areas of the world [22].

In Europe, almost 97 million hectares are affected by land degradation, while many Mediterranean countries, in particular Italy, Greece, Portugal, Spain, France, Malta, Albania, Bosnia and Herzegovina, Croatia, Cyprus, Slovenia, and Turkey face exposure to desertification. In these countries about 37 million hectares have been labeled as vulnerable in view of progressive and irreversible soil degradation. Some regions present very critical conditions locally with an even higher proportion of exposed land (Figure 1). These conditions occur, for example, in some regions of Spain and Greece, southern Portugal, and in the Italian islands Sardinia and Sicily [22,23].

Exposure to land degradation varies considerably across space, widening spatial divides in resource availability and development potential. Heterogeneity in land degradation processes results in monitoring difficulties and the poor development of effective law enforcement actions [24]. In order to promote effective national action plans, the Desertification Information System proved a valuable tool for assessing the location and extent of areas exposed to soil degradation in Mediterranean countries. These plans have been developed within DISMED, a project funded by the European Commission. DISMED evaluated three elements, namely climate, soil, and vegetation to help decision makers oppose the risk of drought and land degradation with helpful scientific knowledge [23]. The results of the project reveal that Spain represents one of the most threatened areas (8.5% of the entire country's territory shows high levels of soil degradation) followed by Greece,

with a percentage of affected lands equal to 5.8% of the national territory (Figure 2). The latter represents the largest area with an intermediate level of desertification risk (36.9%). Italy has 3.1% of vulnerable land and 32.1% of total land exposed to an intermediate level of land degradation. Based on the empirical results of this assessment, Spain was on average the country most affected by land degradation [23].

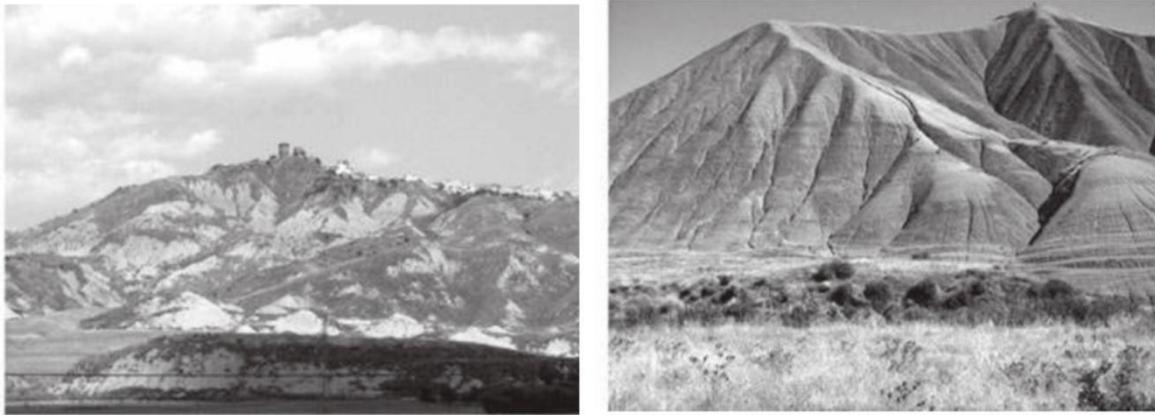


Figure 1. Soil degradation owing to extreme soil erosion in inland areas of southern Italy (southern Sicily, left; Basilicata, right). Source: authors photographs.

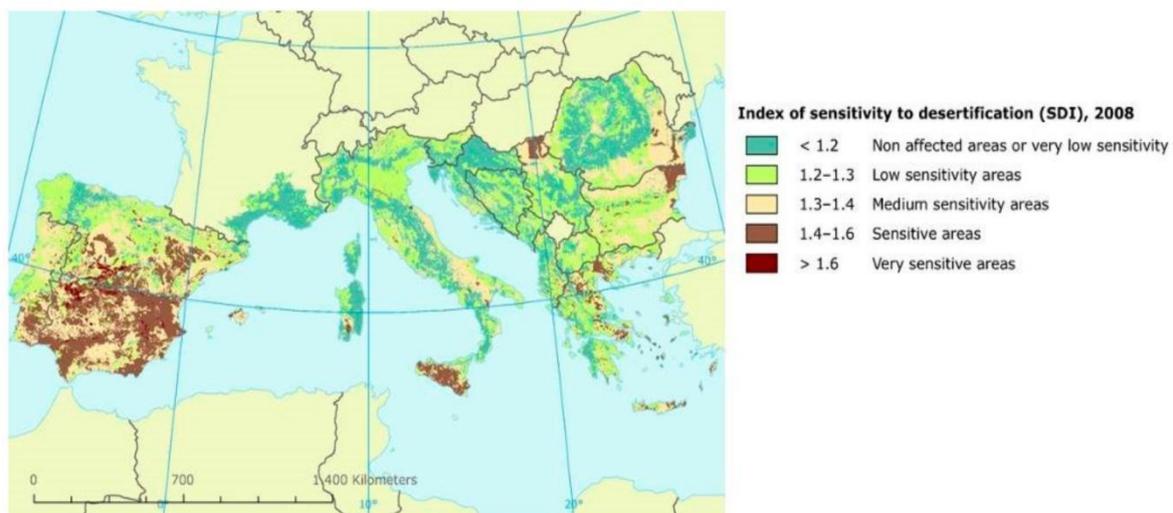


Figure 2. A map showing the degree of vulnerability to land degradation in selected European countries according to the SDI index. Source: DISMED project.

The implementation of strategies to reverse land depletion requires, as necessary preconditions, the detection of areas at risk of desertification and a comprehensive understanding of the causes and consequences of land degradation [22]. The desertification phenomenon affecting the Mediterranean basin is attributable to a complex set of causes that generate unsustainable environmental pressures [25]. Early studies considered land degradation as a complex phenomenon, depicting how one (or more) elements of natural capital have deteriorated from a quantitative (or qualitative) point of view [12]. Since the 1970s, the scientific debate has progressively focused on the concept of desertification, adopting definitions increasingly appropriate to describe the reality and causes of the phenomenon, up to the one adopted by the United Nations Convention to Combat Drought and Desertification (UNCCD), which states as follows ‘Desertification is land degradation in arid, semi-arid and sub-humid dry areas, attributable to various causes, including climatic variations and human activities.’ By identifying the land areas where

desertification may occur, this definition also sets out natural and anthropogenic liabilities [26]. Land degradation is attributable to several causes which, in the first instance, can be distinguished according to their bio-physical or socio-economic origin [16]. It must be pointed out that an articulated and exhaustive taxonomy of the causes of desertification is not currently available, despite the fact that countless national and international initiatives have been undertaken. Natural causes include, for example, climate and climate change, as well as soil deterioration processes accelerated by bio-physical factors; anthropogenic causes include, as paradigmatic examples, changes in land use, landscape transformations, and agriculture, considered both for the pressure they exert on ecosystems and for their positive role in protecting the territory [27].

3. Socioeconomic Drivers

Natural resources' unsustainable use is one of the most important anthropogenic pressures on ecosystems. This alters the environmental balance, leading, in the medium to long term, to the reduction in available natural capital that is gradually replaced by economic capital. The main causes of pressure are due to agriculture, animal husbandry, overexploitation of water resources, fires, urbanization, and progressive land infrastructure and industrialization processes, as well as seasonal tourist concentration [28]. Drivers such as crop production, livestock farming, energy supply, industry, transportation activities, mining, tourism, urban growth, and climate change are placing strong pressure on natural resources as shown in Figure 3 [29].

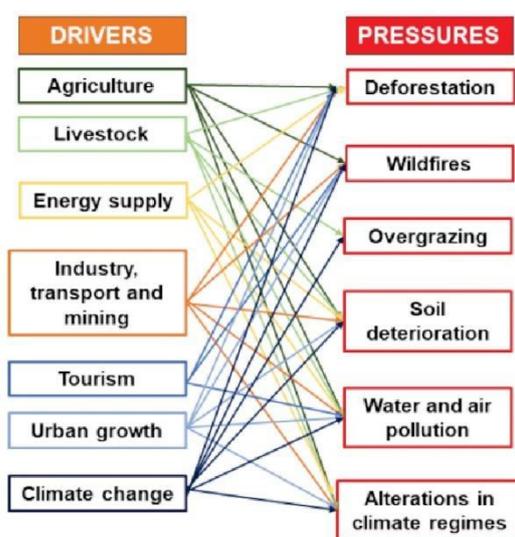


Figure 3. A common pattern depicting the inherent complexity of local systems at 'Soil, Land and Ecosystem Degradation and Desertification risk' (LEDD).

The growth of tourism acts as a high-impact factor when accompanied by other pressure causes and when exerted on ecologically fragile and climatically semi-arid areas. As an example, tourism has played and plays an important role in shaping local land use patterns impacting coastal communities, resulting in shortages of services including water provision [30] and municipal waste disposal. The causal chain initiated by tourism pressure can over time result in significant agricultural land loss. Conflicting opinions on the link between land degradation in the Mediterranean and tourism development have been detected by previous studies, while acknowledging that there are also potentially beneficial effects [31] operating at different spatial and temporal scales. As an example, at the regional level, tourism development can enhance environmental awareness through dedicated policy responses [19] or by increasing knowledge of natural heritage, which in turn leads to positive effects on the local economy [32]. Nevertheless, the most effective development strategies for the governance of the environment and the socio-economic

component [5] can only be identified by applying a holistic approach based on multi-scalar qualitative–quantitative assessments.

Anthropogenic pressures attributable to agriculture depend, instead, on technically incorrect practices, implemented only in order to maximize productivity such as, for example, the excessive use of chemical fertilizers and pesticides, or the immoderate use of irrigation, the lack of or unsuitable crop rotation, and the land processing that alters the soil structure. On the other hand, even the abandonment of the countryside, a phenomenon that affects in particular the poorest and marginal agricultural systems, is the premise of the initiation of soil degradation processes, up to serious effects of hydrogeological instability [33].

Livestock activities, if carried out regardless of environmental characteristics, can also result in soil depletion and/or contamination and, consequently, initiate land degradation processes. Despite the fact that in recent years in the Mediterranean region there has been an overall decrease in the number of livestock, the environmental impact caused by livestock farming has not changed or has increased due to the high concentration and/or high specialization of the sector. Frequently, such zotechnical activity has been forcibly introduced in unsuitable areas, causing imbalances to the agro-ecosystem, especially for the significant nitrate pollution of surface watercourses and aquifers [33].

Although ecosystems have the capacity to recover, even if over a long time, fires considerably compromise natural defenses against desertification. In particular, fire ‘waterproofs’ the soil, increasing the risk of erosive processes. It is important not to forget that fires alter the ecosystem by modifying the composition and structure of plant and animal communities. The main cause of fire in the Mediterranean, in addition to agriculture and pastoralism, is also represented by illegal urbanization, practiced mainly in the fringe territories, which has obvious implications on the sealing of the soil and, again, on the alteration of hydrological regimes at the local scale [34].

Finally, anthropogenic pressure expresses its negative prerogatives in terms of water use. In recent decades, the demand for water for civil, agricultural, and industrial purposes has increased dramatically, severely undermining the renewal processes of the resource. Agriculture, also in this case, is the main suspect since it accounts for about 60–70% of total annual water consumption. The increasing substitution of traditional cultivation systems, with highly intensive and specialized crops, has translated to higher irrigation needs, especially in a context of climate change that involves a decrease in rainfall.

While agriculture is the productive activity with the highest water demand, the effects of water withdrawals for civil use cannot be overlooked, especially in densely populated areas such as coastal zones, large urban areas, and tourist centers. In fact, the unsustainable use of the resource has led, especially in recent decades, a sharp increase in consumption that compromises, both in terms of quantity and quality, the water heritage. The urban expansion, in addition to the consumption of water, involves the removal of important shares of fertile soil, both for the direct sealing of surfaces and land uses resulting from population growth (roads, shopping centers, and landfills). These phenomena are also related to various processes of contamination, punctual and diffuse, which exacerbate soil degradation and the consequent alteration and fragmentation of the landscape [35].

4. Consequences of Land Degradation

Land degradation negatively affects crop productivity and can cause cropland decline. Low land productivity in drylands, coupled with the uncertainty of agricultural returns, tends to discourage investment and technological innovation which, in turn, increase regressive management and weak economic performance further exacerbating land resource degradation. Disparities within the rural sector, between ‘favorable’ and ‘less favorable’ areas, can emerge as a result of these socio-economic biases, introducing potentially disruptive dynamics and pressures on local populations [36].

Population movements from rural to urban and coastal areas can be further exacerbated by land degradation, deepening the depopulation and the land abandonment pro-

cesses started since the Second World War and triggered by industrialization, the decrease in agricultural incomes, and the different market rules introduced by these socio-economic changes. Nowadays, although resized, the phenomenon is still in place. Ecosystem carrying capacity, population density, and land degradation linkages seem in many ways debated even if, in conditions of aridity and low soil fertility, population growth (due to birth and/or immigration) can lead to generalized conditions of poverty and can accelerate the disparities between social classes [37].

Migratory movements represent another complex social phenomenon that often relates, directly or indirectly, to the various problems of environmental degradation. Migration can be analyzed from several aspects, among which the temporal dimension and the direction of movement are very important [38]. Poverty, when acting as a pervasive population condition, can explain migration and land (rural areas) abandonment and/or urban expansion with the consequent triggering of processes of degradation. Such processes have been detected with some regularities (timing, intensity, and spatial direction) in Portugal, Spain, Italy, and Greece (and, albeit partially, also in southern France), indicating how rural depopulation in the Mediterranean countries plays a key role in explaining land degradation and desertification risk [39]. In southern Europe, the geography of social impoverishment often coincides with conditions of aridity and, therefore, with that of vulnerability to desertification processes. Moreover, in this case, the causal mechanisms are not entirely linear and, at the moment, are not fully explored due to the fact that many complex factors concerning the organization of society intervene, such as, for example, governance strategies and market regulation interventions [1]. Poverty conditions can accelerate land degradation phenomena and vice versa also when the political response to address environmental issues and the market and/or institutions are fragile [40].

In Italy, Rodrigo-Comino et al. [29] revealed how environmental and social factors can reduce the ecological quality of low-income territories such as southern Italy, generating the basic background to start a downward spiral of ‘Desertification–Poverty’. This aspect is confirmed by an analysis of the positive relationship between the relative poverty rate and the rate of soil degradation at the regional level. While showing different levels of desertification risk, southern regions showed a poverty rate consistently above 20%, associated with a higher risk of desertification, while in many northern and central regions the poverty rate is significantly below 10%, and sensitivity to LD is low or completely absent [29].

Furthermore, it was observed that in the arid regions of southern Europe, the geographical marginalization of the poorest rural populations often translates to a higher vulnerability to natural disasters as a consequence of the weak accessibility to public services such as education, health, information, and social benefits. The same study by Rodrigo-Comino et al. [29], for example, shows how all indicators, concerning labor market, education, and social factors, are consistent in describing worse social conditions in areas with high sensitivity to land degradation, compared with average Italian conditions. Unemployment rates, especially female and youth unemployment, increase dramatically in municipalities with higher LD rates, while education levels show a clear reversal of the trend [29]. It is important to consider that the migratory movements generated by poverty determine in turn further situations of poverty due to the difficulty, in areas with a high concentration of population, of ensuring adequate employment and wages for the entire population. Indeed, women, young people and, at present, those over 50 (for whom re-entering in the labor market is quite difficult), are the most affected part of the population, further exacerbating other social problems of local and regional impact [6].

5. Disparities in the Spatial Distribution of Land Resources

The environmental and social features that characterize and homogenize the Mediterranean region set in motion a specific complex spiral, where degradation coincides mainly with the abandonment of agricultural activity, the worsening of land structures, the unsustainable exploitation of water resources, the concentration of economic activities in coastal

areas, the uncontrolled development of industrial activities, and tourism [41]. Italy, characterized by a highly anthropized territory and by a complex morphology, is not exempt from degradation processes that are evident in areas of southern regions and islands (Basilicata, Apulia, Calabria, Sardinia, and Sicily) where climatic and anthropic stress has led to a clear decline in biological and agricultural productivity and a progressive loss of biodiversity of natural ecosystems [27].

Even the central-northern regions, which do not seem to suffer from overt desertification phenomena, show signs of progressive deterioration of environmental conditions due to irregular rainfall, drought, and drying. Moreover, in recent years, the decline of agro-environmental quality in these areas is also due to anthropogenic pressures associated with agricultural intensification, soil erosion, and accelerated urbanization rates. Urban and infrastructural expansion has consolidated a settlement pattern based on urban sprawl, high land consumption, and ecological fragmentation [42].

While many Mediterranean countries have undergone impressive economic development in recent decades, regional disparities are not showing the same pattern, highlighting how integrated policy interventions, addressing both environmental and socio-economic issues, are much needed in disadvantaged and arid areas of Portugal, Spain, Italy, and Greece. The processes analyzed so far can contribute to consolidate polarized territories [43], amplifying social inequalities between 'richer' and more disadvantaged areas. The national and local strategies aimed at containing (or, if possible, removing) socio-economic imbalances, while incorporating the spirit of the Lisbon Treaty of 2007 and considering the priority need to stimulate sustainable economic growth fully integrated with environmental issues, have not always been effective. The interest in redressing these imbalances therefore links the concepts of economic and social cohesion with the mitigation of environmental pressures [37].

To guide sustainable development policies, research addressing the regional convergence of economic, social, and cultural variables appears helpful. On the other hand, convergence in the processes of improvement (or decline) in environmental quality, over time and space, has been less investigated than the more classic convergence in economic and (partly) social variables [44]. By applying the traditional convergence analysis for the level of vulnerability to land degradation in some regions of Mediterranean Europe, a complex pattern of convergence/divergence has been observed with regard to Italy, where the level of vulnerability tends to diverge and polarize over time mainly in the regions of northern and central Italy, thus highlighting the influence of the geographical scale on these phenomena [16]. Considering this, it is important to be able to differentiate policies to combat desertification on the basis of territorial specificity. Consequently, two target cases can be recognized: (i) highly vulnerable territories, converging in time, in disadvantaged economic conditions; (ii) only moderately vulnerable territories, with a divergent level of degradation and strongly polarized within, subject to climatic conditions in progressive aridification but in a relatively favorable socio-economic context.

Even though the adoption of policies to mitigate degradation processes is recognized as a priority, regrettably only areas included in the first group have received attention so far, leaving behind the moderately vulnerable territories. Succeeding in improving the set of monitoring indicators is another requirement for ensuring the effectiveness of policies to mitigate and reduce regional disparities.

6. Complexifying Geographies of Land Degradation: The Case for Italy

Several integrated and multidisciplinary approaches have been proposed so far to assess the degree of land vulnerability to degradation [45]. Among the most popular computational procedures, usually adopted on an international scale, the Environmentally Sensitive Areas (ESA) scheme seems to be the most suitable for the study of the Mediterranean basin [46].

This methodology introduces a two-stage assessment process. In the first stage, elementary data (for the individual variables used) are combined to provide four quality

indicators (climate, soil, vegetation, and land management). In the second step, the Environmentally Sensitive Area Index (ESAI), for each spatial unit considered, is calculated as the geometric mean of the four partial environmental quality indicators. The ESAI can be adjusted according to different input data addressing different environmental and socio-economic conditions, as it can be employed in different contexts ranging from Portugal to Turkey [22]. The ESA index assumes values ranging from 1 to 2: lower scores indicate negligible or low vulnerability to land degradation, while higher scores indicate critical environmental conditions that may result in a high level of vulnerability [47].

The analysis of the temporal evolution of land vulnerability allows to evaluate the conditions predisposed to land degradation in Italy according to four degradation systems (climate, soil, vegetation, and land management) and the changes recorded at the regional level. The Italian territory has been classified, in the last fifty years since 1960, in different levels of vulnerability to desertification based on categories derived from a geographical assessment conducted through a synthetic index that assigns an increasing score to each spatial unit, considered on the basis of four dimensions of analysis, related to soil quality, climate, vegetation, and land use. Interestingly, while areas classified as ‘fragile’ and ‘critical’ increased in size rather uniformly throughout the 1960–1990 period, the increase observed in the most recent period was more moderate but spatially widespread [27].

This is evident when looking at the differences in ESAI scores between geographic districts over the indicated period, these have moderately decreased over time, delineating a moderate spatial convergence of land degradation risk in Italy. In more detail, the average ESAI score increased by 1.5%, from 1.34 in 1960 to 1.36 in 2010, showing a slight increase in vulnerability to LD (Table 1). While southern Italy showed a higher level of vulnerability (1.38 in 2010), the highest increases in mean ESAI were found in northern Italy (2.3%) and central Italy (2.0%) during the investigated period [48].

Table 1. Average ESAI score in Italy by geographical division and year.

Year	North	Centre	South	Italy
1960	1.317	1.328	1.374	1.342
1990	1.327	1.342	1.388	1.355
2010	1.347	1.355	1.382	1.363

The integrated analysis of the level of vulnerability of lands and its evolution over time allows, therefore, to outline a dynamic view of the environmental background conditions that determine, at the local and regional level, a higher level of vulnerability and, potentially, a higher risk of desertification, according to the complex interrelations described in the previous paragraphs. The Italian territory, depending on the pressures received and the degree of fragility that characterizes it, presents a rather heterogeneous set of conditions of vulnerability to degradation processes. The greatest criticalities can be recognized mainly in the south of Italy where, in general, climatic conditions are relatively more aggressive than in the rest of the territory. At the beginning of the observation period, which could be correlated to the economic development started in the immediate post-World War II period, the assessments return a geography of the vulnerability of the Italian territory according to classic axes of geographical interest, such as the coast–interior gradient and the urban–rural gradient [17].

The classification by regions, in this case, sees at the opposite extremes Sicily and Trentino Alto Adige, with vulnerable areas far greater than 50% in the first case but of negligible entity in the second, identifying a clear north–south axis. Between the two extremes are all the other regions, among which Molise, Puglia, Basilicata, and Sardinia (all located in the southern part of the country) stand out for the wide extension of their vulnerable areas. Moreover, it is possible to distinguish territorial areas of medium vulnerability, localized above all in central Italy (for example, the Tuscan-Lazio Maremma) and in smaller part in northern Italy (for example, limited portions of the Venetian plain). On the whole, in 1960,

almost 10 million hectares, equal to about 33% of the national territory, were vulnerable to land degradation processes, although at different levels (Figure 4).

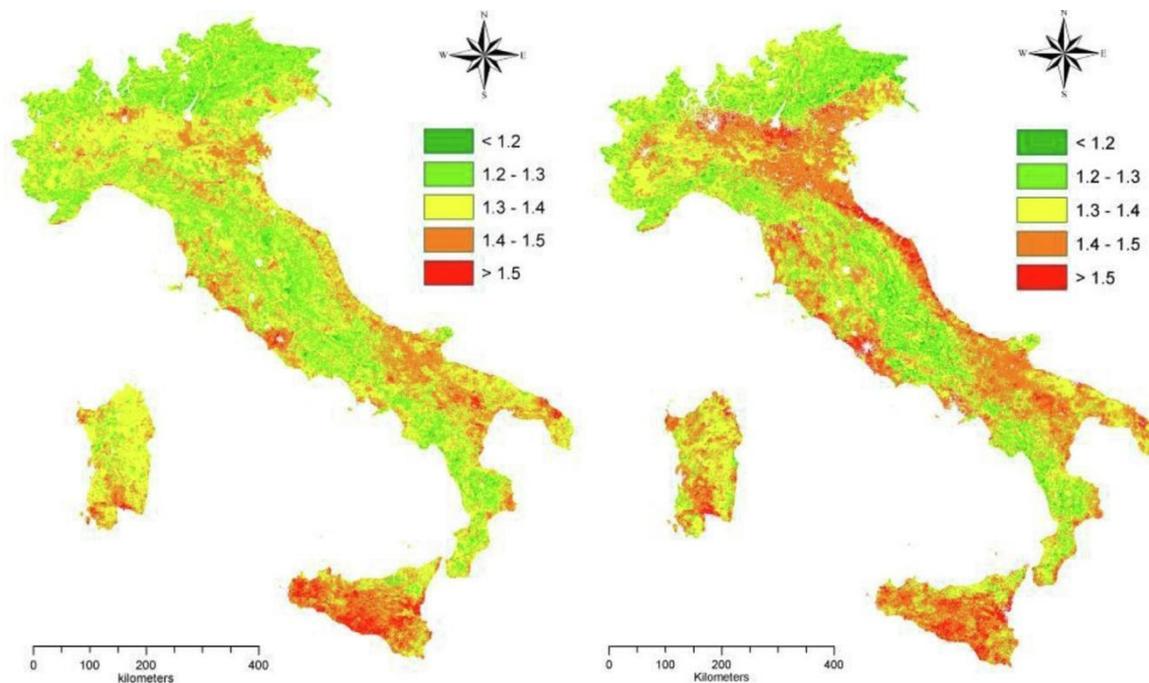


Figure 4. Land classification according to ESA index (**left:** 1960; **right:** 2010; higher values indicate a higher level of land vulnerability. Source: authors' elaboration).

Considering the period between 1960 and 2010, the assessment carried out allows to delineate a long-term temporal dimension that reflects a tendency towards the increasing exacerbation of environmental conditions. This deterioration presents a rather complex spatial distribution that does not allow to identify clear geographical gradients. At a local level, instead, the level of vulnerability shows more structured trends such as, for example, the growth recorded in coastal areas compared with inland areas. The causes, in this case, can be attributed to climate trends (due to reduction in precipitation and general increase in temperatures) responsible for the expansion of arid and semi-arid areas but also to the increase in anthropic pressure, as well as changes in land use [49].

At the local level, there are many areas where, in the last 50 years, the level of vulnerability has decreased. These are regions with low population density, with marked characteristics of rurality and often of marginality, where typical landscapes, traditional agriculture, and ancient settlements resist. Here, the eventual phenomena of land abandonment are somehow mitigated by processes (spontaneous or guided by man) of reforestation that increases the wooded area with positive effects on the conservation of soil and water resources and biodiversity [36].

The geographical analysis can provide further considerations on the diffusion or concentration of areas that present problems of environmental vulnerability. This vulnerability can also be recognized in territorial areas where other types of effects prevail, which are due, for example, to predisposing geomorphological characteristics (e.g., erosive phenomena due to calanqueous soils, scarce vegetal cover, high steepness, etc.). In general, these situations, often associated with inappropriate land management, can be easily observed in the south of Italy but also in other areas of the country where similar conditions persist (e.g., Liguria). On the other hand, situations of low vulnerability, which have remained so throughout the period examined, have been found in limited territorial areas where ecosystems have not been compromised by human presence and climate aggressiveness (for example, inland areas located in the mountain range).

In order to provide a paradigmatic example, one of the most significant changes observed in northern Italy from a socio-economic point of view [50] is represented by the transformation of the landscape of lowland areas due to low-density urban expansion (urban sprawl). This phenomenon determines the conversion of land from agricultural to peri-urban through a process of progressive soil sealing that has grown significantly from 1960 to 2010, both in absolute and relative terms, compared with the resident population. This indicates the need for effective mitigation policies that, even before being operational, represent a paradigm shift in approach that can take into account not only rural territories, economically marginal and socially disadvantaged, but also peri-urban territories in rapid transition where the level of vulnerability is increasing dramatically.

7. Discussion and Conclusions

According to the approach of Blaikie and Brookfield [51], desertification (and more specifically land degradation) can be considered typically socio-economic problems: the productive exploitation of land and land management are essentially derived from social needs. Consequently, the carrying capacity of ecosystems, soil productivity, conflicts over acquiring natural resources, and the very pursuit of sustainable development are to be seen as a result of the continuous human–nature interaction [52]. This highlights the importance concerning the organization of the territory, the integration of the social and economic context, and the reduction in inequalities and territorial disparities. These issues should be properly referred to the concept of sustainable development and, in relation to this, should be interpreted and implemented [53]. The assumptions underlying the processes of desertification also confirm the urge for a holistic approach to sustainable development [54], without which the causal chains described above could turn into environmental spirals that are difficult to counteract.

The introduction of the concept of socially sustainable development, intended as balanced in all its components (economic, social, and environmental) in time and space [37], can significantly contribute to this direction, not only because this connotation of sustainability transcends a specific meaning of development, but also because of the possibility of identifying objectives and mechanisms of policy and feedback that incorporate the concept of sustainability itself. It is difficult to determine whether these expectations will be translated into economic policy measures, but this possibility goes hand in hand with the existing linkage between the perspective of policy makers and the consequences of non-sustainability. In such a social and economic context, however, the development path may generate a negative trade-off with the environment due to the production components with higher impact. Nevertheless, the development path should stimulate counter/mitigation responses to environmental degradation in these cases [7].

We have observed how the phenomena of land degradation do not present a common matrix at the national level, being qualified by different productive, institutional, and value context factors at the basis of the substantial territorial disparities present in Italy. It should also be noted that not only the environmental mechanisms of degradation, but also the channels of transmission of economic and social impacts on the ecosystem, differ significantly in different areas of the country. This proves that even the consolidated subdivision of regions into ‘Objective 1’ and ‘Objective 2’ according to their development potential can usefully capture, on a macro scale, some of the most significant differences inherent in environmental problems. It seems appropriate to point out that, in any case, more articulated classifications of the territory are necessary in order to address environmental sustainability policies more effectively [55].

Truly effective measures against land degradation, coherent with the concept of sustainable development, should prevail over a restricted sectoral vision and carry out a truly multi-target and multi-scalar approach [56]. This is especially relevant to address simultaneously different degradation processes at the local level with interactions and feedbacks difficult to manage by sectoral environmental measures. The ‘local’ dimension, therefore, remains a fundamental premise for any intervention strategy (even if conceived

at a national or supranational scale) and should also include specific actions to mitigate spatial disparities [56].

In particular, we emphasize the need to consider the increased territorial imbalances in the distribution of natural resources as a question of socio-environmental equity with repercussions also in the economic sphere. In the previous paragraphs we have highlighted how the complex geography of land degradation in Italy and the greater interconnection between different environmental gradients, which determine the distribution in space and time, can lead to greater environmental disparities, consolidating even traditionally polarized territories. For this reason, this phenomenon needs to be increasingly integrated into the framework of environmental policies at the national and European scale [57].

The linkage between land degradation and anthropogenic pressure (variously declined in all the manifestations described in this contribution such as, for example, poverty, territorial gaps, urban-rural polarization, and the transformation of production structures, etc.), must be able to stimulate general and local measures of environmental policy capable of addressing new issues of spatial planning, namely the rebalancing of population density gradients and territorial development in a polycentric perspective [58]. For instance, it is very important to mitigate the causes that triggered internal migration, which had an important influence on the phenomena of littoralisation and urban sprawl in Italy as in all the other countries of Annex IV [59].

Finally, great importance is given to scientific research for the concrete ability to indicate policy responses to be implemented specifically in the various contexts [56] taking into account the institutional framework [60], the range of possible strategies that can be pursued, and the overall degree of knowledge of the phenomena and their interactions with the bio-physical and socio-economic dimensions of desertification.

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