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Assessment of Land Susceptibility to Desertification Using the MEDALUS Method: Case Study of the Oued El Abid Catchment, Central High Atlas, Morocco

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Abstract: *This article presents an attempt to assess the sensitivity of land to desertification and drought in the Oued El Abid catchment (Central High Atlas, Morocco) using the MEDALUS method. This is a geospatial method for assessing the sensitivity of an area to desertification by adopting a geographical approach based on calculations of geospatial data in a Geographic Information System (GIS). Four main indicators were used like soil quality, climate quality, vegetation quality and the quality of land use and management. The results show that the Land Sensitivity to Desertification Index (LDI) in the Oued El Abid watershed revealed a low susceptibility in (62%) of the total surface of this catchment, corresponding to intact subhumid and forested areas with little human activities (high mountains with difficult access). Whereas high to moderate sensitivity affected only 38% of the total surface in the arid lands, poorly watered, sparsely vegetated and highly anthropized, especially in the large and fragile synclines and plateaus (El Houanet plateau, Taguleft, Naour and Tizi Nisly synclines), expressed by remarkable over-exploitation of land resources: deforestation of slopes, agricultural expansion to the detriment of forests and intensive pastoral activities.*

Keywords: Desertification Susceptibility Index (DSI), MEDALUS, Oued El Abid Catchment

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1. Introduction

Land degradation is a major challenge facing soil resources and agricultural productivity worldwide, particularly in arid and semi-arid mountain regions. According to the United Nations Convention to Combat Desertification (UNCCD), desertification is defined as land degradation in arid and semi-arid regions resulting from human activities and the effects of climate change. These regions have therefore become more vulnerable. According to the Organization of Islamic Cooperation (2019), 40% of the world's land is vulnerable to desertification. The 1977 UNESCO world conference in Nairobi defined desertification as a common degradation of ecosystems due to climatic conditions becoming more arid, irregular rainfall and excessive human exploitation of natural resources (water, soil, forests, etc.) which leads to a reduction in the capacity of the land or soil to provide production conditions favorable to territorial development and human stability in the area (El Garouani et Tribak. 2006; Janati Idrissi., et al., 2015).

In the face of widespread drought and lands degradation a series of scientific models and methods have been developed and supported by scientific and government bodies and international organizations. For example, the Iranian desertification potential assessment model (AMDP), which is based on nine criteria and 36 indicators, has been used. The ENVASSO project (Environmental Assessment of Soil for Monitoring Project), funded by the European Commission as part of its support for scientific research was also launched to identify and document the continent's soil monitoring and protection system by setting up a specialized committee made up of 25 EU member experts. The committee identified nine threats to soil quality, summarized in 60 indicators covering all natural and man-made components, in order to obtain possible scenarios and predict the potential risks involved (Huber et al., 2008). In Africa, many studies were carried out to assess the desertification levels by using the MEDALUS model (Rasmy and al. 2010, Boutallaka and al, 2020) …

In this context, we have tried to adopt this "MEDALUS" model with the help of GIS techniques for the evaluation of the susceptibility of land to desertification in the Oued El Abid catchment because it has contributed to reduce efforts and money to grasp and understand this complex and multifaceted phenomenon and to come closer to knowing the state of the land degradation in this area.

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2. Study area and Method

The Oued El Abid catchment, above the Bin El Ouidane dam, covers an area of 3001 km² in the central High Atlas, it is one of the major catchment areas in the Oued Oum El Rabia basin. Administratively, it covers the 24 territorial communities in the Beni Mellal Khenifra and Draa Tafillalet regions (Fig.1)

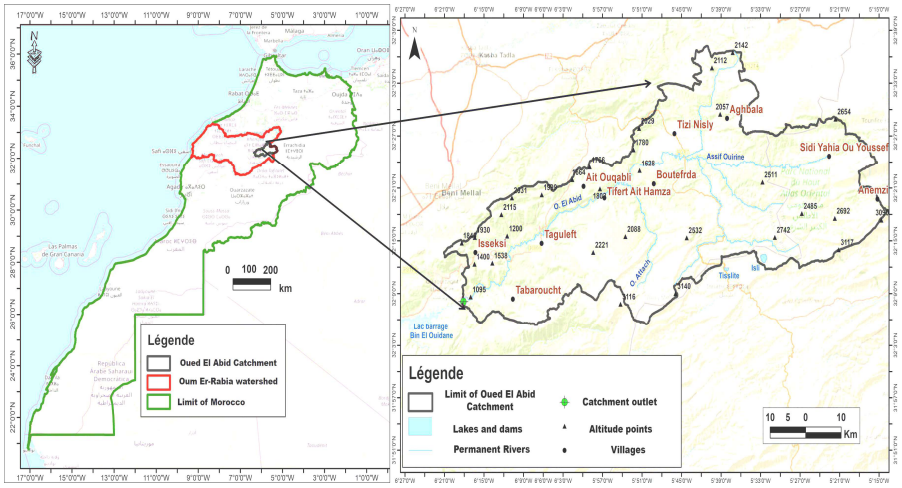

Figure 1: Geographic localization map of the Oued El Abid catchment, Morocco

This study adopts the MEDALUS method (Mediterranean Desertification and Land Use), which is developed to measure the sensitivity of the lands' desertification. This model has proved its effectiveness in many countries that have applied it in numerous scientific studies. This model is created to assess lands degradation using a geospatial mapping approach employing Geographic Information System (GIS) techniques. The Desertification Sustainability Index (DSI) is assessed and calculated by combining four indexes: The climate quality index (CQI), vegetation quality index (VQI), soil quality index (SQI) and land use quality index (LQI), as shown in Figure 2, in order to extract the weighted geometric mean of these four indicators according to the following equation (Domingues and Fons-Esteve, 2008) (Fig.2).

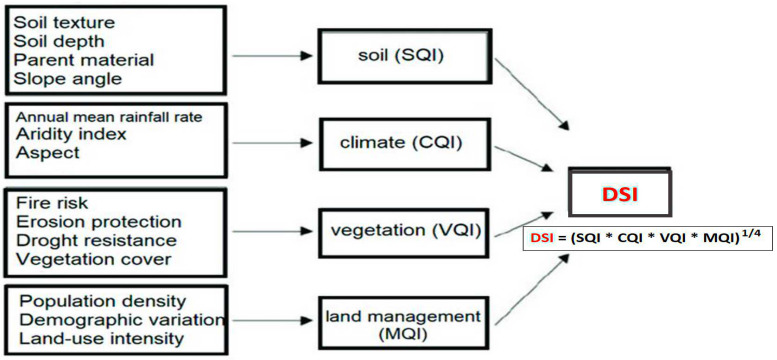

Figure 2: Basic components of specific dimensions of land degradation (soil, climate, vegetation, land management) according to the Environmentally Sensitive Area Index (ESAI) framework (Rosanna Salvia, and al. 2019)

3. Results

The results of the applied study using the MEDALUS model made it possible highlight the most important desertification indicators in the Oued El Abid catchment (Table 1).

Table 1: Results of the desertification Sensibility index in the Oued El Abid catchment (Morocco) (Ait Omar and al, 2024)

Lands' Susceptibility to desertification index	Coding 1 to 2	Area (km²)	Percent %	Description and characteristics of the areas
Weak susceptibility	1	791	26	Semi humid areas with dense vegetation and soil cover and limited anthropic activities
Medium susceptibility	1.5	1056	36	Semi-arid areas, with an earth cover of

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				medium thickness and structure, and vegetation cover of medium density and poorly exploited
High susceptibility	1.75	823	27	Arid areas, with fragile soil cover and weak vegetation, suitable for grazing areas and irrigated crops
Very high susceptibility	2	331	11	Dry areas with fragile soil cover that are bare or exploited for seasonal fallow agriculture
Overall	**-**	**3001**	**100**	✓ 62% of areas have a weak to medium sensibility to desertification ✓ 38 % of the catchment areas are very exposed to desertification risk.

The desertification susceptibility map of the Oued El Abid catchment shows clearly that there is a differential distribution of land susceptibility to desertification. The areas of low to medium susceptibility cover (62% equal a 1857 km²) of the overall surface area of this catchment, where are located in the north and north-est parts, corresponding to sub-humid slops with more or less coherent vegetation and covered soil, associated to limited human activities (Atlas Mountains of Beni Mellal and mountains of Aghbala…) (Fig.4) and may include semi-arid areas, with soil cover of medium thickness and structure, medium-density vegetation and low exploitation. On the other hand, the areas of high to very high susceptibility (38% equal a 1154 km²) are found in dry areas with little vegetation cover, corresponding to grazing areas and irrigated agriculture, as well as in dry and semi-arid areas or areas used for agriculture (Table.1 and Fig.5). These degraded areas are specifically located in the eastern, southern and south-western parts, exactly in the syncline of Tizi Nisly, syncline of Taguleft, Tabaroucht basin and Aghbala et Ait Ouqabli lands where is located the red clay soils extremely vulnerable (Fig.3-4).

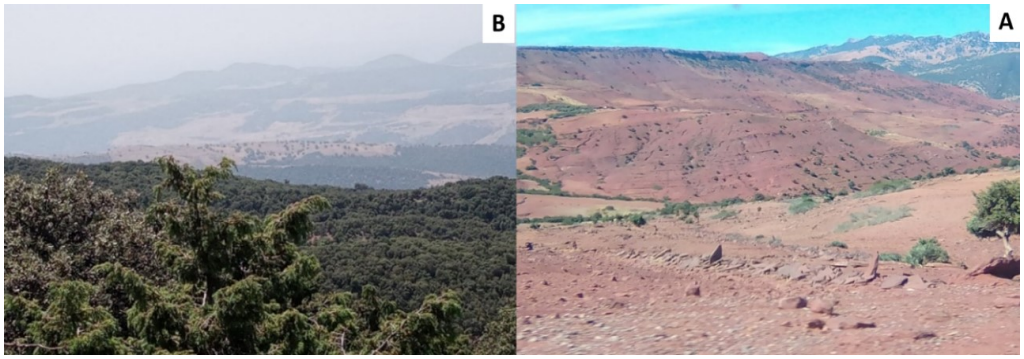

Figure 3:A- arid and semi-bare south-southwest slopes of Jbel Idemrane overlooking the Taguleft syncline; B- Humid vegetated northern and northeastern slopes of the Bou Izerfane jbel dominates the Ben Cherrou syncline, Naour (2023)

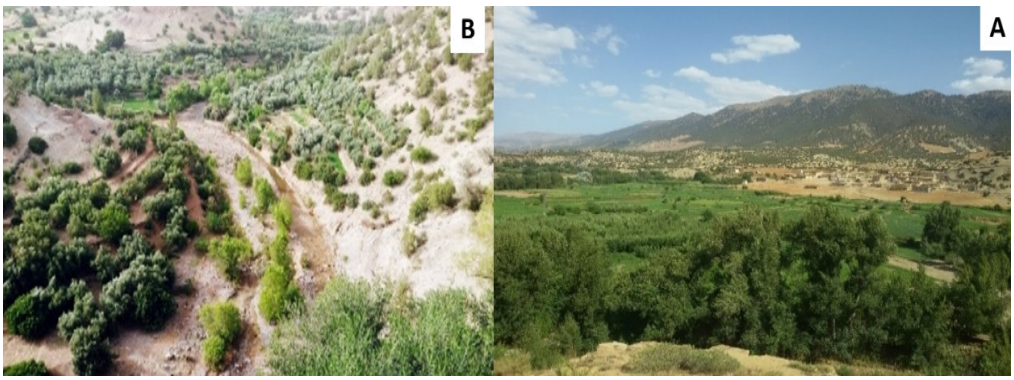

Figure 4: A- Areas of cultivation and arboriculture in the Ouirrine-Aghbala valley - B- arboriculture in the Wahrmach douar in the commune of Taguleft (2023)

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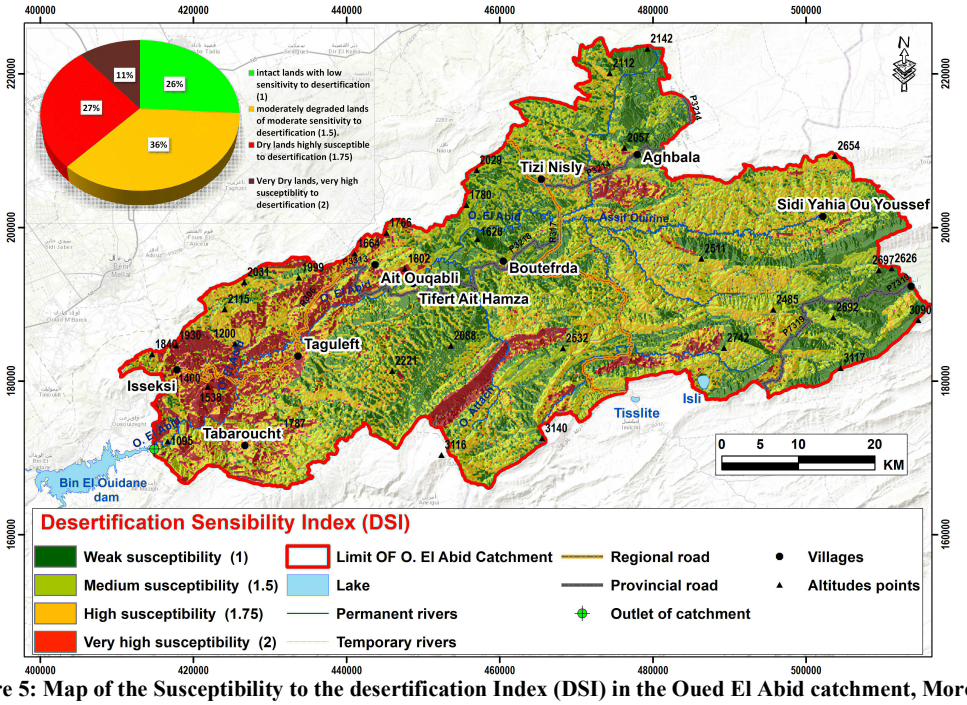

Figure 5: Map of the Susceptibility to the desertification Index (DSI) in the Oued El Abid catchment, Morocco

4. Discussion

The results obtained in this study are relatively close to many previous studies, for example, the study conducted by Boutallaka and al (2020) which has achieved to measure susceptibility to desertification and indicators of fragility in the "Wargha" catchment, applying the "MEDALUS" method. It showed that the Wargha catchment presents a very sensitive environment representing approximately 26.85%, whereas in the Oued El Abid catchment it seems much degraded compared to that of Wargha where the zones of high and very high susceptibility reach (38%). But it seems very near to the results of the study carried out by Lahssini et al (2017) in the Oued El Maleh catchment area, which determined that (35%) of the its area are highly sensitive to desertification and are concentrated in the plains and fragile mountainous areas. Based on these results, the current situation is alarming and also requires the adoption of a comprehensive policy to mitigate the effects of drought in vulnerable areas. Use the desertification susceptibility index map as a decision-making tool to combat the effects of the desertification Finally, to support and develop planning and economic development projects in the basin that take account of the environmental dimension, including the fight against the desertification phenomenon.

5. Conclusion

By way of conclusion, it can be said that the application of the MEDALUS method constitutes a primordial approach to approximating the state of the degradation and the desertification in the Oued El Abid catchment area. The findings revealed that the high susceptibility to desertification of lands affected 38% of the total area, concentrated in the eastern, southern and south-western parts of the catchment. Several factors have contributed to worsening the effects of the land degradation and desertification. The impact of climate change and the fall in rainfall compared with the average, the increase in global temperature, the increase in water evaporation, particularly from surface waters, the severe degradation of forest areas and the reduction in their surface area in the basin, the increasing pressure on forest areas due to deforestation, water erosion, the prevalence of fragile soils with a low capacity to store water for longer and retain water make an impact on the drop in water levels in the Oued El Abid catchment, in light of the growing demand for water resources by the population, and on the drop in water levels in many springs and wells during the hot season of the year. In this context, the definition of target areas needing specific actions for biodiversity and landscape protection, and the dynamic evaluation of the land degradation processes under global change are examples of relevant policy tools and determination of the local districts with degraded land that needing specific measures for supporting biodiversity and landscape quality, reducing de fragile spaces and why not

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trying to make a zero-net land degradation strategy more effective and spatially informed (Salvia Rosanna, 2019). Reducing degraded areas through the development and monitoring of extensive reforestation projects, by encouraging and supporting the regional and local associations and people to plant the trees with economic benefits and most important they must be very adapted to the semi-arid and arid climatic conditions.

Références

Boutallaka Mohamed, Ben-Brahim Youssef, Zouhir driss (2020) : La sensibilité à la sécheresse et les indicateurs de vulnérabilité dans le bassin versant de l'Oued Ouergha selon l'approche MEDALUS ; 21-34 p.

Domingues, F., Fons-Esteve J, (2008). Mapping Sensitivity to desertification (DISMED), Final Report, Version 2, Universitat Autonoma de Barcelona, Edifici C-Torre C5 4a Planta 08193 Bellaterra (Barcelona), Spain, EU, 15 p.

El Garouani, A,. Tribak, (2006). Relation entre Hydrologie et Climat dans le bassin versant de l'Oued Inaouène (Pré-Rif Marocain). Climate Variability and Change- Hydrological Impacts (Proceedings of the Fifth FRIEND World Conference held at Havana, Cuba, November 2006), IAHS Publ.308, p-p: 447-453.

Huber, S., Prokop, G., Arrouays, D., Banko, G., Bispo, A., Jones, R. J., ... & Jones, A. R. (2008). Environmental assessment of soil for monitoring: volume I, indicators & criteria. Office for the Official Publications of the European Communities, Luxembourg, 339.

Janati Idrissi, A., Gartet J., Gartet A. et Daoud A, (2015). Impact du changement climatique dans le bassin du Sebou (Maroc), Spatialisation pluviométrique et étude du régime d'efficacité des flux perturbes, Actes du deuxième colloque International « Eau & climat : regards croisés Nord / Sud », Fès (Maroc), 27-28 Novembre 2013, Publications de la Faculté des lettres et des sciences humaines Sais-Fès, N° 52, P-p : 41-53.

Lahssini, S., Lahlaoi, H., Rhinane H., HILALI A. and Moukrim (2017): Desertification Assessment Using MEDALUS Model in Watershed Oued El Maleh, Morocco, National School of Forestry Engineering, Salé 11000, Morocco, Article in Geosciences P16.

Mokhtari, N., Mrabet, R., Lebailly, P. Et Bock, L, (2014). Spatialisation des Bioclimats, de l'Aridité et des Etages de végétation au Maroc, Revue .Mar.sci.Argon.Vét. p:50-66.

Salamani, M., Kadi Hanifi, H., Hirche, A., Nedjraoui, D, (2013). Évaluation de la Sensibilité à la Désertification en Algérie, Laboratoire d'Ecologie-Environnement, Faculté des Sciences Biologiques, USTHB, Bar Ezzouar, Alger, Algérie, Revue d'Ecologie (Terre vie) 68 (1), P: 71-84.

Salvia Rosanna, Gianluca Egidi, Sabato Vinci, and Luca Salvati. (2019). "Desertification Risk and Rural Development in Southern Europe: Permanent Assessment and Implications for Sustainable Land Management and Mitigation Policies" Land 8, no. 12: 191. https://doi.org/10.3390/land812019.