Chapter 10
PAP/CAR–Based Water Erosion Analysis in the Oued Lakhdar Watershed: A GIS and Remote Sensing Approach

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ABSTRACT

This work is the result of a qualitative assessment of water erosion in the Oued Lakhdar watershed, located within the larger Oum Erbia watershed. The PAP/CAR model and geomatic tools were used for this evaluation. The Oum Erbia watershed, spanning 1664 km^2, experiences severe erosion due to factors such as heavy and aggressive rainfall, steep slopes, sparse vegetation, and the predominance of soft rocks. Human activities, including deforestation, vegetation degradation, and in-

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appropriate agricultural practices, have further exacerbated the erosion problem in the Oued Lakhdar watershed. The PAP/CAR method allowed for a qualitative assessment of erosion throughout the entire watershed and the identification of priority erosion zones. Data analysis using the PAP/CAR method revealed five main erosion states: extreme erosion (20.57%), strong erosion (18.56%), moderate erosion (23.02%), notable erosion (27.02%), and weak erosion (10.84%). In total, 62.15% of the watershed experiences moderate to extreme erosion.

1. INTRODUCTION

In the context of ongoing climate change and land use land cover changes, fertile soils are vital for sustaining human populations (Raj et al., 2019). However, these soils are increasingly threatened by water erosion, a significant global challenge (Osman, 2014). Currently, many soils are in a state of deterioration due to accelerated erosion processes. The Mediterranean region, known for its climatic extremes, faces particularly severe erosion issues (Ferreira et al., 2022). Deforestation for agricultural purposes represents a significant environmental issue, both locally and globally (Thornes & Wainwright, 2004).

In Mediterranean mountainous areas, the expansion of agricultural land through the removal of natural vegetation has amplified erosion vulnerability (López-Bermúdez et al., 1998). These regions face heightened erosion risks not only from the climate but also from increased human intervention and land conversion. Ineffective farming methods, especially in arid, high-altitude regions with steep slopes and shallow soils, coupled with occasional intense rainfall, have significantly accelerated erosion.

In Morocco, particularly in semi-arid regions, soil and environmental degradation is predominantly driven by water erosion (Bou-imajjane et al., 2020; Mazigh et al., 2022; Simonneaux et al., 2015), impacting approximately 40% of the country's land to varying extents (Ayt Ougougdal et al., 2020). The average annual soil erosion rate in Morocco ranges between 23 and 55 t ha−1 yr−1, with extreme values between 115 and 524 t ha−1 yr−1 (Acharki et al., 2022). These variations are influenced by topographic, meteorological, geological, and anthropogenic factors.

The Oued Lakhdar watershed, which is the focus of this study, is part of the larger Oum Rbia basin, located entirely within the Central High Atlas region. This area exhibits physical, climatic, and socio-economic conditions that are conducive to soil degradation, highlighting the need to assess erosion to mitigate its negative effects.

Today, advances in geomatics, such as remote sensing and geographic information systems (GIS), have become essential tools for processing, mapping, managing, and manipulating geographic data. These technologies enable the updating and overlaying of maps to produce an accurate representation of the erosive state of a

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