International Soil and Water Conservation Research 4 (2016) 159–167

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Contents lists available at ScienceDirect

International Soil and Water Conservation Research

journal homepage: www.elsevier.com/locate/iswcr

Original Research Article

Soil erodibility mapping using three approaches in the Tangiers province –Northern Morocco

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ARTICLE INFO

Article history:
Received 15 September 2015
Received in revised form
24 May 2016
Accepted 7 July 2016
Available online 16 August 2016

Keywords:
Erodibility
Soil
Mapping
Tangiers
Morocco

ABSTRACT

Soil erodibility is a key factor in assessing soil loss rates. In fact, soil loss is the most occurring land degradation form in Morocco, affecting rural and urban vulnerable areas. This work deals with large scale mapping of soil erodibility using three mapping approaches: (i) the CORINE approach developed for Europe by the JRC; (ii) the UNEP/FAO approach developed within the frame of the United Nations Environmental Program for the Mediterranean area; (iii) the Universal Soil Loss Equation (USLE) K factor. Our study zone is the province of Tangiers, North-West of Morocco. For each approach, we mapped and analyzed different erodibility factors in terms of parent material, topography and soil attributes. The thematic maps were then integrated using a Geographic Information System to elaborate a soil erodibility map for each of the three approaches. Finally, the validity of each approach was checked in the field, focusing on highly eroded areas, by confronting the estimated soil erodibility and the erosion state as observed in the field. We used three statistical indicators for validation: overall accuracy, weighted Kappa factor and omission/commission errors. We found that the UNEP/FAO approach, based principally on lithofacies and topography as mapping inputs, is the most adapted for the case of our study zone, followed by the CORINE approach. The USLE K factor underestimated the soil erodibility, especially for highly eroded areas.

1. Introduction

Water erosion is one of the most occurring forms of land degradation in the Mediterranean basin (Lahmar & Ruellan, 2007) and the highest rates are reported in Rif Mountains of Morocco (Sabir, Maddi, Naouri, Barthès, & Roose, 2002). It is commonly defined as the displacement of soil surface material due to the action of rain and runoff. In different parts of the world, water erosion leads to several other forms of land degradation: remove of the soil's most fertile layer, pollutants and heavy metals spreading, dams siltation and damaging of roads and various constructions. As an example of the soil surface layer loss rates in Morocco, it reaches 60 t/ha/year (Ait Fora, 1995. in Elbouqdaoui et al., 2005).

Soil loss is a major obstacle to agricultural and infrastructure development in North Morocco. Soil erodibility is one of the main factors for erosion risk assessment. It represents the soil vulnerability, expressed through various intrinsic and extrinsic characteristics, to boost or reduce the effect of the rain erosivity, the slope and the land use.

In Morocco, research works dealing with soil erodibility and erosion risk were undertaken at different scales. For large scale mapping, Elbouqdaoui et al. (2005) used the expert-based model LEAM (Land Erodibility Assessment Model), based on the USLE and satellite imagery to evaluate soil loss rates at the Oued Srou Basin. Bachaoui, Bachaoui, El Harti, and et El Ghamri (2007) used an expert-based approach integrating topography, geology and land use for evaluating soil loss in the Beni Mellal region (Central Morocco), quoting that the output map was validated at 80%. El Garouani, Merzouk, Jabrane and et Boussema (2005) used the

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Peer review under responsibility of International Research and Training Center on Erosion and Sedimentation and China Water and Power Press.

http://dx.doi.org/10.1016/j.iswcr.2016.07.001

USLE in the Oued Jemaa basin (Pre-Rif zone in the North of Morocco). At site-specific scale, studies were generally undertaken for validation or calibration purposes and correlating soil erodibility to various physical and chemical soil characteristics. In fact, Moussadek et al. (2011) studied the effect of various crops residues rates under conservation agriculture on runoff and soil erodibility for a Central Moroccan Vertisol. In the Central Rif Mountains loamy soils, Al Karkouri, Laouina, Roose, and et Sabir (2000) correlated soil erodibility at micro-parcel scale to soil texture, organic matter content, ameliorating prediction by adding surface characteristics such as stoniness, roughness and vegetation cover. In a larger context, Merzouk and Blake (1991) used rainfall simulation to study interrill soil erodibility for various Moroccan soils, correlating it to forty-two soil individual/combined characteristics. In other parts of the Mediterranean basin with pedolandscapes similar to our study zone, several authors mapped soil erodibility using different approaches. The CORINE approach was used at regional scale (Bayarmin, Erpul & Erdogan, 2006; Dogan, Küçükçakar, Özel & Yıldırım, 2000) and at larger scale (Grimm, Jones, & Montanarella, 2002).

Through this work, we studied soil erodibility through large scale mapping in the Tangiers province of Morocco. We tested the three most used mapping approaches in order to know the appropriate one for similar landscape context in the North and Central Morocco. With regard to the fact that data on soil erodibility are limited, we seek a standard soil erodibility mapping method for more effective large scale erosion mapping and modeling.

2. Materials and method

2.1. Description of the study area

The Tangiers province is located at the North-West of Morocco (Fig. 1), covering of 1350 km^2. The geographic longitudinal extents are 5°33'W and 6°05'W, latitudinal extents are 35°19'N and 35°51'N. The landscape of the province is of four main domains. The northern part is of low-hilly marls landscape, while the north-east part is of accidental relief with marls and sandstone flysch escarpments. The central part of the zone is a lowly slopped alluvial area with loose alluviums. The southern part is a medium sloppy area where marl deposits reoccur along with sandstones. The Fig. 2 shows the main soil Reference Groups according to the

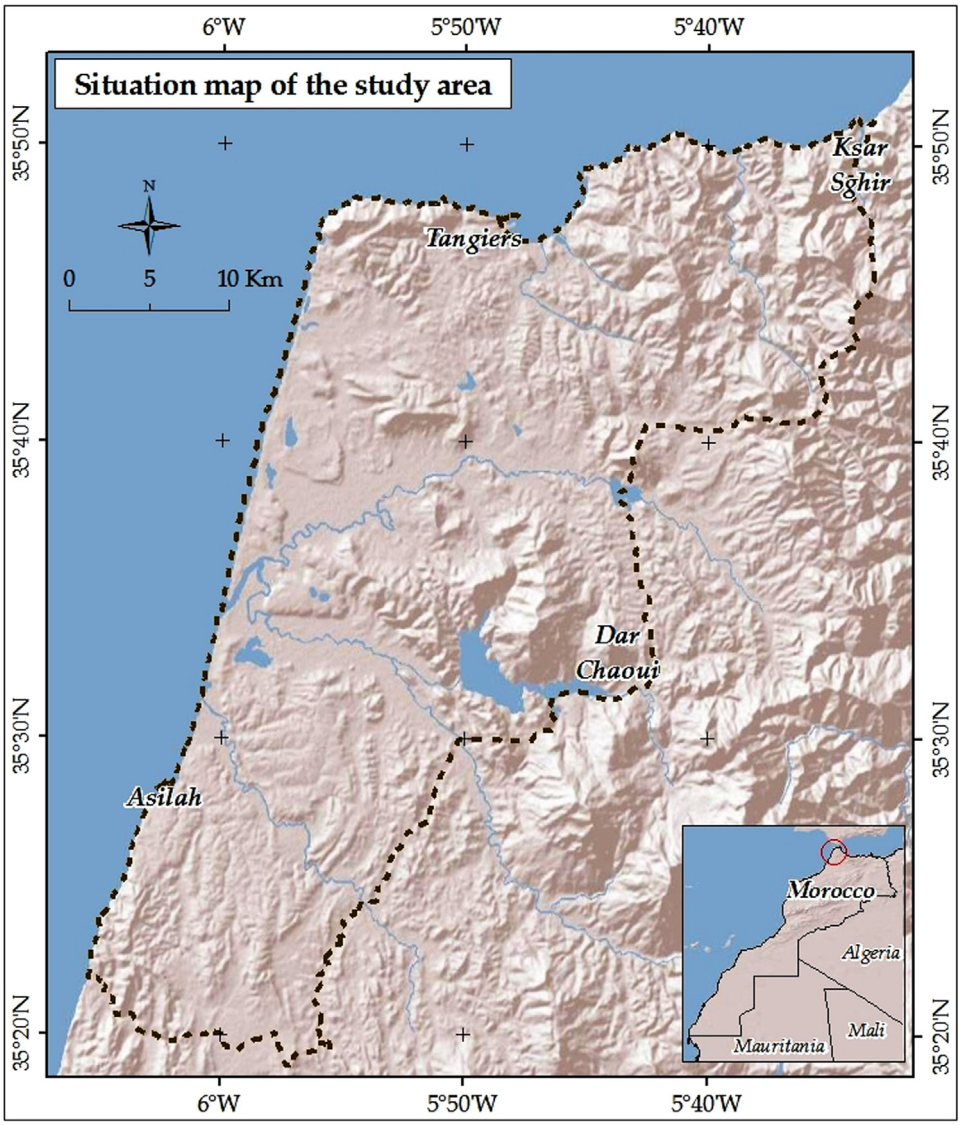

Fig. 1. Situation map of the study area.