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Regional erosion risk mapping for decision support: A case study from West Africa

Farris A.Y. Okou[a,*], Brice Tente[b], Yvonne Bachmann[c], Brice Sinsin[a]

[a] *Laboratory of Applied Ecology, Faculty of Agronomic Sciences, University of Abomey-Calavi, 01 BP 526, Cotonou, Republic of Benin*
[b] *Laboratory of Biogeography and Environmental Science, Department of Geography and Planning, Faculty of Letters, Arts and Humanities, BP 677 Abomey-Calavi, Republic of Benin*
[c] *Institute of Ecology, Evolution and Diversity, J.W. Goethe-University, Max-von-Laue-Straße 13, 60438 Frankfurt/Main, Germany*

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A B S T R A C T

Effective soil and water management strategies require regional-scale assessment of erosion risk in order to locate prioritized area of intervention. Our study focuses on the Atacora mountain and surrounding areas (covering more than 18% of the total land area of Republic of Benin) which face a serious erosion threat despite their ecological and economic importance. To appraise the level of soil erosion risk of large area, we rely on the Instituto Nacional para la Conservación de la Naturaleza (ICONA) erosion model and use data from geographic information system (GIS). The erosion risk model requires four main inputs, namely, information on slope, lithofacies, land use and vegetation cover. The slope layer computed from ASTER digital elevation model (DEM) and the lithofacies layer inferred from digital pedogeological map are combined to draw soil erodibility map. To build soil protection map, we use land use/land cover layer extracted from LANDSAT 7 ETM + images in addition to vegetation cover layer derived from MODIS NDVI product. The final erosion risk map (with a resolution of 1 arc second) is obtained by overlapping erodibility and soil protection maps. We find that 21.8%, 58.5%, and 19.5% of the study area presents very low to low, medium, and high to very high level of erosion risk, respectively. Moreover, our findings are aggregated at the district-level (administrative unit). We observe that erosion risk is more acute in Boukoumbe district. Kerou, Kobli and Natitingou districts are mildly affected by erosion risk, while Kouande, Materi, Pehunco, Tanguieta and Toucountouna districts face a low risk. Ultimately, the proposed erosion risk map can help researchers and decision makers design and implement effective soil and water management interventions in the study area.

1. Introduction

Land degradation is one of the most serious global environmental issues of our time (Dregne, 1998; Reynolds and Stafford Smith, 2002). Land use activities are among the key drivers of land degradation worldwide. These activities shape the land surface and can induce substantial changes to natural phenomena (Steffen et al., 2007). Human activities are at the heart of several environmental challenges. Actually, Humans dominate, transform and modify ecosystems (Zika and Erb, 2009) to their own benefit, yet often at the expense of the global ecological patterns and processes.

Sound soil and water conservation measures (Bou Kheir et al., 2006) are needed to mitigate the pervasive and disruptive impact of land degradation on sustainable natural resource management. Moussa et al. (2002) and Souchère et al. (2005) argue that a spatially distributed assessment of erosion risk is mandatory and must be performed before implementing any effective soil conservation measure. Other authors advocate for the use of geo-indicators, which are aggregate and efficient proxies of surface processes in the assessment of land degradation (Berger, 1996; Berger, 1997; Dumanski and Pieri, 2000; Gupta, 2002; Hammond et al., 1995; Morton, 2002; Zaz and Romshoo, 2012; Zuquette et al., 2004). Moreover, recent advances in scientific computing, remote sensing, and GIS technologies enable cheap and fast processing of large and complex datasets. This may help alleviate a major practical challenge inherent in implementing erosion models (Merritt et al., 2003), as they are data-intensive and time consuming (Vrieling et al., 2006). However, accessing clean data is a pivotal issue in Sub-Saharan African countries that often lack of well-functioning data collection systems. Interestingly, Van Rompaey and Govers (2002) show that when data are scare and/or unreliable, simple erosion models provide a more accurate assessment than complex ones. Complex erosion models are often adequate for small scale applications, but loose tractability for large scale

* Corresponding author at: 01 Po Box: 357 Porto-Novo, Republic of Benin.
E-mail addresses: farrisokou@gmail.com, farrisy@yahoo.fr (F.A.Y. Okou).

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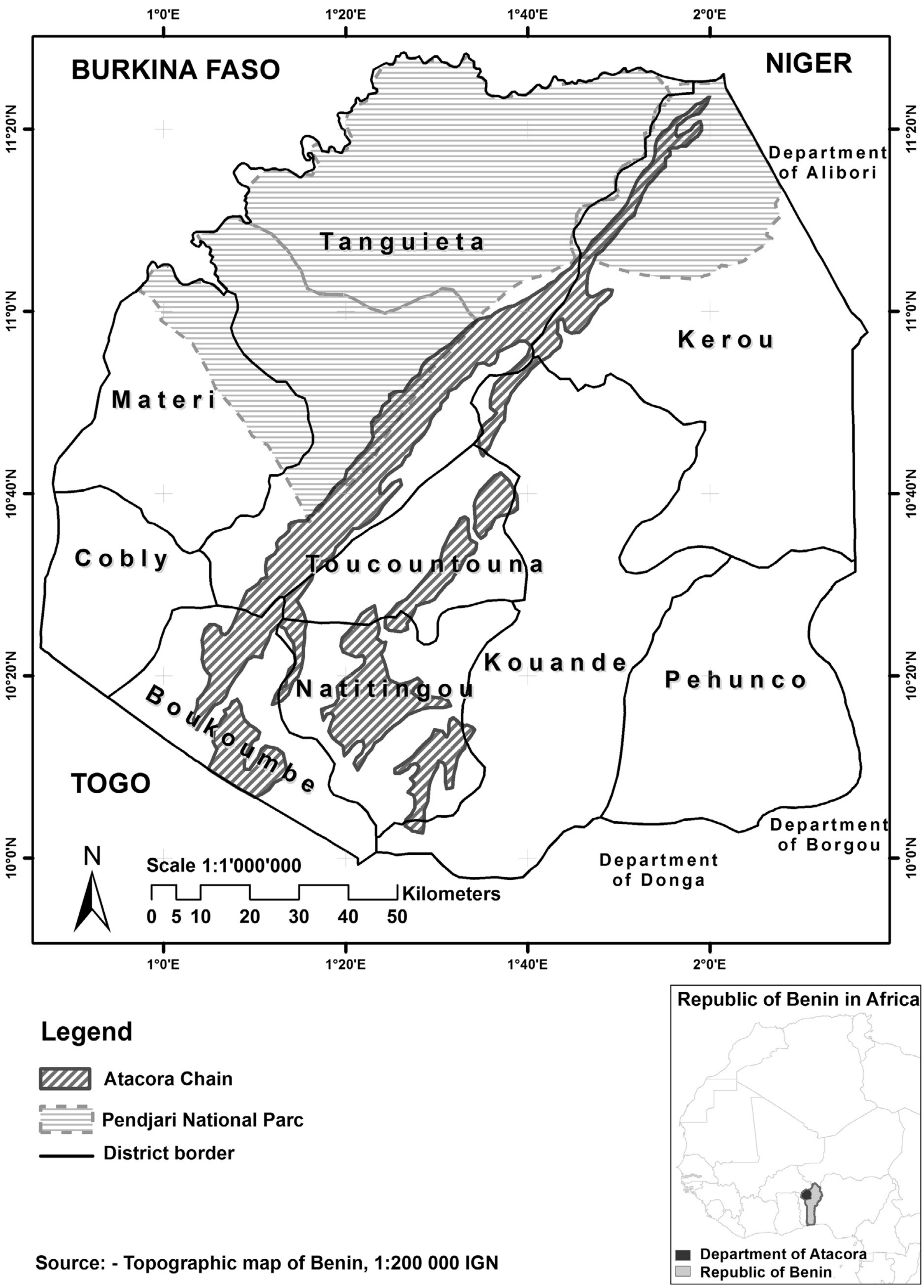

Fig. 1. Location of the study area.

implementations, as pointed out by Kirkby et al. (1996), Schoorl et al. (2000), Yair and Raz-Yassif, (2004), among others. Moreover, less data-consuming methods seem more appealing to decision makers (Renschler and Harbor, 2002). According to Bayramin et al. (2003); ICONA (1991, 1997); Zaz and Romshoo (2012), the ICONA model is one of the easiest and flexible qualitative methods for