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MICHAEL MÄRKER (*,**), VOLKER HOCHSCHILD (***), VIT MACA (****)
& VÍT VILÍMEK (****)

STOCHASTIC ASSESSMENT OF LANDSLIDES AND DEBRIS FLOWS IN THE JEMMA BASIN, BLUE NILE, CENTRAL ETHIOPIA

ABSTRACT: MÄRKER M., HOCHSCHILD V., MACA V. & VILÍMEK V., *Stochastic assessment of landslides and debris flows in the Jemma basin, Blue Nile, Central Ethiopia* (IT ISSN 0391-9838, 2016)

In this paper we evaluate a stochastic method to assess the spatial distribution of landslide and debris flow processes in the Jemma basin, Central Ethiopia. The Jemma basin is draining the highlands (max. 3.676 m a.s.l.) northeast of Addis Ababa towards the Blue Nile. The basin is characterized by a deeply incised stratigraphy made up of volcanic deposits like flood basalts and tephra. Hence, gravitational mass movements as well as water driven erosion processes occur, documented by the respective forms. We mapped these features using Google Earth images, aerial photo interpretation and fieldwork. The information about the spatial distribution of landslide and debris flow forms was taken as dependent variable in the stochastic modelling approach. Moreover, we performed a detailed terrain analysis to derive the independent variables. We applied two different stochastic modelling approaches based on i) Boosted Regression Trees (BRT) and ii) on an Maximum Entropy Method (MEM) to predict the potential spatial distribution of landslides and debris flows in the Jemma basin. The models are statistically evaluated using the training data and a set of performance parameters such as the area under the receiver operating characteristic curve (*AUC*). Variable importance and response curves provide further insight into controlling factors of landslide and debris flow distribution. The study shows that both processes can be perfectly identified and distinguished. The spatial distribution of the predicted process susceptibilities generally follows topographic constraints. Model performance parameters show better results for BRT, that outperforms MEM. However, MEM results are quite robust and hence are used for the spatial prediction of process susceptibilities.

KEY WORDS: Landslides, Debris flows, Boosted Regression Trees (BRT), Maximum Entropy Method (MEM), Spatially explicit prediction, Ethiopia, Blue Nile, Jemma Basin.

INTRODUCTION

The Ethiopian highland is severely affected by land degradation due to soil erosion and mass wasting processes. Generally, Ethiopia show the highest degradation rates in Eastern Africa (de Mûelenaere & *allii,* 2014; Gessesse & *allii,* 2014; Lanckriet & *allii,* 2014, Adugna & *alii,* 2015) and particularly the highland, is facing new strategies to combat desertification (Mekonnen & *allii,* 2015). Especially after long dry periods intensive rainfall events wash away fertile topsoils and trigger debris flows and landslides, particularly if no prevention methods are applied. Hence, agricultural production is at risk and thus, food security is a mayor issue for local population. In order to prevent degradation processes in terms of mass movements, susceptible areas have to be identified and prevention measures established. In the rural areas initiatives have been conducted to fight mass movements in small catchments or on smaller local units. However, to assess the incidence of different mass wasting processes on catchment scale more sophisticated techniques must be applied. In order to derive information on the probability distribution of these processes statistical methods may yield valuable results.

In the recent past several authors categorized the approaches utilized in susceptibility assessments as analytic, heuristic, deterministic and stochastic (e.g. Guzzetti & *alii*, 1999; Brenning, 2005, Lombardo & *alii,* 2014). In terms

(*) *Dipartimento Scienze della Terra e dell'Ambiente, Università degli studi di Pavia, Via Ferrata 1, 27100 Pavia, Italia.*
(**) *Heidelberg Academy of Sciences and Humanities, Germany.*
(***) *Department of Geography, Tübingen University, Germany.*
(****) *Department of Physical Geography and Geoecology, Charles University Prague, Czech Republic.*
Corresponding author: Michael Märker, michael.maerker@unipv.it

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