YEG-Article-5-09/2024

Contributing to landslide risk mitigation over longer terms in Cameroon through a multiscale and multifactorial approach

Danny Love Wamba Djukem

State Key Laboratory of Geohazard Prevention and Geoenvironment Protection (SKLGP), Chengdu University of Technology, 610059 Chengdu, China

wdjukem@gmail.com

1. Motivation

Landslide consequences at a small scale may often be regarded as insignificant since the area affected is left to the detriment of other terrains. However, the repetitive nature of landslide events leads over time to the reduction of areas exploitable by the population. They occupy other hilly lands, formerly forested or not, but stable. Abusive exploitation combined with natural factors exposes these surfaces to new and more destructive landslides added to the reactivation of old ones. The multiscale approach will consist of producing preliminary landslide inventory and susceptibility maps of the entire Cameroon region. Then more detailed investigation will be carried out in the regions marked by a higher probability of landslides occurrence.

The multifactorial approach will integrate climatic data, soil geomechanical parameters and geoenvironmental factors to generate detailed landslide susceptibility maps as initiated in a test area at the western flank of Mount Oku, located at the western flank of the hazardous Cameroon volcanic line by Djukem et al. (2020). This research will help identify lower landslide hazard zones that may fit better for human activities. The final landslides predisposition model will be a suitable tool for correcting site selection and planning, respecting sustainable development, saving lives, and involving individual landowners in Cameroon.

2. Efficiency of the multiscale approach

The simultaneous production of regional and detailed inventory and susceptibility maps of Cameroon will provide an overview of landslide susceptibility and risk in the region. This investigation will combine remote sensing techniques with statistical and physically based landslide susceptibility modeling methods. Areas of high susceptibility will be highlighted for detailed investigation, similar to that of Mount Oku, to capture landslide patterns and elucidate

their mechanisms. The results of the detailed investigation will be used to gradually improve the accuracy of the regional maps.

3. Background of the study: efficiency of the multifactorial approach

Djukem et al. (2020) have shown the importance of integrating soil geomechanical parameters and geo-environmental factors in landslide susceptibility models, taking the western flank of Mount Oku as the study area (Figure 1). Soil geomechanical properties allow for the characterization of soil behavior from a small scale (grain) to a landslide scale.

Land exploitation, combined with heavy rainfall and slope steepness frequently causes landslides in mountainous regions, such as Mount Oku. Geo-environmental factors used in our investigation include lithology, elevation, slope angle and aspect, land use, curvature, and proximity to rivers and roads; while soil geotechnical properties investigated include soil porosity, particle and bulk density, water content, grain sizes, Atterberg limits, methylene blue value, friction angle, and cohesion.

We explored a novel approach to integrate these geo-environmental and soil geomechanical parameters in a landslide susceptibility model. Membership values were assigned to each soil property class, using the fuzzy membership method. The information value method allowed for computing the weight value of geo-environmental factor classes. From the soil geomechanical membership values and the geo-environmental factor weights, three landslide predisposition models were produced, two separate models and one combined model. The model with only soil properties tended to underrate unstable and stable areas, the model combining soil properties and geo-environmental factors allowed for a more precise identification of stability conditions. The geo-environmental factors model and the model combining geo-environmental factors and soil properties displayed predictive powers of 80 and 93%, respectively. It can be concluded that the spatial analysis of soil geomechanical properties can play a major role in the detection of landslide prone areas.

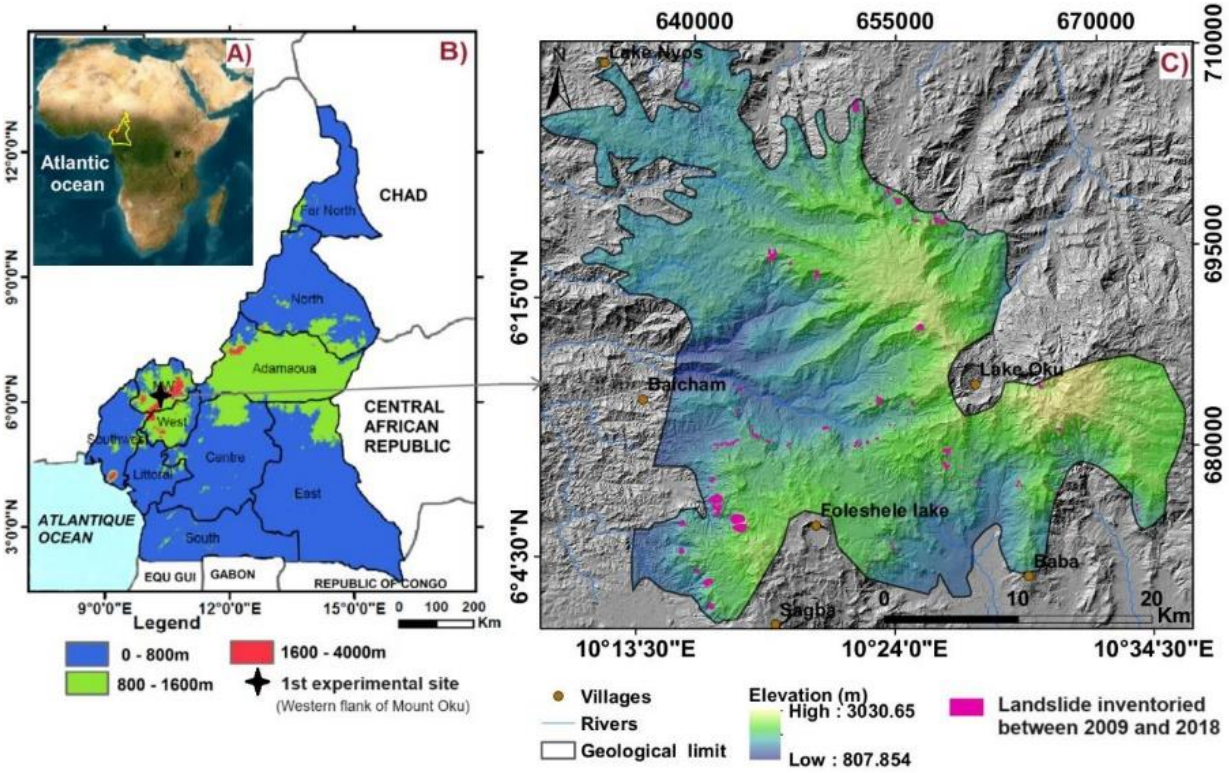

Figure 1 Localization of the study area:(A) on the world imagery map provided by Esri Geographic information system company; (B) on the Cameroon elevation map; (C) an enlargement showing the western flank of Mount Oku elevation, rivers, and landslides.

3. Conclusion

The approach we propose could form the basis for the establishment of a long-term landslide monitoring system. This will finally make it possible to anticipate the occurrence of these landslides and to take measures not only after they have caused irreparable damage, but to anticipate them and limit their damage. This could also be a basis of an establishment of a specific national landslide management plan.

Acknowledgments

I would like to thank Xuanmei Fan from the SKLGP at Chengdu University of Technology, China; Anika Braun from Engineering Geology at Technische Universität Berlin, Germany; Armand Sylvain Ludovic Wouatong from the Department of Earth Sciences at the University of Dschang, Cameroon; and Hans-Balder Havenith from the Georisk & Environment group at ULiege, Belgium, for their invaluable support and contributions.

References

Djukem W D L, Braun A, Wouatong A S L, Guedjeo C, Dohmen K, Wotchoko P, Fernandez-Steeger T M and Havenith H-B (2020). Effect of soil geomechanical properties and geo-environmental factors on landslide predisposition at Mount Oku, Cameroon. International Journal of Environmental Research and Public Health, 17, 6795. https://doi.org/10.3390/ijerph17186795.

Author Responsibility Disclaimer

During the preparation of this work, the author did not utilize ChatGPT or any similar software to generate content and took full responsibility for the publication's content. Additionally, the author is responsible for referencing all figures, tables, and information shared in this article.