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Landslide hazard in Bukavu (DR Congo): a geomorphological assessment in a data-poor context

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Many cities in the Global South are known for facing an important increase in their population size. Many of them are then struggling with the sprawl of new settlements and very often urban planning and sustainable management policies are limited, if not non-existent. When those cities are set in landslide-prone environments, this situation is even more problematic. Despite these environmental constrains, landslide hazard assessments relevant for landscape planning remain rare. The objective of this research is to assess the landslide hazard in Bukavu, a city in DR Congo that is facing such a situation. We used a geomorphological approach (adapted from Cardinali et al., 2002) taking into account the data-poor context and the impact of anthropogenic activities. First, we built a multi-temporal historical inventory for a period of 60 years. A total of 151 landslides were mapped (largest landslide $\sim$1.5 km^2). Their cumulative areas cover 29% of the urban territory and several types of processes are identified. Changes in the distribution and pattern of landslides allowed then to infer the possible evolution of the slopes, the most probable type of failures, and their expected frequency of occurrence and intensity. Despite this comprehensive inventory, hazard linked to the occurrence of new large deep-seated slides cannot be assessed due a scarcity of reliable data on the environmental factors controlling their occurrence. In addition, age estimation of the occurrence of some of the largest landslides refers to periods at the beginning of the Holocene where climatic and seismic conditions were probably different. Therefore, based on the inventory, we propose four hazard scenarios that coincide with today's environment. Hazard assessment was done for (1) reactivation of deep-seated slides, (2) occurrence of new small shallow slides, (3) rock falls, and (4) movements within existing landslides. Based on these assessments, we produced four hazard maps that indicate the zones where landslides may occur as well as the runout zones. Rock fall hazard concerns a very small portion of the urban territory. The other three hazards are much more widely spread. For these three scenarios, the hazard is the highest in areas that cover about 5 to 10% of the urban territory. The maps are presented in four classes. They present an information that can be easily used for further risk analysis and/or urban planning purposes.