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Quantifying the impacts of urban gullying at the scale of the Democratic Republic of Congo

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Urban gullies cause major infrastructural damages and often claim casualties in many tropical cities of the Global South. Nonetheless, our understanding of this hazard currently remains limited to some case studies, while the impacts at larger scales remain poorly quantified. Here, we aim to bridge this gap by making a first assessment of the number of persons and buildings affected by urban gullies at the scale of the Democratic Republic of Congo (DRC). We used Google Earth imagery in combination with local news sources and earlier research to identify 25 cities in DRC where urban gullies occur at a significant scale (at least ten urban gullies). This list is likely exhaustive. Next, for each of these cities, we used Google Earth and other high resolution images to map all visible urban gullies, evaluate their expansion rate and inventorize detectable damages to houses and roads. In total, more than two thousand urban gullies were mapped across the 25 affected cities. Overall, the problem of urban gullies in DRC is especially acute in the cities of Kinshasa, Mbuji-Mayi, Tshikapa, Kananga, Kabinda, and Kikwit. Over 80% of these gullies were active during the observation period (typically from 2002 to 2020). We identified 4257 houses and 998 roads that were destroyed because of the formation and expansion of urban gullies. Nonetheless, the actual impacts are likely much larger since the limited amount of imagery available does not allow quantifying all impacts. For example, in most cases, a large urban gully was already present on the earliest image available.

We also made an estimate of the total number of persons that are directly affected, as well as the number of persons currently at risk. Using high resolution estimates of population density and taking into account the current position of urban gullies, we estimate that a total of 133000 people have already lost their house due to formation and expansion of urban gullies. Given that these gullies are typically less than 30-years old, we estimate that on average, at least 4000 people/year lose their house as a result of urban gullies in DRC. This may still be an underestimation. By considering the population that lives in the direct vicinity (<100 m) of an urban gully, we estimate

that around 1.2 million people in D.R. Congo are currently at risk and/or experience significant impacts because of urban gullies (e.g. reduced land value, problems with trafficability, stress). An estimated 449000 persons live less than 100 m away from a gully head (which is typically the most active part of the gully) and are therefore likely at high risk to be significantly affected by urban gullies in the coming years.

Overall, this research shows that urban gullying is a very serious problem in the DRC, but likely also in many other tropical countries. More research is needed to better understand this processes and, ultimately, to prevent and mitigate its impacts. The results and the database of this study provide an important step towards this.