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Pragmatic, fast and easy to use Model for Predicting Susceptibility to Concentrated Flow Erosion in a GIS in data-sparse regions

Liberty Lazarus Orapine Mgbanyi[1], Matthew Johnson[2], and Colin Thorne[3]
[1]School of Geography,University of Nottingham, Nottingham, UK (lgxllmg@nottingham.ac.uk)
[2]School of Geography,University of Nottingham, Nottingham, UK (M.Johnson@nottingham.ac.uk)
[3]School of Geography,University of Nottingham, Nottingham, UK (colin.thorne@nottingham.ac.uk)

Less Economically Developed Countries (LEDCs) are at particular risk of gullying due to climate change, land-use change, poor agricultural practices and widespread farming intensification, but in these areas, the data required to apply most predictive models are usually unavailable. Therefore, an urgent need for a practical and rapid predictive tool for assessing gullying potential in data-sparse regions, to inform planning, agricultural practices and environmental management decision-making is required. Given the difficulty in applying existing empirical models to developing areas, where input data is sparse, but the risk of gullying is high, alternative methods need to be developed to identify areas susceptible to gullying. Here it is hypothesised that detailed data is required to apply existing models of soil loss from agricultural areas because they focus on predicting the quantities of sediment lost after agriculture has commenced. The data requirements for successful model application could be less if the focus were instead on identifying areas that are susceptible to gullying. The decision to avoiding soil loss by either protecting them from agricultural development or at least applying soil conservation measures from the outset, without attempting to predict the extents or the specific metre-scale locations of individual gully channels will come much handy. The Compound Topography Index (CTI) meets the criteria for that candidate predictive model for concentrated flow erosion in the data-sparse regions. The CTI, however, required quality and high-resolution data(<5m LiDAR DEMs) available in data-rich regions to perform, but with weak quality and low-resolution data(30m DEM) found in the data-sparse regions, fuzzy logic data applied to this data before using it as input into the CTI model to at least on identifying areas that are susceptible to gullying. The accuracy of the model was moderately improved when used with high-resolution data, and consistent in prediction for coarse resolution DEMs. A key finding is that the fuzzy CTI reveals that much of the landscape has the potential to suffer gullying – i.e. there is sufficient planform and profile curvature to concentrate and accelerate overland flow. Soil degradation and loss of soil structure, or removal of natural vegetation and, especially forests, could exacerbate the condition rapidly lead to widespread gullying based on the occurrence of concentrated overland flow driven by the topography, while the incorporation of soil structural stability index in the fuzzy CTI slightly improved it performance as per modelling concentrated flow erosion. The calculation of CTI is easy, repeatable, require less comprehensive, sophisticated data collection and not over extended periods and could widely be an applicable predictor of gullying, for use in sparse data regions.