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Development of Gully Erosion Prediction Model in Sokoto State, Nigeria, using Remote Sensing and Geographical Information System Techniques

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Abstract : The challenge of erosion in the study area is persistent, suggesting the need for a better understanding of the mechanisms that drive it. Thus, the study evolved a predictive erosion model (RUSLE_Sok), deploying Remote Sensing (RS) and Geographical Information System (GIS) tools. The nature and pattern of the factors of erosion were characterized, while soil losses were quantified. Factors' impacts were also measured, and the morphometry of gullies was described. Data on the five factors of RUSLE and distances to settlements, rivers and roads (K, R, LS, P, C, DS DRd and DRv) were combined and processed following standard RS and GIS algorithms. Harmonized World Soil Data (HWSD), Shuttle Radar Topographical Mission (SRTM) image, Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS), Sentinel-2 image accessed and processed within the Google Earth Engine, road network and settlements were the data combined and calibrated into the factors for erosion modeling. A gully morphometric study was conducted at some purposively selected sites. Factors of soil erosion showed low, moderate, to high patterns. Soil losses ranged from 0 to 32.81 tons/ha/year, classified into low (97.6%), moderate (0.2%), severe (1.1%) and very severe (1.05%) forms. The multiple regression analysis shows that factors statistically significantly predicted soil loss, $F(8, 153) = 55.663$, $p < .0005$. Except for the C-Factor with a negative coefficient, all other factors were positive, with contributions in the order of LS>C>R>P>DRv>K>DS>DRd. Gullies are generally from less than 100m to about 3km in length. Average minimum and maximum depths at gully heads are 0.6 and 1.2m, while those at mid-stream are 1 and 1.9m, respectively. The minimum downstream depth is 1.3m, while that for the maximum is 4.7m. Deeper gullies exist in proximity to rivers. With minimum and maximum gully elevation values ranging between 229 and 338m and an average slope of about 3.2%, the study area is relatively flat. The study concluded that major erosion influencers in the study area are topography and vegetation cover and that the RUSLE_Sok well predicted soil loss more effectively than ordinary RUSLE. The adoption of conservation measures such as tree planting and contour ploughing on sloppy farmlands was recommended.

Keywords : RUSLE_Sok, Sokoto, google earth engine, sentinel-2, erosion
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