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Comparative Analysis of the Expansion Rate and Soil Erodibility Factor (K) of Some Gullies in Nnewi and Nnobi, Anambra State Southeastern Nigeria

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Abstract : A comparative analysis of the expansion rate and soil erodibility of some gullies in Nnewi and Nnobi both of Nanka Formation were studied. The study involved an integration of field observations, geotechnical analysis, slope stability analysis, multivariate statistical analysis, gully expansion rate analysis, and determination of the soil erodibility factor (K) from Revised Universal Soil Loss Equation (RUSLE). Fifteen representative gullies were studied extensively, and results reveal that the geotechnical properties of the soil, topography, vegetation cover, rainfall intensity, and the anthropogenic activities in the study area were major factors propagating and influencing the erodibility of the soils. The specific gravity of the soils ranged from 2.45-2.66 and 2.54-2.78 for Nnewi and Nnobi, respectively. Grain size distribution analysis revealed that the soils are composed of gravel (5.77-17.67%), sand (79.90-91.01%), and fines (2.36-4.05%) for Nnewi and gravel (7.01-13.65%), sand (82.47-88.67%), and fines (3.78-5.02%) for Nnobi. The soils are moderately permeable with values ranging from 2.92 x 10-5 - 6.80 x 10-4 m/sec and 2.35 x 10-6 - 3.84 x 10^{-4}m/sec for Nnewi and Nnobi respectively. All have low cohesion values ranging from 1–5kPa and 2-5kPa and internal friction angle ranging from 29-38° and 30-34° for Nnewi and Nnobi, respectively, which suggests that the soils have low shear strength and are susceptible to shear failure. Furthermore, the compaction test revealed that the soils were loose and easily erodible with values of maximum dry density (MDD) and optimum moisture content (OMC) ranging from 1.82-2.11g/cm^3 and 8.20-17.81% for Nnewi and 1.98-2.13g/cm^3 and 6.00-17.80% respectively. The plasticity index (PI) of the fines showed that they are nonplastic to low plastic soils and highly liquefiable with values ranging from 0-10% and 0-9% for Nnewi and Nnobi, respectively. Multivariate statistical analyses were used to establish relationship among the determined parameters. Slope stability analysis gave factor of safety (FoS) values in the range of 0.50-0.76 and 0.82-0.95 for saturated condition and 0.73-0.98 and 0.87-1.04 for unsaturated condition for both Nnewi and Nnobi, respectively indicating that the slopes are generally unstable to critically stable. The erosion expansion rate analysis for a fifteen-year period (2005-2020) revealed an average longitudinal expansion rate of 36.05m/yr, 10.76m/yr, and 183m/yr for Nnewi, Nnobi, and Nanka type gullies, respectively. The soil erodibility factor (K) are 8.57x10^{-2} and 1.62x10-4 for Nnewi and Nnobi, respectively, indicating that the soils in Nnewi have higher erodibility potentials than those of Nnobi. From the study, both the Nnewi and Nnobi areas are highly prone to erosion. However, based on the relatively lower fine content of the soil, relatively lower topography, steeper slope angle, and sparsely vegetated terrain in Nnewi, soil erodibility and gully intensity are more profound in Nnewi than Nnobi.

Keywords : soil erodibility, gully expansion, nnewi-nnobi, slope stability, factor of safety
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