



## The gullies of southeast Nigeria: an ecogeomorphic investigation

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Gully erosion was unknown in the Orlu area of Southeast Nigeria before the Nigerian civil war (from 1967 to 1970) but has now become endemic and continues to present day. Human activities are central to this acceleration of erosion due to their intervention with ecogeomorphic processes. This paper aims to improve understanding of ecogeomorphic drivers of gully erosion using case studies from the Orlu area of southeast Nigeria, and to achieve this aim, focus-group meetings and analyses of remotely sensed data were adopted. High-resolution (0.61 – 5 m) satellite imagery for 2009 and 2018 were acquired from different platforms and used for gully mapping and monitoring while ASTAR DEM was used to estimate topological parameters. Upslope contributing areas were produced for two gullies; A and U, while gully evolutions between 2009 and 2018 were related to changes in contributing areas during same time span. Ecogeomorphic and climatic drivers such as vegetation-cover change, slope angle, elevation, rainfall, and nearness to roads and rivers were studied and their associations with gullying established. Vegetation cover was classified into three: non-vegetated, open vegetation and trees while daily surface runoff between 2009 and 2018 was estimated for these vegetation classes using the Curve Number approach. Results from focus-group meetings show that both gullies started in 1969 during the civil war as a result of increase in population density arising from the influx of refugees as well as other military activities. Gully growth was sustained after the civil war was a result of land use changes. Average gully headcut retreat rate between 2009 and 2018 was  $64 \text{ m yr}^{-1}$  and  $12.2 \text{ m yr}^{-1}$  for gully A and U respectively, while a positive correlation was recorded between change in vegetation cover in contributing areas and increase in gullied area with Pearson's correlation of 0.6 and  $r^2$  of 0.4. The runoff model predicted runoff for only the non-vegetated areas with runoff coefficients ranging from 11.5 % to 22 %. Slope angle, profile and plan curvature had positive associations with gullies while elevation, nearness to rivers and nearness to roads recorded negative correlations with gullies. In conclusion, while geomorphic drivers such as slope angle are preparatory factors, human activities including civil wars and land-use changes are forcing factors of gully erosion. This study has implications for gully remediation especially as regards land use management of upslope contributing areas.

**Keywords:** Gully erosion, Ecogeomorphology, upslope contributing area, south east Nigeria