Factors in the development of urban mega-gullies in the high town of Kinshasa

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Abstract:

Since the start of urbanization at the end of the 60s', the high town of Kinshasa (DRCongo), a hilly country of 240 km² South of the low banks along the Malebo Pool, is the scenery of dramatic gully development. In order to find a way of prevention and treatment, information has been collected about the way gullies in Kinshasa originate and develop. The following questions are addressed: (1) Is gullying linked to urbanization? (2) Is gullying linked to urban water conveying structures? (3) What about topographical control? An anaglyph on the base of two SPOT panchromatic images (2006, 2007, 5 m resolution) has been used to inventor all gullies more than 5 m wide in 2007. These mega-gullies have been mapped in an ArcGis 9.3 project, containing the orthorectified version of the SPOT images, a newly developed numerical model, a geological and a geotechnical map, a gully distribution map of the middle of the 70s, and a WV1 satellite image of 2010, with a resolution of 50 cm, but covering only part of the town. The diachronic information in this GIS-project has been completed by the stereoscopic study of aerial photographs of 1957, and by field truth collected since 2008. Kinshasa counted in the year 2007, 308 gullies with a cumulated length of 94.7 km. The gully density varies between 0.4 and >2 km/km^2. The mean gully width and depth are respectively 21 and 7 m. In the sector of the town covered by the WV1 image, the cumulated gully length is respectively 100, 1000, 13,331, 62,092 and 102,076 m for the years 1957, 1967, 1977, 2007 and 2010. This exponential growth of the cumulated length of the mega-gullies in time is alarming. The causal link between urbanization and gullying is evidenced by maps showing the temporal and spatial development of the urbanized area and the mega-gully pattern in 1957, 1977 and 2007. It appears that mega-gullies develop only about ten years after the first urbanization of a sector of the town. No mega-gullies occur outside the urbanized area. Runoff in the urbanized area is conveyed by roads, gutters, channels and tracks. This results in an artificial network of concentrated runoff which does not flow along the natural slope lines. A gully encroaching by headward retreat in an artificial axis of runoff is called a primary axial gully. There also exist spill-over mega-gullies by progressive erosion and secondary axial mega-gullies. In 2007, Kinshasa counted 72 primary axial mega-gullies, 107 secondary axial mega-gullies and 113 spill-over mega-gullies. We investigated the relation between the log of the slope S_c (m/m) on which a gully head develops and the log of the runon area to the gully head (ha):
The equation of the trend line is: $S_{cr}=0{,}1274A^{-0.584}$, with n=72; $R^2=0.55$; A (ha) ; S_c (m/m). For secondary axial gullies and spill-over gully sections, the relation between S_c and A could not be established.

Key words: Urbanization, runon area, mega-gully, Kinshasa.

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