Paper Number: 3681

Understanding Continental Uplift through Watershed Analysis

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The remarkable configuration of drainage in Africa shows some counter-intuitive and paradoxical configurations. These include rivers such as the Orange and the Niger that rise near a coast, yet empty on distant margins of the continent, after flowing through the arid continental interior. Other rivers such as the Zambezi and the Congo change course by 180° or more on a continental scale. The origins of drainage patterns have been attributed to factors that range in age from the Carboniferous to active tectonics today. Understanding the evolution of such a critical georesource has important societal implications.

Conventional analyses of drainage focuses on the pattern of streams and rivers, commonly inferred from Digital Elevation Models. However, given the typical concave upward profile of rivers, watersheds may be better defined topographically, and yield new insights into the factors that control them. Drainage divides extracted from a DEM also show remarkable patterns (Fig. 1), which are not simply complementary to the pattern of drainages themselves.

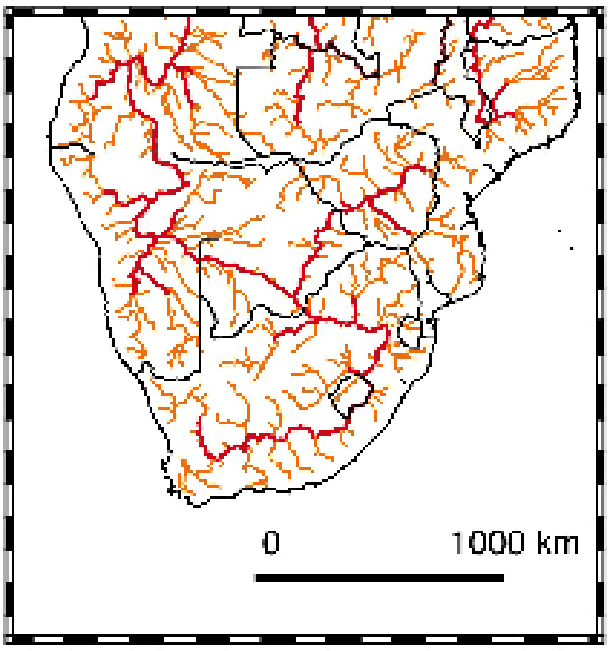

Figure 1: Watersheds in southern Africa. Colour (red, orange) shows relative importance, as indicated by adjacent area, extracted from a DEM (GMTED2010: [1]) with horizontal resolution of ca. 230 m and vertical resolution of ca. 10 m

The three main concentric watersheds previously identified [2,3] are visible, and along strike variations in their significance can be observed. These date from the early and mid Cretaceous, and Paleogene [4]. Apart from the Great Escarpment around the coast of South Africa, the other major drainage divides on a large scale are quite linear, with a polygonal pattern of NW and NE trending segments. Some of the NW trending segments in Namibia have been noted as recent uplift axes, potentially related to rifting [5]. The north-south border faults of east side of the Malawi rift system are prominent, as is a sub-parallel divide in eastern Zambia. The watersheds have variable relationships to local slopes: The Great Escarpment corresponds to high slopes, while the central watershed in Zimbabwe (Fig. 1), has very low slopes.

The complex picture that emerges when the watersheds are delineated in detail shows that regional scale controls on topography and drainage of various ages are important, and at the least strongly modulate any dynamic topography. The nature of these controls can be revealed by the relationship between slopes and watersheds.

References:

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