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Potential changes in perennial drainage systems with predicted precipitation changes across Africa

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Our studies make use of AEON's Africa GIS Databasethat includes all rivers and lakes in Africa, manually digitised from topographic maps. The average stream separation (ratio of land area to total stream length) of the set is 15 km. This corresponds to approximately 2,000,000 km of digitized rivers. All streams are also been classified as either perennial or non-perennial, and all river networks ordered according to the Horton-Strahler ordering scheme. To understand the relationship between rainfall and drainage in Africa, a continental scale analysis was done by subdividing Africa into square blocks of 1,000 km across (giving areas of 1,000,000 km^2. For each of the 37 blocks the mean annual precipitation was computed, as well as the perennial drainage density. This latter quantity is the total perennial stream length per unit area.

Across Africa, perennial drainage density as a function of mean annual rainfall defines three regimes separated by threshold values of precipitation. Areas receiving less than 400 mm per year have virtually no perennial drainage. Above a threshold of $\sim$400 mm/y the perennial drainage density increases linearly with increasing precipitation until another threshold is reached at $\sim$1000 mm/y. This non-linear response of drainage to rainfall will most seriously affect regions in the intermediate, unstable, regime. A 10% decrease in precipitation in regions on the upper regime boundary (1000 mm/y) would reduce drainage by 17 %, while in regions receiving 500-600 mm/y such a drop would cut 50-30 %, respectively, of surface drainage. Using predicted precipitation changes across Africa from an ensemble of 21 fully coupled ocean-atmosphere climate models listed by IPCC, we calculate that decrease in perennial drainage will significantly affect present surface water access across 25% of Africa by the end of this century.