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Groundwater recharge in Africa: identifying critical thresholds

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Increasing access to groundwater is fundamental for improving health, reducing poverty and increasing food security for the rapidly growing African population. Recent assessments of groundwater storage and expected borehole yields highlight the potential of groundwater storage to meet domestic needs and also in some areas extend irrigation [1]. However, there is continued uncertainty about the magnitude and nature of groundwater recharge, especially the distinction between renewable modern groundwater which forms the basis of sustainable development, and palaeo-groundwater, derived from wetter past climates, which is non-renewable [2]. Groundwater recharge remains one of the most difficult parameters to estimate, particularly on a regional scale [3]. The relationship between rainfall and diffuse or focused recharge is poorly resolved across different climate and hydrogeological zones and there is emerging evidence that the relationships are non-linear, controlled by critical recharge thresholds based on rainfall intensity [4]. This observation is of particular importance given climate change projections which suggest a move towards increasingly intense rainfall events in Africa [5].

In this study we analyse data from 200 groundwater recharge field studies published from across Africa. Estimated values from these studies vary from 0 – 940 mm per year with an interquartile range of 6 – 82 mm. We find a direct relationship between long term total annual average rainfall and estimated recharge from the field studies, which describes approximately 50% of the variance. Further analysis of the individual field studies demonstrates that much of the remaining variance can be explained by the patterns of rainfall (such as intensity), land use and variations soil properties and geology. Long term average recharge is rarely more than 10 mm per annum where annual rainfall is less than 250 mm, or less than 10 mm when rainfall is greater than 500 mm. Reliable long term recharge of > 50 mm per annum is observed for nearly all field studies where long term annual rainfall is greater than 1000 mm. An interesting observation from some studies is that actual groundwater recharge can sometimes be limited by the availability of aquifer storage to receive it.

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