A pan-African inter-comparison of the relationship between precipitation and groundwater recharge from \textit{in-situ} observations and large-scale models

\textit{Richard Taylor (UCL Geography) on behalf of The Chronicles Consortium}
“Climate change is projected to reduce renewable... groundwater resources significantly in most dry subtropical regions (robust evidence, high agreement).”


“The uncertainties in projected groundwater recharge that originate in the hydrological models have not yet been explored.”

IPCC WGII (2014) Chapter 3, page 244

artesian borehole, Singida (central Tanzania)
IAH/UNESCO-IHP: The Chronicles Consortium

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and growing... join us?

Sokoine University of Agriculture (Tanzania): 9-12 February, 2017
• **uncertainty** in the magnitude and distribution of modelled recharge is substantial. Mean annual recharge: subsurface runoff (SSR) & groundwater recharge (GWR) from 1980-2014.
modelled recharge by climate zone

- uncertainty in simulated recharge increases in **semi-arid** regions
observations in seasonally humid Benin

- GW levels well simulated using scalar recharge model of precip exceeding a threshold (5 to 15 mm·day⁻¹) & short lag times

- apparent precip threshold of ~ 200 mm·year⁻¹ for recharge to occur

- rapid responses to rainfall inconsistent with a Darcy-Richards representation of unsaturated zone flow, implying bypass flow
observed and simulated relationships between precipitation & diffuse recharge in humid areas (e.g. Benin, Uganda) compare favourably
• diffuse recharge model proves inadequate; focused recharge pathway is evident from groundwater-level observations
recharge observations in semi-arid Tanzania

- recharge occurs episodically (El Niño) and strongly correlated to the duration of ephemeral stream discharge (i.e. focused recharge)
• observed non-linear relationship between precipitation & recharge not well represented in models based on diffuse recharge pathways
models/observations in semi-arid South Africa

- observations clearly reveal substantial, episodic recharge events but these are not well represented in most large-scale models
Preliminary results from the inter-comparison:

• substantial uncertainty exists in recharge modelled by 4 GLDAS LSMs (subsurface runoff) & 5 GHMs

• modelled and observed relationships between precipitation & diffuse recharge in humid areas are comparable – *rapid water-table responses inconsistent with Darcy-Richards soil-zone flow*

• models are inconsistent with observed recharge in semi-arid environments - models do not represent focused recharge, *the primary pathway by which recharge is observed to occur*

• observations across Africa indicate a bias in recharge to heavy rainfall events (daily to seasonal) via pathways *(i.e. soil macropores, focused)* not currently represented in models
Thanks for listening!