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

Mohammad Shamsuudduha (Shams)
UCL Institute for Risk & Disaster Reduction
Department of Geography
University College London (UK)
Email: m.shamsuudduha@ucl.ac.uk

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

Shamsudduha, Mohammad *(University College London, UK)*  
Taylor, Richard *(University College London, UK)*  
Owor, Michael *(Makerere University, Uganda)*  
Todd, Martin *(University of Sussex, United Kingdom)*  
Wada, Yoshihide *(IIASA, Austria)*  
Lo, Min-hui *(National Taiwan University, Taiwan)*  
Müller Schmied, Hannes *(Goethe-University Frankfurt, Germany)*  
Döll, Petra *(Goethe-University Frankfurt, Germany)*  
Rodell, Matthew *(NASA, USA)*  
Jasechko, Scott *(University of Calgary, Canada)*  
Favreau, Guillaume *(IRD, France)*  
Macdonald, Alan *(British Geological Survey, UK)*  
Scanlon, Bridget *(University of Texas at Austin, USA)*  

Study Group is expanding...
Groundwater is a vital resource upon which dependence is growing globally to sustain and amplify the production of food through irrigation and the provision of safe drinking water.

UN SUSTAINABLE DEVELOPMENT GOAL 6: Ensure availability and sustainable management of water and sanitation for all.

Africa – is the home to the world’s most variable freshwater resources, the highest rates of population growth, the lowest rates of per capita food production, and lowest proportions of national populations with access to safe water.
• reliance on Global Hydrological Models (GHMs) and Land-Surface Models (LSMs) alone or in combination with satellite data (GRACE) to assess impacts of global change – this dependence expected to intensify as large-scale model resolutions increase.
Land Surface Models (LSMs) / Global Hydrological Models (GHMs)

- current focus: groundwater recharge (subsurface runoff) estimates from 7 global-scale models including 2 GHMs (WaterGAP, PCR-GLOBWB) and 5 LSMs (CESM-CLM4.5 & NASA’s GLDAS LSMs: CLM, NOAH, VIC, MOSAIC)

<table>
<thead>
<tr>
<th>Model</th>
<th>Grid</th>
<th>Precipitation</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLM</td>
<td>1°</td>
<td>CMAP</td>
<td>SSR</td>
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<tr>
<td>NOAH</td>
<td>1°</td>
<td>CMAP</td>
<td>SSR</td>
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<tr>
<td>VIC</td>
<td>1°</td>
<td>CMAP</td>
<td>SSR</td>
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<tr>
<td>MOSAIC</td>
<td>1°</td>
<td>CMAP</td>
<td>SSR</td>
</tr>
<tr>
<td>CLM4.5</td>
<td>0.5°</td>
<td>CRU-NCEP (v.5)</td>
<td>GWR (diffuse)</td>
</tr>
<tr>
<td>PCR-GLOBWB</td>
<td>0.5°</td>
<td>WFDEI</td>
<td>GWR (diffuse)</td>
</tr>
<tr>
<td>WaterGAP</td>
<td>0.5°</td>
<td>CRU TS 3.23</td>
<td>GWR (diffuse)</td>
</tr>
<tr>
<td>WaterGAP</td>
<td>0.5°</td>
<td>CRU TS 3.23</td>
<td>GWR (combined)</td>
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</table>
Observations: multi-decadal GWL records

- collation of multi-decadal, *in situ* (piezometric) records of groundwater levels across Africa under *The Chronicles Consortium*
• use of rainfall-groundwater stable-isotope ($^{18}\text{O}:^{16}\text{O}$) “pairings” as the “amount effect” observed across Africa enables intensity of rainfall recharging groundwater to be traced

*Jasechko and Taylor (2015)*
mapping simulated SSR & GWR

- substantial variations in the magnitude and distribution of mean annual SSR & groundwater recharge (GWR)

- spatial extent and magnitude of recharge in semi-arid regions increase substantially between WaterGAP (diffuse only) versus WaterGAP (combined diffuse and focused recharge)
simulated SSR & GWR grouped by climate

- simulated recharge in semi-arid regions increases with the inclusion of focused recharge in WaterGAP

![CGIAR Aridity Index map](image-url)
correlation of simulated GWR/SSR and precip

- precipitation and simulated GWR / SSR are strongly correlated in GLDAS-CLM and WaterGAP
- weaker correlations in GLDAS VIC and MOSAIC explained by very low, estimated SSR
semi-arid location: Bamako (Mali)
Preliminary outcomes:

1. Spatial extent and magnitude of simulated GWR & SSR in semi-arid regions are substantially underestimated by large-scale models that ignore focused recharge processes.

2. Simulated GWR & SSR and precipitation are well correlated in semi-arid areas of some models (GLDAS-CLM, WaterGAP) but very weakly correlated in others.

3. Non-linearity evident in the relationship between simulated GWR & SSR and precipitation in semi-arid areas (GLDAS-CLM, WaterGAP) – consistent with limited piezometric and isotopic observations.
Thanks for listening…

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M. Shamsudduha (Shams) | Email: m.shamsudduha@ucl.ac.uk
GroFutures Project Manager (http://grofutures.org/)
https://www.un-igrac.org/special-project/chronicles-consortium