Evaluation of three global gradient-based groundwater models in the Mediterranean region

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EGU General Assembly 2020
Online | 4–8 May 2020

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Motivation: Application of global groundwater models for water table depth estimation in the Mediterranean

Groundwater modelling has moved from local to regional/global scale, offering insights into the status of data-scarce regions, such as the Mediterranean which is recognized as one of the most sensitive regions in the world to water scarcity, due to both climate change and consistently increasing anthropogenic pressures.

Objective

This study aims to compare and evaluate the performance of three groundwater models to represent the steady-state groundwater levels in the Mediterranean region. Thus, the groundwater models of Reinecke et al. (2019), de Graaf et al. (2017) and Fan et al. (2013) will be utilized in this study.

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Methodology

Figure 1: High-resolution satellite image of the Mediterranean region (EOMAP)

- The comparison between the three models has been done by aggregation to a rectangular grid that covers the Mediterranean region; with spatial resolution of 4.44 km.

Table 1: Comparison of the global (steady-state) models (modified from Reinecke et al. 2020)

	Fan et al. (2013)	G^3M	de Graaf et al. (2015)
Spatial resolution	30″ (~900 m)	5′ (~9 km)	6′ (~10 km)
Surface elevation	30″ DEM	Avg. of 30″ DEM	Avg. of 30″ DEM
River elevation	-	P_{30} of 30″ DEM	Avg. of 30″ DEM + calculation based on bankfull flow and naturalized river discharge
Conductivity data	Global lithology (Hartmann and Moosdorf 2012)	GLHYMPS 2.0 (Huscroft et al. 2018)	GLHYMPS 1.0 (Gleeson et al. 2014)
Aquifer thickness	Infinite	200 m	Calibrated
Layers	1	2	2
Groundwater recharge	Mean of multiple GHMs (1961–1990)	WaterGAP mean (1901–2013)	PCR-GLOBWB (Sutanudjaja et al. 2018) mean (1960–2010)
Calibrated	Manual	No	Manual

References

- Reinecke, R. et al. 2019. Challenges in developing a global gradient-based groundwater model (G^3M v1.0) for the integration into a global hydrological model. *Geosci. Model*.
- de Graaf, I. et al. 2017. A global-scale two-layer transient groundwater model: Development and application to groundwater depletion. *Adv. Water Resour.*
- Fan, Y. et al. 2013. Global patterns of groundwater table depth. *Science*.
- Reinecke, R. et al. 2020. Importance of Spatial Resolution in Global Groundwater Modeling. *Groundwater..*

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Preleminary results

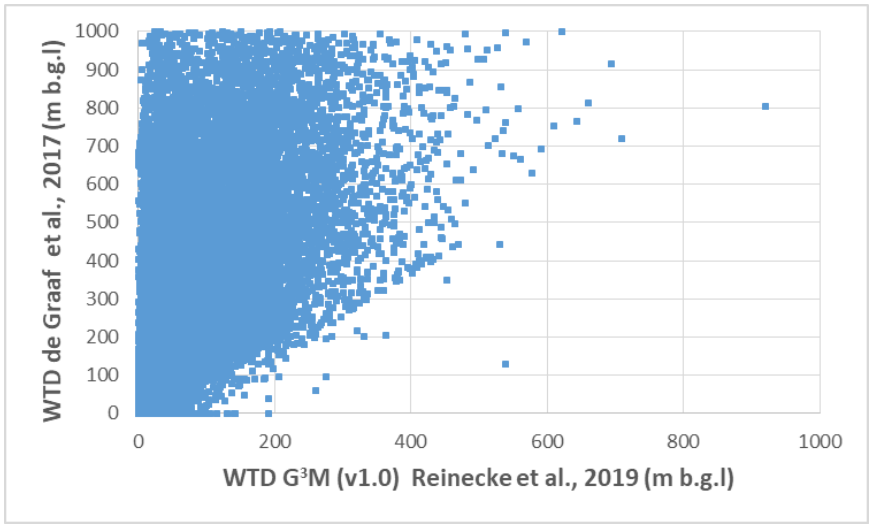

Figure 2 : Scatter plot of (de Graaf et al., 2017) and (Reinecke et al., 2019) models.

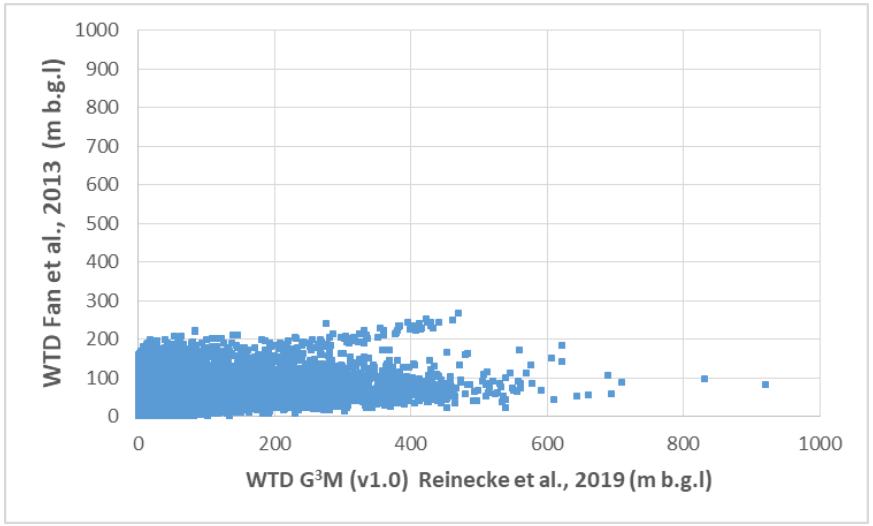

Figure 3 : Scatter plot of (Fan et al., 2013) and (Reinecke et al., 2019) models

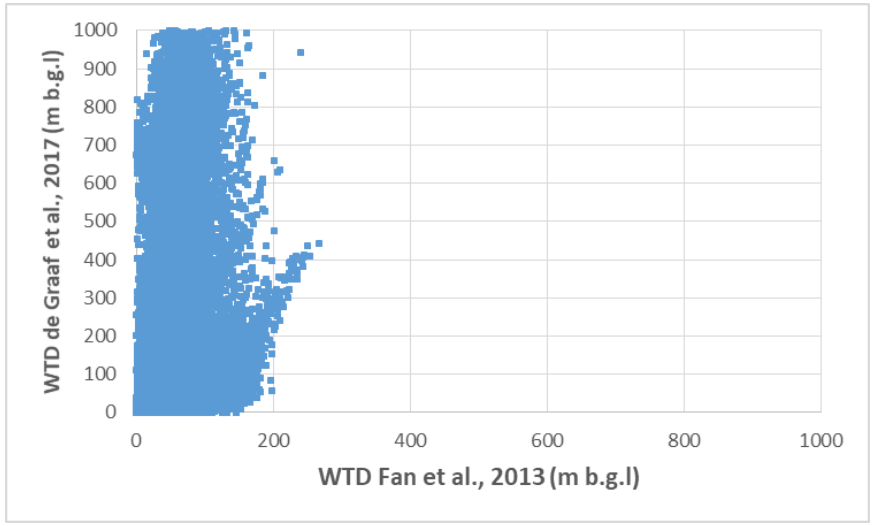

Figure 4 : Scatter plot of (de Graaf et al., 2017) and (Fan et al., 2013) models.

- A comparison of the distribution of the water table depth for the three models is given in Figs. 2-4.
- Results showed that (de Graaf et al., 2017) model presents a deeper water table than (Reinecke et al., 2019) and (Fan et al., 2013) models.
- We observe that there is a greater variability for de Graaf et al., 2017 model compared to other models.

Preleminary results

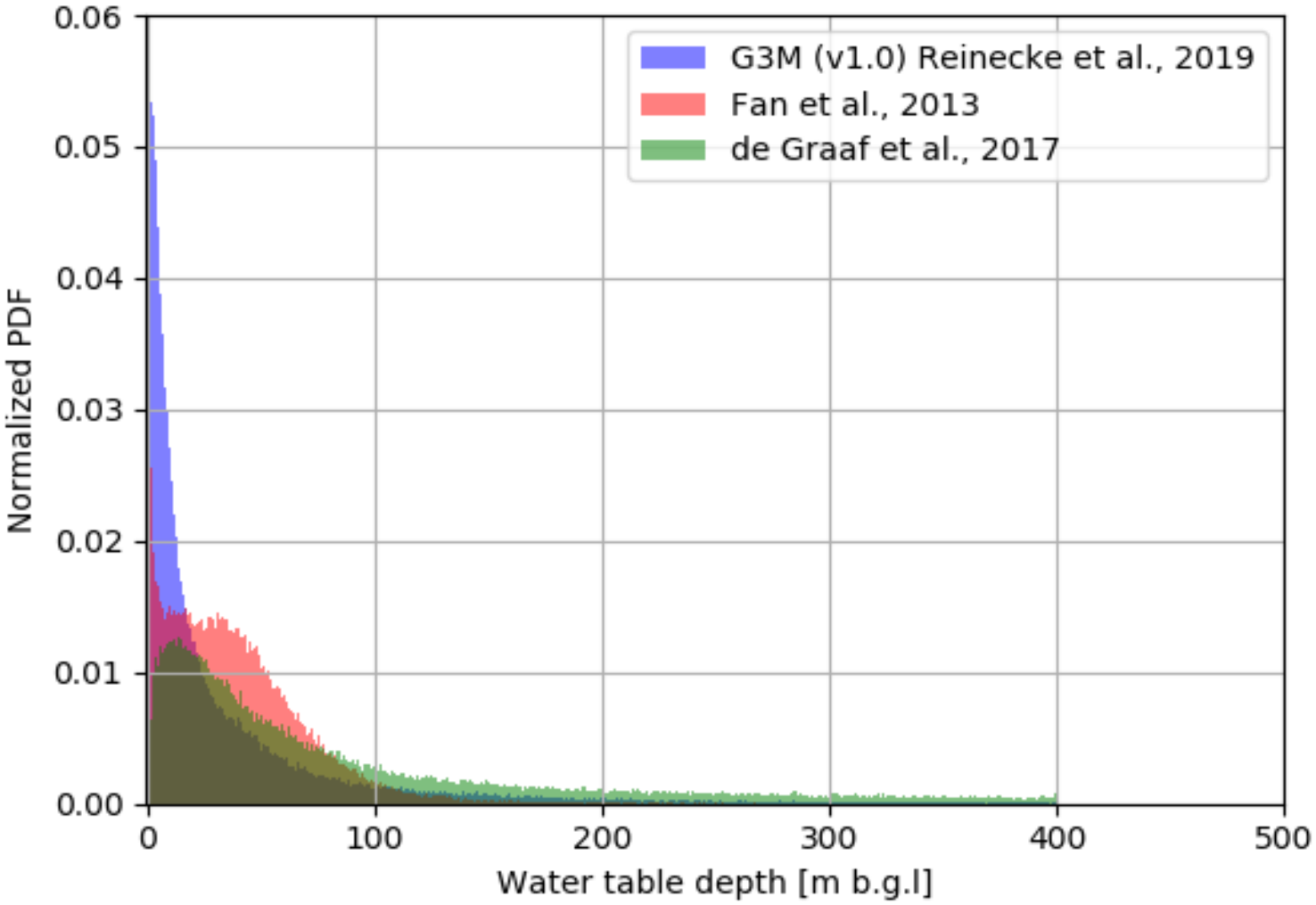

Figure 5: Histograms of the three compared models.

Discussion

- There is a discrepancy between the three compared models outputs.
- The mean water table depth for de Graaf et al. 2017 model (134.16 m) is almost four times higher than Reinecke et al. 2019 (35.03 m) and Fan et al. 2013 (38.8 m) models.
- Comparison between the models results and in-situ data is needed to evaluate the models' performances better.
- Detailed investigation on water table depth patterns in the Mediterranean region is required using the process-based model.
- Further investigation on the prediction of groundwater level at transient regime will be carried out.

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