46TH IAH CONGRESS MALAGA 2019

CEHIUMA CENTER OF HYDROGEOLOGY OF UNIVERSITY OF MALAGA

UNIVERSITY OF MALAGA

Groundwater Management and Governance

Coping with Uncertainty

Proceedings of IAH2019, the 46th Annual Congress of the International Association of Hydrogeologists, Málaga (Spain), September 22-27, 2019

Spanish Chapter of the International Association of Hydrogeologists (AIH-GE)

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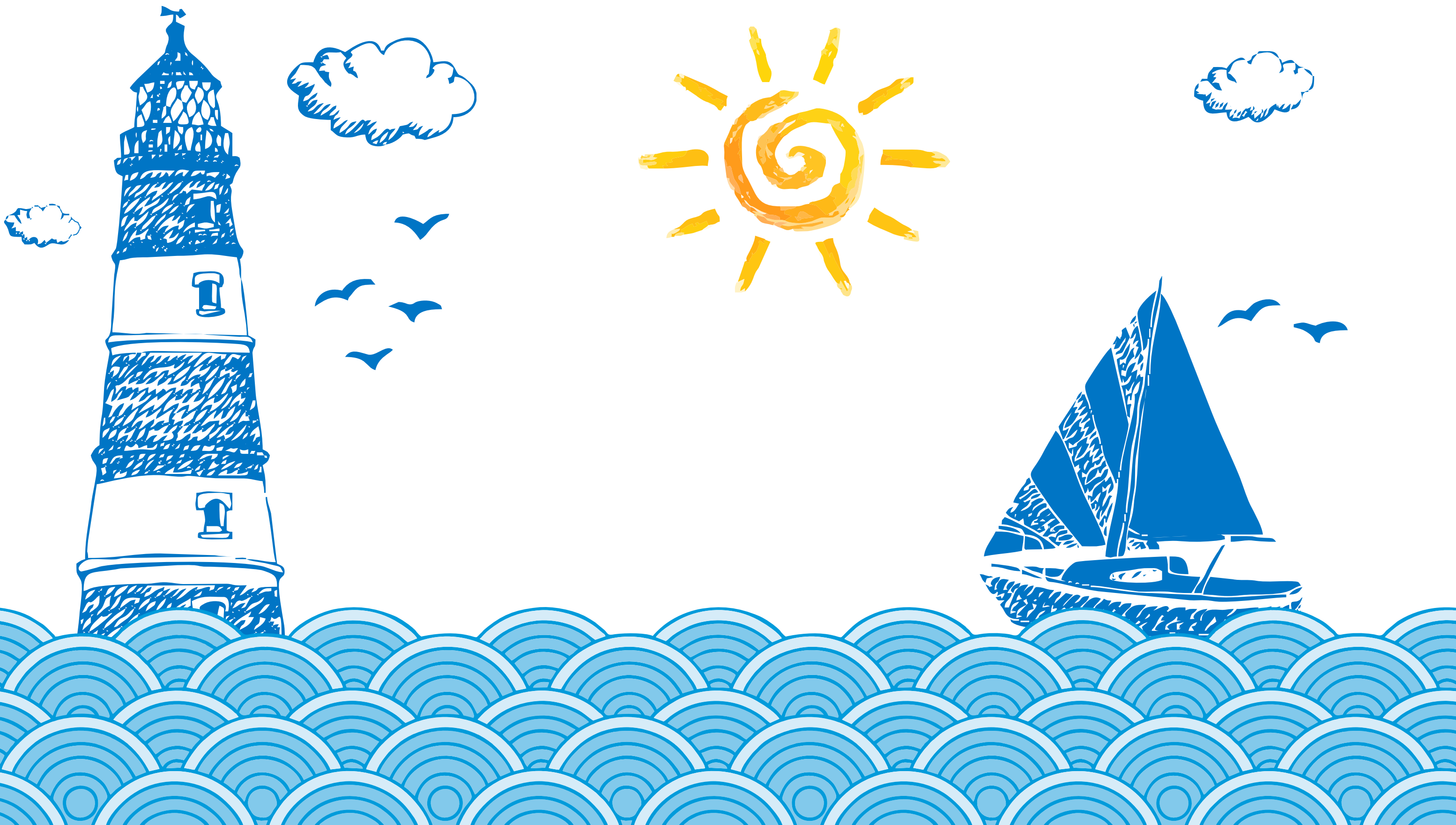

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Investigation of the impact of changed precipitation patterns on groundwater recharge processes in a semi-arid carbonate aquifer by an integrated surface-subsurface, multi-continuum model

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Climate change is expected to have a significant impact on the water budget of Mediterranean karst aquifers due to a projected decrease in mean precipitation, while intensity and frequency of shortduration extreme rainfall might increase (IPCC, 2007). Sustainable water management practices require predictive modeling of large-scale groundwater reservoirs on the basis of a sound estimation of recharge rates and a solid understanding of flow and transport processes. Here, we employ the finite element distributed multi-continuum flow simulator HydroGeoSphere (Aquanty, 2015) on a high-performance-computing platform to simulate the hydrological-hydrogeological cycle of the Western-Mountain-Aquifer (WMA). The WMA (9000 km2), located in Israel and the Palestinian Territories, comprises deep buried karst conduits that determine today's discharge point at the Taninim spring. Submarine depositional and erosional developments during the Oligocene (i.e., formation of canyons as a result of large-scale sliding) as well as further erosion by groundwater and surface water discharge under lowered sea water levels during the Messinian event (~6 Ma) led to the formation of the deep karst conduits. Macroporosity (i.e, fractures and conduits) represent efficient flow paths in karstified rocks, transmitting water under rapid flow conditions, while the primary porosity of the rock matrix provides substantial storage and slow drainage. A double-continuum approach based on the volume-effective Richards' equation with van Genuchten parameters is applied in order to simulate flow in the variably saturated fractured-porous subsurface, accounting for the duality of karstic flow, both in the vadose and phreatic zones, with rapid flow through conduits and slow flow through the rock matrix. Overland flow due to infiltration excess is accounted for via a 2-D friction-based overland flow continuum, coupled with a first-order exchange term to the subsurface. This allows to naturally account for the partitioning of rainfall into diffuse and rapid direct recharge, e.g., along dry valleys or sinkholes. This modeling approach accounts for complex infiltration characteristics of the rock-soil landscape, with local recharge along karst features and transmission losses of ephemeral streams (wadis) under highly variable precipitation patterns. The model will eventually be employed to simulate water flow under changed hydrologic conditions due to climatic changes and employed as a management tool.