Estimating characteristic times of regional groundwater systems along the global coastline with regard to past sea level fluctuations and sediment accumulation patterns

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ABSTRACT

Coastal zones around the globe are under increasing threat of freshwater scarcity due to both anthropogenic and climatic changes. The rising demand for freshwater in highly populated coastal areas combined with sea level rise, extreme weather conditions such as longer drought periods and more frequent storm events could potentially lead to humanitarian crises. To mitigate the risk of the latter while increasing the resilience of coastal communities, it is important to know the current distribution of fresh and saline groundwater in different coastal regions worldwide. We used the classification by Laruelle et al. (2013) into so-called COSCAT regions that combines the inland sediment transport systems with the corresponding continental shelf stretches serving as depositional areas. Consequently, we estimate the composition of coastal groundwater systems in the majority of the COSCAT regions by analyzing the upstream lithological formations (Hartmann & Moosdorf, 2012) and the volume and shape of the continental shelves in each region. To assess the current fresh and saline groundwater distribution, we first need to find a so-called characteristic time of these COSCAT regions. We define this characteristic time as the time that the model shows an identical fresh-saline distribution while initially starting with salinity concentrations of fully fresh or fully saline over the entire model domain. To achieve this, we create an average representative 2D profile for each region and simulate the fresh-saline distribution using the SEAWAT code (Guo & Langevin, 2002). This representative profile is built by averaging all data in the generated 2D profiles from Zamrsky et al. (2018) located in each COSCAT region: viz. the aquifer thickness estimations and extent of the coastal plain (Zamrsky et al., 2018), global topography and bathymetry dataset (Weatherall et al., 2015), the depth of the water table (Fan et al., 2017) and recharge (de Graaf et al., 2015). Since at the moment no global geological borehole dataset is available, we used multiple geological scenarios (position of aquitards) based on the prediction of sand/clay ratio in the depositional area of the COSCAT regions. In this way, we estimate the characteristic time for each coastal COSCAT region worldwide using the state-of-the-art global datasets available.

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