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Estimation of spatial distribution of submarine groundwater discharge in Asian mega-cities using DEMs

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As groundwater is one of nutrient source into coastal zones, it is important to evaluate spatial distributions in submarine groundwater discharge. The SGD varies spatially in the urban coastal zone due to topographic change and groundwater pumping. Especially, the expansion of reclaimed land with the urbanization caused the decline of groundwater flow. In order to estimate the effect of the urbanization on spatial variation in submarine groundwater discharge, we applied a topographic model to the coastal area of Jakarta, Bangkok, Manila and Osaka. Submarine groundwater discharges were calculated based on the Darcy equation and topographic gradient from the coastal line to the inland of 500m. The hydraulic gradients and cross-sectional areas were estimated from the topographic gradients by the empirical relationships. The total SGD calculated by this model into Osaka bay corresponded with that estimated by water balance. The coastal lines with flat topographic surface had no SGD. The spatial distributions in submarine groundwater discharge were similar to the results estimated by tracer method. Especially, the ratios of grids with flat surface increased with the urbanization. Those were 1 % of the total coastal grids in Jakarta, Bangkok and Manila, but 21 % in Osaka. Most of those consist of reclaimed lands. Consequently, the amount of submarine groundwater discharge in Osaka was 15 % lower than those in Jakarta, in spite of similar average topographic gradient. We confirmed that submarine groundwater discharge decreased with the urbanization.

Keywords: Submarine Groundwater Discharge, Topographic model, DEM, Asian Mega-cities