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A regional lumped model approach to study Fresh Submarine Groundwater Discharge (FSGD) on Java, Indonesia

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Fresh submarine groundwater discharge (FSGD), the direct discharge of terrestrial groundwater to the sea, is increasingly recognized as potential nutrient source for coastal ecosystems or water resource for the use by the coastal population. Indonesia is characterized by high water input by monsoon precipitation, intense coastal urbanization and intensive agricultural land use. Hence, several global studies have pointed out Indonesia to be a hot spot for nutrient rich Fresh Submarine Groundwater Discharge (FSGD). Although nutrient rich FSGD might pollute coastal areas of Java, Indonesia, FSGD is barely quantified and data is rarely available. An additional challenge is, that Javas coast is a complex mix of volcanoes, alluvial plains, mountains, and karstic plateaus.

To understand the amount and dynamics of FSGD on Java a regional transient lumped model is built for coastal catchments, which runs from the year 2000 till 2015. General processes of percolation, unsaturated and saturated groundwater flow are conceptualized to quantify FSGD from coastal catchments to coastal waters. Hydrological input data is taken from satellite remote sensing. We use global data sets for soil and aquifer properties. To understand the uncertainties and the importance of the different lithologies and model parameters a Monte Carlo analysis is implemented.

On average, Javanese coastal catchments generate 2 mm/d FSGD, which amounts to 20 % of the precipitation in the coastal catchments. According to the model 73.8 % of the total FSGD is generated from alluvial catchments, 21.6 % from volcanic and 4.6 % from limestone catchments. However, the uncertainties of the estimates are high: The Monte Carlo simulation results in standard deviations of 63%, 85%, and 109% in alluvial soil, volcanic rock, and limestone rock, respectively. While our results demonstrate the general applicability of the model approach, the high uncertainty of global input data might be greatly reduced by adding regional or local information. Nevertheless, the model is suitable to estimate FSGD also in regions without any local data availability.