

Contemporary groundwater salinity in Southwestern Bangladesh as steered by hydrogeological conditions under palaeohydrological and contemporary settings

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ABSTRACT

We studied the palaeohydrological and contemporary natural and anthropogenically induced freshening and salinization processes that control the large observed variation in groundwater salinity in a study area in southwestern Bangladesh. We used a 5 km transect where 32 piezometers were installed at 20 locations. A total of 129 water samples was taken and chemically analyzed from the newly placed piezometers, and from surface water bodies, tube wells, and hand drilled auger holes. Of these, 45 samples were analysed for $\delta^2\text{H}$ and $\delta^{18}\text{O}$ and 23 for tritium. Cation exchange and related chemical processes were simulated according to local conditions with a PHREEQC 1D-transport model to interpret the stage of freshening or salinization of the groundwater.

We found the relative importance of palaeohydrological and recent processes on contemporary groundwater salinity to be controlled by the thickness of the Holocene clay cover. Areas that were transformed into floodplains following the Holocene high stand (~7000 yr BP) developed a thick clay cover (~30 meters). These areas experienced limited influence from recent processes after sealing of the aquifer, and therefore remain brackish-fresh despite more saline conditions at the surface afterwards. Areas with a thin clay cover (~5-10 meters) developed on a large Holocene sandy channel belt during the progradation. This clay cover developed later only after the Ganges river migrated eastwards (~2500-5000 yr BP). Late Holocene and contemporary processes have influenced the groundwater beneath this relative thin clay cover. The type of recent influence depends on small variations in surface altitude (~1.5 meters difference) caused by different amounts of subsidence following sediment autocompaction, and by erosion of tidal creeks or rivers. Slightly elevated areas contain fresh shallow groundwater due to freshening from recharge by rain and anthropogenic ponds. Relatively low lying areas with a thin clay cover contain saline groundwater instead, due to salinization from tidal floods, from tidal creeks or rivers and recently from saline shrimp ponds.

In conclusion, the altitude of the surface and the thickness of the Holocene clay cover control respectively the type and the amount of natural and anthropogenic induced freshening and salinization processes. Those two factors are therefore key in understanding the large variation of groundwater salinity in southwestern Bangladesh.

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