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The influence of surface water - groundwater interactions on the shallow groundwater in agricultural areas near Fu River, China

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The Northern China Plain (NPC) is known as a very productive area in China for the production of maize and winter wheat, which is grown by local farmers rotationally without lag phases throughout the year. The needed application of fertilizers and pesticides can hereby have strong impacts on the quality shallow groundwaters. Because 70-80% percent of the annual rainfall in the NCP is limited to the summer months, irrigation in the spring season is a necessity. As high quality groundwater resources from deeper aquifers are a valuable and rare asset in Northern China, it should preferentially be used as drinking water, and farmers therefore often shift to flood irrigation with surface water from streams. It is due to this reason, that large agricultural areas are located very close alongside these waterways; often without buffer zones.
Fu River is one of the major feeding streams for the Baiyangdian Lake region in the north of Hebei Province. It springs in the west of the lake area and - after passing the populated city of Baoding (with a population of about 600 000 in the metropolitan area) - continues on its course through agricultural area before it feeds into the lake system. Industrial and domestic wastewater as well as surface runoff from urban and agricultural areas substantiates for a significant amount of the river's recharge and often causes poor water quality. As the water from the river may infiltrate into the shallow groundwater, this could cause further deterioration of the groundwater quality, additionally to the effects of the agricultural activities. However, fluctuations may be high because of the strong seasonal differences in precipitation and depending on the connectivity and dynamics of the system .
In order to assess the water quality situation and the potential link between surface water and shallow groundwater in the region, a small-scale investigation site was set up on a typical wheat-maize field that reaches almost up to the river bank in its extension. Samples were taken from groundwater, surface water and the hyperheic zone and analyzed for cations, anion, redox conditions and stable isotopes. Continuous water level monitoring in five groundwater wells and the surface water was done to monitor the hydraulic gradient. Temperature measurements were used as another indicator for the dynamics of the water flow, and it was seen that the system is highly responsive. Inflow of the stream into the very shallow groundwater played the dominant role throughout the sampling year (2013). The hyperheic zone played a special role with its own unique redox conditions, which lessened the influence of the surface water to different extends, and demonstrated the importance of this zone.