Quantifying and predicting river-aquifer exchange in lowland floodplains (Nete, Demer and Dijle), Belgium

Min Lu1,2, Gedeon Matej1, Beerten Koen1, Vandersteen Katrijn1, Huysmans Marijke2,3
1Insitute for Environment, Health and Safety, Belgian Nuclear Research Center (SCK-CEN), Boeretang 200, BE-2400 Mol, Belgium
2Department of Earth and Environmental Sciences, KU Leuven, Celestijnenlaan 200 e-Bus 2410, BE-3001 Heverlee, Belgium
3Department of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel, Pleinlaan2, BE-1050 Brussels, Belgium

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Floodplains provide multiple ecosystem services such as agricultural production, groundwater storage, biodiversity, carbon storage, water buffering and recreation. The interplay between the geomorphological, ecological and hydrological processes of the floodplains is strong and dynamic. However, few studies have succeeded in building a holistic picture and combined these three aspects together. In Belgium, the Fonds Wetenschappelijk Onderzoek – Vlaanderen sponsors a strategic basic research project “Future Floodplains - ecosystem services of floodplains under socio-ecological change” from 2017 to 2021, which aims at providing insights into the mid- to long-term geo-ecohydrological dynamics of the floodplains in Flanders under the changing socio-ecological conditions in the future.

My PhD research focuses on the hydrological processes for the “Future Floodplains” project. The floodplain hydrology is strongly related to the interactions between the shallow groundwater (GW) and the surface water (SW), especially in the hyporheic zone. The exchange fluxes between the river and aquifer are often characterized by a high temporal and spatial variability. For measuring the fluxes, a multi-method approach is considered in the selected study sites in the Scheldt catchment in Belgium. As groundwater head observations do not directly reveal the exchange fluxes, other state variable observations, like temperature measurements or hydrochemical analyses with different spatial support, will be performed to quantify the fluxes.

The exchange fluxes will be computed using independent analytical or/and numerical methods. Afterwards, they will be used as the input data for building the hyporheic zone model. We will then develop an integrated multi-scale GW-SW model, which will couple the small scale hydrological model with a catchment-scale groundwater model. After the model calibration and validation using the multiple measured dataset, the coupled model will be able to stimulate the mid- to long-term hydrological status of the floodplains through the changes in channel morphology, climate change, land cover change and urbanization. Meanwhile, the output from the coupled GW-SW model such as groundwater levels and seepage rates will deliver input for developing the ecological model of the floodplains in other working package.

When the individual geomorphological, ecological and hydrological models are constructed, they will be coupled together as a complete geo-eco-hydrological model, which will enable to predict the resilience as well as the future quantity and quality of the various ecosystem services in the floodplains, and aid policy makers and managers in making the most optimal decisions for the floodplain management in Flanders.

References