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GLOFRIM 2.0 - Assessing the impact of coupling hydrologic, hydrodynamic, and groundwater models on large-scale inundation estimates

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Currently, most global flood models (GFMs) are based on either hydrologic or hydrodynamic model codes. Yet, both of the approaches have shortcomings; the first, because the applied routing scheme, such as the kinematic wave approximation, is often simplistic; the latter, because they depend on observed discharge or synthesized flood waves. Recently, GLOFRIM 1.0 (Hoch et al., 2017, https://doi.org/10.5194/gmd-10-3913-2017) was developed, allowing for coupling the global hydrologic model PCR-GLOBWB (Sutanudjaja et al., 2017, https://doi.org/10.5194/gmd-2017-288) with either Delft3D Flexible Mesh or LISFLOOD-FP. While model coupling improved discharge estimates compared to hydrology-only runs (Hoch et al., 2017, https://doi.org/10.5194/hess-21-117-2017), floodplain inundation is still overestimated. Follow-up studies (Hoch et al., in prep, AWR) showed that this is, amongst others, due to the absence of important feedbacks between hydrodynamics and hydrology.
Additionally, PCR-GLOBWB can be coupled to the groundwater model MODFLOW for simulating both lateral groundwater flow and spatio-temporal variation of groundwater heads. This PCR-GLOBWB-MODFLOW coupling allows a more physically based (i.e. pressure difference driven) water exchange between surface water and groundwater bodies and between unsaturated zones and saturated groundwater bodies (Sutanudjaja et al., 2014, https://doi.org/10.1002/2013WR013807).
Here we present the next generation of model coupling, integrating hydrologic, hydrodynamic and groundwater flow processes. More specifically, we introduce feedbacks between surface water inundation (flood) simulated by a hydrodynamic model to the coupled PCR-GLOBWB-MODFLOW model. The advanced coupling makes the surface water inundation subject to open water evaporation and exchange with unsaturated zones and groundwater bodies. The here presented framework GLOFRIM 2.0 facilitates this coupling and can therefore be beneficial for improved simulation of not only discharge, but also inundation extent and inundation duration. We assessed the added value of applying such a framework in the Niger and Amazon basin to further improve the applicability and contribution of GLOFRIM for large-scale inundation modelling.