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# Process-based hydrological modeling using SWAT: The effect of permafrost on water resources in the large-scale river catchment Kharaa / Mongolia

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In this study, the Soil Water Assessment Tool (SWAT) was applied to obtain a better understanding of hydrological processes in the semi-arid catchment of the Kharaa River in Northern Mongolia. The transient, physical-based model SWAT was set up using spatial datasets on soil, land use, climate, and stream network provided by the project “IWRM-MoMo” to (i.) simulate the water balance components of the basin and (ii.) to identify potential gaps in the input data.

We found that the SWAT model satisfactorily reflects the hydrological processes in the catchment and simulates river runoff as a response to strong rainfall events as well as to snow and ice melt. To obtain correct runoff volumes during spring, permafrost has to be considered. Permafrost-influenced soils constrain water flow in the frozen layer, so that percolation out of the active layer is hampered (Woo 2011). This effect is reproduced in SWAT by assigning an impermeable layer in the subsurface to the areas dominated by permafrost. The simulations indicate that in these regions groundwater resources are limited as a consequence of impermeable ground ice. In addition, groundwater recharge rates in the catchment are generally low due to high evaporation rates (80-90 %). Consequently the base flow contribution is small. Further studies on the estimation of groundwater recharge rates should be carried out, since groundwater is an important resource for water supply.

Model results indicate that the non-uniformity of the precipitation distribution was not sufficiently covered by the interpolated input data, so that precipitation and runoff volumes are partially over- or underestimated. Since precipitation defines the overall water availability in river catchments (Baumgartner 1982), additional climate records would considerably improve model outputs. As a consequence of large evapotranspiration losses, discharge as well as groundwater recharge estimates were identified to be highly sensitive to evapotranspiration parameter changes. Hence, special caution is required in assigning appropriate parameter values to land use, vegetation, and soil. The same applies to the process of sublimation, which significantly reduces the snow cover in the catchment (Wimmer et al. 2009). The simulations indicate that spring discharges are sensitive to corresponding parameters.

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