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Hydrological modelling of the Mara River Basin, Kenya: Application of the Normalised Difference Infrared Index (NDII)

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In hydrology and water resources management, precipitation and discharge are the main time series for hydrological modelling. However, in African river catchments, the quantity and quality of the available precipitation stations and discharge measurements are unfortunately often inadequate for reliable hydrological modelling. To cope with these uncertainties, this study proposes to calibrate on water levels and to constrain the model using the Normalised Difference Infrared Index (NDII) as a proxy for root zone moisture stress.

With the NDII, the leaf water content can be monitored. Previous studies related the NDII to the equivalent water thickness (EWT) of leaves, which is used to determine the vegetation water content (VWC). As the water content in the leaves is related to the water content in the root zone, the NDII can also be used as indicator of the soil moisture content in the root zone. In previous studies it was found that the root zone moisture content is exponentially correlated to the NDII during periods of moisture stress.

In this study, the semi-distributed rainfall runoff model FLEX-Topo has been applied to the Mara River Basin. In this model seven sub-basins are distinguished and four hydrological response units with each a unique model structure based on the expected dominant flow processes. To calibrate the model, the water levels have been back-calculated from modelled discharges, using cross-section data and the Strickler formula calibrating parameter '$k \bullet s^{1/2}$', and compared to measured water levels. In addition, the correlation between the NDII and root zone moisture content has been analysed for this river basin for each sub-catchment and hydrological response unit. Also, the application of the NDII as model constraint or for calibration has been analysed.