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How is water transmitted in large, low gradient, dryland river systems?

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Drylands represent approximately one third of the earth's surface, with a large number of ephemeral river systems, are characterised by an extremely variable flow regime and high transmission losses. Yet the scarcity of gauging infrastructure and challenges of gauging flows in large anastomosing rivers means that critical aspects of the hydrology and ecology of these rivers remains unknown. The paper trials a novel approach to use a hydrodynamic model and remotely sensed data to understand critical questions relating to the water balance and movement of major flood pulses in large dryland river basins.

Along 180km poorly-gauged study reach in upper part of the Diamantina River, Lake Eyre Basin, four water level loggers were installed and water elevations were recorded during the 2011 major flood event. These water elevations were used to build and calibrate a 2D hydrodynamic model at the locations of the loggers (virtual gauging stations). Temporally sporadic (though more accurate) Landsat coverage and daily (lower accuracy) MODIS coverage was also used to calibrate the model. Using the calibrated model, total water loss/gain was calculated in each reach between virtual gauging stations. These water volume changes mostly represent transmission losses and are caused by some combination of: evaporation, infiltration, and terminal water, with lateral (tributary) inflows the only potential water volume gain. These four parameters then were added to the model and sensitivity analyses were performed.

Infiltration transmission losses are highly sensitive to initial soil moisture conditions. Within large dryland catchments, the potential for large rainfall events to occur in downstream parts of the catchment introduces a higher sensitivity to lateral tributary inflows relative to the overall water balance of the trunk stream. In addition, the low gradient, wide, and shallow flow structure introduces a higher sensitivity to terminal water storage (real or DEM derived) relative to the overall water balance. However, in contrast to many other river systems, models under these dryland conditions appear to be less sensitive to roughness parametrisation, and given the very low gradients is anyway likely to be dominated by the DEM surface accuracy. This study emphasizes the significant value optical satellite imagery and altimetry satellites can add to hydrodynamic model calibration and validation in data poor dryland river systems where a better understanding of water resource availability is critical for constraining human and ecosystem needs.