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Continental mapping of groundwater-dependent ecosystems based on a high-resolution global groundwater model

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The increase in global population has led to the expansion of water demands for agriculture, domestic and industrial use in areas with limited precipitation and surface water sources, increasing the dependency on groundwater resources. An increase in groundwater pumping combined with low recharge rates has increased the rate of groundwater depletion globally. An increase in water demand alongside a decrease in recharge rates can lead to reductions in groundwater levels and groundwater discharge, which may adversely affect groundwater-dependent ecosystems (GDEs) and their unique biodiversity and ecosystem services.

Mapping and classifying groundwater-dependent ecosystems (GDEs) are key steps for understanding ecosystem-groundwater interactions as well as for optimizing the allocation of groundwater resources. However, manual mapping of GDEs is tedious, especially across large areas. Here, we aim to calibrate and apply a global groundwater model to map and classify GDEs across large extents. Our initial focus is on Australia, which is characterized by a large dependency of ecosystems on groundwater and for which GDE locations have been mapped across the continent, facilitating model calibration and validation.

We use a recently developed high-resolution (30 arc-seconds) global groundwater model GLOBGM hydrology forced with recharge and surface water levels from the global hydrological model PCR-GLOBWB 2, to map three types of GDE, namely aquatic (streams, rivers and lakes), wetlands (fens, marshes and swamps) and terrestrial GDEs (phreatophytes). The model maps all ecosystems that depend on groundwater recharge in a steady state. To validate model output, it is compared to the Australian GDE atlas using a hit rate analysis and a 90% hit rate was found with aquatic GDEs. In the next steps, we seek to quantify the dependency level of these GDEs on groundwater recharge by running the groundwater model in a transient state globally. This assessment is useful for decision-makers in terms of groundwater allocation and biodiversity conservation within high-dependency GDE regions.