Mapping groundwater dependent ecosystems and their degradation using selected hydroclimatic windows

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Abstract: Terrestrial groundwater dependent ecosystems (GDEs) provide ecosystem services particularly important in arid and semiarid areas. They conserve biodiversity by providing habitats for animals, regulate microclimate and provide aesthetic pleasantness, and in some cases house cultural and spiritual resources (e.g., of Aboriginal people in Australia). In humid areas, GDEs withstand droughts better than other terrestrial ecosystems. However, anthropogenic activities (e.g., mining) may change shallow groundwater on which GDEs are based, leading to GDE degradation. To protect GDEs, the first step is to know where GDEs distribute. Large-scale GDE mapping has been done in Australia. However, similar GDE maps are rare in other parts of the world. Although with mapped potential GDEs, most of them are not validated, assessing anthropogenic impacts on GDE degradation is challenging because vegetation degradation can be related to climate factors (e.g., droughts). Here we propose a hydroclimate-window based method for GDE mapping and degradation detecting.

The mapping approach is based on vegetation response under selected hydroclimatic conditions when non-GDEs and GDEs responses are most likely distinguishable. Here, the appropriate hydroclimate windows are the drought periods in growing season. The method was applied to map GDEs in contiguous China. The results indicate that high potential, moderate potential, and low potential GDEs account for 1.6%, 7.7%, and 22.1% of the total mapping area. These results were validated with observed depths to unconfined aquifers, and land surface temperature (LST) and Normalized Difference Vegetation Index (NDVI) responses during drought events.

A case of GDE degradation detecting was conducted for a mining area in Australia. In this case, the appropriate hydroclimatic window was a period of multiple years with a wetting trend. This hydroclimatic trend made GDE degradation standing out in the analysed remote-sensing imagery, providing evidence of the mining (instead of climate) impact on GDEs.

Keywords: *Groundwater-dependent ecosystems, Remote sensing, Drought events, Land surface temperature, NDVI, Sentinel 2, MODIS, mining impacts, wetting trends, Australia, Contiguous China*