

# GROUNDWATER SUSTAINABILITY AND THE LIMITS OF GROUNDWATER USE

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Population growth, expansion of agriculture and economic development have dramatically increased water demand and the reliance of sectoral water use on groundwater resources. The result is a dramatic rise in groundwater pumping and associated high rates of aquifer depletion around the globe with severe environmental impacts such as land subsidence, groundwater salinisation, and damage to groundwater-dependent ecosystems.

Until now, research into groundwater depletion and overuse has been mostly limited to quantifying current and future trends in extraction or depletion rates. However, depletion rates per se are insufficient to estimate the critical time horizons at which groundwater reserves will become exhausted, and further, they cannot inform on the negative impacts of groundwater use. This will require insight into the critical depths above which groundwater that still can be physically and economically extracted, and on the relationship between depletion depths and detrimental impacts, such as on groundwater dependent ecosystems.

After a short review of previous global assessments on groundwater sustainability, we present the use of a global high-resolution transient ground water model to estimate the depth of the water table with respect to physical, economic and ecological critical depths, which together define the limits to groundwater use. Physical critical depths are related to the depth of the stream-groundwater disconnection, the fresh-saline interface and the maximum depth that allows for high-capacity groundwater pumping. Economic critical depths are reached once the costs of pumping persistently exceed the revenues from water use. Ecological critical depths are the minimal water table depths required to support groundwater dependent ecosystems. We assess the current volumes of groundwater stored above these critical depths and use combined climate and socio-economic scenarios to assess when and where critical depths are reached.