European Commission

Science for Environment Policy

Groundwater footprint reveals unsustainable water consumption

Reservoirs of water stored under the earth's surface, otherwise known as groundwater, are a valuable resource. However, using a footprinting method, a new global study has indicated that about 1.7 billion people live in areas where groundwater is being used more quickly than it can be replenished.

30 November 2012
Issue 308
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Source: Gleeson, T., Wada, Y., Bierkens, M.F.P & van Beek, L.P.H (2012) Water balance of global aquifers revealed by groundwater footprint. *Nature* 488: 197-200. Doi:10.1038/nature11295.

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Theme(s): Environmental information services, Resource efficiency, Sustainable consumption and production, Water

Groundwater supplies water to billions of people and is important for agricultural irrigation and the health of ecosystems. Water resource assessments tend to focus on surface water, but there is increasing concern about the depletion of groundwater. Although groundwater stored in aquifers is naturally renewed, shortages can occur when it is removed more quickly than it is recharged. In order to devise appropriate management strategies and communicate the issue to the public, it is necessary to understand the extent of the problem and identify locations of particular concern.

The 'footprint' concept is a powerful tool to communicate and measure our resource use and is well-known for its application in the ecological footprint and the water footprint. Thus the groundwater footprint is methodologically derived from the model of ecological footprint. The study applies the concept to groundwater to assess the impact of groundwater consumption on natural stocks and flows. It defines the groundwater footprint as the area required to sustain groundwater use and the ecosystem services that are dependent on groundwater for a certain region of interest, such as a watershed, aquifer or community. Essentially, it identifies the right balance between groundwater use and groundwater replenishment for an area.

Using data on recharge rates, natural flow and abstraction from large aquifers around the world, the researchers calculated groundwater footprints for 15 regional aquifers, including the Upper Ganges in India, the Danube basin in Europe and the Central Valley in the USA. A total footprint for other smaller aquifers was also calculated.

All the footprints were then combined to produce a value for a global groundwater footprint. This was estimated to be 131.8 billion km^2, which is roughly 3.5 times the actual global area of active aquifers, and indicates that we are using far more groundwater than is being replenished.

A handful of countries are responsible for the majority of the global groundwater footprint, including the USA, China, Pakistan, Iran, India, Mexico and Saudi Arabia. However, 80% of aquifers have a groundwater footprint that is less than their area, indicating that the global footprint is driven by a few overexploited areas and that there is potential in underused areas for sustainable water supply from groundwater.

The footprint calculation offers a quick tool to assess the sustainability of individual aquifers, which can be used to inform initiatives for planning groundwater use. For example, if a region has potential for agricultural intensification, but its footprint suggests that the aquifers are stressed, then these areas cannot increase crop yield sustainably.

The groundwater footprint does suffer several uncertainties, especially around the estimate of natural flow into aquifers. Nevertheless, it is a powerful tool that is easy to use and understand for water managers and the general public, which can monitor aquifers and inform decisions about their use.