A water scarce Scotland: what role could groundwater play?

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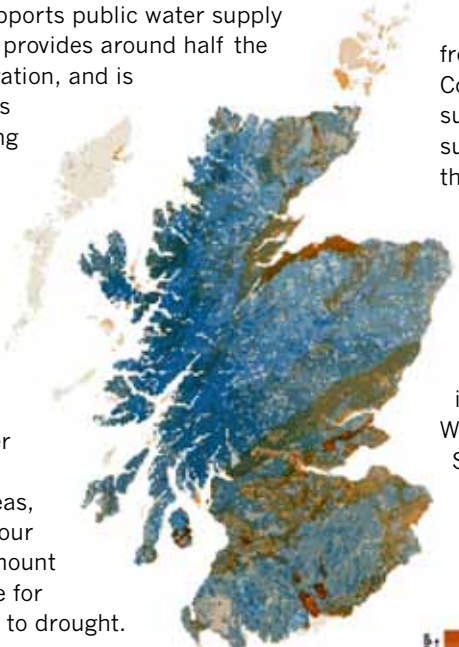
Type 'Scotland's Climate' into AI image generation software and it conjures up images of water: lochs, mountain streams, clouds, dramatic coastlines. Lots of water. But over the last few years, parts of Scotland have increasingly experienced water scarcity as a result of prolonged dry spells. During these periods, we have seen significant lowering of river, loch and groundwater levels, with associated impacts on water supply and the environment. In some areas, the Scottish Environment Protection Agency have had to implement restrictions or suspend water abstraction for important economic activities, such as hydropower and agricultural production. During these prolonged dry periods, most notably in 2018, 2022 and 2023, many private water supplies ran dry, leaving households without running water for days or weeks at a time.

Water scarcity is not a new phenomenon in Scotland. However, the frequency and severity of water scarcity is projected to increase, with drought conditions occurring every one in three years by 2040 (compared to one in 20 years over the historic baseline period). In some parts of the country, water scarcity is being experienced for the first time.

A recent project led by the James Hutton Institute, in partnership with the British Geological Survey, Aberdeen University and SAC Consulting, investigated the potential impacts of water scarcity on the agricultural and distilling sectors in Scotland. We found that many water users, particularly in Eastern Scotland, are already feeling the impacts of increasing water scarcity. The research points to an urgent need for clear advice, funding, and partnerships to support water users adapt to climate change.

One adaptation option, already highlighted in Scotland's National Water Scarcity Plan, is the use of groundwater as an alternative, and potentially more resilient, water source. Groundwater is already an important and valuable natural resource in Scotland. It provides the majority of private water supply, supports public water supply for several major towns, provides around half the water used for crop irrigation, and is widely used by industries such as distilling, brewing and bottled water. Groundwater also provides baseflow to many of Scotland's rivers. However, compared to surface water, which provides 95% of the water used for public supply in Scotland, groundwater is relatively poorly understood. In many areas, there are major gaps in our understanding of the amount of groundwater available for supply and its resilience to drought.



More than half the world's population are now estimated to rely on groundwater for drinking, and in parts of the world that experience water scarcity, groundwater often provides a secure supply of water during drought. In Ethiopia, for example, boreholes exploiting groundwater have been found to provide the most reliable source of water to rural communities when other sources, such as rivers, springs, and shallow wells, fail during drought. This brings significant benefits to those communities reliant on groundwater. Where other water sources fail, communities experience increased collection times, reduced agricultural productivity and food security, reduction in school attendance, and negative health impacts.

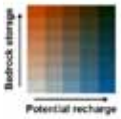
So what role could groundwater play in adapting to future water scarcity in Scotland?

Groundwater is not an infinite resource. To understand the potential role it could play in supporting more resilient supplies in Scotland, we need to quantify groundwater storage, groundwater recharge, and groundwater use. Where groundwater storage (the amount of water that is stored underground in the pore spaces and fractures within rocks) is relatively high, aquifers have greater capacity to support continued groundwater abstraction through droughts. Groundwater recharge (the amount of water that infiltrates the ground to replenish storage) determines the amount of water that can be abstracted sustainably without causing long-term depletion or environmental degradation.

A combined analysis of storage and long-term average recharge in Scotland highlights those parts of the country that are relatively more or less resilient to drought and long-term groundwater depletion. In Eastern Scotland, where the majority of abstraction for agriculture and distilling takes place, long-term average recharge is relatively low. In this region, significant storage within sandstone aquifers can provide a buffer during dry periods, making abstractions from these aquifers potentially more resilient to drought. Conversely, abstraction from relatively low-storage aquifers, such as those found within old crystalline rocks and many superficial deposits, will be more vulnerable to drought. In the west of Scotland, where long-term average recharge is relatively high, we would expect low-storage aquifers to continue to be able to support small-scale abstraction, but these sources will remain vulnerable to prolonged dry periods.

"Many water users are already feeling the impacts of increasing water scarcity."

This analysis provides a useful framework for assessing the potential for groundwater to support adaptation to increased water scarcity in Scotland at a national scale. What's needed next is a more detailed understanding of Scotland's groundwater systems at a catchment and aquifer scale. This will determine where and when groundwater could provide increased resilience for water users, particularly those vital Scottish industries such as agriculture and distilling.



Water security analysis showing combined bedrock aquifer storage and LTA potential recharge. Note that LTA potential groundwater recharge is only available for the mainland and larger islands of the Inner Hebrides. Contains data from the Enhanced Future Flows and Groundwater (eFLaG) project (Hannaford et al, 2022).