RESEARCH CASE STUDY

UK Centre for Ecology & Hydrology

Creating the very first groundwater model of the British mainland

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Hydro-JULES

Why it matters

The underground movement of water is just as important an element of the water cycle as rainfall, rivers and other above-ground components. This not only means that groundwater can provide good quality drinking water, but that it plays an important role in extreme weather events, such as the UK's 2013-2014 winter floods, which saw tens of thousands of acres under water.

However, our ability to model the flow of water through the ground has been limited by the scale and complexity of the task. Computer simulations of groundwater are typically only developed for modest areas measuring up to the size of counties, such as parts of single aquifers, and are rarely developed for entire countries. The prospect of developing a groundwater model for the British mainland is made more difficult by the British Isles' highly complex geology. Given that water will flow differently through different rock types, a detailed understanding of Britain's many rock formations is necessary to model the flow of groundwater.

Despite it's very complex geology, we have developed the first groundwater flow model for Great Britain

Hydro-JULES, is a research programme funded by the UK's Natural Environment Research Council (NERC), in order to advance our ability to predict the future availability of water resources and the risk of water related disasters under a changing climate.

The Hydro-JULES programme is building a three-dimensional, open source, community model of the terrestrial water cycle to support and enable collaborative work across the research and academic communities in hydrology and land-surface science. This five-year programme is delivered by the UK Centre for Ecology & Hydrology (UKCEH) in partnership with the British Geological Survey (BGS) and National Centre for Atmospheric Science (NCAS).

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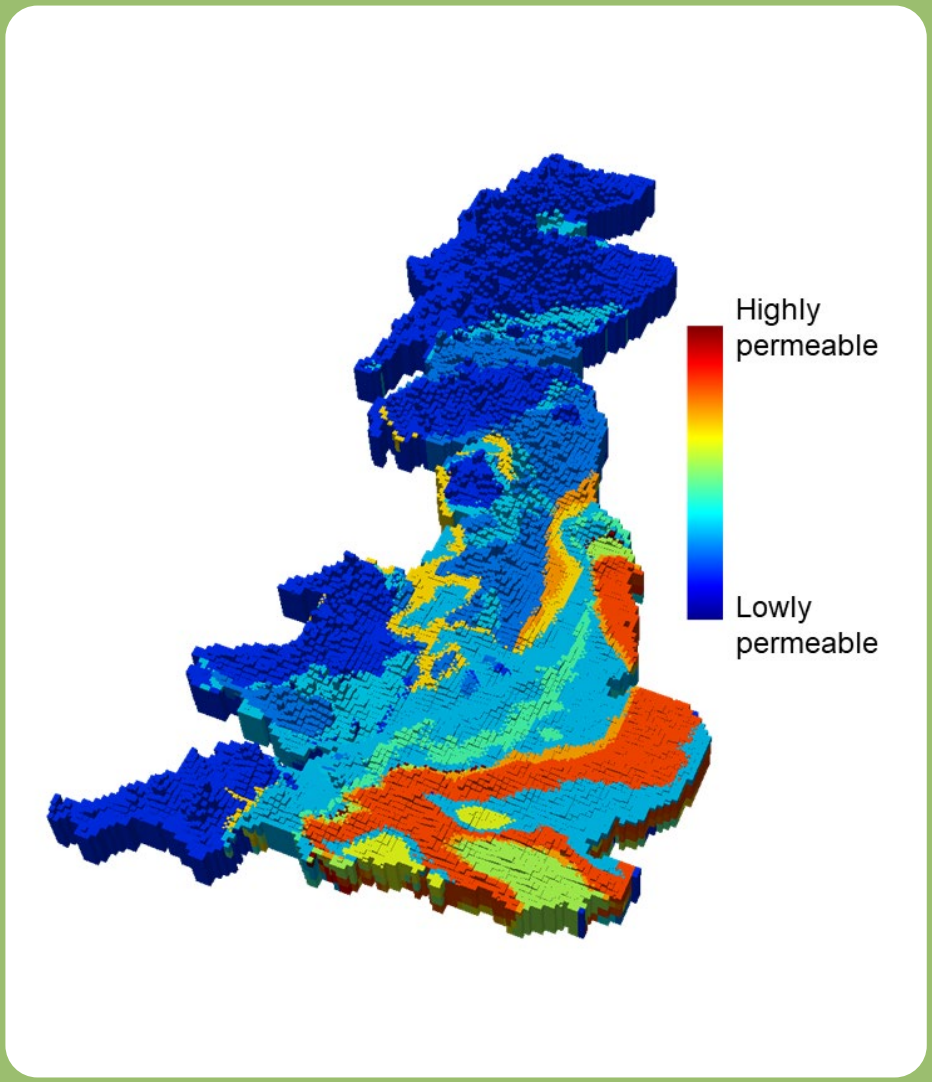

An example of input data (hydraulic conductivity) used for the current version of the groundwater flow model

What we did

Overcoming these challenges, a team at the British Geological Survey have developed the first groundwater flow model of England, Wales and Scotland. This ground-breaking model not only covers the entire British mainland, but also allows more detailed representations of groundwater flow to be modelled where needed. This ability, known as grid refinement, is particularly useful for areas of high water demand, such as around rivers that are connected to important aquifers.

The model was built using the United States Geological Survey's open access groundwater model code MODFLOW6. This reflects a desire to make the British groundwater flow model accessible to other hydrogeologists. The workflow was developed using the widely-used programming language Python, and the scripts that underpin the model can be made available to and readily repeated by a wide range of individuals and organisations, from academics to water companies to national decision makers. The model itself will be made available to other researchers in early 2022 via DataLabs, Hydro-JULES collaborative research environment for the UK hydrological community.

Expected impacts and benefits

The challenge now is to ensure that the model better represents Britain's groundwater system by reproducing groundwater levels and flows to rivers, as well as how these factors change with time. The model will also be linked to the Hydro-JULES framework so that a truly integrated surface water and groundwater flow model of the British mainland can be developed. This will help hydrologists better understand the role of groundwater in past extreme events at a national scale.

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BGS British Geological Survey
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