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Groundwater resilience to climate change in Africa

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Introduction

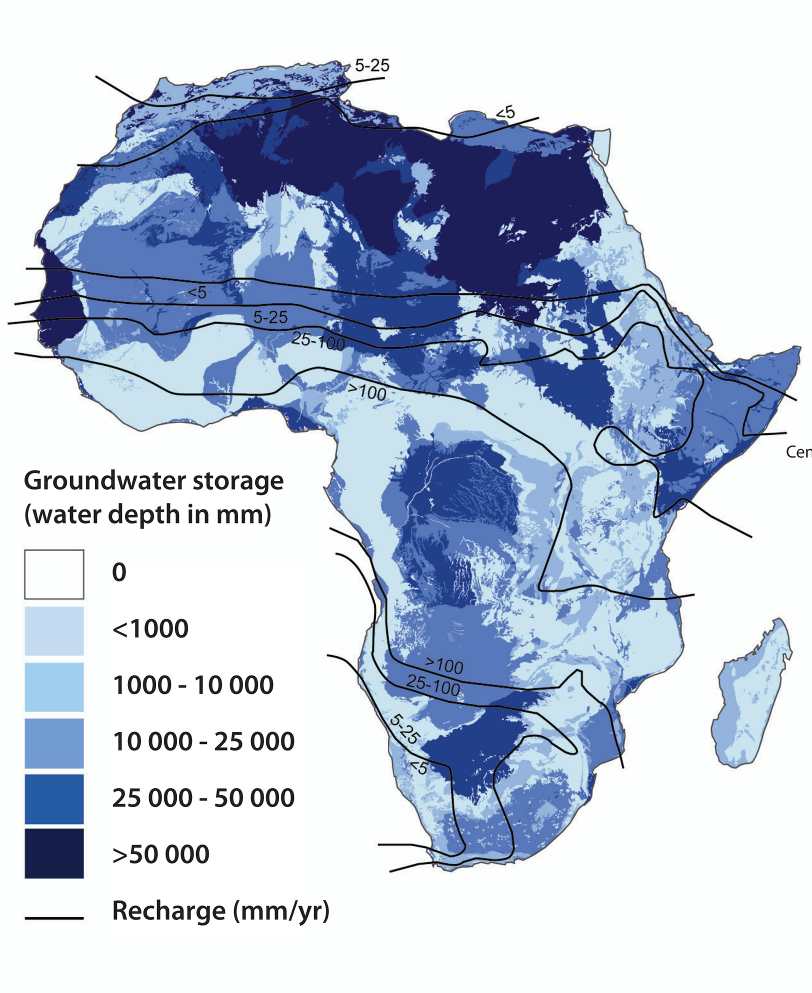
In Africa, groundwater is the major source of drinking water and its use for irrigation is forecast to increase substantially to combat growing food insecurity. Climate change along with rapid population growth are likely to impact all water resources, but the response of groundwater will be slower than that of surface water providing a potential buffer to help support adaptation. Here an interdisciplinary team from the UK and Africa present the results of a DFID funded research project to provide the first quantitative assessment of continental groundwater resources for Africa and to examine how resilient they are to climate change.

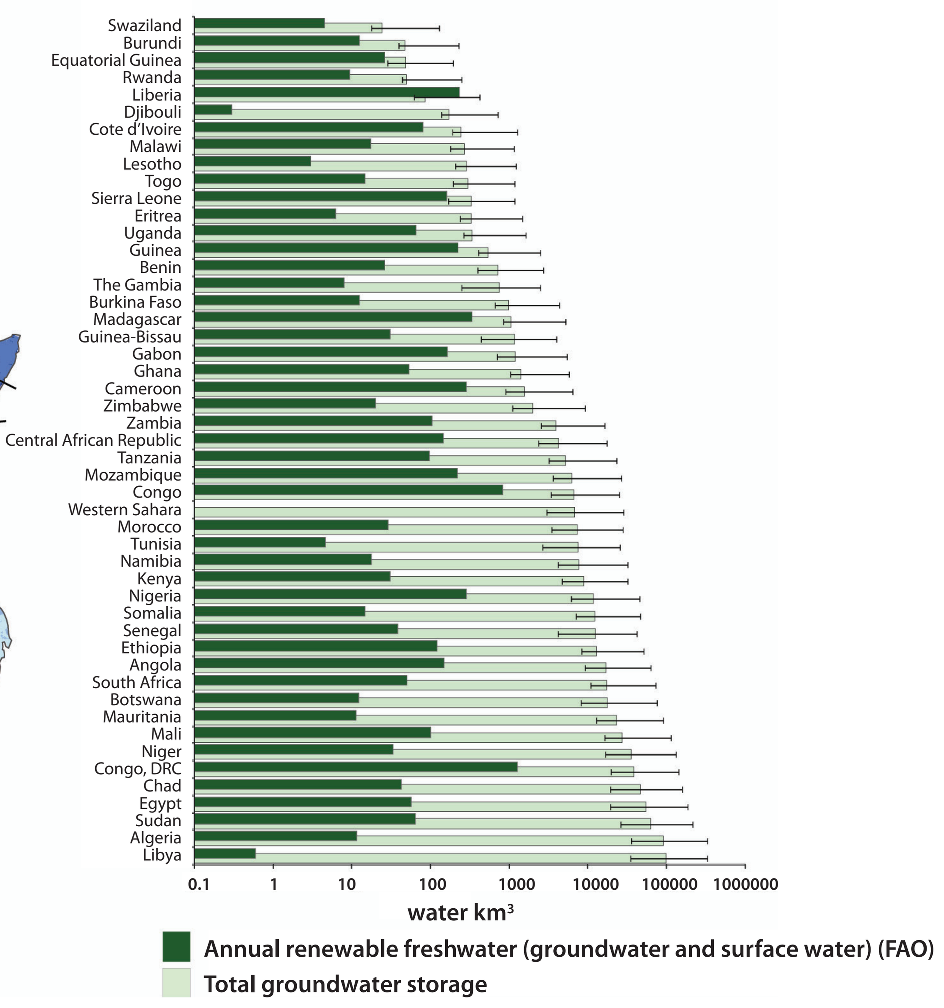
Groundwater storage

To characterise how groundwater will respond to climate change it is necessary to first assess how much groundwater is there. Groundwater maps were developed from an extensive review of available data, reports and regional maps using a modified geological map as a base.

The storage map shows that there is considerable groundwater storage in Africa – 0.66 million km^3. This is more than 100 times the estimated annual renewable freshwater in the continent, and 20 times the water stored in African lakes. Groundwater resources are unevenly distributed: largest groundwater volumes are found in the large sedimentary aquifers in the North African countries Libya, Algeria, Egypt and Sudan. Even in the poorer aquifers there is often enough storage to sustain a handpump through several dry years.

Therefore, as the largest and most widely distributed store of freshwater in Africa, groundwater provides an important buffer to climate variability and change.



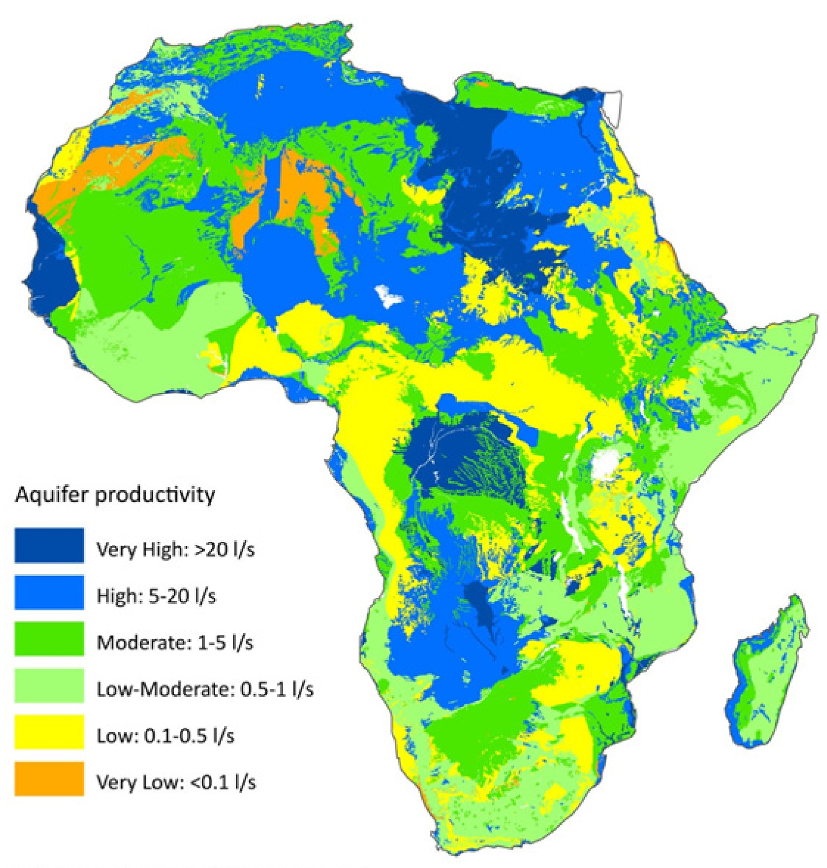


How resilient are African handpumps?

A key question is whether handpumps across Africa will be severely affected by climate change. To help understand this, the age of groundwater being pumped from handpumps was measured along a humid to arid transect in West Africa. Samples for a suite of environmental tracers were taken under closely controlled conditions and sent to the UK for analysis.

The results showed that even in the more arid areas, the groundwater being pumped from the handpumps comprised a mixture of groundwater ages, most of which had average residence times of 20–70 years. This suggests (1) groundwater recharge is still occurring to shallow groundwater in arid areas and (2) that the groundwater is not closely coupled to very recent rainfall, and therefore should be able to buffer interannual variations in rainfall.

Groundwater supply for drinking and irrigation



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The ease with which groundwater can be pumped out of aquifers is as important as the overall groundwater storage in determining how groundwater can help nations and communities adapt to climate change and population growth. The aquifer productivity map shows what yield can be reasonably expected from a borehole sited and drilled using appropriate techniques across Africa.

The map shows that for many African countries appropriately sited and constructed boreholes will be able to support a handpump (0.1–0.3 L/s). However the potential for higher yielding boreholes of >5 L/s is much more limited away from the sedimentary basins in northern Africa. Therefore, there is not widespread potential for industrial scale irrigation which relies on high borehole yields. There may however be potential for much smaller irrigation initiatives which require smaller borehole yields of <2 L/s.

Conclusions

The research has highlighted several important issues about the resilience of groundwater in Africa:

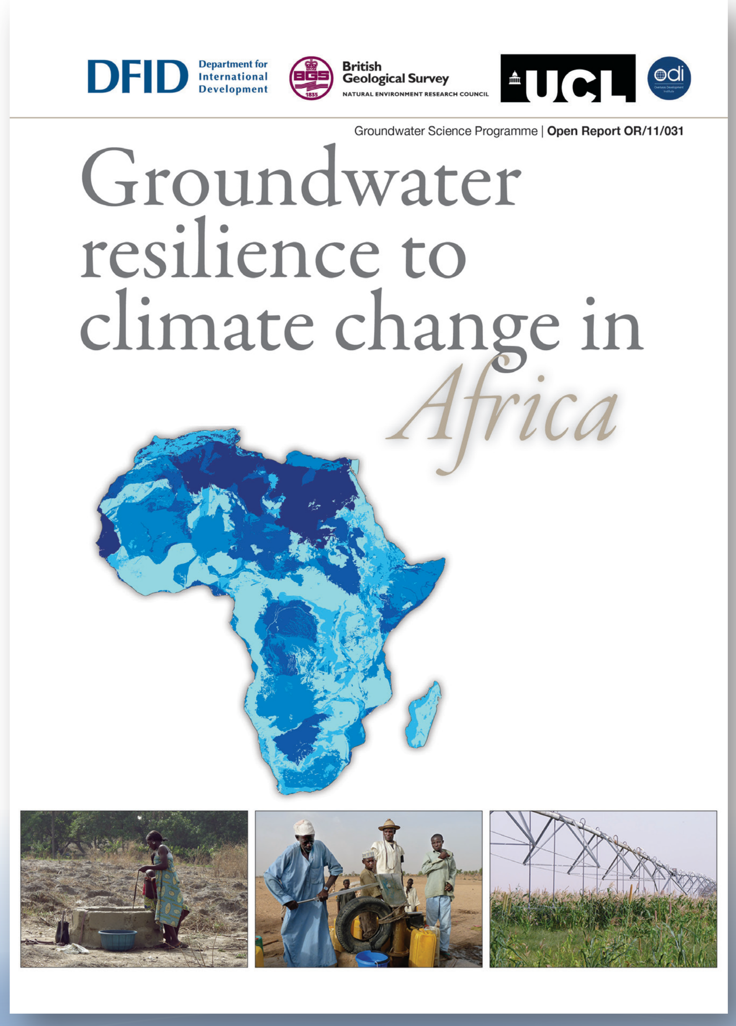
Groundwater is the largest and most widely distributed store of freshwater in Africa, more than 100 times the estimated average annual renewable freshwater resources.

For most African countries appropriately sited boreholes will be able to access groundwater to support handpump abstractions.

Away from the large sedimentary aquifers in northern Africa, high groundwater yields required for industrial scale irrigation or city supply will be more difficult to find.

Rural hand pumps are likely to be resilient to climate change since they generally access groundwater of mixed ages that is not directly coupled to recent rainfall.

The results of the research were published in November 2011 and a summary report is available to download.



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