Physical resources

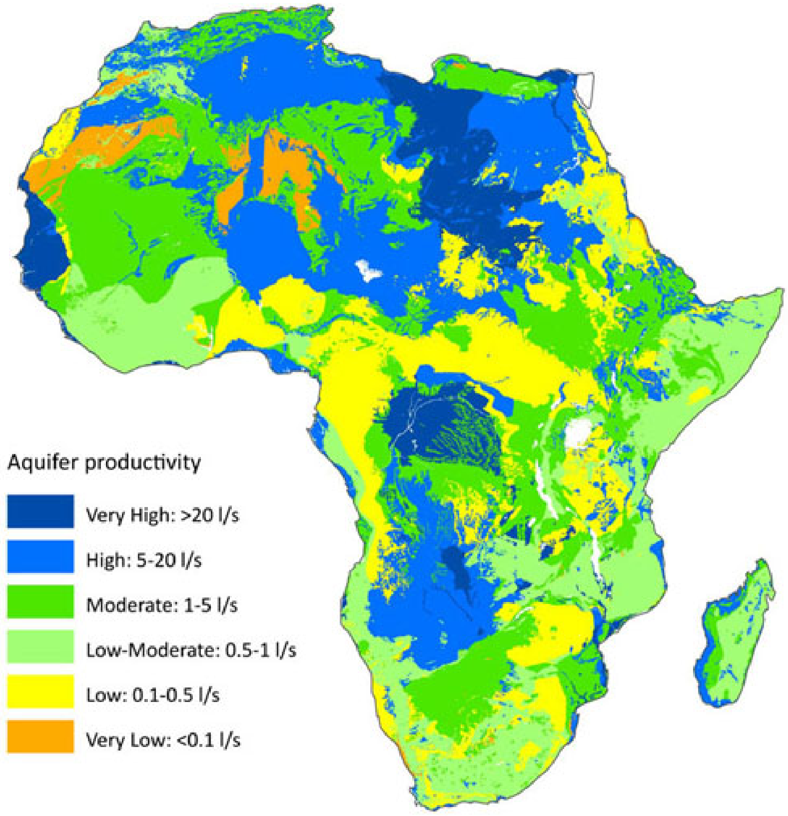
Groundwater in Africa (*May 2012*)

Sub-surface water supplies rarely figure in major journals. Hydrogeologists of the British Geological Survey and University College London have produced a continent-wide review of groundwater prospects for Africa, probably in most need of good news about water supplies (MacDonald, A.M. *et al*. 2012. Quantitative maps of groundwater in Africa. *Environmental Research Letters*, v. **7**(2); DOI: 10.1088/1748-9326/7/2/024009). They used existing hydrogeological maps, publications and other publically available data to estimate total groundwater storage in a variety of aquifer types and the yield potentials of boreholes. The maps can be downloaded at this page on the BGS website.

Drinking water for many sub-Saharan Africans often comes from shallow, often contaminated wells in dry riverbed sand

Around 0.66 million km^3 of groundwater may be present below the continental surface (although dominated by the vast Nubian Sandstone aquifer of Libya, Algeria, Egypt and Sudan): more than 100 times the annually renewable freshwater resources, including the flows in Africa's three largest rivers, the Nile, Congo and Niger. Though only a fraction of this subsurface potential may be available for extraction through wells, the statistics suggest that small diameter boreholes and simple handpumps, as well as traditional wells, can sustainably satisfy the drinking water needs of the bulk of Africa's rural populations with yields from individual wells between 0.1 to 1 l s^{-1}. However, groundwater use in irrigation and for large urban supplies demands well productivities an order of magnitude higher from thick sedimentary sequences, which rarely coincide in Africa with areas suitable for large-scale agriculture or existing cities and large towns.

Both the humid tropical lowlands, with thick unconsolidated sediments, and the deep sedimentary rock aquifers beneath the Sahara and other arid areas match great groundwater potential with, respectively, little need for groundwater or virtually no potential for agricultural development and very few people. Moreover, the truly vast reserves of North Africa that are an order of magnitude or more greater than in any other countries are at such depths and so remote that development needs commensurately huge investment, in the manner of oil-rich Libya's Great Man Made River Project projected at more than US$25 billion investment. To say that reserves, convenience and yields are inequitably distributed in Africa grossly understates the hydrogeological difficulties of the continent.



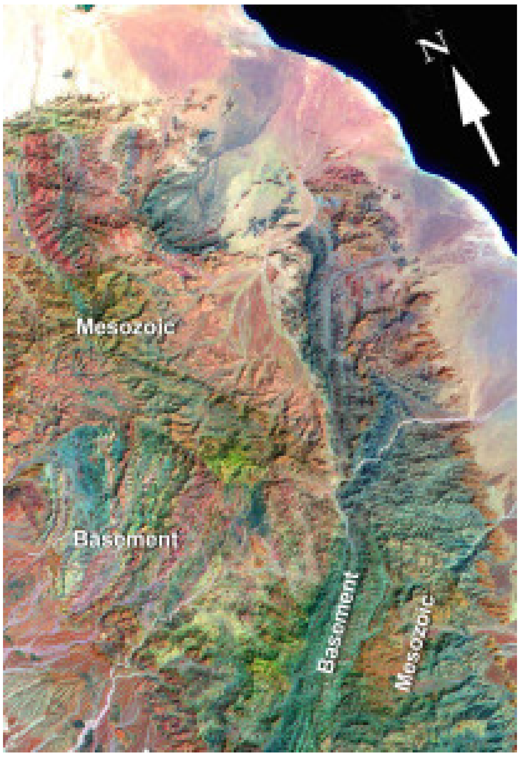
Average well productivity derived by MacDonald *et al*. (2012) from Africa's regional geology

Much of Africa has crystalline basement at or close to the surface, whose useful yields (>0.1 $l\ s^{-1}$) only when deeply weathered, and even then rarely yields better than 1 $l\ s^{-1}$. An exception to this general rule is where basement has been shattered by large faults and fractures. Sedimentary cover is generally thin across the continent and with highly variable yield potential. The other issue is that of sustainability, for if extraction rates exceed those of recharge then groundwater effectively becomes a non-renewable resource. About half of the African surface, mainly in its western equatorial region, has sufficient rainfall and infiltration potential to outpace universally high evapotranspiration to give high recharge rates. For all the areas repeatedly hit by drought and famine, average recharge through the surface that escapes being literally blown away as water vapour is less than half a centimetre. Although taken into account by MacDonald *et al*., BGS does not provide maps of varying evapotranspiration rate and estimated recharge, although they could easily be produced as an aid to independent, local assessment of groundwater porential.

To have synopses of all the important issues surrounding African groundwater – the best choice for safe domestic supplies in hot, poor areas – would seem to be very useful to those engaged in development and relief strategies; i.e. to governments, the UN 'family' and

World Bank. But there are important caveats. An obvious one is the antiquity of many of the surveys drawn on by MacDonald *et al*. Some 23 out of 33 were published more than 20 years ago using data that may be a great deal older: such has been the snail-like pace of publication by *all* geological surveys, including BGS. That is compounded by the small scale of the maps (mainly smaller than 1:1 million) and the extremely sparse geophysical data concerning subsurface geology across most of Africa. 'Quantitative' is not the adjective to use here, for unlike in most of the developed world, groundwater reserves and locations in Africa have not been measured, but estimated from pretty meagre data. In fact to be brutally realistic, most of the source maps are based on educated guesswork by a few hard-pressed geoscientists once personally responsible for areas that would cripple most of their colleagues working in say Europe or North America.

If there is a truism about water exploration in Africa, outside the well-watered parts, it is this: sink a well at random, and it will probably be dry. The stats may well be encouraging, as MacDonald *et al*. clearly believe, but finding useful groundwater supplies relies on a great deal more. Outside cities, people survive as regards groundwater often as a result of traditional means of water exploration and well digging: they or at least some locals are experts at locating shallow sources. Yet to improve their access to decent water in the face of both rising populations and climate change demands sophisticated exploration techniques based on geological knowledge. Most important is to ensure supplies to existing communities, whose locations do not necessarily match deeper groundwater availability, bearing in mind that a universal problem for most African villagers is the sheer distance to wells with safe water. Rigs used to drill tube wells are expensive to hire, so the likelihood of success needs to be maximised. In the absence of large-scale (1:50 000) geological maps – rarities throughout Africa – only skilled hydrogeological interpretation of aerial or satellite images, followed-up by geophysical ground traverses. offer that vital confidence.



Geologically useful ASTER image of the Danakil Block in Eritrea/Ethiopia, showing Mesozoic and Recent sedimentary aquifers and crystalline basement (Steve Drury)

In fact, thanks to the joint US-Japan ASTER imaging system carried in sun-synchronous orbit, geologically-oriented image data are available for the whole continent. Interpretation requires some skills but few if any are beyond learning in a practical, field setting. Indeed, the African surface in its arid to semi-arid parts, most at risk of drought and famine, lends itself to rapid hydrogeological reconnaissance mapping using ASTER data. Given on-line training in image interpretation, a 'crowd-source' approach coordinating many interpreters could complete a truly life-giving and easily available map base for local people to focus their own well-construction programmes.

Related article: Africa may struggle to extract groundwater, experts say (scidev.net)