Quantitative maps of groundwater resources in Africa: supplementary material 2

1. Introduction

Below is the database of aquifer studies used to develop the quantitative groundwater maps of Africa. The details of the systematic review used to identify and classify the studies are also given.

2. Search criteria

Most of the studies identified by the review were found from an extensive web search using several of the main search engines – Web of Science, Science Direct, Google scholar, Google books and Google. The search was conducted during August 2010, therefore studies published after that date may not have been included. Each search generally identified between 5 000 and 30 000 hits. Aquifer properties studies were identified from the web search results, using the following sifting approach:

- the title of item included the word "groundwater" or directly relates to groundwater potential, aquifers or aquifer parameters
- AND the title of item includes, or refers to, a geographic location or aquifer in Africa
- AND the item is within published scientific literature, or downloadable grey literature (e.g. a United Nations report, or a USGS technical document)

An initial sift of the studies identified was used to exclude any reports which did not:

- contain at least some information (qualitative or quantitative) relating to aquifer properties
- AND include some description of the geology

In addition to the web search, aquifer properties data studies and databases (e.g. regional yield databases) were identified within grey literature (e.g. BGS field data reports, country water ministry reports) through individual researchers and organisations known to the project team. The same inclusion criteria were applied to the results of these more focused searches, as were to the web searches (see above).

In total152 suitable aquifer studies were identified in peer-reviewed and grey literature from which 283 aquifer datasets were compiled.

3. The confidence criteria

A confidence rank was applied to all studies included within the review using set criteria (Tables 1 and 2). Due to the scarcity of T and S data within Africa, both yield data (used as a proxy for T) and qualitative review studies have been included within this review. Separate confidence criteria were applied to accommodate the qualitative and quantitative data types reviewed. In general, highest confidence was assigned to the data studies which provide reliable quantitative aquifer properties data (T and S), and regional qualitative review studies with a strong evidence-base.

Table 1. Confidence criteria applied to data studies.

Confidence	Criteria
High 1	Aquifer properties data (T and S) are derived from controlled pumping tests (>5 hr duration) with observation boreholes Large sample base (>20 sites) Good description of field methods, including raw data Description of site including geology and source *Plus any of the following:* Inclusion of yield data within study, as a proxy comparison to pumping test data Recent study (T, S estimates <10 years old)
High-Medium 2	Aquifer properties data (T only) are derived from controlled pumping tests >5 hr duration, but no observation boreholes Large sample base (>20 sites) Good description of field methods Description of geology and source *Plus any of the following:* Raw pumping test data Comparison of study results, to other work within region Inclusion of yield data within study, as a proxy comparison to pumping test data Recent study (T estimate <10 years old)
Medium 3	Aquifer properties data (T only) are derived from pumping tests (some <5hr duration), but little known to methods *And/or:* Aquifer properties data derived from production yields of boreholes and wells *Plus 2 of the following:* Small sample base within recharge area (<20) Summary data only Some qualitative hydrogeological data Limited description of geology and source Comparison of study results, to other work within region Inclusion of yield data within study, as a proxy comparison to pumping test data Modelled data, using sufficient accurate hydrogeological field-data Recent study (T estimate <10 years old)
Medium-Low 4	Aquifer properties data derived from production yields of boreholes and wells, but no information to methods; Summary data only, and small sample base *Or:* Modelled aquifer properties data, based on insufficient accurate field-data; *Plus any of the following:* Small sample base (<20) Limited description of geology and source No comparison of study results, to other work within region Dated study (>10 years)

Low 5	The parameter is modelled, based on little, or no, accurate hydrogeological field-data No comparison of study results, to other work within region, or proxy yield data *Plus any of the following:* Small sample base (<20) Summary data only Little, or no, description of field or modelling methodology Limited description of the geology Dated study (>10 years)

Table 2. Confidence criteria applied to aquifer review studies.

Confidence	Criteria
High 1	Qualitative hydrogeological information relating to a hydrogeological domain, or specific aquifer Strong evidence-base to review (several data sources) Good description of data sources, and the methodology behind summary aquifer properties data Description of geology and source *Plus any of the following:* Inclusion of yield data, comparison to summary T and S data Recent review (<30 years old)
Medium 2	Qualitative information on the regional hydrogeology, the hydrogeological domain, or specific aquifer Moderate evidence base to review (max. 2 data sources) Smaller review area Some description of data sources, but limited information to methodology of data *Plus any of the following:* Inclusion of yield data, or modelled data, comparison to summary T and S data Recent data reviewed (<30 years old)
Low 3	Limited qualitative information on the regional hydrogeology, the hydrogeological domain, or specific aquifer Weak evidence base (one data source), with limited, or no information to data sources and methodology Geographically small review area

Table 3. Database of references of the aquifer properties data studies reviewed, according to confidence rank from the criteria in Table 2 and 3.

Confidence	Study reference
1	Cheney CS, Rutter HK, Farr J and Phofuetsile, P (2006) Hydrogeological potential of the deep aquifer of the Kalahari, southwestern Botswana, QJEGH; 39, 303-312 Cobbing JE and Davies J (2008) The benefits of a scientific approach to sustainable development of groundwater in SSA, in Adalena and MacDonald (eds) Applied groundwater studies in Africa, IAH selected papers, Vol 13; IAH press Dapaah-Siakwan & Gyau-Boake (2000) Hydrogeologic framework and borehole yields in Ghana, Hydrogeology J., 8; 405-416. Davies J (2009) Hydrogeological mapping of north-central Madagascar using limited data, Groundwater conference Cape Town, South Africa, 16-18 Nov 2009 Davies, J (1978) Jwaneng Groundwater Resources Study - Area A - Final Report Descroix L, Mahe G, Lebel, T, et al. (2009) Spatio-temporal variability of hydrological regimes around the boundaries between Sahelian and Sudanian areas of West Africa: a synthesis, J. of Hydrology, 375; 90-102 Guiraud R (1988) L'hydrogeoloie de l'Afrique, J. of African Earth Sciences, 7; 3, 519-543. Gyau-Boakye P, et al. (2008) Groundwater as a vital resource for rural development: an example from Ghana, in Adalena&MacDonald (eds) Applied studies in groundwater studies in Africa, IAH selected papers, 13; IAH press. Houston J (1992) Rural Water Supply: comparative case histories from Nigeria and Zimbabwe, in Wright EP (ed) Hydrogeology of crystalline basement aquifers in Africa Jalludin M & Razach M (2004) Assessment of hydraulic properties of sedimentary and volcanic aquifer systems under arid conditions in the Republic of Djibouti (Horn of Africa), Hydrogeology Journal, 12; 159-170 Kehinde MO & Loehnert EP (1989) Review of African Groundwater resources, Journal of African Earth Sciences, 9; 1,, 179-185 Kouame KJ, Jourda JP, Biemi J and LeBlanc Y (2008) Groundwater modelling and implication for groundwater protection: Case study of the Abidjan aquifer, Cote d'Ivoire, in (Eds) Adalena & MacDonald, Applied Groundwater Studies in Africa, IAH 13, p457-473. Margat J (2007) Great aquifer systems of the world. In: L Chery & G De Marsily (eds) Aquifer systems management: Darcy's legacy in a world of impending water shortage. IAH Selected Papers 105 – 116

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