FORUM FOR GROUNDWATER

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This is the Burdon Network's quarterly Forum for Groundwater, aimed at African groundwater professionals and those with an interest in African groundwater.

Recent work done by the Burdon Network includes a survey of hydrogeologists working in sub-Saharan Africa: How do African hydrogeologists view our profession? Who trains hydrogeologists in Africa? Are there good opportunities for work? What are the main challenges facing us? The results of the survey are summarized in this edition. Please let us know your comments!

Together with the report on the survey, this edition contains an article on the last Groundwater Division of the Geological Society of South Africa conference, and an extended article on an important source of groundwater in Africa, sand rivers.

As usual, the Forum for Groundwater is available to download in PDF format from the following websites, together with all back issues:

http://burdon.wwgw.org/
http://www.waternet.co.za/groundwater/

"Forum for Groundwater" is coordinated by the Burdon Network of the International Association of Hydrogeologists (IAH). Views and opinions expressed in this Forum are those of the individual authors. It is a discussion forum for those interested in groundwater, with an emphasis on African groundwater. The Forum is compiled quarterly by: Jude Cobbing, Suite 240, Private Bag X1, Menlo Park, Gauteng, South Africa. jcobbing@gmail.com

If you would like to contribute to the Forum, please contact Jude (above). We are always looking for short articles with relevance to groundwater in Africa, or of interest to those working in Africa. General comments, announcements, etc are also very welcome.

Specialist drilling on a mine slimes dam, South Africa

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Results of a recent survey of hydrogeology in sub-Saharan Africa – *Jude Cobbing*

Please note that this article follows on from an introductory article in the last edition of this newsletter.

Towards the end of 2007 the Burdon Network of the IAH supported a survey of African groundwater professionals, entitled "Hydrogeology in sub-Saharan Africa: training and employment opportunities". The survey tried to get to the bottom of several issues which are often discussed amongst African hydrogeologists. For example, most people agree that the sub-continent needs a better focus on groundwater, and more groundwater professionals, if the Millennium Development Goals and other important targets are to be met. Yet, how many jobs are really available for groundwater scientists across the sub-continent? Do African hydrogeologists see their profession gaining in importance, and are we optimistic about our professional futures? Who is training hydrogeologists in Africa, and are the best students being attracted to the courses? And what about salaries - does remuneration for hydrogeologists lag behind other professions?

The formal survey aims were as follows:

1. To assess broadly the demand for hydrogeologists, the available training opportunities, and the main technical challenges for professionals working in the region;

2. To assess perceptions of the profession, including career opportunities;

3. To support evidence-based discussion of these issues, and to contribute to further dialogue.

The survey examined these issues by means of an emailed questionnaire. More than 150 questionnaires were sent out to hydrogeologists and related professionals working across sub-Saharan Africa. The survey results were based on more than 50 responses from seventeen different countries, and these have been summarised and discussed in a report entitled "Hydrogeology in sub-Saharan Africa: Training and employment opportunities" by JE Cobbing. The report is available as a PDF download from the Burdon Network website, or directly from the author at africahydrosurvey@gmail.com.

Survey results

The survey found that about 180 hydrogeologists qualify every year in sub-Saharan Africa, around a third of them in Nigeria. Many countries do not have any formal post-graduate training in groundwater science. In general, newly graduated hydrogeologists are able to find employment fairly easily, particularly in southern Africa where many respondents report a shortage. However, there does seem to be a lack of "formal" employment opportunities (for example in the state sector), and several respondents mentioned the need to find their own work and generate their own opportunities. Several, if not most, sub-Saharan African countries also appear to be affected by a "brain-drain" of qualified professionals leaving for better opportunities elsewhere.

A majority of the respondents felt that the situation regarding employment in groundwater science in sub-Saharan Africa is "getting worse". This is serious, and should concern us all, since ideally there needs to be an increase in opportunities, and higher numbers of professionals employed, if African groundwater is to be managed for the benefit of all. Many respondents agreed that, in particular, there is a great need to improve data collection if issues such as better groundwater management, and improved control of pollution, are to be addressed.

In general, it appears that the status of hydrogeology as a profession is still not as high as it should be, and seems to lag behind other professions such as engineering. This can mean that hydrogeologists receive lower salaries than (for example) engineers, and that in some cases personnel with little knowledge of groundwater are employed to carry out many of the tasks of a hydrogeologist. It is likely that this situation is changing, and as professionals we should do all we can to support this.

The survey discussion concluded with several recommendations to the Burdon Network, and to Africa professionals in general. These included:

- Efforts to link groundwater professionals across the continent should be pursued.
- National groundwater associations (such as the Groundwater Association in Nigeria, and the Groundwater Division in South Africa, should be supported as they perform an important regulatory role, and also serve to link professionals. Links between these organisations and the International Association of Hydrogeologists (IAH) are likely to be beneficial.
- Institutions which do train groundwater professionals should be supported. This need not always mean financial support; technical support and cooperation are also needed.

The final report is intended as a document which will generate further discussion. It also seeks to collect contact details for all the institutions which train hydrogeologists in sub-Saharan Africa. This database is still far from complete, and assistance with names and contact details of training institutions is still needed.

Please download the report (144 kb) at http://burdon.wwgw.org/ or email africahydrosurvey@gmail.com for a copy.

Jude Cobbing is a hydrogeologist working in Gauteng, South Africa. He can be contacted at jcobbing@gmail.com

Report back on the Groundwater Division of South Africa conference in Bloemfontein: "An Africa where groundwater is valued and sustainably managed by empowered stakeholders" – *Dr Nick Robins*

Overview

Approximately 200 delegates attended the Geological Society of South Africa Groundwater Division's Biennial conference in Bloemfontein in October 2007. The overall theme was that of stakeholder management of groundwater. Presentations were given by a variety of interests including regulators, funding agents, NGOs and practitioners, including a large contingent of consultants working both at home and abroad. Although the majority of delegates were from South Africa there was good representation from elsewhere including Nigeria, Cameroon and Lesotho as well as a number of countries from Europe and North America.

Two workshops were held during the three day conference. The first looked at the complex technical issues of the groundwater and surface water interface in valley bottoms, the second considered the role that groundwater should play in satisfying the Millennium Development Goals. It was agreed that groundwater has a very significant role and that it is the only reliable source available to the many communities living in the arid and semi-arid savannah lands of much of Africa.

Two important messages came from the conference. The first was that South Africa needs to continue to expand its outreach northwards into continental Africa, the second that hydrogeologists need a Champion that can promote groundwater to our political leaders and policy makers.

South African delegates explained that they are pulled between the urgent needs of their own country, where over 3000 schools remain without a water supply and where mine water decant pollutes whole sub-catchments, against the humane need to improve coverage of safe water supply and sanitation in many countries in Africa. Nevertheless, South Africa continues to increase its activities abroad, most notably in capacity building and technical assistance.

The second issue, that of a middleman to champion our cause as hydrogeolgists and the importance of groundwater as a resource, is vital to the future wellbeing of Africa. Let us hope that we can identify someone with the communication skills that can link between the technical and the political level so that the voice of groundwater can be hear loud and clear throughout Africa.

Dr Nick Robins is a hydrogeologist at the British Geological Survey, and Editor-in-Chief International Association of Hydrogeologists Books. Dr Robins can be contacted at nsro@bgs.ac.uk

Sand Rivers: Recent studies in southern Africa – Jeff Davies

Sand Rivers – what are they?

"Sand rivers" are ephemeral stream and river channels choked with mixed silt, sand and gravel sediment recently eroded from adjacent areas. Ribbon-like fluvial sand-river deposits occur in the semi-arid regions of south-western Zimbabwe, eastern and north-eastern Botswana, northern South Africa and Namibia, where they form important sources of groundwater for rural, agricultural and urban water supply.

(Above) Sand choked Umzingwane River downstream of the Zhovhe dam, S.W. Zimbabwe

The genesis and physical characteristics of these Quaternary to Recent-age alluvial deposits are poorly understood. According to local oral history, the deposition of these mixed texture detrital deposits, often eroded by storm runoff from areas cleared for agriculture during the past 100 years or so, has transformed formerly perennial rivers populated by hippos and crocodiles, into ephemeral sand choked channels. Such deposits reflect anthropogenic impacts (soil erosion) as well as climate change (decline in long term average rainfall and increased storm intensity).

The unconsolidated sediments infilling these channels form linear aquifers, recharged by rapid runoff of rainwater from isolated convective storms during short rainy seasons. The flash-floods that result are analogous to those occurring along Middle Eastern wadi systems with a short duration flood originating in the upper reaches of a catchment recharging valley fill sediments. Since the sands are bare of vegetation water loss by evapotranspiration is minimal. Therefore, recharge waters remain within the sediments, to flow slowly downstream through the sediment fill. They form vital sources of water for isolated rural communities for domestic and stock watering use, particularly where such aquifers occur upon impermeable Precambrian Crystalline Basement rocks.

Surface flow over these aquifers is now being checked by installation of "sand dams" to enhance recharge enabling development of the water resources for township supply and for irrigation. In N.E. Botswana the Shashe Dam supplies Francistown and Selebi Pikwe, and the Letsebogo Dam supplies Gaborone. In Zimbabwe the Zhovhe dam on the Umzingwane River provides dry season water to downstream citrus irrigation schemes.

Sand Rivers in Southern Africa – A Review

Although the use of sand rivers as sources of water is widespread, few studies of the nature and development of sand rivers in Southern Africa are reported in the literature. Those studies that are reported are commissioned by National Departments, the results being presented as "grey literature" project reports.

Botswana:

Studies of the water resources of sand rivers undertaken in N.E. Botswana during the 1980's include:

- *Wikner (1980) and Nord (1985) undertook comprehensive studies of the physical and hydraulic nature of a series of sand rivers in eastern and north eastern Botswana.*
- *Herbert et al. (1997) described novel methods, developed during a collector well project, for assessment of sand river water resources (see case study below).*

Namibia:

Waters for mineral development, rural and ecological water supply are obtained from sand river sources especially in the western parts of north and central Namibia.

- Jacobson et al. (1995) describe the ecology and water occurrence in 12 ephemeral river catchments in the arid north western area of Namibia where groundwater resources are scarce.
- Botes et al. (2003) describe the development of the water resources of the arid area Kuiseb ephemeral river of west-central Namibia.

South Africa:

Water for agriculture, rural and urban water supply is obtained from sand river sources in the northern Limpopo Province of South Africa.

- Clanahan and Joncks (2004) reviewed 67 "sand abstraction" water supply systems in Southern Africa. 39 systems were visited in South Africa and Zimbabwe. Alluvial sand physical and hydraulic parameters and water quality were assessed. Guidelines for system design, construction and operation were produced.

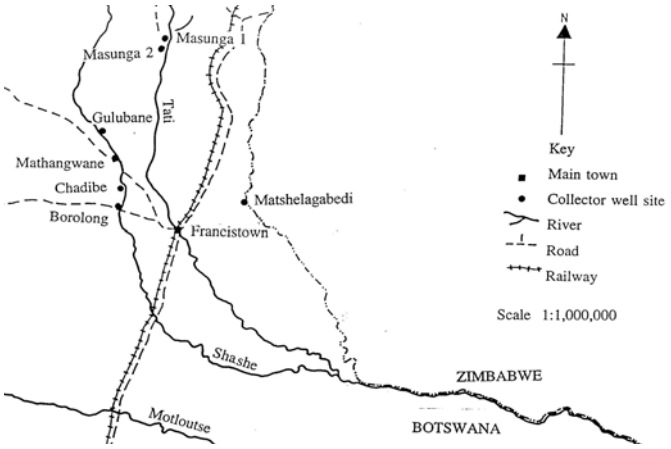
Zimbabwe:

Water for crop irrigation and rural water supply is obtained from sand river sources especially in the semi-arid to arid north-western and south western areas of Zimbabwe.

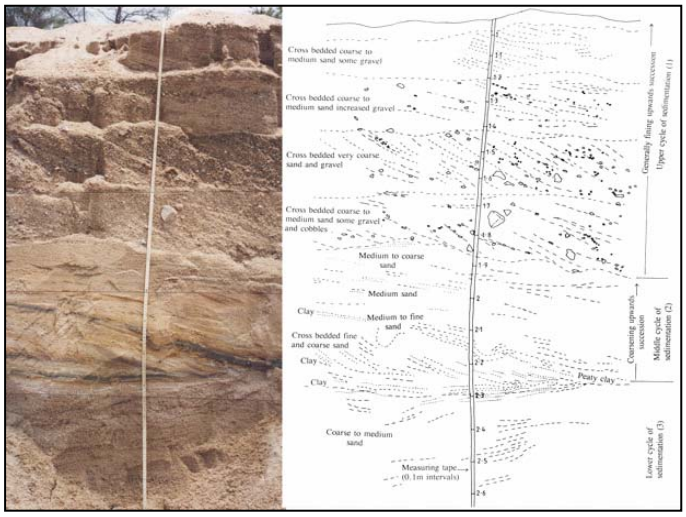
- Owen (1989) investigated the morphology and water resource potential of several shallow sand-river alluvial aquifers to supply small scale irrigation projects. Owen also undertook studies of the subsurface nature of sand river deposits in the Umzingwane and Shangaan Rivers using TEM resistivity and ground penetrating radar in association with groups of students from the Lund University in Sweden.
- Mansell and Hussey (2005) used techniques developed in Botswana (Herbert et al., 1997) to investigate groundwater flows and losses within alluvial sands of ephemeral rivers in Zimbabwe.
- Hussey (2007) latterly produced a series of guidelines for the abstraction of water from sand rivers using data collected in Zimbabwe.

Case Study: Sand River Research in N.E. Botswana

Davies et al., 1998 studied the hydrogeological characteristics of sand river deposits in N.E. Botswana during the installation of a series of collector well systems for village supply. During this project, methods were developed to assess the presence and rate of water flow through sand fill, sediment permeabilities, the susceptibility of screen slots to blockage and the sustainability of the resource (Herbert et al., 1997). These methods have since been applied elsewhere in the region (Mansell and Hussey, 2005). Although such aquifers are rapidly recharged they are also vulnerable to over-abstraction and pollution. Sand river investigations included assessing the underlying weathered basement strata and the nature of channel sediments to ensure that laterals are installed into productive sand layers.



(Above) Collector well sites in NE Botswana



(Above) A section through sand infilling the Tati river at Masunga showing the deposition of mixed flood sediments deposited under ephemeral conditions upon well grades sediments deposited by a perennial stream. A C^{14} radio carbon date of about 50 years BP obtained from the peat in the middle cycle of sedimentation indicates the recent age of the mixed texture sediments.

During the three year project, ten collector well systems were installed to abstract water from three sand rivers for village supply. The project highlighted the need for detailed understanding of the sedimentology and hydrogeology of sand rivers.

Sustainable collector well sand river abstraction systems depend upon:

1. Sand river recharge – often requires only a single storm event somewhere in the catchment upstream of the site within a rainy season.

2. Sand river geometry and sediment infill - investigated using hammer seismic surveys and jack hammered probes to locate the channel base. Electrical resistivity traversing and ground penetrating radar offers rapid methods of identifying channel geometry and the nature and distribution of infill sediments. Only sections dug into the sediments will reveal their exact nature, as at Masunga above.

3. Sand river hydraulic properties – the groundwater resources and flow patterns were investigated using grain-size analyses and falling head tests to assess permeability distribution; and a salt dissolution test was used to determine rate of flow through the system (Davies et al., 1998) (see type results in Table below)

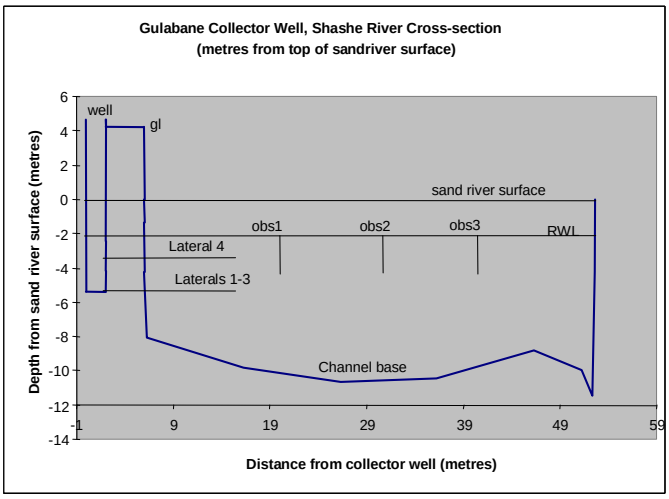
4. Sand river resource use – long term over-pumping of a supply borehole west of Masunga adjacent to the Shashe River resulted in the depletion of water in the sand river system at that point. Discharge of effluent from a waste treatment plant at Masunga resulted in the abandonment of a downstream collector well system.

5. *Collector well shaft and lateral installation* - Screened laterals are installed from base of a 2 m diameter shaft, through weathered basement rocks, into saturated alluvial sands by jetting to distances up to 20 m from the well shaft.

(Above) Tati sand river at Masunga, N.E. Botswana

(Above) Shashe sand river trenched at Gulubane, N.E. Botswana: note shallow water table

(Above) Flow of about 4 l s-1 from sand river through laterals into Gulubane collector well



(Above) Shashe River section at Gulubane showing channel, laterals, observation boreholes and collector well

Site	Salt Dissolution Test Results			Falling Head Permeameter Test
	Channel Cross-section Area (m^2)	Rate of Flow Through Sands in Channel	Sediment In-fill Permeability	Sediment Permeability
Masunga	62.5	59 m^3 day^{-1} 0.7 l s^{-1}	727 m day^{-1}	
Gulubane	173	206.6 m^3 day^{-1} 2.4 l s^{-1}	148-207 m day^{-1}	128-216 m day^{-1}
Matshelagabedi	270	137 m^3 day^{-1} 1.6 l s^{-1}	169-203 m day^{-1}	172-207 m day^{-1}

Examples of sand river channel cross-section areas, infill sediment permeabilities and natural flow rates obtained from sand river collector well test sites in NE Botswana (Davies et al. 1998).

In the context of population growth and climate change, the importance of water supplies drawn from sand river aquifers will become more important within the semi-arid areas of southern Africa in the future. Suggested sources of further information are listed below.

Further reading:

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Jeff Davies is a hydrogeologist at the British Geological Survey. He can be contacted at jdav@bgs.ac.uk