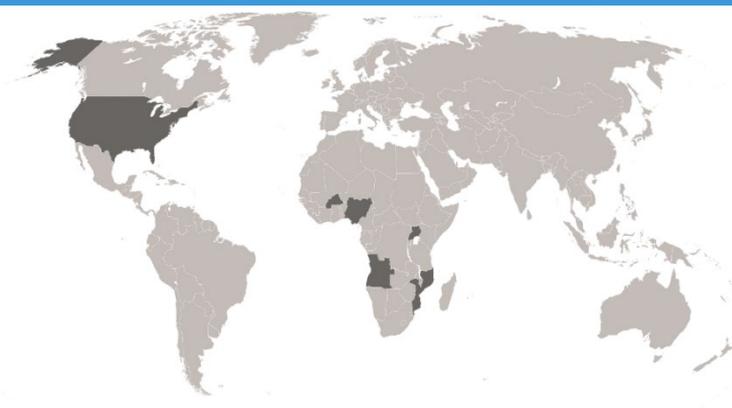


Challenges of Water Well Drillers & Water Well Drillers Associations

Case Studies of Six Countries

Angola, Burkina Faso, Mozambique, Nigeria,
Uganda and United States of America

Uyoyoghene Traoré
February 2020



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This document was written by a Young Professional volunteer. Under its new strategy 2018-2023, the Rural Water Supply Network (RWSN) emphasises engagement with young people in the rural water sector. Through its 2018 Young Professional Engagement Strategy, RWSN launched a call for those who wanted to get involved in RWSN's thematic activities as volunteers. These activities are designed to help young professionals gain experience in the sector by supporting RWSN Theme Leaders, and being mentored in return. For more information, see <https://www.rural-water-supply.net/en/rwsn-for-young-professionals>.

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The Rural Water Supply Network (RWSN) is a global network of rural water supply professionals and organisations committed to improving their knowledge, competence and professionalism, to fulfil RWSN's vision of sustainable rural water services for all. Both individuals and organisations participate in the network.

The Secretariat is hosted by Skat Foundation. RWSN is governed by an Executive Steering Committee with representatives from SDC, UNICEF, the African Development Bank, IRC, WaterAid, the World Bank and Skat Foundation.

RWSN's vision is of a world in which all rural people have access to sustainable and reliable water supplies which can be effectively managed to provide sufficient, affordable and safe water within a reasonable distance of the home.

Membership is free and open to all: <https://www.rural-water-supply.net/en/about/joining>

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Abbreviations and Acronyms

| | |
|-----------|--|
| ANP-SEPAB | Association Nationale des Professionnels du Secteur de l'Eau et de l'Assainissement au Burkina Faso (Burkina Faso) |
| APM | Associação de Perfuração de Mozambique (Mozambique) |
| ARAs | Administração Regional de Águas (Mozambique) |
| AWDROP | Association of Water well drilling Rig owners (Nigeria) |
| BODEN | Borehole Drillers Association of Nigeria (Nigeria) |
| BOQ | Bill of Quantities |
| CSOs | Civil Society Organisations |
| DGRE | Direction Générale des Ressources en Eau (Burkina Faso) |
| DNA | National Directorate of Water (Mozambique) |
| DPEA | Directorate of Energy and Waters (Angola) |
| DPOPHs | Provincial Directorates of Public Works (Mozambique) |
| DWD | Directorate of Water Development (Uganda) |
| DWO | District Water Offices (Uganda) |
| DWRM | Directorate of Water Resources Management (Uganda) |
| EPA | Environmental Protection Agency (United States of America) |
| EPARS | Estaleiros Provinciais de Água Rural (Mozambique) |
| FMWR | Federal Ministry of Water Resources (Nigeria) |
| INRH | Institute for Water Resources (Angola) |
| MINEA | Ministry of Energy and Water of Angola (Angola) |
| MOGECA | Community Water Management Model Component (Angola) |
| MOPH | Ministry of Public Works and Housing (Burkina Faso) |
| MWE | Ministry of Water and Environment (Uganda) |
| NAS | Groundwater Nucleus (United States of America) |
| NDWAC | National Drinking Water Advisory Council (United States of America) |
| NGWA | National Ground Water Association (United States of America) |
| NWRI | National Water Resources Institute (Nigeria) |
| OGWDW | Office of Ground Water and Drinking Water (United States of America) |
| OSHA | Occupational Safety & Health Administration (United States of America) |
| OW | Office of Water (USA) |
| PAGIRE | An Integrated Water Resource Management Action Plan (Burkina Faso) |
| PN-AEPA | National strategic plan for the water (Burkina Faso) |
| RBDA | River Basin Development Authorities (Nigeria) |
| RUWASA | Rural Water and Sanitation (Uganda) |
| RUWASSA | Rural Water Supply and Sanitation Agency (Nigeria) |
| RWSN | Rural Water Supply Network |
| SDGs | Sustainable Development Goals |
| SWDA | Safe Water Drinking Act (United States of America) |
| TSU | Technical Support Unit (Uganda) |
| U.S. | United States of America |
| USD | United States Dollar |
| WSP | Water and Sanitation Programme (Uganda) |
| WUC | Water User Committees (Uganda) |

Summary

Groundwater has been identified as the key to sustainable development and forms the foundation for achieving the Sustainable Development Goals (SDGs) (UN-Water, 2018). Although not properly recognised in the SDG framework, its importance is seen in its provisioning and regulating functions (e.g. maintaining river base flow, preventing land subsidence and seawater intrusion), and acting as a solution for climate change adaptation. Groundwater accounts for over 97% of the world's freshwater resources, and it is readily available.

Groundwater is diminishing in some regions, and water quality deterioration is increasing (UN-Water, 2018). With no incentives to save groundwater, the impacts of unsustainable use are slow and multiple (Villholth, 2018). In order to sustainably manage groundwater resources, intervention is needed at different levels and in accordance with local contexts.

Drillers are in direct contact with groundwater resources and thus understand key issues on the ground. If well organised, such as in the form of an association, and empowered with knowledge, drillers can advocate for and influence policies at state and national levels, and even lobby the governments to bring groundwater issues to the forefront.

This study documents, for the first time, water well drillers associations in six countries, presenting the issues faced by them in their different country contexts. The study set out to enable learning and sharing, as well as to open up opportunities for future collaborations, volunteering and study visits.

The study has found that water well drillers face numerous challenges. The main challenges, based on their reoccurrence in most of the studied countries (five countries), comprise eight categories, as follows:

- Capacity
- Contracts and standards
- Procurement
- Finance and payment
- Corruption
- Data
- Logistics
- Availability of spare parts.

Additional issues include the lack of capacity by national institutions to implement policies, the absence of institutional frameworks for groundwater and the lack of funding to engage in groundwater monitoring. The latter directly relates to the lack of institutional capacities by governments to implement existing policies and little or no awareness of the government on groundwater issues.

The issues for each country are summarised in Table (i). In five of the six countries (Angola, Burkina Faso, Mozambique, Nigeria and Uganda) there appears to be a lack of political willingness to make groundwater a national priority. In four countries (Angola, Burkina Faso, Mozambique and Uganda), the major client is the government, while in two (Nigeria and the United States of America), private households are major clients. It is found that in all countries except for the United States, groundwater awareness by the wider population is limited.

A lack of capacity of drillers and at the institutional levels to implement policies is observed to be a major challenge in five out of the six countries (Angola, Burkina Faso, Mozambique, Nigeria and Uganda). In addition, the lack of funding for water well monitoring and little awareness regarding the contribution of groundwater to livelihoods are evident in five countries (Angola, Burkina Faso, Mozambique, Nigeria and Uganda). There is an urgent need to deepen the knowledge of all stakeholders in the sector.

Poor contract management and challenges in adhering to standards are leading to drillers not being paid for dry holes in some countries. This practice is common in Burkina Faso and Uganda, where it is referred to as a “turnkey contract”, Mozambique, where it is known as the “No water, no pay principle”, and Nigeria. In general, the terms imply the same thing – that the driller is held responsible for the success or failure of drilling the water well. In Angola, there is no defined rule for negative boreholes. Instead, a so-called “gentleman’s agreement” is used whereby 50% of the total amount is paid to the driller or the driller makes up for it by drilling a second or third borehole. There was no mention of “Turnkey contracts” in the United States of America from literature and from interviews. Reference to such contracts is made in literature in Nigeria, although their definition is not clear.

The absence of hydrogeological data is found to be a huge challenge in four out of the six countries (Angola, Burkina Faso, Mozambique, and Nigeria). It leads to the underestimation of the price to drill a water well in difficult hydrogeological terrains and the use of a single pricing system for all wells irrespective of the hydrogeological terrain. The result is that drillers bear all the responsibilities of uncertainty, which in turn results in the delivery of low quality jobs.

The issue of delayed payment is mentioned in four countries (Angola, Burkina Faso, Mozambique and Uganda). These happen to be in the same countries whose clients are majorly the government.

Finally, only three of the six countries have drilling associations that are confirmed to be active and currently operating (Nigeria, Uganda and the USA). Two countries have associations which seem to be dormant (Burkina Faso and Mozambique), and an informal group exists in Angola.

It was observed that there are common challenges faced by all associations, including

1. A lack of interest of non-members in being part of the association or remaining members. In some cases, such drillers see no need for an association, while others feel that there is no benefit. Neither do all of these associations offer incentives to keep members motivated.
2. The problem of sustainability. Either there is a lack of finance due to low membership strength, a lack of support from development agencies, or no dedicated professional is available to run the affairs of the association, or a new generation of experts are lacking in the field to keep the association running and active.
3. A lack of transparency in finances where association exist and are active (except in the United States). Most of the active associations do not have the means to engage the services of an external auditor and do not publish their financial report in the public domain.
4. Lack of continuous capacity building of members. A non-systematic approach to training and retraining within the countries has led to drillers being unable to meet up with emerging issues as well as an inability among them to pass knowledge from one generation to the next.

As added value to this research, an inclusion perspective was also taken into consideration. It was discovered that in all six countries, few women are involved in the water well drilling sector, despite the fact that women bear most of the burden of lacking access to water. Also, there is a generation gap of experts in water well drilling, putting the future of groundwater management at a very high risk.

The study also found that the presence of a water well driller’s association can play a huge role in the sustainable groundwater development of a country. Associations can:

- help to influence and change unrealistic national government policies on groundwater exploration.
- support and organise systematic capacity building programmes for drillers
- support the adoption of latest technologies in the sector
- collaborate with experts in related fields
- set realistic prices for water well drilling and help to tackle emerging challenges in the water well drilling sector

With a wealth of information about the drilling landscape of a country, they can actively support the collection of the much needed data (especially in Africa). Therefore, the absence of a water well drillers association, its inactiveness and lack of proper organisational structure means neglecting a key stakeholder in the water well drilling sector and hence intervening in a non-holistic approach. This further means there will be no organised platform to advocate for the sector, especially with those in direct contact with the resource, to sensitise stakeholders, to collaborate with policy-makers in order to influence policies, to engage with citizens (users) and to support drillers in sustainably engaging in the trade.

The study makes a number of recommendations, which are presented in the following:

Short term

- Further investigate the drillers associations in other countries around the world.
- Prioritise the establishment of an association where there is none, and rekindle non-active ones.
- Build the technical and managerial capacity of water well drillers and put in place a sustainable platform for continuous professional development.
- Sensitise and strengthen the capacity of national institutions on the importance of groundwater in order to help to bring groundwater issues to the fore.
- Develop school curricula for primary and secondary students on groundwater-related topics and advocate for compulsory internships for undergraduate students in water-related fields.
- Create a global platform of young professionals with the objective to deepen the understanding, create awareness and increase interests of youth from different countries regarding groundwater issues. Also, create re-orientation courses where possible.

Long term

- Create a global platform for drillers, experts, institutions working on groundwater issues in collaboration with existing institutions to learn and share best practices.
- Engage in study and exchange programmes including creating mechanisms for internships and volunteering.

Table i: Summary of Findings from Six countries of Study.

| Country, Name of Association(s) & Website | Year Established & Status | Comments |
|---|-------------------------------------|---|
| <p>Angola</p> <p>Lubango Informal working group</p> <p>No website</p> | <p>2017</p> <p>Inactive</p> | <ul style="list-style-type: none"> • Lack of human and technical capacity at the institutional levels • Lack of capacity of drillers and a generation gap of skilled personnel • Absence of groundwater regulations leading to weak standards and contracts in borehole drilling • Absence of hydrogeological data • No existing water well drillers association • No defined rules for negative boreholes but uses the "Gentleman's agreement" (50% of the total amount is paid to the driller or the driller makes up for it by drilling a second or third borehole) • Corruption in the procurement process |
| <p>Burkina Faso</p> <p>Association Nationale des Professionnels du Secteur de l'Eau et de l'Assainissement au Burkina Faso ANP-SEPAB</p> <p>No website</p> | <p>2010</p> <p>Inactive</p> | <ul style="list-style-type: none"> • Lack of capacity of drillers and at the institutional levels • Existing but not active drillers Association • Absence of hydrogeological data • Effect of government's annual financial cycle on the quality borehole drilling projects • Generation gap of expert water well professionals in the country • Turnkey contracts (no payment for negative boreholes). Contracts that combines siting, drilling, construction of the superstructure and pump supply and installation, with companies are only paid for successful boreholes |
| <p>Mozambique</p> <p>Associação de Perfuração de Moçambique (APM)</p> <p>On Facebook https://www.facebook.com/AssociaçãoDePerfuraçãoDeMoçambique/</p> | <p>2006</p> <p>Inactive</p> | <ul style="list-style-type: none"> • No specific laws on groundwater exploration. • Gap in policy and its implementation • Capacity gaps of drillers and supervisors • Existing training institution does not meet the needs of drillers • Problem of negative boreholes (no water no pay principle). All risks in water well construction (siting and drilling) borne by drillers • Inactive drillers association and lack of interest among drillers in being part of the association • Absence of hydrogeological data • Weak contracts, lack of standards and corruption in the procurement process |
| <p>Nigeria</p> <p>Borehole Drillers Association (BODEN)</p> <p>https://www.bodan.com.ng</p> | <p>Date not found</p> <p>Active</p> | <ul style="list-style-type: none"> • Lack of capacity of drillers (Incompetent drillers and supervisors). Poor contract management and corruption in the procurement process • Lack of coordination between levels of government • Lack of capacity to implement existing policies (states and national government) • Two existing and active drillers associations |

| | | |
|---|---------------------------|---|
| <p>Nigeria</p> <p>Association of Water well drilling Rig owners (AWDROP)</p> <p>http://awdrop.org</p> | <p>2008</p> <p>Active</p> | <ul style="list-style-type: none"> ● Absence of hydrogeological data ● No water no pay principle ● Lack of transparency of the association |
| <p>Uganda</p> <p>Uganda Drilling Contractors Association (UCDA)</p> <p>On Facebook</p> <p>https://www.facebook.com/UDCA-Uganda-Drilling-Contractor-Association-101158537999098</p> | <p>2016</p> <p>Active</p> | <ul style="list-style-type: none"> ● CSO's non-compliance to government's procedure ● Inaccurate technical specification in bidding document and poor contract management ● Lack of capacity of drillers ● Lack of transparency of the association ● Turnkey contracts (no water no pay principle) |
| <p>United State of America</p> <p>The National Ground Water Association (NGWA)</p> <p>https://www.ngwa.org</p> | <p>1948</p> <p>Active</p> | <ul style="list-style-type: none"> ● Groundwater regulations are well implemented ● Drillers association is advanced and well organised ● Strong communication platforms for citizens and well owners ● Association is transparent and accountable to members |

Introduction

This is the first ever study of drillers associations that covers more than one country. It set out to investigate challenges of drillers and water well drillers associations in six countries – Angola, Burkina Faso, Mozambique, Nigeria, Uganda, and the United States of America (USA). The study draws out the challenges faced by drillers within their particular country contexts, and concludes with recommendations for the long and short term. It examines how drillers associations are organised and sustained, and how they perform in the different country context in which they exist. It summarises the existing policies and institutional frameworks related to groundwater exploration and their implementation. Given the scant written information available on the topic, and difficulties in obtaining information remotely from informants, the study may raise more questions than it answers. However, by documenting the experiences of drillers and drillers associations, the study is a significant step forward, will hopefully encourage others to engage in further studies and will inspire organisations to provide much needed support to fledgling, struggling or promising drilling associations around the world.

Groundwater accounts for 98% – 99 % of freshwater on Earth, with about 2.5 billion people depending on this source for their basic needs globally (Villholth, 2018). In Africa, over 75 % of the population are highly dependent on groundwater for their basic needs and domestic and socioeconomic activities, and there is some large-scale urban water supply (Foster, et al., 2006). In addition to its provisional functions, groundwater supports regulatory functions such as maintaining river base flow or preventing land subsidence and seawater intrusion. It also acts as a solution for climate change adaptations (UN-Water, 2018). It contributes directly to achieving other Sustainable Development Goals (SDGs) (UN-Water, 2018)¹. Groundwater is a natural resource readily available to all, and it is most reliable in securing equitable water access for the rural and urban poor around the world. However, in some areas, the growing need for groundwater has placed immense pressure on its use, which is difficult to control as it is easily within reach (Villholth, 2018). There are usually no incentives to save groundwater, and the impacts of unsustainable use are slow and multiple (Villholth, 2018).

An overview of literature on groundwater management in the selected countries shows an urgent need to deepen the knowledge of all stakeholders in the sector, and to build the capacity of water well drillers. Groundwater awareness (an understanding of the resource and its management) is another major challenge in the sector that needs to be brought forward at all levels of engagement (international, national and local). In addition, there is a need to raise the capacity of national government institutions on effective implementation of policies related to groundwater resources, especially in contract management.

The study was undertaken as part of the RWSN Young Professional mentoring scheme, and started with the author reviewing the online RWSN Groundwater Discussion² group to identify an area of study. The topic of drilling associations was found to be of particular interest. A relatively short online exchange between eight RWSN members in February 2014 on driller's associations formed the starting point for the study. The participants shared their knowledge on water well drillers associations in their various countries. The information shared was collated into a mini-E-discussion synthesis. While it was not detailed enough to understand the different country context within which the associations exist, or to understand why the associations were successful or not, it was sufficient to trigger a more in-depth review of literature.

The discussion can be found on the link

https://dgroups.org/rwsn/groundwater_rwsn/discussions/467b2987

¹ (Goal 1), food security (Goal 2), gender equality (Goal 5), sustainability of cities and human settlement (Goal 11), combating climate change (Goal 13) and protecting terrestrial ecosystems (Goal 15).

² http://dgroups.org/RWSN/groundwater_rwsn

With the synthesis of the e-discussion as a basis, a literature review was carried out for all the countries mentioned. Most of the materials comprised grey literature sourced from the RWSN website³ and blog⁴ which have a vast collation of reports on groundwater and water well drilling, but not much on associations specifically. Google scholar was used where possible with the keywords “Water well drillers Association” and “Water well drillers association in Africa”, but there was little or no information available on the topic at the time of research. The literature review raised further questions forming the basis for further investigation aimed to understand local context.

Based on the findings from literature review, a questionnaire (Annex 1) was developed for each country. Questions were similar but adapted to the specific country context. After questionnaires were filled, experts were interviewed using Skype and WhatsApp (depending on their access) to clarify responses and ask further questions where necessary. Not all experts were available for face-to-face interviews. To overcome this constraint, questions were resent to them to clarify their responses. With time limited, it was only possible to conduct interviews with two or three experts from each country (with the exception of Burkina Faso). For the purpose of confidentiality, the interviewees are referred to as “Expert [country code]1”, e.g. Expert N1 for Nigeria. This approach was adopted given the limited resources available for this project (time and funds) and to encourage the participation of experts who are always busy with pressing work schedules. The mediums used for the interview was not always perfect due to poor network reception, so that sometimes, several calls had to be made, or interviews had to be rescheduled in order to achieve the objectives of this work.

A snowball sampling method was applied for this research, where an initial expert (identified by Skat Foundation) was used to recruit other experts for the interview. Alas, it was not possible to reach an expert in Burkina Faso due to time constraints, and so findings are based only on literature. The limited time and resources for the research meant using inexpensive methods to ensure the objectives were achieved. The selection of countries for this report was based on countries where some information of drillers associations was available.

The study is structured as one chapter per country, with an overview of the country context and insights into groundwater reliance, the institutional framework, borehole drilling and a description of the association or working group. The study finishes with a synthesis of the key findings, followed by conclusions and recommendations.

³ <https://www.rural-water-supply.net/en/sustainable-groundwater-management/professional-water-well-drilling>

⁴ <https://rwsn.blog/2018/08/21/professional-water-wells-drilling-country-assessments-of-the-sector/>

Angola

Country Context



Figure 1: Map of Angola (Encyclopaedia Britannica, 2019. a)

Key Facts

| | |
|----------------------|---|
| Area | 1,246,620 km ² |
| Population | 27 million (UNDESA, 2017). |
| Rainfall | 800mm in the North and 50mm in the South |
| Temperature | annual average of 23 °C |
| Geology | predominantly precambrian basement complex (Swiecki, 2011) |
| Groundwater Reliance | 27% of the total population rely on a groundwater point source (DHS, 2016) ⁵ |
| Government Structure | Unitary State. 18 provinces (Governo De Angola, 2019). |

Groundwater Reliance

Figure 2a shows the proportion of the total population relying on different types of water sources as their main drinking water supply. It should be noted that this data is presented in a somewhat unconventional way, as it focuses on the water source, rather than on whether it is classified as improved or unimproved. An estimated 37% of Angola's national population rely on tap water and 27% on groundwater. Reliance on other sources and surface water is 17% and 16% respectively.

Figure 2b shows the variation between urban and rural populations in the country. Angola's urban population relies mostly on tap water (52%) and on other sources (25%). Its rural population relies majorly on groundwater (43%) and surface water (39%). Sources classified as "other" may or may not include groundwater.

⁵ Data extracted from 2016 survey published by JMP in 2019 (JMP, 2019a)

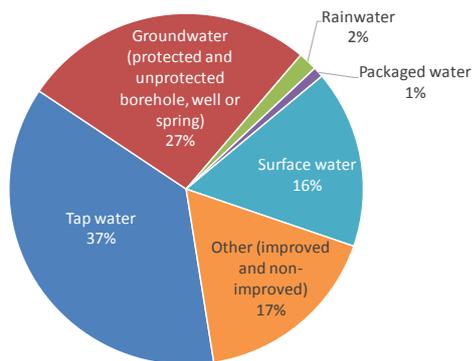


Figure 2a: Percentage of the population relying on different sources of drinking water in Angola (DHS, 2016).

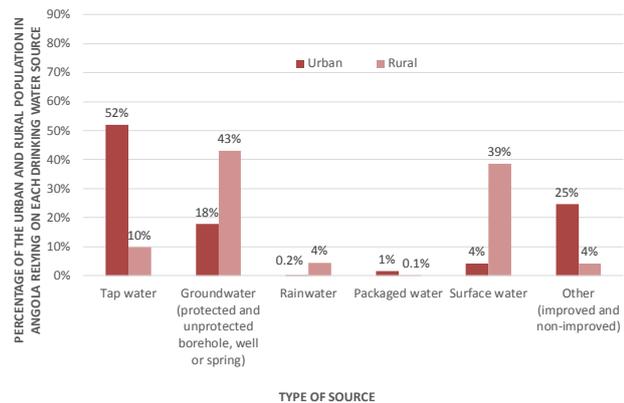


Figure 2b: Percentage of the urban and rural population relying on different sources of drinking water in Angola (DHS, 2016)

Institutional Framework

In Angola, there are various institutional bodies responsible for policies, training, and the management of water resources. At the national level, the National Directorate of Water (DNA), under the Ministry of Energy and Water of Angola (MINEA), is responsible for policies and strategies related to water and sanitation. It is also responsible for groundwater issues in the country but has very little human capacity. In 2017 it had one hydrogeologist and two drillers to carry out this role (Fiel, 2017). As part of its structure, DNA has a drilling company [Groundwater Nucleus (NAS)] with drillers who have worked in the country for over 20 years, but the company is not legalised (Fiel, 2017). DNA is also responsible for the preservation of drilling samples. However, there is no regulation to enforce this role, and so it remains unclear who is responsible for not only the drilling samples but data capturing. Furthermore, not all drillers understand the importance of collecting drilling samples or recording data.

The Directorate of Energy and Waters (DPEA) is responsible for water resources and has autonomous offices at the provincial level.

The Institute for Water Resources (INRH) also works under the supervision of the Ministry of Energy and Water to manage and plan water resources in the country. According to Fiel (2017), its functions include licensing the use of water resources, management of the National Hydrometric Network, security of dams and application of the Economic and Financial Regime of Water Resources.

The Provincial Directorate of Energy and Water (DPEA) is responsible for energy and water issues in the provinces (Fiel, 2017). Water activities at this level are not well regulated due to the absence of regulations and lack of capacity of personnel.

The Community Water Management Model Component (MOGECA) is a mobilisation project of the DNA, and it is responsible for building capacity of communities with boreholes. It has not been able to engage in this role effectively due to lack of budget (Fiel 2017).

Fiel (2017) identified that tasks between institutions working in the water sector in the country lack a clear definition. Also, institutions that need to be at the forefront of project implementation are sometimes excluded from this role. Institutions lack the necessary human technical capacity to engage and manage groundwater resources in the country.

Box 1: The "Water For All" Initiative by the Government of Angola

The Government initiated a "Water for all project" aimed at delivering water to at least 80% of the rural population in the country. The project committee consists of the President, the Secretary of State for Water, representatives from the Ministry of Energy and Water (MINEA) and the Ministry of Finance and Planning. The project was an opportunity for Angola to start developing its hydrogeological database and set drilling standards, but neither of these objectives were achieved. Boreholes were developed without proper capacity building for provincial and municipal governments who were responsible for implementation. The National Directorate of Water (DNA), which is responsible for water and WASH issues in the country, was not part of the implementation committee. There was no proper siting and supervision of the over 3,000 wells drilled, no record keeping, no monitoring of drilled wells, and no effort to integrate institution of higher learning in the process. (Fiel 2017).

Borehole Drilling in Angola

There are currently about 30 to 40 drilling companies in the country (Expert A1, 2019), made up of medium-size and large companies (Expert A2, 2019). According to (Fiel, 2017), drilling companies have modern equipment for drilling, and many trained drillers have worked for international organisations such as UNICEF, the Red Cross, OXFAM and others. Some members of staff have over 15 years' experience in the sector but have not been able to pass knowledge on to the younger generation owing to a lack of any framework encouraging internships and incentives to do so. It could be concluded that the government is the major client in water well drilling in Angola with reference to its "Water For All" Initiative (Box 1).

Despite the Angolan national population's high reliance on groundwater as their main drinking water source, only two studies on water well drilling could be found, Fiel (2017) and Adekile *et al.* (2017). No publication has been identified which sets out the history of borehole drilling in Angola. Table 1 summarises the challenges presented in these reports, together with additional insights from interviews with the two experts.

Table 1: Challenges of Drillers in Angola (Fiel, 2017; Adekile *et al.*, 2017)

| Issue | Description from literature | Description from Interviews |
|----------------------------------|---|---|
| Capacity | <ul style="list-style-type: none"> Lack of clear mechanisms to pass on knowledge and skills to the next generation | <ul style="list-style-type: none"> Major lack of capacity (Lack of training and updating). |
| Contracts & Standards | <ul style="list-style-type: none"> No defined criteria for negative boreholes in Angola⁶, and there is no certification process of drilling companies. General terms of reference for all wells irrespective of the hydrogeological terrain No drilling standards, technical guidelines or regulations on borehole siting, drilling, development and pumping test Boreholes not inspected during the time of drilling due to lack of funds | - ⁷ |
| Procurement | - | - |
| Finance & Payment | <ul style="list-style-type: none"> No standardised prices for borehole construction | |

⁶However the "gentleman's agreement" principle, where 50% of the total amount is paid to the driller or the driller, makes up for this by the drilling of a second or third borehole.

⁷No challenge mentioned

| | | |
|------------------------------------|---|---|
| Corruption | <ul style="list-style-type: none"> ● High level of corruption in borehole procurement process | <ul style="list-style-type: none"> ● Government personnel have their own companies and award contracts to themselves |
| Data | <ul style="list-style-type: none"> ● Absence of a central database to store hydrogeological information ● No existing database of drilling companies and no regulations in place for them to be certified | - |
| Logistics | - | - |
| Availability of Spare Parts | <ul style="list-style-type: none"> ● Lack of spare parts | - |

Although procurement and logistic issues were not identified in the literature or in interviews, this may reflect a lack of emphasis of these topics, rather than indicate a lack of challenges.

Drillers Association of Angola – the Lubango Informal Working Group

From literature, no organised drillers association exists in the country. However, following the 2017 training course on Professional Borehole Drilling Management: Understanding groundwater, cost-effective boreholes, procurement, contract management and costing and pricing of boreholes⁸, there was a discussion about trying to establish one (Adekile et al, 2017). According to Expert A1 (2019), a local groundwater work group was formed in Lubango after the training consisting of students, drillers, contractors and specialists, but the group is not registered and not formally recognised by the government.

Membership

The local group is open to all who are interested to be part of it (Expert A1, 2019). And an idea of membership is to have a representation of all professionals involved in the drilling sector, including the Government as part of the group (Expert A2, 2019). The group includes only few female members and a small number of young members below the age of 35 years who are students (Expert A1, 2019).

Challenge

Currently, no-one is dedicated to pursuing the formation or registration of an association, as this take a lot of time and resources. The group has approached UNICEF for support but has mentioned that nothing is forthcoming. Neither do all water well drillers see the benefits of having an association (Expert A2, 2019).

Way forward

It was mentioned that nothing had changed in the past three years following this study. However, there is a proposed training programme for all stakeholders in October 2019, and the group is currently seeking funds from the government and UNICEF to support the process. As a second option to raise funds, participants will be asked to pay for the training i.e. different government provinces would have to pay for their staff, and at least two would attend the training. It was added that there was a need to organise programmes to arouse the interest of drillers (Expert A2, 2019).

⁸ Organised by UNICEF and Skat Foundation

Key Findings

The key findings from Angola are:

1. There is lack of human technical capacity with respect to groundwater development within the government, especially at the provincial level.
2. No organised and recognised drillers association exists in the country, and drillers do not understand the importance of being a member of a group.
3. Hydrogeological data is lacking.
4. There is a lack of clarity with respect to the roles and responsibilities of different institutions regarding groundwater management and development.
5. The "gentleman's agreement", where 50% of the total amount is paid to the driller or the driller makes up for it by drilling a second or third borehole, is applicable for negative boreholes.
6. Weak capacity of drillers and the need for training programmes. There is also a generation gap of skilled personnel. A younger generation of experts are missing or are yet to be trained.
7. The absence of groundwater regulations leads to weak standards and contracts in borehole drilling, and drilling companies lack certification.
8. The procurement process suffers from corruption.

Although Angola is highly dependent on groundwater, with at least 18% of the urban and 43% of the rural population relying on a groundwater point source, it is not clear from the research whether citizens have groundwater awareness. It can be inferred that given the non-existence of regulations, the generation gap in experts and the lack of a drillers association, there is likely to be very little or no awareness. Further, it is difficult to understand how drillers engage in drilling activities, and how an organised body would operate within the country context or form a deeper understanding of the challenges that they face.

Burkina Faso

Country Context



Figure 3: Map of Burkina Faso (Encyclopaedia Britannica, 2019. b)

Key Facts

| | |
|-----------------------------|---|
| Area | 274,000 km ² . |
| Population | 19 million (UNDESA, 2017). |
| Rainfall | Rainfall in the south is between 900mm and 1,200mm, in the centre between 600mm and 900mm and less than 600mm in the north (Obuobie and Boubacar, 2012) |
| Geology | 80 % Crystalline Basement Rock (Obuobie and Boubacar, 2012). |
| Groundwater Reliance | 72.9 % of the total population rely on a groundwater point source (PMA, 2017a) ⁹ . |
| Government Structure | Unitary. 13 regions, 45 provinces and 301 communes (Obuobie and Boubacar, 2012). |

Groundwater Reliance

Figures 4a and 4b show the proportion of the population relying on different types of water sources as their main drinking water supply in Burkina Faso. This data is presented in a somewhat unconventional way, as it focuses on the water source, rather than on whether it is classified as improved or unimproved. Figure 4a demonstrates that groundwater point sources (73%) is the major source of drinking water in the country. Reliance on other sources such as surface water, packaged and improved or non-improved is at approximately 1%. Tap water (25%) is another important water source, but it is not clear from the data whether some or all of it originates from groundwater.

Figure 4b compares urban and rural reliance and it shows that Burkina Faso's urban population relies heavily on tap water (73%) with a low reliance on groundwater point sources (17%). Its rural population relies majorly on groundwater point sources (86%) with only 14% reliance on tap water. There is a 10% or less reliance on other sources in both rural and urban populations. It is not clear from data the source of tap water.

⁹ Data extracted from 2017 survey published by JMP in 2019 (JMP, 2019b)

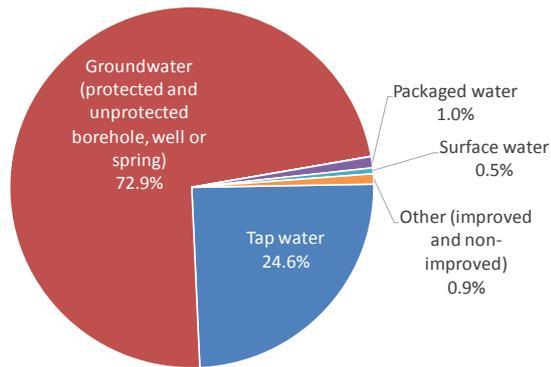


Figure 4a: National percentages of drinking water sources in Burkina Faso (PMA, 2017a).

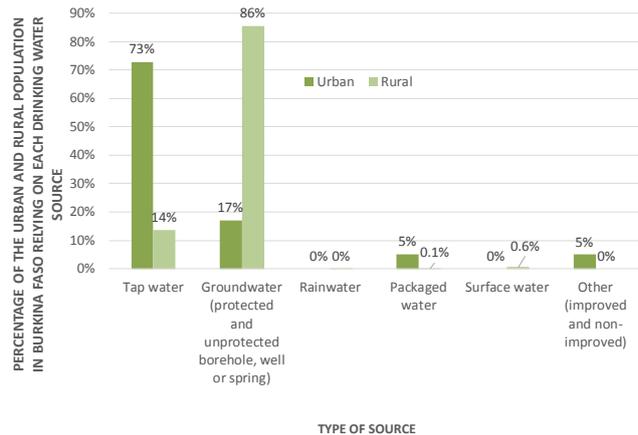


Figure 4b: Urban and rural percentages of drinking water sources in Burkina Faso (PMA, 2017a).

Institutional Framework

In Burkina Faso, the Ministry of Agriculture and Water Affairs and its National Directorate for Water Resources (Direction Générale des Ressources en Eau (DGRE)) are responsible for water well drilling. The supply of water to schools and health facilities falls under the responsibility of the Ministry of Education and the Ministry of Health respectively (Duffau and Ouedraogo, 2009). According to Duffau and Ouedraogo (2009), DGRE developed three tools to support the management of water resources at the national level. They are:

1. An Integrated Water Resource Management Action Plan (PAGIRE) for the management of water resources,
2. A National Strategic plan for the water sector up to 2015, known as the PN-AEPA,
3. A strategy and set of tools for the management of water assets in the rural areas known as the PAR.

The decentralisation of 2009 placed huge responsibilities for WASH activities (rural water supply) on the municipalities. They are the owners of water supply assets, and the DGRE has little or no control at this level. The decentralisation process was identified as a challenge due to a lack of funds and capacity for municipalities to engage effectively in this new role (Duffau and Ouedraogo, 2009). Also, there is a lack of capacity at the national and regional levels regarding the management and supervision of boreholes (Danert et al., 2019).

Borehole drilling

Borehole drilling is usually done by the private sector, and water is mostly used for domestic purposes (Duffau and Ouedraogo, 2009). The country has a 77% rate of drilling success in the southern and western part, a between 50 and 75% success rate around the east and some part of the south eastern area and a less than 50% success rate in the north where aquifers are in hard consolidated rocks (Duffau and Ouedraogo, 2009). In 2009, the country had at least 40 drilling enterprises (Duffau and Ouedraogo, 2009). This number had increased to 56 by 2012 (Danert et al., 2019). Companies are classified based on their activities, and they include:

- Group F: Drilling Companies
- Group P: Modern well construction companies
- Group U: Water supply and utilities companies (Danert et al, 2019).

Drilling companies are licenced by the Ministry of Water and Sanitation of Burkina Faso, which carries out this function through its committee for approval of technical allocation. This committee consists of delegates from Water and Sanitation¹⁰, the Department of Research and Planning of the Ministry in charge of Hydraulics¹¹, the General Directorate in charge of dams and hydro agricultural developments¹², the National Office of Water and Sanitation¹³, the General Directorate of Public Works¹⁴, WASH private sector companies, the Association of Civil Engineers and Technicians¹⁵ and the union of WASH private sector companies¹⁶. They have the mandate to examine and investigate applicants before any approval is given. In reality, this mandate is not effectively fulfilled as the committee is said to be a voluntary body without the resources to execute its function. Hence, its role needs to be reviewed (Danert et al., 2019).

According to Duffau and Ouedraogo, (2009) and Danert et al (2017), the following are challenges faced by drillers in the country:

Table 2: Challenges of drillers in Burkina Faso (Duffau and Ouedraogo, 2009; Danert et al., 2019)

| Challenges | Description from Literature |
|------------------------------------|--|
| Capacity | <ul style="list-style-type: none"> • The lack of capacity of drillers¹⁷ • Lack of skilled personnel to conduct siting and supervision • Lack of skilled personnel in the public sector especially at the municipality level. |
| Contracts & Standards | <ul style="list-style-type: none"> • Non adherence to DGRE standards by contractors. • Turnkey contracts – No payment for negative borehole¹⁸ |
| Procurement | <ul style="list-style-type: none"> • Procurement contracts are not realistic • Weak tendering process¹⁹ |
| Finance & Payment | <ul style="list-style-type: none"> • Delayed payment of contractors • Lack of up to date reference prices |
| Corruption | - ²⁰ |
| Data | <ul style="list-style-type: none"> • Little or no understanding of the hydrogeology of the country due to lack of data |
| Logistics | - |
| Availability of Spare Parts | - |

Other issues identified include: the use of single price standard for all water well projects, the incompatibility of the national government's annual financial cycle and borehole drilling projects, poor quality of hand pumps, lack of sanctions for poorly drilled boreholes and a lack of a national code of

¹⁰ Direction Générale en charge de l'Eau et de l'Assainissement

¹¹ Direction des Etudes et de la Planification de la ministère en charge de l'hydraulique

¹² Direction Générale en charge des barrages et des aménagements hydro- agricoles

¹³ National de l'Eau et de l'Assainissement National Office of Water and Sanitation

¹⁴ Direction Générale des Marchés Publics

¹⁵ Association des Ingénieurs et Techniciens en Génie Civil of Burkina

¹⁶ Nationale des Professionnels du Secteur de l'Assainissement et de l'Eau Potable du Burkina

¹⁷ A capacity building programme for the private sector in the water and sanitation sector (Composante "Appui au Secteur Privé intervenant dans le domaine l'Eau et de l'Assainissement" CASPEA), delivered trainings, but the programme ended in 2010.

¹⁸ This method combines siting, drilling, construction of the superstructure and pump supply and installation into one contract. The companies are only paid for successful boreholes.

¹⁹ Identified as one of the weakest points of the system as work is given to unlicensed companies (Danert et al., 2019).

²⁰ Not mentioned in literature.

practise (Danert et al., 2019). Danert et al., 2019 also identified a generation gap of professionals who do not have adequate training to engage in the water well drilling sector e.g. by drilling and rehabilitating water wells. One could conclude that there is a lack of mentoring and knowledge transfer to the younger generation of experts or intended experts. Also, given the challenges mentioned and others faced by drillers in the country, it could be concluded that the government is the main client in the water well drilling sector in the country.

Drillers Association of Burkina Faso – Association Nationale des Professionnels du Secteur de l’Eau et de l’Assainissement au Burkina Faso (ANP-SEPAB)

Burkina Faso’s drillers association is called - The National association of Professional Contractors in the Water and Sanitation Sector (*Association Nationale des Professionnels du Secteur de l’Eau et de l’Assainissement au Burkina Faso, ANP-SEPAB*). The association started in 2005 but was officially established in 2010. Although in existence, the association is not active, and there has been no interaction with the government since 2012. However, the government is taking steps to engage DGRE and drilling representatives of the association through the establishment of a dialogue framework²¹ (Danert et al., 2019).

Little was found in literature about the drillers association in Burkina Faso. Although apparently not active, brief information from interviews would have thrown more light on the association’s current situation and its future plans. Due to time constraints and the non-availability of experts for interview, this information could not be ascertained. However, Duffau and Ouedraogo (2009) identified the lack of fair competition among drillers as a challenge the association was facing.

Key Findings

The following are key findings from Burkina Faso:

1. There is a lack of internal capacity and funding for municipalities to engage effectively in WASH activities as well as a lack of capacity at the national and regional levels in the management and supervision of boreholes.
2. There is an existing but non active drillers association in the country.
3. Drillers and consultants lack the capacity to sustainably explore groundwater resources in the country.
4. The national government’s annual financial cycle on borehole drilling projects poses a challenge regarding the quality of boreholes.
5. There is a lack of hydrogeological data.
6. There is an existing generation gap of expert water well professionals in the country.
7. Turnkey contracts are used. This type of contract that combines siting, drilling, construction of the superstructure and pump supply and installation into one contract. Companies are only paid for successful boreholes.

Although the country is highly dependent on groundwater, with 73% of the total population relying on groundwater point sources as their main source of drinking water, it is not clear from the research if citizens are aware of the resource and its importance. It can be inferred that due to a gap in generation of experts and the inactiveness of the drillers association, there is likely to be no awareness. Secondly, the challenges faced by drillers in the country and the drillers association are not exhaustive from literature and therefore require further investigation.

²¹ Six-monthly meeting between both institutions.

Mozambique

Country Context



Figure 5: Map of Mozambique (Encyclopaedia Britannica, 2019.c)

Key Facts

| | |
|-----------------------------|--|
| Area | 801,590 km ² |
| Population | 29 million (UNDESA, 2017) |
| Rainfall | Mean annual rainfall of 1,000mm (Pavelic et al., 2012). |
| Geology | 57% basement complex, 21% sedimentary basin (most productive aquifers) and 22% of volcanic terrains with very low borehole yields (Naafs and Rhebergen, 2012). |
| Groundwater Reliance | 46% of the total population rely on a groundwater point source (DHS, 2015) ²² . |
| Government Structure | Unitary State. 11 provinces 154 districts (Commonwealth Local Government Forum, 2018 a). |

Groundwater Reliance

Nationally, the population of Mozambique rely on three major sources for their main drinking water supply, i.e. tap water, groundwater and surface water (Figure 5a). This data is presented in a somewhat unconventional way, as it focuses on the water source, rather than on whether it is classified as improved or unimproved. The country is most reliant on groundwater, which provides approximately 46% of the population with their chief drinking water supply. Figure 5b shows that the urban population rely heavily on tap water (76%), compared to 21% relying on groundwater point sources. The rural population rely more on groundwater (58%) with 21% relying on surface water. According to the statistics, the country has very little or no reliance on packaged water, rainwater or other sources.

²² Data extracted from 2015 survey published by JMP in 2019 (JMP, 2019c)

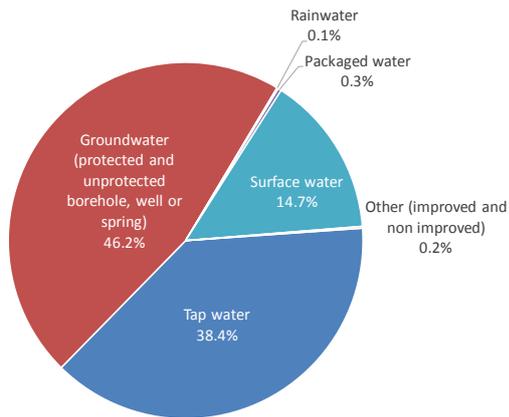


Figure 6a: National percentages of drinking water sources in Mozambique (DHS, 2015).

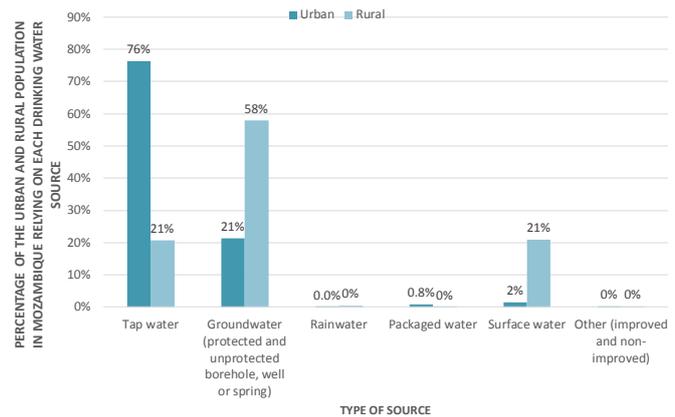


Figure 6b: Urban and rural percentages of drinking water sources in Mozambique (DHS, 2015).

Institutional Framework

According to the water law of Mozambique, water belongs to the state, and institutions exist that are dedicated to water-related issues. At the national level, the National Directorate of Water (DNA), located within the Ministry of Public Works and Housing (MOPH), is responsible for water and sanitation issues (Canuto, 2011). The Ministry of Public Works and Housing is also responsible for the licensing of drilling companies²³.

The Regional Water Administration [Administração Regional de Águas (ARAs)] assigns the daily water management of the nation's water resources, including the use of groundwater for irrigation purposes, to five autonomous and financially independent institutions²⁴ (Naafs and Rhebergen, 2012).

At the province level, the Provincial Directorates of Public Works (DPOPHs) are in charge of water supply. Although information about boreholes is communicated between the various levels of administrations, most of it is concentrated at this level. They face the challenge of inadequate borehole monitoring due to decentralisation (Canuto, 2011).

In Mozambique, communities are responsible for the operation and maintenance of all water infrastructures provided for them (Canuto, 2011).

Although institutions exist that are dedicated to water-related issues and other legal instruments (e.g. Environmental and Land Law) covering the drilling sector, there are no specific laws on groundwater use in the country.(Canuto, 2011; WE Consult, 2006; Naafs and Rhebergen, 2012). According to the World Bank Group (2012) report, there is a huge gap between policy and implementation, leading to poor delivery of WASH services in the country. Naafs and Rhebergen (2012) established a lack of capacity of institutions to legislate the groundwater sector in the country.

²³ This is done by issuing a permit referred to as avara.

²⁴ Each of these financial institutions covers a series of basins.

Borehole Drilling

According to Expert M2 (2019), water well drilling in Mozambique was formerly carried out by the Government. At the beginning of the new millennium, the Mozambique Government privatised its drilling facilities, and these were acquired by their former workers. Although these workers made an effort to run the water drilling businesses efficiently, they were no match to competition from foreign drilling companies, with their modern and portable equipment. Most of them went out of business, while the few remaining ones only worked based on market demands. Just a small number of local drilling companies still have drilling as their sole activity.

Boreholes are the most common source of water supply in rural parts of the country, where 60% of the population live. These water wells are mostly drilled by the private sector (Canuto, 2011).

Unfortunately, rural water supply does not seem to be a priority for the Government, who is the largest borehole customer (Expert M2, 2019).

There has been an increase in the number of drillers in the country due to decentralisation, and the use of manual drilling technique is a common practice (Canuto, 2011). The two experts interviewed had different estimates on the number of drillers in the country, 35 (Expert M1, 2019) and 50 (Expert M2, 2019). As at 2006, the following three categories of drillers exist in the country:

- Private drilling companies
- Semi-public drilling companies (Estaleiros Provinciais de Água Rural EPARS) and
- NGOs (Canuto, 2011)

The Ministry of Public Works, Housing and Water Resources Management is responsible for the certification/licensing of drilling companies (Expert M1, 2019; Expert M2, 2019). Certification is done through the issuance of *Alvara* (which states the kind of work and the amount that each drilling company can apply for) and it is renewed every three years. It is also responsible for the accreditation of consultants and supervisors (Expert M1, 2019).

The Ministry of Economy and Finance issues *Cadastro Unico*, a document which allows drilling companies to apply for public tenders launched by the Government and NGOs and needs to be renewed each year.

The drillers association (see below) issues "Carteira Profissional", a document that certifies that the professional is really qualified to work in the sector, to drillers. The interviews did not reveal how often this document needs to be renewed (Expert M1, 2019).

Borehole drilling in Mozambique is faced with a lot of challenges (Table 3). These challenges were gathered from literature and interviews of experts.

Table 3: Challenges of Drillers in Mozambique [WE Consult (2006), Canuto (2011); (Domingos 27 February (2014) and Luis and Peter (2015)].

| Type of Challenge | Description from Literature | Description from Interviews |
|----------------------------------|---|---|
| Capacity | <ul style="list-style-type: none"> • Lack of skilled personnel (mostly among small drillers) • Lack of knowledge of supervisors • Gap between small and big companies | <ul style="list-style-type: none"> • Unfair competition due to the presence of foreign companies • Lack of business for SME |
| Contracts & Standards | <ul style="list-style-type: none"> • "Contractual issues"²⁵ • Lack of standardised operations • Lack of improved safety standards for employees in the sector | <ul style="list-style-type: none"> • Pre-awarded tenders to companies with links to the government |

²⁵ The specific issues in quotation marks were not explained in literature but were taken from descriptions in interviews.

| | | |
|------------------------------------|---|--|
| Procurement | <ul style="list-style-type: none"> • Contradictions in procurement documents | |
| Finance & Payment | <ul style="list-style-type: none"> • Difficulty in accessing loans from the bank by drillers • No standard rule of payment by the government and payment delays for government projects • No water no pay principle • No fair wages | <ul style="list-style-type: none"> • Non-payment of negative boreholes • Dry boreholes, low yield and/or salty water increases the unit price of boreholes |
| Corruption | <ul style="list-style-type: none"> • Corruption in the sector | <ul style="list-style-type: none"> • Hidden cost of corruptions which increases prices • Tenders affected by corruption |
| Data | <ul style="list-style-type: none"> • Lack of hydrogeological data | <ul style="list-style-type: none"> • |
| Logistics | <ul style="list-style-type: none"> • Problem of transport and communication (though communication is improving due to the presence of mobile network). | <ul style="list-style-type: none"> • |
| Availability of Spare Parts | <ul style="list-style-type: none"> • "Imports" • "Low market price" • "Dimension of work" | <ul style="list-style-type: none"> • Issues explained by experts in interviews |

It was gathered from the interviews that despite the high importation taxes, it is still cheaper to import borehole construction materials than buy locally produced materials that are of low quality²⁶. Thus, the limited number of boreholes drilled per year directly contributes to the high importation cost (Expert, M1). In addition, the cost of consumables is tied to the cost of foreign currency, and it is not affordable to Small and Medium Enterprise (SME) drillers (Expert M2, 2019). Secondly, big tenders require that the bidder's present bank guarantees which cannot be afforded by SME drillers (Expert M2, 2019). It was also gathered from interview that citizens have groundwater awareness in the country (Expert M1, 2019; Expert M2, 2019).

There is a professional training centre for water and sanitation in the country, but it does not meet the needs of drillers, and the Ministry of Labour does not have the capacity to train personnel in the drilling industry (Luis and Peter, 2015).

Drillers Association: Associação de Perfuração de Moçambique (APM)

The Mozambique drillers association (Associação de Perfuração de Moçambique APM) was formed in 2006 as a voluntary, non-profit organisation consisting of companies and professionals (Luis and Peter, 2015). The association was started in order to recognise the drilling profession and defend its interests through research and technology, and also to promote and empower its members on the use of suitable and low-cost techniques for mining and water well drilling (Expert M1, 2019). On the other hand, expert M2 (2019) mentioned that the organisation had been started because the business environment was a threat to the SME drillers and there was need to be united in order to survive.

The association is recognised by the government. It is sometimes consulted regarding decisions to be made in the sector, and it is in contact with other Water Sector stakeholders in Mozambique (Expert M1; 2019 and Expert M2, 2019). It was mentioned that the association was not as active as it should be and needed to be revitalised (Expert M1, 2019).

²⁶ The production of borehole materials in Mozambique is fledgling, hence quality of materials is low, production is not massive, and prices are not competitive.

Membership

Members have to first of all register and pay a drilling fee of 5,000 MZN (~76 Euros) monthly. The association intends to categorise its members (Expert M1, 2019). There are many drillers who could be part of the association but are not members because they do not understand its importance (Expert, M1, 2019; Expert M2, 2019). It is unclear whether there are members below the age of 35 years. Only one member is female, although she is also the president (Expert M1, 2019). The association has a nationwide coverage but more presence in the capital city (Expert M1, 2019; Expert M2, 2019).

Activities

Expert 1 mentioned that the activities of the association are to include

- capacity building for drilling companies and drillers, consultants and supervisors
- advocate for conducive business environment (certification of drilling companies/drillers, consultants and supervisors)

In addition, it is to provide information on drilling techniques and support drillers (Expert 2). The association ensures that drillers submit data to the appropriate government authority²⁷.

Its future planned activities include facilitation of bank loans to its members, certification of drillers (issuance of Carteira Profissional) and supervisors and improving on already existing activities (Expert 1; Expert 2).

Benefits and Achievements

The association leverages on training, certification and access to hydrogeological data as benefits for its members. This method is also helping to attract new members (Luis and Peter, 2015).

In 2008, the association successfully lobbied the national government against the unrealistic contract deal stipulated by the One Million Initiative²⁸. The association, in collaboration with the water and sanitation programme (WSP) of the World Bank, started training courses for members on different topics²⁹ and is currently the only platform for training drillers (Luis and Peter, 2015). It also worked with WSP to create a professional drilling certification framework within the Ministry of Labour and has been issuing certificates since 2015. It is working on other issues affecting drillers, such as the award of public contracts, non-payment for negative boreholes and delays in the payment of invoices.

Finance and Sustainability

The association is maintained by membership fees but needs other sources of funds in order to be sustainable (Luis and Peter, 2015). The association has benefitted in the past from the World Bank Water and Sanitation Program and FAN (Fundo de Apoio ao Ambiente de Negócios) regarding the acceleration of the drilling business in Mozambique, aimed at achieving MDG 7 by 2015 (Expert 2).

Currently, the association is struggling financially due to low membership, and existing members (small companies) find it difficult to pay their fees.

The few members who are able to pay their fees believe the association is transparent and accountable. However, it has been unable to publish its financial reports and hire the service of external auditors.

²⁷ The National Directorate of Water and Sanitation Affairs through Water and Sanitation Department at Provincial level compiles data via SINAS (National Information System of Water and Sanitation).

²⁸ A Dutch funded project designed to provide water, sanitation and hygiene project to one million people between 2007 and 2013 (Luis and Peter, 2015).

²⁹ Courses cover field geophysics, drilling supervision, costing and pricing and business management.

Challenges

According to Luis and Peter (2015), the Mozambique drillers association is faced with the following challenges: lack of competition due to the presence of foreign large skilled drillers in the country, lack of competent personnel to qualify for executive positions (presumably within the association), the need to address the difference between large and small firms and better ways to earn the trust of members.

In the interviews, the lack of funds to operate, membership and retention of already existing members, delayed payment of membership fees and the non-prioritisation of members in the awards of contracts in public tenders were mentioned as the challenges faced by the association (Expert 1; Expert 2). Also, there is competition between drillers which was referred to as "jungle competition". This competition arises through the limited number of boreholes to be drilled nationwide by the drilling companies, so that drillers ensure they will do what it takes to get jobs. To resolve this challenge, the association is making efforts to have a stronger partnership with the government and other WASH partners. The result of these efforts seems to be below expectation. Unfortunately, some drilling companies are out of business or are about to be (Expert 1).

Way forward

The association would like to increase its presence in other parts of the countries by expanding its activities, increasing funds through a membership campaign, reducing the amount paid per member per month, making itself relevant to drillers, being a partner to the government, ensuring drillers are prioritised for water well drilling work and ensuring good quality boreholes (Expert 1; Expert 2).

Key Findings

The following are key findings from Mozambique:

1. There are no laws governing the specific use of groundwater in the country, and there is a challenge in the implementation of already existing laws in the WASH sector.
2. There is a lack of capacity of drillers and supervisors directly involved in water well drilling, and there is no training platform.
3. Weak contracts, lack of standards and corruption in tenders
4. The presence of small and medium enterprise drillers have difficulties accessing loans from the bank to engage in business.
5. Lack of hydrogeological data and delayed payment by the government
6. Transportation problems during the rainy season
7. The association is not currently functioning to its full capacity (inactive), and drillers do not understand its importance.
8. There is the challenge of non-payment for negative boreholes (no water no pay principle). This principle also increases the unit price of boreholes, since the driller bears the risk of finding water.

More than 50% of Mozambique's population are highly reliant on groundwater as their source of drinking water. Hence it is necessary to have regulations specific to groundwater exploration in the country. It was mentioned that citizens have groundwater awareness in the country. However it is not clear if there is continuous sensitisation. We Consult (2006) mentioned delayed payment, transportation and corruption as major challenges facing water well drilling in Mozambique.

Nigeria

Country context



Figure 7: Map of Nigeria and country context (Encyclopaedia Britannica, 2018.a).

Key Facts

| | |
|-----------------------------|--|
| Area | 923,768 km ² |
| Population | 191 million (UNDESA, 2017) |
| Rainfall | South – 1,250mm to over 4,000mm of mean annual rainfall, Central – 1,000mm to 1,250 mm of mean annual rainfall, North – 75 mm of mean annual rainfall (Adekile and Olabode, 2009a) |
| Geology | 50% sedimentary and 50% crystalline of underlying rocks. (Adekile and Olabode, 2009b). |
| Groundwater Reliance | 70.1% of the total population rely on a groundwater point source (NSB/FMWR, 2018) ³⁰ . Decline in people's access to water in premises from 3 persons out of 10 in 1990 to less than 1 in 2015 (World Bank, 2017) |
| Government Structure | Federal – 36 states and 774 local governments (Adekile and Olabode) 2009a). |

Groundwater Reliance

Nigeria's total population primarily rely on three major drinking water sources – tap water, groundwater, and surface water (Figure 8a). This data is presented in a somewhat unconventional way, as it focuses on the water source, rather than on whether it is classified as improved or unimproved. Groundwater point sources dominate, providing 70% of the total population with their main drinking water supply. Figure 5b compares the main drinking water sources between urban and rural populations. Notably packaged water is important in the urban context, with 20% of the population relying on it as their main drinking water source, even more than tap water, which is used by an estimated 13% of the urban population. The extent to which packaged water and tap water supplies are sourced from groundwater sources in Nigeria is not known.

³⁰ Data extracted from 2018 survey published by JMP in 2019 (JMP, 2019d)

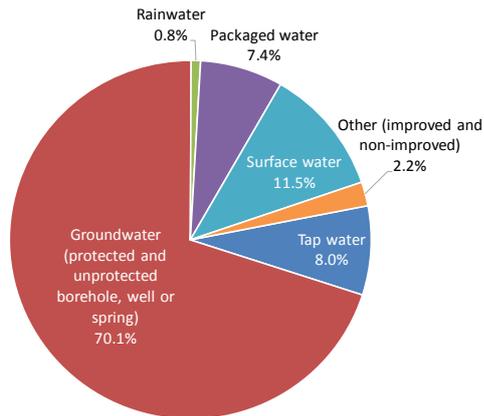


Figure 8a: National percentages of Drinking Water Source in Nigeria (NSB/FMWR, 2018).

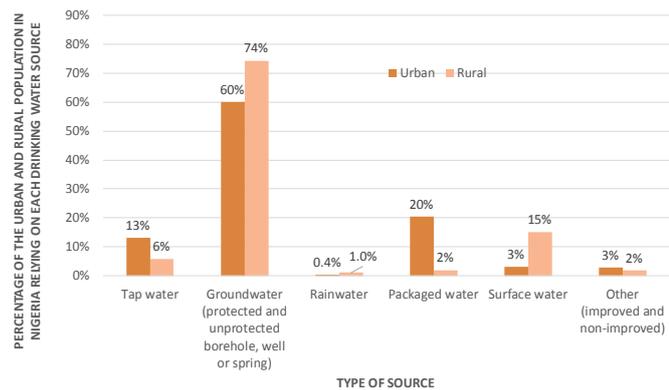


Figure 8b: Urban and rural percentages of drinking water sources in Nigeria (NSB/FMWR, 2018).

Institutional Framework

Nigeria has national institutions and frameworks for managing water resources. At the national level, the institutions were set up in the 1970's³¹ and include the Federal Ministry of Water Resources (FMWR), the River Basin Development Authorities (RBDA) and the National Water Resources Institute (NWRI).

The FMWR is responsible for formulating policies, data collection, monitoring and harmonising water resources development including the execution of contracts (Adekile and Olabode, 2009a). The RBDA provides water to communities for domestic use and irrigation, and are also involved in the award of drilling contracts (Adelike 2007). The NWRI has the responsibility to engage in training and research (Adekile, 2007).

At state level, the state governments are responsible for providing water through the state water boards in urban areas and through the agency called Rural Water Supply and Sanitation Agency (RUWASSA) in the rural areas (Adekile and Olabode, 2009a). The local governments are in charge of the small towns within their districts. The state and local government authorities are also involved in contract awards (Adekile and Olabode, 2009a). Other institutions party to contract awards in the country include UNICEF, WaterAid, NGOs, faith-based organisations and oil companies³² (Adelike, 2007). There are also numerous specific initiatives and programmes involved in water supply in Nigeria (Box 2). Adekile (2007) identified that a lack of coordination between the levels of government has led to a duplication of effort in water project implementation.

The Federal Ministry of Water Resources has set standards for borehole design based on the geologic terrain, and a National Code of Practice for Water Well Construction has been adopted (Nigerian Industrial Standard, 2010). However, these standards and the code are not adhered to. *"The Procurement Act and the National Code of Practice for Water Well Construction in Nigeria has put in place systems and the legal framework that could lead to cost effective borehole provision in the country but the systems are yet to be implemented in their entirety"* (Mangai et al., 2011).

³¹ FMWR and RBDA were established in 1976, NWRI was established in 1977. The setting up of the institutions was prompted by the drought experienced at that time.

³² Faith-based organisations: the Roman Catholic Church and the Evangelical Church of West Africa; oil companies: Chevron Nigeria Limited, Shell Petroleum Development Corporation of Nigeria.

Box 2: Initiatives and programmes involved in water supply, and borehole drilling in particular, in Nigeria (Adekile, 2007).

The federal government and development agencies have initiated several water supply schemes in Nigeria which involve considerable investment in borehole drilling, including

- the National Borehole Programme
- the Department of Food, Roads and Rural Infrastructure RUWATSAN Programme
- the FGN/UNICEF Water and Environmental Sanitation Programme
- the UNDP – World Bank Rusafiya Project
- Water Supply Projects of the Agricultural Development Programmes
- the Drought Relief Water Supply Programme
- the National Water Rehabilitation Project
- the Federal Ministry of Health/UNICEF/ Fund-In-Trust (FIT) Water Supply and Sanitation Project
- the European Economic Community Middle Belt Rural Water Supply Project
- the Petroleum Trust Fund (PTF) Water Supply Project
- the DFID Water and Sanitation Project in Benue State
- JICA intervention in some guinea worm endemic states
- Improved National Access to Water Supply and Sanitation
- the Federal Rural Water Supply Project

Borehole Drilling in Nigeria

The history of borehole drilling in Nigeria has been fairly well documented (Adekile and Olabode, 2009a). It started in the 1940's. Before this period, water had been abstracted from unlined hand dug wells. However, in the 1930's, the 1.2m diameter lined hand dug well was improved. Between 1940 and the mid 1980's (i.e. before Nigeria's economy went into recession), international drilling operators came into the country (those from Italy, Germany, Britain and Greece came into Nigeria before the 1980's and those from China, Japan and Canada joined in the 1980's). These international drilling operators hired and trained some Nigerians as mechanics, rig operators, drivers and welders.

The recession in the mid 1980's forced many of the international operators out of the country. This created an opportunity for the trained employees to start up their own drilling companies (Adekile and Olabode, 2009a). However, during the period when the international companies were operating, they were, too, but without proper standards and regulations, which led to many projects being abandoned (Expert N2, 2019). Currently, drilling is mainly done by the private sector, and the country is estimated to have well over 1,000 drillers (Expert 1, 2019; Expert 2, 2019). It is reckoned that 200 manual drilling enterprises employ 1,000 people operate in Lagos state alone (Danert, Adekile and Canuto, 2014). In Nigeria, the major clients for boreholes are private households, rather than development projects.

All water well drilling companies are registered as a business with the government. The Code of Practice for Water Well Drilling empowers the National Water Resources Institute (NWRI) in Kaduna state to license all drillers in the country but this has not been realistic. This is because of the sheer size of Nigeria, insufficient capacity and lack of awareness of the institution's existence among drillers, especially in other states of the country (Expert N1, 2019).

The Council of Mining Engineers and Geoscientists (COMEG) registers all graduates who want to practise in mining and geology. After registration with COMEG, drillers have to inform the state where they intend to practise (Expert N1, 2019). Notably, there is no special certification to practise as a groundwater consultant.

According to Expert 2 (2019), the Association of Water Well Drilling Rig Owners – AWDROP (described below) is currently lobbying the government to give it the authority to license the groundwater sector under the Federal Ministry of Water Resources (FMWR). This licencing could go a long way in contributing towards the regulating the groundwater sector and ensuring the removal of quacks.

According to Adekile (2007), drillers in Nigeria can be grouped into the following categories:

- Organised drilling contractors with equipment and a management structure
- Artisan drillers engaged in manual drilling or using locally fabricated rigs
- Contractors with some interest in drilling but no equipment whatsoever

The organised drillers are recognised by the national authorities, but the artisan drillers are yet to be recognised (Adelike, 2007) . The challenges faced by drillers in the country are summarised in Table 4.

Table 4: Challenges of Drillers in Nigeria (Mangai, Adekile and Retchen, 2011), and (Adekile, 2007).

| Type of Challenge | Description from Literature | Description from Interviews |
|------------------------------------|---|---|
| Capacity | <ul style="list-style-type: none"> • Lack of competent drillers and supervisors to supervise drilling activities • Inappropriate borehole siting • Lack of monitoring of boreholes due to lack of capacity at the state and local levels | _33 |
| Contracts & standards | <ul style="list-style-type: none"> • Third party involvement in drilling contracts • Small contract packages • Long distances between contract locations • Clients not following contract procedure | - |
| Procurement | <ul style="list-style-type: none"> • Lack of transparency in the procurement procedure | |
| Finance & Payment | <ul style="list-style-type: none"> • Lack of credit facilities • Delayed payment of contractors • No payment for dry holes | |
| Corruption | | <ul style="list-style-type: none"> • Does not affect drillers in the country |
| Data | <ul style="list-style-type: none"> • Poor access to data and problems with geophysical survey. • lack of data/ record-keeping system | |
| Logistics | Poor access to drilling sites in some drilling locations | |
| Availability of Spare Parts | Difficulty in obtaining spares and consumables | |

There is clearly a need to support consultant and drillers to professionalise the trade. Adekile (2007) mentioned other capacity needs to include communication, networking and management skills, although it was mentioned from interview that corruption does not affect drillers in the country. However, some consider corruption to be prevalent in the procurement process (Anonymous, 2019). From the interviews, Experts N1 and N2 (2019) confirmed that citizens do not have groundwater awareness.

³³ not mentioned in literature and interview

Drillers Associations of Nigeria

From the interviews, it was found out that there are two drillers association in Nigeria. They are the Association of water well drilling rig owners (AWDROP) and the Borehole Drillers Association of Nigeria (BODAN).

The Association of Water Well Drilling Rig Owners (AWDROP)

History

The Association of Water Well Drilling Rig Owners (AWDROP) was inaugurated in May 2008 with the support of the World Bank³⁴ and Skat Foundation, under the umbrella of the Rural Water Supply Network (RWSN), following an initial stakeholders workshop in August 2007 (Adelike, 2007). The need to start a drillers association arose when companies at the state levels had to regulate water well drilling prices (uniform prices) and had to defend the profession owing to litigations on dry and failed boreholes (Expert N1, 2019). Also, members had to be assisted in developing their capacity and meeting up with International Standards of Operation (Expert N2, 2019). The World Bank, through Skat Foundation, initiated the setting up of a national drillers association to identify the professional drillers.

At the inauguration, the objectives, constitution and a one-year work plan were major outcomes (Adekile, 2008), and the sum of \$20,000 was contributed by participants as donations to start off activities for the organisation's development (Adekile, 2014). This was the launch of AWDROP.

Membership

Members of AWDROP include drilling companies, contractors, drillers, practitioners (geoscientists, pump installers). AWDROP's members include local and international companies. There are two categories of members:

- rig owners
- professional practitioners

To be part of the rig owners category, a company must be registered, have a geoscientist and own a rig, and to be a practitioner, a member must have a registered company with many years of experience. AWDROP is responsible for the certification of its members.

One can become a member of the association if specific criteria are fulfilled³⁵ and after due consideration by members of the executive as well as payment of a registration fee of 47,000 naira (€116). Some drillers are not members of the association because they are unable to meet its standards. As a result, according to one expert, they register as members of the second association called the Borehole Drillers Association of Nigeria (BODAN), which has less stringent standards. Approximately 25% of AWDROP's members are below 35 years of age, and less than 5% are females (Expert N2, 2019).

The aforementioned two categories of members do not attend the same meetings because they have different objectives but do come together during events such as conferences (e.g. the annual master drilling conference), Water Technical events (held once every three years) and annual congress meetings.

AWDROP is recognised at the National Level and by the Federal government. There is a contradiction in the responses of experts as regards the representation of AWDROP at the states level. One expert expressed that there is recognition of AWDROP in some southern states (maybe because the AWDROP Headquarters is in Lagos, in southern Nigeria) while another explained that AWDROP is represented in 27 out of 36 states in Nigeria.

³⁴ Water and Sanitation Program of the World Bank

³⁵ To be part of the rig owners, a company must be registered, have a geoscientist and own a rig, and to be a practitioner, a member has to have been a registered company with many years of experience.

State governments hold dialogues with the state associations, and in states where AWDROP is represented, the national body gives advice to members on how to engage with stakeholders in their various states.

Activities

Expert N2 (2019) mentioned that AWDROP engages in the following activities

- publication of newsletters
- training/ capacity building
- accreditation and certification of local drilling companies.
- sensitisation
- member's welfare
- research & training

AWDROP also leases its rigs to competent members. When there is competition between members, the association sets up a reconciliation committee to resolve issues.

Benefits/Achievements

Members benefit from the association by having a membership card, listing of their company on the AWDROP website, discount registration for events, permission to use the AWDROP logo on proposals and other official documents, and opportunities to make an input in the development of state and national regulations (Ale, 2014). Members are also introduced to government incentives such as international trainings. Its future plans include the building of homemade rigs (Expert N2, 2019).

Internationally, AWDROP has membership agreements with RWSN, the Drilling Safety Association (formerly the British Safety Council) and the National Groundwater Association (NGWA) in the USA (AWDROP, 2008). Locally, it is affiliated with Nigeria Water and Sanitation Association (NIWASA), Nigeria Association of Hydrogeologist (NAH), Nigeria Mining and Geosciences Society (NMGS) and the Council of Mining Engineers and Geoscientists (COMEG) (Adelike, 2007).

Finance and sustainability

The activities of AWDROP are funded by:

- an initial registration fee of 47,000 NGN (€116)
- an annual subscription fee of 12,000 NGN (€30) for all members
- donations or sponsorship by members
- fees for training courses
- a well drilling site fee
- specific partnerships/projects (mainly with the Federal Ministry of Agriculture).

According to Expert N2 (2019), membership fees are affordable by members. The well drilling site fee is collected during the drilling of each water well and is used for the welfare of the state associations. A task force is put in place along with the government to collect these fees. A member, individual or a company could sponsor events. In summary, a bottom-up approach has helped in the institutionalisation of the association (Ale, 2014).

AWDROP also receives regular funding from the budget of the Federal Ministry of Agriculture under the Agro-Rural Water Supply Support Initiative (A- RUWASSI). In order to be able to receive this funding, the association has a public private partnership agreement with the initiative. The project has been running for three consecutive years, up to 2019. AWDROP has benefitted to the tune of twenty million naira (€50,000) since its inception. The funds were used to buy drilling rigs with two rigs given

to credible members in each of the six geopolitical zones³⁶. Forty per cent of the revenue generated from the use of the rigs by AWDROP members goes to the government, 40% is spent on operation and maintenance of the equipment, and 20% goes to AWDROP. The funds are remitted for a period of three years, after which the member takes full ownership of the rig (Expert N2, 2019).

On transparency and accountability, AWDROP publishes annual financial and activity reports and makes them available only to its members (Expert N2, 2019). These documents are not placed in the public domain (organisation's website), and accounts have not been audited due to lack of funds.

Challenges

The challenges of the association include intimidation of its members (drillers) as a result of the government's inability to license drillers in the country. Licencing will go a long way towards ending intimidation as well as empowering the association to protect its members and the sector from unqualified and non-licenced professionals.

Way forward

AWDROP would like to improve on supporting capacity building of members to manage drilling jobs and in licencing of companies (Expert N2, 2019). The recommendations from cost effective borehole drilling have been taken forward to an extent. Drillers are already adopting cost effective techniques and use the appropriate equipment for specific sites, but the government could do more to adopt cost effective practices in contract management and supervision and in facilitating maintenance of boreholes after installation (Expert N1, 2019).

The Borehole Drillers Association of Nigeria (BODAN)

Information about the association was mainly gathered from its website and from just one expert, no others having been available.

History

The association aims to unite all drilling companies in order to regulate the sector by identifying non-professionals in the industry. To achieve this, it is currently working with all players in the drilling sector (BODAN, 2019). There is no mention of when the association was formed.

It was gathered from an interview with Expert N3 (2019) that BODAN was formed to standardise the borehole industry in Nigeria and control and regulate borehole business activities in order to preserve, conserve and sustain the industry for incoming professions and investors. The association is located in Abuja and has zonal offices with zonal coordinators in the six geopolitical zones in Nigeria (BODAN, 2019). However, it was mentioned in the interview that the association is not represented at the state levels. The organisation is registered with the government (Expert N3, 2019). According to Expert N3 (2019), there is another drillers association in Nigeria, and members can be part of both.

Membership

To be part of the organisation, one has to fill an expression of interest form and pay the membership fees. It currently has 42 members (Expert, N3, 2019). The amount paid was not mentioned during the interviews. Members include geologists, engineers, hydrologists, contractors, consultants and government employees working in groundwater industry, rig owners, and pump and borehole material suppliers (BODAN, 2019). The association has different categories of drillers, members younger than 36 and female members, although the specific numbers were not estimated (Expert N3, 2019). It was also mentioned that there are drillers who could be part of the association but are not because they do not

³⁶ North east, North West, North Central, South West, South south and South East.

understand its significance as it only exists at the national level (Expert N3, 2019), while its website states that it has zonal representations with states chairpersons³⁷.

Activities

The association's activities include

- providing up to date drilling technique to its members
- supporting rural communities annually with WASH programs by donation of free boreholes (BODAN, 2019)

Its future activities are to cover setting up modalities to make the industry sustainable, not compromising with standards as well as adhering to government policies guiding drilling operations (BODAN, 2019).

Benefits and Achievements

The benefits of the association are unknown due to limited information. However, it has partnerships with the National Ground Water Association (NGWA) in the USA, UNICEF, Water Aid and the Federal Ministry of Water Resources (BODAN, 2019).

With only limited information available online, association's mode of operation, activities, sustainability, challenges are not known.

Key Findings

The key findings from Nigeria can be summarised as follows:

1. Although Nigeria has policies in place, there are challenges to putting these policies into practice. This has consequences regarding how groundwater is managed in the country.
2. There is a lack of coordination between different levels of government.
3. There are major capacity gaps at all levels (drillers, states and national government), resulting in poor contract management, procurement, borehole supervision, siting and monitoring.
4. Nigeria has two national drillers associations. It is not clear whether the two associations in the country complement one another, but it could be deduced that they do not work together to achieve their objectives even though they are similar.
5. Nigeria is a large country, hence both associations could have more members if they had a stronger presence at the state levels than they have nationally.
6. There is little representation of female and young professionals in the groundwater sector (AWDROP). The representation of female and young professionals is unknown due to limited information (BODAN)
7. Transparency of the associations is a challenge as financial documents are not placed in the public domain. AWDROP lacks funding to audit its accounts, and the transparency of BODAN is unknown due limited information.

Nigeria is highly dependent on groundwater, with 70% of the total population relying on groundwater point sources and Nigerian citizens as the major investors in boreholes. However, citizens lack awareness of groundwater³⁸.

³⁷ <https://bodan.com.ng/2015-08-09-11-02-03/state-chairmen-offices.html>

³⁸ See introduction, paragraph 3 for definition of groundwater awareness.

Uganda

Country Context



Figure 9: Map of Uganda and country context (Encyclopædia Britannica, 2019.d)

Key Facts

| | |
|-------------------------------|--|
| Area | 249,000km ² . Landlocked Country |
| Population | 42 million (UNDESA, 2017). |
| Rainfall | Annual mean rainfall of 1,200mm Evaporation is usually higher than rainfall ³⁹ (Tindimugaya, 2012) |
| Geology | 90% Old Precambrian basement terrain and less than 10% of Cenozoic rift valley sediments and Pleistocene volcanics (Tindimugaya, 2012) |
| Groundwater Dependency | 72% of the total population rely on groundwater point sources (PMA, 2017b) ⁴⁰ |
| Government Structure | Unitary State. The country is divided into 4 regions, 121 districts (Commonwealth Local Government Forum, 2018 b). |

Groundwater Reliance

There is heavy reliance on groundwater for rural and urban supply in Uganda (Tindimugaya, 2016). Nationally, 72% of population rely on groundwater point sources for their drinking water supplies, compared to 20% on tap water (Figure 9a). This data is presented in a somewhat unconventional way, as it focuses on the water source, rather than on whether it is classified as improved or unimproved. Figure 9b shows that the rural population of Uganda has an 80% reliance on groundwater point sources compared to 36% of the urban population. An estimated 58% of the urban population rely on tap water, whereas 36% rely on groundwater.

³⁹ 130mm per month.

⁴⁰ Data extracted from 2017 survey published by JMP in 2019 (JMP, 2019e)

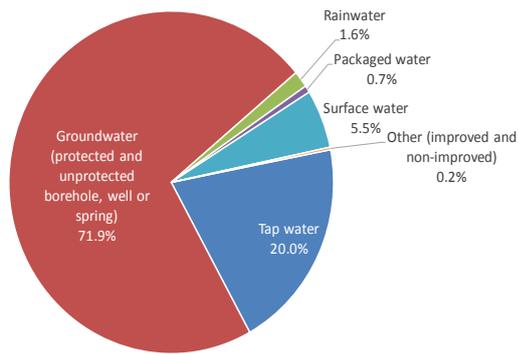


Figure 10a: National percentages of drinking water sources in Uganda (PMA, 2017b).

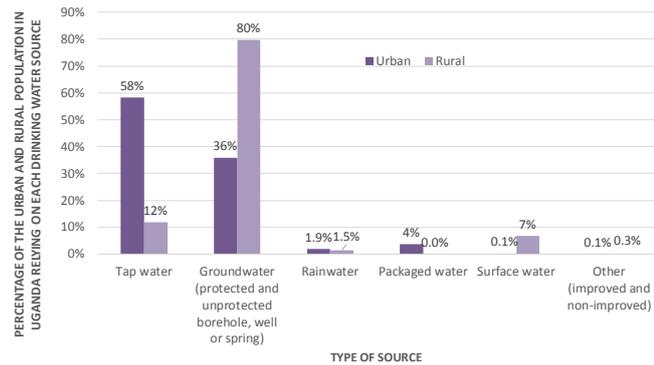


Figure 10b: Urban and rural percentages of drinking water sources in Uganda (PMA, 2017b).

Institutional Framework

Uganda has legal frameworks, policies and Institutions for the implementation of water and sanitation services (Sloots, 2010). At the national level, the Ministry of Water and Environment (MWE) heads all water related activities in the country, including planning, monitoring regulating and providing support to local governments. It performs its role through the Directorate of Water Development (DWD) and the Directorate of Water Resources Management (DWRM) (Sloots, 2010; Liddle and Fenner, 2017).

DWD is responsible for rural services and supports District Local Governments under their Rural Water Supply and Sanitation Department. DWD provides technical oversight planning, procurement, implementation and capacity development. It also supports the implementation of decentralised water supply and sanitation programmes, implementation of new construction and schemes rehabilitation in small towns and Rural Growth Centres (Sloots, 2010; Liddle and Fenner, 2017). The DWD has nine Technical Support Units (TSUs) that work across the country, supporting the development of District Local Government annual work plans, verifying work, monitoring, communicating and reviewing performance. They also help to build capacity at the district level (Sloots, 2010; Liddle and Fenner, 2017).

The DWRM is responsible for developing, maintaining and regulating water laws and policies through the issuance of water abstraction and wastewater discharge permits (including the licensing of drilling contractors and groundwater professionals). It also facilitates the country's participation in joint management of trans-boundary waters resources and cooperation with other riparian countries of the Nile Basin (Sloots, 2010; Liddle and Fenner, 2017).

Development partners work with the Government of Uganda to give single funding to rural water development programmes. They also fund Civil Society Organisations constructing rural water services in the country. Although their efforts are meant to complement the work of the Local Governments and follow the implementation standard of the government, they often follow donors' procedures (Sloots, 2010).

District Local Governments engage in procurement planning and implementation. The Operation and maintenance of rural projects (new water facilities) are carried out by recipient communities through Water User Committees (Liddle and Fenner 2017).

Borehole Drilling in Uganda

According to Tindimugaya (2016), groundwater drilling started in Uganda in the 1930's. However, Expert UG1 (2019) mentioned that it started in the 1950s, and boreholes drilled have identification letters indicating the institution responsible for the job⁴¹. Borehole drilling started with Crelius Drillers, using percussion rigs. In the 1960s, it was taken over by the government's Geological Survey and Mines department, and subsequently the Water Development Department. Finally in the 1990s groundwater drilling was taken over by the Directorate of Water Development within what is now the Ministry of Water and Environment (MWE).

Until 1996, the Ministry of Water and Environment was drilling the boreholes in Uganda. Subsequently, the private sector became involved in drilling, with the first companies being engaged in the Rural Water and Sanitation (RUWASA) programme. Drilling and drilling supervision procedures were developed as part of this programme. The contracts paid according to the work done, as set out in the Bill of Quantities (BoQ).

However, this changed after many NGOs got involved in drilling boreholes for the Internally Displaced Camps in the northern part of the country. Large numbers of boreholes went dry, mainly due to poor performance of the hydrogeologists who were siting boreholes and designing the wells. As a result, the NGOs started working under new "no water no money contracts".

More contractors, mostly business people rather than groundwater professionals, came into the market, leading to high competition among contractors. Hence, contractors began to quote below cost price, and the quality of boreholes was reduced. The government is currently making effort to reverse this trend by putting regulations in place. However, enforcement is still poor. In 2016, MWE and the Uganda Drilling Contractors Association (UDCA) became partners, and it is hoped that UDCA can help with improving the drilling quality again (Expert UG2, 2019).

The Government, under the Directorate of Water Resources Management, gives an annual licence to drilling companies. An applicant submits his/her application with all details of personnel and equipment, and this is followed by an inspection. The same institution also certifies consultants/supervisors. The applicants submit certified copies of their qualification, reports of work done, including references, after which they will be evaluated, interviewed and categorised as Junior hydrogeologist, hydrogeologist, Senior Hydrogeologist, or an Expert, all depending on the number of years in the field (Expert UG1, 2019).

In July 2009, 42 drilling companies in the country were licensed (Sloots 2010). Expert UG1 (2019) estimated the number of drilling companies in the country to be 52. Expert UG2 (2019) gave the number of licensed drillers by MWE to be 62 of which only 21 are members of UDCA. According to Sloots (2010), 1,000 -1,500 boreholes are drilled in the country annually. Drillers drill for institutions and private individuals (Expert UG1, 2019), but mostly for the government and NGOs (Expert UG2, 2019).

Table 5 summarises the challenges faced by drillers and consultants in Uganda as gathered from literature and interviews.

⁴¹ Boreholes drilled by Crelius Drillers have the prefix letters "CD", boreholes drilled by Geological Survey and Mines, the prefix letters "GS". Water Development Department boreholes have the prefix letters "WDD". Drilling by the Directorate of Water Development and boreholes has the prefix letters "DWD".

Table 5: Challenges faced by drillers in Uganda (Liddle and Fenner, 2017; sloot, 2010)

| Type of Challenge | Description from Literature | Description from Interviews |
|------------------------------------|--|---|
| Capacity | <ul style="list-style-type: none"> • Lack of skilled personnel to conduct siting • Low quality data submitted to DWRM and Unrealistic hydrogeological maps. • No quality control of work | <ul style="list-style-type: none"> • Lack of technical capacity |
| Contracts & standards | <ul style="list-style-type: none"> • Turnkey contracts - No siting and supervision • No strict adherence to procurement process • Inaccurate technical specification in bidding document | <ul style="list-style-type: none"> • Turnkey contracts: mostly done by NGOS and few local governments.. The association is currently working to see to it that this contract type ends and has counselled its members to avoid it. |
| Procurement | ⁴² | - |
| Finance/Payment | <ul style="list-style-type: none"> • The no water no pay principle • VAT (No adherence to the VAT exemption for water works • Unrealistic prices in bidding document • Delayed procurement process due to late disbursement of funds from the Ministry of Finance, resulting in delayed payment • High competition among drillers causes them to lower their prices | <ul style="list-style-type: none"> • Delayed payment by the Government who is the main Client • Underpayments, linked to poor water quality, poor water depth, etc. • Underquoting by many contractors |
| Corruption | <ul style="list-style-type: none"> • Corruption in the procurement process especially for District Water Offices (DWO) projects • <i>"Political influence"</i> • | - |
| Data | <ul style="list-style-type: none"> • Not all unsuccessful boreholes are recorded | - |
| Logistics | <ul style="list-style-type: none"> • Fragmentation of drilling works increases time spent on projects | - |
| Availability of Spare Parts | <ul style="list-style-type: none"> • <i>"Import Duties"</i> | <ul style="list-style-type: none"> • Old equipment by most drillers |

It is not certain in what context some of these challenges exist. For example, it is not clear how political influence and import duties affect drillers. However, both experts mentioned in interviews that political influence is not a major challenge faced by drillers, whereas the high price of fuel is. In Uganda, citizens do not have groundwater awareness. The association is already engaging the process of awareness creation. Key players in the water sector have this awareness and can identify professionals in the sector (Expert UG1, 2019).

⁴² None stated in the literature document.

Drillers Association of Uganda –Uganda Drilling Contractors Association (UDCA)

The Uganda Drilling contractors Association (UDCA) was formally organised in 2016, but had been set up a few years before (Expert UG1, 2019). According to Expert UG2 (2019), the association has failed twice in the past due to low membership adherence. However, there is hope that this time, membership will increase with the support of government (see activities section).

UDCA was started in order to defend the interests of contractors in a more organised way on well cost issues, the nature of contracts and improving the quality of boreholes (Expert UG1, 2019; Expert UG2, 2019).

The association is recognised by the government and has a signed renewable Memorandum of Understanding for five years. Its mandate in partnership with the government includes:

- Support MWE towards fulfilling its water resources management and development mandates and targets through monitoring drilling contractors and their activities.
- Provide technical support, especially through sharing scientific information and submission of data to MWE.
- Mobilise the drilling permit holders to adhere to permit conditions, and encourage all drilling contractors to register with MWE.
- Share relevant reports, information and lessons learnt to enhance the effective development, management and safeguarding of water resources.
- Mobilise finance and technical resources for the implementation of jointly agreed programmes.
- Participate in MWE reviews of water development and management activities, policies and laws pertinent to borehole drilling (Expert UG1, 2019; Expert UG2, 2019)

Membership

Members of the association are made up of drilling contractors only (Expert UG1, 2019; Expert UG2, 2019). A contractor can become a member by registering and paying an annual membership fee of UGX 1,000,000 (€238) (Expert UG1, 2019; Expert UG2, 2019).

There are drillers who could be part of the association but are not because they are yet to understand its usefulness (Expert UG1, 2019; Expert UG2, 2019). The association has carried out training courses and is in the process of developing more that can only be attended by members. It is envisaged that shortly, contractors will only be able to obtain a license when they have followed the trainings organised by the association or have certificates for all their technical staff (Expert UG2, 2019).

There are no members less than 35 years of age (Expert UG1, 2019; Expert UG2, 2019). There is only one female member among the registered members of the association. She is said to be a rig owner and a member of the board of the association (Expert UG2, 2019). The majority of the drilling contractors (95%) are based in the country's capital but do have widespread jobs all over the country (Expert UG1, 2019).

Activities

Expert UG1 and UG2 (2019) mentioned the activities of the association to include:

- quality control of drilling activities
- capacity building of members
- membership drive
- assist government in enforcing regulations
- monitor wells drilled by members and none members
- lobbying with respect to pricing and better contracts
- coordination of meetings with MWE

- assist member companies in costing of boreholes drilling activities
- ensure members do not forget to submit documents to the government

The association's future plans include further engaging in the activities it is already undertaking (Expert UG1, 2019). It also plans to carry out training on company management, engage more in inspection surveys, and have more stringent regulations in place for the sector – such as no issuing of a licence (by Government) without taking training courses organised by UDCA (Expert UG2, 2019).

The association also supports the collection of data. The licencing process of the government (by DWRM) is designed in a way that drillers are required to submit groundwater data as a criteria (Expert UG2, 2019). In addition, the association makes it a responsibility to remind and train drillers on how to collect these data in accordance with government standards (Expert UG1, 2019).

According to Liddel and Fenner (2017), the future plans of the association include:

- “regular spot-checks of drilling operations,
- capacity building through running short courses for drillers,
- communication of new government guidelines and rules with drillers,
- the development of a code of practice for drilling
- working with MWE to identify and sanction problematic Drilling Contractors”

Benefits and Achievements

Member companies stand to attend free capacity building programmes, the association intervenes when members have issues with their clients, and in general, it stands up for the interests of drilling contractors in the sector (Expert UG1, 2019; Expert UG2, 2019).

Since its inception, the association has succeeded in bringing drilling contractors together and giving training on pump tests, drilling and supervision (Expert UG1, 2019). In addition members and government officials [staff of the National Water and Sewerage Corporation (NWSC)] have been trained and the association has supported contractors in getting their payment for work done (Expert UG2, 2019).

Finance and Sustainability

The association sustains itself from membership dues and donations from the government (Expert UG1, 2019). It was also mentioned that members of the association are too few hence, making it difficult for the association to exist without added support (Expert UG2, 2019). Expert UG2 (2019) believes that financial support from the Ministry of Water and Environment and other donors agencies would go a long way in trainings and monitoring borehole quality, which would in turn automatically support self-regulation in the sector.

Members pay the sum of UGX 1,000,000 (€238 Euros). The fees were increased to UGX 1,500,000 (€361) at the general meeting held in 2018, with an additional UGX 10,000 (€2.4) per borehole drilled (Expert UG1, 2019; Expert UG2, 2019). This increase in fees is to enable the smooth running of the association given its low membership strength (Expert UG2, 2019). These new fee rates are obviously affordable for members as they unanimously agreed to them (Expert UG1, 2019; Expert UG2, 2019).

Both experts interviewed agreed that the association is transparent to its members. Financial accountability is given during annual general meetings, and executives and board members are easily accessible at any time. The account books are opened to any member of the association. Members have confidence in the association, which has no website at the moment and only makes its financial statements available to members. However, it engages the service of an auditor annually, as stipulated in its constitution (Expert UG1, 2019).

Challenges

A major challenge faced by the association is not having adequate resources to engage in all activities, especially in training and monitoring the quality of water sources (Expert UG1, 2019). The association does not have the membership strength to address the challenge of poor enforcement of laws and guidelines by MWE, and this has allowed some NGOs and districts governments to continue to issue out poor quality contracts (Expert UG2, 2019).

Expert UG1 (2019) mentioned that competition among members is a big challenge, which results in the quotation of low prices. But the association tries to counsel them to avoid this situation. According to Expert UG2 (2019), the association does not get involved because some contractors do not understand how their businesses work, and some have very poor employment conditions. It was concluded that this is not an easy issue to deal with.

Way Forward

Both experts mentioned that as an association, it would like to increase its membership strength. In addition, Expert UG2 (2019) noted that it would like the association to have a say in policies to be developed by the government as these improvements could attract more external support.

In the drilling sector in general, existing laws are not well implemented, but an effort is being made to ensure their implementation. New laws are also being drafted (Expert UG1, 2019). Expert UG2 (2019) believes that the sector will improve if there is a strong collaboration between the association and the MWE. This will increase membership strength, improvement of existing drilling implementation guidelines of contract as proposed by RWSN and enforcement of standards, including penalising poor job performances. There is need to sensitise donors agencies on some of the recommendations from RWSN publications on the effective use of limited resources on water projects.

Key Findings

The key findings from Uganda are summarised as follows:

1. There are capacity weaknesses at the level of drillers and at the institutional level. This is evident in the lack of capacity to conduct siting, the use of turnkey contracts (No water no pay principle) and inaccurate technical specification in bidding documents.
2. There is a lack of coordination of effort between civil society organisations and local government on water well drilling projects.
3. There is a lack of diversification of skills of members in the drillers association of Uganda, as its members currently consist only of contractors.
4. Unrealistic prices in bidding document, corruption in procurement process and high competition among drillers
5. There is need to sensitise drillers to become members of the association, and there are no members below the age of 35. There is also little representation of women in the sector.
6. Though the association audits its financial records annually, these records are not in the public domain. They are only assessed by members and it could be concluded that this is currently transparent.

Uganda's population relies mainly on groundwater, with 72% of the population using a groundwater point source. The private sector, in the form of a re-established drilling contractors association, is actively collaborating with the Ministry of Water and Environment to try and improve coordination, address key issues and find ways of ensuring the quality of drilling works.

United States of America

Country Context

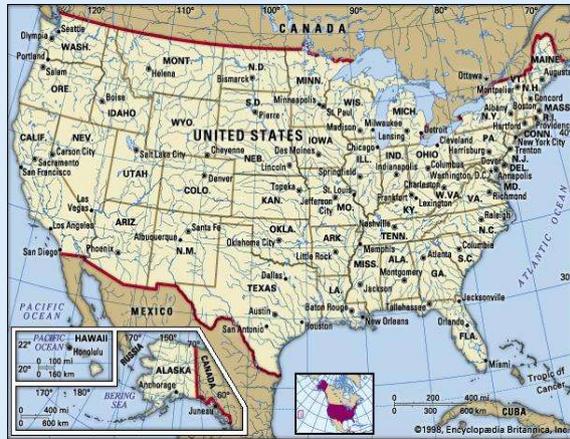


Figure 11: Map of the United States of America and country context (Encyclopaedia Britannica, 2018.b)

Key Facts

| | |
|----------------------|--|
| Area | 9,857,306 km ² (US Census Bureau, 2010) |
| Population | 320 million (UNDESA, 2017) |
| Rainfall | Annual range from 241 mm –1,618 mm (Current Results, n.d.) |
| Geology | Precambrian rocks predominantly covered by sedimentary and volcanic rocks (Sims P. et al., 2008). |
| Groundwater Reliance | 38% of the population depend on groundwater from either public sources or private wells (NGWA, 2019). 43 million Americans depend on private wells for drinking water (EPA, 2019). |
| Government Structure | Federal State – 50 states (USAGov, 2019). |

Groundwater Use

Water well drilling is a very important industry for the economy of the United States of America (U.S.) but this varies across the country (Meyer and Wyrick, 1996). Data available on groundwater use in the USA is quite different from that for the other five case study countries. Dieter *et al.* (2018) show estimate the change in the use of various water sources in the United States from 1950 to 2015 (Figure 12a). The trend shows that the country relies mostly on surface water in its different activities. There was a marked increase in the volume of groundwater abstracted up to the mid-1970s.

Figure 12a shows that the use of groundwater between 2010 and 2015 increased by 8.3%, while surface water use declined by 13.9%. The increase is due to the 2% increase in irrigation and 1% increase in mining, and a decrease in surface water is due to the decrease in the use of thermoelectric power supply (Dieter et al. 2018).

Figure 12b shows that the dominant use of water is for irrigation (37%), followed by public supply. Self-supply industrial and self-supply domestic account for 5% and 1% of water use respectively. The U.S. Department of Agriculture, Farm and Ranch Irrigation Survey 2013, and Dieter C. A., et al. (2018) report on 2015 water use confirmed that irrigation accounts for the highest percentage of groundwater use in the country.

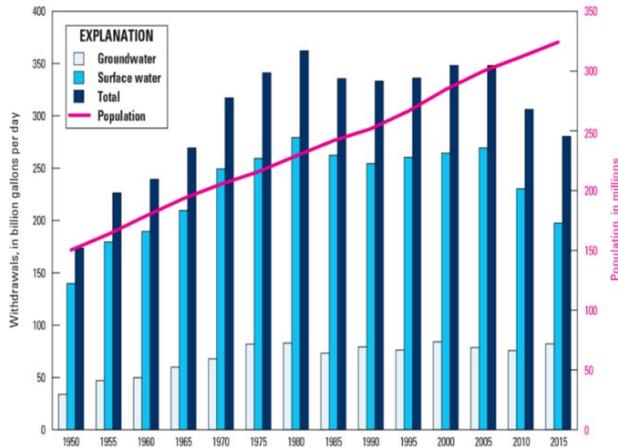


Figure 12a: Water Use Trend in the United States from 1950 to 2015 (Dieter C.A., et. 2018)

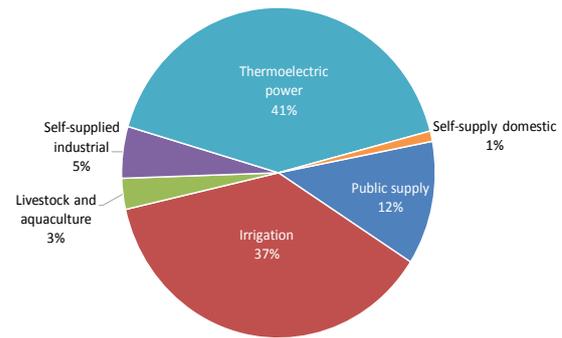


Figure 12b: Water use category in the United States (Dieter C.A., et. 2018)

Institutional Framework

At the national level, The Safe Water Drinking Act of 1974 is the major guiding document for safeguarding drinking water in the country (CDC, 2009a). Under this Act, the Environmental Protection Agency (EPA) is mandated with the responsibility to set and enforce appropriate drinking water regulations and standards. The EPA has ten regional offices across the country, with each office responsible for several states, territories or special environmental programmes (US EPA, n.d. c). The Office of Water is an organ of the EPA that ensures the safety of drinking water and restores and maintains oceans, watersheds and the wellbeing of its aquatic ecosystems. This function is carried out in order to protect human health, support economic and recreational activities and provide healthy habitat for fish, plants and wildlife (US EPA, n.d.a). The National Drinking Water Advisory Council was established under the Safe Water Drinking Act of 1974 to give advice and recommendations to the EPA on national water programmes (US EPA, n. d. b).

The Office of Ground Water and Drinking Water (OGWD) is one of five organisations under the Office of Water (OW). It oversees the implementation of the Safe Water Drinking Act and protects public health by ensuring the safety of drinking water and the protection of groundwater. It works together with the states, tribes⁴³ and partners and also provides the public with information on drinking water quality (US EPA, n.d.a). The Office of Ground Water and Drinking Water manages programmes and projects including Drinking Water Contaminants, Drinking Water Basics, Drinking Water Standards, Public Drinking Water Systems, Small Public Drinking Water Systems, Source Water Protection, Sustainable Infrastructure, Underground Injection Control, Water Security and Private Drinking Water Wells.

Within the states, laws made at the federal level are enforced and implemented. The EPA, through its implementing arm, is responsible for enforcing laws at state levels. States are empowered to establish laws tailored towards local realities and according to stakeholders' interests. The state by state approach is found to have many advantages and has encouraged interventions that are safe and reliable (Maya, 2018).

Organised local communities, tribes and private individuals are in regular partnerships with the states and federal institution to implement water regulations in the country. According to the EPA (2018) in its 2018-2020 strategic plan, one of its goals is to *"restore power to the states through cooperative federalism and work in partnership with states, tribes, territories, and local communities"*.

⁴³ Existent Native American historical clans or groups.

To effectively regulate and serve the 43 million Americans that depend on private wells for drinking water, strong communication and engagement platforms have been put in place. This includes the **'Private Drinking Water Wells'** platform⁴⁴ hosted by the Office of Ground Water and Drinking Water. The platform encourages private well owners to be part of the well owners association, and gives information on how they can effectively manage and maintain their wells with a guide manual called **'The Well Owner's Manual'** (Water System Council, 2015). The 32-page document provides details of all that there is to know before, during and after water well construction, including how to get a qualified professional well driller to handle all issues related to a well. It also provides other valuable information, such as free private well training, info sheets and resources.

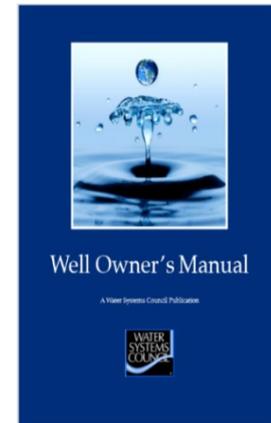


Figure 13: Well Owner's Manual

Borehole Drilling in the U.S.

In the U.S., water well drilling started in 1808 with the use of a standard cable-tool drilling rig. In 1820, the first water well professional, Levi Disbrow, drilled the first artesian well in Charleston, South Carolina. The first successful auger bored well was not completed until after 1825 in the same city. Well jetting was invented in 1884 and was used through the end of the century (Carlston, 1943). The water well drilling industry in the U.S. has grown over the decades and is an important industry for the economy of the country, with some variation in the regions. These variations are due to changes in economy, development, population, irrigation practice and natural phenomena such as earthquakes and droughts (Meyer and Wyrick, 1996). Based on the estimated membership of the National Ground Water Association (NGWA), there are probably 5,000 to 6,000 drilling contractors operating in the country (Expert US1, 2019; Expert US2, 2019).

Drilling methods adopted in the country include rotary, cable tool, direct push, sonic, coring, reverse circulation and percussion (Expert US1, 2019; Expert US2, 2019). Manual drilling is virtually non-existent in the U.S. (Expert US1, 2019). According to the two experts interviewed, drillers comply with the EPA's regulations, which primarily focus on pollution laws as well as drilling on contaminated sites under federal jurisdiction. Additional laws regarding water well drilling are mostly done at the state level, and they are usually more stringent. Other federal laws affecting drilling firms are related to workers' safety [Occupational Safety and Health Administration (OSHA)]⁴⁵ and the need to have a commercial driver's license in order to drive vehicles with heavy drilling equipment (Expert US1, 2019).

The licencing and registration of drilling companies is done by the state government (Expert US1, 2019; Expert US2, 2019). About 16 states use National Groundwater Association (NGWA) certification exams for licencing purposes. Other states have their own exams or process (Expert US1, 2019).

The licencing and certification of consultants is done by only few states in the country. The most common designations of a consultant status are Professional Geologist and Professional Engineer, and there is often tension between the two of them. Some states have special designations for a hydrogeologist or contaminated site clean-up oversight. In the United States, the quality of work done determines your reputation irrespective of whether you are a licensed consultant or not (Expert US1, 2019).

Certification is voluntary and is administered by the NGWA. Individuals are certified, not firms. Voluntary certification requires passing a general examination on drilling knowledge, and then passing at least one out of the two specialty exams⁴⁶. If an individual wishes to take the two specialty exams, he/she is eligible to sit for the examination to become a Master Ground Water Contractor –there are

⁴⁴ <https://www.epa.gov/privatewells>

⁴⁵ <https://www.osha.gov/laws-regs/regulations/standardnumber/1910>

⁴⁶ Rotary drilling, or cable tool (percussion) drilling.

fewer than 100 in the country. To renew one's certification, it is important to pass at least seven units of courses of continuing education annually. Failure to recertify (pay fee and demonstrate evidence of continuing education) would result in loss of certification status. A voluntary certification boosts one's personal profile in the drilling sector (Expert US1, 2019).

The challenges faced by drillers in the United States are unique since the groundwater sector is well regulated and with standard procedures. According to Hix (2018), a driller and former water well contractor, the challenges include the housing economy, environmental regulations and climatic change. Hix (2018) advised water well drillers who want to remain in the business to be diverse, modernise their trade and update themselves on latest trends in the market. The decreased demand for new well systems, regulation (typically those related to worker safety and movement of heavy equipment on highways) and increased management of groundwater withdrawals are additional challenges faced by drillers in the country. The changing market means drillers have to diversify their skills. As a driller, having a knowledge of repair and service work is very important, and there is need to understand how to be better business persons in order remain in business (Expert US1, 2019). According to Expert US2 (2019), the continually changing regulations by the state and federal governments, increased pricing of insurance, materials (due to tariffs) higher fuel pricing and increased competition due to new companies who don't understand costs are other challenges faced by drillers in the country. Challenges have been summarised in the table below.

Table 6: Challenges of drillers in the United States and from interviews (Hix, 2018)

| Type of Challenge | Description from Literature | Description from Interviews |
|------------------------------------|---|--|
| Capacity | There is need for drillers to update their skills because of the following changes in the country: <ul style="list-style-type: none"> ● housing economy ● environmental regulations climatic change | <ul style="list-style-type: none"> ● changing market ● diversification of skills ● increased competition by new companies ● changing regulations ● decreased demand for new well systems ● increased management of groundwater withdrawals |
| Contracts & standards | - | - |
| Procurement | ⁴⁷ | - |
| Finance/ Payment | - | <ul style="list-style-type: none"> ● increased insurance price ● increased prices of drilling materials ● increased fuel prices |
| Corruption | - | - |
| Data | - | - |
| Logistics | - | - |
| Availability of Spare Parts | - | - |

⁴⁷ Not available

Drillers Associations in U.S. – The National Groundwater Association (NGWA)

History

The National Ground Water Association (NGWA) USA has been in existence since 1948 and has a range of diverse professionals such as contractors, scientists and engineers, manufacturers and suppliers (NGWA, 2018). It started in Illinois⁴⁸ as the National Water Well Association and later moved to Ohio where it is currently located (Expert US2, 2019). NGWA was formed mainly to help US drilling contractors have a stronger national exchange of information, but also to help find ways to increase the amount of tubular steel for well casing following World War II (Expert US1, 2019). The association is in affiliation with 38 organisation and has a memorandum of understanding with domestic and international bodies (Mcgray, 2014). Expert US1 (2019) states that the NGWA has over 6,000 members (, 2019), but according to Expert US2 (2019), membership is about 5,000.

Membership

At the national level, membership is open to any water well contracting business willing to pay its annual dues (Expert US1, 2019). NGWA has maintained affiliation status with more than 40 state associations (though not all states have associations). This is most likely because the states valued NGWA being an advocate for water well construction and their firms. NGWA collaborates with other already existing associations in the states (Expert US1, 2019).

However, Expert US2 (2019) explained that there are some states associations that choose not to have a relationship with the NGWA and operate on their own with success. Also, other state associations feel NGWA takes members away from them, but Expert US2 (2019) does not believe this to be the case as the data usually show that a majority of NGWA members also belong to their state associations without any added cost. There are only a few NGWA members who don't belong to both national and state associations. According to Expert US2 (2019), there are drillers who choose not to be part of the association but do participate in the continuing education event it organises. In this case, they have to pay higher participation fees.

Less than 30% of the NGWA members are below 35 years and less than 5% are females (Expert US1, 2019; Expert US2, 2019).

Activities

As part of its activities at the national level, NGWA:

- engages in advocacy, publication of newsletters, publication of journals,
- hosts and has a platform dedicated to citizen's sensitisation⁴⁹
- has a foundation dedicated to the awards scholarships
- provides opportunities for learning and sharing
- does certification
- raises general public awareness
- does lobbying (Expert US1, 2019)
- provides continuing education to contractors
- serves as an interface between the government and the general public in terms of groundwater protection (Expert US2, 2019)

Contact details of professionals can be found on the association's website⁵⁰ as well as at the local levels (Water Systems Council, 2015).

⁴⁸ Illinois state association started in the 1920's (Expert US2, 2019)

⁴⁹ <https://www.epa.gov/privatewells>

⁵⁰ <https://www.ngwa.org/>

Although the association supports data collection, this activity is usually carried out by federal agencies such as the U.S. Geological Survey and the U.S. EPA. Data collection is done in coordination with various state agencies, such as the state geological survey, a state's natural resources department, and a state's water agency. Data sets collected are gathered from different sectors, e.g. irrigation and household wells (Expert US1, 2019). Data is collected mostly when a new well is constructed and filled on the well completion form (Expert US2, 2019). However, there is the challenge in unifying terminologies within the country (Expert US1, 2019).

Benefits/ Achievements

Members have benefitted immensely from learning and sharing. As members of the association, contractors benefit from:

- access to continued education at a lower rate
- access to reduced insurance rates through member companies
- having a voice in the industry, sharing of knowledge and techniques, and being part of a platform that advocates for the profession (Expert US1, 2019; Expert US2, 2019)

To keep members motivated and remain members, the association makes efforts to support members develop their businesses. For example a financial tool was developed to help members effectively manage their businesses (Expert US1, 2019). Unfortunately, drillers only get involved in NGWA when there is crisis in the industry that has negatively affected their businesses (Expert US2, 2019).

The existence of NGWA for over six decades is considered an achievement. NGWA has made water well construction a recognised profession in the country, and it has developed a manual of water well construction and other educational tools (Expert US1, 2019). In addition, it has created financial management tools to help firms remain in business and become profitable (Expert US1, 2019). At the state level, the association has created continued education for the state license programme (Illinois State) and lobbied for the passing of legislation for the licensing of water well and pump installation and also, recently, geothermal installation regulations (Expert US2, 2019).

Finance and Sustainability

On finance and sustainability of the association, it raises funds from membership dues, events (annual conference and trade show), publishing (print and digital) and education/training (Expert US1, 2019; Expert US2, 2019). In addition, the association has received funding in terms of royalties paid over the years from various affinity relationships significantly from insurance programmes through a licensed insurance agency operated by the association. Also, starting in the early 1970's, NGWA has been contracted by the government and development association for the completion of various contracts related to water wells or groundwater protection (Expert US1, 2019). At the state level, the association has received grants from the U.S. Environmental Protection Agency (EPA) and the National Ground Water Association to assist on specific projects (Expert US2, 2019).

At the national level, an amount of USD 375 is paid annually as a subscription fee by water well companies, not individuals (Expert US1, 2019). A due of USD 225 dollars is paid annually for a company membership at the state level (Expert US2, 2019). According to Expert US2 (2019), dues are affordable compared to other professional industries and the prices of materials and equipment needed in the industry.

On transparency and accountability of the association, prior to 1995, it is believed that NGWA was less transparent to its members. However, from 1979 on, the leadership demonstrated more willingness to share information, e.g. annual reports, financial reports than in the past. Reports are published (including financial reports) on the organisation's website and also sent to the federal tax authorities, which are all in the public domain⁵¹. Also, leaders try as much as possible to be more accessible than before (Expert US1, 2019). At the state level, the association provides annual update to its members at the yearly meetings and to any member who requests to see the financial reports, but these are not in

⁵¹ <https://www.guidestar.org/profile/31-0961448>

the public domain. However, it has audited its account a few times over the past 20 years, especially before a change of leadership (Expert US2, 2019).

The experts attribute one of the successes of the association's ability to exist for so long as having full-time paid professional staff on the ground.

Challenges

The major challenge faced by the association is staying up to date on what it does for the industry each year (Expert US1, 2019). Also, there is the aging population of its members and a lack of interest by younger generations of family businesses to continue in the trade. A huge void of skilled workers in the industry is envisaged in the next 10-15 years as older workers retire (Expert US2, 2019).

When there is competition between members, the association does not interfere but tries to seek a level playing field for all where possible. However, the association is at the forefront in facilitating cooperation between members. Members help each other out by subletting services and equipment that they do not have expertise on. Also, they share techniques that have worked for them (Expert US1, 2019). Expert US2 (2019) added that the association does not interfere with competition between its members as it would show favouritism for one member over the other and this is not good for the body. Members do not expect the association to get involved in their businesses either. Hence, if a member is having an issue with another member in terms of competition, it is usually handled at the local level with the state's health department as this means that a company is likely cutting corners and doing something against the construction codes.

Way forward

The association would like to see more people become interested to be members and younger generations step into the leadership roles. There is need for qualified individuals to serve on committees and within the board positions to lead the association as the quality of leaders on the board has dropped over the last few years (Expert US2, 2019).

Key Findings

The following are findings from the United States of America

1. The U.S. has frameworks and regulations for groundwater and an agency (the Environmental Protection Agency) responsible for enforcing rules and adherence.
2. There is a strong presence of the implementing agency (EPA) at the state levels, ensuring adherence and, in most cases, empowering the states to make regulations according to local context.
3. National institutions and states work in collaboration with organised bodies on water issues.
4. Citizens, especially well owners, are well sensitised about their water well and on the need to use professionals for maintenance.
5. The National Groundwater Association (NGWA) has a strong presence at the state level, and members can be part of both national and state bodies without any added cost.
6. The association at the national level is transparent –it publishes its activity and financial report in the public domain. Although the state association interviewed does not publish in the public domain, it ensures transparency by auditing its account before a change of leadership.
7. There are few women in the sector, and a generation gap of experts in the country has been identified to be threatening the future of the water well drilling sector in the country.

The United States relies on two major water sources – surface and ground water. Its reliance on groundwater is relatively low compared to its reliance on surface water. However, data shows a slight increase between 2010 and 2015 stemming from its reliance in the irrigation sector.

Synthesis of Key Findings

This study shows highlights eight overarching challenges facing drillers – (i) lack of capacity in the drilling industry, (ii) inappropriate contracts and standards, (iii) lack of transparency in the procurement process, (iv) finance resulting from unrealistic pricing and delayed payment by the government, (v) corruption in the bidding process, (vi) lack of data, (vii) logistics (long distances between contract locations) and (viii) the non-availability of quality spare parts, which is common to five countries (Angola, Burkina Faso, Mozambique, Nigeria and Uganda)

A lack of capacity of drillers and by institutions levels to implement policies is observed to be a major challenge in five (Angola, Burkina Faso, Mozambique, Nigeria and Uganda) out of the six countries of study. In addition, lack of funding for water well monitoring and little awareness of the contribution of groundwater to livelihood are evident in all countries of study except the U.S. Therefore, there is an urgent need to deepen the knowledge of all stakeholders in the sector.

The non-payment of drillers for dry boreholes is common practice in four countries (Burkina Faso, Mozambique, Nigeria and Uganda), with the driller held responsible for the success or failure of drilling water well. In Angola, there is no defined rule for negative boreholes, but rather a so-called gentleman's agreement is used whereby 50% of the total amount is paid to the driller or the driller makes up for it by drilling a second or third borehole. There was no clear definition of this term in Nigeria. There was no mention of "Turnkey contracts" in the United States of America from literature and from interviews.

The absence of hydrogeological data is found to be a huge challenge in four (Angola, Burkina Faso, Mozambique, and Nigeria) out of the six countries. This leads to underestimation of drilling a water well in difficult hydrogeological terrains. Hence drillers bear all the responsibilities of uncertainty which in turns lead to the delivery of low quality jobs. In addition there is the challenge of using a single pricing system for all wells irrespective of the hydrogeological terrain.

The issue of delayed payment is mentioned in four (Angola, Burkina Faso, Mozambique, and Uganda) out of the six countries of study. These happen to be in the same countries whose clients are majorly the government.

Only three out of the six countries of study have associations that are confirmed to be active and currently operating (Nigeria, Uganda and the U.S.), while two countries have associations which seem to be dormant (Burkina Faso and Mozambique) and an informal group exists in Angola.

It is observed that common challenges faced by all associations include:

- Firstly, a lack of interest of non-members to be part of the association. In some cases, such drillers do not see the need of an association, while others feel there is no benefit. Also, there are no incentives among some of these associations to keep members motivated.
- Secondly, the problem of sustainability. It is either that there is a lack of finance due to low membership strength, a lack of support from development agencies, or no dedicated professional to run the affairs of the association. Further, a new generation of experts in the field to keep the association running and active are lacking.
- Thirdly, a lack of transparency in cases where association exist and are active (except the United States). Most of the active associations do not have the means to engage the services of an external auditor and do not publish their financial report in the public domain.
- Lastly, lack of continuous capacity building of members in all countries except the United States. A non-systematic approach to training and retraining has led to drillers' inability to meet up with emerging issues and may have contributed to the inability to pass knowledge from one generation to the next.

As added value to this research, an inclusion perspective was also taken into consideration. It was found that there are few women in the water well drilling sector despite the fact that they are the ones who bear the burden of lack of access to water. Also, there is a generation gap of experts in the water well drilling sector. This helps us understand clearly that the challenge facing the groundwater component of the water sector is indeed in need of urgent attention.

Conclusions and Recommendations

There is no doubt that if the water goal of the SDGs is to be taken seriously, groundwater has a huge role to play. The presence of water well driller's associations can play an instrumental role in the sustainable groundwater development of a country. They can create a platform to engage with national government and other relevant stakeholders in the sector in an organised manner and help to easily identify challenges, including advocating for the water well drilling sector. Associations can also help to influence unrealistic national government policies on groundwater, support and organise systematic capacity building programmes for drillers, support the adoption of the latest technologies in the sector, collaborate with experts in related fields, set realistic prices for water well drilling and help to tackle emerging challenges in the water well drilling sector.

With a wealth of information about the drilling landscape of a country, they can actively support the collection of the much needed data (especially in Africa). Drillers associations could serve as a strategic entry point for development partners and other stakeholders. Hence, the absence of a water well drillers association, its inactiveness and/or lack of proper organisational structure means that major stakeholders in the water well drilling sector are being neglected. Neglecting a drillers association is intervening in a non - holistic approach. Lack of an active association further means there will be no organised platform to advocate for the sector, especially with those in direct contact with the resource, sensitise stakeholders and collaborate with policy-makers and influence policies, engage with citizens (users) and support drillers to sustainably engage in the trade.

Based on findings from the study, recommendations to support the sustainable management of groundwater resources have been grouped into short and long term recommendations.

Short term

- Further investigate the drillers associations in other countries around the world.
- Prioritise the establishment of an association where there is none and rekindle non-active ones.
- Build the technical and managerial capacity of water well drillers and put in place a sustainable platform for continuous professional development.
- Sensitise and strengthen the capacity of national institutions on the importance of groundwater in order to help to bring groundwater issues to the fore.
- Develop a school curriculum for primary and secondary students on groundwater related topics and advocate for compulsory internships for undergraduate students in water related fields.
- Create a global platform of young professionals with the objective to deepen the understanding, create awareness and increase interests of youth from different countries on groundwater issues. Also, create re-orientation courses where possible.

Long term

- Create a global platform for drillers, experts and institutions working on groundwater water issues in collaboration with existing institutions to learn and share best practices.
- Engage in study and exchange programmes, including creating mechanisms for internships and volunteering.

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Annex 1 Question Guide

A. Please introduce yourself

| |
|---|
| Name (include title) |
| Contact detail |
| Area of specialisation/ Sector of work |
| Role and activities in borehole drilling in the country |
| Sex |

B. Recap a little about what you know about the Drilling and the Drillers Association in the country – (please keep very short)

1. History and Set-up

| |
|--|
| Why and how was the organisation started? |
| When was it started? |
| Who are the members (researchers, contractors, drillers, government representatives)? |
| Please give name, website, Facebook, email, phone number and contact person for your country's drillers association. |
| Is the organisation recognised by the government? If YES, How? |

2. Borehole Drilling in the Country

| |
|--|
| What is the current estimated number of drillers in the country? |
| Who are the organised drillers? Are they the same as registered members of the drillers association? |
| Are there Artisan drillers in the country? If YES, are they organised? |
| What is the difference between an artisan driller and a manual driller in the country? |
| Do citizens have groundwater awareness in the country? |

3. Membership

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| How does one become a member of the association? |
| Are manual drillers' part of or members of the drillers association? If NO, are there plans to include them? |
| Are artisan drillers' part of the association? If NO, are there plans to include them? |
| Are there members below age 35 in the association? |
| Do you have female members? |
| Are there drillers who could be part of the association and are not? If YES/NO, why? |

4. Activities (Please fill where applicable)

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| Are there certified consultants/supervisors for groundwater exploration in the country? If YES, how are they certified? If NO, why? |
| Who is responsible for the certification of drilling companies? |
| Who is responsible for the accreditation of drilling companies? |
| Who is responsible for the licensing of drilling companies? |
| As an association, do you support the collection of groundwater data? If YES, how? |
| What other activities is the association engaged in? |
| Future planned activities |

5. Benefits/ Achievements

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| What do members stand to gain as members of the association? |
| How do you keep members motivated? i. e. to be active and remain members? |
| What have the achievements of the association been since inception? |

6. Finance/ Sustainability

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| How does the association sustain itself financially? |
| Has the association had the support of external bodies (present or past)? If YES, who? And how was it supported? |
| What subscription fees are charged (amount and frequency)? |
| Do members pay these fees? |
| Do you think fees and dues are affordable by members? |
| Do you collect well drilling site fees? If YES, what is the money used for? How do you ensure effective collection of these fees? |
| Does the association have the support of the government and stakeholders? If yes, How? (give an example) If No, what are your strategies to ensure support from stakeholders? |
| In your opinion, do you think the association is transparent and accountable to its members? |

7. Challenges

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| What are the major challenges faced by drillers in the country? |
| What are the major challenges faced by the association? |
| Is there competition among drillers? If YES, how does the association handle it? |
| Where and how would you like to improve as an association? |
| Do you think the recommendations for cost effective borehole drilling been taken forward in the country? |

Other remarks: