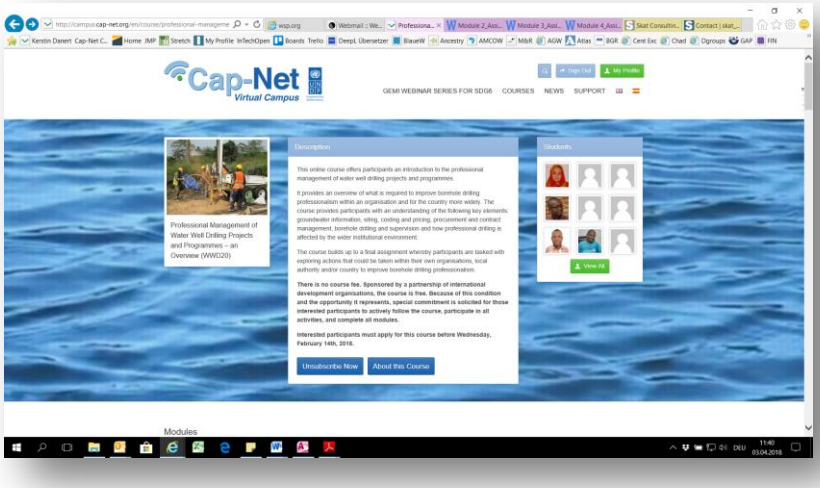
Professional Management of Water Well Drilling Projects and Programmes Online Course 2018

Report for Course Participants



UNICEF-Skat Foundation Collaboration 2017-2019

"Drilling supervision is like the belt that holds a good pair of trousers on place at the waist, without which one will not be confident in walking about and being productive"
Mumuni Kere Osman, UNICEF, Ghana.

"These are very relevant modules and trainings that all government agencies involved in drilling should take",
Course Evaluation Respondent

"As a facilitator I have learnt a lot from the forum discussions and assignment submissions by the participants. It is like being on a voyage of discovery, wondering where the assignment I am about to open is from, Nepal or Sierra Leone or Saudi Arabia, and yet to read it and find something similar to other countries."
Dotun Adekile, Course Facilitator, Nigeria

Prepared by Dr Kerstin Danert and Stephanie Theis
25th July 2018

This document reports on the online course on professional management of water well drilling projects and programmes that took place in early 2018 as part of the Project Collaboration Agreement (PCA) 2017-2019 between UNICEF and Skat Foundation. Developing and running the course was made possible with financial support from UNICEF, Skat Foundation and UPGro and in-kind support from UNICEF Madagascar.

A separate, internal report documents the recommended amendments to the course for future editions.

The course materials are available for everyone who registers a username at the Cap-Net Virtual Campus, on: http://campus.cap-net.org/en/course/professional-management-of-water-well-drilling-projects-and-programmes-an-overview-wwd20/

If you are interested in future courses, or would like to co-sponsor a course, please contact foundation@skat.ch

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Abbreviations

BoQ Bill of Quantities

CoC Code of Conduct

CoP Code of Practice

DHS Demographic and Health Survey

JMP Joint Monitoring Programme

MICS Multiple Indicator Cluster Survey

NSPMS National Social Protection Monitoring Survey (Yemen)

PCA Project Collaboration Agreement

RWSN Rural Water Supply Network

ToR Terms of Reference

UNDP United Nations Development Program

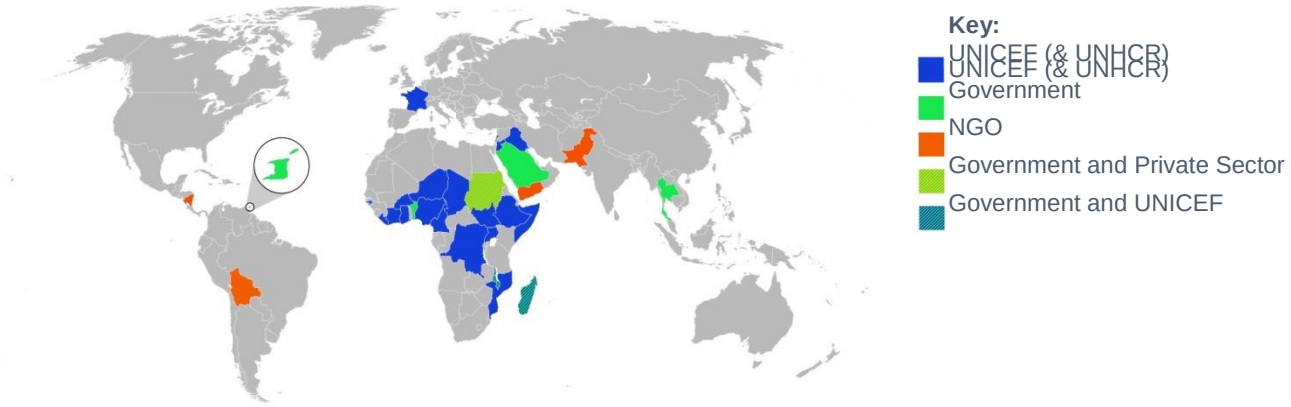
WHO World Health Organisation

Summary

The first online course on the **professional management of water well drilling projects and programmes** provided the opportunity for 84 participants from 43 countries to improve their skills and knowledge, as well as learn from each other. The course comprised five modules, covering groundwater information and siting; costing and pricing; procurement and contract management; borehole drilling and supervision; institutional frameworks and dialogue and action to raise drilling professionalism. The course was hosted by UNDP Cap-Net on their Virtual Campus, an online learning platform. Participants were provided with a combination of reading materials, videos and presentations for each module.

Of the 84 people who started the course, 86% participated actively, and 51% (44 no.) passed the course and were awarded certificates. Of those that passed, 29 are UNICEF staff. The pass rate and active participation rate is higher than the 2017 average for Cap-Net (41% and 59% respectively).

Location and type of organisation of successful participants



The evaluation survey found that 96% of the respondents found the course to be extremely or very relevant. The course exceeded, and completely met the expectation of 33% and 57% of the respondents respectively. This reflects particularly well on the participant selection process. 90% of the respondents rated the course as excellent or very good. Respondents to the survey rated that their knowledge on the topics had increased across all course modules.

Quote from evaluation: In my experience the course was ***"Extremely beneficial and helpful to me and by extensions my organisation. After each module came out, I sat down with my boss and discussed how we could incorporate the different principles that [were] learnt into our daily activities. The information was well received by my superiors."***

Three types of activities (i.e. quizzes/questionnaire, discussion forums and written assignments) enabled participants to engage in depth with the subject matter, reflect on their own experiences and consider the effectiveness of policies and practices within their own organisations and more widely in the country (or state) in which they work. Participation in these activities was excellent, with 72% of the participants who passed completing at least ten of the 15 activities.

A total of 37 participants passed the final assignment which included interviewing stakeholders and defining actions that (i) they themselves would like to undertake to improve drilling professionalism in their organisation or country and (ii) that the organisation that they work with should undertake.

The facilitation by Cap-Net guided the participants through the course through regular communication (by email). A team of five experienced professionals from Switzerland, Nigeria, Senegal, Madagascar and Kenya responded to the participants on the discussion forums and marked the assignments for each module, providing individual feedback. ***"I was carried away by the flow of exchanges that made me visit almost every aspect of a drilling project. It was like an endless trip, because I never knew what to expect when I opened a message from the forum or read a homework assignment. I had the impression to review worldwide drilling issues from my chair in Madagascar"*** *Charles Serele, UNICEF Madagascar.*

The separation of technical support, content facilitation and organisational support enabled the team running the course to focus on their roles. The content of the modules and flow of topics worked very well and do not need to be changed for a subsequent course. Participants responded well to the discussion forums for all modules, raising pertinent issues, sharing experiences, as well as relevant reports or guidelines and asking questions. There was a logical flow between the modules, with participants often raising issues that the course covered in subsequent modules (particularly in relation to the institutional framework.

A number of improvements can be made to the course. Better signposting of the materials should be given in the form of an orientation presentation (slides) for each module. Mechanisms to prevent corruption should feature more strongly in future courses and some minor improvements should be made to some of the discussion forum questions and assignments. Additional materials on issues that were raised by the participants but not covered, or not sufficiently detailed (e.g. community support to supervision, contents of a groundwater database) could also be added. There is no need to amend the quizzes.

A wealth of information was shared through both the discussion forums and assignments and has been synthesised in this report. Collating information on specific countries, and frequently faced challenges contributes to the work required to better document policies and practices with respect to professional drilling. The rich tapestry of insights shared by course participants highlight the need for continuing efforts globally and locally to raise professional drilling, and drilling management capacity. It is hoped that this will incentivise RWSN partners such as UNICEF and others to ramp up and institutionalise efforts to improve borehole drilling professionalism worldwide. **The experience of this online course highlights the tremendous need for capacity strengthening with respect to borehole drilling professionalism in order to meet the sustainable development goal target for drinking water.**

The online course provided not just an opportunity to train the participants, but also to learn from them; and about realities faced and good practices. The submissions by the participants provided a unique opportunity to collate information on the prevalence of groundwater databases and groundwater mapping initiatives; drilling associations; regulations, manuals and guidelines and concerns about groundwater, including salinity. Insightful short stories about siting, supervision and payment have also been captured.

There is considerable demand to run this course again. Of the 648 applications received from potential candidates, only 84 (13%) could be accepted onto the course due to budget limitations for facilitation. Given the high interest and tremendous success of the course it is hoped that it can be repeated, perhaps on an annual basis. The lion's share of the work (and cost) to prepare, and review this online course has been done!

1. Background

Developing sustainable water services that rely on boreholes is a highly skilled endeavour. To be effective, organisations need to ensure that their staff and partners manage contracts, site boreholes and drill in a professional manner, ideally in the context of a supportive enabling environment. In many countries, appropriate policies, regulation and capacity to oversee implementation are inappropriate, compromising sustainable access to water.

Figure 1 UNICEF Guidance Note Published as part of 2015 - 2017 UNICEF-Skat Foundation PCA

This document reports on the online course on professional management of water well drilling projects and programmes that took place in 2018 as part of the Project Collaboration Agreement (PCA) 2017-2019 between UNICEF and Skat Foundation. The course development was financed through the aforementioned PCA. Facilitation was financed through the PCA, as well as through in-kind support from UNICEF Madagascar and financial support from UPGro[1].

Chapter 2 provides an overview of the course. The activities undertaken, as set out in the results framework, are described in chapter 3. Chapter 4 summarises the participation in the course and level of engagement. The feedback from the participants from the course evaluation is summarised in chapter 5. Chapter 6 sets out reflections on, and lessons learned from the course, including experiences of borehole drilling management by the participants, and recommended future courses. Chapter 7 provides a synopsis of opportunities and issues raised on the subject of professional management of borehole drilling by the course participants.

Box 1 UNICEF Skat Foundation collaboration on cost-effective boreholes

The cooperation on cost-effective boreholes between UNICEF and Skat Foundation from 2015 and 2017 culminated with the publication of a UNICEF Guidance Note on Professional Water Well Drilling (Figure 1) which consolidates over a decade of experiences and publications into an easy-to-use manual for UNICEF staff and partners.

Additionally, a training course in Zambia triggered interest in systematically strengthening the capacity of the drilling sector in the country; in-country support to the Democratic Republic of Congo helped to strengthen on-going efforts to introduce, and raise professionalism of manual drilling and engagement with UNICEF Angola has laid the foundation for subsequent training within a new vocational training institution. Support to a study in Burkina Faso has helped to improve understanding of drilling technology options in different parts of the country and to see where the main strengths and gaps of the drilling sector are. Dialogue and remote support to 16 countries continued to highlight the importance of drilling professionalism as well as find practical solutions to pertinent problems for each specific context.

The emphasis of the 2017-2019 UNICEF–Skat Foundation PCA is strengthening UNICEF and partner capacity to raise water well drilling professionalism. The PCA emphasises learning, particularly with respect to approaches that can be shared between countries, and potentially taken to scale. It builds on collaboration between UNICEF Programme Division and Supply Division to develop a UNICEF Toolkit for the Planning, Contracting and Management of Borehole Drilling, supported by from Skat Foundation. The PCA also strengthens existing online communities by building linkages around similar areas of interest.

[1] Unlocking the Potential of Groundwater for the Poor (UPGro), is a seven-year international research programme (2013-2020) jointly funded by UK's Department for International Development (DFID), Natural Environment Research Council (NERC) and the Economic and Social Research Council (ESRC). Over 130 researchers from 43 organisations across Africa and Europe are focused on improving the evidence base around groundwater availability and management in Sub-Saharan Africa. For more details see: https://upgro.org/

2. Course Overview

The online course offered participants an introduction to the professional management of water well drilling projects and programmes. It provided an overview of what is required to improve professionalism in the organisations and countries in which they work. The course provided participants an understanding of the following key elements: groundwater information, siting, costing and pricing, procurement and contract management, borehole drilling and supervision and how professional drilling is affected by the wider institutional environment. Throughout the course, the participants were required to reflect on the pros and cons of practices and policies in their own organisation, organisations that they work with and country. Using state-of-the-art materials, i.e. videos, documents, presentations and websites, the course built up to the final assignment whereby participants were tasked with exploring actions that could be taken within their own organisations, local authority and/or country to improve borehole drilling professionalism.

Box 2 Learning objectives of online course

By the end of the course participants will:

- Have a broad understanding of the key elements that constitute a professional water well drilling sector and be able to relate these to the organisation and country in which they work.
- Appreciate the importance of groundwater for drinking water supplies, recognise the value of groundwater data and know what constitutes good borehole siting.
- Be familiar with the cost components of borehole drilling and have improved knowledge to reflect on procurement and contract management within their own organisation/country.
- Understand key reasons for immediate and longer term borehole failure, appreciate the importance of drilling supervision and the responsibilities of the drilling supervisor and the actions to be carried out.
- Understand what constitutes a strong institutional framework (at national or state level) for borehole drilling, including driller licencing, borehole permits and associations.
- Have engaged in dialogue with at least one other actor and defined potential actions that could be taken within their own organisations, local authority and/or country to improve borehole drilling professionalism.
- Have access to and signposts for high quality materials that support further learning with respect to the professional management of borehole drilling projects and programmes.
- Learn about practices, initiatives and challenges to improve drilling professionalism from participants in other countries.

Time requirements - Participants were expected to dedicate a minimum of 6 hours per week to the course plus an additional four hours for the final assignment[2]. This time dedication should have been sufficient to review basic (compulsory) readings and participate in all activities (forums, assignments, multiple choice quizzes). Participants who wished to read additional materials and watch related videos required more time, as did those with no previous knowledge of groundwater or borehole drilling.

Participants - The course targeted 80 participants but 84 took part. Participants should have ideally been involved in the budgeting, planning, procurement, management, implementation, supervision, monitoring of water supply projects or programmes, or be involved in water resources monitoring, regulation or other governance aspects. The course applied to Africa, Latin America, Asia, the Middle East, Pacific and East and Central Europe regions.

Participants could be:

[2] In the course announcement 4 hours per week was stated as a requirement.

- Government ministry, authority and agency employees
- NGOs and civil society organisation management and staff
- donor organisation management and staff
- academics and trainers from relevant institutions
- private, or state run drilling enterprise management and staff
- Independent consultants

The six-week course, comprising five Modules (Figure 2) was designed for those with a technical (i.e. engineering/science) and those with a non-technical (i.e. social science/economics/arts/politics) background. Participants were expected to have a diploma or bachelor's degree qualifications and at preferably at least three years of work experience in water supply service delivery (social or technical aspects), civil engineering, rural development or water/environmental management. As this was an introductory course, participants were not expected to have a detailed understanding of hydrogeology. Additional materials were provided for those not familiar with groundwater or drilling at all, but as noted above, this required additional study time (2-4 hours).

Figure 2 Course modules

3. Development of course, facilitation and promotion

The course content drew considerably on the UNICEF Guidance Note for Professional Drilling (Box 1) and additional materials as recommended by the co-facilitators. Further references to explain the basics of groundwater were added to help participants with a limited technical background of the subject. Videos to welcome, motivate the participants, and introduce them to the topics were recorded for modules 1 and 4 Figure 3 and Figure 13. The facilitators of the course are introduced in Table 1.

Figure 3 Screen Shots of welcome video

Table 1: Course facilitators

Dr. Kerstin Danert, Skat Foundation, Switzerland

Rural water supply specialist, who has undertaken studies, raised awareness and provided capacity strengthening services for mechanised and manual water well drilling. She has developed publications and animated films, and run training courses that provide guidance on borehole siting, costing and pricing, supervision, procurement and contract management, and she has produced guidance for UNICEF on Professional Water Well Drilling.

Dotun Adekile, Independent Consultant, Nigeria

Dotun Adekile is a Nigerian geologist with over 35 years of experience in groundwater development in Africa. He was involved in the development of the RWSN Code of Practice for Cost Effective Boreholes and has authored and contributed to several publications and webinars in support of the Code. In the past three years he has been involved in training and capacity development of WASH personnel in the Cost Effective Borehole process in Nigeria, Sierra Leone, Zambia and Angola.

Prof. Moustapha Diene, Cheikh Anta Diop University, Dakar, Senega; Africa Groundwater Network (AGW-Net) and UPGro Ambassador

Moustapha Diene is hydrogeologist working currently at University Cheikh Anta Diop, Dakar – Senegal. Since January 2015, Dr. Moustapha Diene has taken over as Network Manager of the Africa Groundwater Network (AGW-Net); he has facilitated many training courses on integrated groundwater management in Africa.

Tom Armstrong, J.B. Drilling, Kenya

Mr Armstrong is an international consultant with a master's degree in Civil Engineering and over 30 years of professional practice in Africa and Asia. Tom was elected chair of the Kenya Water Industry Association in mid-2016, chairs the technical committee and is a founding member. He has expertise in all aspects of design and implementation of water engineering projects, and is a groundwater specialist.

Dr. Charles Serele, UNICEF, Madagascar

Charles is a hydrogeologist working for UNICEF Madagascar as a WASH Specialist. He provides technical guidance on water supply projects including mechanized and manual drillings. He develops innovative mapping solutions to improve boreholes siting and reduce the rate of drilling failure. Additionally, Charles delivers capacity building activities to UNICEF WASH staff, government and private sector to strengthen competencies in drilling sustainable and cost effective boreholes.

Damian Indij, Cap-Net UNDP (Course Coordinator), Argentina

Cap-Net´s Virtual Campus Coordinator and Manager of the Latin America Water Education & Training Network (LA-WETnet). Damian has facilitated water-related courses in Latin America, Africa, Asia, and Europe, and participated as team member for the development of various training manuals

Stephanie Theis, Skat Foundation, Switzerland

Development professional with experience in managing projects for marginalized people, with a strong focus on SMEs, gender mainstreaming, capacity building and knowledge management. Stephanie has facilitated workshops, designed and implemented knowledge sharing events and is enthusiastic about innovative ideas and methods which foster the achievement of the SDGs.

Promotion of the course

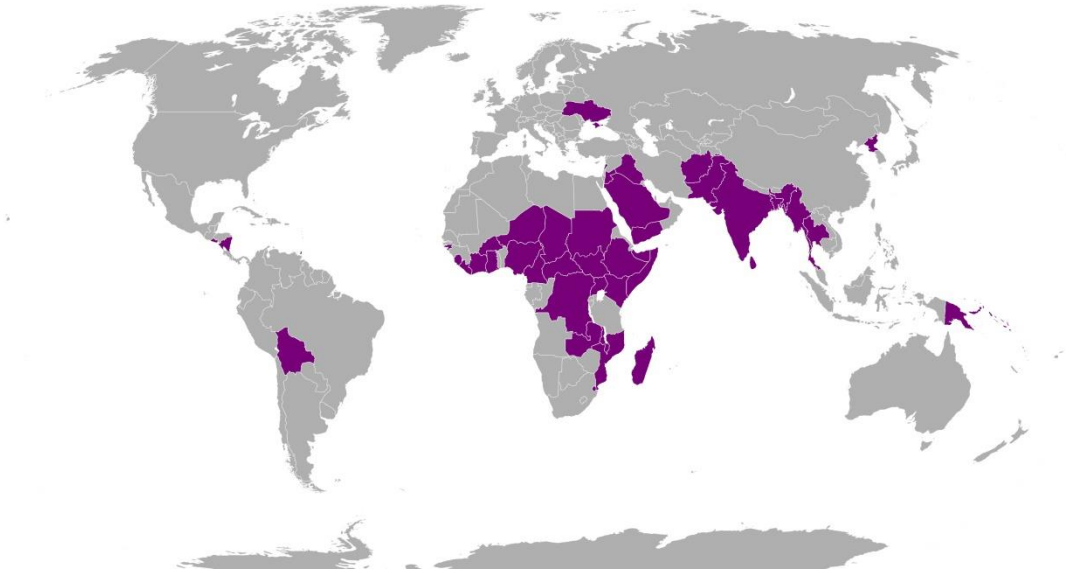
Registration for the online course was promoted from 18th January to 14th February 2018 through by Cap-Net, Skat Consulting Ltd. and Skat Foundation, the Rural Water Supply Network, the International Association of Hydrogeologists (IAH), Engineering for Change, and GRIPP.

648 applications were received from potential candidates from 381 organisations in 96 countries. This indicates widespread interest in the course, although notably participation is free of charge, making it particularly attractive. Of the applicants, 16% were female and 45% were young professionals, i.e. age 35 years or less (Annex 1). UNICEF selected 45 participants. Cap-Net selected the remainder, based on the criteria in Box 3. Of the 648 who applied, only 84 (13%) could be accepted onto the course (28% female; 33% young professionals). The main limiting factor for participants was the cost of facilitation, in particular budget to mark the assignments properly.

Box 3 Criteria used by Cap-Net to select participants

- 50-50 gender balance
- A fair regional balance, respecting the region which had most applications, roughly: Africa 14 / Latin America and Caribbean 5/ Arab countries 9/ Asia 8
- Those participants who presented a letter of intuitional support
- Members of Cap-Net affiliated network or partners, as RWSN
- Their type of organisation and position, aiming for positions directly related to the course topic.

Figure 4 Map of countries where participants of online course are based



Running the course

The course ran from 5th March to 24th May 2018. Modules 1 to 3 lasted for one week each, module 4 for two weeks (over Easter) and module 5 for one week, plus a week extension. An additional 3 weeks were given for the completion of the final assignments. The course thus ran for 10 weeks in total. The course facilitators (engaged in the forum dialogue and marking assignments) provided extremely positive feedback on their experience (Box 4).

Box 4 Comments by the course facilitators

"I was carried away by the flow of exchanges that made me visit almost every aspect of a drilling project. It was like an endless trip, because I never knew what to expect when I opened a message from the forum or read a homework assignment. I had the impression to review worldwide drilling issues from my chair in Madagascar" - Charles Serele, UNICEF Madagascar

"As a facilitator I have learnt a lot from the forum discussions and assignment submissions by the participants. It is like being on a voyage of discovery, wondering where the assignment I am about to open is from, Nepal or Sierra Leone or Saudi Arabia, and yet to read it and find something similar to other countries."– Dotun Adekile, Nigeria

"This is my first time participating in an online course – as a participant and as co-facilitator as well. So I am learning thanks to the training course. It is like a hydrogeology trip through the world." – Moustapha Diene, Cheikh Anta Diop University, Dakar, Senegal

"The course has highlighted the huge capacity building demand of WASH staff and the need to advocate for groundwater data collection and availability" – Moustapha Diene, Cheikh Anta Diop University, Dakar, Senegal

"It is exciting to hear from people working in such different countries and contexts. Other than an online course, what opportunities are there for you to learn about these topics in such a structured way if you are working in Yemen or northern Iraq, for example?" – Kerstin Danert, Skat Foundation, Switzerland

"It was very much a privilege to be involved and input into this course, with a very wide ambitious scope. Personally it was eye-opening to gain insight into drilling sectors world-wide and I am confident that all participants advanced their knowledge. I heartily commend RWSN on the establishment of this valuable course and to UNICEF for their support." Tom Armstrong, J.B. Drilling Kenya

4. Participation and Engagement

Overview

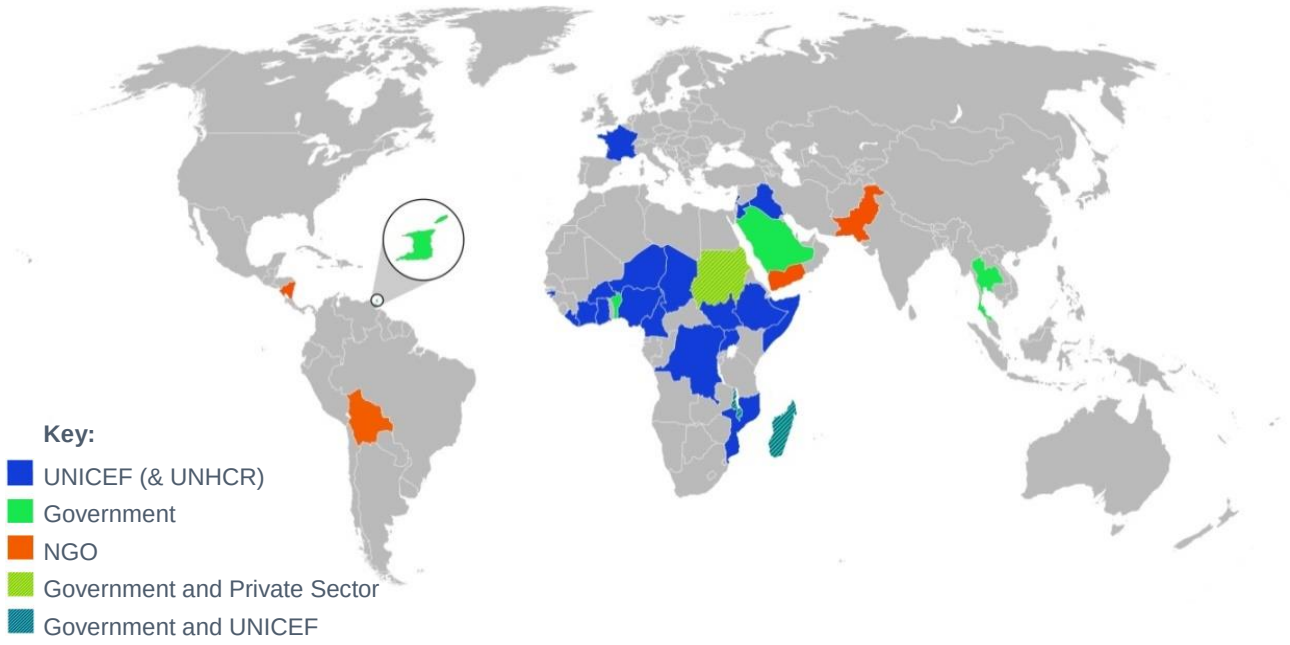
Participants had to score at least 40 out of 100 points[3] to successfully complete the course, of which 44 of the 84 did by engaging in the quizzes, assignments and discussion forums. The 52% successful completion rate is higher than the average of 41% for Cap-Net Courses in 2017. Figure 5 visualises where participants who successfully completed the course are based, and the type of organisation they work for. Of those who took the course, 86% received scores of over 20 and were thus active participants. This is also above the Cap-Net average of 59% in 2017.

Only 14% of the participants checked in but did not participate at all (considered "visitors"), a great achievement compared to 41% visitors on average in Cap-Net courses in 2017. There was very good participation over the duration of the course in quizzes, discussion forum and the written assignments

[3] Participants received points for participating in the Discussion forums, successfully completing the quizzes (by scoring 60%), and passing the assignments for each module.

(Figure 6). Engagement remained fairly stable throughout the weeks, with only the discussion forums in Module 3 and 4 witnessing somewhat lower participation.

Figure 5 Map of countries where participants who successfully completed the online course are based



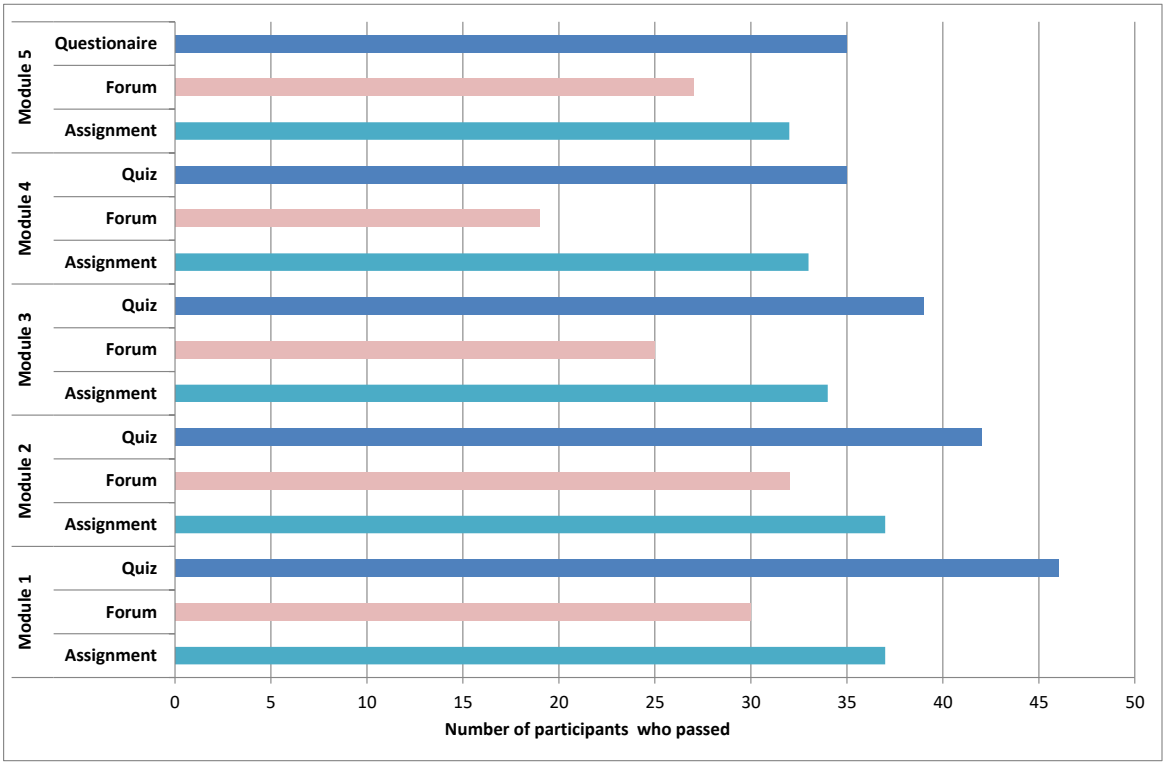
Quizzes

The quizzes worked very well, with over 40 participants taking each one, and over half of the participants scoring 80% or more across all modules. Performance was the highest for Modules 1 and 3. One quiz answer had to be amended once the course had started. On review of the quiz questions, there is no need to make any changes for a subsequent course. In the course evaluation, 87% of the respondents stated that the quiz at the end of each module was very good or excellent.

Table 2 Number of participants passing quizzes and scores

Module	No. of Participants Passing Quiz	Scores (%)		
		60-79	80-99	100
1: Introduction, Groundwater Information and Siting	48	29%	31%	40%
2: Costing and Pricing and the Procurement and Contract Management of Borehole Drilling	46	46%	27%	23%
3: Borehole Drilling and Supervision	43	4%	50%	35%
4: Institutional Frameworks for Borehole Drilling Professionalism	44	13%	65%	15%
5: Dialogue and Actions to Raise Drilling Professionalism	35	Questionnaire – no score		

Figure 6 Participation in discussion forums and passing assignments & quizzes for all modules



Assignments

On average, 35 assignments were successfully completed[4] (Table 3). In the majority of cases, participants who only partially fulfilled the requirements the first time round revised it considering the feedback of the facilitator. All the assignments which were revised and re-submitted met the requirements and passed. The participants were supported throughout the whole course on their assignments. The timely and personal response of the support facilitator and feedback of the facilitator marking assignments ensured good communication with the participants and encouraged them to complete. Key issues raised through the assignments, including insights into practices in-country are synthesised in chapters 6 and 7.

Table 3 Number of participants submitting and passing assignments

Module	1	2	3	4	5	Ave.
Number participants submitting assignments	53	49	50	49	42	49
Number of successfully completed assignments (passes)	37	37	34	33	32	35
Percentage of participants submitting that passed	70%	76%	68%	67%	76%	71%

Discussion forums

The discussion forums for each module were supported by the facilitators who tried to respond to each participant. Participants responded to set questions, which provided opportunities to share stories, challenges, lessons learned and opinions from their respective countries. Resources were also shared. On average 26.6 participants participated in the discussion forum (see Figure 5 for breakdown). Overall the discussion forums lead to an active exchange among some participants and contributed to reaching the learning objectives of the course but there discussions tended to be between the participants and the

[4] Assignments were not scored numerically.

facilitators rather than between the participants themselves. Chapter 6 and 7 summarise the challenges and ideas put forward by participants in the discussion forums.

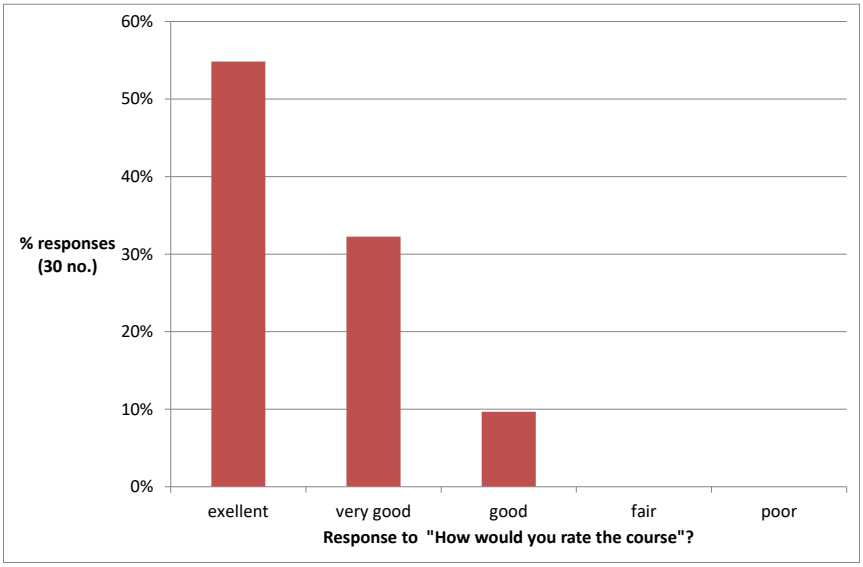
Scoring

Overall, engagement in the required activities was excellent, as evidenced by the fact that 32 of the 44 participants who passed (72%) completing at least 10 of the 15 point-scoring activities of the course. The set of required activities which need to be completed (variation of readings, forum participation, developing an exercise, and completing a quiz) was considered adequate by 90% of the 31 respondents to the evaluation survey, with 10% considering them to be excessive. One participant commented that the required activities *"kept participants on track".*

5. Course Evaluation

A total of 31 participants (42% of those who actively participated) completed in the online evaluation survey[5]. 96%[6] found the course to be extremely or very relevant. The course exceeded, and completely met the expectation of 33% and 57% of the participants. These figures reflect very well on the participant selection process. 90%[6] of the respondents rated the course as excellent or very good (Figure 7). The survey found that the respondents rated that their knowledge on the topics had increased across all modules, with a considerable number shifting from basic and poor to excellent and good (Figure 8). Box 5 provides select comments from the course evaluation survey.

Figure 7 Response to evaluation question *"How would you rate the course?"*



Upon completion of the course 83%[6] respondents considered sharing contents with colleagues, raising awareness and incorporating contents in their daily activities/projects. 70%[6] consider continuing learning about the course subject and 57%[6] consider advocating for changes to borehole drilling management policies and practices. A total of five respondents 5 are considering organising training or delivering the content through teaching. Others activities included encouraging their colleagues to enrolled on a similar course. *"I have already shared some content with my colleague in the office and intend to share with the*

[5] The evaluation survey was sent out one week after module 5 closed using Survey Monkey.

[6] of 30 respondents to the question

implementing partners who are procuring contractors and consultants for borehole drilling this year" (evaluation survey respondent).

Box 5 Select comments from the course evaluation

In my experience, this course was…

"Very important and useful for my job, It help me to enhance significantly my knowledge in the field of boreholes."

"was excellent, a lot of knowledge was gained, actually most of the stuff taught, were stuff that we already follow at the office, sometimes I felt that the section was built out of this course provided me with the information I need to know."

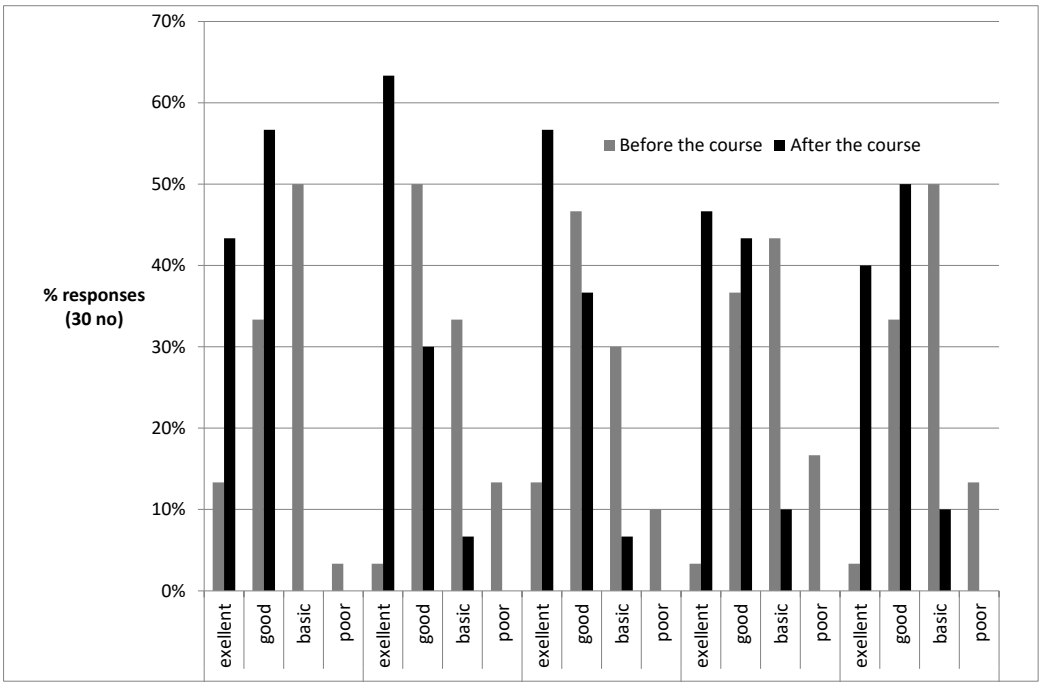
"Extremely beneficial and helpful to me and by extensions my organisation. After each module came out, I sat down with my boss and discussed how we could incorporate the different principles that was learnt into our daily activities. The information was well received by my superiors."

"Was excellent, even being a non-technical person, I learned a lot. The non-compulsory reference material was awesome however, need quit more time to read."

"Valuable because I strengthened my knowledge and I get a better view of the different aspects that are involved in the subject which I did not know before taking the course."

"Very relevant and a very excellent refresher of what I have good appreciation of. It is a very good course. I will recommend it for UNICEF Cos to conduct training for their partners."

Figure 8 Response to question *"How do you rate your knowledge on each module topic before and after the course?"*



Other key findings from the survey are:

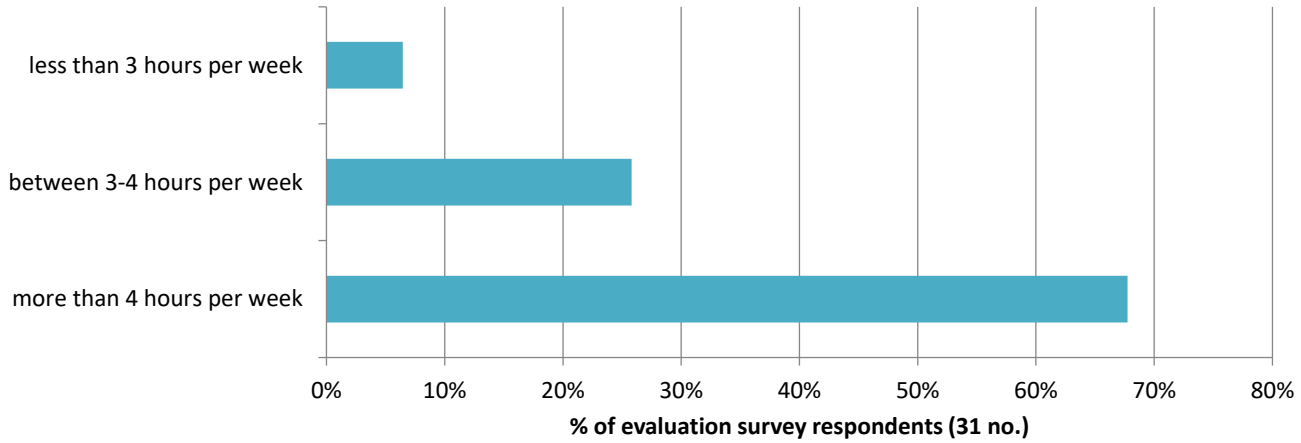
- 84% of the survey respondents found the course announcement including objectives, length, expected dedication and activities was clear
- 94% of the participants stated that the registration process was user-friendly

- 77% of the respondents stated that overall the web based platform where the course was hosted was user-friendly, with 41% stating that the design of the web based platform where the course was hosted is very clear and 52% of the respondents stating that the platform was clear enough
- 84% of the respondents found the technical support to be very good or excellent
- 84% of the respondents used a work computer to participate, with 13% (4 respondents) using their private computer. One participant used a mobile phone as their main device and no respondents used a private tablet.

Challenges faced by the participants included:

- Internet connectivity, as stated by 11 out of 28 (40%) respondents to this question and 10 respondents (36%) stated that they had difficulty to access relevant in-country information to complete the assignments. Specific comments included that was especially difficult to access the course material online in rural areas and internet access limited due to frequent remote field visit.
- Respondents also stated that all readings could not be completed, with four (of 28) respondents having difficulties in understanding the English. One respondent (3.5%) stated that the assignment instructions were not very clear.

Figure 9 Response to evaluation question on the average time per week dedicated to the course over the first 6 core weeks



Responses in relation to the length of the course and time recommended were:

- 28 out of 31 (90%) of the respondents stated that the course length (i.e. 6 weeks plus four weeks to complete the assignments) was adequate, with one participant commenting that *"Not all participants have the same level of understanding … and so the length gives that leeway for others to catch up".*
- The estimation of 4 hours to complete the compulsory readings is adequate for 19 respondents (61%) but insufficient for 7 respondents (23%) and excessive for 5 (16%). One participant comment that the time is adequate considering that some participants are "old" in the business and have to get familiar with the module (platform).
- One participant noted that the reading materials seem to be too much to complete in the given time.
- 21 respondents (68%) dedicated more than the estimated 4 hours per week in the first 6 core weeks of the course (Figure 7)

- After the 6 core weeks the participants were given 4 weeks more time to complete the assignments. 51% of the respondents dedicated 3-4 hours per week to complete the assignments, while 23% dedicated even more than 4 hours.

For future courses, an estimated time of 6 hours per week, plus an additional four hours for the final assignment will be stated in the announcement. Also, improved orientation will be provided with respect to the reading material (in the form of an orientation PowerPoint presentation) so as to help participants select the materials are most relevant for their needs from the extensive recommended reading/videos list.

12 participants stated that the additional materials included in every module was excellent, 12 others stated that it was very good and 6 considered the additional material as good. A participant commented that the additional material is good for reading after the course and also for future references.

Table 4 summaries the rating of the training materials for the five modules. Module 3 scored the highest and module 4 scored the lowest. This actually reflects the fact that when developing the course, finding suitable wider reading materials for modules 4 and 5 was more difficult than for first three modules. It is hoped that as more stakeholders strive to improve drilling professionalism (and document their experiences), that modules 4 and 5 can be improved further. Following up the participants of this course and encouraging them to write can contribute to better courses in the future.

One respondent stated: "*these are very relevant modules and trainings that all government agencies involved in drilling should take.*"

Table 4 Response to survey question "*How do you rate the content of the training materials provided in each module?*"

	EXCELLENT	GOOD	MODERATE LEVEL	INSUFFICIENT	TOTAL	WEIGHTED AVERAGE
Module 1: Introduction, Groundwater Information and Siting	63.33% 19	30.00% 9	6.67% 2	0.00% 0	30	3.57
Module 2: Costing and Pricing and the Procurement and Contract Management of Borehole Drilling	63.33% 19	33.33% 10	3.33% 1	0.00% 0	30	3.60
Module 3: Borehole Drilling and Supervision	70.00% 21	30.00% 9	0.00% 0	0.00% 0	30	3.70
Module 4: Institutional Frameworks for Borehole Drilling Professionalism	53.33% 16	33.33% 10	13.33% 4	0.00% 0	30	3.40
Module 5: Actions to Raise Drilling Professionalism	48.28% 14	44.83% 13	6.90% 2	0.00% 0	29	3.41

6. Reflections and Lessons Learned from the Course

Module 1 - Introduction and Groundwater Information and Siting

The goal of the first module is to provide participants with an appreciation of the importance of groundwater for drinking water supplies; an understanding of key groundwater terms; recognition of the value of groundwater data; knowledge of what constitutes good borehole siting and how the siting process depends on the hydrogeological environment. The individual exercise and discussion forum requires participants to find out about their country's dependence on groundwater, availability of information on groundwater and reflect on the different stages of borehole siting.

Discussion forum– groundwater use, siting responsibility and process, logical approach to siting

30 participants responded to the discussion forum, with overall good engagement in the content. Evidence of a logical approach to borehole siting was provided by many. Few participants knew the proportion of the population that depends on groundwater for drinking water, and many responded by providing data on improved drinking water supplies. Of those that did provide data on groundwater dependency, there were often discrepancies with what they estimated, and what national survey data shows, e.g. Box 6.

Box 6 Examples of discrepancies between national survey data & perceptions of groundwater dependency

- *"Following collapse of central government in 1991 and subsequent collapse of public water systems, majority of population rely on ground water sources (about 80 – 90% – my own estimate)"* Participant, Somalia. This does reflect the 2016 Somalia High Frequency Survey, which estimates that 11% of the population rely on groundwater point sources, even considering that the trucked water (serving 23% of the population) may also rely on groundwater.
- *Discrepancies with respect to the data for Yemen were shared with the World Health Organisation (WHO), which compiles the Joint Monitoring Programme (JMP) Data:*
    - Question to JMP: *"A participant from Yemen estimates groundwater use in the country to be significantly higher (70-75%) rather than the survey estimate of 37%".*
    - JMP response (abbreviated): "*Good to hear that the survey data are leading to some interesting discussions. The Yemen Country File*[7] *indicates that the most recent data source we had was the 2013 DHS survey which indicates e.g. 14.6% of the population using improved wells, and another 22.3% using unimproved groundwater (springs and wells). The results of this survey are similar to the previous household surveys in the country file (NSPMS 2013, MICS 2006). It's important to note that in these surveys people are asked what the main source of drinking water for their house is, and it's possible that people use a non-groundwater drinking water source (e.g. bottled water, 10.3% of respondents, or tanker truck deliveries for 14.1% of respondents) while still accessing groundwater for other purposes. Our data files don't collect this level of details, but the published reports sometimes do. Unfortunately the attached Yemen DHS 2013 report shows that the survey didn't ask about use of non-drinking water sources. And of course … the surveys can't provide information on the source of water used for piped systems, so again if piped supplies (about 30% of the population, from DHS 2013) are drawing on groundwater resources, that wouldn't be reflected in the survey data.*
    - Response by participant from Yemen *"We in Yemen have lack of updated data on all kind of surveys, which is causing inaccurate information. As I explained… Yemen does not have many sources of water such as rivers and lakes, so if 37 % of people using groundwater, which is the only water source for water, from where the remaining 63% of people getting their water?*

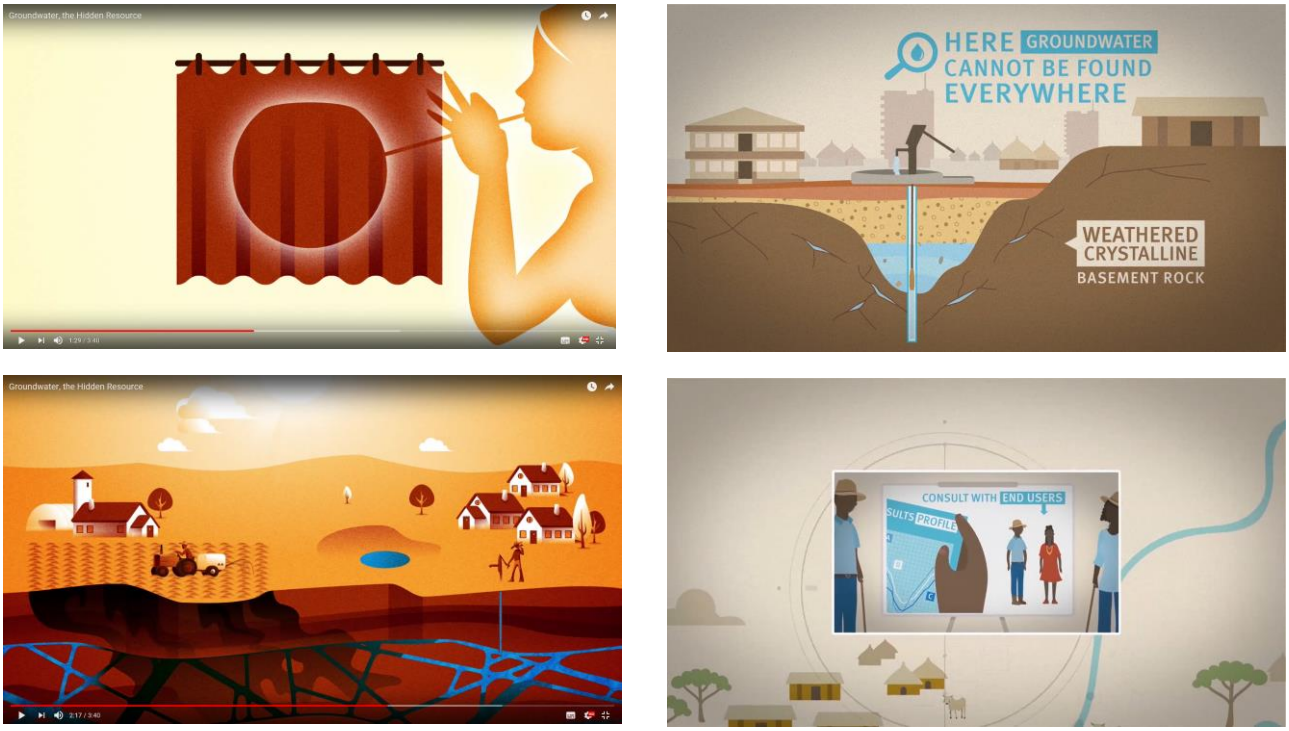
[7] https://washdata.org/data/country/YEM/download

The data on point source groundwater as a main drinking water supply for all 43 countries was sent out in week 6 (as compiled from the JMP – Annex 2).

Assignment – hydrogeological study

The quality of the submissions for the assignment was variable, with some participants understanding the assignment very well and submitting considerable detail, and others not understanding the questions, or submitting superficial information. Very useful references were shared by some participants, some of which were circulated widely (e.g. report on Hydrogeology of Sierra Leone[8]).

Figure 10 Screen shots of compulsory videos for module 1



[8] http://www.salgrid.org/final_report/Final_Report_20170822.pdf

Module 2 – Costing and Pricing, and Procurement and Contract Management

The module goal is that upon completion, participants will better appreciate the financial risks of borehole drilling and be familiar with the various cost components. They will also be able to critically reflect on the borehole drilling procurement and contract management processes within their own organisation. The training materials, individual assessment and forum will enable the participants to understand the intricacies of borehole costing and pricing, and the importance of preparing engineers estimates. The participants should have a better appreciation of the long-term implications on a project and country when clients try to avoid paying for dry boreholes.

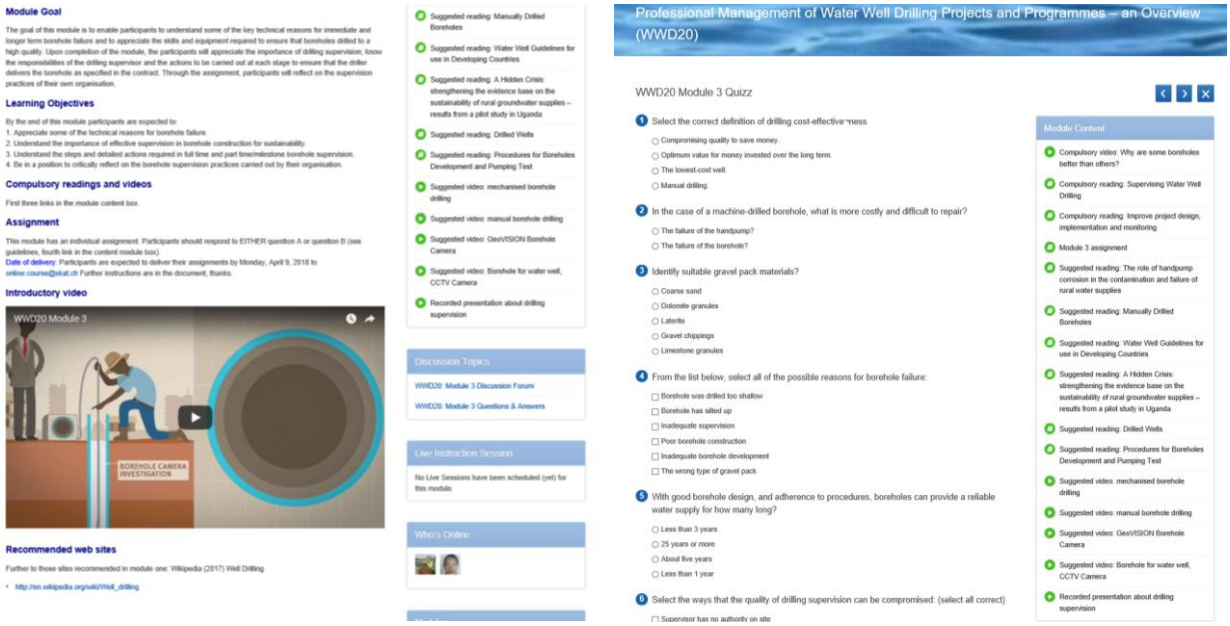
Discussion forum – hiding the cost of failed boreholes

32 participants responded to the discussion forum, with thoughtful responses, for which some undertook investigation of existing practices. There are examples of participants reflecting on the need for better mechanisms to pay, such as according to a Bill of Quantities/for the work done; and finding ways to prevent the driller carrying all the risk for dry boreholes. A motivational story of learning and pertinent issues raised with respect to supervision are summarised in Boxes 7 and 8 respectively.

Box 7 Learning-story about the importance of drilling supervision

"There was one time that a Municipality (local government) invest in a water system project in order to supply a community. In the first stage, a hydrogeological study was hire and the drilling site was defined. In a second stage, the procurement was oriented to complete the construction of the different components of the system (well construction, conduction line, storage container, distribution network). It is very important to mention that the community was involved during the whole process. At the beginning, the water well rate was around 11m^3/hour, but after few days of completion, the discharge rate decreased considerably. Then, the contractor assumed the replacement of the well, as the community inferred the failure to a bad implementation of the gravel packing. All this happen because there was no supervision involved and neither the municipality engineers were trained for that".

Figure 11 Screen shots from online course module 2 (main page and quiz)



Box 8 Issues with respect to costing and pricing, procurement and contract management raised by participants

Observations:

- *"…most companies bidding do not apply some of the pricing and costing considerations as discussed in the reading materials… [and] we end up with unrealistic bids"*
- There is a lack of disaggregated information on well drilling costs, and "turnkey" contracts, so the costs incurred by the company are not disaggregated.

Reasons and consequences of not paying contractors for failed/negative boreholes:

- *"fear associated with paying for dry boreholes… may not mind submitting claims for dry boreholes, and not bother doing a good job… hence no payment for dry boreholes"*
- *"We were requested by our donor's that we need focus on projects where the value for money would be maximized"; "many donors are ignorant of the nature and complexity of groundwater".*
- The cost for the negative borehole leaves an uncomfortable situation dealing with contractors; not paying for negative/failed boreholes forces contractors to exaggerate the cost for successful boreholes; *…my organisation does not pay for failed boreholes. All the risks are in the contractor side. For this, in the bedrock area, the unit cost of borehole is high".*

Practices of payment for dry boreholes:

- Allocate a percentage of the cost for the failed borehole according to the zone of risk of failed borehole
- Client pays 50% (quite a common practice, and support from others); client pays 100% (if it is not the fault of the driller); client pays 35% of the cost of contract; paying 50% may not be fair to the client as the driller may not have incurred 50% of the cost.
- Payment depends on previous success rates for a given area

Challenges:

- *"…contractors bidding and claiming that they have all the professional staff and equipment… [but] when supervising, you don't see those kind of professionals or equipment on the ground*".
- *"…contractor tends to front load costs in the drilling phase so that in the event a dry hole is drilled, he will get the majority of the money from the contract."*
- *"…contractors exaggerate the depths of drilled boreholes to cover for the cost of unsuccessful boreholes - this is mainly linked to poor supervision during drilling"; "depths reached given by drillers are sometimes questionable".*
- Problems faced by drillers who may encounter problems in the field, such as loss of drill bits, and *"expect the wrath of their bosses in town who know nothing about drilling but signing pay cheques"*
- *"contractors …not being paid for abortive …has always been a [sic] area of concern… however we also face the issues with false claims from contractors about capacity in terms of equipment and human resources."*

Solutions:

- *"We are thinking of the drilling company staff signing availability statement…visits to premises will certainly be made. This will help identify brief-case companies"*
- *"We must always do hydrogeological studies (and geophysical if necessary)"*
- *There is need to "increase the incentive for supervisors to prevent false reports"*

Assignment – analysis of the four steps for better drilling or ministers brief

Most of the participants responded to question A, examining the extent to which the organisation for which they work follow the four steps to better drilling contracts as set out in the RWSN animated film and publication. Overall, the standard of submissions was excellent, including reflections about what could be improved within their own organisations (Box 9) and emphasis on aspects considered to be particularly important (Box 10). Other challenges, not covered in detail by the course were also raised (Box 11). Box 12 highlights in-country management realities faced.

Problems of corruption, individual interest, conflict of interest and low staff moral were mentioned by participants from several countries as affecting procurement and contract management. It was noted that lack of timely payments has caused causing some reputable and competent contractors not to bid for certain contracts. In many cases, the forth step – that of post-construction monitoring - was not well addressed by the participants in their assignments and at times conflated with final inspection following the defects liability period. This was pointed out by the facilitators, emphasising it importance. Notably the importance of post-construction monitoring was emphasis in several assignments later in the course.

Box 9 Possible improvements to costing and pricing and contract management processes proposed by participants

1. Lack of **pre-qualification** often leads to some contracts failing to provide good equipment during the construction phase.
2. The challenges faced in our programme can be traced to weaknesses in the **procurement planning phase** that did not adequately consider the local context; challenges of preparing a procurement plan with a methodological framework which can manage risks faced in a variable and changing climate
3. The procurement process was **time consuming**, and causes significant delays in implementing the emergency drilling programme. Having pre-qualified vendors in the first place would have significantly cut on the time spent in the process.
4. Preparing procurement **bid documents** diligently, rather than through copy and paste.
5. Holding a **pre-bid meeting** also referred to as an information meeting or pre-bid conference.
6. Publishing the **results of the tenders**.
7. State the time that the contractor has to repair damage within the contract (as part of the **defects liability**).
8. Reconsider how to better deal with the **risk of drilling dry boreholes**.
9. Improve **drilling supervision**; contract management is the main reason behind the high rate of construction failure after completion – supervision remains a key issue.
10. No monitoring or reporting is done **after construction** by the state or national agencies.

Box 10 Important aspects to consider in contract management

1. **Prequalification** is done at an early stage, involving checks and verification of company details, history, equipment and personnel by the procurement section before being approved by the Authority.
2. Bidders **failing to understand** the bidding documents, especially the technicalities involved and tending to make mistakes which results in the rejection of the bids; incomplete bid documents by the contractor; technically competent contractor submitting bank statement instead of bank guarantee and this being disqualified.
3. The advantage of **regular meetings** between drillers and the client to avoid misunderstandings; we always have communications with the contractor; of recent, monthly contract performance meetings have been introduced for review of progress of work by all stakeholders..
4. **Separation of siting of the boreholes and drilling contracts** ensures the responsibility of dry/low yielding boreholes of poor water quality is not transferred to the driller.
5. **Reducing the distance and travelling time** between borehole sites can save money, make supervision easier and less hazardous, and if the contractor works in a similar geology it will most probably require identical drilling techniques.
6. The importance of a third party consulting firm to undertake **supervision and rigorous evaluation**.

Box 11 Challenges mentioned which were not captured in existing course documentation

1. In the case of **emergencies**, procurement plans may have to be rapidly revised.
2. The usefulness of **Long Term Agreements** with construction service providers that are pre-qualified and judged to be competitive.
3. The importance of **assessing the financial capacity** of contractors as the contract work is paid in repayment mode.
4. The difficulties encountered by **district government staff** responsible for daily supervision, but who may not have the contracts, no authority over payment, and so cannot hold contractors accountable in the field; lack of resources for central government staff to go to the field.
5. Selecting technically competent but foreign consultants (i.e. who do not come from the project areas) presented a challenge as they required **security escorts** to undertake their assignment.
6. The **lengthy nature of the procurement and contract award process**; cumbersome processes that only allow contractors to win one lot, but they tender for many; the paper work takes a lot of time; the administrative slowness; development of a plan and delays in funding disbursement.
7. **Payment** (of contractors) on time is an issue in long duration drilling programmes, and is sometimes due to a lack of responsibility by the **funding agency** to provide financial resources on time.
8. The challenge of paying to send qualified personnel to the field within the guarantee period **after the grant** for the actual construction has expired.
9. The need for **special conditions** in the contract to ensure quality (e.g. hot weather concreting; what to do if it rains.

Box 12 In-country contract management realities:

- The Dams Implementation Unit (DIU), **Sudan** in charge of water infrastructure in the country is a relatively new body and lacks expertise in hydrogeology/groundwater to properly plan, design and supervise the implementation.
- Staff at the DG-Eau/**Benin** lack means to go to the field regularly for supervision, even at decentralised level.
- Lack of professionals (hydrogeologists to cover the demand in **Nicaragua.**
- Supervision in **Kenya** is challenged by inadequate transport and allowance to enable them to get into the field.

Module 3 – Borehole Drilling and Supervision

The goal of module 3 is to enable participants to understand some of the key technical reasons for immediate and longer term borehole failure and to appreciate the skills and equipment required to ensure that boreholes drilled to a high quality. Upon completion of the module, the participants will appreciate the importance of drilling supervision; know the responsibilities of the drilling supervisor and the actions to be carried out at each stage to ensure that the driller delivers the borehole as specified in the contract. Through the assignment, participants will reflect on the supervision practices of their own organisation.

Discussion forum – why are some boreholes better than others?

25 participants responded to the discussion forum. The responses covered the key issues in the course materials as anticipated. Some participants focussed more on a few points that they consider pertinent, while others raised a wider spectrum of challenges (Box 13). Corruption and collusion between the driller and supervisor was mentioned repeatedly, as was the weak capacity of driller staff and supervisors. Several issues were raised that were not included in the course, or only mentioned briefly (Box 14).

Probing questions by the facilitators tended to be replied to, but there was relatively little discussion between the participants themselves. Overall the discussion forum went very well, with the responses naturally leading onto issues that were to be covered in modules 4 (institutional framework) and 5 (dialogue and action) as shown in Box 15.

Box 13 Select comments by the participants on why some boreholes are better than others

1. The main challenge is to avoid **corruption**, which takes place at all levels (including in the selection of candidates for training); irregular contract process and contract management and corruption; lack of the right motivation, especially where corruption is rampant.
2. **Hydrogeological data** – accessing it, and using it properly; need proper understanding of the groundwater system and aquifers.
3. Need to make the **bidding documents** more detailed and clearer.
4. The **entire process** from planning through to completion needs to be undertaken properly, i.e.
   a. siting, borehole design, use of right drilling technique for environment, drilling diameter, correct depth, right materials (casing, screens and gravel pack), correct placement of screen and casing in the formation, proper well development, good quality sanitary seal, check pH of the well water (to avoid corrosion)
   b. Problem is the thinking that pumping tests are sufficient enough to clean the borehole
5. Ensure **supervision**, role of the supervisor, 24 hour supervision; low capacity of supervisors; lack of close supervision by the client; need proper supervision of the drilling process right from inception to completion.
6. Drillers skill, knowledge and field experience; technical and financial **capacity**, equipment quality and type.
7. Need capacity building **training** of drilling contractors; need regular training of client and staff; train the technical staff in what they do in the field.
8. Need to engage **experienced hydrogeologists** starting form siting to supervision; recruit consultant hydrogeologist

Box 14 Issues mentioned that are not covered by the course included

1. Quality of the laboratory system
2. Terms of Reference and Statements of Work for Supervisors
3. Problem of lack of time to so proper hydrogeological studies and to the bidding/procurement process by a humanitarian organisation
4. Groundwater balance (mentioned briefly in Module 1)
5. 3rd Party Monitors

Box 15 In-country issues raised in module 3 concerning institutional frameworks (module 4) and dialogue and action (module 5)

- **Nicaragua** needs a registry of not only drillers, but also supervisors
- There is a near total lack of a regulatory framework in **Somalia coupled by** weak capacity of government
- Improve guidelines and regulations in **Yemen**
- Need a specific department focusing on groundwater exploration in every government line Ministry
- Need groundwater legislation to regulate groundwater drilling activities including licences for drilling companies and providing permits for borehole drilling.
- Inadequate authority to regulate the drilling operations.
- The main challenge in the **Democratic Republic of Congo** are the establishment of an institutional framework
- Establish guidelines for wells/drilling in **Lebanon**

Assignment – Drilling Supervision

"Drilling supervision is like the belt that holds a good pair of trousers on place at the waist, without which one will not be confident in walking about and being productive" Mumuni Kere Osman, UNICEF Ghana.

Most participants responded to question A (describing the drilling supervision process). Specific concerns raised were in relation to the means to supervise, skills and experience, government involvement, corruption, security and contract terms (Box 16). One participant used the assignment to undertake a critical analysis of milestone supervision, setting out the weaknesses at key stages. Very detailed reports of the supervision process were submitted by participants from Trinidad and Tobago, including weaknesses of the approach. These could form the basis of a future RWSN publication.

Box 16 Drilling Supervision concerns

The means to supervise

- Insufficient financial and logistical resources of government limit its ability to adequately monitor (supervise) borehole construction adequately in **Cameroon**.
- In **Kenya**, the District engineers, who supervise are not well facilitated and are forced to depend on the contractor for logistics; meanwhile Technical engineer (at regional level), who coordinates the drilling process tends to be well facilitated but is not available all the time to supervise.
- In **Malawi**, the district Water Office may be hit by logistical problems and personnel shortages in the office. UNICEF is responsible for providing enough funds for supervision at the agreed rates with the District council. UNICEF also provides capacity building support to the field supervision staff. However, government lack technical capacity in interpreting the design and specifications. To address this, UNICEF assigns staff to monitor and verify critical activities (e.g. siting, borehole development, pumping test, gravel pack, casing installation and sanitary seal). Prior to payment the certificate of completion by the district, the construction report by the contractor, and the verification report by the UNICEF Engineer must be submitted.
- Lack of supervision equipment and transportation in **Ethiopia**.
- Hiring of a consultant for the drilling planning, bidding document preparation, contract management and supervision is justified when regular funding for drilling campaigns is envisaged for several years, as was the case from 2013 in UNICEF **South Sudan**.
- Limited logistical support for government supervisors in **South Sudan** makes it difficult to go to the field.
- In **Trinidad and Tobago**, there used to be 24 hour supervision, but it was reduced to 12 hour supervision to cut costs: this, coupled with a lack of cameras to photographs drilling or drill cuttings has been a source of contention when disputes had to go to arbitration.
- Qualified consultant undertaking full-time supervision in **Yemen** with responsibilities including approval of siting, informing the district water office and checking the drillers' records regularly.

Skills and experience

- Lack of technical skills, experience of background in drilling to be able to professionally supervise borehole drilling in a number of countries; lack of technical training for drilling contracts to collect and report data appropriately in **Lebanon;** lack of data recorder/record keeper by drilling enterprises operating in **Somalia**.
- At district level in **Ethiopia** there is a lack of hydrogeologists. Supervision is undertaken by junior geologists with limited experience and minimal backup from zonal and regional water offices. There is a critical shortage of senior hydrogeologists in all government structures and little capacity building to enhance/upgrade the skills of government geologists/hydrogeologists. However, government is employing more geologists at all levels.
- In **Ghana**, drilling supervision is undertaken by a consultant belonging to the same organisation that was contracted to undertake the siting, or geophysical investigation. Supervisors are normally expected to have a minimum university degree in Geology or related field and about two years' experience in drilling supervision. Drilling supervision is supposed to be full-time. Alas sometimes consultancy firms do not feature supervisors with the required level of education and experience, which can compromise the quality of the work.
- A mandatory requirement for a drilling supervisor in **Trinidad and Tobago** is that they have a degree in Geology/hydrogeology/mechanical engineering and/or possess at least five years drilling experience.
- Very limited knowledge of drilling by government supervisors in **South Sudan**.
- Sometimes consultants (supervisors) have problems handling villagers.
- Participants in **Ethiopia** and **Guinea Bissau** stressed the cost-effectiveness of experienced government staff, rather than the private sector, undertaking drilling supervision.
- Insufficient geologists and hydrogeologists supervisors in **Nicaragua**.
- Limited training and expertise of local hydrogeologists and water engineers in **Somalia**.

Government involvement

- Lack of involvement of the Ministry of Agriculture and Underground Water in drilling supervision in **Iraq**.
- Rural Water Supply and Sanitation Agency (RUWASSA) in **Nigeria** is the client and supervisor for UNICEF projects.
- Regional and district government, as well as UNICEF, or consultants working for UNICEF are all involved in oversight or supervision in several countries for UNICEF-funded programmes.

Corruption

- Increasing the drilling depth of the borehole and receive some money from contractors
- connivance between the drilling supervisor and the consultant
- the proximity in a small country between the drillers and controllers
- government staff may be compromised to enforce standards
- some contractors may be politically connected and hence uncontrollable
- when supervisors come from the same community as the drillers they may be compromised
- when areas cannot be controlled externally (due to or security) supervisors may be compromised

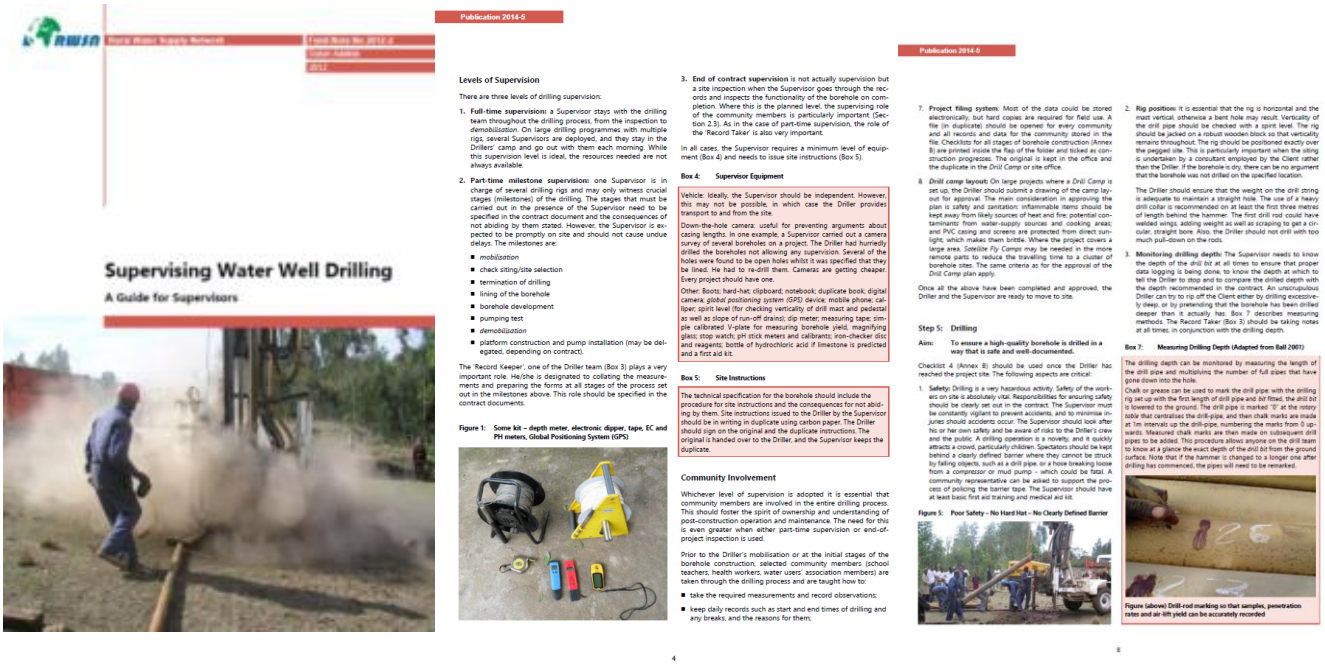
Security

- Travel restrictions for security limit drilling supervision in **Iraq** and **Somalia**. The result is "remote monitoring and supervision". Alternatives include hiring local consultants not held by UNICEF's security restrictions.

Contract terms

- As only positive boreholes are paid for, there is a risk that boreholes which do not produce enough water are validated (**DRC**).
- The importance of the warranty, or defects liability period was highlighted frequently, but without details.

Figure 12 Extracts from compulsory reading for module 3 – borehole drilling and supervision



There was some emphasis on the **role of the community** to support the supervision process, as well as challenges with this (Box 17)

Box 17 The role of the community to support the drilling supervision process

- The implication of community in the monitoring can be improved; community have some selected members as watchdogs, especially those with basic literacy and numeracy knowledge
- The use of community to supervise with the community able to raise any issue which they feel is compromising the drilling process and even refusing the contractor to leave the site until the work is done to standard
- The villagers with the water point committee are always on site
- Villagers are not fully empowered to control the contractors and are left out in decision-making
- Importance to get complementary information from the community.
- Lack of community involvement in Trinidad and Tobago together with the site being cordoned off means that the community sometimes think that the government agency is secretly drilling for oil and stealing from their natural resources.

Several UNICEF offices (e.g. Iraq and Nigeria, mentioned the use of 3rd party monitoring, referring to the hiring of technical persons, also known as facilitators, for milestone supervision, thus providing triangulation. It should be noted that 3rd party monitors do not always have a specialisation in borehole drilling.

Module 4 - Institutional Framework

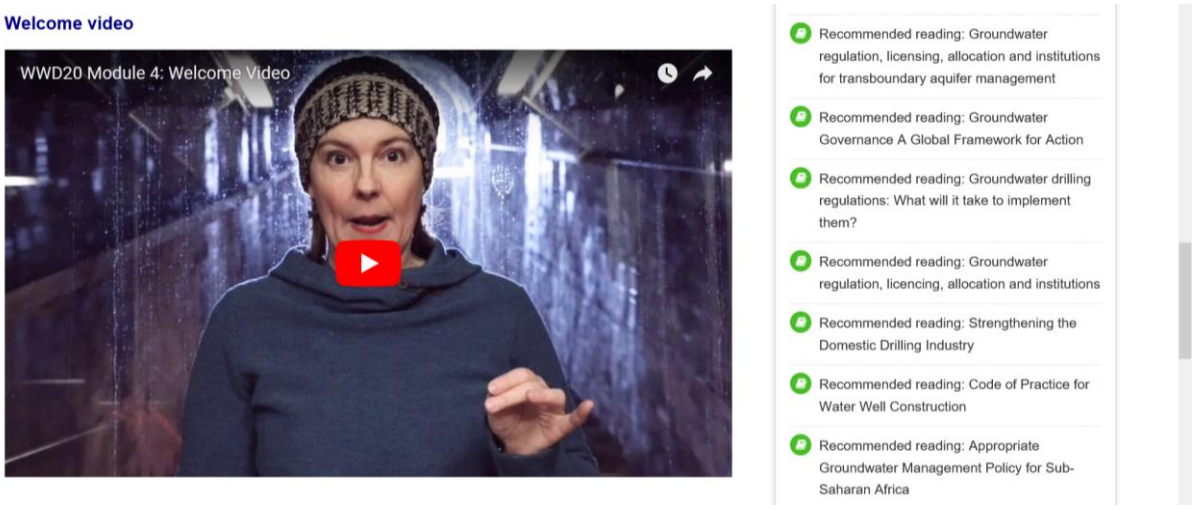
The goal of this module is to introduce participants to the key elements of an institutional framework (at national or state level) that is supports borehole drilling professionalism. These include driller licencing, borehole permits and national (or state level) associations. Through the discussion forum and assignment, participants will have the opportunity to reflect on the institutional framework in the county (or state) in which they work.

Participants responded very well to the questions in both the discussion forum and the assignment, generally providing a clear analysis of the strengths and weaknesses of the institutional framework. However not all participants were clear of the difference between a water point database and a groundwater database, which should clarified at the outset in the next course (i.e. within Module 1).

Annex 3 summarises the responses of the participants and provides a snapshot of the status of the institutional framework for drilling professionalism for 24 countries. Responses to the assignment (against each country) have been collated as a separate excel spread sheet. This information could be used to prepare an overview of the extent to which the principles in the RWSN Code of Practice are perceived as being adhered to in select countries.

Minor weaknesses in the assignment were that the phrase "*arrangements in place*" (RWSN Code of Practice, Principle 6) was interpreted by some as referring to the formal arrangements and by others as the practical realities. Nevertheless, the assignment provided the opportunity for reflection according to the objectives of the module.

Figure 13 Screen shot from motivational "Welcome Video" for Module 4 - on institutional frameworks



The course manager contacted a number of participants during and after the course to obtain soft copies or links to key national documents that could be shared widely and incorporated into subsequent courses[9].

[9] e.g. Technical guidance and standard operating procedures for Malawi: http://www.rural-water-supply.net/en/resources/details/807.

Module 5 - Dialogue and Actions

This goal of this module it to equip participants with a wider perspective of the groundwater development sector in the country in which they work. Participants are expected to draw upon, and integrate the knowledge developed through the previous modules, and engage in dialogue with at least one other stakeholder group to consider the issue of drilling professionalism from their perspective. The final assignment requires participants to set out actions that could be taken to improve borehole drilling professionalism in the context in which they work.

Discussion forum – unrealistic pricing, non-payment for dry boreholes, corruption, low cost drilling

27 participants took part in the Module 5 discussion forum, reflecting on their own experiences or perspectives on one of four contentions, i.e. clients pushing drilling prices unrealistically low; contractors shouldering the risk of dry boreholes; effects of corruption on tendering by contractor; or the role of low-cost drilling technologies. Select cases discussed by the participants are summarised in Box 18. The discussion worked very well.

Box 18 Examples of contentious issues in borehole drilling and solutions

1. The effects of **competition** reduce drilling prices but economies of scale favouring large companies. This has led to smaller companies being compelled to bid with unrealistically low prices, forced to work as sub-contractors for the larger companies that win the tenders or put out of business as they cannot compete, lack of proper assessment of the technical and financial capability of the bidders.
2. **Intermediaries** winning the bidding process and subcontracting; intermediaries drilling with no written contact document; tender rules that do not prohibit sub-contracting.
3. **Litigation** after borehole failure of wells drilled for private clients (Kenya) - *"It is crucial to conduct awareness for the general public on professional groundwater development, provide guidance on costs for borehole drilling in different areas, and have framework to hold drillers who cheat their clients to account".*
4. *"Professional contractors will become very expensive and their prices can fall outside the engineering estimate when organisations do not pay for a dry borehole. In this case, the risk of losing a professional contractor is high"* (Malawi).
5. ***Corruption*** *in the tender process; "back-door" discussions* (issue raised by many participants). One participant shared the findings of the problematic audit of PPEA II in Benin, a programme funded by the Netherlands Government which includes issues related to borehole drilling and its management.
6. Many drillers rushing for few jobs and **bidding unrealistically low**, then cutting corners; more drillers than the number of jobs and so are ready to take up the job irrespective of the price even if they will not break even; drillers knowing that they can get away with bidding too low, and cutting corners as there will not be proper supervision; contractors take short cuts to recover costs incurred from dry wells by drilling shallow (productive) wells; drilling abandoned as companies could no longer cope with the expenses; tender awarded to lowest bidder who used substandard materials; company blacklisted after abandoning work due to the low price it had submitted.
7. Important role of **manual drilling** where feasible.
8. There is need for more **dialogue** between the government, regulators, drilling contractors, consultants, international and local NGOs and also the beneficiaries; government should help stakeholders to meet and discuss the problems.

Assignment – dialogue and action to raise drilling professionalism

The final assignment required participants to undertake dialogue regarding drilling professionalism with another type of actor or stakeholder. 32 participants passed the assignments of module 5 successfully. Overall, the submissions showed illustrated excellent understanding of key challenges within the country, and a high level of engagement with the topic. Requiring participants to interview other stakeholders groups was worthwhile. It enabled participants to discuss their particular areas of interest with others and hear their perspectives as well as ideas for improvement. Annex 4 provides an overview of the topics discussed and actions proposed. Select issues raised are summarized in Box 19.

Box 19 Select issues raised in stakeholder interviews for assignment module 5[10]

1. **Donor requirements**: *"Programme design in UNICEF is "result based"… i.e. planning for results…and based on specific per capita cost of providing the service…investment without any result (i.e. dry or very expensive) is not acceptable by many donors (or is considered no progress to achieve planned results). Some donors don't accept or recognise the risk of drilling negative boreholes"*
2. **Costing:** There is a tendency to underestimate the cost of drilling, which limits the use of experienced expertise.
3. **Payments**: Payment of the first slice after 30% completion makes cash flow for the drilling contractor difficult. The first payment should be made after receipt of materials on site (for drilling); we encounter late payment especially by …government.
4. **Siting**: *"some hydrogeologists cook reports or depend on reports previously conducted for different boreholes…some copy past reports from other areas hence not providing the true picture of the hydrogeology of the area to be drilled."*
5. **Procurement**:
    a. Usually bidders to not get enough time to go to the site and see the locations for bidding accordingly; there is no design or other details in the tender document; lack of time by the contracting NGOs to prepare documents due to very short donor deadlines.
    b. Should categorize drillers according to the volume or complexity of the drilling and ability to access sites.
    c. We need to bid for work in more than 50 districts, which is cumbersome and costly. Drilling operations should be clustered regionally and a contract framework for at least three years with varying annual rates to take care of inflation should be put in place (Drilling contractor, Uganda).
    d. There is inadequate background check for the procured contractor, hence those contracted lack capacity have no drilling equipment. "Briefcase" contractors later sub-contract the work to other contractors who have not been assessed.
    e. *"The procurement system is not flawed per say, the legislation is there to follow, but most contractors do not follow procedure…as well as there is no repercussions for it, hence the large occurrence of corruption."*
6. **Corruption**:
    a. *"The contractors have no choice but to give commission to the department/some representative to secure contract, it's very rarely observed that contractor secure contract without giving share in cash or in kind".*
    b. *There is a lot of political interference in procurement of contractors and with politicians working to push contracts for their colleagues and relatives.*
    c. Consultant and contractor can still connive even if supervision is contracted separately.

[10] In order to provide anonymity, in some cases, countries from which the statements came have been left out.

d. Contracts awarded to companies who have corruption relationship with tender/tender committee.

7. **Supervision (including community engagement)**:
    a. There is no proper supervision of the drilling process. Most of the time the drilling contractor is lest to drill the boreholes and at the same time supervise the work providing conflict of interest.
    b. There is no proper community participation in the drilling process…the capacity of the community can be enhanced to support supervision.
    c. Consultancy firms do not field the right calibre of personnel as stated in their proposal documents thus affecting the quality of the work.
    d. Lack of attention by Government to due diligence and background checks on the drilling companies.
8. **Drilling contractor practices**:
    a. **"***It was surprising but strange to find that the [drilling team] did not have a contract document on site… they did not have the specific details required for the special borehole they were to drill"*
    b. *"The drillers complain about little salaries and how late the salaries come out… and harshness and ill-treatment of staff by the company owners. Mistrust takes centre stage whether the owner of the company feels the workers steal."*
    c. In **Trinidad and Tobago** there is a stringent Quality Assurance/Quality control regime in order to import drilling materials thus substandard materials aren't allowed in.
    d. The cost of new drilling equipment and critical economic situation in the north of Iraq is prohibitive to investment by the private sector.
9. **Human (and institutional) capacity**:
    a. There is a lack of hydrogeologists within government in **Lebanon** with roles and responsibilities in terms of public well drilling are unclear with many uncoordinated actors.
    b. County level staff in **Kenya** has inadequate capacity, lack experience and technical skills to effectively supervise the drilling and equipping of boreholes.
    c. *"Before the collapse of the Said Barre government in 1991, **Somalia** had strong institutions ... and boreholes drilled at the time were to international standards. The current government and its capacity needs to be built as a starting point to promote professionalism in the drilling sector."*
    d. There are concerns about the limited number of qualifies technicians, including geologists and supervisors, as well as the advanced age of drillers in Eastern Equatoria State, South Sudan.
10. **Post-construction**:
    a. Post installation monitoring by line departments in **Pakistan** is rare; NGOs quit the area after completion of the project; respective line departments tend to visit big schemes with major issues.
    b. The **Sierra Leone** Water Company (SALWACO) prepared a **Sustainability Plan** for each borehole to help increase functionality and ensure sustainability involving 1) formation of water management committee, 2) training water management committee; 3) technical training to caretaker; 4) provide O&M manual; 5) provide key spare parts; 6) monitoring functionality and testing water quality every three months; 7) provide major repairs and maintenance. There are budget constraints to adherence.

7. Synopsis of Opportunities and Issues Raised by the Participants

This section synthesises opportunities and key issues with respect to the professional management of borehole drilling programmes and projects which have not been captured elsewhere in this report. Box 20 provides an overview of the status of groundwater databases and groundwater mapping for 18 countries. Insightful experiences of groundwater data and siting were shared (Box 21).

Box 20 Groundwater databases and groundwater mapping status for 18 countries

Benin – Systeme National d'Information sur l'Eau (http://snieau.bj)

Cameroon – There is need to ensure that data of the drilling process are well documented and kept.

Chad - Groundwater database maintained by the ministry in charge of water and is regularly updated, containing 17,000 records.

Côte d'Ivoire – no systematic groundwater database.

Democratic Republic of Congo - Groundwater database exists from the 1950'5 and the public company that manages the mines and geographical institute are trying to update hydrogeological maps.

Ethiopia – no system to store drilled borehole data; groundwater mapping project (involving the Government and UNICEF) is on-going; hard copy records of boreholes drilled for Government in the region but not well organised and scattered; lack attention by government to collect, store and collate borehole data lack co a standard borehole data reporting format.

Ghana – groundwater database is not well developed and needs a careful collection and integration of all data from relevant institution and organisations into one database.

Guinea Bissau – has an official borehole database (including functionality, location, type of borehole); does not have a well-established system but is being assisted by UNICEF with an online system. Information on **Guinea Bissau** in the African Groundwater Atlas was considered very basic and limited

Kenya - historic database is not comprehensive, particularly of recent decades. There is no central point for storing information and many boreholes lack proper documentation.

Lebanon does not have a geological survey. Each project follows its own template for the borehole completion report. There is a groundwater database structure in the Ministry of Energy and Water, but it is almost empty.

Malawi – there is a groundwater database (at the Groundwater Division) which uses two software's (WISH and HYDSTRA).

Mozambique is in the process of establishing a National Database (data is currently scattered with Excel files in the provinces of boreholes constructed in each district.

Pakistan – some organisations are collecting some data (depending on need), but there is no systematic sharing and even if data is submitted to the relevant department, the database is not updated on a regular basis.

Sierra Leone – Salone groundwater resources database (SALGRID) – http://www.salgrid.org/#.

Somalia – no database of groundwater resources.

South Sudan – no groundwater database.

Sudan – due to lack of institutional and legal mandate, available groundwater data are incomplete, not up to date, un-checked, fragmented in different places/organisations and considered as highly confidential.

Trinidad and Tobago – no national groundwater database, but persons working within the Water and Sewerage Authority will have their personal databases created for their ease of reference when doing their job. There is reluctant to share data. *"People must understand that the data doesn't belong to them, it belongs to the organisation … for the betterment of Trinidad and Tobago".* Needs to be a deconstruction of the "siloed" approach towards data sharing.

Box 21 Select groundwater data and siting experiences

"The main problem that we face [with siting] is lack of data… data obtained throughout the drilling is not public… companies to not allow access to the information". The most critical communities (without a water supply system) are in the central and Atlantic regions of **Nicaragua**, but no groundwater studies have been carried out, and so basic data is lacking

In **Somalia**, *"security factors constrain ability to fully follow a logical approach to siting, [with the need to] minimise exposure [and time] for consultant teams in the field … in insecure areas. [This] affects quality of the [drilling] works and success rates"*, Participant, Somalia. One driller estimated that less than a quarter of drilling activities are based on professional-grade hydrogeological, geophysical and environmental assessment/studies.

In **Malawi**, *"not many private organisations have geophysical survey equipment"*. There is concern about the validity and reliability of drilling data in **Malawi** (Participant, Malawi)

Siting of boreholes has been very challenging in the areas of Eastern Equatoria, **South Sudan**.

*"Blame game where every time someone is looking for data with respect to wells, persons have to search throughout the organisation to find it, and nobody has it, most times you are sent on a wild goose chase". (*Participant, **Trinidad and Tobago**)

Siting practices vary between countries, and organisations, with some contracting out the siting separately, and others including it in the drilling contract. In cases where the driller sites the borehole, they usually directly bare the cost of a dry well. It was noted that while it is better for the programme management to know all the drilling sites in advance, which also helps detailed budgeting, the disadvantage is that there are *more contracts to manage (i.e. siting, drilling and supervision).*

The Uganda Drillers Contractors Association (UCDA) and Kenya Water Industry Association are examples of associations from which others could learn (Box 22).

Box 22 Drilling Association Examples

There is no association of drillers in **Eastern Equatoria State, South Sudan** or **Trinidad and Tobago**.

There is a **Uganda Drillers Contractors Association (UCDA).**

*"In 2003 the **Kenya** Water Industry Association (KWIA) was formed; drillers represent over 40% of membership. KWIA is active and reputable, promoting good governance and an associative culture – otherwise lacking among sector players; the members include the premier water sector stakeholders (manufactures, suppliers, contractors, consultants, etc.) and main functions includes 1. lobbying/advocacy with collective representation to government (e.g. waiver of VAT from Borehole Drilling & Equipping 2003-2013), and 2. Services to Members (e.g. business promotion, conferences, study tours, skills development such as Operational Safety & Health Guidelines, website and a biannual magazine for information and advertising). To demystify the National Code of Practice and make guidance more accessible/understandable for both drillers and customers, a **Code of Conduct** for Drilling in Kenya has been drafted by KWIA"* (Tom Armstrong, Course Facilitator, Kenya).

Box 23 provides insights into the existence (or not) of regulations, manuals and guidelines on professional drilling for six countries, and Box 24 provides further details for Trinidad and Tobago, a country from which much could be learnt.

Box 23 Regulation, manuals and guidelines

Bolivia – Groundwater is considered in national laws and water management plans. New regulatory framework has been created form Supremo Decree No. 2855 (August 2, 2016) which norm the drilling of wells for water supply as an exclusive competence of the Central Government.

Cameroon – a process to develop technical guidelines for all contractors and managers of drilling projects is on-going

Côte d'Ivoire – there is no manual setting out drilling procedures

Ethiopia – there is a licensing system for drilling contractors provided with different grades based on their capacity in terms of machinery, human and financial resources. The drilling companies are expected to fulfil the criterion in order to be licensed and their license is renewed annually. However, there are some challenges with the system as there is a lack of documentation of actual driller performance. There is need for a nationally (or locally adapted) standard code of conduct and code of practice for borehole drilling that is accepted by all stakeholders.

The only official document considered as a manual by a (specific) drilling contractor in **Iraq** is the bill of Quantity.

Malawi – Water Resources Act 2013 Part IV, Section 69 includes requirement to submit all data pertaining to the borehole to the Water Resources Authority. New Standards and Guidelines[11]. With the permission of the Government of Malawi, this information was put on line (on the RWSN website - http://www.rural-water-supply.net/en/resources/details/807) and circulated to the RWSN Online Groundwater Community.

Thailand – Groundwater Act B.E 2520 and notifications /regulations under the act specify that for groundwater drilling, a geologist or engineer has to be responsible for supervision. They have to be certified, which involved passing training. The certificate is valid for 5 years. However, the act does not specify any standards of practices for supervisors.

Although there is no national guideline of standard for borehole drilling in **Trinidad and Tobago**, there are two pieces of legislation that are applied to all borehole drilling and rehabilitation contracts (Box 24).

Box 24 Legislation applied to borehole drilling and rehabilitation in Trinidad and Tobago

The **Certificate of Environmental Clearance Rules,** 2001 (legislation generated from the Environmental Management Act Chapter 35:05) stipulates that all contractors must submit a finalized Scope of Works (SOW) and a detailed scheduling prior to drilling or rehabilitation of any borehole to the Environmental and Management Authority of Trinidad and Tobago (EMA) at least 20 works days prior to the start of the project.

Contractors must submit an **Emergency Response Plan and Job Safety Analysis**, set up temporary enclosures to exclude public from work site and implement efficient waste removal and sediment removal during drilling or rehabilitation. The **Occupational Safety and Health Act** 2004 stipulates that all personnel during drilling or rehab works must wear full Personal Protective Equipment (PPE) and conduct tool box meetings at the beginning of every shift.

All drillers and all drilling crew are required to have their PLEA Passports, a **health and safety training course** in Trinidad and Tobago. Prior to the start of project, the contractors must have their rigs certified and if requested by the client, all drilling pipe, drill collars, subs etc. must be x-rayed to ensure that there are no cracks. All contractors must be prequalified in order to drill for the government of Trinidad and Tobago. However, in the case of an NGO or private user, it is not mandatory for a registered contractor to drill for them.

[11] i.e. ***Standard Operating Procedure for Drilling and Construction of National Monitoring Boreholes***, Document No 06GW01/2012; ***Standard Operating Procedure for Aquifer Pumping Tests,*** Document No GW02/ 2012; ***Standard Operating Procedure for Groundwater Level Monitoring,*** Document No GW03/2012; ***Standard Operating Procedure for Groundwater Sampling,*** Document No GW04/ 2012; ***Standard Operating Procedure for Operation and Management of the National Groundwater Database,*** Document No GW05/2012; ***Standard Operating Procedures for Groundwater Use Permitting,*** Document No GW06/2012; ***Standard Operating Procedure for Drilling and Construction of Production Boreholes,*** Document No GW07/2012; ***Technical Manual - Water Wells and Groundwater Monitoring Systems*** – all published in 2016 by the Ministry of Agriculture, Irrigation and Water Development, Malawi

There was considerable debate about who should pay for the cost of a dry borehole, and other payment challenges (Box 25). A number of participants noted that UNICEF has supported capacity strengthening of independent drillers, particularly in manual drilling as well as financial and administrative management to enable them to ensure drilling quality and adequate management. Examples of drilling supervision realities from Ethiopia and Cameroon are given in Box 26.

Box 25 Payment Realities

In **Ghana**, "*the contractors payment is based on the depth of drilling, the cuttings, types and quantities of materials used in the construction of the wells etc. all of which will have to be validated and approved by the consultant of the supervisor (same as the person(s) who did the siting"*, Participant, Ghana.

UNICEF **Madagascar** has a policy of "no data no payment" for boreholes.

Pakistan Public Procurement Regulatory Authority does not allow payment for dry boreholes.

The government of **Cameroon** is in the process to request that payment of any borehole shall be based on an acknowledge (sic) of data reception by its services.

In **Yemen**, there are organisations that avoid drilling boreholes and prefer rehabilitation to avoid high costs.

Box 26 Drilling Supervision Stories

In **Ethiopia**, although site selection for drilling is done by hydrogeologists *"… drilling supervision is not properly conducted and sometimes guidance is provided to the drillers by telephone communications from offices… because of lack of hydrogeologists in the government offices… the government doesn't have sufficient budget to employ the required number of hydrogeologists… [and] when the hydrogeologists gain experience they move to other organizations who pay better. "; "The primary objective of drilling supervision is to certify payments."*

In **Cameroon**, UNICEF is addressing weaknesses in the contract setting out eight key steps for "minimal supervision" or part time supervision, i.e. validation of siting, pumping test, handpump and pipe reception, wall construction, technical reception, temporary reception, technical visit before final reception and final reception. In addition, samples for water analysis should be taken with the participation of a *national water inspector* who is mandated for this.

Last but not least, examples of salinity problems in Chad, Kenya, and Trinidad and Tobago were shared (Box 27); concerns were raised about groundwater in Benaadir (Somalia), Sana'a (Yemen), El Salvador and Bolivia (Box 28) and particularly high or increasing groundwater use (Box 29).

Box 27 Salinity and Saline Intrusion

To overcome the challenge of salinity in the North of **Chad** (Lake Chad basin), we attempted to use a conductivity meter during drilling of a borehole and we could measure the conductivity at every layer of soil as we drill (the drilling was done manually using percussion techniques)… due to the high level of salinity it was agreed with WASH partners to recommend a borehole with less or equal to 3000 µS/cm regardless of the WHO standard of 2500 µS/cm so as to cover for the water demand in those areas.

*"In parts of **Kenya**, groundwater is saline and mostly steel pipes are used for casing of the boreholes. The steel casing will rust due to saline water and therefore will not last longer only for 2 to 3 years"* (Participant, Kenya).

In **Trinidad and Tobago**, *"we always have to be cognizant of the fact that saline intrusion is a possibility… this occurred in one of the well fields where 12 producing wells saw their salinity increase to over the acceptable WHO standard for potable water. As a result, the well field was shut down for 15 years for it to recover.. the authority tries to avoid siting coastal wells but where they do, a number of observation wells must be drilled along with the production wells in order to monitor salt water intrusion"* (Participant, Trinidad and Tobago).

Box 28 Concerns about groundwater in Somalia, Yemen, El Salvador and Bolivia

Benaadir (covers **Mogadishu** with a population of 2.4 million), **Somalia** – mainly coral limestone geology, the population relies nearly 100% on groundwater. Following the collapse of the public water distribution system, which was based in high-yielding boreholes from neighbouring Middle Shabbele region, Mogadishu reverted to use un-centralized hand dug wells and small scale reticulated systems. The number of wells established within the city and groundwater abstraction has increased since the collapse of the government. AWD/cholera has become endemic in Banaadir region and is largely attributed to the use of contaminated groundwater sources. Water wells tap the shallow coral limestone aquifer, which is mostly contaminated. The absence of a sewerage system forces the majority of residents to rely in pit latrines and unlined septic tanks. According to various recent studies, there is also evidence of a growing trend of increase in electrical conductivity of water collected from wells in Banaadir, possibly due to sea water intrusion.

Sana'a, Yemen is facing what has been described as a "race to the bottom", with "every man for himself" when it comes to capturing the remains of the decreasing groundwater resources in the city. The combined output of the 125 wells operated by the state-owned Sana'a Local Cooperation for Water Supply and Sanitation barely meet 35% of the growing city's needs. Concerns are being raised about the increasing pressure on groundwater, combined with falling water tables. Alas, data is lacking on groundwater withdrawals, storage, quality as well as aquifer characteristics. Meanwhile, there is a drive to pump large quantities of groundwater to sell.

In **El Salvador**, *"deforestation is the main cause of drying aquifers",* Participant, Nicaragua

Infiltration of pollutants into the groundwater is a concern in parts of **Bolivia**, particularly from the mining industry, of which remediation is difficult and costly (Participant, Bolivia).

Box 29 High, or increasing groundwater use in Bolivia, Lebanon, Mozambique, and Trinidad and Tobago

Maputo, **Mozambique** (population 1.2 million) – water authorities are planning to drill 46 boreholes in different areas of Maputo to mitigate the water shortage that experienced due to low rainfall and reduced volumes of water in the Pequenos Libombos Dam (Participant, Mozambique).

In **Bolivia**, water from aquifers is exploited in the eastern and very eastern areas (Chaco), where there are no glaciers. However, the water crisis in La Paz in 2015 led to the exploration of wells and aquifers as an emergency measure. The interest in groundwater in the country is growing, but from mid-2017 to early 2018 the rains intensified and the lagoons filled and low temperatures allowed the glaciers to freeze, which has relaxed the need to consider groundwater for the time being (Participant, Bolivia).

In **Trinidad and Tobago** approximately 32 % of the national water supply comes from Groundwater (Water and Sewerage Authority, Water Resources Agency's Groundwater Master Plan 2013). Participant, Trinidad and Tobago. The dependence on groundwater in the country has increased significantly (Participant, Trinidad and Tobago).

In **Lebanon**, drinking water supply is mostly based in groundwater, but there is no specific reference to this as water establishments so not report on the source, and the National Water Strategy (2010) does not include such detailed information related to the source (Participant, Lebanon)

Annexes

Annex 1 Applicants and Participants of the Online Training Course

Table A1.1 Breakdown of Applicants and Selected Participants by Age and Gender

Applicants			**Applicants Female**		
35 and under	293	45%	35 and under	59	57%
36 to 55	324	50%	36 to 55	40	38%
over 55	31	5%	over 55	5	5%
Total Applicants	**647**			**104**	(16%)
Selected			**Selected Female**		
35 and under	22	26%	35 and under	8	33%
36 to 55	57	68%	36 to 55	14	58%
over 55	5	6%	over 55	2	8%
Total Selected	84			24	(29%)

16% of the applicants and 29% of the participants were female

participants from 35 organisations; female participants from 19 organisation

participants from 43 countries; female participants in 18 countries

Table A1.2 Breakdown of participant nationalities

Country	Number of Participants	Country	Number of Participants
Afghanistan	1		
Bangladesh	1	Malawi	4
Bolivia	1	Mozambique	1
Burkina Faso	2	Myanmar	1
Cameroon	1	Nepal	1
Chad	1	Nicaragua	1
Cote d'Ivoire	1	Niger	1
Democratic Republic of Congo	5	Nigeria	4
Democratic People's Republic of Korea	1	Pakistan	1
El Salvador	1	Papua New Guinea	1
Ethiopia	5	Saudi Arabia	1
France	1	South Sudan	1
Ghana	2	Spain	1
Guinea Bissau	2	Sri Lanka	1
India	1	Sudan	3
Iraq	3	Swaziland	1
Jordan	2	Thailand	3
Kenya	3	Trinidad and Tobago	2
Lebanon	4	Uganda	3
Liberia	1	Yemen	5
Madagascar	5	Zambia	1
Grand Total		**84 participants from 43 countries**	

Table A1.3 Breakdown of types of organisations with participants who successfully completed the course

UNICEF (& UNHCR)	30
Government	8
NGO	5
Private Sector	1
Grand Total	**44**

Annex 2 Groundwater Use Statistics

The table below provides an overview of use of groundwater point sources as the main drinking water supply for the populations of select countries. It should be noted that groundwater dependence may be higher, as piped water supplies may also draw on groundwater, but are not captured by this dataset. The data for each country has been taken from the most recent national survey, as captured in the JMP (Joint Monitoring Programme) data. To access JMP data see https://washdata.org/data, click on map to select country, download "Country file", and see "Water Data" tab. In this workbook each country sheet contains two data sets. However, the JMP files contain several datasets and can this provide more information. The data was compiled by Kerstin Danert as part of the March/April online course on the Professional Management of Borehole Drilling Projects and Programmes, supported by UNICEF, Skat Foundation and UPGro.

	Recent	Population	Proportion of total population using groundwater point sources	No. using groundwater point sources	Total Proportion using Tubewell/ borehole	Total no of people rural using tubewell/ borehole	Reference	Notes
	Year R	Year R	Year R	Year R	Year R	Year R		
Afghanistan	2015	32,526,562	63%	20,621,840	20%	6,602,892	Demographic and Health Survey	
Bangladesh	2014	159,077,513	88%	140,428,856	87%	138,686,957	Demographic and Health Survey	
Benin	2014	10,598,482	49%	5,182,658	21%	2,204,484	Multiple Indicator Cluster Survey, 2014	
Bolivia	2013	10,399,931	20%	2,069,586	6%	613,596	Encuesta continua de hogares, 2013	
Burkina Faso	2014	17,589,198	76%	13,442,567	46%	8,050,126	Enquete Multisectorielle Continue, 2013-2014	
Cameroon	2014	22,773,014	56%	12,639,023	25%	5,761,573	Enquête par grappes à indicateurs multiples, 2014	
Central African Republic	2010	4,444,973	75%	3,351,510	32%	1,417,946	Enquête par grappes à indicateurs multiples – MICS couplée avec la sérologie VIH, RCA, 2010	
Chad	2015	14,037,472	75%	10,474,785	32%	4,499,366	Enquête Démographique et de Santé et à Indicateurs Multiples au Tchad, 2014-2015	
Cote d'Ivoire	2016	22,701,556	42%	9,626,698	11%	2,544,861	Multiple Indicator Cluster Survey	
Democratic People's Republic of Korea	2009	24,371,806	11%	2,632,155	7%	1,681,655	Multiple Indicator Cluster Survey	

	Recent	Population	Proportion of total population using groundwater point sources	No. using groundwater point sources	Total Proportion using Tubewell/ borehole	Total no of people rural using tubewell/ borehole	Reference	Notes
	Year R	Year R	Year R	Year R	Year R	Year R		
Democratic Republic of Congo	2014	74,877,030	64%	47,567,247	2%	1,743,817	Enquête Démographique et de Santé en République Démocratique du Congo (EDS-RDC II) 2013-2014	
El Salvador	2014	6,107,706	8%	492,696	3%	153,047	Encuesta de Hogares de Propositos Multiples, 2014	
Ethiopia	2016	99,390,750	53%	52,478,316	11%	11,032,373	Demographic and Health Survey	
Ghana	2015	27,409,893	38%	10,485,723	27%	7,410,925	Performance Monitoring and Accountability	
Guinnea Bissau	2014	1,800,513	62%	1,110,502	15%	271,769	Multiple Indicator Cluster Survey	
India	2012	1,263,589,639	52%	652,133,685	42%	532,121,858	National sample survey 69th round	
Iraq	2013	34,107,366	5%	1,582,582	-	-	Household Socio-economic and Expenditure Survey	Tubewell/borehole data not collected in Iraq Surveys
Jordan	2015	7,594,547	0%	35,942	-	-	Population and Housing Census	Tubewell/borehole data not collected in Jordan Surveys
Kenya	2015	46,050,302	33%	15,107,723	8%	3,513,178	Kenya Malaria Indicator Survey 2015	
Lebanon	2016	5,850,743	12%	730,142	0.5%	26,694	Lebanon water quality survey 2016	
Liberia	2013	4,293,692	77%	3,292,889	1%	58,204	Liberia Demographic and Health Survey (LDHS)	
Madagascar	2016	24,235,390	58%	13,970,571	4%	968,570	Malaria Indicator Survey	
Malawi	2016	17,215,232	76%	13,063,075	63%	10,787,264	Demographic and Health Survey	
Mozambique	2015	27,977,863	53%	14,828,267	19%	5,287,816	Inquérito ao Orçamento Familiar, 2014-2015	
Myanmar	2016	53,897,154	64%	34,494,179	28%	15,145,100	Demographic and Health Survey 2015-16	
Nepal	2014	28,174,724	51%	14,340,935	43%	12,227,830	Multiple Indicator Cluster Surveys	
Nicaragua	2014	6,013,913	28%	1,699,228	-	-	Encuesta Nacional de Hogares sobre Medición de Nivel de Vida, 2014	Tubewell/borehole data not collected in Nigaragua Surveys

	Recent	Population	Proportion of total population using groundwater point sources	No. using groundwater point sources	Total Proportion using Tubewell/ borehole	Total no of people rural using tubewell/ borehole	Reference	Notes
	Year R	Year R	Year R	Year R	Year R	Year R		
Niger	2015	19,899.12	67%	13,412	14%	2,825.68	Etude Nationale d'Evalulation d'Indicateurs Socio-economiques et Demographiques	
Nigeria	2016	182,201.96	61%	110,704	35%	64,366.02	General Household Survey, 2015-2016	
Pakistan	2015	188,924.87	36%	68,013	33%	62,345.21	Pakistan Social and Living Standards Measurement Survey 2014-15	
Papua New Guinea	2010	6,847.52	20%	1,383	-	-	HIS	Tubewell/borehole data not collected in PNG Surveys
Saudi Arabia	2010	28,090.65	3%	956	-	-	Census	Tubewell/borehole data not collected in SAU Surveys
Sierra Leone	2015	6,453.18	41%	2,662	8%	505.36	Census	
Somalia	2016	10,787.10	11%	1,230	2%	199.82	Somalia High Frequency Survey, 2016	
South Sudan	2013	11,453.81	70%	8,041	52%	5,978.89	South Sudan Malaria Indicator Survey, 2013	
Sri Lanka	2012	20,421.86	59%	12,131	10%	1,940.08	Census of Population and Housing 2012	
Sudan	2010	36,114.89	33%	11,797	22%	8,057.87	Multiple Indicator Cluster Survey	
Swaziland	2014	1,269.11	0.0%	-	0%	-	Multiple Indicator Cluster Survey, 2014	
Thailand (see notes)	2016	67,959.36	4%	2,854	1%	747.55	Multiple Indicator Cluster Survey 2015-16	NOTE 2015 POPULATION HAS BEEN USED
Trinidad and Tobago	2009	1,321.62	0%	-	0%	-	Household Budget Survey	
Ukraine	2014	45,002.50	28%	12,691	2%	765.04	Living Conditions Survey	
Uganda	2015	39,032.38	72%	28,065	38%	14,834.74	Malaria Indicator Survey, 2014-2015	
Yemen	2013	25,533.22	37%	9,427	15%	3,724.53	National Demographic and Health Survey	
Zambia	2015	16,211.77	56%	9,050	25%	3,975.29	Living Conditions and Monitoring Survey	

Annex 3 Institutional Framework – Key Components for Select Countries - Module 4 Discussion Forum

Country	Licencing/registration /certificate		Guidelines [12] & Standards	National drillers association	Abstraction permit/ licence	Groundwater database	Who registers and/or regulates drillers and consultants?	Notes
	drillers	consultants						
Benin	Yes		Yes	Yes	Yes	Yes		▪ Drillers association does not seem to be active ▪ DANIDA supported development of guidelines/standards ▪ No licence, but drillers need to be registered with the Direction General de l'Eau ▪ Permit required if a private company wants to use groundwater for industrial use ▪ Groundwater database in the national Water Resources Information System (WRIS)
Chad	Yes (for manual drilling)		Yes	Yes	No	Yes		▪ National guidelines have been published for borehole drilling and specifically for manual drilling ▪ Drillers association is active and sometimes involved in training/capacity building ▪ National Water Fund (new agency under the ministry of Water) is working on groundwater abstraction regulations ▪ Groundwater database maintained by the ministry in charge of water and is regularly updated, containing 17,000 records.
Côte d'Ivoire	Yes		No	No		Yes	• National Office for Drinking Water	▪ Drillers require approval from the National Office for Drinking Water ▪ Regulation of drinking water exists but not widely known and does not actually apply ▪ Groundwater database is not up to date and data collection is not systematic
Democratic Republic of Congo	Yes		No	Yes/No		Yes/No	• Ministry of Public Works (medium-sized companies) • Ministry of Energy (large companies)	▪ Company needs trade registration number (RCCM), tax number and approval from the respective ministry to be able to operate. ▪ The Water Code (2016) has been promulgated and government has repealed all previous provisions on drilling ▪ Manual drillers association with provincial branches exists ▪ Groundwater database exists from the 1950's and the public company that manages the mines and geographical institute are trying to update hydrogeological maps
Ethiopia	Yes	No	No	No	No	No	• MoWIE	▪ Annual renewal of drillers licences ▪ Norm is to use standard BoQs and technical specifications ▪ Drilling contractors can be members of the National Water Works Contractors Association, but this association is not considered reputable by all, and only few contractors are members ▪ Drilling permits exist, but are not enforced; abstraction licencing under development ▪ Groundwater mapping efforts are on-going

[12] for Borehole & Rehabilitation

Country	Licencing/registration /certificate		Guidelines [12] & Standards	National drillers association	Abstraction permit/ licence	Groundwater database	Who registers and/or regulates drillers and consultants?	Notes
	drillers	consultants						
Ghana	Yes		Yes	No	Yes	No	• Water Resources Commission	▪ Guidelines for borehole drilling and rehabilitation published but they may not be well-known to practitioners due to insufficient dissemination; guidelines are straightforward to understand; lack of incentives to adhere to guidelines ▪ Most unregistered companies able to work for government, NGOs and private users ▪ Enforcement of regulation of abstraction has been weak
Iraq			Yes (but old)			No	• Directorate of underground water	▪ UNICEF building capacity of directorate of underground water in 2018 ▪ UNDP may support groundwater database
Kenya	Yes	Yes	Yes	Yes	Yes		• Ministry of Water and Irrigation	▪ All drillers, hydro-geologists and water sector consultants must be registered and licenced. However, annual renewal of registration and licence is normally automatic. Ministry published a list of contractors who have been licenced; in devolved units some contractors can practice without licence. ▪ National Codes of Practice (CoP[13]) gazetted in 2013 but not widely known/availed/ adhered to. CoP's are under review. ▪ Kenya Water industry Association (KWIA) is active and reputable, promoting good governance and an associative culture; drillers represent 40% of membership ▪ Groundwater authorization is required from Water Resources Authority for borehole drilling; this can be converted to a Groundwater Abstraction Licence. ▪ Historic database is not comprehensive, particularly of recent decades; KWIA has pilot project to digitally map boreholes and is trying to obtain funding to scale up.
Lebanon	Yes		No		Yes			▪ Water Code (2018) includes articles related to groundwater protection, well drilling licences and groundwater abstraction ▪ Supposed to have a permit, but there is widespread illegal, unlicensed drilling
Liberia	No		No	No	No	No		▪ Chapter on "Drilled Well" within the Guidelines for Water and Sanitation Services ▪ Discussions regarding abstraction permits are on-going
Madagascar	Yes			No	Yes	No	• Ministry of Water	▪ Abstraction permits are in the code of water but not put into effect ▪ Groundwater database under development
Malawi			Yes	No	Yes	Yes	• National Construction Industry Council • Malawi Institute of Engineers	▪ Drillers need registration when bidding ▪ New drilling guidelines and standards published in 2016 (JICA supported) ▪ Association not necessarily registered ▪ Enforcement of water permits not good ▪ Old data in groundwater database

[13] 1. Siting of Boreholes, 2. Borehole Construction; 3 Supervision of Construction of Boreholes and 4. Pumping Test of Boreholes

Country	Licencing/registration /certificate		Guidelines [12] & Standards	National drillers association	Abstraction permit/ licence	Groundwater database	Who registers and/or regulates drillers and consultants?	Notes
	drillers	consultants						
Mozambique	Yes	Yes	Yes	Yes	Yes	No		▪ Regulation according to Public Works ministerial diploma 77/2015. No company can drill boreholes for states without a licence. ▪ Guideline approved by Government (degree law 18/2012 for exploration of groundwater through wells and boreholes, but not widely known beyond government staff. Government has capacity limitations for enforcement. ▪ Mozambique National Driller Association (APM) has small support from World Bank ▪ Decree 43/2007 & 12/2012 regulates water abstractions. Permits required for commercial & industrial use; irrigation of area more than 1 hectare and piped water ▪ On-going process to establish national database
Nicaragua				No		Yes		▪ Norms exist but are not well known by the public ▪ Efforts to implement a database system since 2012 but with difficulties. Data not public
Nigeria	No		Yes		No			▪ Code of Practice for Water Well construction issued in 2010 is comprehensive but little known, even among professionals. ▪ Adherence to the regulations and enforcement weak. ▪ Drilling companies only have to register as corporate organisations
Saudi Arabia	Yes		No	No	Yes	No		▪ General procedures about borehole drilling available when drillers get their licence ▪ Study underway to better monitor and manage drilling contractors ▪ New Water Law
Sierra Leone	No	No	Yes	No	No	No		▪ New act of National Water Resources Management Act 2017 will regulate companies /consultants and abstraction ▪ Principles of Borehole Drilling and rehabilitation published
South Sudan	No		Yes	No	No	Yes/No		▪ Guideline on drilling association is being worked on. ▪ Hand dug well water association newly initiated by government with UNICEF support. ▪ Issuing of permits & regulating abstraction has not been clearly streamlined to states. ▪ There are ten groundwater databases located in ten states, but they are poorly managed. E.G. only 1,642 boreholes recorded in Torit state since 2011.
Sudan	No			No	No	No		
Trinidad and Tobago	Yes		No	No	Yes	No	• Water and Sewerage Authority (WASA)	▪ To become approved (pre-qualify) by the Water and Sewerage Authority (WASA), drillers are required to have their rig inspected and approved for the use specified. ▪ National Energy Skills Center's Drilling Academy trains upcoming drillers and sets out standards and procedures for them to follow

Country	Licencing/registration /certificate		Guidelines [12] & Standards	National drillers association	Abstraction permit/ licence	Groundwater database	Who registers and/or regulates drillers and consultants?	Notes
	drillers	consultants						
Thailand	Yes		Yes	Yes	Yes	Yes	• Department of Groundwater Resources	▪ Drillers without certificates cannot obtain work for government, NGOs or private ▪ Guidelines not widely known nor so easy to understand; Incentives to adhere to guidelines lacking, as is enforcement ▪ Drillers association is active and reputable ▪ All types of drilling and abstraction operations require licences ▪ Groundwater database maintained by Department of Groundwater Resources and contains thousands of drilling records.
Ukraine	Yes				Yes	No	•	▪ Permission for a borehole is needed if daily consumption is bigger than 5 m^3 or the water is to be used for farming
Uganda	Yes	Yes	Yes	Yes	Yes	Yes	• Directorate of Water Resources Management	▪ Drillers **and consultants** licences issued on an annual basis; list is on Ministry of Water and Environment website ▪ Policies, regulation, guidelines, standards in place but enforcement is a challenge ▪ Borehole numbering system in place ▪ Permits required for motorised boreholes
Yemen	Yes		No			Yes/No	• Ministry of Water	▪ Drilling permission paper exercise only/ standards & regulations not strictly enforced ▪ Standards need to be updated ▪ SWSLC has established a department to supervise drillers ▪ National Water Resources Authority used to collect groundwater and water level data but stopped due to funding shortages/struggle to collect data and some NGOs as well as private users do not submit data ▪ Young professionals prefer to seek opportunities with NGOs other than government

Annex 4 Actions to Raise Drilling Professionalism

The table below summaries the topics discussed and actions proposed by participants to raise drilling professionalism in assignment module 5.

			Stakeholders Interviewed/Surveyed									
			Govt.-ment				Private Sector					
Organisation	Country	Topic(s) Discussed	National	Regional/ Provincial / Local	UNICEF	NGO	Siting/supervision	Drilling	Support Organisation	Donor	Civil society or research	Ideas for action
Government	Benin	Groundwater database and groundwater monitoring network	✓									Noted that monitoring is financed by donors rather than government.
UNICEF	Cameroon	Key actions required	✓			✓		✓				Elaboration of a construction code/technical guideline Training of borehole drilling companies Improved planning at council level Audit of borehole drilling companies
UNICEF	Chad	**Manual drilling** association (issues, technical capability, expectation and plans)						✓				Survey on the quality of the upper aquifer that underlies N'Djamena Raise awareness of positioning wells to avoid contamination in the urban setting Train new members of the association, on drilling techniques and bidding
UNICEF	Côte d'Ivoire	Delays in execution of works Procurement and supervision Data	✓					✓			✓	Set up data collection tools Recover VAT
UNICEF	DRC	**Manual drilling** professionalization (company registration, associations, govt. dialogue)				✓						Support the establishment of a drillers association
UNICEF	DRC	**Manual drilling** – what needs to be done? (institutional framework, providers, donors) **Mapping** of areas favourable for		✓		✓						Include supervision by an experienced hydrogeologists in all tenders

			Stakeholders Interviewed/Surveyed									
			Govt.-ment				Private Sector					
Organisation	Country	Topic(s) Discussed	National	Regional/ Provincial / Local	UNICEF	NGO	Siting/supervision	Drilling	Support Organisation	Donor	Civil society or research	Ideas for action
		manual drilling Obstacles to use of **hydrogeologists** to site and supervise										
UNICEF	Ethiopia	Drilling **Supervision** (availability, capacity, qualifications, delays, milestones, in-house vs. outsourcing)		✓	✓			✓				Study to better understand economic value of drilling supervision. Develop code of conduct/code of practice Support groundwater legislation
UNICEF	Ethiopia	Groundwater **information** **Project design, implementation & monitoring** Human resources **capacity in local** government (experience, equipment, turnover)		✓								Expand detailed hydrogeological studies involving remote sensing and overlay analysis, field studies and drilling test wells. Support and lobby for improved data collection, including sharing best practice. Provide on-job and practical training to professionals
UNICEF	Ghana	**Value for money, procurement**, professional **expertise**	✓				✓					Have a central point at national level for data collation. See how many reports by different stakeholders can be routinely shared.
UNICEF	Ghana	Mechanisms for **professionalism**, borehole drilling **management**, data	✓									Hold discussions with CWSA on the workflow and steps to improve on professionalism. Ensure measures are in place to improve data collection. Will validate all sites selected by consultants before construction takes place. Carry out a nation-wide capacity building and refresher training on professionalism within borehole drilling.
UNICEF	Iraq	Selection of borehole **location**						✓			✓	Mapping water aquifers Enhance capacity in Directorate of Underground Water Update/ activate technical guidelines for water including

Organisation	Country	Topic(s) Discussed	Stakeholders Interviewed/Surveyed									Ideas for action
			Govt.-ment				Private Sector					
			National	Regional/ Provincial / Local	UNICEF	NGO	Siting/supervision	Drilling	Support Organisation	Donor	Civil society or research	
												boreholes
UNICEF	Iraq	**Authorisation** to drill, drilling **professionalism**, **improvements**	✓	✓	✓							Share knowledge learned Explore how to establish better information management system for boreholes
UNICEF	Jordan	Lack of drilling contractors, maintenance of completed borehole, government oversight	✓									Technical training Conduct feasibility studies for planned projects Differentiate between development and emergency projects
UNICEF	Kenya	Major challenges, community engagement and procurement		✓		✓						Support capacity building of county team to build drilling supervision capacity through workshops and on-job training.
UNHCR	Lebanon	Siting, permits	✓									Will include a hydrogeologist for site selection, follow-up during drilling and documentation of results. Engage in dialogue to reach a proper coordination and data sharing, plus harmonized data recording.
UNICEF	Madagascar	Private sector perspective						✓				Try to enable drillers to be paid their first instalment after receiving materials to support small drilling companies. Map areas with groundwater potential (project underway).
UNICEF	Madagascar	Reduce **negative boreholes**, **sustainability** of boreholes and **control** office						✓				Several solutions proposed (improve siting and database, and set up monitoring chain)
Government	Malawi	On-site practical issues (contract document, equipment, safety and security)						✓				Hold site meetings so that all parties involved can meet and discuss pertinent issues of the contract and check equipment.
Government	Nicaragua	Familiarity with procedures, obstacles								✓		Develop a training program to reproduce knowledge learned during the course

			Stakeholders Interviewed/Surveyed									
			Govt.-ment				Private Sector					
Organisation	Country	Topic(s) Discussed	National	Regional/ Provincial / Local	UNICEF	NGO	Siting/supervision	Drilling	Support Organisation	Donor	Civil society or research	Ideas for action
												Implement a system to register contractors that demonstrate capacity to provide the services.
UNICEF	Nigeria	Code of Practice, supervising capacity, payment for dry boreholes and roles.					✓					Strengthen adherence to Nigerian Code of Practice
UNICEF	Nigeria	Borehole failure, non-adherence to specifications, quality control		✓			✓					Organise on-job field training programme for contractors to demonstrate key stages such as test pumping and platform construction. Technical training of government for supervision and 3rd party monitoring
NGO	Pakistan	Bidding, siting, coordination, post-construction monitoring				✓		✓				I can share resistivity test data for areas where the chances of dry boreholes are high with the relevant government line department. Pay for dry boreholes in areas where chances are high.
Government	Saudi Arabia	**Siting** - use of geophysical methods, maps and hydrogeological reports before drilling; **licencing; costing; quality; dry boreholes**										Strengthen capacity Training on costing Borehole database Guidelines
UNICEF	Sierra Leone	**Drilling process** including contract award, supervision, regulation, groundwater database and operation and maintenance	✓									Try to scale up SALWACO Sustainability Plans across the country.
UNICEF	Somalia	Borehole **lifespan**, **reasons for failure, professional siting** and						✓				Will advocate with the water department to include drilling sector stakeholder conference in the 2018 work

			Stakeholders Interviewed/Surveyed									
			Govt.-ment				Private Sector					
Organisation	Country	Topic(s) Discussed	National	Regional/ Provincial / Local	UNICEF	NGO	Siting/supervision	Drilling	Support Organisation	Donor	Civil society or research	Ideas for action
		construction										plan.
UNICEF	South Sudan	**Procurement**, **supervision** and **monitoring** of borehole drilling							✓			Improve professional skills of drilling supervision On job training for newly recruited drillers Closer collaboration between agencies for procurement
Government	Thailand	**Problems** of borehole drilling, **challenges** and **solutions**						✓				Noted that the lack of deeds of ownership of land where drilling is to take place causes problems for drillers. Provide budget to enhance drilling capacity.
Government	Trinidad and Tobago	**Groundwater information**	✓									Put all data available into one national water database
Government	Trinidad and Tobago	**Groundwater database, data sharing, drillers association; human capacity: licences;**	✓					✓				Establish a national database Educate the public about the benefits of water well drilling Engage Ministry of Planning in siting process. Share plans with other relevant ministries
UNICEF	Uganda	**Difficulties and how to address them**						✓				Discuss clustering drilling works for a number of districts with the government
UNICEF	Uganda	**Hydrogeological information and borehole records**				✓						Advocate for inclusion of supervision in borehole procurement, ensuring budget provision and experienced and skilled person is assigned to supervise. Efforts to improve borehole record keeping by drillers and sharing with government
NGO	Yemen	**Equipment, challenges, siting, driller orientation**								✓		Share what has been learnt Organisation to set a good example
NGO	Yemen	**Technical drilling challenges**		✓								Follow systematic steps for borehole project