

Capacity building of Acholi people in Uganda to develop and manage village water supplies.

*Geoscientists Without Borders Application:
Q3Q4 2020*

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FollowUp Form

Basic Information

Project Name*

Name of Project

Capacity building of Acholi people in Uganda to develop and manage village water supplies.

Project Start Date*

Select the date when your project was started.

01/04/2023

Project End Date*

Select the date when the project ended.

07/31/2023

Report Author(s)*

List the names of the primary author(s) of this final report.

Paul Bauman, Landon Woods, Kate Robey

Executive Summary

The Executive Summary section of the report should succinctly, yet comprehensively, summarize the project and its outcomes. Greater detail on the project will be provided as outlined in the additional sections of the report.

Introduction*

Provide a brief, focused introduction to the project and its need.

This project was designed to provide or restore safe water supplies and livelihoods to Acholi villagers affected by the 23 year civil war with the LRA.

Project Goals and Objectives*

Describe the project goal(s) and objectives as they were outlined in the Phase II application or subsequent project revisions approved by the GWB Committee.

The project was designed to:

1. Restore safe groundwater supplies in villages with non-operating hand pumps
2. Provide safe groundwater to villages without safe water supplies
3. Provide skills training to Acholi people working in the water sector
4. Develop an enhanced geoscience understanding of crystalline basement aquifers

Project Participants*

List all project participants, with title and affiliation.

Paul Bauman, Technical Director and Principal Geophysicist, Geophysics, BGC Engineering.
Vanda Golani, IsraAID, Director of Finance.
Selda Edris, IsraAID Africa WASH Director.
Landon Woods, Geophysicist and Hydrogeologist, BGC Engineering.
Junior Olok, Uganda WASH Manager, IsraAID.
Daniel Kintu, Country Manager, IsraAID.

Methods Used*

List all methods used, including application and specific instrumentation.

Geophysical Exploration: Electrical resistivity tomography, EM34 terrain conductivity mapping
Borehole geophysics: Magnetic susceptibility, EM39 induction
Stable oxygen and hydrogen isotope analyses
Major and minor groundwater chemistry
Trace metal chemistry
Hand pump functionality
Manual drilling using the Baptist Method

Summary of Results and Key Findings*

Provide a summary of the project's results and key findings.

Geophysics surveys were used to site water wells in 10 villages and one school. Over the same period, non-functioning hand pumps were repaired in nine villages. To date, 8 of the village exploration water wells and one primary school water well have been successfully drilled and completed with India Mark II (U2) hand pumps. The 9 new wells benefit an estimated 7,400 people and the nine repaired wells benefit an estimated 6,920 people. The ongoing drilling of a further 2 wells will benefit an additional estimated 1,000 people.

Conclusion and Implications*

List the conclusions that the project team derived and the implications those conclusions have.

1. Weathered and fractured crystalline basement aquifers can be bracketed by well defined formation conductivities (or the inverse, formation resistivities).
2. Groundwater reported lower risk to contamination based on E.coli counts, while most of the water samples from unprotected springs and surface water (i.e., 10 of the 14 samples) had E.coli counts within the high to very high risk range for drinking water.
3. Groundwater systems are predominantly recharged by heavy monsoonal rains with little contribution from lighter rains during the drier seasons.

4. Groundwater quality is generally excellent as a drinking water source.
5. Groundwater hand pump non-functionality is greatly underreported.
6. Manual drilling facilitates the drilling, well construction, and hand pump installation at a relatively low cost of less than \$2,200 USD per well.

Non-functioning hand pumps were repaired in 9 villages.
New wells were drilled and pumps installed in 9 villages and 1 school.
1 village well currently being drilled.

Deliverables*

List all deliverables that will be discussed in the final report, including those that were given to the in-country partners and participants.

Final 176 page report including exploration and repair program, detailed methodologies, results, and conclusions.

Final Report

The final report should be comprehensive and provide enough information for assessment of whether the project has accomplished the technical, humanitarian, educational, and sustainability goals outlined in the Phase II application. You are expected to write the report with the care and attention to detail that a published paper requires. Reports are published (with confidential information removed, including financial data) on the GWB website to help educate the public on the program and its impact. Reports should be proofread to ensure accuracy of language and data.

Figures and pictures should be original, high quality graphics and must include captions and appropriate scales. All maps should be oriented with north at the top. All field data and interpretations should be shown on logs, maps, and sections within the same georeferenced projection system, datum, and scale. All maps and sections are to have distance scales in the same unit system. Include color legends, if appropriate.

If you would like additional guidelines to help you prepare your report, please email us at withoutborders@seg.org and ask for more specific instructions.

Reports that have not been written with the highest attention to detail and accuracy will be returned to draft status for editing and any pending payments will be delayed until an acceptable report is received.

Project Location and Geologic Setting*

In the space below, provide a description of the project's location, including its geologic setting. Using the upload button, attach a Word document, pdf, jpeg or preferably, a geotiff with a map of the area where the team is working. Include a bounded polygon around the area where studies are being conducted. Include the title "Project Location" at the top of the document.

The project was located in the Acholiland sub-Region of Northern Uganda. The entire sub-Region is underlain, almost completely, by Pre-Cambrian crystalline rocks.

Project Location continued*

Upload a Google Earth kmz file that outlines the boundaries of the project location. This file will be used to display the project location on a master map of GWB projects, including the project map on the GWB website.

Acholiland_Sub-region.kmz

Humanitarian Need and Benefit*

Summarize the reason, need(s) and benefit(s) of the project (humanitarian, community, environmental, etc.)

Provide safe water to communities that do not have any access to safe drinking water supplies for the purposes of consumption, cooking, sanitation, and hygiene.

Project Goals and Objectives*

Describe the project goal(s) and objectives as they were outlined in the Phase II application or subsequent project revisions approved by the GWB Committee and the methods used to accomplish the goal(s).

Provide safe water and livelihoods to Acholi people of Northern Uganda.

Provide an enhanced understanding of crystalline basement aquifers as rural water supply sources in East Africa.

Previous Studies in the Project Area*

Provide a summary of the pertinent previous studies by others in the project area. Describe how the current project goals complemented previous work or filled a void.

This project follows 2015 and 2016 geophysics and groundwater training courses by Paul Bauman and IsraAID, and a 2018 GWB rural water supply development program. This program continues to provide water to more villages, develop the skill sets of the 2015 and 2016 trainees, and continues to develop relationships with Gulu Universities and the Government of Uganda.

Field Studies*

Using the space below, describe the field studies conducted during the course of the project. Be sure to include the following:

- Approach(es) used, including your rationale for the particular approach(es), the application mode applied, and instrumentation used (manufacturers and models, number of electrodes, etc.);
- Brief description of methods used;
- Who conducted the field work (professors, students, locals, professionals?)? Be sure to clearly indicate who did what;
- Provide maps of data acquisition and acquisition dates;
- Provide evaluation of data quality and usefulness;
- Describe inversions applied and software used;

- Provide field results, including pertinent samples with inversion residual error values)
- Describe any field challenges or problems and the actions taken to mitigate them.

Use the upload button to attach a Word document or pdf appendix with the maps and figures referenced in your summary, including captions. Include the title "Figures for Field Studies" at the top of the document.

Figures_for_Field Studies.docx

The scope of work for this project includes:

1. EM34 terrain conductivity mapping and ERT to explore for, and site water wells for 10 villages and one school. In the process, the Acholi students were trained in the use of these methods, and the interpretation of the data. They were also trained on surveying and positioning using GPS mapping units.
2. Unmanned Aerial Vehicle (UAV) photogrammetry to create high resolution georeferenced basemaps at all exploration sites. These maps are essential for confidently siting water wells months after the geophysical surveys have been completed.
3. Microbiological (E.coli) testing of spring and surface water sources at all exploration sites where groundwater (via hand pumps) was not available.
4. Repairing non-functional water hand pumps at nine villages.
5. ERT and borehole formation conductivity logging at the repair sites in order to better understand the geology and physical properties that characterize productive crystalline basement aquifers.
6. Magnetic susceptibility logging to determine whether magnetics may be a useful physical property to aid in water exploration in Northern Uganda.
7. Downhole inspection camera surveys to understand the construction of the various water wells that were repaired, as well as to identify obstructions in the wells that could interfere with the borehole geophysics and the repair of the hand pump.
8. Geochemical and stable isotope water sampling.
9. Limited field water quality testing.
10. A simple but novel method of testing hand pump functionality. The test was utilized to assess the hand pumps performance before and after repair.
11. A full classroom day with the Acholi trainees to present and jointly interpret the preliminary results of the field program. Topics covered included the interpreting processed geophysical results, water quality, and hand pump evaluations. This served to reinforce the training and contextualize the field work performed together.

Interpretation of Data*

In the space below, describe the interpretation of data for the project. Be sure to include all of the following:

- Describe the interpretation process applied, including data integration, borehole comparisons, 2D surfaces developed, 3D interpretative images, fence diagrams, voxels, etc.;
- Provide examples of representative final interpretations including maps, sections, images, charts, tables, etc.;
- Provide an evaluation of the data quality and usefulness as application to interpretation;
- Include discussion on whether the data support the goals, objectives, and hypotheses and discuss what additional data would be useful.

Use the upload button to attach a Word document or pdf appendix with any figures or pictures referenced in your summary, including captions. Include the title "Figures for Interpretation of Data" at the top of the document.

List of Photos

1. Uganda geophysics and groundwater team
2. Canadian geophysics and groundwater team
3. Water Miller-Repair
4. Labroromor-Repair
5. Lakwela-Repair
6. Latyeng-Repair
7. Loyoalero-Repair
8. Agung-Repair
9. Abongorwot B-Repair
10. Abongorwot A-Repair
11. Lela Obaro Village-Repair
12. Lela Obaro School-Exploration
13. Pato-Exploration
14. Obolokume-Exploration
15. Bungajubi-Exploration
16. Lacid-Exploration
17. Teolam-Exploration
18. Ayac Kal-Exploration
19. Goro-Exploration
20. Onyomolil-Exploration
21. Agikanyi-Exploration
22. Ayila-Exploration
23. Classroom Training at Gulu University
24. Baptist Drilling Method in Teolam
25. E. Coli Testing
26. Completed Water Well in Teolam
27. Baptist Drilling Action
28. GWB Photographer Linda Harrison

Human Element*

Describe the involvement of participants. Include all participants, such as college professors, professional consultants, students (either local or from outside the local region), local residents, local governments, and others.

Approximately 32 Acholi people, all of whom had participated in earlier GWB programs, worked on this program. Two professors from Gulu Universty were involved in the program, both of whom are Acholi. The Acholi trainees did all of the drilling, pump repair, and pump installations without any assistance from the Canadian geoscientists.

Project Sustainability*

It is a goal of GWB that funded projects continue sustainably after their end dates. To receive GWB funding and achieve that goal, funded projects proposed sustainability goals and objectives to achieve them. Describe measures taken to ensure the sustainability of the project beyond the end date. What methods did you use and what objectives were accomplished to ensure project sustainability?

Measures to ensure sustainability included:

1. Working with the same group of Acholi since 2015
2. Including women in all program aspects
3. Incorporating village assistance and participation in all drilling programs
4. Using high quality stainless steel pump components
5. Installing only hand pumps that do not have the capability to over-pump the aquifers

6. Using geophysical methods to optimally site wells in zones of thickest aquifer material
7. Preceding all field work with village engagements
8. Following up all field work with village engagements
9. Providing equipment donations of equipment that is appropriate and on which the trainees are trained

Education*

What educational institutions within the host country have been involved in the project? What other educational institutions have been involved? Describe any specific educational opportunities that have been provided during the project to any stakeholders (local residents, professionals, students, government officials, etc.) within the host country.

We have worked closely, and continue to do so, with the BioEngineering Department at Gulu University. We have provided field opportunities for both students and faculty. As well, we continue to work with the same group of about 63 Acholi trainees as we have since 2015.

Lessons Learned*

Describe the positive and negative lessons learned while conducting the project. What you recommend to do and not to do during future projects?

The single most important lesson we have learned is that continual training, reinforcement, and personal interaction are essential to moving any region or project forward. A one-off, single visit intervention is quickly forgotten. As such, though we have now done 4 programs in Northern Uganda, we find the value of every program is ever increasing as our returning to the region inspires increased confidence in the trainees, the University, and the Government.

Financials*

Provide a categorical comparison of the actual expenses versus the proposed expenses (as outlined in the project budget submitted for inclusion in the grant agreement).

You may upload a file showing the budget to actuals comparison or use the space below to describe the financials.

Deliverables

Access to Data

As a program of the SEG, a society devoted to advancing an applied science, GWB encourages its project participants to foster transparency and further educational goals of the program by providing access to data collected during the course of the project. In the following question, you will be asked to share the status of the availability of your project's data for others to use for educational purposes.

Access to Data*

Please select the option that describes the status of the availability of your project's data for others to use for educational purposes and type it in the space below:

- Data associated with this project are available and can be accessed via the following URL: _____. Note: A digital object identifier (DOI) linking to the data in a general or discipline-specific repository is strongly preferred.
- Data associated with this project are available and can be obtained by contacting the following project participant: _____ at _____.
- Data associated with this project are confidential and cannot be released for the following reason(s): _____. Note: Confidentiality should be limited to 1 to 2 years after project completion. (If you choose to keep it confidential, please describe a way for the GWB Committee to have access to the raw and processed data for three years.
- Your own custom statement of data and materials availability.

The data is available to anyone by contacting Paul Bauman, Landon Woods, or Colin Miazga at pbauman@bgcengineering.ca or lwoods@bgcengineering.ca or cmiazga@bgcengineering.ca

Photos and Videos*

Please provide the GWB office with relevant photos and videos of people, places, and activities to document the project and for later use on the website, social media and other venues for sharing about the GWB program's impact. In the space below, describe how you will make the media available and when the office can expect to receive the items.

Photos have been included in report and on social media. Some high-res photos have been provided to GWB as requested. We will provide GWB with any material we have that they may request.

References

References*

List all references to previously published work cited in the report. Provide complete citations, following the SEG guidelines to authors for articles in *Geophysics* and *The Leading Edge*. We encourage use of the digital object identifier (DOI) number for citations, when available.

- Bauman, P., Miazga, C., Layton, M., Woods, L., & Pankratow, L. (2018, December 12). Community Groundwater Supply Development in Acholiland, Northern Uganda: Groundwater Geophysical Exploration, Well Repair, Drilling, Well Construction, and Water Chemistry Study. [Report]. Prepared for IsraAID and Geoscientists Without Borders. <https://seg.org/programs/geoscientists-without-borders/funded-projects/Brett>, M.E. (2015). Field Study Investigating the Potential of Water Quality Testing to Predict Corrosion in Boreholes in Northern Uganda [M.Sc. Thesis]. Mercer University. Macon, Georgia.
- Casey, V., Brown, L., Carpenter, J.D., Nekeska, J., and Etti, B. (2016). The role of handpump corrosion in the contamination and failure of rural water supplies. *Waterlines*, 35.
- Craig, H. (1961). Isotopic variations in meteoric waters. *Science*, 133, 1702-1703.
- DWRM (Ministry of Water and Environment, Directorate of Water Resources Management). (April 2012 April). Gulu District Groundwater Report : Mapping of Groundwater Resources in Uganda. EU Water Facility, Lahmeyer International. 84 pp.

- Fader, Caleb T. (2011). Retrofitting Boreholes Contaminated with Iron in Rural Uganda [M.Sc. Report]. Michigan Technological University.
- Fitterman, D.V. and Labson, V.F. (2005). Electromagnetic Induction Methods for Environmental Problems. *Investigations in Geophysics* : 301-356. <https://doi.org/10.1190/1.9781560801719.ch10>
- Ibe, K.M., Egereonu, A.H., & Sowa, H.O. (2001). The impact of handpump corrosion on water quality in rural areas of west African sub-region. *Environmental Monitoring and Assessment*, 78, 31-43.
- Kellett, R. and Bauman, P. (2004). Mapping Groundwater in Regolith and Fractured Bedrock Using Ground Geophysics: A Case Study from Malawi. *Focus Article, CSEG Recorder*, Vol. 29, No. 02.

Current and Planned Abstracts, Articles, and Presentations*

List all current and planned abstracts, journal articles, and presentations based on the project.

Geophysical Water Exploration and Self-Supply in Post-Conflict Uganda, abstract and presentation at May 2023 Calgary GeoConvention

Building Water Resilience in Uganda, One Well at a Time, Abstract submitted to SAGEEP2024

Providing Water to 400 Million People in Sub-Saharan Africa, paper presented at SEG ICEG in the UAE, October 2023

A Case Study on Capacity Development in Rural Groundwater Supply in Acholiland, Northern Uganda, abstract and presentation at IAH Conference in South Africa, 2023

Using Geophysical and Hydrogeological Field Methods to Establish Safe Community Water Supplies in Northern Uganda: A Grassroots Approach, GeoSaskatoon, 2023
also planned IAH 2024 in Davos, and IMAGE 2024