

**Response to “Comments on ‘An investigation of the basement complex aquifer system in Lofa county, Liberia, for the purpose of siting boreholes’”**

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Hydrogeological knowledge is vital for developing sustainable groundwater supplies globally. This is particularly true for the underpinning data from basement complex areas, such as those in Liberia, with complex hydrogeology and where past political instability has led to information and knowledge loss. The authors are therefore appreciative of the attention paid to their paper (Elster et al 2014) by Beeson and Jones (2014) and welcome the opportunity it provides for discussion on this important topic.

In Liberia, Action Contre la Faim (ACF) works in a consortium with Concern Worldwide, Oxfam GB, Solidarités and Tearfund. As intimated by Beeson & Jones, these organisations were not able to provide details of any previous work they or others had conducted on the basement complex aquifer system in Lofa county. There was also no information available on any geophysical methods used for siting boreholes previously in this area.

We agree that electrical resistivity traversing does indeed enable investigators to detect significant changes in subsurface resistivity along large section distances, assuming that surface vegetation does not hinder access. However, such an approach was not seen as a potential advantage in this

case, as the boreholes needed to be sited close to the specific villages and the study looked to understand local groundwater occurrence in a range of key features, including deep weathering zones, fracture zones, weathered dykes and seasonal wetlands. In our particular study, we considered that the advantage of the improved hydrogeological interpretation gained from the depth information provided by 2D electrical tomography and the greater ease of laying out the cables, given the dense local vegetation, outweighed the shorter lateral distances covered.

We recognise that electromagnetic induction (EMI) systems, such as the EM-34 which can give variable depths of exploration down to 60 meters, are commonly used for groundwater exploration. However, the only functioning equipment available to the researchers at the time of the study was for 2D geo-electrical surveying, so no comparisons were possible with other types of surveys. However, one of our recommendations at the time was that ACF should consider the purchase of electromagnetic equipment to use in the future, given the faster surveying over larger areas and the relative ease of use in densely vegetated areas.

The hydrogeological and geomorphical mapping and borehole siting was conducted in collaboration with the local drilling team who did understand the particular hydrogeology of each site. Also, the study concluded with a 4-day lecture and practical workshop on improving borehole siting with geophysical and hydrogeological methods, attended by 18 participants from ACF partners (NGOs, governmental institutions and the UN). Beeson and Jones (2014) are correct to highlight this need, as building local capacity is a vital step in achieving safe water supplies.

Our search for previous studies which might inform the research focussed on Lofa county and the geographically and geologically similar Nimba county in north eastern Liberia, although discussions were also had with the Liberian Geological Survey, Liberian Hydrological Survey and the University of Liberia. Unfortunately this resulted in the details of the DANIDA funded project mentioned by Beeson and Jones (2014) being overlooked as it was based in Maryland which is 1000km away in the far south of the country. However, a broader search of the British Geological Survey's online library

catalogue and DANIDA's Research Portal failed to identify the particular DANIDA study referred to by Beeson and Jones. We agree with Beeson and Jones (2014) that this demonstrates the need for information sharing between agencies but also highlights the importance of archiving and retaining research and consultancy outputs in accessible and maintained repositories for possible future use by the hydrogeological community.

## **References**

BEESON, S., JONES, C., 2014. Comments on 'An investigation of the basement complex aquifer system in Lofa county, Liberia, for the purpose of siting boreholes'. Quarterly Journal of Engineering Geology and Hydrogeology, in press

ELSTER, D, HOLMAN, I.P, PARKER, A. & RUDGE, L. 2014. An investigation of the basement complex aquifer system in Lofa county, Liberia, for the purpose of siting boreholes. Quarterly Journal of Engineering Geology and Hydrogeology, 47, 2014, pp. 159-167