**Meeting report on a national technical review of UNESCO - GRIDMAP Advanced Survey of Hydrogeological Resources of the Upper Jarer - Fafem, Somali Regional State**

**28 February 2013**

**Background:**

UNESCO Addis Ababa in collaboration with the Ministry of Water and Energy has contracted Radar Technology International (RTI) to conduct groundwater survey in Somali regional state in a specific locality called Upper Jarer and Fafem. The study has been finalized and the report submitted in September 2012. A method called WATEXTM has been used in this particular study by the contractor. Two outcomes of the study are an identification of undocumented graben aquifer named as ‘Karamara graben aquifer’ and estimates on groundwater storage in recharge. The method is an integration of conventional hydrogeological mapping and radar remote sensing. UNESCO is in a process of communicating the finding of this study in national and international press conference. Before doing this, it was found important to discuss the finding of the study and the approach that has led to the results. Two main issues of discussion were a) get experts opinion about the different figures and numbers given in the report about groundwater potential including recharge and storage and b) to discuss about the conceptual groundwater model particularly about the geometry and presence of the graben.

To facilitate the discussion process a meeting agenda has been drafted (attached) and used during the meeting. The final study report has been distributed to the experts before the start of the meeting on the same day. Furthermore, the agenda lists the objectives, purpose, expected output and point of discussion for the meeting. The experts were drawn from different institutions and different domains of expertise (geophysics, geology, stratigraphy, hydrogeology, drilling etc)(see annex ii).

**Conduct of the meeting:**

The meeting started with presentation by Dr Alain Gachet, President of RTI. Dr Gachet made three consecutive presentations. The first one introducing the WATEX technology with particular reference to Radar Remote Sensing component, the second one on the application of WATEX for shallow groundwater mapping and third application of the same for deep groundwater mapping. The entire presentation took 1 hour and 45 minutes. The presentation was followed by discussions, Q&A and comments that last for another two hours. The following were discussed with respect to the guiding discussion agenda and the presentation made as well as the report prepared by RTI.

1. **‘Discovery’ of graben aquifer East of Karamara range:** Mr Abebe Ketema and Ato Engida Zemedagegnhu raised the issue that there has been several previous geological and hydrogeological studies in the area mainly referring to the maps prepared by the Geological Survey of Ethiopia (EGS, 1996) and the earlier works conducted by Hadwen et al. (1973). Furthermore the Ethiopian Water Works Design and Supervision Enterprise is conducting a hydrogeological survey in the area and have known the presence of the graben in the region. A reply to this by Dr Alain Gachet and clarification made by Dr Seifu Kebede was that the graben known in earlier times was the geomorphologic valley that is drained by the Jarer Valley East of Karamara range. The graben that has been identified in this work was a buried graben that underlay the foothill of the Karamara range underlying a topographically higher ground.

The discussion on the structural graben continued. Ato Abebe Ketema and Ato Engida Zemedagegnehu referred that we lack evidence for the presence of this graben. One of the evidence that could highlight the presence of the graben was a well which is currently being drilled by IRC in Gereselay area which is located where one could encounter the structural graben. However the well didn’t reveal much information as the borehole encountered a very hard formation which could not be penetrated by drilling. According to Dr Gachet this could be shale layer intercalated within the Hamanile formation. According to an intervention made later by Dr Asfawossen Asrat shale lithology is rare within Hamanile limestone formation and suggested this could be some other rock. If this hard formation is proven to be basement rock it could disprove the idea of the presence of structural graben at the foot hill of the Karamara range in Jarer valley. At this stage there is little evidence to proof or disproof the new conceptual model made about the previously undocumented structural graben.

1. **Groundwater recharge, storage potential, groundwater target map and conceptual model:** According to Mr Engida Zemedagenghu and Dr Wagari Furi, the estimate made on groundwater storage in the alluvial aquifer is an underestimation. Although little evidence exist about the groundwater storage in deeper aquifer the number given still appears overestimation according to Dr Wagari Furi but he recommends further works on this. The recharge rate given is made on very crude estimation eg. ‘Rule of thumb’ and much cannot be said about it.

Dr Wagari Furi raised a question whether the WATEX method could be used to map groundwater potential. According to him groundwater potential should be determined once the transmissivity, storage properties are determined. Dr Alain Gachet replied that WATEX product is a groundwater target map where one could target for drilling productive wells without necessarily referring the yield of that particular well. Ato Engida Zemedagegnehu commented that WATEX application would be interesting if one could get information about thickness of alluvial sediments and grain size distribution.

The other discussion point was the conceptual model presented by Dr Alain Gachet stating a gently dipping graben aquifer towards the SE, getting its recharge from the northern sector and conveying the water southwards and predicting the possibility of an artesian system in the southern sector of the study area. Dr Asfawossen, geologist/geomorphologist from Addis Ababa University commented that in such a model what is happening underneath may affect the groundwater potential. According to him (and view shared by Taye Alemayehu) if there is underground stream that concentrate all the groundwater to channel instead of distributing into porosities across the graben, considering the fact that the conceptual model refers to highly karstified Hammanlei Formation as the main aquifer, using the groundwater target map one could miss the water. Later Dr Asfawossn admitted this could not be verified easily as there is insufficient data to suggest that there is significant karstification of the Hammanlei Formation.

1. **WATEX methodology in general:** Dr Tigistu Haile a geophysicist from Addis Ababa University raised a technical question about the capability of the Radar component of WATEX package. According to him with remote sensing radar image one could not penetrate inside the surface more than few centimeters to map moistures against the presentation that the method has been used to investigate to depth of 30 meters or even more. Dr Alain’s reply was that their system could go deeper. He stated that the moisture mapping has been used in such a way that it identifies conductive/wet fractures from dry fractures. Dr Seifu Kebede proposed some of the conductive fractures containing moisture are located at higher elevation so much so that upward leakage needs significant hydraulic head which may not present in the region and cautioned about the interpretation of the conductive fractures.

According to Ato Abebe Ketema his impression about WATEX was its rapidity and cost effectiveness. Ato Engida expectation, as it was told by the Dr Gachet a year ago during project launcing, was that it could give information about grain size distribution in sediments and their vertical extent.

Ato Zebene Lakew, Ato Abebe Ketema, Ato Enginda Zemedagenhu and Ato Taye Alemayehu commented further that the WATEX technology has a promising scope to be applied in drier areas of Ethiopia such as the Northern Ethiopian region that is bordering Eritrea, in Borena plain bordering Kenya where the main water bearing formations are shallow sediments mantling the basement. For this they recommend any future intervention could make use of national consultation as where one can successfully apply WATEX. Ethiopia’s context- that the terrain is topographically heterogeneous, alluvial and other shallow sediment aquifers are texturally heterogeneous. In addition to these, the climate in most parts of the country is relatively not dry enough for RADAR application. This makes most parts of the country less suitable for RADAR technology application that may complicate results or lead to mistake if not applied with care. While the mentioned professional agree that WATEX could be used convincingly in areas such as Darfur or Chad, in Ethiopia best targets needs to be select beforehand.

1. **Other issues raised**
2. WATEX probably worked very well in Darfur and Chad (as reported by Dr Gachet) but needs to be tested further in Ethiopia (Ato Taye Alemayehu, Dr Tigistu Haile)
3. The recommendation by RTI to obtain seismic data for better understanding of the hydrogeology of the region is useful, given the cost involved one can also opt for magnetotelluic method. Undertaking geophysical survey was suggested to validate results (Dr Tigistu)
4. The leaking fractures and apparently wet signals observed in Jesoma sandstone needs further review because in drilled wells in Jessoma sandstone we have not witnessed such in field experience (Ato Engida Zemedagegnehu)
5. Issue of depth of penetration of radar signal has been debated in back and forth, Dr Alain Gachet and Dr Tigistu Haile, the former saying deeper and the later saying shallower.
6. We have been expecting WATEX to give as thickness of alluvial sediments, so what is the added value if we don’t get thickness value (Ato Engida Zemedagenehu). WATEX has added value in distinguishing between dry alluvial sediments and wet alluvial sediments so it has added value (Ato Taye Alemayehu)
7. Application of integrated approach other than WATEX for GW exploration for irrigation purpose in adjacent area with similar setup is giving very encouraging results, 100% m 12 wells drilled so far.
8. Ways forward
   1. Prioritize areas for intervention with national consultation. WATEX could be used in northern and southern Ethiopia basement covered areas may not be elsewhere in basalt plateau covered by wetlands and clay soils (audience) may not also contribute much in Mesozoic carbonaceous sedimentary terrains.
   2. Hydrogeological survey and ongoing drilling operation in Jarer and Fafem valleys may reveal the validity of the newly proposed structural graben.