Rendiconti online Soc. Geol. It., Vol. 2 (2008), 1-3

Hydrogeological and geophysical investigations for groundwater in the Arumeru District (Northern Tanzania)

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ABSTRACT

Key words*: Groundwater, Fluoride pollution, Tanzania*

Due to water shortage, in the wards of Ngarenanyuki and Oldonyosambu (Arumeru District, Northern Tanzania), the per capita daily water consumption is 8 liters as.average, The avaleability goes down to 3-4 liters in the dry seasons when most of the population cannot resort to seasonal ponds or streams and so it is compelled to concentrate around the few perennial water points. This datum is quite far from the Millennium Goal objectives that foresee a quantity of at least 20 l/d/p (litres per day per person) for the Development Countries population, within 2015. Problems are also related to water quality, in particular, the high concentration of fluoride that characterises the waters in East Africa Rift System.. As known, water with a high fluoride concentration cannot be drunk, since an excessive assumption of fluoride can cause serious pathologies classified as dental fluorosis and skeletal fluorosis. On this account, the World Health Organization has imposed the limit of 1,5 mg/l of fluoride, but the Tanzanian government has been forced to move up its security limit from 4 to 8 mg/l of fluoride, just in order to face the widespread problem of water shortage. In addition, phenomena of pollution due to bad management and lack of maintenance of water supplying structures are widespread.

In the above context, this research was aimed at finding fresh and safe groundwater easily deliverable to the Wards that suffer water shortage. This general aim has been pursued through a multidisciplinary action consisting of geological, hydrogeological, hydro-chemical, geophysical and hydrological studies.

The study area has a surface of approximately 440 km^2 and lies in the northern part of the Arumeru District, approximately 50 km from Arusha, the capital city of the region. It is bounded by the Mount Meru (4565 m a.s.l.) and the Arusha National Park, and includes 9 villages belonging to the Oldonyo Sambu and Ngarenanyuki Wards. Climate is generally semi-arid, with two different seasons: the dry season and the rain season.

The topography of the area is dominated by the volcanic cone of the Mt. Meru (4565 m a.s.l.) whose slopes cover most of the area. The remaining land is overlain by gently sloping alluvial fans fed by the Mount Meru detritus. Recent small volcanic cones are preserved NW of the Meru; small maar-type flat craters often occur. The drainage pattern around the Meru is clearly radial, but downhill the stream courses are modified by tilting and capture. East and north-east of the Mt. Meru, the only perennial river is the Engare Nanyuki the waters of which have very high fluoride content. This stream flows northwards into the inner Amboseli Basin allowing local irrigation.

The dominant rocks are mainly Cenozoic volcanic sequences, while the most recent are alluvial deposits. Linear features and bench are frequent on the flanks of the Meru and it is highly probable that the early volcanic structure has been block-faulted. The thickness of the volcanic rocks is only approximately known because of the uncertainties associated withdepositional, tectonic and geomorphologic events during the Cenozoic evolution of the volcanic building up. These events exert a strong control on the geometry of the aquifers, the recharge and discharge areas and the groundwater quality.

In the whole area, important hydrogeological complexes occur within different lithologies. The main aquifer systems are made up of volcanic formations, occurring singularly or superimposed each other. Subordinate perched aquifers are present in sedimentary formations. However, some of these aquifer systems have only local occurrence.

The groundwater flow system has been interpreted on the base of springs spatial distribution taking into account their chemical and isotopic composition. The groundwater regional flow system has been found as generally controlled by the morphology, and involving a multidirectional flow with the dominant pattern from the higher elevation area in the south, towards the lower area in the north.

With the aim of evaluating the potentiality of the two areas with respect to the groundwater resources, geophysical surveys have been carried out. Measurements have been performed by means of the VES (Vertical Electrical Sounding) technique.

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Lavoro eseguito con il finanziamento di Istituto Oikos e nell'ambito delle attività di Cooperazione decentrata (LR 19/96 E.F. 2006) con il contributo finanziario della Regione Sardegna

The whole data allowed to work out the hydrogeological conceptual model and to define a “drilling suitability” for each of the sub-areas investigated.

The main results of the research can be synthesized as follows:

- Definition of the geological, hydrogeological and hydrochemical setting;
- Assessment of the hydrogeologic unit;
- Geological and hydrogeological conceptual model, synthesized into hydrogeological cross sections, derived from the integration of field surveys and bore hole data;
- Groundwater circulation and recharge scheme;
- Water quality classification (fluoride concentration and distribution);
- Isotopic analyses;
- Recognition of homogeneous sub-areas suitable by well drilling, mainly based on the geophysical results;
- Construction of the borehole Ichnusa well1 at Mkuru, including well design, well completion and development joined to pumping test. This work led to define a confined aquifer with good water quality (fluoride concentration is 3.1 g/l) that we named Mkuru aquifer. Its thickness is around 20 m (from 38 and 59 m below g.l.); it consists of scoriaceous, autobrecciated basalt with high permeability;
- Drawdown versus time measurement was performed during 48 hours at a constant pumping rate of 3,8 l/s, which was the maximum yield allowed by the pumping device. None barrier boundary or recharge effect has been highlighted.

REFERENCES

AA.VV. (2000) - *Arusha Region water master plan. Final Report* - United Republic of Tanzania, United Nation Development Programme

AA.VV. (1983) - *Geological map: Arusha* – Quarter Degree Sheet 55 scale 1:125.000 Geological Survey of Tanzania

DETTMAN D.L., PALACIOS-FEST M.R., NKOTAGU H., COHEN A.S. (2005) - *Paleolimnological investigations of anthropogenic environmental change in Lake Tanganyka: VII. Carbonate isotope geochemistry as a record of riverine runoff.* Journal of Paleolimnology **34**: 93-105pp

GEA F. (2005) - *Analysis of issues connected with water supplying in Maasai pasturelands around the village of Uwiro (Arusha, Tanzania).* Graduation Thesis University of Torino (Italy) 149pp

JAROSLAV VRBA & ANNUKKA LIPPONEN (2007) - *Groundwater Resources Sustainability Indicators* -. Unesco, IAEA, IAH. United Nations Educational, Scientific and Cultural Organization. IHP/2007/GW-**14** 115pp

O.M.S. (2006) - *Guidelines for drinking-water quality*. First addendum to third edition. Vol.1 – Recommendations, WHO 2006

RIADE project (2002-2006) - *Integrated Research for Applying new technologies and processes for combating Desertification* www.riade.net