Water recourse management in the Valley of Cochabamba – A geophysical survey

The demand of Earths recources has increased with the world's growth in population. Fresh water is one of the most important natural resources, needed for many disciplines within society. Water is naturally occurring in so-called aquifers, porous sediments within the ground that store water. It can be extracted with the use of wells. However, the demand for drinking water in overpopulated areas can result in unsustainable overexploitation on local aquifers. This is the case for the population of Cochabamba in Bolivia. The use of geophysical investigations can help provide information about the subsurface, without needing to dig or mine the area and can thus be used to study aquifers.

This article aims to determine the geometry of a potential aquifer and the depth to the bedrock on a farmland outside the city of Cochabamba. Two geophysical methods have been used: Electrical Resistivity Tomography (ERT) and the Transient Electromagnetic method (TEM). These methods measure the resistivity of the subsurface, i.e. the ability of materials to resist the flow of electrical current. The ERT method is based on passing a current through the subsurface and measuring the resistivity of the ground. TEM on the other hand, uses a magnetic field that is sent through the ground. It will induce a current in the subsurface and the ground will generate a new magnetic field. Measuring instruments and computer programs will then create a resistivity model for ERT and TEM. The resistivity of any given geological material can vary, and different geological formations can have overlapping resistivities, sometimes making interpretations difficult. It is therefore important to be aware of the local geology to avoid faulty interpretations.

Fig. 1 shows a 3D model consisting of several TEM profiles. As seen from the model, the upper parts of the subsurface consists of resistivities up to 2000 Ωm. Below, the resistivity drops to around 100 Ωm. The Valley of Cochabamba is filled with sediments of different grain sizes. In general, coarse grains show higher resistivities than finer grains due to the difference in porosity. Coarse grains have more space between themselves compared to finer grains, which increases the resistivity. The high resistivities in the upper part are linked to coarse-grained sediments (gravel & sand). Furthermore, the resistivity of up to 2000 Ωm is within the resistivity range of gravel and sand. Below, finer grains, such as clay, is likely to dominate the grain size in the lower parts of the subsurface.

These coarse sediments (gravel & sand) potentially allows water to be stored in the space between the grains. The layer reaches a maximum thickness of 110 m in in the northern and eastern part of the study area (Fig. 1). In the southern and western part, the thickness decreases to 40 and 20 m respectively, whereas it only reaches a few meters in the south-western part (Fig. 1). Thus, this will be the geometry of the potential aquifer. The depth to the bedrock could not be determined due to inadequate penetration depth of the measurements. The maximum penetration depth is 260 m, whereas the expected depth to the bedrock in the study area is close to 1000 m.

It would be of interest to the population of Cochabamba to protect this potential aquifer since it could be used as a source of drinking water in the future. It is therefore important to keep this open farmland free from buildings or other structures that would otherwise hinder the infiltration of water.

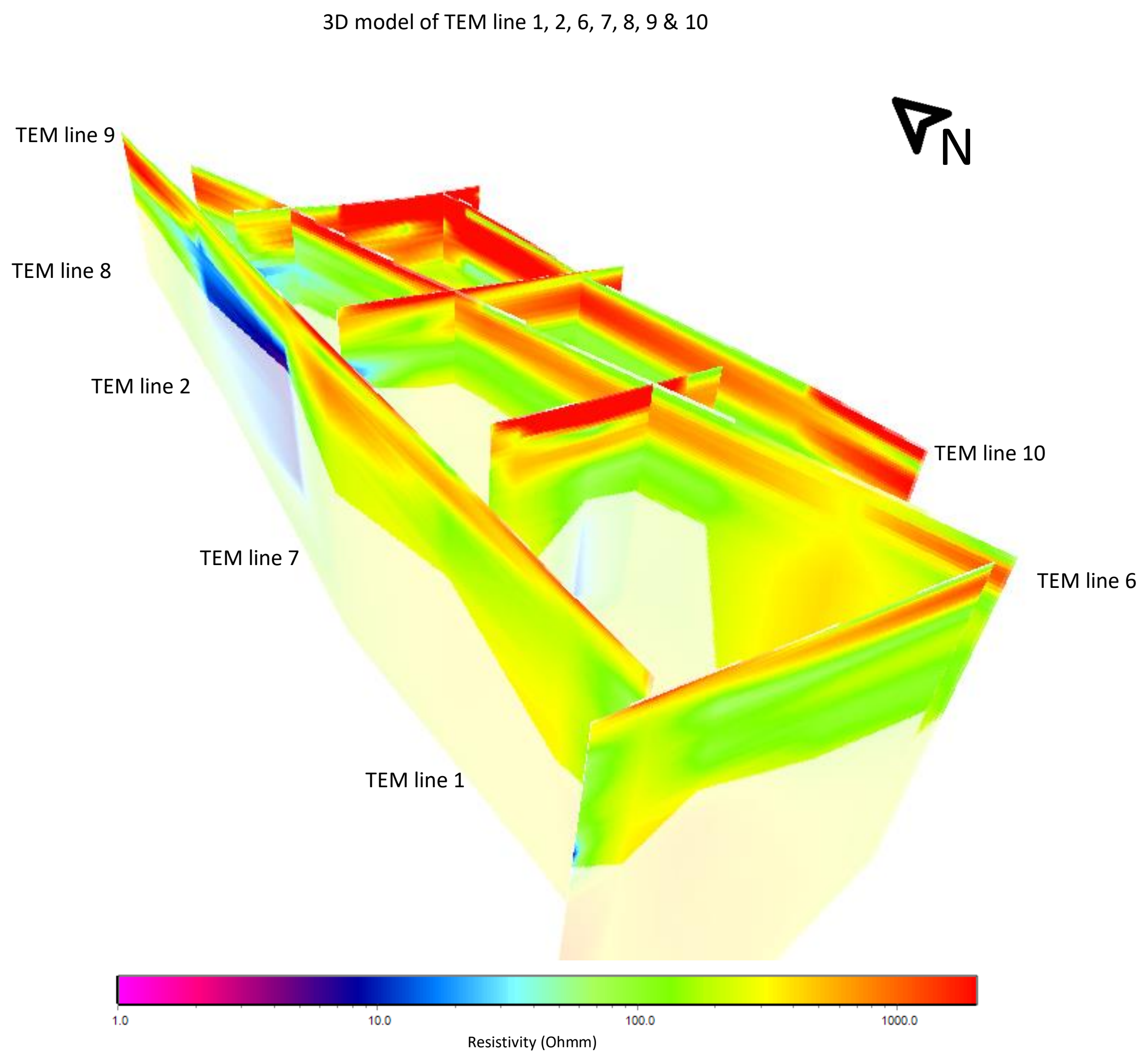

Figure 1. A 3D model consisting of TEM line 1, 2, 6, 7, 8, 9 and 10. The model shows the variations in resistivity within the study area.