Post-tsunami helicopter-borne electromagnetics along the coasts of Aceh, Indonesia

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Introduction

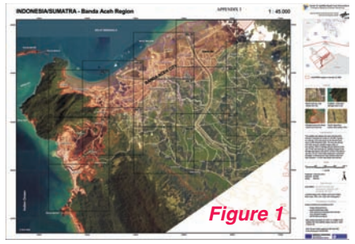
The earthquake and the tsunami-event on December 26th, 2004, caused the loss of life of more than 120,000 people, the missing and injuring of more than 110,000 people and the destruction of about 80% of all private houses, basic infrastructure and public facilities in the coastal region in the Province of Nanggroe Aceh Darussalam. The tsunami waves caused large scale coastal salt-water intrusions and destroyed thousands of shallow drinking water wells ***(Figure 1)***.

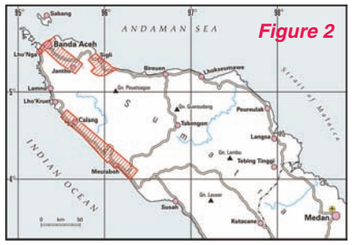
This presentation documents a project between the Indonesian and German governments that is dedicated to re-install the public life and to secure the future health and wealth of the people that suffered from the consequences of the catastrophe. The focal point is the water assessment in coastal areas of Aceh about nine months after the tsunami.

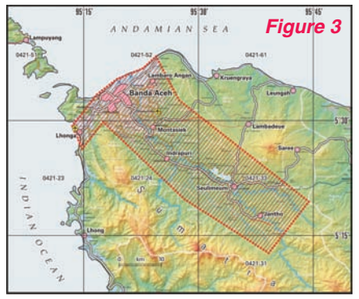
The aim of the project of the Federal Institute for Geosciences and Natural Resources (BGR) is to assist the Directorate General for Geology and Mineral Resources (DGGMR), the National Development Planning Agency (BAPPENAS) and the Executive Agency for the Rehabilitation and Reconstruction in Aceh and Nias (BRR) in their efforts to plan and realize a sustainable reconstruction of community infrastructure (like fresh-water supply) by providing geophysical, hydrogeological, geological and topographic data that will serve as a base for spatial planning.

The main activities comprise an airborne geophysical survey and a hydrogeological reconnaissance survey. The target areas are: Banda Aceh, Calang - Meulaboh and Sigli ***(Figure 2)***. The helicopter-borne survey was conducted by the airborne group of the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) from August to November 2005. This poster exemplifies the results of the airborne and surface water assessments in the area of Banda Aceh, Aceh Besar ***(Figure 3)***.

The BGR helicopter-borne geophysical system includes five-frequency electromagnetics (HEM), magnetics (MAG) and gamma-ray spectrometry (SCI). The electromagnetic system provides information about the distribution of electrical conductivity in the earth down to a maximum depth of 150 m (***Figure 4***).







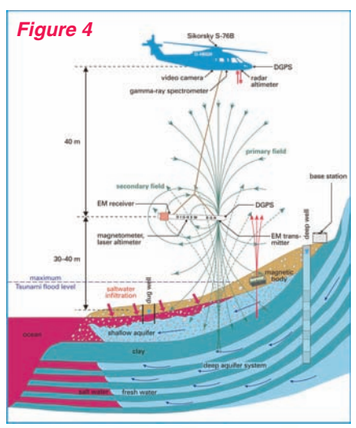


Figure 5
Shallow saltwater intrusion

Resistivity at 5 m bgl; red and pink colours outline areas of shallow saltwater intrusion. EC values measured in February 2005 by Planéte Urgence and August-October 2005 by BGR are shown as coloured circles and boxes, respectively.

Planéte Urgence, 2005. Identification inventory and analysis of drinking water points in the region of Aceh, island of Sumatra. Development mission following the tsunami of December 2004 Indonesia.

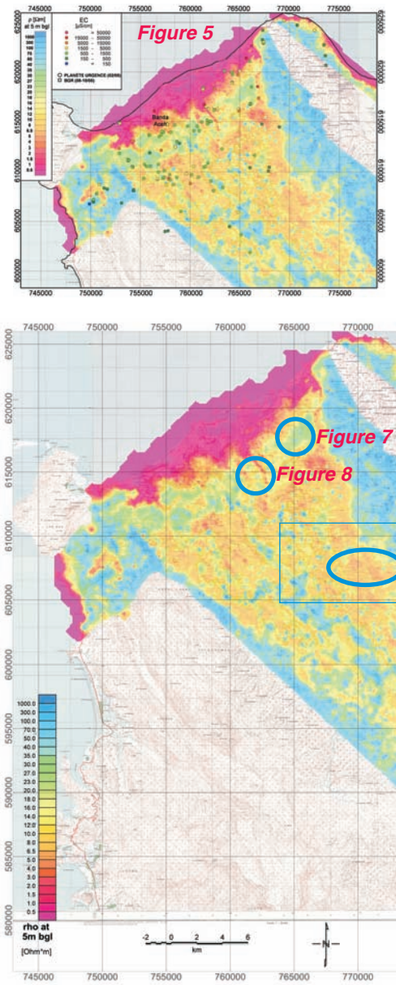
Figure 6
Deep saltwater intrusion

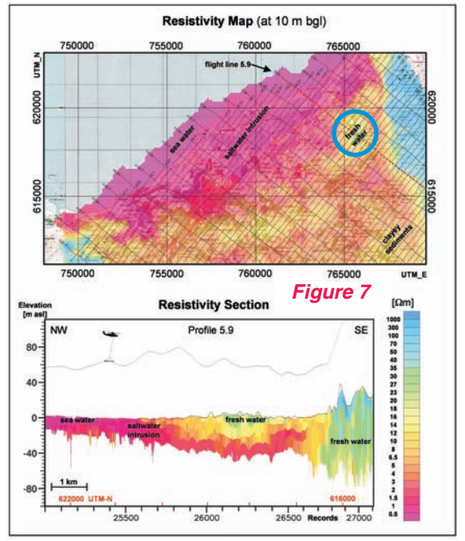
Resistivity at 30 m bgl; red and pink colours outline areas of saltwater intrusion. Saline water at 30-50 m depth was reported in at least two boreholes confirming that saltwater intruded several kilometres inland.

Farr, J.L. & Djaeni, A. (1975): A Reconnaissance Hydrogeological Study of the Krueng Aceh Basin, North Sumatra.- Report No. 1909 (GSI) / No. WD/OS/75/8 (IGS): 13 pp., Geological Survey of Indonesia (GSI), Engineering Geology – Hydrogeology Sub-Directorate, Bandung, in cooperation with the Engineering Geology Unit of the U.K. Institute of Geological Sciences (IGS), London.

Figure 7
Fresh-water lens

One of the main tasks of HELP ACEH has been to outline fresh-water resources. From the resistivities maps it is evident that there are only some shallow fresh-water resources within the coastal areas of the Krueng Aceh valley. One is situated some 10 km east of the city of Banda Aceh. Lateral and vertical extend of this fresh-water lens on top of saline water are clearly outlined by resistivity maps and sections, respectively.





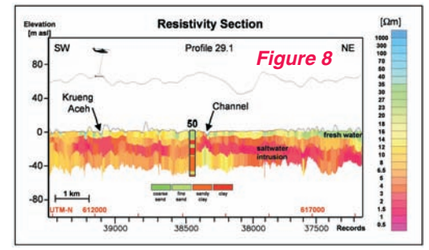


Figure 8
Comparison to well log

Comparison of 1-D HEM inversion results along profile 29.1 and drillings results: At borehole no. 50 situated 6.5 km inland, a low resistive layer (4 Ohm m) at 14-26 m bsl is sandwiched between slightly more resistive layers (5-10 Ohm m) below a moderate resistive cover (>12 Ohm m). That corresponds well with clay/sand layers sandwiched between sand cover and underlying sandy clay, but the thin sand layer at about 45 m bsl cannot be revealed. The low resistivities are obviously caused by clay and/or saline water saturated sand/clay.

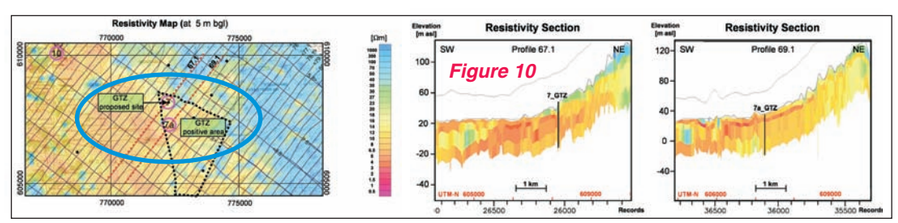
Figure 9
Proposed depth of fresh-water well

Several organisations are drilling water wells in order to provide the population of Banda Aceh / Aceh Besar with potable water. BGR received many enquiries for appropriate drilling sites or, if the site had already been chosen, for information about the lithology to be expected. One example is shown in the figure. SDC (Swiss Agency for Development and Cooperation) planned a water well close to the Krueng Aceh (river) and wanted to know how deep their borehole should be. From the resistivity section it could be assumed that about 14 m of sand/gravel covers a thick layer of clay or sandy clay.

Figure 10
Proposed location for sanitary landfill

GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit GmbH) investigated the area within 20 km around Banda Aceh with respect to potential sites for sanitary landfills. Krause (2005) outlines several potential areas and proposed a small set of potential sites. Unfortunately, no geological information other than the Geological Map 1:250.000 were available for this study. Therefore, some potential sites were placed where no geological barrier (clay) exists. HEM may help to overcome this difficulty due to its sensitivity to clayey sediments. GTZ's best proposed site, from a geological point of view, has been site no. 7 (on profile 67.1), but a better choice within the positive (allowed) area would be shifting the site towards the south (e. g. site 7a) where more clay (red layer in resistivity section along profile 69.1) can be expected.

Krause, P., 2005. Pre-selection of a sanitary landfill site for the City of Banda Aceh. Volume I, SLGSR-GTZ, Banda Aceh.



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