FACTSHEET
Seismology

German Indonesian Tsunami Early Warning System

Establishment of a Tsunami Early Warning System in the Indian Ocean – The German Contribution

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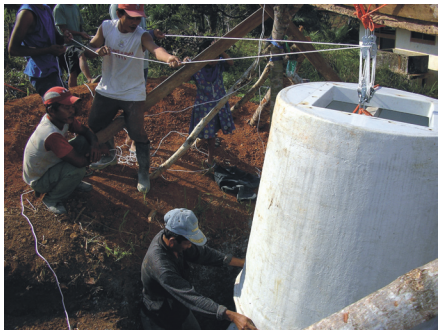
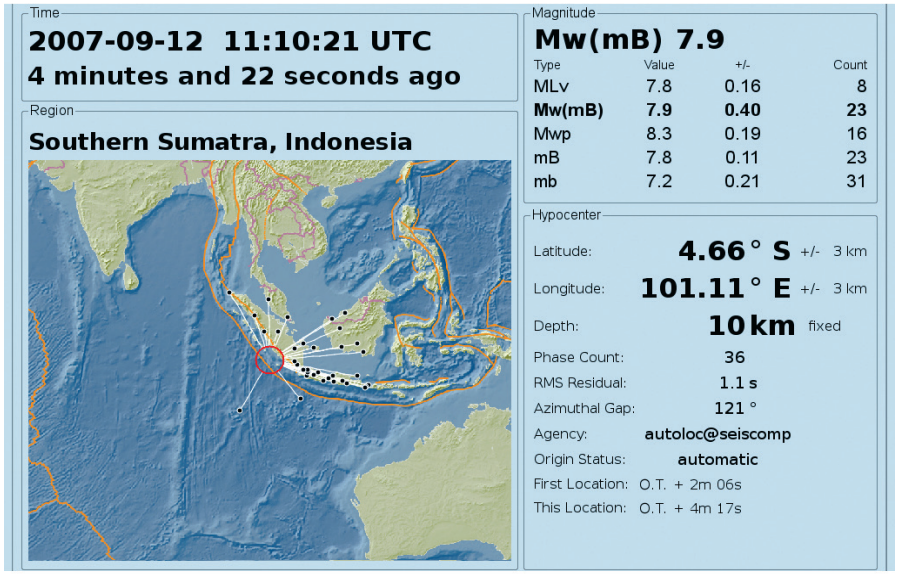
The GITEWS Earthquake Monitoring System

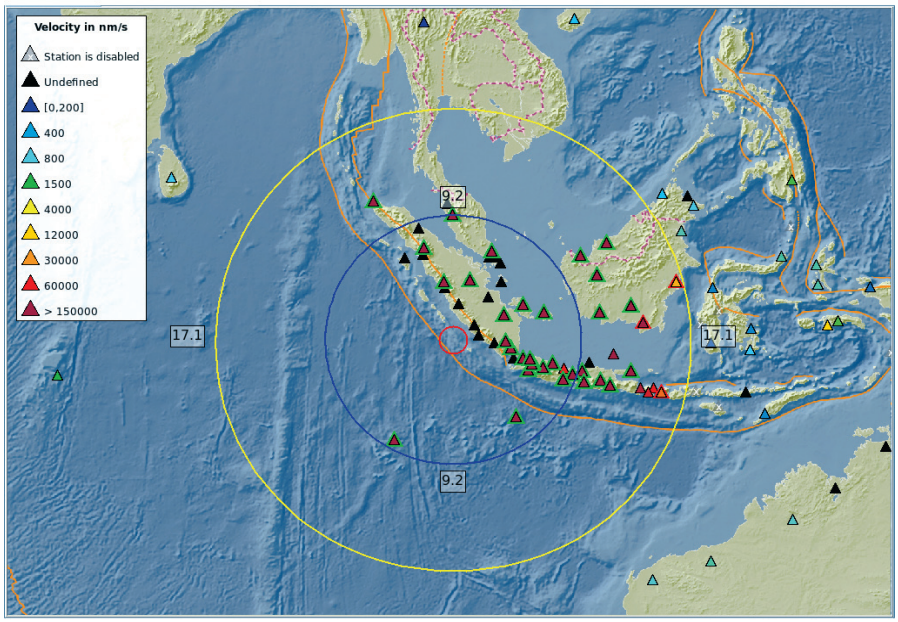
Within the concept of the German-Indonesian Tsunami Warning System (GITEWS), the Earthquake Monitoring System plays a central role. The time available to warn the population in coastal areas after a tsunami has been generated by a large earthquake in the Sunda trench is extremely short since possible tsunamis hit the coast only 20 to 40 minutes later. Therefore tsunami watch or warning bulletins have to be issued preferably within 5 minutes and these will primarily be based on rapidly determined earthquake parameters and pre-calculated tsunami scenarios fitting these parameters. Other sensor data such as buoy and tide gauge data will usually not be available within such short time frame but will be needed later to either validate a warning status or to be able to cancel it.

The rapid determination of seismic parameters for tsunamogenic earthquakes requires a dense seismic network with many stations as close to the source region as possible. The final goal for the overall network in Indonesia is about 160 stations throughout the country, 22 of these will be supplied by GITEWS, the largest contribution from the various donor states. Others are from Japan (15 stations) and China (10 stations), about 90 stations are funded by Indonesia itself. Standard seismic equipment will be saturated if too close. Therefore GITEWS and other seismic stations in Indonesia are equipped with normal broadband seismometers as well as with strong motion accelerographs. A private VSAT system using the Indonesian Telkom-2 satellite is used for data transfer from the GITEWS stations to the warning center at BMG in Jakarta. In addition to the Indonesian stations, all openly available seismic data from stations around the Indian Ocean are imported in real time via the Internet. Among these, up to another 20 more GITEWS stations are installed or in preparation to be installedin Sri Lanka, Maldives, Yemen, Madagascar, Kenya, Tanzania and South Africa until the end of the project in 2010.



But even with a sophisticated seismic network and reliable VSAT communication the determination of correct information on earthquake location, depth and size within 5 minutes remains a challenge. The special software packet SeisComp 3.0 has been developed which combines generalized data acquisition, a real-time data transfer protocol, automatic procedures





to determine location, depth, magnitudes and rupture parameters and sophisticated alert and visualization tools. The first challenge for the system is to acquire and harmonize the data streams from the different subnetworks. The SeisComP software is capable to fulfill this requirement and to form a virtually unique seismic monitoring network. Although 24/7 operation is mandatory at BMG, the basic parameter calculation is at first carried out fully automatic, but visual supervision is provided at each stage. Acoustic and optical alert tools are implemented to guarantee the attention of the seismic experts in the warning center. They can interfere any time and correct automatic results and can also accelerate the automatic processing if desired.

A prototype version of SeisComP 3.0 was installed at BMG for testing in early May 2007. An updated version for routine service became available in early September, just before the Bengkulu earthquake sequence at September 12-13, 2007 and could successfully prove its capabilities. Since the system at that time already processed the real-time data of a quite big virtual seismic network about 100 stations within and around Indonesia it was possible to achieve already an almost perfect timing for the real-time data analysis for this events. It was possible to obtain for the first and most tsunamogenic quake on September 12 (final moment magnitude 8.4) a first "heads-up" alert after just less than 2 minutes and a first estimate of location, depth range and magnitude after 2 minutes, 30 seconds. A stable solution estimating a moment magnitude of 7.9 based on 25 stations was available after 4 minutes, 20 seconds leading to the first tsunami alert ever issued by BMG in less than 5 minutes.

The excellent performance is on the one hand owed to the efficient professional software design, but on the other also to newly developed algorithms for the estimation of the final moment magnitude from the very first signals recorded. Future developments will provide additional seismic parameters such as rupture direction and length, but will also allow to link the central system in Jakarta to other SeisComP installations at regional centres in Indonesia and also to other GITEWS partners institutions in the Indian Ocean area.

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China Earthquake Networks Center (CENC)
Institute Observatory of Geophysics of Abtananarivo, Madagascar (IOGA)
Japan Meteorological Agency (JMA)
National Research Institute for Earth Science and Disaster Prevention (NIED)
Dept. of Meteorology of the Republic of Maldives
Ministry of DisasterManagement and Human Rights of Sri Lanka (MDMHR)
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