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The GNSS-based component for the new Indonesian tsunami early warning centre provided by GITEWS

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Introduction

Nowadays GNSS technologies are used for a large variety of precise positioning applications. The accuracy can reach the mm level depending on the data analysis methods. GNSS technologies thus offer a high potential to support tsunami early warning systems, e.g., by detection of ground motions due to earthquakes and of tsunami waves on the ocean by GNSS instruments on a buoy. Although GNSS-based precise positioning is a standard method, it is not yet common to apply this technique under tight time constraints and, hence, in the absence of precise satellite orbits and clocks.

The new developed GNSS-based component utilises on- and offshore measured GNSS data and is the first system of its kind that was integrated into an operational early warning system. (Indonesian Tsunami Early Warning Centre INATEWS, inaugurated at BMKG, Jakarta on November, 11th 2008)

Motivation

After the Tsunami event of 26th December 2004 the German government initiated the GITEWS project (German Indonesian Tsunami Early Warning System) to develop a tsunami early warning system for Indonesia. The GFZ Potsdam (German Research Centre for Geosciences) as the consortial leader of GITEWS also covers several work packages, most of them related to sensor systems. The geodetic branch (Department 1) of the GFZ was assigned to develop a GNSS-based component.

Brief system description

The system covers all aspects from sensor stations with new developed hard- and software designs, manufacturing and installation of stations, real-time data transfer issues, a new developed automatic near real-time data processing and a graphical user interface for early warning centre operators including training on the system. GNSS sensors are installed on buoys, at tide gauges and as real-time reference stations (RTR stations), either stand-alone or co-located with seismic sensors. The GNSS data are transmitted to the warning centre where they are processed in a near real-time data processing chain.

For sensors on land the processing system delivers deviations from their normal, mean coordinates. The deviations or so called displacements are indicators for land mass movements which can occur, e.g., due to strong earthquakes. The ground motion information is a valuable source for a fast understanding of an earthquake's mechanism with possible relevance for a potentially following tsunami. By this means the GNSS system supports the decision finding process whether most probably a tsunami has been generated or not.

For buoy based GNSS data the processing (differential, with GNSS reference station on land) delivers coordinates as well. Only the vertical component is of interest as it corresponds to the instant sea level height. Deviations to the mean sea level height are an indicator for a possibly passing tsunami wave.

The graphical user interface (GUI) of the GNSS system supports both, a quick view for all staff members at the warning centre (24h/7d shifts) and deeper analysis by GNSS experts. The GNSS GUI system is implemented as a web-based application and allows all views to be displayed on different screens at the same time, even at remote locations. This is part of the concept, as it can support the dialogue between warning centre staff on duty or on standby and sensor station maintenance staff.

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