THE GNSS-BASED COMPONENT OF THE GERMAN-INDONESIAN TSUNAMI EARLY WARNING SYSTEM (GITEWS): OVERVIEW, FIRST OPERATION RESULTS AND CURRENT DEVELOPMENTS

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1. INTRODUCTION

The German Indonesian Tsunami Early Warning System GITEWS follows a new approach for tsunami early warning including more sensor system types and assigned components than earlier systems. All GITEWS components have been integrated in the Indonesian Tsunami Early Warning System INATEWS, inaugurated in Jakarta on 11.11. 2008. One important component is a GNSS-based system that supports a firsthand, near real-time detection of landmass movements and tsunamis. We will give a brief end to end overview of the completed GITEWS GNSS-components, the current works and proposals for next future activities such as the development and installation of low cost single frequency GNSS receiver stations.

2. BRIEF SYSTEM DESCRIPTION

The task for the GNSS-based components within the GITEWS project [3] is to support the determination of sea levels (measured onshore and offshore) and to detect co-seismic land mass displacements with the lowest possible latency. The completed system is designed to fulfil these tasks in near real-time and thus in absence of precise satellite orbits, rather than requirements of scientific research.

The GITEWS project covered all aspects from sensor stations with new developed hard- and software designs, manufacturing and installation of sensor stations, real-time data transfer issues, an automatic data processing system with near real-time strategy, a graphical user interface for early warning centre operators and training courses. GNSS sensors are installed on buoys, at tide gauges and as real-time reference stations (GNSS-RTR), 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.

The obtained data products are used by the warning centre in manifold ways. For buoy based GNSS data the processing (single baseline, with GNSS station on land as reference, double differences) delivers time series of coordinates. Only the vertical component is of interest as it corresponds to the instant sea level. The measurements from GNSS instruments on buoys allow an early detection or confirmation of tsunami waves on the ocean without using additional instruments on the ocean's bottom.

For sensors on land (co-located with tide gauges or seismological stations) the processing system delivers deviations from their normal, mean coordinates. This information is important to separate tsunami-caused from apparent sea height changes at tide gauge locations due to sensor station lifting [1]. It is also most valuable to support the determination whether a strong earthquake has the potential to generate a tsunami, which may only be the case if the earthquakes' mechanism includes a vertical movement of large areas [4].

The new developed graphical user interface (GUI) supports fast system check for all staff members at the warning centre (24h/7d shifts) and detailed analysis by GNSS experts. The GNSS processing 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. A more detailed system description can be found in [2].

3. CURRENT AND PLANNED ACTIVITIES

The GITEWS components are operated routinely in Jakarta, Indonesia since end of 2008. The GITEWS project will continue until March 2011 (with reduced financial and personnel efforts) in order to give further support for INATEWS and to react on first lessons learned from the initial operation time, which can be regarded as a commissioning phase.

The network of GNSS real-time reference stations has been supplemented with new GNSS stations at Panjang and on Kandui (island near of Siberut), in the area which is suspected to have the highest probability for a tsunamigenic earthquake in Indonesia. We suggest the use of low cost, single frequency GNSS receivers in the vicinity of dual frequency GNSS receiver stations for early warning purposes and plan to install some about mid of 2010. These single frequency receiver stations can be regarded as discrete sensors to densify a network or as part of a sensor constellation to monitor a region's movements with improved reliability.

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5. BIOGRAPHIES

Carsten Falck received a diploma in Geophysics in 1998 from the University of Hamburg, Germany. In the same year he started working for the GFZ German Research Centre for Geosciences, being head of the PRARE Masterstation in Oberpfaffenhofen from 1999 to 2007. In 2001 he became a member of the CHAMP satellite science (instruments) operation team in Potsdam. He was involved in a couple of satellite and GNSS-related projects (e.g., SWARM, MicroGEM, GSTB-V2), the development of GNSS sensor station technology and manages GFZ's satellite receiving station at Ny-Ålesund, Spitsbergen. Since March 2008 he is heading the team in charge for the GNSS real-time reference station network in Indonesia and the processing of land- and buoy-based GNSS sensor data. (together with Markus Ramatschi).

Markus Ramatschi received his diploma in Geophysics in 1992 and a doctorate degree in Geophysics in 1998 from the Technical University (TU) of Clausthal. Between 1992 and 1998 he worked at the Technical University Clausthal and from 1998 to 1999 at the Friedrich Schiller University (FSU) Jena, mainly in the field of geodynamics. Since 2000 he is working for the GFZ German Research Centre for Geosciences. He is responsible for GFZ's network of globally distributed GNSS reference stations and a dense network of GNSS stations in Germany. He takes part in projects such as GASP and GSTB-V2 and is involved in the IGS activities of GFZ, especially technical aspects of the IGS real-time pilot project. Since March 2008 he is heading the team in charge for the GNSS real-time reference station network in Indonesia and the processing of land- and buoy-based GNSS sensor data. (together with Carsten Falck).

Mitja Bartsch studied at the Technical University of Berlin (TUB), Germany and finished as a graduated engineer for Geodesy and Geoinformation Science. In October 2006 he started as a research assistant for GITEWS at the GFZ German Research Centre for Geosciences. He is an

expert for GNSS data processing and software development. His main responsibilities were the adaptation of the BERNESE software package to the requirements of the GITEWS near real-time GNSS processing system, including automation and detection algorithms developments and the implementation into the INATEWS warning centre infrastructure. Since April 2010 he is responsible for the development and implementation of a general GNSS data processing service at GFZ.

Alexander Merx is a graduated engineer for Geodesy and Geoinformation Science and received his degree from the Technical University Berlin (TUB), Germany. He has a strong background in software development and started working for the GFZ German Research Centre for Geosciences as a research assistant in March 2008. Since then he was mainly responsible for the development of the Web-based Graphical User Interface (GUI) of the GITEWS GNSS processing system. Being involved in the implementation and operation support of the near real-time processing system in Jakarta his focus is now on the development of refined methods of GNSS data processing for early warning applications.

6. REFERENCES

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