Münch, U., Rudloff, A., Lauterjung, J. (2011): Postface 'The GITEWS Project – results, summary and outlook'. - Natural Hazards and Earth System Sciences (NHESS), 11, 3, 765-769

DOI: 10.5194/nhess-11-765-2011

Nat. Hazards Earth Syst. Sci., 11, 765–769, 2011
www.nat-hazards-earth-syst-sci.net/11/765/2011/
doi:10.5194/nhess-11-765-2011


Natural Hazards and Earth System Sciences

*Postface*

# "The GITEWS Project – results, summary and outlook"

**U. Münch[1,*], A. Rudloff[1], and J. Lauterjung[1]**

[1]Deutsches GeoForschungsZentrum GFZ, Telegrafenberg, 14473 Potsdam, Germany
[*]now at: GEOTECHNOLOGIEN, Coordination office, Telegrafenberg, 14473 Potsdam, Germany

**Abstract.** This paper reflects the experiences and results gained during the GITEWS project (German Indonesian Tsunami Early Warning System), which was funded by the Federal German Ministry of Education and Research between spring 2005 and spring 2011. Many of the individual results have been presented at international conferences and in international journals. The NHESS special issue offers a comprehensive overview of the key findings within the project and the first phase of operation of the warning system.

## 1 Introduction

During the European Geosciences Union's (EGU) 2009 General Assembly in Vienna the idea of presenting a special issue of NHESS comprising the most important aspects of the GITEWS project was initiated. A few weeks later the editorial office agreed to our proposal and we began to inform and motivate the different working groups and project partners during the annual meeting of the GITEWS project in Potsdam in May 2009.

Now, almost two years later, we are happy and proud to present this special issue with a total number of 22 peer-reviewed articles, plus an additional preface (Rudloff et al., 2009) and this summary chapter.

Since the GITEWS project was structured into different work packages (s. Fig. 1), we decided to follow this structure as a guideline throughout the publication phase. It will, furthermore, be the structural element for a dedicated print version of this special issue.

Lauterjung et al. (2010a) describe the framework and outline the challenge of tsunami early-warning in Indonesia and its neighbouring countries caused by the particular geological situation along the Sunda trench.

## 2 Seismology

Based on the long lasting experience in global earthquake monitoring in Potsdam at GFZ, (e.g. GEOFON – www.gfz-potsdam.de/geofon) seismology is the backbone of the Tsunami Early Warning System in the Indian Ocean region. In their recent paper, Hanka et al. (2010) present on behalf of GFZ's seismology group their latest efforts and developments, which finally resulted in a new design and development of the SeisComP3 system. The software package is already in operation in more than 25 earthquake monitoring centres worldwide. Additional work was realised through new routines for rupture characterization, which were developed by the seismology group at the University of Potsdam, Germany (Roessler et al., 2010). They show application to a number of several prominent earthquakes (http://141.89.112.130/arbeitsgruppen/Geophysik_Seismologie/forschung/ruptrack/index.php).

*Correspondence to:* A. Rudloff
(rudloff@gfz-potsdam.de)

Published by Copernicus Publications on behalf of the European Geosciences Union.

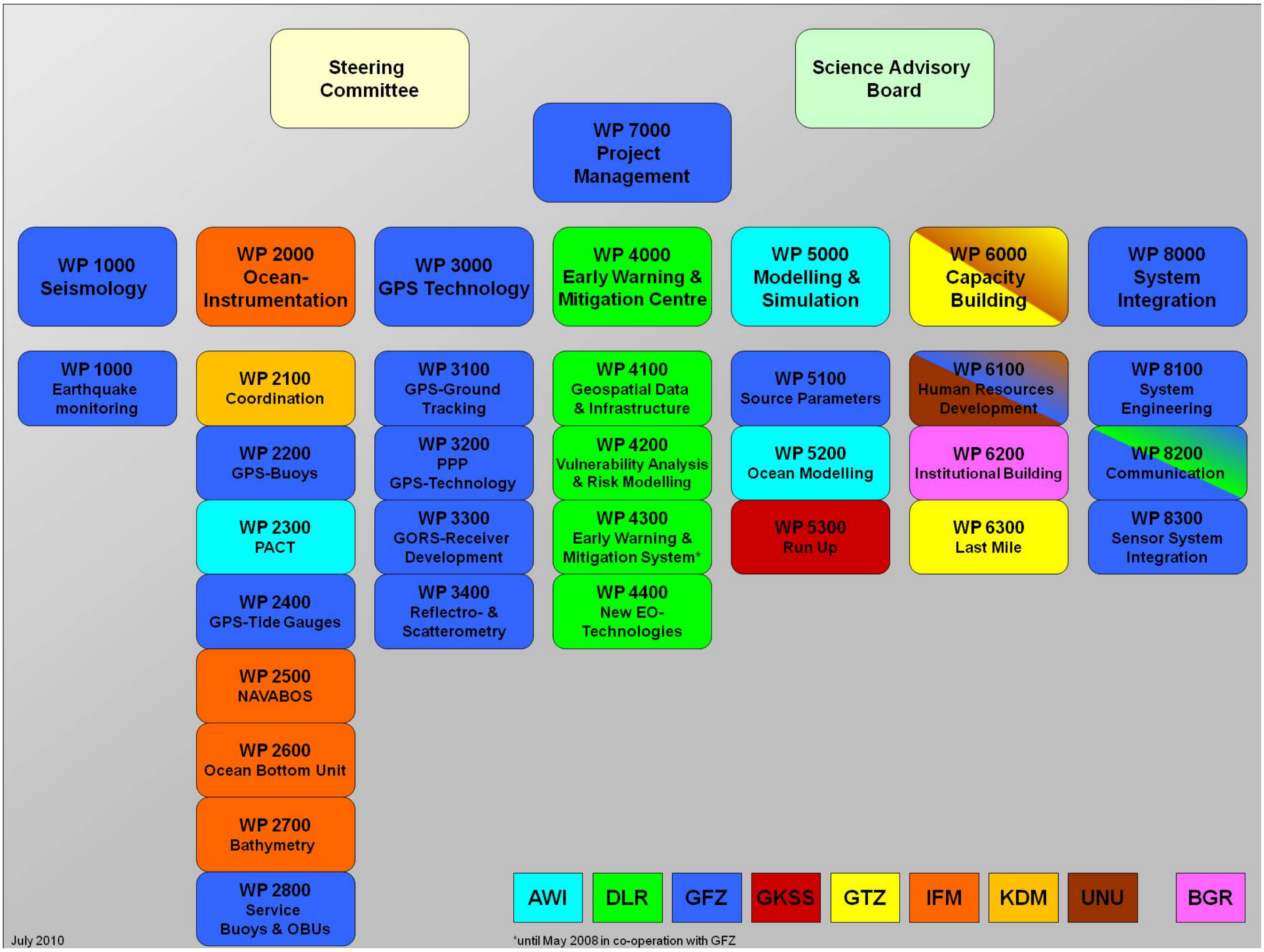


**Fig. 1.** Organisational chart of the GITEWS project.

## 3 Ocean instrumentation

The ocean instrumentation group (WP 2000, see Fig. 1) comprised a large number of scientists and brought together specialists from different German institutions, right from the beginning. Several tasks such as bathymetric measurements, design, construction, deployment and maintenance of GPS-buoys were organised jointly by the partners (Krabbenhoeft et al., 2010, Schöne et al., 2011b). Two different types of ocean floor sensor platforms were developed and tested (Boebel et al., 2010). This part of the system still remains to be optimised.

Other important ocean-monitoring components for tsunami early warning are tide gauges. The GITEWS tide gauges equipped with additional GPS sensors for position control have been installed in Indonesia and other countries around the Indian Ocean (Schöne et al., 2011a) and contribute also to the Global Sea Level Observing System (GLOSS).

## 4 GPS technology

The GPS technology group (WP 3000) worked on GPS and other earth observation technologies. Falck et al. (2010) explain the strategy of near-real time GPS processing within the early warning system. The GPS installations provide measurements of land mass movements due to earthquakes and also determine sea level changes by GPS sensors on buoys. This strongly supports the reliability of tsunami detection using GPS data from land and the confirmation of a tsunami with offshore measured data at the earliest possible time.

In addition, a simulation study for the detection of tsunami and sea level anomalies in general by GNSS-Reflectometry using Low Earth Orbiting satellites as a detection system was carried out. As the Sumatra tsunami has shown, an upper limit of 15 min detection time is required for such a tsunami detection system. Stosius et al. (2010) discuss the necessary scientific-technical framework.

## 5 Early warning & Mitigation centre

The "heart" of the early warning system is the warning centre (WP 4000) where all information comes together and is aggregated in a Decision Support System (DSS). Steinmetz et al. (2010) describe the processes of establishing a "situation picture", based on geospatial information and incoming sensor information using a tsunami simulation data base, as a reliable basis for a warning. In addition Strunz et al. (2011) use the simulation database for detailed risk and vulnerability studies along the coastlines of Indonesia.

Bittner et al. (2010) and Börner et al. (2010) report on case studies for the design and application of new technologies using large high altitude airships and radar technologies as well as perturbations of the mesopause by infrasound for sea level monitoring.

## 6 Modelling and simulation

The modelling group (WP 5000) covers the complete spectrum of tsunami modelling from source modelling (Babeyko et al., 2010) through wave propagation to run up modeling (Behrens et al., 2010). The strategy used in this project is especially designed for the challenge of near-field tsunami forecast and integrates a multi-sensor approach for the characterization of the tsunami source, especially taking into account the co-seismic deformation measured by continuous GPS.

In addition a large number of simulations of different tsunami scenarios enabled the run-up modeling group to get a detailed insight into possible hazards during flood events in the selected priority regions Padang, Cilacap, and Kuta which were investigated by Gayer et al. (2010).

Submarine slope failures may also occur at many locations in the Indonesian archipelago. The distribution of submarine landslides and the associated tsunami hazard has been investigated by Brune et al. (2010).

## 7 Capacity building

Capacity building, nowadays often called capacity development, was identified to be essential for a project such as GITEWS. This is reflected by a broad spectre of different measures such as local work and support at different levels in Indonesia, described by Spahn et al. (2010). The academic and technical training courses and a small but dedicated PhD programme, conducted by the United Nations University (UNU-EHS) in Bonn/Germany gave additional support (Schlurmann and Siebert, 2011). Despite all technical innovation, the human component will continue to be the decisive element. If this important part does not have a future perspective, it will be hard to ensure the sustainable success of the GITEWS project.

## 8 System integration

The work packages dedicated to system engineering and implementation started at a later stage, in summer 2006. Nevertheless, their impact on the project has been essential. Fleischer et al. (2010) report on their work, implementing an integrating platform for heterogeneous data exchange, where Angermann et al. (2010) give insights to the complex architecture and levels of different communication tools for an early-warning system.

## 9 Outlook

At the end of 2010 the project was evaluated by an international group of experts. The evaluation revealed the innovative approach to the challenge of near-field tsunami early warning and gave advice on improvements and ideas for future development of such systems. This will be tracked in particular in the growing international framework for the establishment of world-wide early warning systems (Lauterjung et al., 2010b).

Future activities in Indonesia will follow a dedicated road map. Since 2009 a group of German and Indonesian experts has been developing, discussing and presenting the idea of a sustainable public private partnership structure for the maintenance and service part of the GITEWS elements. By 29 March 2011 the system will be handed over into the responsibility of Indonesia. A joint German-Indonesian company will assist the maintenance and operation process for the next five years.

The natural hazard potential of Indonesia, posed by tsunamis, will remain unchanged. Through the GITEWS initiative and add-on funding, we hope that the warning capability will be able to reduce injury and fatalities in the case of natural hazards in the future.

*Acknowledgements.* We owe many thanks to a large number of people, who have contributed to the project: Daniel J. Acksel (GFZ) and Knut Mühlstein (IABG) have been key pillars within the project management team, while Jost Munder (STI) contributed significantly in the early days. Great support has also been provided by Petra Köhler in the first years (2005–2007) and Katja Schaar since 2009. The management of travel arrangements through Sylvia Henning as well the "mother tongue support" by Mary Lavin-Zimmer was of fundamental help and highly appreciated. Horst Letz, Michael Günther and Thorsten Schöckel as integrated experts with the German CIM programme at BMKG in Indonesia have considerably supported the project's management and technical implementation in Indonesia, as well as Alexander Hansen, Andrea Heyn and Michael Rottmann on the administrative and political channels.

The work and the successful implementation of the warning system would not have been possible without the enormous assistance and cooperation with the Indonesian partner institutions. Representing numerous Indonesian scientists, engineers and administrators we would like to thank Director General Sri Woro Handojo, Prih Harjadi, and Fauzi (all at BMKG), Cecep Subarya, and Paluhut Manurung (both at BAKOSURTANAL), Ridwan Djamaluddin (BPPT), and Vice-Minister Idwan Suhardi (RISTEK).

We would also like to thank the Tsunami Group of UNESCO IOC for their support in establishing early warning structures in the Indian Ocean region. Special thanks to Peter Koltermann, Ulrich Wolf, Tony Elliot, and Masahiro Yamamoto as well as to Jan Sopaheluwakan from IOC-IOTWS.

This GITEWS NHESS special issue would have not been possible without the extraordinary efforts of a large number of referees, which we would like to thank:

Tim le Bas (NOC, UK), Rémy Bossu (EMSC, France), Ramon Carbonell (CSIC, Spain), John Clinton, (ETH, Switzerland), Paul H. Denys (University of Otago, New Zealand), Frank I. Gonzalez (NOAA, USA), Chris Gregg (ETSU, USA), Tom de Groeve (JRC, Italy), Harsh Gupta (NGRI, India), Sam. Hettiarachchi (University of Moratuwa, Sri Lanka), Alex Hutko (USGS/IRIS, USA), Utku Kanoglu (METU, Turkey), Heidrun Kopp (IFM-GEOMAR, Germany), Erich Leitgeb (Technical University of Graz, Austria), Stefano Lorito (INGV, Italy), Brian G. McAdoo (Vassar College, USA), Markus Noack (University of Stuttgart, Germany), Lars Ottemöller (University of Bergen, Norway), Stefan Scheer (JRC, Italy), Gerd Tetzlaff (University of Leipzig, Germany), Juan Carlos Villagran de Leon (UNOOSA, Austria), Philip L. Woodworth (POL, UK), John Woodside (VU University Amsterdam, Netherlands), and 27 more anonymous referees.

We would also like to thank the excellent support from the managing and topical editors of NHESS as well as the editorial office at Copernicus for their very professional quality.

Finally we owe all the GITEWS project partners great thanks. All participating scientists, technicians, and students have contributed to the success of the efforts of building up a tsunami early warning system. We all hope it will be maintained and updated during the next decades and will help to save as many lives as possible. Nevertheless, the tsunami threat will not vanish in the region, and we will, still, have to be prepared for fatalities in the case of future events.

The GITEWS project (German Indonesian Tsunami Early Warning System) was carried out by a large group of scientists and engineers from the GFZ German Research Centre for Geosciences (consortium leader) and its partners from the Alfred Wegener Institute for Polar and Marine Research (AWI), the German Aerospace Center (DLR), the Helmholtz Centre Geesthacht (HZG, formerly GKSS), the German Marine Research Consortium (KDM), the Leibniz Institute for Marine Sciences (IFM-GEOMAR), the United Nations University's Institute for Environment and Human Security (UNU-EHS), the Federal Institute for Geosciences and Natural Resources (BGR), the German Agency for International Cooperation (GIZ, formerly GTZ), as well as from Indonesia and other international partners. Funding is provided by the German Federal Ministry of Education and Research (BMBF), Grant03TSU01. This is GITEWS publication no. 123.

## References

Angermann, M., Guenther, M., and Wendlandt, K.: Communication architecture of an early warning system, Nat. Hazards Earth Syst. Sci., 10, 2215–2228, doi:10.5194/nhess-10-2215-2010, 2010.

Babeyko, A. Y., Hoechner, A., and Sobolev, S. V.: Source modeling and inversion with near real-time GPS: a GITEWS perspective for Indonesia, Nat. Hazards Earth Syst. Sci., 10, 1617–1627, doi:10.5194/nhess-10-1617-2010, 2010.

Behrens, J., Androsov, A., Babeyko, A. Y., Harig, S., Klaschka, F., and Mentrup, L.: A new multi-sensor approach to simulation assisted tsunami early warning, Nat. Hazards Earth Syst. Sci., 10, 1085–1100, doi:10.5194/nhess-10-1085-2010, 2010.

Bittner, M., Höppner, K., Pilger, C., and Schmidt, C.: Mesopause temperature perturbations caused by infrasonic waves as a potential indicator for the detection of tsunamis and other geo-hazards, Nat. Hazards Earth Syst. Sci., 10, 1431–1442, doi:10.5194/nhess-10-1431-2010, 2010.

Boebel, O., Busack, M., Flueh, E. R., Gouretski, V., Rohr, H., Macrander, A., Krabbenhoeft, A., Motz, M., and Radtke, T.: The GITEWS ocean bottom sensor packages, Nat. Hazards Earth Syst. Sci., 10, 1759–1780, doi:10.5194/nhess-10-1759-2010, 2010.

Börner, T., Galletti, M., Marquart, N. P., and Krieger, G.: Concept study of radar sensors for near-field tsunami early warning, Nat. Hazards Earth Syst. Sci., 10, 1957–1964, doi:10.5194/nhess-10-1957-2010, 2010.

Brune, S., Babeyko, A. Y., Ladage, S., and Sobolev, S. V.: Landslide tsunami hazard in the Indonesian Sunda Arc, Nat. Hazards Earth Syst. Sci., 10, 589–604, doi:10.5194/nhess-10-589-2010, 2010.

Falck, C., Ramatschi, M., Subarya, C., Bartsch, M., Merx, A., Hoeberechts, J., and Schmidt, G.: Near real-time GPS applications for tsunami early warning systems, Nat. Hazards Earth Syst. Sci., 10, 181–189, doi:10.5194/nhess-10-181-2010, 2010.

Fleischer, J., Häner, R., Herrnkind, S., Kloth, A., Kriegel, U., Schwarting, H., and Wächter, J.: An integration platform for heterogeneous sensor systems in GITEWS – Tsunami Service Bus, Nat. Hazards Earth Syst. Sci., 10, 1239–1252, doi:10.5194/nhess-10-1239-2010, 2010.

Gayer, G., Leschka, S., Nöhren, I., Larsen, O., and Günther, H.: Tsunami inundation modelling based on detailed roughness maps of densely populated areas, Nat. Hazards Earth Syst. Sci., 10, 1679–1687, doi:10.5194/nhess-10-1679-2010, 2010.

Hanka, W., Saul, J., Weber, B., Becker, J., Harjadi, P., Fauzi, and GITEWS Seismology Group: Real-time earthquake monitoring for tsunami warning in the Indian Ocean and beyond, Nat. Hazards Earth Syst. Sci., 10, 2611–2622, doi:10.5194/nhess-10-2611-2010, 2010.

Krabbenhoeft, A., Weinrebe, R. W., Kopp, H., Flueh, E. R., Ladage, S., Papenberg, C., Planert, L., and Djajadihardja, Y.: Bathymetry of the Indonesian Sunda margin-relating morphological features of the upper plate slopes to the location and extent of the seismogenic zone, Nat. Hazards Earth Syst. Sci., 10, 1899–1911, doi:10.5194/nhess-10-1899-2010, 2010.

Lauterjung, J., Münch, U., and Rudloff, A.: The challenge of installing a tsunami early warning system in the vicinity of the Sunda Arc, Indonesia, Nat. Hazards Earth Syst. Sci., 10, 641–646, doi:10.5194/nhess-10-641-2010, 2010a.

Lauterjung, J., Koltermann, P., Wolf, U., and Sopaheluwakan, J.: The UNESCO-IOC framework – establishing an international early warning infrastructure in the Indian Ocean region, Nat. Hazards Earth Syst. Sci., 10, 2623–2629, doi:10.5194/nhess-10-2623-2010, 2010b.

Roessler, D., Krueger, F., Ohrnberger, M., and Ehlert, L.: Rapid characterisation of large earthquakes by multiple seismic broadband arrays, Nat. Hazards Earth Syst. Sci., 10, 923–932, doi:10.5194/nhess-10-923-2010, 2010.

Rudloff, A., Lauterjung, J., Münch, U., and Tinti, S.: Preface "The GITEWS Project (German-Indonesian Tsunami Early Warning System)", Nat. Hazards Earth Syst. Sci., 9, 1381–1382, doi:10.5194/nhess-9-1381-2009, 2009.

Schlurmann, T. and Siebert, M.: The Capacity Building programmes of GITEWS – visions, goals, lessons learned, and reiterated needs and demands, Nat. Hazards Earth Syst. Sci., 11, 293–300, doi:10.5194/nhess-11-293-2011, 2011.

Schöne, T., Illigner, J., Manurung, P., Subarya, C., Khafid, Zech, C., and Galas, R.: GPS-controlled tide gauges in Indonesia – a German contribution to Indonesia's Tsunami Early Warning System, Nat. Hazards Earth Syst. Sci., 11, 731–740, doi:10.5194/nhess-11-731-2011, 2011a.

Schöne, T., Pandoe, W., Mudita, I., Roemer, S., Illigner, J., Zech, C., and Galas, R.: GPS water level measurements for Indonesia's Tsunami Early Warning System, Nat. Hazards Earth Syst. Sci., 11, 741–749, doi:10.5194/nhess-11-741-2011, 2011b.

Spahn, H., Hoppe, M., Vidiarina, H. D., and Usdianto, B.: Experience from three years of local capacity development for tsunami early warning in Indonesia: challenges, lessons and the way ahead, Nat. Hazards Earth Syst. Sci., 10, 1411–1429, doi:10.5194/nhess-10-1411-2010, 2010.

Steinmetz, T., Raape, U., Teßmann, S., Strobl, C., Friedemann, M., Kukofka, T., Riedlinger, T., Mikusch, E., and Dech, S.: Tsunami early warning and decision support, Nat. Hazards Earth Syst. Sci., 10, 1839–1850, doi:10.5194/nhess-10-1839-2010, 2010.

Stosius, R., Beyerle, G., Helm, A., Hoechner, A., and Wickert, J.: Simulation of space-borne tsunami detection using GNSS-Reflectometry applied to tsunamis in the Indian Ocean, Nat. Hazards Earth Syst. Sci., 10, 1359–1372, doi:10.5194/nhess-10-1359-2010, 2010.

Strunz, G., Post, J., Zosseder, K., Wegscheider, S., Mück, M., Riedlinger, T., Mehl, H., Dech, S., Birkmann, J., Gebert, N., Harjono, H., Anwar, H. Z., Sumaryono, Khomarudin, R. M., and Muhari, A.: Tsunami risk assessment in Indonesia, Nat. Hazards Earth Syst. Sci., 11, 67–82, doi:10.5194/nhess-11-67-2011, 2011.