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EDITORIAL

Early warning systems for natural hazards and risks

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Natural hazards pose an increasing threat to society. Processes change in magnitude and frequency and exposures are modified within short time periods over large areas. Despite our increasing knowledge, the damage tolls due to natural hazards seem to be on the rise. Therefore, a comprehensive risk management strategy is needed to reduce the disaster risks. Within a sustainable management of disaster risks, the installation of an early warning system is often a cost-effective risk mitigation measure, and in some instances the only suitable option.

Consequently, the guest editors decided to convene a session within the European Geoscience Union conference to present different early warning systems for natural hazards, independent of whether these deal with landslides, floods, tsunamis, earthquakes, droughts or hydro-meteorological events. The invited presentations addressed conceptual issues, already operating installations or planned systems. It was highlighted that the session was not explicitly focussing on single hazards, but rather addressing the different approaches taken to install, monitor and analyse the hazards. In addition, any research on the establishment of warning thresholds, the communication chain and the prevention strategies were welcome. In total, six oral presentations and 11 poster presentations were received and presented during the conference. These were structured into the different sections: Integrative Warning Systems, Earthquake Warning Systems, Landslide and Debris Flow Warning Systems and Challenges in Early Warning. Out of the 17 presentations, seven papers that provide an overview of related specific topics have been accepted for this topical volume.

The contribution entitled “The Common Information Platform for Natural Hazards in Switzerland” is authored by Benedikt Heil, Ingo Petzold, Hans E. Romang and Josef Hess.

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Following a series of remarkable hazardous events in Switzerland, a co-operation between the official Swiss warning centres for individual natural hazards was initiated. This initiative has received high attention and support on a political level. A “Common Information Platform for Natural Hazards” GIN, which aims to present safety-relevant data in real time, was launched. In order to achieve this in a sustainable manner, the collaboration between the different Swiss warning centres had to be enhanced. In the presented contribution, Heil and his colleagues describe the concept of GIN and the main structural components.

In the second contribution, Corey R. Froese describes the “Structure and components for the warning and emergency response system on Turtle Mountain, Alberta, Canada”. This work focuses on the site of the 1903 Frank Slide, where over 80 sensors have been installed. The data that are continuously collected and analysed help to characterize and provide warning for an expected second large rock avalanche from the eastern face of the mountain, where various unstable masses have been identified. The local conditions in terms of deformation patterns and slope kinematics have been investigated in detail, and the warning and emergency response procedures are addressed. Froese points out that not only responsibilities and communications protocols during an emergency have to be detailed but also the day-to-day operational responses and procedures to ensure a sustainable operational system have to be addressed.

In the contribution, “Infrasound produced by debris flow: Propagation and frequency content evolution” authored by Arnold Kogelnig, Johannes Hübl, Emma Suriñach, Ignasi Vilajosanaa and Brian McArdell, the detection of signals of debris flow movements is done by using an infrasound vibration measurement technique. In recent studies, it was shown that debris flows generate characteristic signals in the low-frequency infrasonic spectrum (4–15 Hz), which can travel thousands of kilometres and can still be detected. Consequently, these signals are implemented into an automated monitoring system, which is located at a safe distance from the debris flow channel. The system has been installed in the Lattenbach torrent, Tyrol (Austria), and in the Illgraben torrent, Canton of Valais (Switzerland). The low-frequency infrasonic signals emitted by a debris flow can be monitored and correlated with seismic signals. During the passage of different debris flows, several surges were identified by ultrasonic gauges and detected in the time series and the running spectra of infrasonic data.

Huaxi Gao presents in his “Study on Spatial Prediction and Time Forecast of Landslide Hazard” components of an early warning system in Xincheng District, Badong County, China. Studies on spatial prediction and zonation of regional landslide hazard are developed using an information content model. Using this model, he is able to quantify and predict the probability of landslide initiations with different magnitudes and with recurrence intervals ranging between 5 and 10 years. The scientific research results serve as a basis for disaster prevention and risk reduction as well as for disaster management with socio-economic development.

Within the paper “Climate Input Parameters for Real Time Online Risk Assessment”, Richard Petritsch and Hubert Hasenauer investigate the link between the assessment of natural risks in combination with the actual or forecasted weather situation. They use the climate interpolation routine DAYMET to construct a new climate database with a standard interface and implement a framework for providing daily updated weather data for online daily weather interpolations across regions. The core of the work is the implementation of the DAYMET interpolation routines within the new framework. Two possible interpolation routines, which use the optimal number of stations, are investigated. Respective error bounds are assessed using an independent validation data set, and the results are compared with a previous validation study. Finally, the developed methodology is derived for the calculation of a fire danger index for a 1 km grid over Austria.

The sixth contribution authored by Tsung-Yi Pan, Lung-Yao Chang, Jihn-Sung Lai, Hsiang-Kuan Chang, Cheng-Shang Lee and Yih-Chi Tan is titled "Coupling typhoon rainfall forecasting with overland-flow modelling for early warning of inundation". In Taiwan, potential inundation maps have been widely used as a non-structural risk mitigation strategy for floods. The authors point out that spatiotemporal rainfall distributions must be addressed to improve the accuracy of inundation forecasting for emergency response operations. Therefore, they present a system for 24-h forecast early warning system of inundation by coupling the forecasting of typhoon rainfall with the modelling of overland flow. The forecast of the typhoon rainfall is carried out by the climatology model (TRCM) in order to approximate dynamically the spatiotemporal rainfall distribution based on typhoon tracks. The scheme is superior to traditional early warning method that determines the maximum extent and depth of inundation from conditional uniform rainfall. It can forecast spatiotemporal rainfall patterns, leading to improved performance of inundation forecasting, which is critical for emergency response operations.

The final contribution by Desiree Hilbring, Tanja Titzschkau, Alfons Buchmann, Gottfried Bonn, Friedemann Wenzel and Eberhard Hohnecker deals with "Earthquake Early Warning for Transport Lines". This interdisciplinary work focuses on the immediate production of an alert map during an ongoing earthquake. Furthermore, a damage map representing the consequences to the railway infrastructure is calculated immediately after the strong motion phase. The procedure is based on a service-oriented architecture applying geospatial standards. It is aimed that the system architecture can be used in different geographical regions and can be potentially transferred to other types of natural hazards and infrastructure systems. Besides the general description of the architecture, an online demonstrator has been applied to a test area in the Federal State of Baden-Württemberg, Germany. Furthermore, this system is coupled with the implementation of low-cost sensors in the railway track in order to provide a dense network directly on the railway infrastructure.

We strongly believe that the covered topics provide a range of interesting themes related to early warning systems and further our knowledge in this field. Indeed, there are many other aspects of early warning systems which deserve detailed attention. The provided manuscripts do, however, provide a sample of some of the work being carried out in the respective fields. The guest editors want to thank the authors for their submissions and their patience during the process of managing this special issue. We also want to acknowledge the hard work of numerous reviewers, who improved the quality of the manuscripts significantly. Finally, we deeply appreciate the guidance and support of the NHAZ editorial team, who helped us tremendously to finalize this special issue.