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'Integration of technologies for landslide monitoring and quantitative hazard assessment'

Landslides, debris flows and rockfalls can endanger inhabitants and infrastructures. Innovative investigation, monitoring and mapping techniques are being developed in order to improve the methods for local and regional landslide hazard assessment and/or the design of early warning systems. The objective of this Special Issue is to address technical and methodological developments for the monitoring and mapping of specific mass movement features. These developments range from improved remote sensing and on-site geophysical surveys to characterize landslide dynamics, to the set up of integrated methodologies to combine heterogeneous datasets, and finally to the modeling of the spatial and temporal probabilities of occurrences, and the intensity of landslide events using simple statistical or complex coupled process-based models.

Research in the field of mass movement is generally considered quite broad. It deals with the mechanisms and dynamics of the movements, triggering factors, mapping and monitoring techniques, societal consequences, mitigation and warning systems, only to name a few. Consequently, mass movement analysis demands for strong multi-disciplinary research. This is by no means a burden; contrarily this opens exciting new research fields, technological innovations and stimulates communication and discussions between end-users and developers, between researchers and innovators, between modelers and surveyors, and maybe even between young scientists and seniors.

It is therefore quite unique to organize a conference covering such a range of topics describing the full scope of mass movement analysis. This Special Issue is a selection of some research manuscripts presented at the International Conference "*Landslide Processes: From Geomorphologic Mapping to Dynamic Modelling; A tribute to Dr. Theo van Asch*" held in Strasbourg (France) on 6–7 February 2009. The editors of Engineering Geology are warmly thanked for giving us the opportunity to present a coherent selection of manuscripts as a special issue.

The work of Niethammer et al. consisted in the use of UAV (unmanned-aerial vehicles) platforms for the acquisition of optical images ortho-mosaics. The image products allow the analysis of morphometric features of landslides and to characterize their surface displacements. This results in low-cost, high resolution aerial photographs. These results have to be interpreted in combination to the results obtained by Walter et al. on the micro-seismic monitoring of clay-rich landslides (Super-Sauze landslide, France). The authors are able, using advanced signal processing tools, to characterize the spatial pattern and temporal occurrence of slide-quake events of very low magnitudes in very attenuating sediments. The spatial distribution of the localized seismic landslide events correlates with those parts of the slope which show the higher displacement rates at the surface and a complex bumping underlying topography of the bedrock. Interestingly, both papers address the monitoring of the fissure network which has a clear signature on the Super-Sauze landslide albeit from a distinct different viewpoint.

Hibert et al. developed a methodology able to combine ground-based images of geophysical parameters such as acoustic (P), shear (S) wave velocity and electrical resistivity which are essential to estimate the mechanical properties of materials. Seismic data provide information on fissure density and on the presence of shear-banded material, whereas the electrical resistivity data provide information on water content. Petrophysical interpretations are proposed on the basis of data fusion concepts using the fuzzy set theory.

Travelletti et al. developed a methodology for the 3D geometrical modeling of landslide structures, and discuss the main possible errors in integrating multi-source and multi-resolution data (geophysical, geotechnical and geomorphological) in the modeling. The authors analyzed the influence of bedrock geometry on the kinematic deformation pattern and the general morphology of slow-moving landslides characterized by the development of extension and compression zones. Travelletti et al. have managed to give a clear example of multi-disciplinary research combined in one paper and use the combined information for mechanical interpretation.

Ghosh et al. used a statistical technique to quantify the spatial and temporal probability of landslides at the regional scale by combining heuristic and statistical methods. The method is being developed for a region characterized with very limited historical information on landslides, inferring the use and the combination of various data sources. The known landslides were related with the intensity of triggering rainfall events for the assessment of temporal probability. The value of combining different sources of information is again stressed in the research work.

Quan Luna et al. analyzed the dynamics of muddy debris flows by taking into account changing volumes (entrainment of channel path material, material deposition) during run-out. A simple process-based model is proposed able to take into account material entrainment and the generation of excess pore water pressure, and its performance is tested on a detailed case study in the French Alps (Faucon creek).

Froese et al. quantified the potentially unstable volumes and identified the possible failure mechanisms of the Turtle Mountain (Canada). The methodology combines a structural analysis, high-resolution DEMs analysis, geometrical modeling (SLBL method) and runout modeling. The proposed analysis workflow associates several datasets and processing techniques and renders an improved hazard assessment for rock avalanches.

Marcato et al. presented a method to characterize the stability conditions and the possible development of large landslides which deformation may led to a constant widening of the source area. The authors analyzed the collapse of the source areas by combining geomorphological observations, kinematic monitoring and process-based modeling. The results, using extended multi-disciplinary knowledge, make possible to evaluate the hazard and the conclusions are beneficial to the decision makers.

The general tendency which becomes clear is the added value of combining new high resolution observation techniques and smart modeling concepts. This is, in our opinion, the vision and open mind promoted by Theo van Asch during his entire career.

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