Preface

Rapid development of modern technologies in last decades had a significant influence on development of technologies used in landslide investigation, monitoring, simulation, remediation and mitigation all in order to mutually reduce landslide disaster hazard and risk. Development of modern technologies heavily influenced on all parts of landslide researches represented in this Volume: Landslide Monitoring and Warning: Monitoring Techniques and Technologies, and Early Warning Systems; Landslide Disasters and Relief: Case Studies, Emergency Measures, First Aid, and Civil Protection Measures and Landslide Mitigation, Remediation and Stabilization: Landslide Protection Works, Landslide Stabilization and Remediation, and Landslide Non-structural Measures.

Landslides are by definition characterized by movement (Cruden 1991). Knowledge of the movement magnitude and velocity, that is, movement distribution along the slope, are the most important data for all landslide analysis. Monitoring is required to observe the changing conditions that may lead to total failure of the slope where slope movement is occurring, where safety factors against sliding are low, or where high risk is present fromof the ISDR-ICL Sendai a possible slope failure. Landslide movement monitoring expressed via ground surface displacements and deformation of structures (including the landslide body) related to landslides can be accomplished using different types of monitoring systems and techniques (Mihalić Arbanas and Arbanas 2016). Monitoring techniques are classified according to Savvaidis (2003) as follows: satellite and remote sensing techniques, photogrammetric techniques, geodetic or observational techniques, and geotechnical or instrumentation or physical techniques. Except conventional ground-based geodetic techniques used for surface displacement monitoring of landslides and geotechnical sensors used to ensure efficient data for landslide behavior prediction and landslide stability analysis (inclinometers, extensometers, crack meters, piezometers, deformeters, tiltmeters, klinometers, load and pressure cells, and geophones), all other monitoring techniques, especially satellite and remote sensing techniques (photography and imagery ranging from ground-based mobile units to airborne or satellite platforms using LiDAR, optical, and radar sensors) are based on new technologies developed in last 25 years (Delacourt et al. 2007, Casagli et al., 2010, Corsini et al., 2006; Jaboyedoff et al. 2012; Abellan et al. 2014, Casagli et al. 2017). Modern technologies development significantly influenced on further improvement geodetic or observational techniques by introduction of Global Positioning System (GPS) (Gili et al. 2000) and other satellite-related positioning systems as well as technological improving of conventional geodetical and geotechnical equipment and possibility for connection of monitoring equipment in rapid wireless network. Usually, different types of monitoring techniques and instrumentation are used in different combinations and connected in a unique comprehensive landslide monitoring system and because of the variability in landslide types and processes, targets of landslide investigation, field conditions, and ongoing technological development of monitoring sensors, no standardization can be adopted as a universal solution for landslide monitoring system setups (Mihalić Arbanas and Arbanas 2016).

In some situations where the volume of a landslide are too large to enable effective landslide remediation or the countermeasures are too expensive, other types of mitigations have to be performed in order to decrease the landslide risk (Michoud et al. 2013). Appropriate and prompt mitigation measures should reduce the number of people exposed to the risk by establishing an adequate and reliable early warning systems that are able and competent to define alarm conditions and alert endangered populations in time based on monitoring results from the observed landslide. Early warning systems are defined by the United Nations as “the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss” (UN-ISDR 2009). Effective landslide early warning systems should hold four major elements integrated in one unique system: (1) risk assessment, (2) phenomenon monitoring and forecasting, (3) warning communication and alert dissemination, and (4) local response aptitudes (UN-ISDR 2009). Similarly as for a landslide monitoring system, no standardization can be adopted as a universal solution for landslide early warning system establishment.

Despite the significant advancement in landslides science, technology and landslide risk preparedness, the occurrences of landslide disaster are still numerous, unexpected and deadly in different reliefs and geological conditions over the world. Activities related to landslide post-disaster emergency measures are very important for reduction of final number of landslide victims and depend on well preparedness of first aid and civil protection organization as well as preparedness and self-organization of local community.

The purpose of landslide stabilization and remediation measures is to ensure permanent stability of the slope against current and reasonably possible conditions in the slope (Cornforth 2005). Landslide stabilization methods and remediation measures can be established following two general principles in soil stabilization: reducing the active forces that caused the landslide or increasing the soil or rock resistance (strength). However, there is no general recipe for landslide remediation, and an original stabilization approach should be accepted for each landslide (Hutchinson 1977). Terzaghi (1951) has underlined that ‘if a slope has started to move, the means for stopping movement must be adapted to the processes which started the slide’. The successful application of each performed measure depends on correct recognition during the investigation of the specific soil and groundwater conditions in the field and application in the remediation design (Popescu 2001) and each landslide stabilization design should be an original consideration about landslide geometry, active forces, soil or rock strength, and their development in time.

This WLF4 Volume 3: Advances in Landslide Technology collected results of recent researches related to the topics Landslide Monitoring and Warning; Landslide Disasters and Relief and Landslide Mitigation, Remediation and Stabilization that make the main Sessions of this Volume. The Volume 3 Advances in Landslide Technology includes 67 research papers from 28 countries (Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, China, Chinese Taipei, Croatia, Czech Republic, France, Germany, Hungary, Indonesia, India, Italy, Japan, Korea, Mexico, New Zealand, Norway, Poland, Serbia, Slovenia, Spain, Switzerland, Turkey, Uganda and Ukraine): one Keynote Lecture; 41 research papers in Session Landslide Monitoring and Warning: Monitoring Techniques and Technologies, and Early Warning Systems; 6 research papers in Session Landslide Disasters and Relief: Case Studies, Emergency Measures, First Aid, and Civil Protection Measures; 19 research papers in Session Landslide Mitigation, Remediation and Stabilization: Landslide Protection Works, Landslide Stabilization and Remediation, and Landslide Non-structural Measures; as well as adequate Session Introductions.

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