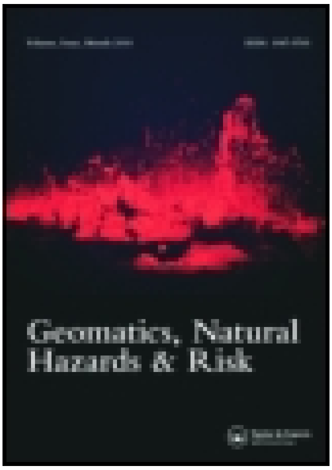

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Preface to the special issue: the role of geomatics in hydrogeological risk

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Preface to the special issue: the role of geomatics in hydrogeological risk

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In accordance with recent studies, most of the observed natural hazards throughout the globe are related to the dynamics of hydrological variability. This determines the fundamental importance of studies related to hydrogeological risk assessment, in terms of both prevention and mitigation of damages; science shall provide the modelling and forecasting tools in order to support the management of natural phenomena. Geomatic technologies have a leading role in this context, as they model the physical elements in the earth's surface, their dynamics in time and space, and the causes of their modifications. The main aim of this special issue is to provide a review of the state-of-the-art of geomatic technologies applied to landslides and flooding and to give certain insights on new ideas and future perspectives on these themes. The contributions presented in this issue were presented at the workshop "The Role of Geomatics in Hydrogeological Risk" held in Padova, Italy, where 82% of the municipalities are subject to a degree of hydrogeological risk and where several natural disasters occurred in the past years, which made the workshop location particularly well suited and makes this special issue significant.

1. Introduction

In accordance with recent studies (European Commission 2005), most of the observed natural hazards throughout the globe are related to the dynamics of hydrological variability. This determines the fundamental importance of studies related to hydrogeological risk assessment, in terms of both prevention and mitigation of damages. Although in most of the cases, humans do not have chances to change the intensity and frequency of natural phenomena, they can actually reduce the incidence of natural events that turn out to be disasters. To this end, science shall provide the modelling and forecasting tools in order to support the management of natural phenomena. Geomatic technologies have a leading role in this context, as they model the physical elements in the earth's surface, their dynamics in time and space, and the causes of their modifications.

The main aim of this special issue is to provide a review of the state-of-the-art of geomatic technologies applied to landslides and flooding in both urban and rural areas, and to give certain insights on new ideas and future perspectives on these themes. The contributions presented in this issue were presented at the workshop "The Role of Geomatics in Hydrogeological Risk" held in Padova, Italy, in February 2013. Since the workshop was held in Italy, where 82% of the municipalities are

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subject to a degree of hydrogeological risk (Ministero dell'Ambiente e della Tutela del Territorio e del Mare 2008) and where several natural disasters occurred in the past years, it made the workshop location particularly well suited and makes this special issue even more significant. Practically, most modern technologies of geomatic surveying are touched upon in this special issue, i.e. photogrammetry (Borgogno Mondino 2014; Scaioni et al. 2014), structure from motion (Forlani et al. 2013), optical remote sensing (Franci et al. 2014), laser scanning (Barbarella et al. 2013), global navigation satellite systems (GNSS) (Cina & Piras 2014), synthetic aperture radar (SAR) (Frangioni et al. 2014; Nascetti et al. 2014; Vittuari et al. 2014) and geographic information systems (GISs) as decision support using advanced models (Cencetti et al. 2014; Federici et al. 2014). A digital terrain model (DTM) is fundamental to successive analysis; Casella and Franzini (2014) have taken the vertical information and investigated, respectively, on high-resolution DTM accuracy and the dynamic aspect (movement) of the vertical component of the vertical component of the DTMs.

Fourteen papers from three different countries are included in this special issue. We have divided the contributions into the main branches of geomatics, giving a quick overview of the contribution related to the field of natural hazards and risk analysis.

2. GNSS

The "low-cost sensors" paradigm always attracts interest for obvious reasons: obtaining accurate measurements and decreasing the overall costs. Cina and Piras (2014) tested a GNSS L1 carrier phase-only receiver, with a budget below 300 Euros, for landslide monitoring, presenting the accuracies obtained from a site-specific case study. Guarnieri et al. (in press) have used a Bayesian approach to identify significant displacement of GNSS positions. GNSS technology is also a part of the method used by Forlani et al. (2013) in the PhotoGPS technique which allows "fast photogrammetry", i.e. using structure from motion algorithms. Any geomatic technology requires accurate positioning of the sensors and therefore of the data; GNSS is, therefore, an important aspect common to all other methods, even if in some cases it is not the focus of the investigation.

3. Photogrammetry

Scaioni et al. (2014) have used scaled-down models in a lab, applying a controlled scenario where coded targets and photogrammetric methods were used to create a spatial sensor network (SSN) to monitor a simulation of landslide activity. Borgogno Mondino (2014) used bundle adjustment of multi-temporal images to assess whether accuracy and reliability improve using low-quality data-sets (paper prints scanned with a non-photogrammetric scanner). These types of case studies are important as when practice meets theory, and the quality of the datasets becomes an important factor. Forlani et al. (2013) have also used a photogrammetric method, PhotoGPS, where structure from motion techniques is followed by automated dense-matching to create a DTM from images.

4. Synthetic aperture radar

Permanent scatterers (PSs) are an important technology which can potentially support monitoring of vertical movements of the terrain. In this sense, Vittuari et al. (2014) have defined movements in the magnitude between 1 and 10 cm using such technique.

Radar displacement rates also allowed to monitor the movement of landslides at large scales in Frangioni et al. (2014). ENVISAT was used in this case study to support updating the landslide inventories in a specific basin where more than 200 areas were monitored, thanks to PS interferometry. High-resolution SAR imagery has also been proven effective by Nascetti et al. (2014) in providing a high-resolution digital surface model (DSM) obtained using InSAR and radargrammetry using COSMO-SkyMed SpotLight stereo pairs and InSAR, sharing one common image which in turn provide support for hydrogeological risk mapping and emergency management.

5. Remote sensing

Multi-temporal remote sensing analysis allowed to assess flooded areas by Franci et al. (2014). The authors used it to compare the estimated results with real data from extreme events in an urban context. Accurate land-cover mapping methods from satellite images can be important not only for post-disaster decision support, but also to encourage sustainable development of urban sprawl.

6. Laser scanning

Terrestrial laser scanning (TLS) has recently developed new potential due to increased maximum range, lighter weight of the components, better accuracy and, in some models, also the ability to return multiple echoes and waveform information. This contributes to a better definition of the ground surface, allowing also to filter vegetation elements (Pirotti 2011). In Barbarella et al. (2013), multi-temporal TLS is used for accurate monitoring of a ground displacement in a landslide causing serious hazard on railway track. Detecting and analysing areas with homogenous behaviour allowed to model the dynamics of the movements with significant accuracy and thus provide scenarios for future actions.

7. GIS and modelling

In geomatic methodologies, measures are taken directly or inferred with models. The phenomena and related elements which are measured are bound to be modelled to reach a certain knowledge of the dynamics of past events, the status quo of the present state, and, where possible, a model to determine possible scenarios and support actions and decisions (Pirotti et al. 2011). GISs enable processing of databases with a spatial component. Cencetti et al. (2014) have used GIS technology to test a method for defining a unique threshold for extracting the drainage network in a basin, which is an important step for further hydrological modelling. Federici et al. (2014) instead use a model to predict landslides over wide areas and have positive results when confronting with a specific case study with extensive kinematic phenomenon. Both used open source GRASS GIS, a common tool in the research community (Neteler et al. 2012).

8. Conclusions

We have provided several applications of the latest methods of geomatic technologies applied to natural hazards and risk. The importance of investigations in this field is proven from these contributions and also from recent papers. The future holds even more promising outcomes as development of new and improved sensors will not only improve the existing state, but also provide new types of data. Recent examples of what might be coming are the nano-satellites from Skybox and Planet Labs, which promise a revisit times of more than once a day, with resolutions of 1 and 4–5 m, respectively; the effects of such imagery can easily be imagined; see Belward & Skøien (2014) for further reference on future scenarios of remote sensing, both active (e.g. SAR) and passive. GNSS is increasing the number of orbiting satellites adding to the United States' GPS constellation with Europe's Galileo, Russia's GLONASS and the China's BeiDou. Laser scanners are notably getting longer ranges, and are faster, more accurate and with waveform-related capabilities (Pirotti et al. 2013). It is the role of geomatics to define and assess the methods to make the best use of the data that come from these technologies. Natural hazard and risk are upon the primary fields of applications in line to prevent disasters and limit consequences.

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