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Introduction to the special issue: “High resolution topography, quantitative analysis and geomorphological mapping”

Paolo Tarolli & Marco Cavalli

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This special issue collects papers regarding the use of Digital Terrain Models (DTMs) derived by different remote sensing technologies for the analysis of the Earth surface. In the last few years, remote sensing technologies, such as airborne and terrestrial Light Detection and Ranging (LiDAR) technology, offered to the scientific community the opportunity to analyze terrain morphology over large areas, at a higher resolution than the one provided by other technologies [Slatton et al., 2007; Tarolli et al., 2009]. This new generation of topographic data served as the basis for the development of new methodologies to better recognize surface landforms [e.g. Mazzarini et al., 2007; Cavalli and Marchi, 2008; Arrowsmith and Zielke, 2009; Booth et al., 2009; Trevisani et al., 2012; Cazorzi et al., 2013; Lin et al., 2013] and, thus to understand Earth surface processes [Tarolli and Dalla Fontana, 2009]. One of the most important advances of LiDAR technology is the capability to detect bare ground morphology in forested areas, and collect high-quality land cover information (Digital Surface Models, DSMs) opening also new opportunities in forest and environmental sciences [Corona et al., 2012; Pirotti et al., 2012]. Other remote sensing technologies, such as Synthetic Aperture Radar (SAR) and Advanced Spaceborne Thermal Emission and Reflectance Radiometer (ASTER), deserve to be mentioned for their effectiveness in geomorphology as well [Catani et al., 2005; Metternicht et al., 2005; Bubenzer and Bolten, 2008; Kawabata and Bandibas, 2009], especially for large-scale analysis [Siart et al., 2009]. Tarolli et al. [2009], after a successful session convened at the 2007 Fall Meeting of the American Geophysical Union, that consisted in 41 abstracts from North America, Europe and Asia, provided a first collection of papers in the special issue "Understanding earth surface processes from remotely sensed digital terrain models" published in Geomorphology journal.

The idea for this special issue arose from a session on "L'informazione topografica ad alta risoluzione per l'analisi dei processi superficiali" convened by the proponents during the 8th edition of the Italian Forum of Earth Sciences, Geoitalia 2011, held in Torino, Italy. The session, consisting into two oral and one poster blocks, attracted 26 abstracts from different Italian contexts and other Countries, providing an opportunity to analyze different case studies and processes, with different approaches and topographic data. Along the same line adopted for the issue by Tarolli et al. [2009], the sequence of contributions is arranged according to the spatial characteristics of the techniques and methods concerned: from very high resolution, to a progressively coarser resolution of the topographic data.

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Pirotti et al. [2013] presented a review about the state of the art of terrestrial and aerial laser scanner sensors with a critical discussion about quality of the surveyed dataset. The importance of accuracy for high resolution topographic surveys has been analyzed in terms of the factors that influence positional accuracy, range, point density and quality of the final product. Costantino and Angelini [2013] implemented an appropiate and simplified procedure for generating DTM derived from Terrestrial Laser Scanner (TLS) data using a Time Of Fly (TOF) instrument. Then the results have been compared to those produced by commercial software. Bertacchini et al. [2013] discussed about the critical issues and data management of a multi-sensors integrated system for landslide monitoring, consisting in Global Navigation Satellite System (GNSS), Automated Total Stations (ATS), and Ground Based InSAR (GB-InSAR). An active landslide located in the northern Apennines of Italy, monitored from 2007 to 2011 with both a continuous and a periodic approach, has been considered as a study area. Along the same line of Bertacchini et al. [2013], but relying on a different technology, Barbarella and Fiani [2013] monitored with TLS and Global Positioning System (GPS) a large landslide that has caused extensive damage. Different TLSs types were considered to better evaluate the reliability of the surveys. Cavalli et al. [2013] proposed a methdology for the derivation of the channel network from a high resolution DTM in a regional context presenting a case study in the Autonomous Province of Trento (north of Italy). A preliminary automatic extraction of the raw channel network was conducted using a curvature-based algorithm applied to a 4 m resolution LiDAR-derived DTM. The extracted channel network was then integrated by means of different informative layers (i.e. geomorphometric indexes, orthophoto imagery and technical cartography). The final result is an accurate and fine-scale channel network for the whole Province of Trento. Tarolli et al. [2013] developed a methodology for the automatic recognition of roads and trails induced surface water flow redistribution. The algorithm is based on the calculation of the drainage area variation in the presence, or in the absence of anthropic features such as roads and trails on hillslopes. Road networks in mountainous forest landscapes have the potential to increase the susceptibility to erosion and shallow landsliding. The same issue is observed also for minor trail networks, with evidence of surface erosion. The methodology could have a role in risk management and environmental planning for mountain areas where tourism and the related economic activities are critical. Different algorithms, usually available in GIS environment, are analyzed in the work of Godone and Garnero [2013] in order to spot an optimal interpolation methodology and to define, by classification techniques, which morphological variable affects the interpolation quality. The classification has drawn the attention to surface roughness as the main factor affecting interpolation accuracy. Lucchesi et al. [2013] tested the application of digital images and high resolution LiDAR-derived DTMs associated with GIS in geomorphologic analysis in two different geological and geomorphological contexts of North West (NW) of Italy. The procedure needs to be improved since this is a first attempt toward a more detailed and accurate analysis. However, suitable results have been obtained for areas characterized by difficult accessibility, with reduced costs and work time, compared to traditional field techniques. Forno et al. [2013] proposed a new tool (GSTOP) for 3D field geomorphological survey and mapping. The tool can be mounted on laptops or modern tablets, managing a direct connection with low cost navigation sensors in real time, to define its location and attitude angles. The user can generate a 3D solid image in order to compare the effective scene to record notes and to acquire evidence. GSTOP has been used to produce a detailed digital geomorphological map of the Rodoretto Valley (Germanasca Valley, NW Italy). Nitti et al. [2013] analyzed the potentiality of COSMO/SkyMed (CSK) data in providing interferometric Digital Elevation Model (DEM). They processed a stack of CSK data in order to measure the ground elevation on the available coherent targets with meter accuracy, and they used these values to check the accuracy of DEMs derived from 5 tandem-like CSK pairs. The atmospheric signal was suppressed through a classical spatial filtering of the differential phase as well as the use of weather prediction. Tandem-like pairs with normal baselines higher than 300 m allow to derive DEMs fulfilling the HRTI Level 3 specifications on the relative vertical accuracy. A first step towards a landslide inventory map of the Central Karakoram National Park has been discussed in the work of Calligaris et al. [2013]. The Bagrot Valley study area was partially surveyed and part of the landslide-prone areas were preliminarily identified through DEM analysis, GIS techniques and Analytical Hierarchy Process (AHP) methodology. ASTER DEM was used as the basis of morphometric analysis. According to the authors this research has obvious limits due to the scale of the available geological map, the grid cell size of the ASTER DEM and to the lack of some fundamental information such as the land use or top soil cover. The work represents just the beginning of a multi-disciplinary study in which different topics are going to converge during the next years.

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With our best regards,

Paolo Tarolli (Department of Land, Environment,
Agriculture and Forestry - University of Padova)
and Marco Cavalli (CNR-IRPI)
Guest Editors

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