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Debris flow cartography using differential GNSS and Theodolite measurements

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The presented results form part of a CHARMA project, which pursues a broad objective of reducing damage caused by uncontrolled mass movements, such as rockfalls, snow avalanches and debris flows. Ultimate goal of the project is to contribute towards the establishment of new scientific knowledge and tools that can help in the design and creation of early warning systems. Here we present the specific results that deal with the application of differential GNSS and classical geodetic (e.g. theodolite) methods for mapping debris and torrential flows. Specifically, we investigate the Portainé stream located in the Pallars Sobirà region of Catalonia (Spain), in the eastern Pyrenees. In the last decade more than ten debris-flow type phenomena have affected the region, causing considerable economic losses.

Since early 2014, we have conducted several field campaigns within the study area, where we have employed a multi-disciplinary approach, consisting of geomorphological, dendro-chronological and geodetic methods, in order to map the river bed and reconstruct the history of the extreme flooding and debris flow events. Geodetic studies included several approaches, using the classical and satellite based methods. The former consisted of angle and distance measurements between the Geodolite 502 total station and the reflecting prisms placed on top of the control points located within the riverbed. These type of measurements are precise, although present several disadvantages such as the lack of absolute coordinates that makes the geo-referencing difficult, as well as a relatively time-consuming process that involves two persons. For this reason, we have also measured the same control points using the differential GNSS system, in order to evaluate the feasibility of replacing the total station measurements with the GNSS. The latter measuring method is fast and can be conducted by one person. However, the fact that the study area is within the riverbed, often below the trees, limits the visibility of the satellites and thus, can result in meter-level errors while estimating the positions.

We have conducted 2 measurements using various differential GNSS systems in March and in September of 2015. During these measurements we used Leica Viva GS14 receiver as a rover station, which was equipped with a GSM card to establish an internet connection in order to receive differential corrections from continuous GNSS networks. During the first campaign we have used the RTK positioning method using the SmartNet network (http://es.smartnet-eu.com) operated by Leica. This system had the advantage of transmitting differential corrections for GPS and GLONASS systems. During the second campaign, we have had an access to the ICGC (http://www.icc.cat) CatNet permanent GPS network, which only provides GPS satellite corrections. Here we present the analysis of the obtained precisions from these two RTK systems. Additionally, we have analyzed the geodetic data in a post-processing mode using the Leica Geo Office 8.4 software with IGS estimated final orbits. For this procedure, in addition to using the data from nearby CatNet CGPS stations, we have also used data from the base station(s) specifically setup near the study area during the campaign period.

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