Analysis and integration of data sources for the hydrogeological hazard classification in the Autonomous Province of Trento

Elisa Sbrissa, MSc[1]; Carla Pendino, MSc[1]; Ruggero Valentinotti, MSc[1]; Stefano Fait, MSc[1]

INTRODUCTION

In order to reduce the probability of flooding and its potential consequences, by 2015 the European Union requires Member States to draw up the flood risk management plans focusing particularly on prevention (Floods Directive 2007/60/EC). According to this focus, the Autonomous Province of Trento (Italy) developed an integrated methodology to produce hazard maps of its territory (Autonomous Province of Trento, 2014). Nowadays the most common approach to define hazard areas is using LiDAR data for mathematical modelling, most of all for debris flow phenomena. Despite the high resolution that characterizes LiDAR data, the results are often unreliable because of the input parameters. Indeed input data, required into models, is a question still open due to uncertainty determined by hydrology, rheological characteristics, availability of sediment, influence of vegetation, etc. Based on these considerations we understand the importance of integrating information to draw hazard maps. In this study we present an integrated assessment of all available information for the Province of Trento, that is advantageous both to understand the causes and effects of historical events and to hypothesize scenarios of events that may occur in the territory. Furthermore LiDAR data analysis allows to identify morphological evidences that indicate hydrogeological instability, which is very useful mostly where there's no possible to apply adequate mathematical model.

METHOD

To describe the procedure used we present three different case studies. The first one individuates morphological evidences of past events from LiDAR data, such as debris flow levees, torrential and alluvial fans. Integrating evidence of LiDAR data with a bibliographical research of past events and a detailed on-site inspection, we can have useful information to delimit the hazard area of the cones, despite lack of hydrodynamic simulations (Fig. 1). A recent landslide, occurred on province territory, represents the second case study (Fig. 2). To take into account the new contribution of detrital material close to the riverbed, it is necessary to update the DTM with field topographic measurements. The integration of LiDAR data with field topographic measurements permits us to estimate landslide volume and deposit areas, useful for hydraulic simulation of the event and for the hazard map design. In the third case study, LiDAR data analysis allows to identify morphological evidences of lateral erosion of the banks that indicate hydrogeological instability. We can individuate steep banks and possible landslide phenomena from LiDAR data crossing slope degrees and terrain profile curvature, as shown in Fig. 3. In this way it's possible to draw up hazard maps including external sides of the banks.

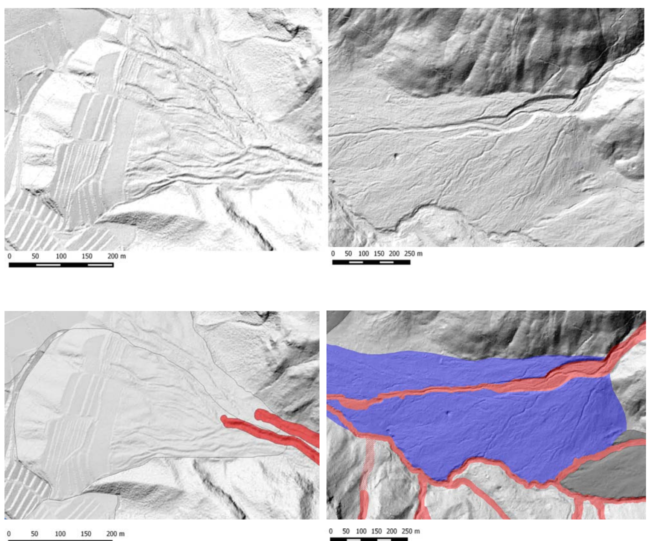

Figure 1. Morphological evidences of debris flow levees and torrential fans, with the associated hazard maps (red polygons represent high hazard, blue polygons represent medium hazard and grey polygons represent potential hazard).

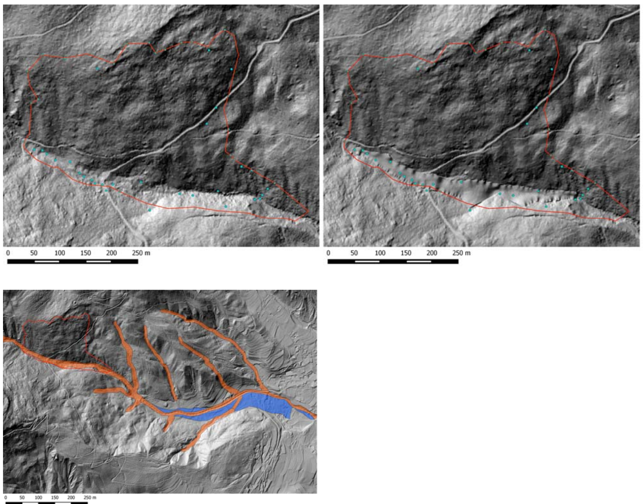

Figure 2. Integration of DTM with topographic measurements (green points) - before and after landslide (red line). Hazard map resulting from data integrations (red polygons represent high hazard, blue polygons represent medium hazard).

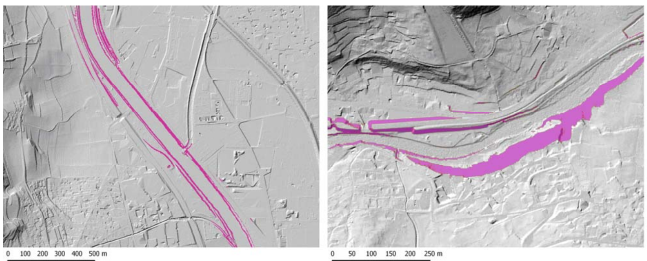

Figure 3. Morphological evidences of steep banks (left) lateral erosion of the banks (right).

CONCLUSION

In this study we presented the strategy developed by the Autonomous Province of Trento to produce hazard maps of its territory, according to the prescriptions required by the European Union to its member states (Floods Directive 2007/60/EC). This methodology is based on an integrated evaluation of all available information, focusing on the importance of LiDAR data both for quantitative and qualitative evaluations. In fact we tested the necessity of integrating information to draw hazard maps. We analyzed different case studies where LiDAR data analysis allows to identify morphological evidences such as debris flow levees, torrential and alluvial fans, lateral erosion of the banks that indicate hydrogeological instability. We also presented the integration of the LiDAR data with field topographic measurements, to update the hazard map where a recent landslide occurred. In conclusion these case studies show how the hazard assessment of fluvial and torrential phenomena is a complex process and it requires the integrated evaluation of all available information, both to understand the causes and effects of historical events, and to assume the scenarios of events that may occur on territory.

KEYWORDS

LiDAR data; hazard map; integreted assesment.

1 Provincia Autonoma di Trento, Trento, ITALY, elisasbrissa1@gmail.com

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