VULNERABILITY ASSESSMENT OF SARDINIA (ITALY) TO EXTREME RAINFALL EVENTS

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Abstract

During the last ten years, at least 5 flash floods caused several deaths, the destruction of houses, land and properties in Sardinia. Despite a clear evidence for the vulnerability of Sardinia to severe rainfall events, at the official level the lack of complete and extended data about damaging hydro-geologic events yields misinformation about the true extent of hydro-geological risk. To make up for this lack of information, authors study the role of meteorological and climatic conditions in the occurrence of damaging hydro-geologic events in Sardinia.

1 Introduction

Violent storms are characteristic of Mediterranean climate areas, leading to flash floods that often represent important natural hazards. In Sardinia, flash floods have occurred frequently in the last 5 years hitting the Central-East and South-West areas mainly. Here, intense rainfall is usually caused by warm and moist air flows coming from North Africa and meeting the steep mountains near the sea. Statistical analysis of daily rainfall data has been performed to estimated return levels of main rainfall events and to check for trends in extreme events. A few recent flash

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floods have been analysed in detail (Cossu et al. 2007, De Waele et al. *in press*): the analysis of one of them is briefly presented here.

2 Methodology

Heavy rainfall has been modelled by fitting a Generalized Extreme Values distribution to annual maxima (period from 1951-2000, 144 pluviometric stations). Trend analysis has been carried out on several indices of extreme event (see Bodini & Cossu 2010 and therein references).

Peak discharge has been estimated by empirical formulae (Manning, Jarret and Costa equations). The distributed physically based hydrological model TOPKAPI (Ciarapica & Todini, 2002) has been used to compute what it would have been the river flow of December 2004 without karst losses in the river, but only considering the distributed hydrological processes on the hillslopes (such as infilitration, percolation, subsurface flow, etc.).

3 Climatic analysis

Only a few stations show decreasing annual precipitation. None of the considered indices show clear trend. Only in the case of the maximum 5-day precipitation total (R5D), the analysis suggests a decreasing trend, which is limited to the central-eastern area.

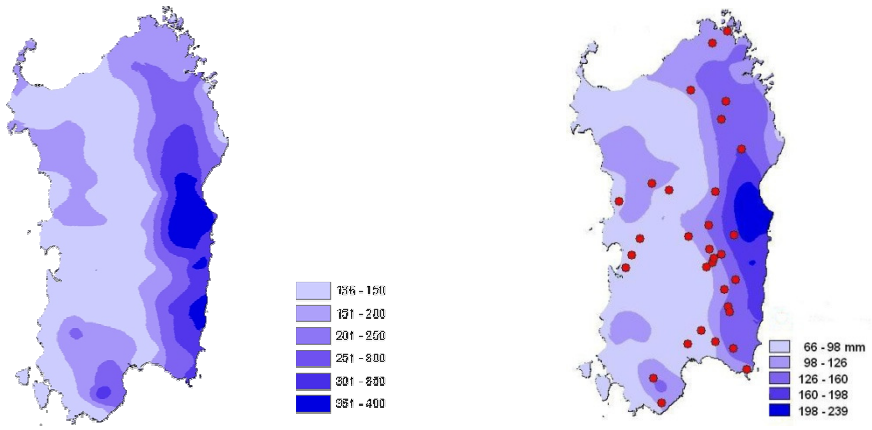

Figure 1. Spatial variability of 50 year-return level (left) and R5D, red dots indicate stations showing a significant negative trend (right).

However, the area most affected by extreme events, is only marginally interested by this result, as shown in Fig. 1.

4 Flash flood case study

In Fig. 2 the results of the analysis of the flash flood occurred in December 2004 at the Flumineddu river are summarized, in terms of the computed river peak flow and the estimated karst losses or gains in some river reaches.

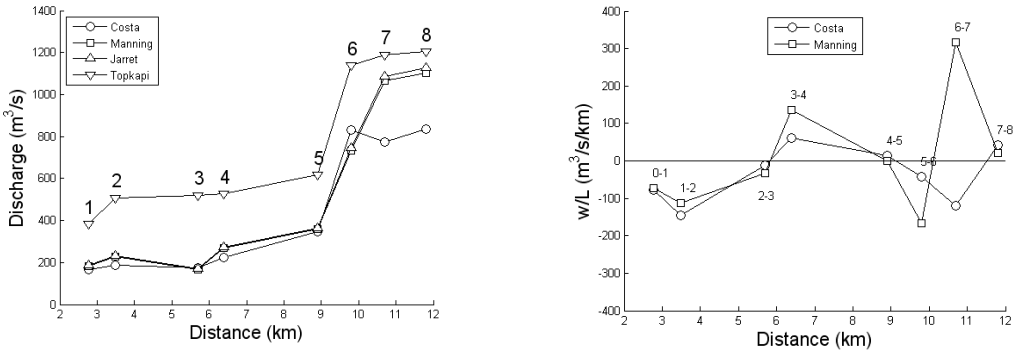

Figure 2. River peak flow at different transects estimate by the empirical formulae and by the hydrological model TOPKAPI (left); karst losses/gains estimated by comparison along the river reaches (right).

An extremely high runoff event of ~10 $m^3/s/km^2$ together with a very complex karst dynamic, with water losses of ~200 $m^3/s/km$ and water gains of >300 $m^3/s/km$ along the river, indicate the exceptionality of the triggering rainfall event (~70 year return time).

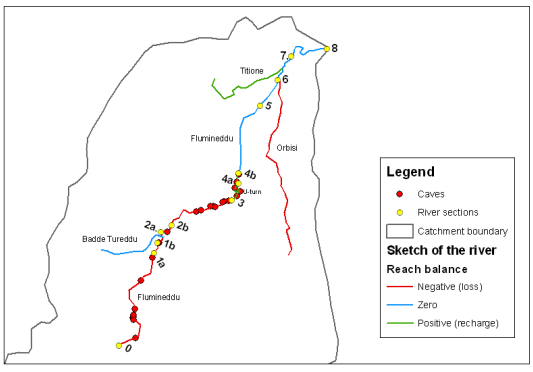

Figure 3. Conceptual scheme of the water balance in the river reaches as estimated by the model and location of the main known caves (left) and waterfall during flood at the confluence of Orbisi torrent and Flumineddu river (right).

These results are confirmed by the presence of the main known caves, as shown in Fig. 3 where they are overlapped on the conceptual representation of the water balance in the river reaches.

5 Conclusions

To assess the vulnerability of Sardinia to hydro-geological events, a deep analysis of the effects of past events in terms of types of triggered phenomena, meteorological conditions, and economical and environmental damage has been undertaken (PROTERINA C project). Sardinia to the occurrence of heavy rainfall can also depend on land use, these information will be compared to a few informative layers like forested areas, land abandonment, roads and urban developments.

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