

multi-Risk sciEnce for resilienT commUnities undeR a changiNgclimate

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both in real-time and for prediction purposes.**

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1. Technical references

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2. ABSTRACT

Flood risk protection infrastructure are essential for debris flow risk mitigation. The main approach to managing the volume of sediment transported by stony debris flows routing along channels is through retention basins and open check dams, usually built in the lower reach just upstream of inhabited areas where slopes are gentler. In some cases, these measures are not sufficient to retain all the volume of sediment transported by debris flows. An alternative solution could be a retention basin open on the downstream side, that is, without the ending transversal embankment or berm. Therefore, it can be designated as a deposition area because the retention effect of the downstream embankment is missing, and sediment deposition only occurs due to the flatness of the basin.

This Deliverable reports on one specific contribution from RETURN – SPOKE WATER on this topic, as follows:

- Deposition areas: An effective solution for the reduction of the sediment volume transported by stony debris flows on the high-sloping reach of channels incising fans and debris cones, University of Padova;

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4. Improved models of water-induced debris-flow to be used both in real-time and for prediction purposes

4.1 Deposition areas: An effective solution for the reduction of the sediment volume transported by stony debris flows on the high-sloping reach of channels incising fans and debris cones

University of Padova

The destructive power of debris flows is directly related to the volume of sediment transported, that is, its magnitude, and to the velocity. In recent years, there has been a significant increase in the occurrence of high-magnitude stony debris flows, mainly due to the increasing frequency of two factors associated with climate change: extreme precipitations, leading to increased runoff generation, and the rock collapse events, providing large quantities of sediments that are needed for the formation of solid-liquid surges. The hazard due to the destructive power of debris flows and their increased frequency calls for structural countermeasures for the protection of sites of medium to high value. Furthermore, the presence of such protective works can enhance the sense of safety among the population and promote the development of tourist and economic activities, considering the increased perception of the risk.

The main scope of the structural countermeasures for in-channel stony debris flows is to control sediment for protecting inhabited areas, tourist and economic infrastructure, as well as the main routes located in the valley bottom. The main work for sediment control is represented by the retention basin or sediment trap, which is an area closed off on the downstream side by an embankment or berm that provides the blocking action. The retention basins are usually built just upstream of the threatened area on the valley bottom. Here, the low-sloping terrain allows an easier construction of the basin and limited excavation works for the trapping of large volumes of sediment. Additionally, the proximity to main roads facilitates control and maintenance operations. If an outlet structure is present, typically an open check dam, the basin can be built also upstream in the intermediate sloping reach. However, in the case of high-magnitude debris flows, where the areas available for their construction are limited, these basins could not retain the entire sediment volume transported.

In these cases, an effective reduction of the sediment volume can be achieved through the use of flat areas, that is, basins open on the downstream side, which promote the deposition of large quantities of sediment due to their flatness. The absence of a downstream retention effect suggests for these works the name deposition area, rather than retention basin.

This deliverable DV 2.5 introduces the concept and functionality of the deposition area for controlling in-channel debris flows (i.e., for the reduction of the transported sediment volume), investigates the morphology of debris-flow deposits on it, proposes some criteria for its sizing and examines the geomorphic conditions for its positioning and building.

An alternative approach for the sediment control of in-channel stony debris flows.

The work proposes the use of deposition areas as an effective solution for the reduction of the volume of sediment transported by debris flows in the high-sloping reach of channels incised on debris flow fans or cones. The deposition area, a retention basin opened on the downstream side, allows a simpler construction and management with respect to a single or a series of barriers. In addition, it also has a certain degree of flexibility

in the sense that some changes could be implemented after observing the depositional behaviour of occurred events.

The research was carried out based on data from the Rovina di Cancia (Eastern Italian Alps) test site.

The Rovina di Cancia debris-flow site (hereinafter Cancia) is located on the Venetian Dolomites, Eastern Italian Alps. This site, prone to a debris-flow activity, has experienced an increasing frequency of debris-flow occurrence since 2009, resulting in significant damages and casualties. Here, we focus on the upper part of the basin and the relative control works, both those existing and the removed and planned ones. For the purpose of stopping the debris flows of small- to medium-magnitude and reducing the volume of high-magnitude debris flows, a deposition area was built after the high-magnitude debris flow occurred on 1996. This basin was positioned downstream of the apex of the Cancia fan, in a zone where the bed slope decreases to values lower than 20deg so that the enlargement does not incise steep talus slopes.

The experience of Cancia suggests that the deposition area should have an upstream sloping part at the purpose of addressing the flow along the longitudinal direction, if the incoming channel is not aligned with it. This avoids the flow displacement on a side with possible uncontrolled overflow of the bank and promotes an optimal filling degree of the available deposition area. This facility should be built where the flow is channelized at steep slopes and far enough from unstable cliffs. The preferable position is at the transition from the high to the intermediate-sloping reach. This implies a smaller slope of the lateral banks avoiding possible instabilities, as well as a lower volume to be excavated during the construction.

Two relationships depending on the depositional area are proposed for estimating the volume of sediment depositing on it during a medium- to high-magnitude stony debris-flow event. The former derives from the volumetric schematization of the debris-flow deposit based on simple rheological observations. The latter is empirically.