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Regional-scale economic efficiency evaluation of defensive works in Alpine valleys

P. Frattini (1), G.B. Crosta (1), S. Mossa (1) and D. Fossati (2)

(1) Universita' degli Studi di Milano - Bicocca, P.za della Scienza 4, Milano, Italy (paolo.frattini@unimib.it), (2) Regione Lombardia, DG Territorio e Urbanistica, via Sassetti 32/2, Milano, Italy

Following up catastrophic flooding and landslide events, governments often supply extensive funding for defensive works and risk mitigation. A sudden availability of funds in a state of post-emergency normally prevents a rational use of this money. In particular, the evaluation of the efficiency of the works is limited to an engineering appraisal of the work itself. This approach can be correct when actions are focused on specific local problems, but not when works directly interact with a more regional or distributed system or with other works. In this research, we suggested a simplified approach for the evaluation of cost-benefits deriving from the construction of protective works in small Alpine alluvial systems. We focused on basins for which the main concern is the potential supply of large amount of sediments that can suddenly increase the solid discharge, causing damages to downward towns. We applied this approach to the Mallero river valley (Val Malenco, 300 sqkm , Central Italian Alps), that flows toward the city of Sondrio (nearly 22,000 inhabitants). The valley have been interested by many severe hydrological events, recorded since 1463. In July 1987, an exceptional rainfall event triggered hundreds of small landslides and two major deep-seated ones, that temporarily dammed a tributary valley of the Mallero river. The dam was breached after few hours, causing an outburst flood that partially destroyed a small village within the valley, and seriously threatened the town of Sondrio along the alluvial fan at the valley outlet. After the 1987 event, the administration financed about 650 hydraulic and 250 stabilization works, with a total actualized cost in excess of 50,000,000 euros. In order to evaluate the cost-benefit of the major defensive works, we considered a scenario of a catastrophic flood with a 300 yr recurrence time, and we assessed the benefit of the works in terms of reduction of potential direct and indirect

costs due to mitigation. Considering the regional nature of the study, we didn't apply a hydrological model to estimate the liquid and solid discharge, but we more simply adopted some empirical laws. To assess the benefit due to mitigation, we calculated for each work the degree of potential mitigation (i.e., physical efficacy), and the value of the protected elements. The first is a function of the expected intensity, the work typology, and its technical specifications. The second is the summation of the values of each protected element at risk attributed to each work in proportion to the ratio of the intensity of the flood at the element to the intensity at the work. This benefit was then compared with the actualized cost of the work to evaluate the level of economic efficiency of each work. This method extensively makes use of GIS to analyse the spatial relationships among the different works and the elements at risk, and to estimate the expected intensity of the hazardous process. As a result, we demonstrate that the costs are higher than the potential benefits for more than half of the works of the Mallero river catchment, even with a catastrophic flood scenario. This suggests a misallocation of public money in order to develop a complete and appropriate mitigation strategy at the basin scale. We retain that the method could also be applied ex-ante for an efficiency evaluation finalized to a rational use of public reconstruction and mitigation funds.