How do existing torrent control structures perform effectively? From first-level inspections   
to maintenance strategies

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**Abstract.** Torrent control structures are countermeasures build in torrent catchment areas for mitigating losses due to flood and debris flow events. The durability of these measures depends on structure type, material, quality of design, construction, and maintenance as well as on the physical pressures they are under. During last half-century the decrease of investments in ordinary maintenance activities and the natural degradation of the structures have exacerbated the reduction of protection level, reason why they were built. In this context, monitoring and getting maintenance of existing structures should be the focus of the future investments to improve or maintain their functionality and to increase safety from natural hazards. The present study describes a proposal of a first-level inspection that was applied on the torrent control structures of Pioverna torrent, in Valsassina (North Italy). The results of the first-level inspection have filled a dataset with a wide spectrum of information, such as absent structure details (width, length, height, age of construction, materials, etc.), structure’s status, residual functionality, torrent and hillslope instability level of the neighboring area. Then, a homogeneous Markov chain model was adopted to assess the vulnerability of the existing surveyed torrent control structures. Such proposed approach was integrated with a statistical analysis of the dataset in function of structure type, construction materials and neighboring torrent-hillslope conditions. These additional results provide a comprehensive knowledge of how actually control structures perform, crucial for planning risk management, and a reliable model for forecasting the decline of functionality over the time. Moreover, this framework allows to evaluate the time-dependent impacts of different levels of ordinary maintenance on torrent control structures. Finally, the study could be extremely useful for enhancing the role of the first-level inspection and monitoring, essential for estimating the actual and future vulnerability of existing torrent control structures, and for improving a decision support method that can manage the future investments in ordinary maintenance of torrent control structures.