



# Valuing landslide risk reduction programs in the Italian Alps: The effect of visual information on preference stability



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## ABSTRACT

Climate change has increased the frequency and intensity of weather-related natural hazards everywhere. In particular, mountain areas with dense human settlements, such as the Italian Alps, stand to suffer the costliest consequences from landslides. Options for risk management policies are currently being debated among residents and decision makers. Preference analysis of residents for risk reduction programs is hence needed to inform the policy debate. We use discrete choice experiments to investigate the social demand for landslide protection projects. Given the importance of information in public good valuation via surveys, we explore the effect of specific visual information on the stability of preference estimates. In our survey, we elicit preferences before and after providing respondents with scientific-based information, based on visual simulations of possible events. This enables us to measure information effects. Choice data are used to estimate a Mixed Logit (MXL) model in WTP space to obtain robust estimates of marginal willingness-to-pay (mWTP) estimates and control for the effect of information. Mapping posterior individual specific mWTP estimates provide additional policy implications. Overall, we found the mWTP estimates to be dependent on information.

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## 1. Introduction

Climate change has increased the frequency of geohydrogeological calamities, over both time and space. Worldwide a growing number of people are affected by such natural phenomena. This study specifically addresses landslides in the Italian Alps, an area where landslides are an increasingly common major natural hazard. They are complex events for which current data records provide no precise estimations of risk; scientists are hence unable to provide accurate predictions of probability of occurrence. In the engineering literature, there have been several proposals of technical solutions aimed to reduce the impacts of landslide events (Berti et al., 1999; Gregoretti and Dalla Fontana, 2008; D'Agostino et al., 2010). Most solutions consist of specific safety devices to mitigate the risk in pre-existing landslides' trajectories. However,

few studies address individuals' preferences to the proposed solutions.

Landslides have been studied extensively in Europe, especially in Italy, Norway, Switzerland and the UK, mainly with a focus on their economic impact. From the analysis of previous literature on this topic, it emerges that few studies employed non-market valuation techniques, and especially stated preference techniques, to estimate the value of landslide risk reductions programs (Ahlheim et al., 2008; Mori et al., 2006; Flügel et al., 2015; Thiene et al., 2016 and Vlaeminck et al., 2016). However, there is still limited work carried out in the investigation on the social acceptability of risk mitigation programs, and on their specific demand.

This study reports the results of a Discrete Choice Experiment (hereafter DCE) for the evaluation of landslide protection devices. This approach is well suited for such analysis as it allows researchers to elicit individuals' preferences for alternative policy measures.

The present investigation contributes to the small literature on people's preferences for landslide mitigation programs. Specifically, we estimate the implied willingness-to-pay (WTP) of the local population of visitors and residents of the Boite Valley (Belluno, Italy) inferring it from a sample. The WTP estimates concern

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different engineering solutions designed to increase safety from potential landslides. To develop preferences over the alternative solutions, the population during the debate should be exposed to scientific-based information such as hydro-geological simulations of possible events. So, we also test whether the provision of visual information affects the stability of our estimates of respondents' preferences. In particular, we focus on detecting whether information about a safety device increases individuals' WTP for that specific device. This is particularly relevant from a policy perspective, as it may help policymakers to evaluate whether it is appropriate to allocate resources in promoting information campaigns. This analysis is grounded on previous literature that showed that WTP estimates are impacted by the type of information provided to respondents (Munro and Hanley, 2002; Chanel et al., 2006; MacMillan et al., 2006; Oppewal et al., 2010). Furthermore, uninformed respondents may underestimate benefits of protection projects for the community. Finally, to explore the validity of our results, we map the mean values of marginal WTP estimates at the individual level within each municipality. To our knowledge, the analysis of how the sample estimates of marginal WTP are distributed over space has not been previously employed to evaluate alternative risk management policies.

The remainder of this paper is organized in four sections. Section 2 presents the case study by giving the reader an overview of the landslide hazard, the policy context of the study and presenting the hypotheses to be tested. Section 3 describes the survey design and the modelling approach used for the data analysis and the hypotheses' tests. In Section 4 we discuss the results, including the geographical representations of the respondent-specific marginal WTP estimates. Finally, our conclusions are reported in Section 5 along with the policy implications for landslide risk mitigation in the Boite Valley.

## 2. The case study

### 2.1. The case study and policy debate

In the steep mountain areas of the Dolomites (North-East of Italy) there is substantial evidence of recent and past landslide occurrences. The high vulnerability of this area to landslides, especially debris-flows, is likely to be exacerbated by future climate change. The local population are exposed to the risk of serious socio-economic consequences from these natural events. Historical records show that they often resulted in fatalities, homelessness, damaged buildings and interrupted road traffic (Sterlacchini et al., 2007; Salvati et al., 2010). These occurrences harshly affect the main local industry, which is based on tourism. Due to high hydrogeological risk levels, several landslides occurred in the Boite Valley – the specific location of our study – and caused deaths and damage to houses and other property. In 1814, a massive landslide destroyed two villages, killing 257 people. The biggest events happened in 1925, causing 288 victims and 53 people went missing. In the last decade, this area suffered a series of devastating landslides. Recently, in summer 2015, intense rainfall over a short period of time triggered eight events, causing significant damage to public infrastructure and three victims among visitors. Geologists believe that there are approximately 350 potential and active landslides that can be highly dangerous for the population living in the valley (Guidoboni and Valensise, 2014).

Local authorities are still debating with the community what possible landslide risk mitigating options to undertake. A large scale evaluation of both public support and acceptability for alternative risk reducing programs is underway. This is because: i) realization costs are high and many roads and municipalities are at risk; ii)

protection devices could have major environmental impacts; and iii) major changes of the municipalities' planning are expected.

### 2.2. Hypotheses

This paper specifically investigates the following three hypotheses:

*H1: People perceive the current level of protection from landslide hazard as inadequate.*

Because of recent landslide events, it is clear that risk mitigation is still a major safety issue for local authorities in the Boite Valley. However, interventions to mitigate the risk are expensive to implement. A unanimous decision about the measures to be adopted in the valley has not yet been reached. Therefore, there is a need for better understanding public acceptability of landslide risk management for an efficient use of public funds. For this reason, it seems useful to acquire additional information on preferences of residents and visitors, given that they would be the main beneficiaries, but also they would be the main financial contributors. The inclusion of social preferences in the public debate allows policy makers to take into account the economic dimension (expressed in terms of WTP), in addition to the other dimensions that feed into such debate. Specifically, preferences regard the use of a range of mitigation devices to increase protection. No previous studies have investigated respondents' preferences among a variety of safety devices against natural hazards.

*H2: The provision of specific scientific-based information will positively shift the WTP for the specific attribute for which the information was provided as well as for the other attributes.*

Many stated preference researchers investigated information effects on WTP estimates. Findings from previous studies in the context of environmental goods showed controversial results. The majority of the studies found that provision of information about a good leads to changes in WTP estimates. Among them, Munro and Hanley (2002) showed that an individual's WTP increased if positive information about the good was provided. The information effect was also investigated by O'Brien and Teisl (2004) regarding environmental certification and labelling. Their results suggest that additional information considerably altered estimates of mWTP for specific attributes. Instead, the results of a study conducted by Oppewal et al. (2010) suggest that providing explanatory information about an unfamiliar attribute not only results in parameter shifts for the particular attribute but also affects the estimates of the remaining attributes and the scale unit of the utility function. The study conducted by Czajkowski and Hanley (2012) suggested that respondents were more deterministic in their choices when provided with additional information. In a contingent valuation study, Chanel et al. (2006) showed that scientific information could have a positive impact on the respondents' WTP, but not so for public opinion. Other studies focused on the effect of information provision for goods that differ in term of familiarity. Among them, MacMillan et al. (2006) found that half of respondents changed their WTP over successive rounds of information provision, especially for the less familiar good. In our case people might value more those protection measures offering the highest level of safety, such as passive devices, than those offering a lower safety level, such as active devices.

*H3: There is spatial heterogeneity in the distribution of the WTP estimates and in the effect of information provision.*

Residents in the Boite Valley can, in fact, benefit more for the implementation of landslide mitigation programs than visitors. Therefore, there could be evidence of a distance decay effect. Respondents' familiarity with the problem and exposure to it can lead to different impacts of additional information across the region. We expect a stronger information impact on individuals liv-

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