Landslides (2016) 13:349–360
DOI 10.1007/s10346-015-0572-7
Received: 27 August 2014
Accepted: 6 March 2015
Published online: 3 April 2015

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Landslide risk perception: a case study in Southern Italy

Abstract Perceptions of risk are a key issue when seeking to develop systems, practices and policies to protect local populations. This is particularly evident when risk mitigation strategies involve non-structural measures such as relocation and warning systems which presuppose the active involvement of the communities in question. This study adopts an interdisciplinary approach to studying the perceptions, knowledge and opinions on landslide risk amongst residents in Sarno, a small town in Southern Italy which was hit by disastrous landslides on 5–6 May 1998. The paper presents the results of a survey conducted in the months of March, April and May 2013 using a purpose-designed questionnaire. The survey was conducted using face-to-face interviews with 100 residents, 60 of whom live inside the so-called "red zone", a territory declared at high residual risk soon after the events of 1998. The questionnaire included questions relating to perceived risk exposure, trust in institutions responsible for risk management, evaluations of risk mitigation measures and the early-warning strategy. The results of the study clearly emerges, amongst other issues, that the organisms which are responsible for risk management in Sarno need to develop more effective communication strategies in order to transmit knowledge about the actions implemented to reduce landslide risk in the area.

Keywords Risk · Perception · Landslide · Communication · Education · Community · Resilience

Introduction

The resilience of a community facing risks deriving from natural disasters is greatest when the local population can participate in decisions about risk management systems and agree with the central aims of such systems. Perceptions of risk are one of the fundamental elements that condition the behaviour of local residents (Tulloch and Lupton 2003) and thus have a decisive impact on community resilience. Perceptions of landslide risks are influenced by the ways in which decisions are implemented following processes of analysis and zoning, which imply that appropriate forms of communication are central to the success of risk management systems (Lombardi 2005; Albanesi et al. 2011). Communication must be bilateral if it is to be effective and must involve listening to the opinions of residents as well as understanding their views and perceptions.

The empirical analysis of perceptions raises a series of complex issues which demand an interdisciplinary approach, including the role of socio-economic structure, social networks, cultural practices and social identities. The present study is the result of a collaborative process integrating a sociological perspective with approaches drawn from engineering. The concept of risk has played an important role in the development of sociological theory in recent years (Renn 1988; Beck 1992; Lash 2000). These authors view uncertainty as constitutive of modernity using the concept of risk to denote a range of strategies that aim to rationalise or manage uncertainties regarding the future. Perceptions of risks—including the notion of "objective" risk—are consequently analysed in relation to their social functions and effects (Wynne 2002; Zinn 2004). Although natural hazards are often viewed as a source of social uncertainty and risk, these are rarely explored in concrete terms using the tools of empirical social research. A key insight of sociological research is that public policies, in order to be effective, must make reference to the local social context and seek to understand the relationship between interactive and limited forms of social and cultural rationality, on the one hand, and the unbounded rationality that is often implicit in technical models, on the other (Tulloch and Lupton 2003). Mitigating risk through social and behavioural routes must accommodate the fact that people interpret the information presented with regard to their expectations, experience, beliefs and misconceptions, and these, in turn, influence their decision-making and behaviour (Dow and Cutter 2000; Paton 2008). Researchers, planners and emergency managers must acknowledge heterogeneity in community characteristics and perceptual processes and develop resilience models that accommodate contingent relationships between hazard effects and community, cultural, geographical and temporal factors (Paton et al. 1999).

The latest edition of a global risk perception survey (World Economic Forum 2015) puts the environmental risks related to extreme weather events, natural catastrophes and failure of climate change adaptation amongst the top 10 risks—respectively in 2nd, 6th and 7th place—in terms of likelihood of occurrence. However, the perception of risks related to natural hazards has arguably not received sufficient attention in the scientific literature, with the exception of some scattered examples, mostly focused on earthquakes (e.g. Lindell and Perry 2000) more than on hydrogeological hazards, i.e. floods and landslides (e.g. Wachinger and Renn 2010). Rogers et al. (1983), investigating the people's willingness to undertake precautionary actions related to floods, propose a socio-psychological model based on the protection motivation theory (Bubeck et al. 2012). The model suggests that high-risk perception together with coping appraisal results in protective response. Other factors such as previous flood experience and reliability of public flood protection have been also taken into account (Grothmann and Reusswig 2006). Lin et al. (2008) found that people affected by floods and landslides are less willing to adopt risk mitigation measures, even if they perceive higher risk, and are more worried and attentive to hazard information. Nathan (2008) shows that residents, community leaders and city planners, with reference to landslides in the hill slopes in the city of La Paz in Bolivia, tend to underestimate or deny risk, with important consequences for risk management, such as a failure to raise risk awareness. Perceptions of a low level of risk have been associated, in other cases, with insufficient or defective knowledge of threats. According to Finlay and Fell (1997), most people seldom think about the possibility that landslides might affect their lives, with the obvious exception of those who are involved in landslide-related work. The results of a study of mental models of flash floods and landslides corroborate this notion by showing that people who have better knowledge of hazards are those who draw

on many different sources of information, who express fear about natural hazards or have previous experience with hazards (Wagner 2007). However, how can vulnerable communities achieve a greater awareness of the hazards they face? According to Solana and Kilburn (2003), this can best be accomplished by a public information programme designed around existing perceptions of landslides. Such an approach was implemented by Plattner et al. (2006), who proposed a procedure to quantify risk by formally integrating individual risk and a weighted mean of relevant perception affecting factors. The latter covers the following: voluntariness of risk taking, individual reducibility of risk, knowledge and experience, endangerment, subjective damage rating and subjective recurrence frequency perception. Along the same line, Scolobig et al. (2011) defined and tested a deliberative stakeholder procedure for selecting landslide risk mitigation measures, taking technical as well as economic, environmental and social factors into account. Recently, in Italy, two national surveys were conducted to assess the perception of risk in relation to landslides and flooding in the respondent's area of residence, in comparison with other kinds of risks (CNR-IRPI 2013; Salvati et al. 2014). These revealed that Italians fear technological risks more than natural risks, whilst earthquakes were considered more dangerous than floods, landslides and volcanic eruptions. As far as landslide risk is concerned, a comparison of risk perceptions with "objective measures"—including the number of fatal events, the number of fatalities and the mortality rates—revealed that perceptions generally did not match the long-term risk posed by landslides, with the relevant exception of the Campania region, where landslide risk and perceptions of risk were both high.

Taking the main results of these researches as our point of departure, we designed a study of the perception of landslide risk amongst residents in the Campania region living in the Sarno municipality, which experienced enormous damage and loss of life—137 deaths—in 1998 as a result of a landslide event of great magnitude, with numerous landslides of the flow type occurring within a few hours after 2 days of exceptional rainfall (e.g. Cascini 2004). Following the landslide event, the community experienced a number of different phases of risk management characterised by varying levels of involvement, including periods of very substantial investment and intense activity (Versace et al. 2008b). Landslides of the flow type often begin as slides and then continue moving over long distances (Hungr et al. 2001); the landslide source volumes generally collapse, far from urbanised areas, without precursory signs. The flowing mass is typically moving with extremely rapid velocities (Cruden and Varnes 1996). In the study area, the frequency of occurrence of landslides of the flow type, comparable in magnitude with those experienced in 1998, is relative low (Cascini 2004). The peculiar characteristics of these landslides may affect the individual perception of their risk and people's willingness to support and engage in risk mitigation actions. For these reasons, studies are needed to investigate the main factors that determine a positive and proactive behaviour in relation to management strategies implemented to reduce the risk posed by such phenomena. Aiming to identify the key elements and factors which can contribute to the optimisation of such strategies, we investigated several different aspects of individual perceptions and opinions on the subject. Starting with the need to understand how risks are perceived in this area, we then tried to investigate the level of information that was available to the public. The degree of trust which exists in relation to the organisms charged with managing hydrogeological risk was also investigated. Finally, we examined how residents evaluate various kinds of risk reduction measures.

The survey

Case study

The study was carried out in Sarno, a town of about 30,000 people in southern Italy which experienced disastrous landslides in 1998. As reported by Cascini (2004), from 11.00 a.m. on May 5th to 2.30 a.m. on May 6th, hundreds of landslides occurred inside an area of about 60 km^2 of the Pizzo d'Alvano massif. The landslides, whose triggering zones were located primarily in the upper part of the basins of the massif, developed into large flow-like mass movements along the valleys and the channels below, down to the highly urbanised piedmont areas of the Bracigliano, Quindici, Sarno and Siano towns. As the unstable masses travelled downslope, their initial volume increased, mainly due to soil erosion in the gullies and to minor slides mobilised along the flanks of the gullies. Besides the widespread damage caused, the landslides killed 160 people, 137 of which within the municipality of Sarno.

The landslides in question, typically referred to as flowslides, mud flows or debris flows, are frequent phenomena in the pyroclastic terrain that covers the carbonate rock surrounding Mount Vesuvius (e.g. Crosta and Dal Negro 2003; Olivares and Picarelli 2003; Budetta and De Riso 2004; Cascini et al. 2005; Picarelli et al. 2008; Revellino et al. 2008; Scotto di Santolo and Evangelista 2009; Pagano et al. 2010; Cascini et al. 2014). Numerous studies dealing with the physical characteristics of such events have been carried out over the years, including the various triggering mechanisms, the flow propagation dynamics and interactions with urbanisation (e.g. Del Prete et al. 1998; Guadagno et al. 1999; Pareschi et al. 2000; D'Ambrosio et al. 2003; Oramas Dorta et al. 2007; Cascini et al. 2008, 2013; Martino and Papa 2008; Sorbino et al. 2010; Papa et al. 2013). For instance, over 200 papers were collected by Guadagno et al. (2011) to compare contrasting interpretations concerning both different classification criteria used to describe the events and different triggering mechanisms proposed.

Very few scientific papers deal with the measures carried out to mitigate the residual risk in the area or with the financial aspect of the disaster. According to a 1991 note from the Salerno prefect (as reported by D'Alisa 2012), damages to private buildings reached 24.2 million € and businesses lost assets worth 8.2 million €. Once again, Sarno was the town most affected, with 24.7 million € of estimated damages to buildings and business assets. Risk mitigation measures comprised short-term and long-term actions. The first ones mainly focused on cleaning and improving the existing drainage channel network in the area (Cascini 2005), and the second ones included both structural control works and the setup of a strategy for emergency management. The structural measures constitute a system comprising 35 mudflow retention basins, 26 km of canals and 120 weirs and check dams (Versace et al. 2008a). The emergency management strategy is based on an early-warning system comprising: four emergency phases, a geo-idro-meteorological

monitoring network, a suite of models relating monitoring data to emergency phases and a territorial presidium composed of engineers and geologists (Versace et al. 2008b). All the measures were carried out by a purposefully created governmental Emergency Commission Structure, which was finally disbanded in 2008. Concerning the costs of the risk mitigation measures, D'Alisa (2012) reports a planned investment of 550 million €, 70 % of which devoted to structural passive measures, i.e. engineering works not aiming at reducing the probability of occurrence of the landslides but aimed at reducing the probability that the phenomena may reach human settlements and assets. Versace et al. (2008a) reported that 190 million € were spent for such works up to 2005 and estimated that the final cost of these measures would total 310 million €. According to D'Alisa (2012), the final amount of money spent exceeded significantly the initial plan. These estimates do not consider the operational costs of the Emergency Commission.

Sample and questionnaire

The study involved a questionnaire survey, which was carried out in March, April and May 2013 primarily in Episcopio, a townland of Sarno, and surrounding areas (Fig. 1). The sample comprised two sub-samples, the first of which involved residents living inside the so-called "red zone" and the second of which included residents outside this area. The red zone identifies the urbanised area which was considered to be exposed to residual risk soon after the 1998 landslides. Mapping of the residual risk zone was based on geological analyses performed within 11 days from the events (Cascini 2004). All neighbourhoods situated within the red zone were further classified in July 2011. This new zoning was based on a map of residual risk that was developed by the Emergency Commission Structure (BURC 2006) and takes account of the effects of the structural control works in the area, namely the construction of retention basins and related interventions. According to this new zoning system, the residual risk in the area influenced by these interventions was greatly reduced, essentially confined to the areas classified B4 and B3, whilst those classified B1 or B2 are, respectively, considered to be at very low and low risk (see BURC 2006 for a detailed description of the new zoning rules).

The sample is composed of 100 respondents. The first sub-sample, which we will refer to as the "red zone residents", is based on 60 people, whilst the second includes data from 40 individuals. Within each area, a combination of sampling techniques was used to identify respondents, including both random selection of addresses and snowball sampling guided by the aim of maximising the heterogeneity of the two samples. Although this implies that the sample was not constructed in rigorous fashion—which was impossible given the available time and resources—we have compared the two sub-samples and carried out a spatial analysis of the distribution of respondents to control for what we consider to be the main sources of potential bias.

The questionnaire was designed specifically with the aims of this study in mind and contains four distinct sections:

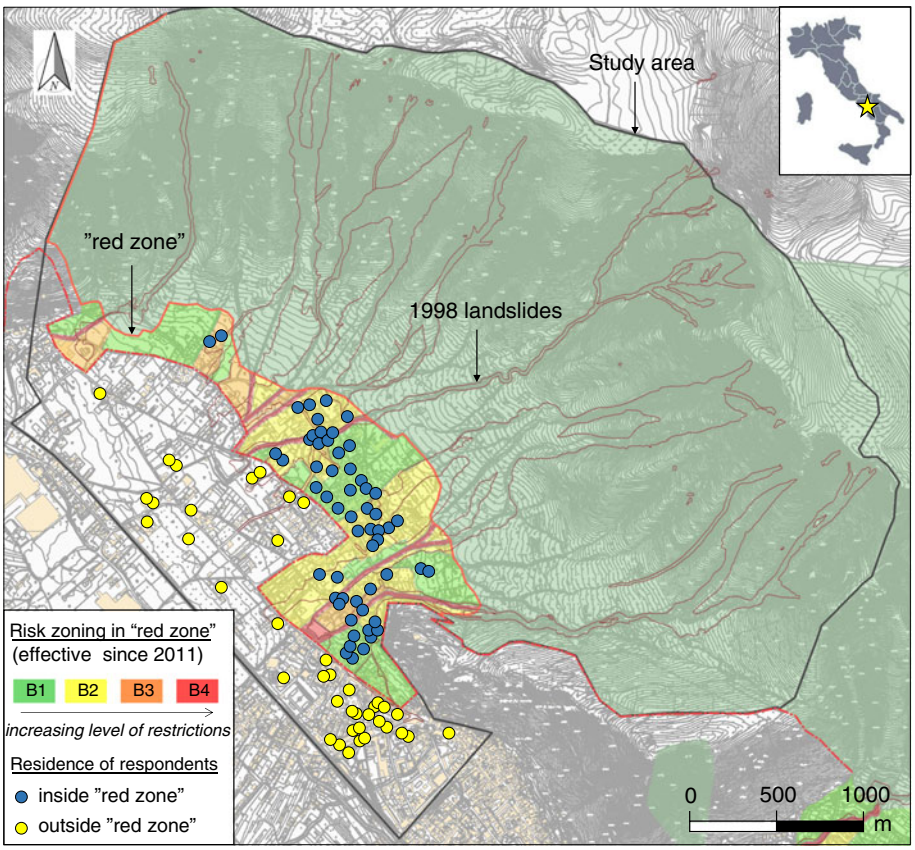

Fig. 1 Location of residence of respondents in the study area with indication of the 1998 landslides, the so-called "red zone" (i.e. area which was considered to be exposed to residual risk following the 1998 landslides) and the risk zoning of the red zone effective since 2011

A. Socio-demographic and socio-economic characteristics of the respondent
B. Perceptions, knowledge and opinions about risk management after the event
C. Perceptions, knowledge and opinions in relation to risk classification
D. Perceptions, knowledge and opinions in relation to the early-warning strategy

Each of these four sections contains a series of bespoke items which were developed on the basis of the main research questions underlying the study (summarised in Table 1; the full questionnaire is available at http://landslideriskperception.wordpress.com/sarno-italy-case-study/the-questionnaire/). The question items rely on a range of different response scales, including Yes/No/Don't know categories, 10-point Likert scales, multiple choice and open questions.

Table 1 Survey questionnaire: sections, investigated notions, research questions and question IDs

Section	Investigated notion	Research question	Question IDs
(A) Socio-demographic and socio-economic characteristics of the respondent	Trust	1. Trust in experts	A.2.6
		2. Trust in politics and Institutions	A.2.1-A.2.5
	Personal interests	3. Properties and businesses in areas at risk	A.3.1-A.3.2
		4. Family members in areas at risk	A.4.1
	Social status	5. Age, gender, education, employment	A.5.1-A.5.4
		6. Associations and/or civic activism	A.6.1-A.6.3
		7. Access to information networks	A.7.1-A.7.2
	Prejudices	11. Ability to mitigate landslide risk with actions	A.11.1-A.11.4
	Risk experiences	12. Place and type of residence (landlord, tenant)	A.1.1, A.12.1-A.12.3
		13. Involvement in 1998 events	A.13.1-A.13.6
(B) Perceptions, knowledge and opinions about risk management after the event	Management by institutions	1. Role of Government Emergency Unit, Region, Municipality	B.1.1-B.1.3
	Realised risk mitigation works	2. Risk mitigation works	B.2.1-B.2.4
		3. Cost of risk mitigation works	B.3.1-B.3.2
		4. Delocalization: experiences, availability	B.4.1-B.4.3
		5. Other alternatives	B.5.1-B.5.2
(C) Perceptions, knowledge and opinions in relation to risk classification	Landslide risk	1. Landslides	C.1.1-C.1.2
		2. Knowledge of historical landslides	C.2.1-C.2.2
	Management by institutions	3. Responsibility	C.3.1-C.3.2
		4. Process and information management	C.4.1-C.4.2
	Zoning and land use	5. Current restraints	C.5.1
		6. Modification proposals	C.6.1-C.6.2
	Future risk	7. Future risk prospects without mitigation	C.7.1-C.7.2
(D) Perceptions, knowledge and opinions in relation to the early-warning strategy	Current structure	1. Existence and operation	D.1.1-D.1.3
		2. Adequacy	D.2.1
		3. Alert dissemination	D.3.1-D.3.4
		4. Behaviour during emergencies	D.4.1-D.4.2
	Management by institutions	5. Responsibility	D.5.1-D.5.2
		6. Process and information management	D.6.1-D.6.3
	Individual behaviour	7. Availability to evacuation	D.7.1
		8. Availability to evacuation exercises	D.8.1
		9. Availability to active involvement	D.9.1-D.9.2
	Proactive opinions	10. Alert dissemination options	D.10.1
		11. Other proposals	D.11.1

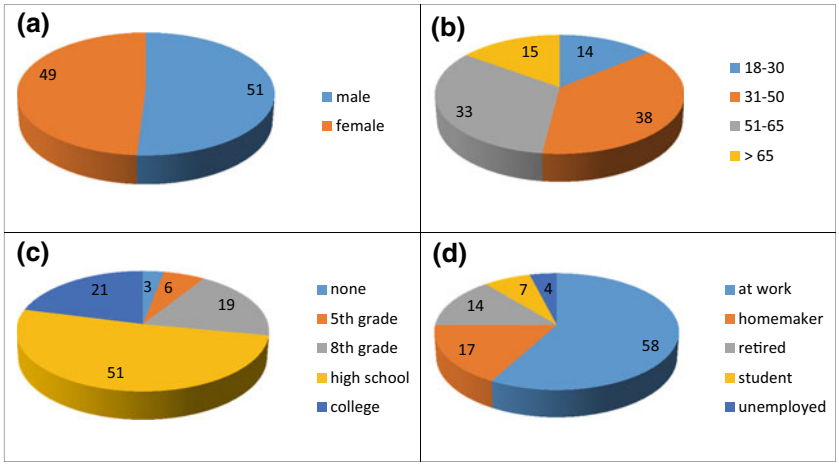

Fig. 2 Percentage distribution of respondents by **a** gender, **b** age, **c** employment and **d** education

Figure 2 shows that the sample of 100 respondents comprises a similar number of men (51 %) and women (49 %), with an age range of 19–85 years. More than 80 % of respondents live in a household with 3–5 family members. More than 70 % of the sample has at least a high school diploma, and the sample has the following composition in terms of employment status: at work (58 %), homemaker (17 %), retired (14 %), student (7 %) and unemployed (4 %).

Unsurprisingly, given that the sample is drawn from the population of Sarno which was worst hit by the events of 1998, almost all respondents define themselves as having been strongly and directly affected by the devastating landslides that occurred that year (Fig. 3). In fact, 98 % of respondents personally knew at least one of the victims of the disaster, roughly 40 % experienced damage to their own home and almost half were temporarily evacuated in the period immediately following the landslide event.

Results and discussion

Knowledge of landslide risk

We asked respondents to indicate whether they currently reside in an area that is classified as being at a high risk from landslides, with a view to assessing their awareness of the restrictions imposed by the public authorities following the events of 1998 (question C5.1). The spatial distribution of the responses to this question (Fig. 4) yields an interesting finding: Almost all respondents who are living outside the red zone (34/40) and more than half (31/60) of those living inside it indicated that they are not living in a high-risk area.

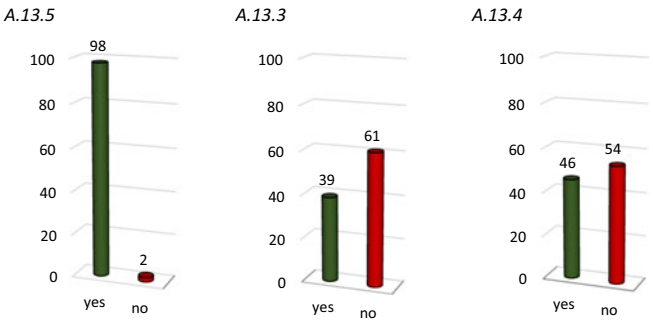

Fig. 3 Answers to questions about personal involvement in the events of 1998: [A135] "Did you know any of the victims of the 1998 event?"; [A133] "Was your home damaged?"; [A134] "Were you evacuated from your home?"

As already mentioned, following the completion of the structural control works in the area, residual risk within the red zone was further classified in July 2011. Since then, the area considered to be at high (B4) or medium (B3) risk greatly reduced. In order to assess whether the responses were influenced by direct knowledge of this new zoning system or by the previous classification of areas, we asked those who believed that their current area of residence is considered to be at high risk to indicate the restrictions which apply to their dwelling (question C.5.1.1). Almost all residents outside the red zone (4/6) correctly reply that their dwelling is not subject to any particular restrictions. Of those living inside the red zone, however, none cited the new zoning criteria, and only two (both of whom reside in areas classified B2) mentioned the existence of building restrictions.

On the basis of these results, it is evident that the specificities of the planning restrictions associated with definitions of residual risk within the red zone are not sufficiently familiar to local residents. This impression is reinforced by the respondents' knowledge of the public bodies which are responsible for zoning regulations (Fig. 5). Almost two thirds of respondents (65 %) did not know which organism was in charge of identifying areas at risk (question C.3.1), and many of those who stated that they knew which body was responsible for this did not subsequently provide the correct answer. The situation is rather different for the identification of organisms responsible for handling emergency situations (question C.3.2), as most respondents knew that the civil protection and municipality are the key actors in emergencies and only 35 % of respondents were unable to name these.

The finding that residents in Sarno have a low level of knowledge of prevailing classifications of risk, as determined by competent public bodies, is a surprising result, particularly given the enormous consequences for the local community of the landslide event that occurred just 15 years before, and the substantial state-funded investments that were made subsequently

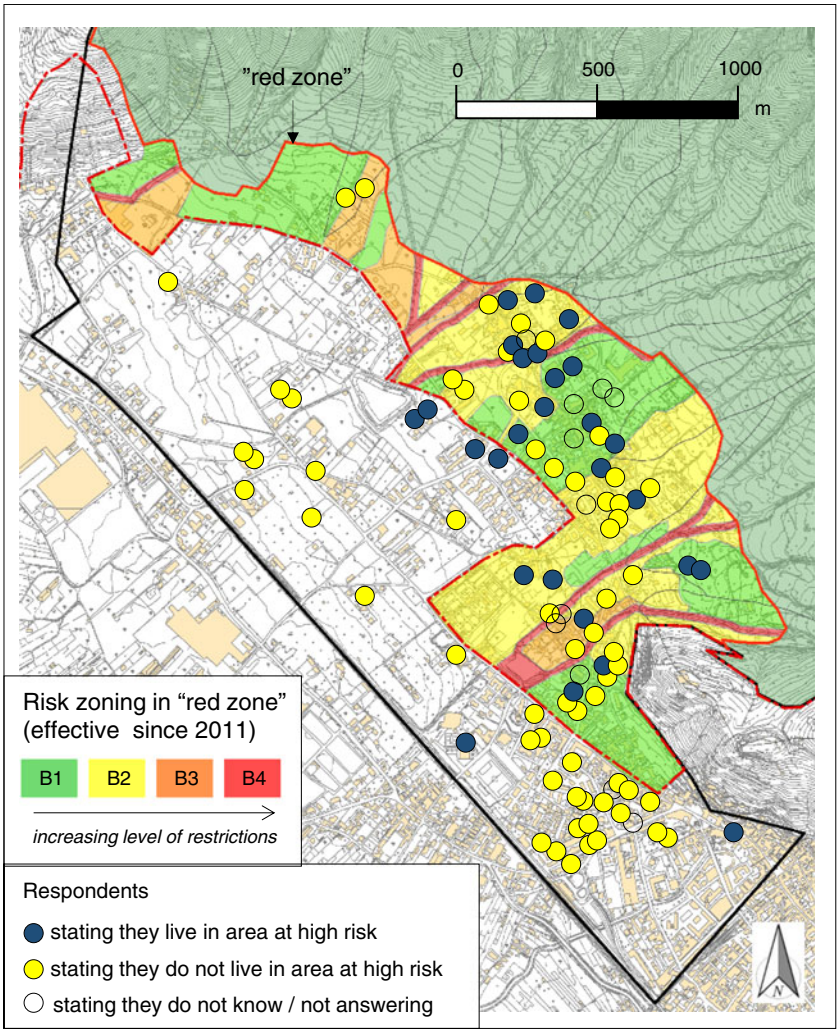

Fig. 4 Answers to question [C51] "Do you currently live in an area classified at high risk for landslides?" and current zoning of the residual risk (BURC 2006) within the "red zone"

to reduce the residual risk. The level of information was further investigated by asking respondents whether they have ever received information on the risk of landslides in their neighbourhood, whether they knew how much had been spent for the construction of protective structures in Sarno and how much had been spent for the development of emergency plans. The responses are shown graphically in Fig. 6. Only 15 % of respondents indicated that they have received information from a public body on the risk of

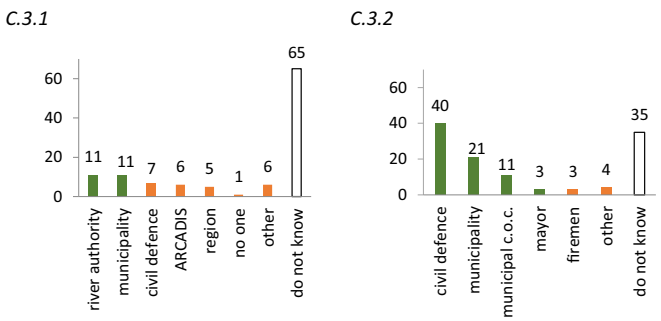

Fig. 5 Answers to questions: [C31] (OPEN response) "Do you know what is the institution, or the institutions, dealing with landslide risk zoning?"; [C32] (OPEN response) "Do you know what is the institution, or the institutions, dealing with emergency management?"

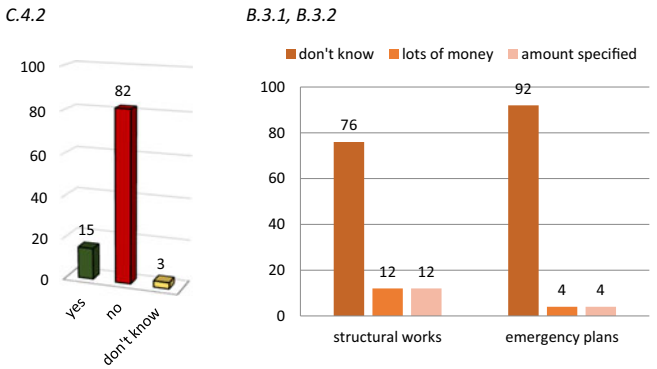

Fig. 6 Answers to questions: [C42] "Did you ever receive information on landslide risk in you community?"; [B31] (OPEN response) "Do you know the cost of the structural works carried out in Sarno?"; [B32] (OPEN response) "Do you know the cost of the emergency plan?"

landslides, only 12 % were able to provide an estimate of the cost of the protective structures and only 4 % for the cost of emergency plans.

The authors do not have detailed information on the strategies adopted by the authorities to communicate with the residents of Sarno on these topics, yet the existence of an information deficit emerges clearly. Even if risk information activities were performed, they nevertheless seem to have been ineffective. In a study dealing with volcanic and earthquake hazards, Ballantyne et al. (2000) state that communication effectiveness can be influenced by beliefs regarding existing knowledge. If people over-estimate their existing knowledge, the likelihood of their attending to public information will be reduced. They also state that risk communication based on passive forms of communication, like the dissemination of general information by pamphlets and media advertisements, fails to address the diversity of needs and expectations within a community.

Perception of exposure to landslide risk

As reported in the introduction, an interesting study was recently carried out to assess the perception of risk in relation to landslides and flooding in Italy (Salvati et al. 2014). The most relevant question of this study in relation to our study is the following: "To what extent do you think you are personally exposed to the risk of flooding or landslides?" (Fig. 7). A relatively low percentage of respondents believe that they are exposed to these two risks "a lot" or "quite a lot". Concerning the national sample, 24 % of respondents indicate they are at great risk of flooding and 17 % at risk of landslides, reaching 27 % in the Campania Region for both risks. A comparison between the nation survey and our questionnaire is presented (Fig. 8), although the questions (and response scales) are not identical. Perhaps, unsurprisingly, the perception of landslide risk in Sarno is considerably higher. Indeed, almost 40 % of respondents believe that landslides represent a significant threat to their dwelling, and 60 % perceive these to be life-threatening. This result is coherent with the founding of several studies outlining the powerful impact of previous flood and landslide experience to individual risk perception and

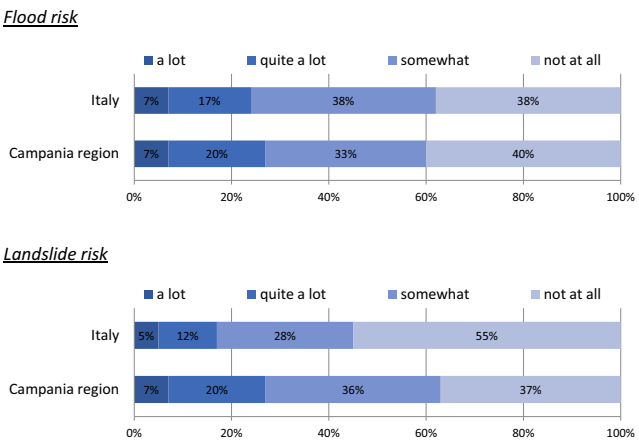

Fig. 7 Some results of a national survey conducted in 2013 in Italy (Salvati et al. 2014); answer to question: "How much do you think you may be exposed to flood and landslide risk?"

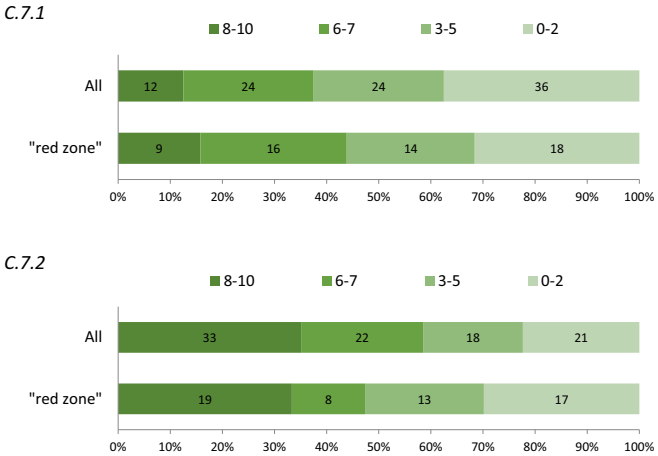

Fig. 8 Answers to questions: [C71] "Rating from 1 to 10, how much do you think landslides are a hazard to your home?"; [C72] "Rating from 1 to 10, how much do you think landslides are a hazard to your life?" (*bars' labels* indicate the number of respondents)

mitigation behaviour (Bubeck et al. 2012; Lin et al. 2008). What is interesting is that residents in the red zone are a little more worried about the risk to their property than all those surveyed in this town, but perceive a lower risk to their lives. Figure 9 shows the geographical distribution of responses to these questions. The proportion of residents who believe that their dwelling is at risk rises rapidly as one enters the red zone, but the perception of a life-threatening risk is, if anything, higher outside this area. Many respondents indicated that, when responding to this question, they were thinking, in particular, of the high risks that prevail in other areas of the municipality and the possibility of experiencing a landslide whilst present in one of these areas. Paradoxically, those who live in the red zone appear to have a similar (or even slightly lower) perception of life-threatening risks due to landslides, once again highlighting the complex ways in which perceptions of risk are socially constructed. In relation to this issue, Bubeck et al. (2012) state that the objective risk, as defined by experts, is not clearly related to risk perception.

Perceptions of exposure to life-threatening risks are often influenced by fatalistic dispositions (e.g. Peters and Slovic 1996; Kouabenan 2006; Rubin et al. 2007). To evaluate this hypothesis in relation to landslide risk, we asked respondents whether they agreed or disagreed with the following statement: "landslides of the flow type can be controlled" (question A.11.1). The results show a well-sorted mix of opinions on this issue, with almost 50 % of respondents agreeing or strongly agreeing with the sentence (Fig. 10). To analyse further the results, the residents of the red zone were divided in two groups on the basis of their reply to the question "how much do you think landslides are a hazard to your life?" The group of individuals who replied with a rating from 0 to 5 was extracted and their replies to a series of other questions were analysed separately. Responses to the previous question do not reveal any significant differences between those who reside inside or outside the red zone or between those who believe that their lives are threatened by landslides and those who do not.

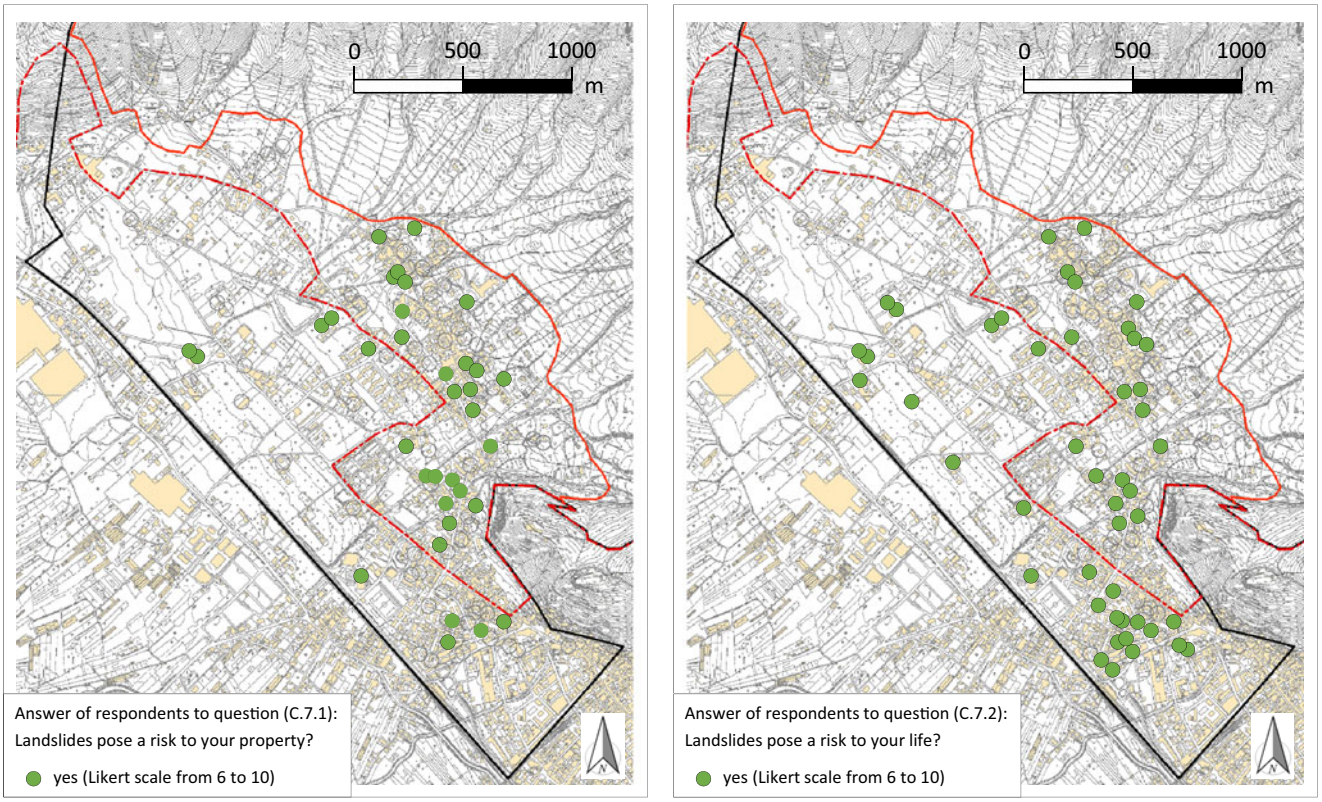

Fig. 9 Geographical distribution of respondents with respect to the answers to questions [C71] and [C72]

Evaluation of adopted strategies for risk management

Paton and Johnston (2001) stress the importance, within an all-hazard management framework, of assimilating and coordinating the perspectives/needs derived from community consultation within a strategic context and seeking, as far as possible, to provide the information and resources necessary to sustain empowerment, self-help and resilience. They also state that whilst perception of a threat remains a pertinent precursor of risk-reducing behaviour, the key factors are action-outcome expectancies (consideration of whether risk may be reduced) and self-efficacy (whether the required actions are within the capabilities of the individual) judgements. The first of these factors, together with other factors linked with the trust on the man-made actions for the protection against the risk, will be the main focus of this section.

Almost all respondents, regardless of where they live or their perception of personal risk, attribute central importance to land management for the reduction of landslides and related risks (Fig. 11). Significant differences emerge, however, when they are asked to rate the capacity of public bodies to manage emergencies, the efficacy of the protective structures built in Sarno and the management of emergency plans and alert systems (Fig. 12). As far as public bodies are concerned, the overall perception is highly critical, increasing in the red zone and amongst those who do not believe that their lives are at risk. A similar (but rather weaker) pattern of responses is observed for the management of emergency plans and alert systems. In contrast, the protective structures which were built in the area receive quite positive evaluations from all groups. People who live in the red zone but do not feel that their lives

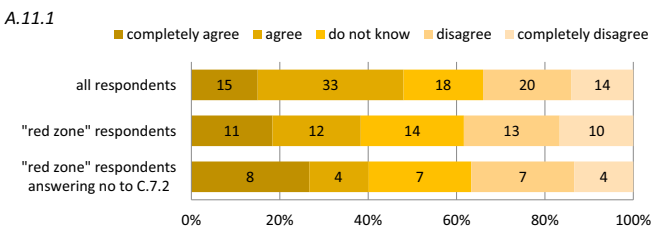

Fig. 10 Answers to question: [A111] "Tell me how much you agree with the following statement: landslides can be controlled" (*bars' labels* indicate the number of respondents)

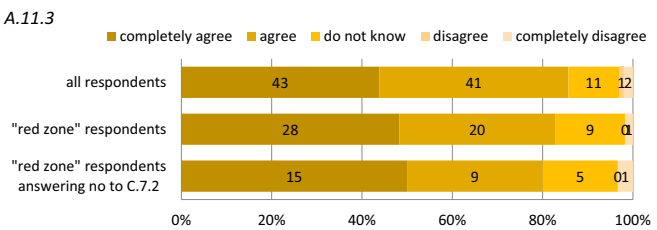

Fig. 11 Answers to question: [A113] "Tell me how much you agree with the following statement: correct land management can prevent landsliding" (*bars' labels* indicate the number of respondents)

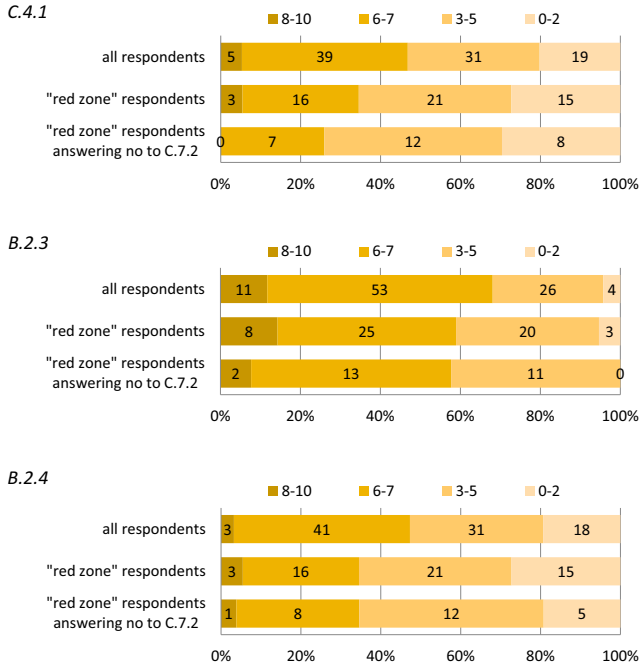

Fig. 12 Answers to questions: [C41] "Rate from 1 to 10 the ability of the responsible institutions to cope with the emergencies"; [B23] "Rate from 1 to 10 the structural works carried out in Sarno"; [B24] "Rate from 1 to 10 the management of the emergency plan and the early-warning system" (*bars' labels* indicate the number of respondents)

are threatened by landslides do not have a higher degree of confidence in public bodies, protective structures or the alert system (see Figs. 11 and 12), and in several cases, they have even less confidence than the rest of the respondents. Grothmann and Reusswig (2006) found that the reliance on public measure for flood protection is negatively correlated to threat appraisal. In this case, the lack of treat appraisal of the respondents does not seem to be explained by the past risk management practices.

In an earlier section, we identified the lack of official information as a key issue in Sarno, and this emerges once again when respondents are asked how they think people in areas at high risk should best be protected (question C.6.2). As Fig. 13 shows, most people mention additional information as the main priority, followed by such measures as population transfers, respecting nature and preparing effective emergency plans. The question of transferring residents away from areas of high risk is an interesting one and was suggested spontaneously by 15 respondents, despite the fact that it had not been mentioned in previous questions.

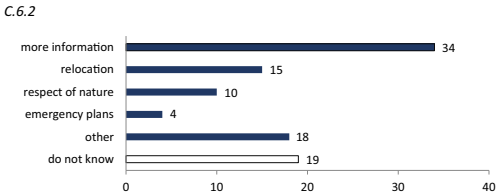

Fig. 13 Answers to question: [C62] (OPEN response) "In your opinion, how could one safeguard people living in areas at high risk?"

Figure 14 shows the geographical distribution of responses to question B.2.2, which asks respondents to identify the most effective techniques for reducing risks due to landslides, choosing between: (a) the construction of protective measures such as retention basins, (b) limitations in relation to land use and (c) emergency plans and early-warning systems. Relatively, few respondents trust emergency plans or warning systems (26/100), whilst the other two options were selected by a larger (and similar) number of respondents. Protective measures are generally preferred by residents in the red zone, whilst limitations in land use are indicated more often by those who live outside this area. When asked explicitly about forced relocation of residents (Fig. 15), no less than 83 respondents out of 100 felt that this was a good way of reducing risks. More than 70 % of respondents would personally be willing to move away from a high-risk area if a sufficient level of compensation was offered. An amount of money was deliberately not specified within this question to let the respondents free to assess the relocation option in view of whatever they may consider adequate for them. Although these results may reflect the fact that relocation is not currently on the agenda, they warrant further study, particularly as relocation is generally considered to be a difficult measure to apply.

In order to investigate views of warning systems, we asked respondents whether they thought it was useful to have an early-warning system in Sarno for landslides (Fig. 16). More than 80 % of respondents answered positively, although almost one third pointed out (spontaneously) that it would be important to receive more information about the system currently in use. The latter once again highlights the role of communication as an issue that intersects practically all other aspects of community participation, awareness and involvement. This is consistent with findings from Paton (2008), who states that preparedness is a process that must be managed through the active engagement of community members within the risk communication process.

Concluding remarks

The study presented in this paper explores perceptions of risks associated with landslides amongst residents in Sarno, a town in the Campania region which has received very substantial public funds for the reduction of residual risk following disastrous landslides which caused 137 deaths in 1998.

We concentrated on issues of knowledge, perception and opinions of risk, risk management and interventions to reduce risks. We reported the unexpected finding that residents in Sarno, despite its recent history, are relatively unaware of the risks to which they are exposed (i.e. as defined by the public bodies charged with this task). The responses evince a clear lack of information, including an almost total ignorance of the total cost of public investments to reduce risks in recent years, focusing on residents in the so-called red zone (i.e. area which was considered to be exposed to residual risk following the 1998 landslides). As far as perceptions are concerned, the feeling of being at risk is certainly greater than that observed at national level, as we showed by comparing our data with the results of a national survey carried out in 2013. Nevertheless, more than 60 % of respondents believe that their dwelling is not at risk, and approximately 40 % are not particularly concerned about risks to their own lives. It is particularly striking to discover that people living inside the red zone are

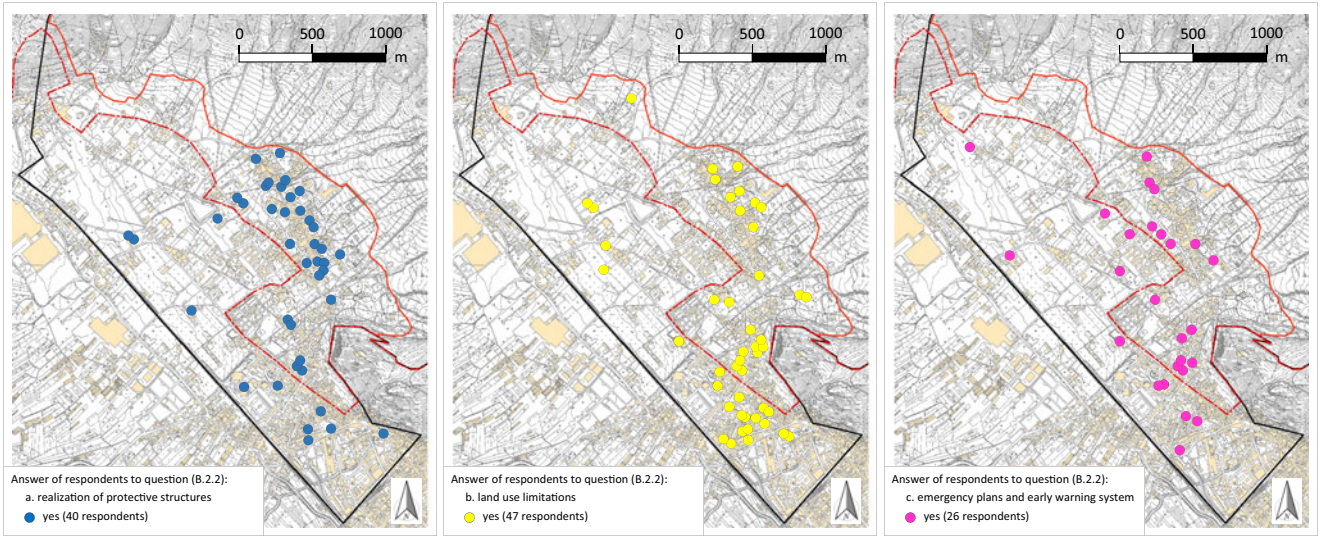

Fig. 14 Answers to question: [B22] "In your opinion, what are the most effective landslide risk mitigation tools amongst: **a** structural works (for instance: the "tanks"), **b** limitation of land use and **c** emergency plans and early-warning systems"

actually a little less concerned about personal risks than those living outside this area.

Almost all respondents, regardless of where they live and how they perceive risks, attribute great importance to land management for the reduction of risks deriving from landslides. At the same time, assessments of public bodies, local actors and those charged with handling emergencies were nearly always critical and become even more negative amongst residents of the red zone. As far as specific types of intervention to reduce risk are concerned, the most surprising finding is perhaps that a large majority of the sample would be prepared to consider residential relocation in the presence of adequate compensation. When asked about early-warning systems, more than 80 % of respondents believe that these are useful, but many feel that the effectiveness of such systems is greatly reduced by the absence of official information. Moreover, when asked about measures to protect the local population, the majority of respondents indicated a need for more information. In overall terms, therefore, there are signs not only of a deficit of information but also of a latent and unmet demand for public participation in the management of landslide risk in Sarno.

The results of this study may provide policy-makers with useful information for designing future mitigation strategies. A crucial insight is provided by the respondent preferences on the mitigation measures disproving commonplaces such us the presumed resident's opposition to relocation measures. Another suggestion clearly emerging from the study is the need to develop more effective communication strategies in order to transmit knowledge about actions to reduce risk below an "acceptable" threshold. This would have the effect of promoting awareness amongst citizens and favouring the development of individual as well as collective forms of responsibility. The improved communication could also accomplish the positive effect of remediating the lack of trust the respondents manifested towards the public organism which are responsible for risk management. As the absence of trust can significantly reduce the

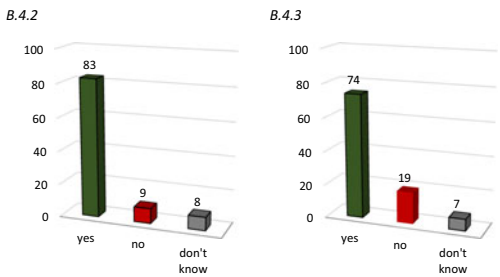

Fig. 15 Answers to questions: [B42] "Generally speaking, do you think home relocation from high-risk areas towards safer areas is a good idea?"; [B43] "If needed, would you be personally available, upon receiving adequate financial compensation, to relocate to a new home in a safer area?"

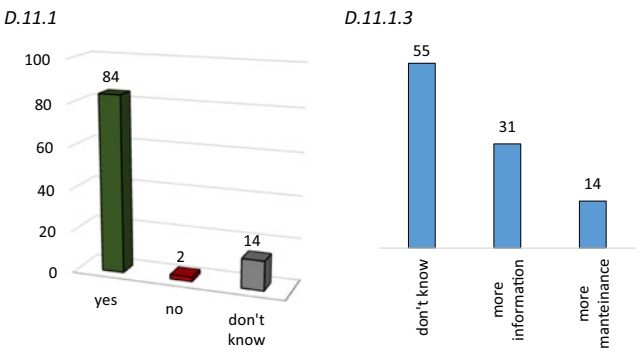

Fig. 16 Answers to questions: [D111] "Is a landslide early-warning system useful for the people living in Sarno?"; [D1113] (OPEN answer) "What improvements would you make to the current landslide early-warning system?"

efficacy of mitigation policies, this is an issue that should be brought into focus. It is essential that the administrations understand the opinions and perceptions of the populations that they are charged with protecting, as the effective management and implementation of risk reduction measures cannot happen without the active involvement of the local community.

References

Albanesi C, Pietrantoni L, Zani B, Cicognani E, Prati G, Porretta B (2011) La comunicazione istituzionale dei rischi, Linee guida. http://www.rischio.unibo.it/wp-content/uploads/2011/04/Linee_Guida.pdf. Accessed 26 August 2014 (in Italian)

Ballantyne M, Paton D, Johnston D, Kozuch M, Daly M (2000) Information on volcanic and earthquake hazards: the impact on awareness and preparation. Inst. Geol. Nucl. Sci. Rep. No. 2

Beck U (1992) Risk society. Towards a new modernity. Sage, London

Bubeck P, Botzen WJW, Aerts JCJH (2012) A review of risk perceptions and other factors that influence flood mitigation behavior. Risk Anal 32(9):1481–1495

Budetta P, De Riso R (2004) The mobility of some debris flows in pyroclastic deposits of the northwestern Campanian region (southern Italy). Bull Eng Geol Environ 63(4):293–302

BURC (2006). Zonazione delle aree comprese tra l'attuale linea rossa e la nuova perimetrazione. Ordinanza N. 4561 del Commissariato di governo per l'Emergenza Idrogeologica nella regione Campania, Boll. Uff. Reg. Campania N.50 del 6/11/2006 (in Italian)

Cascini L (2004) The flowslides of May 1998 in the Campania region, Italy: the scientific emergency management. Riv Ital Geotecnica 2:11–44

Cascini L (2005) La gestione scientifica dell'emergenza idrogeologica del maggio 1998 nella Regione Campania. Rubbettino editore, Soveria Mannelli (in Italian)

Cascini L, Cuomo S, Sorbino G (2005) Flow-like mass movements in pyroclastic soils: remarks on the modelling of triggering mechanisms. Riv Ital Geotecnica 4:11–31

Cascini L, Cuomo S, Guida D (2008) Typical source areas of May 1998 flow-like mass movements in the Campania region, Southern Italy. Eng Geol 96:107–125

Cascini L, Cuomo S, Pastor M, Sacco C (2013a) Modelling the post-failure stage of rainfall-induced landslides of the flow-type. Can Geotech J 50(9):924–934

Cascini L, Sorbino G, Cuomo S, Ferlisi S (2014) Seasonal effects of rainfall on the shallow pyroclastic deposits of the Campania region (southern Italy). Landslides 11(5):779–792

CNR-IRPI (2013) Indagine sulla percezione del rischio degli eventi idrogeologici. Indagine DOXA per CNR PERUGIA S.13019c. http://vglobale.it/public/files/2013/DOXA-CNR-IRPI.pdf. Accessed 26 August 2014 (in Italian)

Crosta GB, Dal Negro P (2003) Observations and modelling of soil slip—debris flow initiation processes in pyroclastic deposits: the Sarno 1998 event. Nat Hazards Earth Syst Sci 3(1):53–69

Cruden DM, Varnes DJ (1996) Landslides: investigation and mitigation. Chapter 3-Landslide types and processes. Transp. Res. Board Spec. Rep. No. 247

D'Alisa G (2012) Human –from the (Quasi)Northern Campania Region. CLICO Work. Pap. No. 14

D'Ambrosio D, Di Gregorio S, Iovine G, Lupiano V, Rongo R, Spataro W (2003) First simulations of the Sarno debris flows through cellular automata modelling. Geomorphology 54:91–117

Del Prete M, Guadagno FM, Hawkins AB (1998) Preliminary report on the landslides of 5 May 1998, Campania, southern Italy. Bull Eng Geol Environ 57:113–129

Dow K, Cutter SL (2000) Public orders and personal opinions: household strategies for hurricane risk assessment. Environ Hazards 2:143–155

Finlay PJ, Fell R (1997) Landslides: risk perception and acceptance. Can Geotech J 34(2):169–188

Grothmann T, Reusswig F (2006) People at risk of flooding: why some residents take precautionary action while others do not. Nat Hazards 38(1–2):101–120

Guadagno FM, Celico PB, Esposito L, Perriello Zampelli S, Scarascia Mugnozza G (1999) The debris flows of 5–6 May 1998 in Campania, Southern Italy. Landslide News 12:5–7

Guadagno FM, Revellino P, Grelle G (2011) The 1998 Sarno landslides: conflicting interpretations of a natural event. Ital. J. Eng. Geol. Environ. – Book 71–81

Hungr O, Evans SG, Bovi MJ, Hutchinson JN (2001) A review of the classification of landslides of the flow type environmental. Eng Geosci 7(3):221–238

Kouabenan DR (2006) Beliefs and the perception of risks and accidents. Risk Anal 18(3):243–252

Lash S (2000) Risk culture. In: Adam B, Beck U, Van Loon J (eds) The risk society and beyond: critical issues for social theory. Sage, London, pp 47–62

Lin S, Shaw D, Ho MC (2008) Why are flood and landslide victims less willing to take mitigation measures than the public? Nat Hazards 44(2):305–314

Lindell MK, Perry RW (2000) Household adjustment to earthquake hazard: a review of research. Environ Behav 32(4):491–501

Lombardi M (2005) La comunicazione dei rischi naturali - Un confronto internazionale. Vita e Pensiero, Milano (in Italian)

Martino R, Papa MN (2008) Variable-concentration and boundary effects on debris flow discharge predictions. J Hydraul Eng 134:1191–1404

Nathan F (2008) Risk perception, risk management and vulnerability to landslides in the hill slopes in the city of La Paz. Bolivia A preliminary statement. Disasters 32:337–357

Olivares L, Picarelli L (2003) Shallow flowslides triggered by intense rainfalls on natural slopes covered by loose unsaturated pyroclastic soils. Geotechnique 53(2):283–288

Oramas Dorta D, Toyos G, Oppenheimer C, Pareschi MT, Sulpizio R, Zanchetta G (2007) Empirical modelling of the May 1998 small debris flows in Sarno (Italy) using LAHARZ. Nat Hazards 40(2):381–396

Pagano L, Picarelli L, Rianna G, Urciuoli G (2010) A simple numerical procedure for timely prediction of precipitation-induced landslides in unsaturated pyroclastic soils. Landslides 7(3):273–289

Papa MN, Medina V, Ciervo F, Bateman A (2013) Derivation of critical rainfall thresholds for shallow landslides as a tool for debris flow early warning systems. Hydrol Earth Syst Sci 17(10):4095–4107

Pareschi MT, Favalli M, Giannini F, Sulpizio R, Zanchetta G, Santacroce R (2000) May 5, 1998, debris flows in circum-vesuvian areas (southern Italy): insights for hazard assessment. Geology 28(7):639–642

Paton D (2008) Community resilience: integrating individual, community and societal perspective. In Gow K, Paton D (eds) The Phoenix of Natural Disasters: Community Resilience 13–21

Paton D, Johnston D (2001) Disasters and communities: vulnerability, resilience and preparedness. Disaster Prev Manag: Int J 10(4):270–277

Paton D, Johnston D, Gough J, Dowrick D, Daly M, Baddon L, Batistich T, Wood I (1999) Auckland volcanic risk project: report 1. ARC Tech. Publ. No. 126

Peters E, Slovic P (1996) The role of affect and worldviews as orienting dispositions in the perception and acceptance of nuclear power. J Appl Soc Psychol 26(16):1427–1453

Picarelli L, Olivares L, Avolio B (2008) Zoning for flowslide and debris flow in pyroclastic soils of Campania region based on "infinite slope" analysis. Eng Geol 102:132–141

Plattner T, Plapp T, Hebel B (2006) Integrating public risk perception into formal natural hazard risk assessment. Nat Hazards Earth Syst Sci 6:471–483

Renn O (1988) Three decades of risk research: accomplishments and new challenges. J Risk Res 1(1):49–71

Revellino P, Guadagno FM, Hungr O (2008) Morphological methods and dynamic modelling in landslide hazard assessment of the Campania Apennine carbonate slope. Landslides 5(1):59–70

Rogers RW, Cacioppo JT, Petty R (1983) Cognitive and physiological processes in fear appeals and attitude change: a revised theory of protection motivation In Social psychophysiology: Sourcebook 153–177

Rubin GJ, Page LA, Morgan O, Pinder RJ, Riley P, Hatch S et al (2007) Public information needs after the poisoning of Alexander Litvinenko with polonium-210 in London: cross sectional telephone survey and qualitative analysis. Br Med J 335:1143–1146

Salvati P, Bianchi C, Fiorucci F, Giostrella P, Marchesini I, Guzzetti F (2014) Perception of flood and landslide risk in Italy: a preliminary analysis. Nat Hazards Earth Syst Sci Discuss 2:3465–3497

Scolobig A, Bayer J, Cascini L, Ferlisi S (2011). Design and testing: a risk communication strategy and a deliberative process for choosing a set of mitigation and prevention measures. Project Safe Land "Living with landslide risk in Europe, D. 5.7

Scotto di Santolo AS, Evangelista A (2009) Some observations on the prediction of the dynamic parameters of debris flows in pyroclastic deposits in the Campania region of Italy. Nat Hazards 50:605–622

Solana MC, Kilburn CRJ (2003) Public awareness of landslide hazards: the Barranco de Tirajana, Gran Canaria, Spain. Geomorphology 54(1–2):39–48

Sorbino G, Sica C, Cascini L (2010) Susceptibility analysis of shallow landslides source areas using physically based models. Nat Haz 53(2):313–332
Tulloch J, Lupton D (2003) Risk and everyday life. Sage, London
Versace P, Altomare P, Serra M (2008a) Interventi strutturali per la riduzione del rischio di colata - Il modello Sarno. Quad CAMIlab 3(3):1–54 (in Italian)
Versace P, Caruso A, Cassetti M, Capparelli G (2008b) Il Presidio Territoriale e la gestione dell'emergenza a Sarno. Quad CAMIlab 3(3):55–84 (in Italian)
Wachinger G, Renn O (2010). Risk perception and natural hazards. CapHaz-Net WP3 Report, DIALOGIK Non-Profit Institute for Communication and Cooperative Research, Stuttgart. http://caphaz-net.org/outcomes-results/CapHaz-Net_WP3_Risk-Perception2.pdf. Accessed 27 August 2014
Wagner K (2007) Mental models of flash floods and landslides. Risk Anal 27:671–682
World Economic Forum (2015) Global risks 2015, 10th edition. World Economic Forum Report ref: 090115
Wynne B (2002) Risk and environment as legitimatory discourses of technology: reflexivity inside Out? Curr Sociol 50(3):459–477
Zinn JO (2004) Literature review: sociology and risk. SCARR Working Paper 2004/1. http://www.kent.ac.uk/scarr/papers/Sociology%20Literature%20Review%20WP1.04%20Zinn.pdf. Accessed 27 August 2014

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