Nat Hazards (2016) 81:S69–S88
DOI 10.1007/s11069-015-1805-8

ORIGINAL PAPER

Expert engagement in participatory processes: translating stakeholder discourses into policy options

JoAnne Linnerooth-Bayer[1] · Anna Scolobig[1,2] · Settimio Ferlisi[3] · Leonardo Cascini[3] · Michael Thompson[1]

Received: 10 April 2014 / Accepted: 9 May 2015 / Published online: 21 May 2015

Abstract This paper demonstrates an innovative role for experts in supporting participatory policy processes with an application to landslide risk management in the Italian town of Nocera Inferiore. Experts co-produce risk mitigation options based on their specialized knowledge taking account of local knowledge and values by directly coupling stakeholder discourses with option design. Drawing on the theory of plural rationality and based on a literature review, interviews and a public questionnaire, stakeholder discourses are elicited on the landslide risk problem and its solution. Armed with the discourses and in close interaction with stakeholders, experts provide a range of technical mitigation options, each within a given budget constraint. These options are subsequently deliberated in the participatory process with the intent of reaching compromise recommendations for landslide risk mitigation. As we show in an accompanying paper, "Compromise not consensus. Designing a participatory process for landslide risk mitigation" (this issue), the provision of multiple co-produced policy options enhances stakeholder deliberation by respecting legitimate differences in values and worldviews.

Keywords Science–policy interface · Landslide risk · Usable knowledge · Plural rationality · Public participation · Knowledge co-production

Original data (including interviews' protocol and transcripts, questionnaire protocol, statistical data analysis, etc.) are freely available.

✉ Anna Scolobig
scolobig@iiasa.ac.at; anna.scolobig@usys.ethz.ch;
http://www.cp.ethz.ch/

[1] Risk, Policy and Vulnerability Program, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

[2] Climate Policy Group, Department of Environmental Systems Science, Swiss Federal Institute of Technology (ETH), Universitätstrasse 22 CHN J72.2, 8092 Zurich, Switzerland

[3] Department of Civil Engineering, University of Salerno, Fisciano, Italy

1 Introduction

In Italy and throughout the world investment and regulatory decisions aimed at reducing the risk of landslides, floods and other disasters are typically made by policymakers in consultation with their expert networks with little, if any, direct input from stakeholders. This was the case in Nocera Inferiore, a town at the foot of Mount Albino in southern Italy. In 2008, the regional Emergency Commissioner, based on its in-house expertise, crafted a plan for reducing landslide risk. The plan consisted mainly of passive structural measures (which intercept but do not prevent landslides) with a significant environmental impact, and partly for this reason, it was rejected after sustained opposition from local politicians and citizens.

The flow of knowledge exemplified by the Nocera Inferiore case is one way: from experts to policy-makers. This exclusive link between science and public policy, having now repeatedly run into setbacks such as that encountered in Nocera Inferiore, is increasingly seen as outdated and unsatisfactory (Thompson and Rayner 1998; Thompson et al. 1998; Funtowicz and Ravetz 1993; Leiss 1995; Durant 1999; Guston 1999, 2000, 2001; Jasanoff 2005; McNie 2007; Sarewitz and Pielke 2007; Fischoff 2013). Critics argue that top-down, expert-driven processes stifle and misrepresent the complex and interconnected relationship between experts and public policy and are increasingly viewed as illegitimate by those ultimately affected, resulting in a loss of trust in public institutions (Fischoff 1995; Agrawala et al. 2001; European Environmental Agency 2001; Pielke and Byerly 1998). Shortcomings of the one-way model have reinforced calls for greater public participation (Thompson and Gyawali 2006; Jasanoff 2004, 2005; Beck et al. 2011). More and more often the expert advice is not considered anymore as a matter of dealing with the easy issues that need technical solutions. Rather, it is largely sought in "dealing with sensitive matters of high public concern and inevitably associated with uncertainty and considerable scientific and political complexity" (Gluckman 2014). Thus, the engagement of stakeholders is becoming more and more crucial to improve the quality, efficiency and effectiveness of decisions.

The addition of stakeholders to what have hitherto been expert-driven processes is not, however, straightforward, and there is little explicit guidance on how to institutionalize the two-way model: How, that is, to design participatory processes that involve stakeholders and scientific experts in such a way that they co-produce useable knowledge for the policy process. In this paper, we describe an expert-stakeholder process for achieving this shift. Its core feature is the interactive coupling of expert-formulated technical risk mitigation options with values and worldviews expressed by the local stakeholders. In this way, constructive account is taken of both the specialist expert knowledge and the local (and more generalized) lay knowledge and values. The challenge was to provide a range of equal cost and technically consistent policy options informed by stakeholder perceptions and worldviews. The stakeholders would then deliberate these options in the participatory process (described in Scolobig et al. 2011).

The following section provides background on the Nocera Inferiore case before turning in Sect. 3 to describing stakeholder views on the landslide problem derived from desktop research, questionnaires and interviews. The core of the expert/stakeholder process is formulating stakeholder discourses, which are presented in Sect. 4, as well as coupling these discourses with technical risk reduction policy options, which are illustrated in Sect. 5. We conclude our discussion in Sect. 6.

2 Policy context[1]

The high-risk areas of Nocera Inferiore lie at the foot of the Mount Albino massif, which is prone to rainfall-induced slope instabilities (for a discussion, see Ferlisi et al. (2015) and Narasimhan et al. (2015)). In March 2005, the first-time landslide triggered on Mount Albino's open slopes resulted in three deaths and extensive material damage in the town (Pagano 2009). It came in the wake of a more serious event on the neighboring Pizzo d'Alvano massif, where in 1998, more than 100 shallow landslides were triggered in about 16 h of rainfall along the slopes (Cascini 2004; Cascini et al. 2008), killing 159 people in four towns located at the toe of the massif (the most affected town was Sarno where 137 people died). Subsequently, about €190 million were spent on risk-reducing measures, including over 120 concrete decanting/straining structures (like check dams) and 20 storage basins (Versace et al. 2008).

In the aftermath of the Nocera Inferiore event, the regional and municipal authorities (in cooperation with several other authorities from national to local level) deliberated on actions to protect residents from future slides, as well as on disbursement of compensation for damaged property from the event. The provincial engineering corporation (Genio Civile of the Province of Salerno) provided the expertise and was in charge of the project. In November 2005, a sum of €178,000 was spent on the first urgent provisional works, including the partial removal of the debris in the areas affected by the landslide and (uncompleted) construction of a storage basin. Because of the provisional nature of these measures, there was an active debate among citizens and local authorities on three issues: public compensation for damaged property and lost lives, measures to significantly reduce the risk of future events and the attribution of responsibility. Moreover, a landslide victims' committee initiated a lawsuit against the owners of a quarry on Mount Albino, which many residents suspected had destabilized the slope. At the same time, the municipality created the Urban System Forum as a way of encouraging residents and local associations to actively engage in political discourse on landslide risk management.

Following these initiatives, in November 2008, the regional Emergency Commissioner presented a more comprehensive risk mitigation action plan (extending beyond the first urgent measures already carried out) prepared by the technical officers of the Emergency Commissariat. The action plan called for mainly passive structural protection measures, including check dams and storage basins, with a budget of €24.5 million. The municipal authorities, supported by many citizens and local associations, refused to endorse the plan. As well as pointing out that the costs were not fully covered by regional funds (a major concern) and that there were technical deficiencies, there was also opposition to large-scale passive measures. Many residents expressed a preference for investing in the existing hydraulic network and emergency plan, and supplementing that with environment-friendly measures, such as greening the slope to actively prevent landslides from occurring.

After the rejection of the action plan and the appointment of a new Emergency Commissioner, a sum of €7 million was allocated for continuing risk mitigation measures. At the same time, partial responsibility for risk mitigation was transferred from the regional soil defense agency to the local municipal authorities. Subsequently, the municipality contracted yet another group of external experts to produce a study on still urgent risk mitigation measures, including an estimation of their costs. The study suggested partly environmental-friendly interventions—such as removal of fallen/cut trees or solid waste from drainage channels with naturalistic engineering works—as well as investments to

[1] This section is based on a literature survey and desk study of policy documents, legislation, gray literature, media and published papers, as well as on stakeholder interviews.

protect the sewer system (e.g., suspended water sediment collection tanks to be installed in the piedmont urbanized area). A private consultant was asked by the municipality to present a preliminary project based on this study taking into account a budget of €1.4 million for its implementation. The project was approved by the Conference of the Services in 2010. When the fieldwork for this reported research was completed in 2011, the project had not been initiated.

In conclusion, in the 6 years following the landslide event, only limited and urgent measures had been taken to reduce the risk of subsequent slides. Furthermore, the experts were without exception commissioned by, or part of, the public authorities, and included the provincial civil engineers, the technical officers of the Emergency Commissariat and the Regional Civil Protection authorities, external experts and a private consultant. The expertise and the resulting projects were one way, that is, the experts informed the public decision makers. In no case was the expertise itself informed by stakeholder views on landslide risk mitigation.

3 Stakeholder views on risk mitigation

3.1 Mitigation measures

Interventions that aim at reducing landslide risk can be classified as "active" or "passive" depending on whether they "actively" pursue an improvement of the slope stability or "passively" intercept the run out when a landslide occurs thereby protecting the elements at risk (Vaciago et al. 2012). Since intercepting the landslide run out requires strong structural interventions, passive measures consist mainly of deflection structures and storage basins and can also include impediments and straining structures (e.g., reinforced concrete frames, decanting or retaining structures, sabo dams and steel frames, check dams).

Active measures to increase slope stability include diverse interventions, for example:

- steel palings[2] and soil cover removal;
- slope reshaping[3];
- gabions,[4] for example, along slope rills[5];
- improved slope maintenance, for example, cleaning drainage channels;
- small-scale farming on the slopes;
- vegetation, such as hydro-seeding,[6] turfing, and soil reinforcement systems utilizing bushes and trees;
- soil bioengineering[7] or naturalistic engineering works, such as fascines,[8] brush mattresses and geosynthetics[9] combined with live plants.

[2] Metal barriers can be constructed with pressed steel palings which are fixed to cross-rails with security bolts.

[3] Slope reshaping consists in changing the slope geometry, by adding or subtracting material from the slope.

[4] A gabion wall is a retaining wall made of stacked stone-filled steel mesh containers.

[5] Shallow waterways along an open slope (often a sign of erosion).

[6] Hydroseeding is a planting process that uses a sprayed slurry of seed and mulch.

[7] Bioengineering systems are usually established by conventional seeding or live planting (Morgan and Rickson 1995).

[8] As stated by Vaciago et al. (2012) "fascines are made of up bundles of thin live cuttings of willow or red-osier dogwood".

[9] Any synthetic material used in geotechnical engineering, such as geotextiles and geocomposites.

Another class of measures that are neither active nor passive comprises policy interventions to reduce landslide risk exposure. These include making or enforcing land-use legislation and regulations, which can require risk mapping and even relocating homes and other structures away from high-risk areas. In addition, exposure can be reduced by warning systems and evacuation plans, which require monitoring technology.

3.2 Research methods

For the purpose of identifying and articulating stakeholder views on landslide risk mitigation for Mount Albino, we used a triangulation of methods, including:

- a literature survey and desk study of policy documents, legislation, gray literature, media and published papers;
- two rounds of interviews (18 and 25) and focus groups (3) with local stakeholders; and
- a questionnaire administered to local residents (373).

The stakeholder interviews and focus groups were instrumental in eliciting views on the sources and seriousness of the landslide risk problem, and on risk mitigation, including active and passive structural measures and non-structural measures, such as warning systems and emergency response. The interviews were also instrumental in establishing links with local stakeholders, many of whom provided continuing inputs and feedback for the research. The interviewees were selected on the basis of their experience and knowledge of landslide risk or the relevant social context. They included officials in organizations dealing with risk management at provincial and regional levels (e.g., the regional agency for soil defense and forest management, river basin authorities, civil protection and fire brigades) together with university professors, members of non-governmental organizations and, of course, residents of Nocera Inferiore. The interviews were audio-taped, transcribed and analyzed in order to identify recurrent themes, key concepts and conceptual categories. We then used extracts from these interviews to illustrate points of agreement and contention, to support evidence for stakeholder arguments and to characterize the risk mitigation discourses.

The desk study and interviews provided the requisite background for the public questionnaire, which (as shown in Table 1) consisted of 50 questions related to seven landslide risk topics. The details on the sampling procedures, the questionnaire preparation, data collection and implementation, as well as the analysis of the results, are detailed in Table 1. Selected results from the questionnaire are presented below (for an overview of the full results, see Scolobig et al. 2011).

3.3 Stakeholder views

The questionnaire revealed markedly diverse views on the prioritization of risk mitigation measures, and also some agreement, for example, on the desirability of combining passive and active measures. Respondents were presented with a list of potential measures elicited from the interviews from which they could choose a maximum of two for priority action. Figure 1 shows the priority measures according to their frequency of choice.

As expressed by the respondents, the highest priority was improving maintenance of the endangered slopes in Mount Albino, which included active measures such as clearing drainage ditches and also enhancing monitoring. From the interviews, it was clear that very few respondents (4.7 %) were supportive of the intensive use of concrete structural measures, such as check dams and storage basins, but many (25.2 %) were in favor of

Table 1 Questionnaire and sampling procedure

Questionnaire construction	50 questions addressing following topics: 1. Landslide risk, causes and consequences; 2. Risk maps and land-use restrictions; 3. Risk mitigation and decision-making process; 4. Responsibility and insurance; 5. Risk communication; 6. Risk management, emergency planning and warning; and 7. General information
Sampling procedures	Residents (18–89) quota sample based on: gender, age, educational qualifications and risk exposure
Survey	
Preparation	Contacts with local authorities, letters for residents Questionnaire pretest (20) Training of interviewers (members of 6 local associations)
Data collection	Face to face: local association members. Grids containing the target distribution of interviewees. One interview per household Online survey: http://safeland.iiasa.ac.at/index.php/Questionario
Questionnaires collected	373 (346 by local association members and 27 on-line)
Data analysis	Frequency distribution, bivariate data analysis as cross-tabulation and mean comparison (Chi-square and eta test)

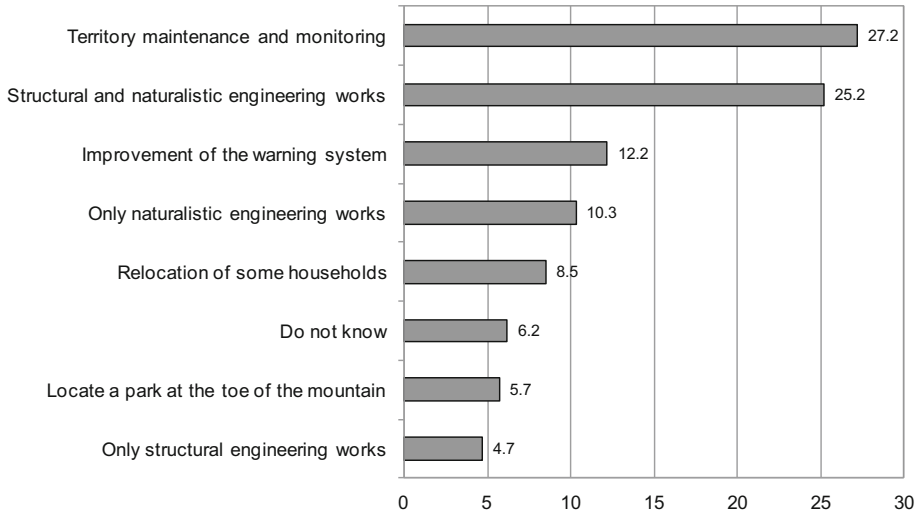

Fig. 1 Priority actions for risk mitigation

combining the most necessary structural engineering works with risk mitigation measures having a low environmental impact, for example, erosion control. This hybrid path, it was felt, would work best with an improved warning system. The relocation of homes out of the high-risk areas was viewed by some (8.5 %) as necessary, but was not a preferred measure, nor was the location of a green belt or park at the foot of the mountain (5.7 %).

While these aggregated responses give an overall picture of stakeholder views on landslide mitigation, they mask the heterogeneity of the responses and thus the intense

debates and controversies surrounding the policy issues—the *contested terrain* (Gallie 1956; Thompson and Warburton 1985; Schwarz and Thompson 1990; Raynor and Malone 1998; Ney 2009; Verweij 2011; Ingram et al. 2012). One such debate involved the emphasis on *passive versus active* mitigation measures. Barriers and other passive mitigation structures were generally perceived as providing a level of safety difficult to achieve through active and exposure-reducing measures, such as vegetation/bioengineering or warning systems. Some stakeholders favored a mix of structural and naturalistic engineering works. Others, insisting that landslides are a natural part of the overall ecological and geomorphological system, saw the structural mitigation measures as part of the problem, not the solution. As reported by a member of a local NGO: "We can choose any option, the problem is to take into account all of them (including option zero) and to evaluate them according to economic, social and ecological criteria. Personally, I will choose the option which will impact least on the ecosystem."

Other stakeholders, taking a more economistic approach, supported the option of *moving people out of areas where the costs of prevention are too high*. This option, however, was categorically ruled out by many stakeholders. As one resident living in the area of Mount Albino put it: "I do not agree with relocation because I have a strong feeling of belonging to this area. I was born here and grew up here. I am aware of the risk and would like to prevent it and know more about it. I do not want to move elsewhere." In Italy, relocation is not a common practice.

Although not a common practice, almost two-thirds of the respondents (64.9 %) agreed that some households might be relocated if they are within the most endangered areas of Mount Albino. They were divided, however, on how that relocation should be carried out. More than a third (37.3 %) supported the option: "households should be forced to relocate with compensation;" more than a quarter (27.6 %) felt that "households should be relocated, but only if the homeowners agree." Another quarter (23.9 %) felt that "households should not be relocated, but householders should be aware of the risks to them; it is their decision to relocate." A few respondents (7.8 %) were against relocation in any form.

The relocation debate also raised the issue of land-use planning, and this too was fiercely contested. In this densely populated and industrialized region, there are high economic costs to preventing development in high-risk areas. Though land-use restrictions are in place, a long history of illegal construction (especially prior to the enforcement of new legal provisions in 1998) plagues the policy debate.

4 Risk mitigation discourses

4.1 Conceptual framework

Based on the literature survey, interviews and public questionnaire, we identified three prototypical discourses (or narratives) that characterized the debate on landslide risk mitigation in Nocera Inferiore. In its most general interpretation, discourse analysis is the study of the language in use or of broad systems of communication that link concepts together in a web of relationships through an underlying logic (Weber 1985; Potter 1996; Gee 2011; Hannigan 2012). Discourses simultaneously refer to a set of ideas and to the interactive process by which these ideas are conveyed. As expressed by Dryzek (1997), discourses are the shared, structured ways of speaking, thinking, interpreting and representing things in the world.

Our conceptual framework for eliciting and interpreting stakeholder discourses is the theory of plural rationality (also called cultural theory; Thompson et al. 1990; Linnerooth-Bayer et al. 2003, 2006; Thompson 2008; Verweij 2011),[10] which postulates that stakeholder discourses (or voices) are plural but limited in number. The discourses stem from different social contexts, which, in turn, are shaped by the ways in which people organize, perceive and justify their social relations. The theory argues that there are four ways of organizing (thus the limited number of discourses): *hierarchy*, *individualism*, *egalitarianism* and *fatalism.*

- The hierarchical voice is *pro-control*. It talks of "wise guidance" and insists that problems, such as landslide risk management, demand expertly planned solutions. This translates into top-down planning through government authorities with their network of experts.
- The individualist voice is *pro-market*. It calls for deregulation, for the freedom to innovate and take risks, and for the explicit recognition of tradeoffs among competing uses of resources. Those residents who feel that individuals should make informed decisions on where to live and when to evacuate, and who see tradeoffs between costly landslide risk mitigation and other competing uses of public funds (requiring attention to costs and benefits), represent the individualistic voice.
- The egalitarian voice is s*trident and critical*. Deeply skeptical of both the individualist notion of tradeoffs (especially when lives and other "sacred" values are at issue) and the hierarchy's claim that their experts know what is best for protecting against landslide risk, this voice argues for a more holistic, moralistic and natural approach to landslide risk management. Egalitarian respondents, focusing on the inequalities among humans and the consequent disruptions to the overall ecological and geomorphological system, tend to see structural measures as the problem and not the solution.
- It is difficult to characterize the fatalist voice, because those who see *no possibility of effecting change for the better* tend not to have one (that, of course, is why we have elected to work with just the hierarchical, individualist and egalitarian discourses). Even so, they do have their vital part to play, because their muted counsel can avoid wasting time and money on things about which nothing can be done. Those who see landslides as out of anyone's control, and who are convinced there is little they can do to reduce their risks, fit here. Yet, only 1.6 % of the questionnaire respondents supported the fatalist view and, unsurprisingly, this view was unrepresented among those who wished to be included in the participatory process (Scolobig et al. 2011). For this reason, this discourse was not included in the participatory process.

In the following, we describe the three discourses, each of which reflects elements of the hierarchical, egalitarian and individualist perspectives, although none solely reflects one worldview. The first discourse—*safety first*—is more hierarchical than the others, in that it emphasizes the importance of expert-derived safety, in this case, in the form of a mix of passive and active mitigation measures.[11] The second—*careful stewardship of the*

[10] Originally developed by Douglas (1978) as a "heuristic device" or "analytical scheme," it *is* a cultural theory—a theory of cultural bias, to be precise—but it all too easily gives the mistaken impression that it is culture that is doing the explaining. "Plural rationality" avoids that; it also helps position this theory in relation to those—rational choice and post-structuralism—that it challenges.

[11] More properly, it is the *narrative* (or *storyline*) that underlies the discourse. It can be seen as imparting shape and coherence: keeping the discourse itself "on track" through all the contingencies (and shifts in the other discourses that it is defining itself in opposition to) that it inevitably runs into. For simplicity, however, we will stick to "discourse" in this paper (but see Ney 2009).

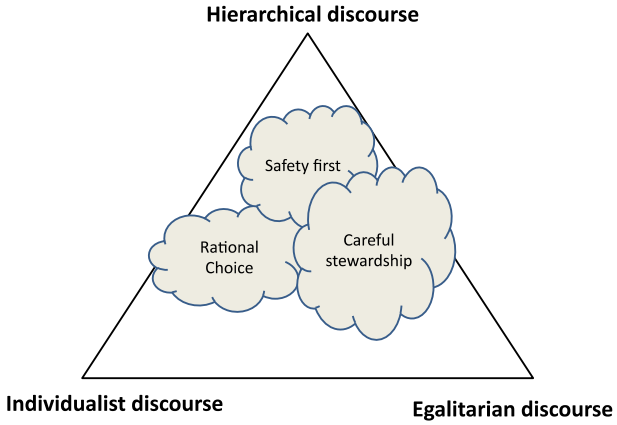

Fig. 2 Three discourses characterizing the landslide risk mitigation debate

mountain—is more egalitarian, with its greater emphasis on active and natural engineering measures, as well as on the equitable sharing of the risk. The third—*rational choice*—tends to emphasize the right of citizens themselves to decide, along with the importance of considering the costs of the proposed measures in relation to their social benefits. The three discourses and where they are approximately located in the conceptual framework are illustrated in Fig. 2.

These discourses (sketched below) formed the basis for discussions throughout the participatory process (see Scolobig et al. 2011), during which the participants were asked to choose the discourse with which they most closely identified. They reported no difficulties in choosing one representative discourse, and they also confirmed that the three discourses represented the range of relevant public perspectives. During the process, several working groups were organized to discuss the discourses and their related policy options. Moreover, the participants themselves organized autonomous parallel activities to further discuss the discourses and accompanying risk mitigation measures.

4.2 Three Mount Albino discourses

The discourses as they were presented to the participants in the participatory process are paraphrased below:

1. Safety first
   Many residents of Mount Albino are living in areas at risk of landslides, threatening their own and their children's lives, as well as their properties. It is the responsibility of the Italian government and other public authorities at the regional and municipal levels to reduce this risk to acceptable levels. There is no such thing as "zero risk," but available public resources should ensure the greatest protection possible. It is far wiser to provide protection before lives and property are lost than to spend possibly greater sums on compensating victims.
   Protection does not mean large, unesthetic and very expensive structural measures (as were adopted in Sarno). Rather, the job can be done with a careful mix of active measures, such as cleaning drains and properly managing forests. However, limited passive measures, such as decanting structures and storage basins, will be necessary. Special care should be devoted to assuring low visibility and limited disruption to the

environment. A mix of active and passive measures is also desirable because it is difficult to assure the proper maintenance of some passive works.
Still, there will be residual risks. Existing buildings in high-risk areas should be safeguarded, and only under very exceptional cases should homes be relocated. The emotional cost of residents abandoning their long-time homes is too high for this to be an acceptable option. The local authorities, however, should have more responsibility for preventing future construction in designated high-risk areas.
Insurance is not the answer since the government, and not the individual residents, is responsible for protecting against landslide risk and compensating victims.
Of course, early warning systems, combined with emergency plans, are important and the existing system should be improved. Since residents may not have adequate information on the risks, it is important for the experts to further develop the warning system. At the same time, the public needs to be informed on appropriate emergency actions in the case of a warning.

This discourse is a hybrid of mainly hierarchical and egalitarian views. It emphasizes a mix of passive and active measures, as well as the improvement of the landslide warning system. As expressed by a farmer living on the Mount Albino slope: "Structural control works should be built… I am a farmer and I know where the unstable areas are on my property, but the Mount Albino slope is very wide and it is difficult to identify the most endangered areas." Because of this uncertainty, the farmer supported passive measures. Another resident of Mount Albino added: "The construction of control works upstream is necessary to stop the debris and soil from sliding down."

Trust in government and expert knowledge is a prerequisite for this storyline. As one local politician put it: "We all know who is going to make the decision: the regional Emergency Commissioner. We need to be more realistic about decision-making processes related to risk mitigation. Bottom-up initiatives cannot work because the residents can neither provide any new information nor meaningfully contribute to the risk mitigation discussion. Instead, we need top-down participation because experts are the only ones who can provide useful advice."

Many residents recognized the need for a warning system in addition to stabilization measures. As a member of the local committee for the landslide victims observed: "Neither active nor passive control works can guarantee 100 percent safety. A long-lasting rain, for example, would jeopardize the stability of the entire slope. As a result, investing in improving the warning system is also a priority. We know that many families living on the open slope will never leave their homes and the only way they can reduce the risk to their lives is to invest in the warning system." In consequence, investing in warning, risk and emergency communication is also crucial.

Other stakeholders, especially civil protection officers, had supported the massive investment in passive mitigation measures that was subsequently rejected. They therefore blamed the Municipal Council and the supporting local associations for the stalled decision process. These stakeholders, unsurprisingly, continued to support passive mitigation measures.

2. Careful stewardship of the mountain
   Due especially to environmentally detrimental anthropogenic practices, such as building roads, industrial activities and even power lines at the edge of the slope, Mount Albino has become less stable and subjected to dangerous landslides. Climate change may be worsening the situation. While some immediate measures will be needed to reduce the acute risks to residents of Mount Albino, the critical long-term

issue is to deal with the multitude of factors that are contributing to the instability of the slopes. It is imperative, for instance, to investigate industrial activities that are adding to the problem. Not only must the residents be protected, but also the natural cycles and the evolving mountain terrain should be respected. This will mean taking a more holistic and ecological view of the mountain and its maintenance.

Expensive structural passive measures will only aggravate the ecological problems and are not necessary. Moreover, they are problematic due to the complex mix of authorities in charge. Rather, active measures (including naturalistic engineering works) can do the job. Authorities might even consider the creation of a natural park at the toe of the slope to reduce urbanization in the area. A network of walking paths should be created so that local residents can enjoy the mountain areas and check on the terrain at the same time. In addition to the park and walking paths, small-scale organic farming on the mountain and better management of the public and private forests could be encouraged. Improved monitoring of the slopes and warning system is essential, and the residents, themselves, can be very good at knowing when to evacuate.

Illegal construction in restricted areas is a major culprit, and it will be necessary to more forcibly prohibit construction in some areas. The bureaucratic hurdles for informing oneself about the regulations are complex, and building in risky areas is widespread in the Campania region. Although it is inequitable to restrict construction or to relocate families in dangerous areas where homes are already located, in some exceptional cases, it may be necessary in order to send an important signal to those thinking of building in restricted areas.

Insurance, even if it were available, is not the answer since this places too much responsibility on residents, some of whom would not be able to afford the premiums. And, besides, insurers cannot be trusted.

Of course, early warning systems, combined with emergency plans, are essential and should be improved. It is very important that the residents are involved in the design and implementation of these systems, especially since they often have a very good understanding of the mountain and its risks.

"Sarno!" became the battle cry of this discourse community since many residents were highly critical of Sarno's unsightly landslide protection measures. Besides their esthetic problem, critics noted that they can give a false sense of full protection. As reported by a member of the victims' committee: "Sarno gives the wrong illusion to the local population: that everything can be solved with technical solutions. Instead the visual impact of the control works in Sarno is excessive."

The Sarno case also raised the issue of equity. Many stakeholders viewed the large investment as unfairly allocating resources to only one community. Equity in the risk distribution, even strict equality, is a very important consideration in this discourse. As reported by the head of a local environmental NGO: "There is a need to guarantee equal safety standards for all families living on the Mount Albino slope. We should ideally have a risk map with the same color (risk level) everywhere, but I am not sure this is technically feasible. However, we know that there are some illegal buildings in the Mount Albino area and protecting those houses would be unfair: priority for enhanced safety should be given to houses built legally."

The "Careful stewardship of the mountains" discourse is egualitarian because it focuses on the inequalities among humans and the consequent disruptions to the mountain precious ecosystem, and it tends to see structural measures as the problem and not the solution.

3. Rational choice

   The residents of Mount Albino are living with landslide risk, but the seriousness of this risk is highly uncertain and may be exaggerated. In fact, only a small number of residents and homes may be dangerously threatened, and it is very difficult to identify them because of the large uncertainties about landslide-triggering factors. Landslide risk is not the only concern of the residents, and probably not the main one. Unemployment, environmental pollution and waste management are among other worries. Moreover, many residents also face a risk of flooding, and it may be more cost effective to invest in flood prevention. It is very important to allocate scarce public resources taking into account ALL the municipalities' priorities, and for this reason, it is important to evaluate the use of public funds if "no action" for landslides is taken. If landslide risk is shown to be high and unacceptable, then investments for the reduction in these risks should be carefully considered. It is important to calculate the costs and the benefits to the residents. This should determine how we invest, whether in active measures (e.g., cleaning drains, reforestation), passive measures (e.g., embedded walls or reinforced fills) or more ecological measures (e.g., creating a park or subsidies for organic farming). Relocating residents may be more cost effective than expensive mitigation measures.

   What is of utmost importance is that residents are aware of the risks they are facing. It is the obligation of the authorities to supply this information. Expert knowledge and risk maps are most valuable.

   Concerning relocation, it is the residents' decision (if they are informed) whether to relocate or not. While public compensation is justified for those wishing to relocate, it should not be applied to anyone consciously deciding to build in a dangerous area after information is available. As reported by a civil protection officer: "rather than spending a million Euros to make the entire slope area safer, we should consider the relocation option."

   There is a residual risk, however, even in some unrestricted areas, and to protect residents against the economic risk, insurance should be more readily available. This is the role of the private market, but the government could support this role with public–private partnerships. If individuals or businesses are aware of the risk—and required to purchase insurance (that currently is not available in Italy)—illegal building will no longer be an issue. High insurance premiums will keep people from locating in areas with high residual risk. Otherwise, informed and knowledgeable people should be allowed to build on their property.

This discourse emphasizes the importance of rational and informed choice on the part of individuals and the public authorities. While few interviewees expressed the sentiments of this discourse, probably because Italians are accustomed to government intervention and compensation for landslides and other hazards, there were voices along these lines. An interviewee living in the Mount Albino area emphasized the importance of information: "Many people are not aware of the existence of building restrictions and think that they can do whatever they want on their private property. For example, I realized I was living in an area of very high risk (R4) only when I went to the municipal technical office to request a permit to enlarge my house." Another interviewee expressed concern that the seriousness of landslide risk on Mount Albino is exaggerated, especially given that only a small number of homes may be threatened, and it might be more effective to invest scarce resources in flood risk management.

Tradeoffs are the hallmark of this discourse. Decisions on public investments in landslide risk mitigation should be made taking account of the returns to the public if one invests, instead, in flood risk mitigation or other social needs. Consequently, benefit-cost estimates should be a guiding framework for making these decisions. Individual responsibility, where appropriate, is also important to this discourse community. By pricing risk, insurance can provide incentives for location and other decisions made within the private sector.

The "Rational choice" discourse is individualistic because it emphasizes the right of citizens themselves to decide, along with the importance of considering the costs of the proposed measures in relation to their social benefits.

5 From stakeholder discourses to policy options

The Nocera Inferiore participatory process (described in Scolobig et al. 2011) was premised on the theory of plural rationality, which requires that stakeholder voices are both "heard and responded to" in deliberative processes (Ney 2009). In contrast to many stakeholder meetings that seek consensus by convincing participants to adjust or change their views, the Nocera Inferiore process was designed to respect the contending values and problem frames (plural rationalities) of the participants, and to seek compromise rather than consensus—what is referred to as a "clumsy" rather than "elegant" solution (Verweij and Thompson 2011). The challenge was to support this contested terrain-respecting process with expert knowledge on the technical options for reducing landslide risk on Mount Albino.

The role of the expert team in the Nocera Inferiore participatory process, in consequence, differed greatly from accepted practice for landslide risk management, where typically experts advise policymakers on a preferred technical solution, as demonstrated by the earlier failed plan for Mount Albino. In this case, the expert team together with the participants agreed to interactively co-produce three sets of mitigation measures that would reflect the three discourses described above. The options were grounded on scientific knowledge, in this case, on the expert team's knowledge of the rainfall-induced slope instabilities, namely debris flows and debris avalanches (Hungr et al. 2001) as well as hyperconcentrated flows (Costa 1988; Coussot and Meunier 1996), to which Mount Albino hillslopes are mainly prone.

The intent of each option was to reduce the risk to property and people living at the toe of Mount Albino, yet keeping within the earmarked budget of €7 million. Safeguarding the residents was high priority as established by Italian Law (D.P.C.M. 29.11.1998 n.180, art. 1). In other words, each policy option package, in addition to reflecting stakeholder views, would be designed to conform to both the budget constraint and Italian law.

The policy options were characterized by a mix or package of active structural measures (for example, sheet pilings to stabilize the slopes) and passive structural measures (for example, storage basins to catch water and debris), as well as non-structural measures (for example, investment in the warning system). To conform to the budget and legal constraints, it was important to have a package of measures. Depending only on an improved warning system, for example, could unacceptably compromise safety especially for the slope instabilities having the highest frequency as with the "debris avalanches" that occurred in 2005. Even within these constraints, there was sufficient flexibility for the design of options to take account of diverse stakeholder preferences.

In what follows, we describe the three policy option packages as they were produced and presented to the participants of the stakeholder process. It should be kept in mind that the options were formulated as a deliberative device and do not contain all the detail necessary for their implementation. The idea was to reach an agreement by the participants on a general risk mitigation concept that would then be worked out in more detail, while also assuring it met the budget and legal constraints.

5.1 Safety first

Adherents to the "safety first" discourse were willing to accept more emphasis on passive structural measures but not to the extent seen in the Sarno case. Like the other discourses, a mix of passive and active measures, and including improvements in the warning system, was viewed as desirable (see Fig. 3). The expert team constructed the following package consistent with this discourse:

- Active mitigation measures over an area of about three hectares of open slopes. The precise measures would depend on local conditions characterizing the soil cover deposits (slope angles, total thickness, presence of pumice layers, etc.) and would include anchored sheet piling;
- Passive mitigation measures consisting of six storage basins located at the toe of the mountain catchments that would be designed for hyperconcentrated flows triggered by rainfall having a return period of 200 years (Ferlisi et al. 2015);
- Investments in the current monitoring/warning system like installing equipment to measure soil suction to improve the accuracy of short-term risk forecasts. This could also include enhanced monitoring of the mountain areas with expert surveys (territorial survey as described by Cascini 2004).

The cost for this risk mitigation package or option is shown in Table 2.

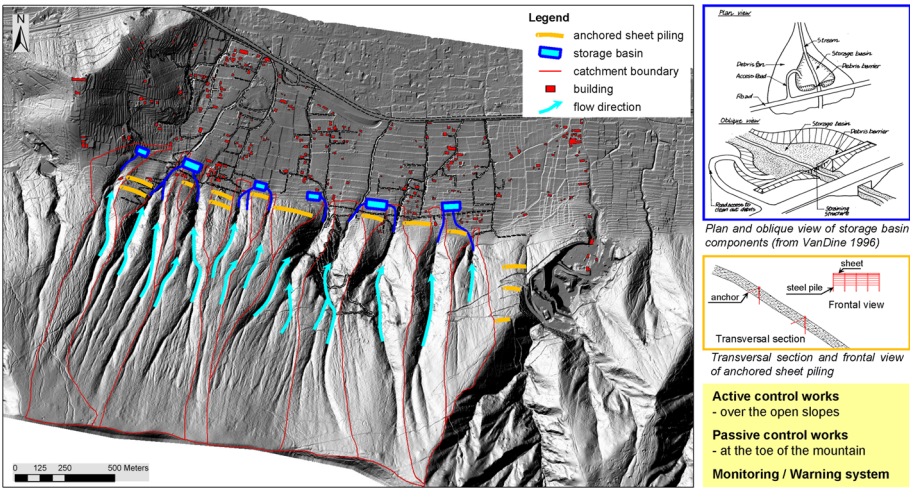

Fig. 3 Risk mitigation option corresponding to the "safety first" discourse

Table 2 Cost estimate of the "safety first" risk mitigation option

Category	Typology	Cost [€] per typology	Cost [€] per category	Total cost [€]
Active mitigation measures	Anchored sheet piling	1,354,087	1,354,087	6,950,842
Passive mitigation measures	Storage basins	5,296,755	5,296,755	
Non-structural mitigation measures	Warning system	300,000	300,000	

5.2 Careful stewardship of the mountain

Adherents to the "careful stewardship of the mountain" discourse were willing to accept limited passive structural measures but preferred an emphasis on active measures. As shown in Fig. 4, the expert team translated this discourse into a mitigation package that relied on passive measures in the form of small water retention tanks, extensive active measures, including forestation, and a warning system. Specifically, the expert team constructed the following package to translate this discourse into a policy scenario:

- Passive structural control measures in the form of small-sized water tanks located in the piedmont area. The purpose of the tanks is to reduce the impact of flooding phenomena so that negligible amounts of suspended sediments are conveyed along the major flow paths;
- Active structural mitigation measures, including sheet piling, over about three hectares of open slopes, and natural engineering measures like channel lining and vegetated gabions aimed at reducing erosion due to frequent rainfall events, along more than 10,000 m of the rills;
- Forestation with a belt of oak trees located at the toe of the Mount Albino slopes. Their purpose is to partially dissipate the kinetic energy of flow-type landslides;
- Monitoring/warning system, including a territorial survey.

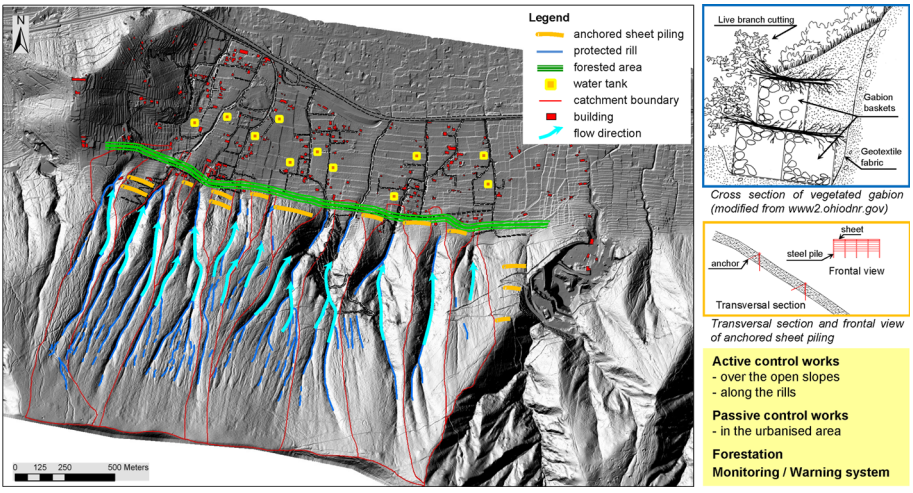

Fig. 4 Risk mitigation option corresponding to the "careful stewardship of the mountain" discourse

Table 3 Cost estimate of the "careful stewardship of the mountain" risk mitigation option

Category	Typology	Cost [€] per typology	Cost [€] per category	Total cost [€]
Active mitigation measures	Anchored sheet piling	1,354,087	3,061,372	6,930,397
	Gabions	1,707,285		
Passive mitigation measures	Water tanks	2,000,000	2,000,000	
	Forestation	1,569,025	1,569,025	
Non-structural mitigation measures	Warning system	300,000	300,000	

Since the water tanks will not contain large debris flows, the monitoring and warning systems combined with an emergency evacuation plan take on added importance in this mitigation scenario.

The cost for this risk mitigation package is shown in Table 3.

5.3 Rational choice

The "rational choice" discourse placed emphasis on delineating policy measures with a high benefit to society relative to their costs (see Narasimhan et al. (2015), for a discussion of the benefits and costs). This meant considering the relocation of households most at risk, and balancing active and passive measures by taking account of the extent to which they reduce the hazard, exposure to the hazard or vulnerability of people and property. As illustrated in Fig. 5, the expert team constructed the following package to correspond with this discourse:

- Active and/or passive mitigation measures depending on their costs and benefits;
- Relocation of some households located in the most at risk areas at the toe of the Mount Albino massif;
- Monitoring/warning system supported by a territorial survey.

The cost for this risk mitigation package is shown in Table 4.

The above three technical policy options, each designed interactively with the participants, provided sufficient detail for those participants to deliberate on a compromise package of mitigation measures. Again, it should be stressed that the options were formulated as a deliberative device and do not contain the detail necessary for their implementation. The idea was to reach an agreement by the participants on a general risk mitigation concept that would then be worked out in more detail, assuring it met the budget and legal constraints. As described in Scolobig et al. (2011), the stakeholders did reach a compromise that emphasized a mixed package of passive and active measures accompanied by an improved warning system. The participants reported satisfaction in the co-produced policy options as a basis for their deliberations.

6 Summary

In the sector of natural risk management, the one-way flow of knowledge "model" (from experts to policy-makers) is still mainstream and has hardly been questioned. In this paper, we present a new role for experts that provide an informed opinion and different options, balancing evidence, uncertainties, economic, institutional and social contextual factors.

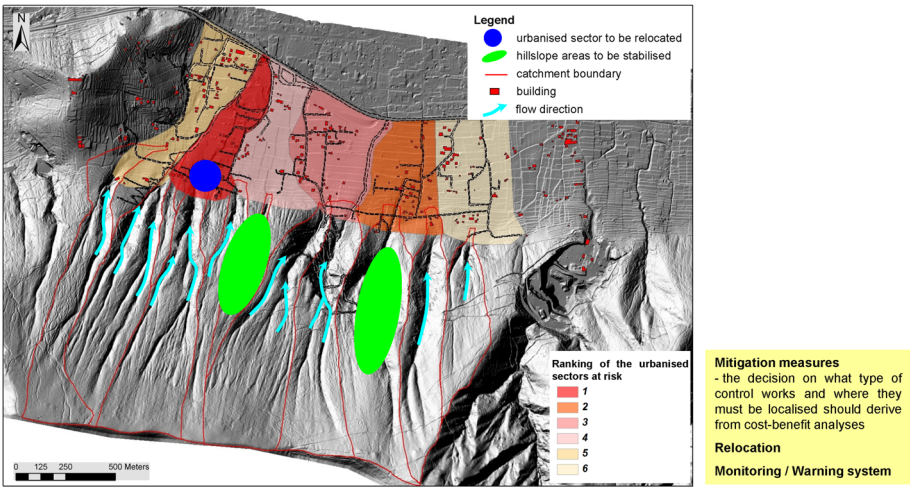

Fig. 5 Risk mitigation option corresponding to the "relocation" discourse

Table 4 Costs of the "rational choice" risk mitigation option

Category	Typology	Cost [€] per typology
Active mitigation measures	To be established on the basis of cost-benefit analysis	–
Passive mitigation measures	To be established on the basis of cost-benefit analysis	–
Non-structural mitigation measures	Relocation of up to 29 households	3,480,000
	Warning system	300,000

More precisely, in the context of the Nocera Inferiore participatory process, the role of the expert differed greatly from the form it takes within more conventional practices for landslide risk management. Typically, experts advocate or advise policy-makers on a preferred policy solution, a practice that contributed to the failed decision on risk mitigation measures for Mount Albino. The expert role described in this paper differs from the traditional role by providing technically proven options for landslide risk mitigation that correspond to the worldviews and preferences of the public stakeholders as expressed by their discourses. In this way, experts co-produce policy options based on their specialized knowledge as well as local knowledge and values.

Drawing on the theory of plural rationality, we elicited stakeholder discourses on the landslide risk problem as well as options for its mitigation using desktop research, interviews and a public questionnaire. Experts interactively provided differentiated technical mitigation options along with estimates of their costs based on the elicited discourses. These options were subsequently deliberated in the participatory process with the intent of reaching a compromise on a recommended policy option.

The value of this novel role for experts is its provision of useable knowledge to deliberative participatory processes, and this new role can extend beyond the Nocera Inferiore case. To date, there has been little guidance on how to institutionalize the two-way model: How, that is, to design participatory processes that involve stakeholders and scientific experts for the purpose of co-producing useable knowledge for the decision-making

process. The core feature of the Nocera Inferiore process is interactively coupling expert-formulated policy options with stakeholder discourses, a feature that can inform two-way expert-stakeholder interaction in all types of public participatory processes.

Acknowledgments The work described in this publication was supported by the European Community's Seventh Framework Programme through the grant to the budget of the SafeLand Project (http://www.safeland-fp7.eu/Introduction.html), Grant Agreement: 226479. The paper reflects the authors' views and not those of the European Community. Neither the European Community nor any member of the SafeLand Consortium is liable for any use of the information in this paper. We thank the 43 local stakeholders and the 18 participants to the participatory process in Nocera Inferiore who devoted their precious time to our interviews and meetings. Without them, our research work would not have been possible. The same gratitude goes to the numerous volunteers of the 7 local associations providing help to collect the questionnaires, as well as for the 373 survey respondents. This paper is dedicated to the memory of Professor Giuseppe Sorbino and of Paolo Fabbricatore, leader of the local NGO "Montagna Amica" (Mountains' friends). There are no words to describe their precious contribution to the research in Nocera Inferiore as well as to describe the deep sadness for their loss.

References

Agrawala S, Broad K, Guston D (2001) Integrating climate forecasts and societal decision making: challenges to an emergent boundary organization. Sci Technol Human Values 26:454–477

Beck MB, Thompson M, Ney S, Gyawali D, Jeffrey P (2011) On governance for re-engineering city infrastructure. Eng Sustain 164(2):129–142

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

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

Costa JE (1988) Rheologic, geomorphic, and sedimentologic differentiation of water floods, hyperconcentrated flows, and debris flows. In: Baker VR, Kochel RC, Patton PC (eds) Flood geomorphology. Wiley, New York, pp 113–122

Coussot P, Meunier M (1996) Recognition, classification and mechanical description of debris flows. Earth Sci Rev 40:209–227

Douglas M (1978) Cultural bias. Occasional paper of the Royal Anthropological Institute 35 (London). Reprinted in Douglas, in the active voice: 183–254. Routledge and Kegan Paul, London

Dryzek J (1997) Environmental discourses. Oxford University Press, New York

Durant J (1999) Participatory technology assessment and the democratic model of the public understanding of science. Sci Public Policy 26:313–319

European Environmental Agency (2001) Late lessons from early warnings: the precautionary principle 1896–2000, Environmental issue Report, No. 22, Copenhagen http://www.eea.eu.int

Ferlisi S, De Chiara G, Cascini L (2015) Quantitative risk analysis for hyperconcentrated flows in Nocera Inferiore (southern Italy). Nat Hazards. doi:10.1007/s11069-015-1784-9

Fischoff B (1995) Risk perception and communication unplugged: twenty years of process. Risk Anal 5(2):137–145

Fischoff B (2013) The sciences of science communication. Proc Natl Acad Sci 110:14033–14039

Funtowicz S, Ravetz J (1993) Science for a post normal age. Futures 25(7):739–755

Gallie WB (1956) Essentially contested concepts. Proc Aristot Soc 56:167–198

Gee JP (2011) An introduction to discourse analysis: theory and method, 3rd edn. Routledge, London

Gluckman P (2014) The art of science advice to government. Nature 507:163–165

Guston D (1999) Stabilizing the boundary between US politics and science: the role of the Office of Technology Transfer as a boundary organization. Soc Stud Sci 29:87–112

Guston D (2000) Between politics and science: assuring the integrity and productivity of research. Cambridge University Press, New York

Guston D (2001) Boundary organizations in environmental policy and science: an introduction. Sci Technol Human Values 26:399–408

Hannigan J (2012) Disasters without borders. The international politics of natural disasters. Polity Press, Cambridge

Hungr O, Evans S, Bovis M, Hutchinson J (2001) A review of the classification of landslides of the flow type. Environ Eng Geosci 3:221–238
Ingram D, Taylor P, Thompson M (2012) Surprise, surprise: from neoclassical economics to e-life. ASTIN Bull J Int Actuar Assoc 42:389–412
Jasanoff S (2004) The idiom of co-production. In: Jasanoff S (ed) States of knowledge: the co-production of science and social order. Routledge, London, pp 1–13
Jasanoff S (2005) Designs on nature: science and democracy in Europe and the United States. Princeton University Press, Princeton
Leiss W (1995) Three phases in the evolution of risk communication practice, working-paper series 95-2, Environmental Policy Unit—September 1995—School of Policy Studies, Queen's University
Linnerooth-Bayer J, Vari A, Ferencz Z (2003) Stakeholder views on flood risk management in Hungary's Upper Tisza Basin. In: Linnerooth-Bayer J, Amendola A (eds) Special edition on flood risks in Europe. Risk Analysis 23: 581–601
Linnerooth-Bayer J, Vari A, Thompson M (2006) Floods and fairness in Hungary. In: Verweij M, Thompson M (eds) Clumsy solutions for a complex world: governance, politics and plural perception. Palgrave Macmillan Ltd, Basingstoke
McNie E (2007) Reconciling the supply of scientific information with user demands: an analysis of the problem and review of the literature. Environ Sci Policy 20:17–38
Morgan RPC, Rickson RJ (1995) Slope stabilization and erosion control: a bioengineering approach. E & FN Spon, London
Narasimhan H, Ferlisi S, Cascini L, De Chiara G, Faber MH (2015) A cost-benefit analysis of mitigation options for optimal management of risks posed by flow-like phenomena. doi:10.1007/s11069-015-1755-1
Ney S (2009) Resolving messy policy problems. Earthscan, London
Pagano L (2009) The role of rainfall history on the interpretation of flowslide triggering in pyroclastic soils. In: Picarelli L, Tommasi P, Urciuoli G, Versace P (eds) Proceedings of the workshop on "Rainfall-induced landslides: mechanisms, monitoring techniques and nowcasting models for early warning systems". Naples, 8–10 June 2009: 216–223, Studio Editoriale Doppiavoce, Napoli
Pielke P Jr, Byerly R Jr (1998) Beyond basic and applied. Phys Today 51:42–46
Potter J (1996) Representing reality: discourse, rhetoric and social construction 1st ed. SAGE Publications Lts
Raynor S, Malone EL (eds) (1998) Human choice and climate change (4 vols) Columbus. Battelle Press, Ohio
Sarewitz P, Pielke RA Jr (2007) The neglected heart of science policy: reconciling supply of and demand for science. Environ Sci Policy 10:5–16
Schwarz M, Thompson M (1990) Divided we stand. University of Pennsylvania Press, Philadelphia
Scolobig A, Linnerooth-Bayer J, Cascini L, Ferlisi S (2011) Design and testing: a risk communication strategy and a participatory process for choosing a set of mitigation and prevention measures, Deliverable 5.7, SafeLand Project—7th Framework Programme Cooperation Theme 6 Environment (including climate change) Sub-Activity 6.1.3 Natural Hazards
Thompson M (2008) Organising and disorganising. Triarchy Press, Axminster
Thompson M, Gyawali D (2006) Uncertainty revisited or the triumph of hype over experience. New introduction to the republished in Thompson M, Warburton M and Hatley T, Uncertainty on a Himalayan Scale. Lalitpur, Nepal: Himal Books
Thompson M, Rayner S (1998) Risk and governance part 1: the discourses of climate change. Govern Opposit 33:139–166
Thompson M, Warburton M (1985) Decision making under contradictory certainties: how to save the Himalayas when you can't find out what's wrong with them. Appl Syst Anal 12:3–33
Thompson M, Ellis RJ, Wildavsky A (1990) Cultural theory. Boulder, Colorado-West View
Thompson M, Rayner S, Ney S (1998) Risk and governance part 2: policy in a complex and pluraly perceived world. Govern Opposit 33:330–354
Vaciago G, Rocchi G, Bianchini A (2012) Compendium of tested and innovative structural, non-structural and risk-transfer mitigation measures for different landslide types, deliverable 5.1—toolbox for landslide hazard and risk mitigation measures. SafeLand project—7th framework programme cooperation theme 6 environment (including climate change) Sub-Activity 6.1.3 Natural Hazards
VanDine DF (1996) Debris flow control structures for forest engineering. Research Branch, British Columbia Ministry of Forests, Victoria, B.C., Work. Pap. 08/1996. http://www.for.gov.bc.ca/hfd/pubs/docs/wp/wp22.htm (last access: 11 November 2013)

Versace P, Altomare P, Serra M (2008) Interventi strutturali per la riduzione del rischio di colata. Il modello Sarno. In: Quaderni del CAMIlab, 3(3), November 2008, pp 1–22. http://www.camilab.unical.it/ricerca/pubblicazioni/PDF/Camilab_3.pdf (last access: 11 November 2013)
Verweij M (2011) Clumsy solutions for a wicked world. Palgrave Macmillan, Basingstoke
Verweij M, Thompson M (eds) (2011) Clumsy solutions for a complex world (revised edition, in paperback). Palgrave Macmillan, Basingstoke
Weber RP (1985) Basic content analysis. Sage, Beverly Hills