

# The district of North Vancouver's landslide management strategy: role of public involvement for determining tolerable risk and increasing community resilience

Kristen M. Tappenden

Received: 4 October 2013 / Accepted: 20 December 2013 / Published online: 4 January 2014  
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**Abstract** This paper examines the public involvement processes contained within the Landslide Management Strategy for the District of North Vancouver in British Columbia, Canada. Following a fatal landslide in the Berkley neighborhood in 2005, the District of North Vancouver convened a community-based Natural Hazards task force to establish risk-tolerance criteria for natural hazards. This paper describes the community task force approach and evaluates it against four criteria for successful public involvement: representative participation; early involvement; information availability; and impact on policy. It is identified that the District could have incorporated a broader understanding of risk, allowing public perspectives to influence the initial framing of the risk issue before charging the Natural Hazards task force to arrive at quantitative risk-tolerance criteria. The District could also have sought to engage a somewhat more representative portion of the population to serve on the Natural Hazards task force, seeking to incorporate a broader set of public values and types of knowledge. Notwithstanding, the Natural Hazards task force successfully utilized social, legal, and scientific information for informed decision-making, and their recommended risk-tolerance criteria were enacted into policy by the District of North Vancouver as a result of the process. The paper also investigates the District's ongoing public involvement and education efforts with respect to landslide risks, considering information accessibility and its usefulness for increasing individual capacity and community resilience. Overall, the District's ongoing, dynamic approach to risk management promises to empower individuals and foster resilient communities in the aftermath of the tragic Berkley landslide.

**Keywords** Landslide · Task force · Public participation · Stakeholder · Tolerable risk · Resilience

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K. M. Tappenden (✉)

University of Alberta, 1-036 Markin/CNRL NREF, Edmonton, AB T6G 2W2, Canada  
e-mail: kgruber@ualberta.ca

## 1 Introduction

This paper examines the District of North Vancouver's (DNV or District) Landslide Management Strategy, with a particular focus on the District's public involvement efforts. In seeking to establish tolerable levels of risk to life from natural hazards, the District convened a community-based Natural Hazards task force in October 2007. To their knowledge, they were the only municipality in Canada at that time to assemble a community task force for the determination of tolerable risk due to natural hazards (DNV 2011). This pioneering approach resulted in legislated risk-tolerance criteria that now govern the development of all sites exposed to landslide and debris flow hazards in the District of North Vancouver. This paper describes the DNV's community task force approach and evaluates it against current best practices for stakeholder involvement in risk decision-making<sup>1</sup>. The paper also investigates the District's ongoing public involvement and education efforts in light of their potential for increasing individual capacity and community resilience.

### 1.1 Setting

The District of North Vancouver is located on sloping terrain between the Coast Mountains of British Columbia and the Pacific Ocean, with a population of approximately 84,000 people (DNV 2011). The location of the District of North Vancouver is depicted in Fig. 1 below. The topography of the area descends from north to south, containing a series of steep escarpments incised by mountain streams. During rapid residential development of the area in the 1950s through the 1970s, building sites were often leveled by pushing or end-dumping loose materials over the escarpment crests, resulting in many residential lots perched on marginally stable colluvium and loose fill soils (DNV 2011). The District receives, on average, 2,400 mm of annual rainfall, with most precipitation occurring during the period of November to February, when the region is subject to "pineapple express" tropical storms (DNV 2011). These storms often trigger landslides and debris flows throughout southwest British Columbia, with the colluvium and loose fill soils along the DNV escarpments especially vulnerable to landslides when saturated.

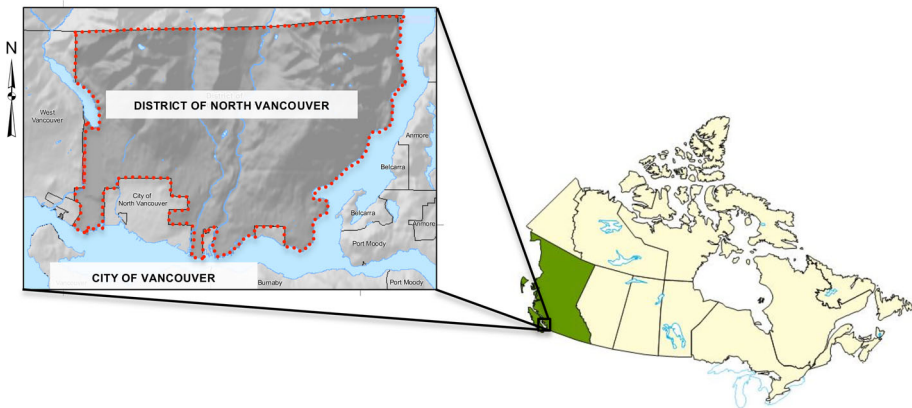
### 1.2 Berkley landslide

In the early morning of January 19, 2005, after prolonged and intense precipitation, a sudden slope failure occurred at the crest of the Berkley Escarpment in the District of North Vancouver, destroying two homes at the base of the slope. One woman, Eliza Kuttner, was killed, and her husband seriously injured (DNV 2011; Porter et al. 2009).

In the wake of the Berkley tragedy, concerns over the potential for future landslides in the District prompted the DNV Municipal Council to implement a Landslide Management Strategy in 2007, as part of an overall Natural Hazards Management Program (Porter et al. 2009). The strategy emphasizes a risk-based approach for the management of landslide hazards, with a focus on public involvement and open, transparent dissemination of hazard and risk information. The Provincial Coroner's report into the landslide fatality, issued in 2008, confirmed the need for an organized approach to managing landslide risks, stating

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<sup>1</sup> For the purposes of this discussion, stakeholder refers to "interested and affected parties" as per the US National Research Council (1996).



**Fig. 1** Schematic map of Canada, showing the location of the District of North Vancouver inset in British Columbia (*shaded*), modified from BGC (2010a) and Environment Canada. (<http://www.ec.gc.ca/meteo-weather/default.asp?lang=En&n=F83FB906-1>)

that landsliding in the Berkley area was both “predictable and preventable” (Province of BC 2008).

## 2 Natural Hazards task force

A key component of the DNV’s Landslide Management Strategy was the convening of a community task force for the development of risk-tolerance criteria for natural hazards. The purpose of the risk-tolerance criteria was to set forth maximum levels of tolerable risk to life for new and existing developments within the community, providing a basis for clear, consistent, and defensible decision-making with respect to required mitigation measures and future land use planning (Dercole 2009).

Convened in October 2007, the Natural Hazards task force was comprised of eight volunteer District residents (six men, two women), with backgrounds in various related fields including engineering, geology, emergency preparedness, outdoor education, and ocean transportation (DNV 2013b; NHTF 2008). The DNV invited representation from select community associations to ensure a geographical balance of the District (Joyce 2007). The task force was to “gather input from an informed, broad-based community perspective regarding quantitative tolerable risk or risk acceptance criteria for landslides and other natural hazards” (Dercole 2009), with the mandate to recommend to Council the tolerable level of risk to life from natural hazards (DNV 2013a).

To fulfill their mandate, the Natural Hazards task force participated in education sessions delivered by subject matter experts in the areas of natural hazards, risk assessment and mitigation, finance, and law. The task force also reviewed the literature concerning risk-tolerance criteria enacted in other jurisdictions with similar legal frameworks and natural hazard situations, including the United Kingdom, Hong Kong, and Australia. In addition, the task force solicited input from the broader public through an open house, a public meeting, and an online survey, before deliberating and preparing their recommendations to Council (Dercole 2009; NHTF 2008). The activities of the task force are described in the following sections.

## 2.1 Expert definition of tolerable risk

Seeking to quantify tolerable risk is a contentious and emotional issue, and there are by no means any universally accepted definitions or processes for doing so. As Jardine et al. (2003) aptly observed, “Resolving risk-tolerance conflicts involves an understanding of ...values and beliefs, coupled with open, honest communication and regulatory accountability.” The following section summarizes the information presented to the DNV’s Natural Hazards task force by the engineering consulting firm engaged to provide expert opinion on the subject of tolerable risk.

While risk-tolerance levels vary among jurisdictions, some general principles apply when seeking to define tolerable risk to the public from a particular hazard (Leroi et al. 2005):

- The incremental risk to an individual from the hazard should not be significant compared to other risks to which a person is exposed in everyday life;
- The ALARP (as low as reasonably practicable) principle shall apply, such that the incremental risk from the hazard shall be reduced to the extent that is reasonably practicable;
- If there is a possibility of many lives lost from a single incident, the probability of occurrence should be reduced accordingly;
- Higher levels of risk are more likely to be tolerated for existing developments than for newly proposed developments.

*Tolerable* risk in this context applies to risks that individuals are willing to accept in exchange for perceived benefits, and subject to ongoing monitoring and/or mitigation in accordance with the ALARP principle. This is differentiated from the concept of *acceptable* risk, which refers to those risks considered broadly acceptable and not requiring any further monitoring or management.

## 2.2 Comparison to other jurisdictions

As part of the literature review process, the task force sought to learn from the experiences of other jurisdictions with similar legal frameworks and natural hazard situations (Dercole 2009). The task force examined risk-tolerance criteria enacted for land use planning in the United Kingdom, for landslide risk from natural slopes in Hong Kong and for large dam failures in Australia. All three jurisdictions utilize similar criteria for tolerable risk to the public, consisting of an annual risk of mortality of  $1 \times 10^{-4}$  (1:10,000) for existing developments, and a more stringent criterion of  $1 \times 10^{-5}$  (1:100,000) for new developments (Jakob and Porter 2007). In order to manage landslide risks in the immediate aftermath of the Berkley landslide, the DNV adopted an interim risk-tolerance criterion of 1:10,000 pending the recommendations of the task force (Joyce 2007).

## 2.3 Public meetings

The Natural Hazards task force convened a public open house on November 22, 2007, with approximately 30 District residents in attendance. Seven of the eight task force members were on hand, along with five DNV staff and representatives from the engineering consulting firm engaged by the DNV. A second public meeting was held the following month with approximately 20 residents in attendance (NHTF 2008). When discussing the concept of legislated risk-tolerance criteria, District residents expressed concerns regarding (DNV 2008):

- The impact on homeowners of potentially mandatory remediation costs and the possibility of reduced property values;
- The amount of assessment work versus the amount of mitigation work being performed by the District;
- The differing levels of risk tolerance among residents, in that some property owners may wish to accept a higher level of risk than others.

## 2.4 Public survey

To supplement the feedback gathered at the public meetings, an online survey was conducted via the DNV Web site between November 20 and December 10, 2007. Seventy-eight survey responses were collected via the Web site, with an additional 12 responses gathered at the open house. The survey used risk comparisons to assist respondents in selecting quantifiable levels of tolerable risk for natural hazards. When compared to other annual mortality rates in British Columbia such as death from poisoning (approximately 1:20,000, Statistics Canada 2007) or death from a motor vehicle accident (approximately 1:10,000, Statistics Canada 2007), 72 % of respondents placed the tolerable level of risk of death from natural hazards between 1:10,000 and 1:100,000 per annum. Fourteen percent considered the tolerable risk of death from natural hazards to be higher (1:600–1:3,700), while 14 % viewed the tolerable risk to be lower (1:200,000) (DNV 2008). The results of the survey are summarized in Fig. 2 below.

In addition, the survey indicated that the majority of respondents felt the DNV should (DNV 2008):

- Be responsible for managing natural hazard risks on public lands;
- Regulate and/or be responsible for risk mitigation on private lands;
- Spend no more than \$1,000,000 per year on natural hazards (the survey question correlated an expenditure of \$600,000 with a yearly tax increase of 1 %).

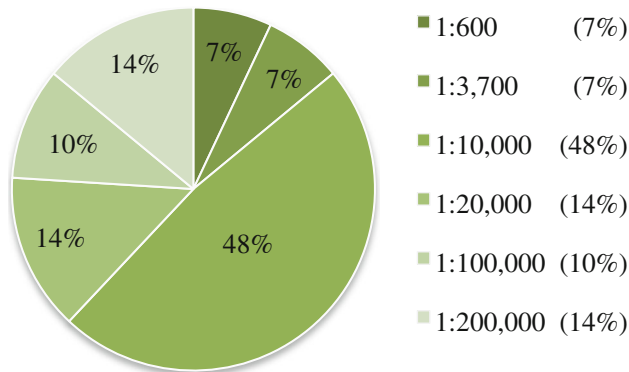
The majority of respondents felt that personal emergency preparedness was the responsibility of the resident (DNV 2008).

## 2.5 Task force recommendations and implementation

After discussion and deliberation, the Natural Hazards task force presented their recommendations to the District Council on April 14, 2008. The task force proposed the following two-tier risk-tolerance criteria for the District of North Vancouver (DNV 2013a):

- 1:10,000 risk of death per year from natural hazards for existing developments;
- 1:100,000 risk of death per year from natural hazards for new developments.

The recommended risk-tolerance criteria are similar to those used in other international jurisdictions, and in agreement with the interim criterion that was adopted by the DNV, as outlined in Sect. 2.2. The criteria also reflect the public opinion gathered from the survey, where 72 % of respondents placed the tolerable level of annual risk of mortality from natural hazards between 1:10,000 and 1:100,000 (Sect. 2.4). The two-tiered nature of the risk-tolerance criteria acknowledges that it is generally more attainable to reduce risk by altering proposed developments, as compared to existing structures. The ALARP principle also requires that tolerable risks be subject to ongoing monitoring and be further reduced below the stated tolerance levels when a significant reduction in risk can be reasonably achieved (DNV 2013a).



**Fig. 2** Diagram showing tolerable level of annual risk of death from natural hazards, as selected by survey respondents (modified from DNV 2008)

On November 16, 2009, the District Council endorsed a policy implementing the recommended risk-tolerance criteria for the District of North Vancouver, following an investigation by District staff into the various practical implications. The policy gives the District's Chief Building Official the discretion to apply the risk-tolerance criteria to building permits, subdivision and development applications for sites exposed to landslide and debris flow hazards (DNV 2013a). District Council's report on the policy concludes with the commitment to continually revisit the risk-tolerance criteria and make adjustments, as required, to meet the future needs of the community, acknowledging, "Ongoing discussion with stakeholders is paramount, as risk tolerance criteria [are] determined more by social values than by technical advances" (Dercole 2009).

### 3 Technical risk assessment and mitigation measures

In conjunction with the public involvement process for determining the quantitative level of tolerable risk from natural hazards, the District engaged an engineering consulting firm to evaluate the risk posed to individuals dwelling along the crest and at the base of eight escarpments located in the District of North Vancouver (Berkley, Capilano River East, Deep Cove/Cove Cliff, Mosquito Creek West, Mount Fromme East, Pemberton, Riverside West, and Westlynn). A quantitative risk assessment (QRA) methodology was developed and calibrated for the Berkley escarpment, then extended to the other seven study areas where qualitative assessment was applied to prioritize sites for more detailed QRA (BGC 2010a, 2006a)<sup>2</sup>. The preliminary qualitative landslide screening studies were predominantly desk-based studies supplemented by brief field inspections (BGC 2010a). Additional data collected for the more detailed quantitative risk assessments included visual observations such as slope angle, the presence of seepage and evidence of slope deformation, with shallow auger holes completed to assess the thickness of loose fill and colluvial soils

<sup>2</sup> Some landslide hazards involved different geological conditions, failure mechanisms, or urban development scenarios than those present along the Berkley Escarpment. These sites required the use of different landslide hazard and risk assessment techniques, including limit equilibrium slope stability analyses, rock fall runout analyses, and professional judgment (BGC 2010a). Where limit equilibrium slope stability analyses were used, the results were compared to the DNV's criteria for existing engineered slopes (static factor of safety >1.3 (BGC 2010b; Dercole 2009)).

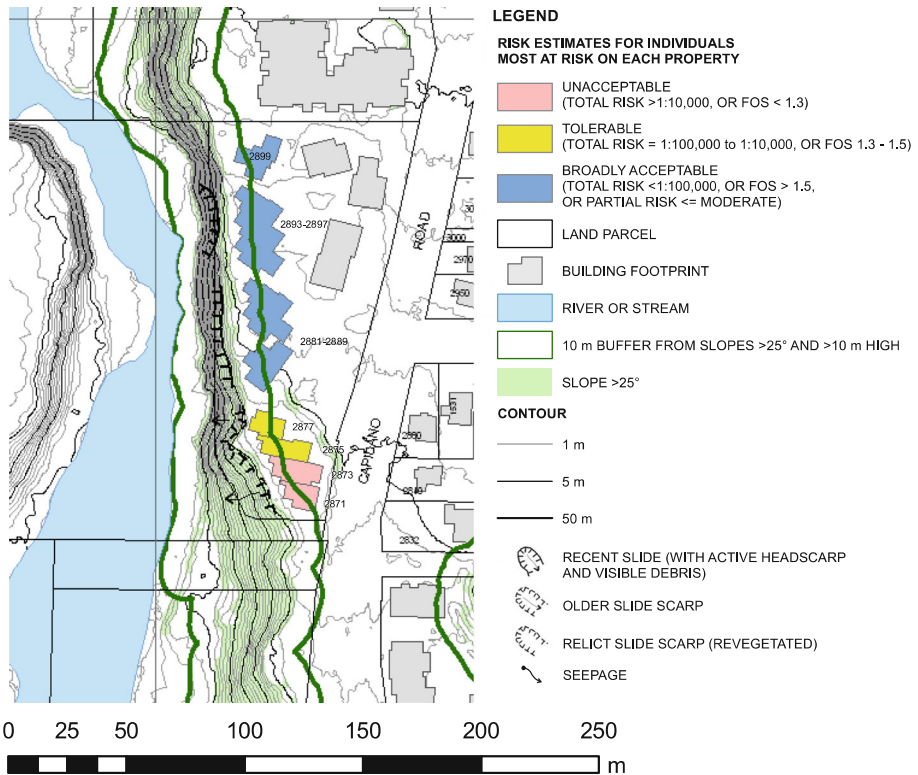
(BGC 2010a). For details concerning the quantitative risk assessment methodology, the reader is referred to Porter et al. (2007) and BGC (2010a, 2006a).

The engineering risk assessments estimated the annual risk of mortality from a landslide for the most exposed individual at each property, and detailed risk maps were produced with individual properties delineated at scales of 1:1,500–1:3,000. The level of detail of the geotechnical investigation, i.e., the use of site-specific field observations and the scale of the risk maps produced, is in agreement with Fell et al. (2008a, b) for defensible decision-making at the property-specific scale. The landslide risk maps, and associated engineering risk assessment reports, were made publicly available via the District's Web site. A portion of the landslide risk map prepared for the Capilano River East Escarpment is shown in Fig. 3 below. Based on a review of the associated engineering reports, the eight study areas contained approximately 547 properties and 322 properties were selected for detailed quantitative risk assessment; of these, the QRA identified 44 properties where unmitigated individual risk estimates exceeded an incremental risk of fatality of 1:10,000 per year (BGC 2011, 2010a, 2007, 2006a, b). Forty-one of these 44 properties were located along the base of the Berkley Escarpment; two properties were located at the crest of the Berkley Escarpment, and one property was located at the crest of the Capilano River East Escarpment (BGC 2010a, 2006b). Due to the red shading used to highlight these properties on the risk maps, they became known as the "red zone" properties (Porter et al. 2007). Based on the interim risk-tolerance criteria adopted by the District, and ultimately endorsed by the task force, mitigation measures were justified to reduce the risk of mortality on these properties from known landslide hazards to the tolerable level of 1:10,000 per annum.

At the time the engineering risk assessment was completed, the District had already initiated a number of capital projects to mitigate the landslide risk along the Berkley Escarpment, including land acquisitions and extension of the storm sewer system (Porter et al. 2007). The District requested approximately 40 residences along the crest of the Berkley Escarpment to connect their roof and perimeter drains to the municipal storm sewer system, offering a grant of \$500 (CAD) and a refund of the permitting fee for homeowners who promptly complied (Porter et al. 2007; DNV 2006a). With financial assistance from the Province of British Columbia, the District also purchased eight properties (at full market value) in the immediate vicinity of the 2005 Berkley landslide, demolishing the homes, re-grading the escarpment crest, and designating the area as a municipal park dedicated to the memory of Eliza Kuttner (DNV 2012, 2006a; Porter et al. 2007; BGC 2006a).

Following this first stage of capital improvements, the number of properties in the "red zone" was substantially reduced from 44 to 16 (BGC 2011, 2007). Second-stage mitigation measures generally consisted of the removal of fill and deteriorating retaining walls, slope reshaping at an approximate 2:1 (horizontal:vertical) grade, and design and installation of bioengineering measures to control surface erosion (BGC 2007; Porter et al. 2007). These measures were the responsibility of the homeowners of seven properties located along the escarpment crests, which comprised the source areas of the landslide hazards affecting the 16 remaining "red zone" properties (BGC 2011, 2007). The DNV held open public meetings to present the results of each phase of the study, and smaller group meetings open to the affected residents were held to discuss the details of the engineering assessments (Porter et al. 2007). Porter et al. (2007) reports that residents living at the top of the escarpments tended to argue that the risk estimates were conservative, perhaps in part because of concerns that they would bear the costs of any required mitigation; while residents living along the base of the escarpments argued the





**Fig. 3** Portion of the risk map produced for the Capilano River East Escarpment (modified from BGC 2010a)

risk estimates were not conservative enough, perhaps in part because they were the ones most vulnerable. However, in general, there was public support for the process, and presentation of the results in the form of annual risk of fatality did not prompt public outcry (Porter et al. 2007). The District of North Vancouver committed to providing in-kind assistance to the homeowners required to undertake remedial work, including construction coordination, on-site geotechnical support, arborist services, and the waiving of associated permitting fees (Ridge 2006). District Council also directed that if the homeowners failed to promptly undertake the required remedial work on their properties; the municipality would perform the work at the owners' expense and recover the costs as debt or taxes in arrear (DNV 2006b)<sup>3</sup>. Thus, through the cooperative efforts of the DNV and the affected homeowners, the required mitigation measures were implemented in a timely manner, resulting in the identified landslide hazards posing an annual residual risk of mortality of no more than 1:10,000 for the individuals most at risk (BGC 2011, 2010a, 2007).

<sup>3</sup> There is a legal basis for this action: under Canadian tort law, property owners may be strictly liable for damages arising from the escape of material that has been introduced or accumulated on their land, and for interference with the use and enjoyment of another person's property (Linden 2001).



## 4 Ongoing communication with stakeholders

In addition to the work of Natural Hazards task force and the legislated risk-tolerance criteria, the DNV has implemented several platforms for facilitating ongoing dialog and public education concerning landslide risk, including a Guide to Living Near Steep Slopes, a publicly available GeoWeb Hazards Database, and the Geotech on Demand Program.

### 4.1 Guide to Living Near Steep Slopes

The Guide to Living Near Steep Slopes is an educational Web site and brochure prepared by the DNV, to inform residents about landslide risk factors and warning signs of impending slope failure, along with practical steps that homeowners can take to reduce the risk of a landslide occurring on their property. The Web site makes effective use of graphics and non-technical language in presenting the information in a way that would be understandable and accessible to most members of the interested/affected public (DNV 2013c).

### 4.2 GeoWeb Hazards Database

Among other recommendations contained in the 2008 Coroner's report on the Berkley landslide fatality, the Coroner recommended to the province that a database of landslide hazard and risk information be created and made accessible to the public to facilitate informed decision-making (Province of British Columbia 2008). The DNV's GeoWeb Hazards application, which is publicly accessible through the District's website, visually indicates areas of the District that are susceptible to natural hazards. The application allows users to interactively pan and zoom the map to locations of interest, and to turn "on" and "off" shading showing different types natural hazards affecting a particular area. A separate layer shows areas where hazard and risk assessment reports have been completed by qualified professionals; these reports can be downloaded directly from the GeoWeb site. The maps are continually updated as additional information becomes available (DNV 2013a).

### 4.3 Geotech on Demand Program

The Geotech on Demand Program, funded by the DNV, connects property owners with geotechnical experts for improved understanding of personal landslide risk, and identification of mitigative measures that they can undertake on their own property. When engineering assessments of landslide risk are completed and released to the public through the GeoWeb site, property owners may contact the DNV to request further explanation of the findings. The Geotech on Demand Program enables a DNV staff member and geotechnical professional to visit the resident at their property to explain the findings of the assessment. The geotechnical professional can also identify locations on the property that homeowners should monitor for signs of instability, and suggest actions that can be taken to minimize the risk of a landslide occurring. The intent of this service is to build "relationships between property owners, geotechnical professionals, and the DNV; opening lines of communication and reaching a common understanding of hazards and risks" (DNV 2011).

## 5 Discussion

The following discussion presents the case for public involvement in risk decision-making and evaluates the DNV's Natural Hazards task force against current best practices for stakeholder involvement. Consideration is subsequently given to the effectiveness of the District's ongoing public involvement and education efforts for building individual capacity and community resilience.

### 5.1 Case for public involvement in risk decision-making

In the current social context, “tolerable risk” may seem to be an oxymoron. Some authors contend that we are living in a modern society where the public is increasingly aware of and intolerant toward any degree of risk (Holub and Fuchs 2009; Slovic 1999; Kasperson et al. 1988); this “zero-risk” appetite prompted Wildavsky (1990) to decry that “No risk is the highest risk of all.” Indeed, the undertaking of some risk is necessary for individuals and society to learn, grow, progress, and evolve (Jardine et al. 2003). With this in mind, safety cannot be defined as zero risk; there ought to be a sufficiently low level of risk that does not warrant further action or attention and, as such, constitutes safety (Jardine et al. 2003). But how safe is safe enough? Jardine et al. (2003) confirm that “risk tolerance is a complex concept that often transcends scientific and technical arguments.” Democratic governments are thus faced with the dilemma of providing evidence-based policy decisions on the one hand, while also seeking to incorporate the richness of the social understanding of risk which is typically omitted from “expert” assessments (Kasperson et al. 1988; Slovic 1987). The mandate of the DNV's community task force to deliver “an informed, broad-based community perspective regarding quantitative tolerable risk” was indeed a challenging task (Dercole 2009).

While public involvement in risk decision-making is generally viewed to be an essential element of democratic society (Gauvin and Abelson 2006), McDaniels et al. (1999) found that some parties still question the public's ability to tackle complex decisions involving technical uncertainties and value trade-offs. Moreover, the perception persists that public participation may be unproductive, time consuming and costly, delaying the decision process, over-emphasizing the interests of the active publics, and usurping the role of elected officials (Dorcey and McDaniels 1999). Despite the objective challenges of involving the public in risk decision-making, the influential U.S. National Research Council (1996) publication asserts that risk characterization ought to be viewed as an analytic deliberative process involving all interested and affected parties. Within this framework, analysis employs rigorous, replicable scientific methods to arrive at answers to factual questions, whereas deliberation involves such processes as “discussion, reflection and persuasion to communicate, raise and collectively consider issues, increase understanding, and arrive at substantive decisions” (USNRC 1996). In this manner, the technical and social understandings of risk coexist in a recursive process, whereby deliberation frames analysis, and analysis informs deliberation (USNRC 1996).

Acknowledging the importance of incorporating public perspectives in the management of risk, Leiss (2001) asserts that the resources devoted to the social management of risk should be equal to those employed in the technical assessment of risk. Renn (2008) affirms public involvement as a necessary, although insufficient, prerequisite for tackling risks in a sustainable and acceptable manner. He further expounds upon the concept of inclusive risk governance, which acknowledges that all stakeholders have something to contribute to the risk management process and that the mutual exchange of ideas, assessments, and

evaluations ultimately *improves* the final decisions, rather than impeding the decision-making process or compromising the quality of scientific input or the legitimacy of legal requirements (Renn 2008, emphasis added). Beierle's (2002) systematic review of stakeholder involvement in environmental decision-making confirms that stakeholder participation improves the quality of final decisions compared to the status quo. Moreover, Wachinger et al. (2013) contend that "public participation measures are probably the most effective means to ...encourage citizens to take more personal responsibility for protection and disaster preparedness." In this light, the public involvement efforts spearheaded by the DNV's Natural Hazards task force serve both the democratic purpose of gathering a community perspective on risk tolerance and also foster individual capacity by virtue of engaging community members in the discussion of risks that affect them. That is, public involvement in this context functions not only to legitimize the risk-tolerance decisions but also to empower those affected by them.

## 5.2 Evaluating the Natural Hazards task force

Based on the preceding discussion, there are strong arguments for involving the public in risk decision-making, whether as an essential element of the democratic process, as a means for improving the overall decision quality, or to foster a more empowered citizenry. This being said, what constitutes "good" public involvement? The following four criteria represent oft-cited factors for participatory success, which can be used to evaluate the DNV's Natural Hazards task force approach:

- Representative participation;
- Early and appropriately intensive stakeholder involvement;
- Participants are provided with accessible, transparent information;
- Participants impact the final decision.

### 5.2.1 *Representative participation*

Many authors (Gauvin and Abelson 2006; Jardine 2008a; USNRC 1996) stress the importance of "getting the right participation" (USNRC 1996); that is, ensuring a sufficiently broad perspective enters into the decision-making process through engagement of all interested and affected parties. The DNV's Natural Hazards task force was comprised of eight volunteer District residents (six men and two women), with backgrounds in related fields including engineering, geology, emergency preparedness, outdoor education, and ocean transportation (DNV 2013b). Though the task force does consist of members of the community actually affected by the natural hazard risks, there is an obvious underrepresentation of women on the committee compared to the number of men. Many authors have commented on the role of gender in affecting risk perception, with women and visible minorities generally less risk-tolerant compared with white males (Boholm 1998). In addition, the backgrounds of the task force members reflect primarily technical educations, with no less than four engineers and one engineering geologist represented (DNV 2013b; NHTF 2008). Beierle (2002) notes that more intensive public involvement processes tend to favor those with more training and experience with the topics at hand, and the Natural Hazards task force members were selected, at least in part, for their technical backgrounds (NHTF 2008; Joyce 2007). While there are doubtless benefits associated with involving "lay experts" in the task force, a more balanced, diverse perspective is desirable from the standpoint of public representation. While the task force may thus be characterized as

masculine and technocentric, additional participatory activities, including two public meetings and a public survey, were undertaken to elicit the views of the broader District population (as discussed in Sects. 2.3, 2.4) and these may have served to offset this bias to some degree.

### 5.2.2 *Early and appropriately intensive stakeholder involvement*

Early stakeholder involvement is advocated by many authors as key to successful participation (Chess and Purcell 1999; Gauvin and Abelson 2006; Jardine 2008a; Petts 2004); moreover, Beierle (2002) reports that more intensive stakeholder involvement processes are more likely to produce high quality decisions compared to traditional public participation methods. The DNV is to be commended in this regard, by convening the Natural Hazards task force at the outset of the process for determining tolerable risk criteria, and for enacting the more intensive task force method, enabling in-depth consideration of the issues at hand, with the degree of intensity appropriate to the nature, complexity, and extent of the risk issue and decision (USPCC 1997).

Notwithstanding, Petts (2004) emphasizes the importance of involving stakeholders at the problem formulation stage, such that the nature of the risks and the assessment required is determined *through* discussion with the public, not in *advance* of it. In this setting, public perspectives may serve to define or reframe what the problems or issues actually are, as well as identify appropriate solutions (Petts 2004). Horlick-Jones (1998) confirms that the initial framing of the issue is of critical importance and should include a wider range of understandings than merely that of the expert. Slovic (1999) observed that “Whoever controls the definition of risk controls the rational solution to the problem at hand.” The DNV’s Natural Hazards task force was given a very specific mandate, in being asked to recommend quantitative criteria for tolerable risk levels. The specificity of this mandate serves to frame the issue in a technocentric way, asking the task force to simply deliver a numerical solution to the problem, rather than investigate the underlying issues and various potential avenues which may exist for addressing them. The problem framing was likely driven by the pragmatic desire to arrive at an answer that the District could readily implement into existing development approval policies. In this light, it is not particularly surprising that the task force’s recommendations were very similar, if not identical, to the interim risk tolerance criterion adopted by the District, and to policies already enacted in other international jurisdictions. While the DNV’s public involvement process lends legitimacy to the final risk-tolerance criteria, the initial framing of the problem could have benefitted from the incorporation of a wider range of knowledge, such as experiential knowledge, local knowledge, folklore wisdom, and common sense (Jardine 2008b; Renn 2008).

In addition, the DNV’s framing of the fatal Berkley landslide as a natural hazard may have been somewhat misleading, obscuring the critical role of anthropogenic factors in contributing to the landslide. Popescu (1994) underscores that all landslides are caused by a combination of preparatory and triggering factors. Preparatory factors make the slope increasingly susceptible to failure without actually initiating it, while triggering factors are those which initiate movement. In the case of the Berkley landslide, the heavy rainfall which preceded the fatal slope failure may be considered the triggering factor, and such storm events are indeed a natural occurrence (BGC 2006a). However, the preparatory factors for the landslide included not only the naturally steep slopes which characterize the District escarpments, but anthropogenic influences such as the indiscriminant placement of fill soils along the escarpment crest, deterioration of upslope retaining walls and discharge

of surface runoff over the crest of the slope (BGC 2006a). On June 21, 2005, a statement of claim was filed on behalf of Michael Kuttner, his daughter Amita and the Estate of Eliza Kuttner against the District of North Vancouver and the current and previous owners of the upslope property where the landslide initiated (Statement of Claim 2005). The claim contended that in addition to other anthropogenic preparatory factors, the placement of excessive loads on a concrete retaining wall at the westerly edge of the upslope property resulted in its failure and triggering of the fatal landslide. The Kuttner claim squarely blamed the actions (and inactions) of the District and the upslope property owners for the fatal Berkley slide—characterizing it not as a natural hazard at all, but rather as an anthropogenic one. The claim was settled out of court in January of 2009 for an undisclosed amount (North Shore News 2009)<sup>4</sup>.

The World Bank/United Nations (2010) report on natural disasters and prevention confirms that “several factors usually contribute to any disaster, some less obvious than others... A deeper questioning of what happened, and why, could prevent a repetition of disasters.” Had the Natural Hazards task force been admitted into the initial problem formulation stage and allowed to consider the role of anthropogenic factors in contributing to the Berkley landslide, they might have arrived at a very different recommendation for addressing the underlying issues related to past development practices and ongoing modifications of upslope properties. While original development of the residential areas in question occurred under a different municipal administration decades before the Berkley landslide, there are still lessons to be learned regarding the long-term social and financial costs of permitting short-sighted growth and “value-free” development (Logan and Molotch 1987).

### 5.2.3 Participants are provided with accessible, transparent information

A third criterion cited by several authors (Bierle 2002; Gauvin and Abelson 2006; Jardine et al. 2003) for successful stakeholder participation is the provision of accessible, transparent information from the sponsoring agency to the participants. Jardine et al. (2003) emphasize the importance of “full and honest disclosure of all the information required for informed decisions.” It appears that the DNV’s Natural Hazards task force had access to a relatively well-rounded set of information. The task force received not only scientific/expert opinion on relevant subjects (through participation in education sessions), but also had access to public opinion (through public meetings and an online survey) and obtained information related to risk-tolerance criteria enacted in other international jurisdictions. Renn (2008) underscores the importance of involving four spheres of actors in what he characterizes as “inclusive risk governance:” experts, politics, civil society, and the economic system. The approach taken by the Natural Hazards task force to seek out opinion from experts, the public and other political jurisdictions is reminiscent of Renn’s (2008) holistic method. While the economic system was not explicitly consulted in the task force’s process, economic considerations were implicit in the need to define quantitative risk-tolerance criteria for prioritizing mitigative works.

The information obtained through the public survey should be viewed with some caution, however, as only 90 responses were collected, amounting to approximately 0.1 % of the District population. Moreover, the survey compared the risk of death from a natural hazard to the average person’s risk of mortality in an automobile accident or by poisoning. These comparisons, while perhaps designed to contextualize the quantitative risk-tolerance

<sup>4</sup> It is worth noting that home insurance in Canada generally does not cover damage from landslides or other earth movements (IBC 2012).

criteria, subtly obfuscate the issue by equating risks over which people presumably have some control with risks which are essentially involuntary.

#### 5.2.4 *Participants impact the final decision*

Finally, the impact which a public involvement process has on the final risk decision may be viewed as a measure of its success (Gauvin and Abelson 2006; Jardine 2008a; Lynn and Busenberg 1995). Agency implementation of stakeholder recommendations may serve to legitimize the participatory process in the eyes of the public, whereas involving stakeholders when the decision has already been made is not only unethical, but breeds frustration and distrust (Jardine 2008a). As Jardine (2008a) cautions, “Agencies should only involve stakeholders in the process if they are willing and able to respond to stakeholder input in making the final risk decisions.” In this sense, both parties should be given joint rights and responsibilities in the decision-making process for public participation to be meaningful.

The DNV’s Natural Hazards task force was successful in seeing their recommendations implemented in the final policy decision. The task force’s recommended risk-tolerance criteria were endorsed by the District Council on November 16, 2009, enacting a policy which gives the Chief Building Official the discretion to apply the risk-tolerance criteria to building permits, subdivision and development applications for sites exposed to landslide and debris flow hazards (DNV 2013a). This is not a particularly surprising outcome given the specific initial framing of the task force’s mandate, to recommend to Council “quantitative tolerable risk” criteria (Dercole 2009), which by nature would be amenable to implementation within existing development approval policies. Moreover, one might speculate that the task force’s power to affect policy might be partially due to the socio-economic standing of the DNV residents, having the highest median household income of Metro Vancouver in 2005 (DNV 2006c). Notwithstanding, within the public involvement arena where examples exist of participatory processes which have been undertaken solely for the purpose of fulfilling legal requirements or to serve as vehicles for persuasion, the District’s endorsement of the task force’s recommendations is still a significant and encouraging outcome (Lynn and Busenberg 1995).

District Council’s report approving the risk-tolerance criteria concludes with the commitment to continually revisit the criteria and make adjustments, as required, to meet the future needs of the community. This commitment to ongoing dialog with the public, coupled with the flexibility and adaptability embodied in ongoing evaluation of the risk-tolerance criteria, underscores the importance of shaping the criteria to the local context. Jardine et al. (2003) confirm that “As risk acceptance and the judgment on hazardous activities is a highly contextual topic, the use of acceptance criteria strongly depends on country, on time, on activity, on risks and related benefits.” The DNV’s commitment to ongoing re-evaluation of the legislated risk-tolerance criteria within the social context represents an enlightened approach to the management of natural hazards. Perrow (1984) agrees that living with risk means “keeping the controversies alive, listening to the public, and recognizing the essentially political nature of risk assessment.” The DNV’s commitment to ongoing public involvement may also serve as the basis for increasing individual capacity and community resilience, as discussed in the following section.

### 5.3 Building individual capacity and community resilience

Social resilience may be characterized as the collective ability to adapt to disruptions in a dynamic environment (Brunner and Giroux 2009). Recognizing that not all disasters can be

predicted, nor avoided, the resilience paradigm emphasizes the role of individuals and communities in preparing for and responding to emergency situations (Brunner and Giroux 2009). Rooted in the work of ecologist C.S. Holling (1979), the notion of resilience acknowledges the existence of multiple dynamic states of equilibrium, wherein adaptation, learning, and self-organization play important roles (Frommer 2013). Maguire and Hagan (2007) described social resilience as a group or community's capacity to "bounce back" or respond positively to adversity. While Wildavsky (1988) draws a strong distinction between anticipation (attempts to avoid potential hazards) and resilience (ability to cope with hazards that have been realized), he acknowledges that both capacities are needed. Aguirre (2006) takes a broader view of resilience as "*both* the capacity of a system to react appropriately to moments of crises that have not been entirely anticipated, and its ability to anticipate these crises..." (emphasis added).

In the context of natural hazard risk governance, Wachinger et al. (2013) contend that "public participation measures are probably the most effective means to ...encourage citizens to take more personal responsibility for protection and disaster preparedness." Their literature review underscores the importance of the "risk perception paradox," stressing that high risk perception does not necessarily prompt individuals to take appropriate preparedness actions (Wachinger et al. 2013). Wachinger et al. (2013) and many other authors (Siegrist and Gutscher 2006; Njome et al. 2010; Bird et al. 2010; Grothmann and Reusswig 2006) contend that raising risk perception is a necessary, but not sufficient, antecedent for action; rather, individuals should also be provided with the resources and course of action to affect their own situation. Pearce (2013) contends that community participation is a prerequisite to achieving sustainable disaster management strategies that are themselves embedded in the community. Brunner and Giroux (2009) agree that building and maintaining community resilience requires agency commitment "...to engage in constant dialog and feedback with community members," and to provide tools and resources such as educational platforms in order to encourage individual and collective capacity.

The DNV was successful in utilizing the adopted risk-tolerance criteria as a basis for requiring structural mitigation measures on private properties, employing a mixture of policy instruments including information, financial incentives, in-kind support, and authority, as described in Sect. 3. Holub and Fuchs (2009) suggest that risk mitigation measures can be classified according to their ability to raise individual awareness and facilitate proactive behavior and financial investment on the part of affected individuals. They also underscore the need for innovative risk sharing approaches to reduce the individual and collective vulnerability to natural hazards. In this light, the DNV's implementation of the required technical mitigation measures conveys a well-rounded approach. A mixture of publicly funded capital projects, such as land acquisitions and storm sewer upgrading, were combined with mitigation requirements for private properties, such as storm water connections and fill removal. Moreover, the District provided financial incentives and in-kind support to alleviate the financial burden for those homeowners required to undertake remedial work on their properties. The District's commitment to open, transparent dissemination of risk information, and commitment to involve the public in a meaningful dialog on tolerable levels of risk, no doubt aided in public acceptance and support of the process.

The District of North Vancouver did not overlook the importance of supplementing technical mitigation measures with non-technical undertakings. As noted previously, the District has committed to "ongoing discussion with stakeholders" in its policy document regarding risk-tolerance criteria (Dercole 2009). To this end, the DNV has implemented



several platforms for ongoing public education and dialog with stakeholders, including the Guide to Living Near Steep Slopes, the GeoWeb Hazards Database, and the Geotech on Demand Program described in Sect. 4. These platforms serve the important function of facilitating ongoing public education with respect to landslide hazards and risk, but they commendably go a step beyond simple one-way communication of generalized information. In particular, the GeoWeb application allows users to interact with hazard maps and risk estimates in a way that personalizes the information, allowing people to visualize the risks that apply specifically to their own property or area of concern. Holub and Fuchs (2009) underscore the vital role of effective dissemination of target-oriented risk information as an essential prerequisite for risk awareness and disaster-resilient communities. Roth (2012) affirms that visual forms of risk communication are often easier for both experts and lay people to understand, and are especially useful in communicating multi-dimensional risk information, such as the risks posed by multiple natural hazards present in the District of North Vancouver. Holub and Fuchs (2009) note that there is a deficit of information in the literature concerning the use and design of risk maps for decision-making and communication with the public. In this respect, the DNV's Landslide Management Strategy forms an important contribution to the field of risk communication and governance concerning natural hazards.

The DNV's Geotech on Demand Program serves to facilitate ongoing dialog between the public, the agency, and the experts in an accessible and understandable way. The program allows concerned residents to meet with District staff and a geotechnical expert on their own property, to discuss issues of concern and receive expert advice tailored to their individual situation. Jardine et al. (2003) emphasize that effective participation requires not only "accessible and understandable information, ... but also an accessible and open environment for participation." The District's commitment to meet with the homeowner face-to-face, on their own property, not only increases the accessibility of the information but also provides a nonthreatening environment for participation and mutual understanding. Having an expert on hand to explain the geotechnical issues and provide personalized advice serves to increase understanding of the risk information and allows homeowners access to expert advice that they might not otherwise have the resources to acquire.

Platforms such as these that emphasize ongoing, personalized, accessible, two-way communication between the public, agency and experts reflect a progressive view of risk management as a "continuous dynamic process" (Jardine et al. 2003), which promises to increase individual capacity and overall community resilience.

## 6 Conclusions and recommendations

The District of North Vancouver's Landslide Management Strategy demonstrates the value of meaningful public involvement for arriving at risk-tolerance criteria and fostering individual capacity and community resilience. The District has received international recognition for their Natural Hazards Management Program, of which the Landslide Management Strategy forms an important part. In 2011, the District received the United Nations Sasakawa Award for Disaster Risk Reduction, and in 2012, when the United Nations published the handbook entitled "How to Make Cities More Resilient", the DNV was recognized as an example of innovation and community engagement (DNV 2013a; UNISDR 2012).

The preceding discussion illustrates the importance of the DNV's public involvement efforts for developing risk-tolerance criteria that would be acceptable to those affected and

for promoting ongoing dialog between residents, District staff, and geotechnical experts to facilitate informed decision-making and personal agency. The District's use of a community-based Natural Hazards task force was evaluated using four criteria for successful public involvement: representative participation; early involvement; information availability; and impact on policy. The evaluation identified that the District could have sought to engage a more representative portion of the population to serve on the Natural Hazards task force, with the aim of incorporating a broader set of public values and types of knowledge. The participatory process might also have benefitted from allowing public perspectives to influence the initial framing of the risk issue before charging the task force to arrive at quantitative risk-tolerance criteria. In characterizing potential landslides as strictly *natural* hazards, the District may have obscured the critical importance of anthropogenic influences in contributing to the risk of a landslide along the DNV escarpments. Notwithstanding, the Natural Hazards task force successfully utilized social, legal, and scientific information for informed decision-making, and their recommended risk-tolerance criteria were enacted into policy by the District of North Vancouver as a result of the process. While the quantitative risk-tolerance criteria recommended by the task force were in keeping with the status quo (i.e., similar to the DNV's interim criterion and those enacted in other international jurisdictions), the public involvement process used to generate the criteria no doubt contributed to the legitimacy and public acceptance of the outcome.

Looking toward the future, the District of North Vancouver might consider further decentralization of landslide risk management and disaster preparedness, in favor of fostering community resilience; this paradigm is premised on creating the necessary framework for action while encouraging community resilience to emerge and develop locally over time. Proponents of social resilience emphasize a move away from a centralized, command-and-control style of crisis management toward a decentralized, holistic, participatory approach which utilizes and builds upon existing social networks and community resources (Lorenz 2013; Maguire and Hagan 2007; Aguirre 2006; Wildavsky 1988). For example, Pearce (2013) describes the Home Emergency Response Organization System (HEROS) enacted in Coquitlam, British Columbia, which entails recruiting community leaders and volunteers to (1) identify equipment (e.g., chainsaws) and skills (e.g., nursing) within the community that could be utilized during and after a disaster; (2) to develop a list of special-needs situations (e.g., elderly people living alone); and (3) to arrange for local stockpiling of medical supplies, food and water, with the local government providing basic emergency training and financial assistance. In advocating the critical role that citizens and communities play in addressing a complex risk landscape, Edwards (2009) argues for agency actions that not only empower, but also actively *encourage* individuals and communities to play a role in disaster preparedness. Such encouragement could include, for example, monetary grants to DNV community associations for landslide risk education and emergency preparedness planning at the local level. The World Bank/United Nations (2010) report on natural disasters urges institutions to permit public oversight of disaster preparedness and encourage communities to “experiment with, and devise, their own sustainable arrangements that promote prevention.”

Overall, the District of North Vancouver is to be commended for engaging the public in a meaningful dialog on landslide risks, not only through the Natural Hazards task force, but also through the ongoing communication and education efforts contained within their Landslide Management Strategy. The District has demonstrated a progressive approach to landslide risk management, involving ongoing dialog with stakeholders, innovative implementation of technical mitigation measures and public programs designed to

empower citizens to know their level of risk and to take mitigative actions. Overall, the District's ongoing, dynamic approach to landslide risk management remains a "courageous" political act (Leroi et al. 2005), which promises to empower individuals and foster resilient communities in the aftermath of the tragic Berkley landslide.

## 7 Limitations and future research

The information contained in this manuscript, and hence the conclusions drawn from it, are based on publicly available material regarding the District of North Vancouver's Landslide Management Strategy and the associated public involvement efforts. The author did not have any personal or professional involvement with the strategy nor the participatory process, and as such, the conclusions and recommendations made are based on the information available. The views expressed are the author's own and do not necessarily represent the opinions of the District of North Vancouver or its agents. With respect to future research on the matter, it would be interesting to follow up with the eight members of the Natural Hazards task force, to gain insights into their personal experiences with the participatory process. It would also be informative to contact residents of the District to gain a better sense of their degree of acceptance of the risk-tolerance criteria and their level of understanding/awareness of the DNV's ongoing public involvement efforts and their effect on motivating personal action.

**Acknowledgments** Dr. D.M. Cruden, Dr. C.G. Jardine, Dr. C.D. Martin, and Dr. N.R. Morgenstern are thanked for their thoughtful comments and encouragement during the drafting of this manuscript; two anonymous referees also provided constructive input. Funding for this research was provided by the Natural Sciences and Engineering Research Council of Canada (NSERC), Alberta Innovates Technology Futures, and the University of Alberta.

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