Surveying Perception of Landslide Risk Management Performance, a Case Study in Norway

Jessica Chiu and Unni Eidsvig

Abstract

The effectiveness of landslide risk management should be assessed to optimize the implementation of landslide risk mitigation measures. The Risk Management Index (RMI) of Cardona et al. (Disaster risk and risk management benchmarking: a methodology based on indicators at national level. IDB/IDEA Program on Indicators for Disaster Risk Management, Universidad Nacional de Colombia, Manizales, p 101, 2004) provides useful procedures to holistically measure perceptions of risk management for natural hazards from selected actors. This paper uses Norway as a case study to present a modified RMI for surveying perceptions of landslide risk management at two time scenarios: 2015 (present) and 2050 (future), and for various administrative levels: national, county, and municipality. All survey respondents are practitioners in landslide risk management in Norway. The survey results are able to reflect some viewpoints of these experts on landslide risk management in Norway. Factors considered for assessing the future performance of landslide risk management by respondents are also studied to understand how respondents project their expectations. This paper also demonstrates how areas of improvement in landslide risk management in Norway can be identified based on the survey results. Due to limited responses, limited knowledge of respondents and the subjective nature of perceptions, the survey results are associated with uncertainties and should thus be used with care. Upon simplification of technical terms, the survey can be applied to survey public perceptions. The survey can also be regarded as a starting point for developing a common language/terminology for landslide risk management in Norway. This research activity has been funded by the Norwegian Centre of Innovation Klima 2050 (www.klima2050.no).

Keywords

Landslide risk management • Opinion survey • Landslide risk management index

Introduction

Effective management of landslide risk ensures that mitigation measures are optimally implemented. Therefore, it is important to assess the effectiveness of landslide risk management in order to identify areas for improvement and to prioritise future work plans for landslide risk reduction.

One of the ways to assess the performance of landslide risk management is to collect opinions and perceptions. The Risk Management Index (RMI) of Cardona et al. (2004) is a well-established method to holistically measure perceptions of risk management for natural hazards from selected actors. The RMI method involves an opinion survey to practitioners, such as technical staff, decision-makers, and stakeholders, in any stages of landslide risk management. It considers both structural and non-structural landslide risk

J. Chiu (✉) · U. Eidsvig
Norwegian Geotechnical Institute, Sognsveien 72,
0855 Oslo, Norway
e-mail: kyc@ngi.no

U. Eidsvig
e-mail: uke@ngi.no

mitigation strategies, the latter including monitoring and warning systems, disaster management, and risk transfer.

Based on the RMI method of Cardona et al. (2004), a survey to local practitioners in landslide risk reduction in Norway was conducted between mid-September and late October 2015. The survey was modified to fit with Norwegian conditions. It aimed at measuring the performance of landslide risk management in Norway perceived for 2015 (present) and for 2050 (future) at national, county, and municipality levels. Measurement based on different administrative levels enables comparisons among different spatial scales, whereas measurement based on present and future time scenarios allows one to project future expectations.

Background

The RMI method was first proposed by Cardona et al. (2004). It was later modified and applied periodically to measure performance of risk management of natural disasters in countries in Latin America and the Caribbean (Cardona et al. 2005; Carreño et al. 2007; Cãrdona and Carreño 2011).

Chiu (2015) implemented the RMI method to study the perceptions on landslide risk management at county and national levels in Norway for 2004, 2014 and 2024. A total of nine responses were received from both public and private Norwegian institutes which are involved in landslide risk management in the country. The present survey simplify the questionnaires by Chiu (2015) to increase survey responses and reliability of the survey results. Useful survey data from Chiu (2015) (data for 2014) were also collaborated to the new data from the present survey.

Methodology

The RMI

The RMI measured in the present survey consists of four public policies, which are represented by policy indices, namely Risk Identification index (RMI_{RI}), Risk Reduction index (RMI_{RR}), Disaster Management index (RMI_{DM}), and Governance and Financial Protection index (RMI_{FP}). Each policy index comprises of three to six indicators. Figure 1 shows the structure of the RMI and Table 1 gives a brief description of each public policy.

Procedures of how the RMI is obtained are schematically presented in Fig. 2. Each policy index is quantified by an aggregation of the weighed values of its indicators. The weighed values are calculated from performance levels and
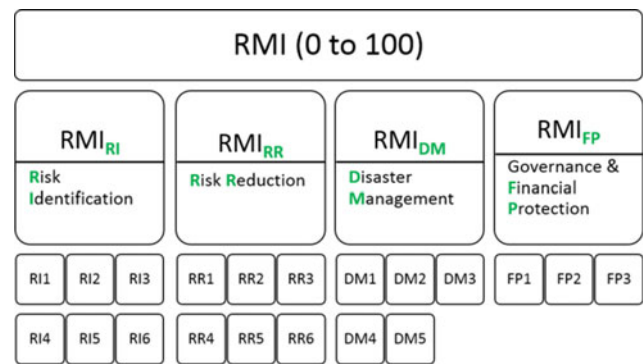

Fig. 1 Structure of the RMI (adopted from Chiu and Eidsvig 2016). Title of indicators is provided in Fig. 3

relative weights, which are collected by separated questionnaires. The title of each indicator is provided in the vertical axis of Fig. 3.

Five management performance levels are designated, corresponding to linguistic expressions from 'low', to 'optimal' or numerically from 1 to 5, respectively. Each performance level has its benchmark criteria. The criteria were modified from Cardona et al. (2005) and Lahidji (2009) to become representative for landslide hazards in Norway. Based on a brief scope of indicators and detailed benchmarking criteria, survey participants have to assign a performance level for each indicator, but they can also select 'not relevant' or 'not able to answer' if appropriate. Each management performance level represents a membership function of a fuzzy set (Fig. 2a). A fuzzy set gives flexibility to modelling of linguistic or qualitative expressions.

Relative importance of each indicator within a public policy is allocated using the Analytic Hierarchy Process (AHP). AHP decomposes a decision-making problem into hierarchy to enable evaluation of a problem based on both qualitative and quantitative aspects. Via AHP, indicators in a public policy are compared pairwise by two steps: (1) 'Which is more important?' and (2) 'In which degree? Rate from 1 to 9.' A degree of 1 represents equal importance between two indicators, whereas a degree of 9 represents that one is 9 times more important than the other one. Results of each comparison can be tabulated into a comparison matrix (see example in Fig. 2), from which relative weights are calculated using an eigenvector technique, with consistency checked against the consistency ratio after Saaty (1987) and Carreño et al. (2007). The standardised relative weights determined by AHP for each indicator give the height to the membership function of each fuzzy set (Fig. 2b). The policy index is then calculated as the centroid of area of the fuzzy set (Fig. 2b).

Table 1 Public policies in RMI (adopted from Cardona et al. 2005; Carreño et al. 2007; Chiu and Eidsvig 2016)

Public policy	Policy index	Description
Risk identification (RI)	RMI_{RI}	Individual and social risk awareness of landslide hazards; methodological approaches in landslide hazard assessment
Risk reduction (RR)	RMI_{RR}	Prevention and mitigation measures against landslides
Disaster management (DM)	RMI_{DM}	Response and recovery following a disaster
Governance and financial protection (loss transfer) (FP)	RMI_{FP}	Allocation and use of financial resources for dealing with disaster

The RMI is defined as the mean of the four public policy indices. Each policy index, as well as the RMI, can vary from 0 to 100. The lowest and highest values correspond to the poorest and best performance respectively.

The Survey

Target participants were invited from organisations that are involved in any stages/disciplines of landslide risk management in Norway, including government agencies, local authorities, consultants, contractors, research institutes as well as academic bodies.

The performance levels are assessed in terms of two time scenarios (2015 and 2050) and three administrative levels (national, county, and municipality). All participants were invited to rate the performance level but only those whose work or expertise is related to the public policy were invited to assign relative weights for the indicators in the policy.

Information about participants' technical background was also surveyed. In addition, participants were asked to explain the predominant factor(s) that influence(s) their performance rating for 2050. These factors include anthropogenic activities, climate, demography, knowledge and technology, socio-economy, risk perception, as well as other possible factors provided by the participants.

Results

Background of Respondents

Twenty eight (61% of all invitees) responses were received. Seventy percent of the respondents work in the public sector, among which the majority works in municipalities and counties. Around 20% works in research institute and universities. In addition, around 10% works in the private sector, including manufacturer, consultant, financial and insurance companies. In addition, more respondents work in landslide risk assessment and public information and community participation (17–30%) than other disciplines such as

emergency response, physical mitigation measures, research, insurance, legislation, and finance ($\leq 10\%$).

RMI Results

Figure 3 presents the medians of performance levels and average AHP weights of different indicators. These numbers are used to calculate the policy indices and RMI and the results are presented in Fig. 4.

Policy indices at any administrative level in 2015 and 2050 range from 17 to 45 and 37 to 77 respectively (Fig. 4). The most popular factors considered for projecting the 2050 performance include advanced knowledge and technology, climate change that leads to increased landslide hazards, increased risk awareness, expanded development, and adequate mitigation measures and planning.

Policy indices as well as RMIs are higher for national level than sub-national levels. RMI_{RI} at national level is the highest among all policy indices in both years, especially in 2050. RMI_{RR} and RMI_{DM} are similar at any administrative level. RMI_{FP} is the lowest among all policy indices in both years, but this public policy is perceived to improve the most (more than 100% increment in RMI_{FP} from 2015 to 2050).

Discussion

The higher RMIs at national than sub-national level, as obtained in this study, may be related to individuals' assumption that other municipalities/countries have better performance so the country as a whole should be better. This may also reflect that respondents have higher expectations for local levels than the national level.

High national RMI_{RI} for 2050 may indicate a much higher expectation on risk awareness and landslide hazard assessment overall in Norway in the future.

Within RR and DM public policies, indicators related to upgrading, retrofitting, and reconstruction of assets (RR4,
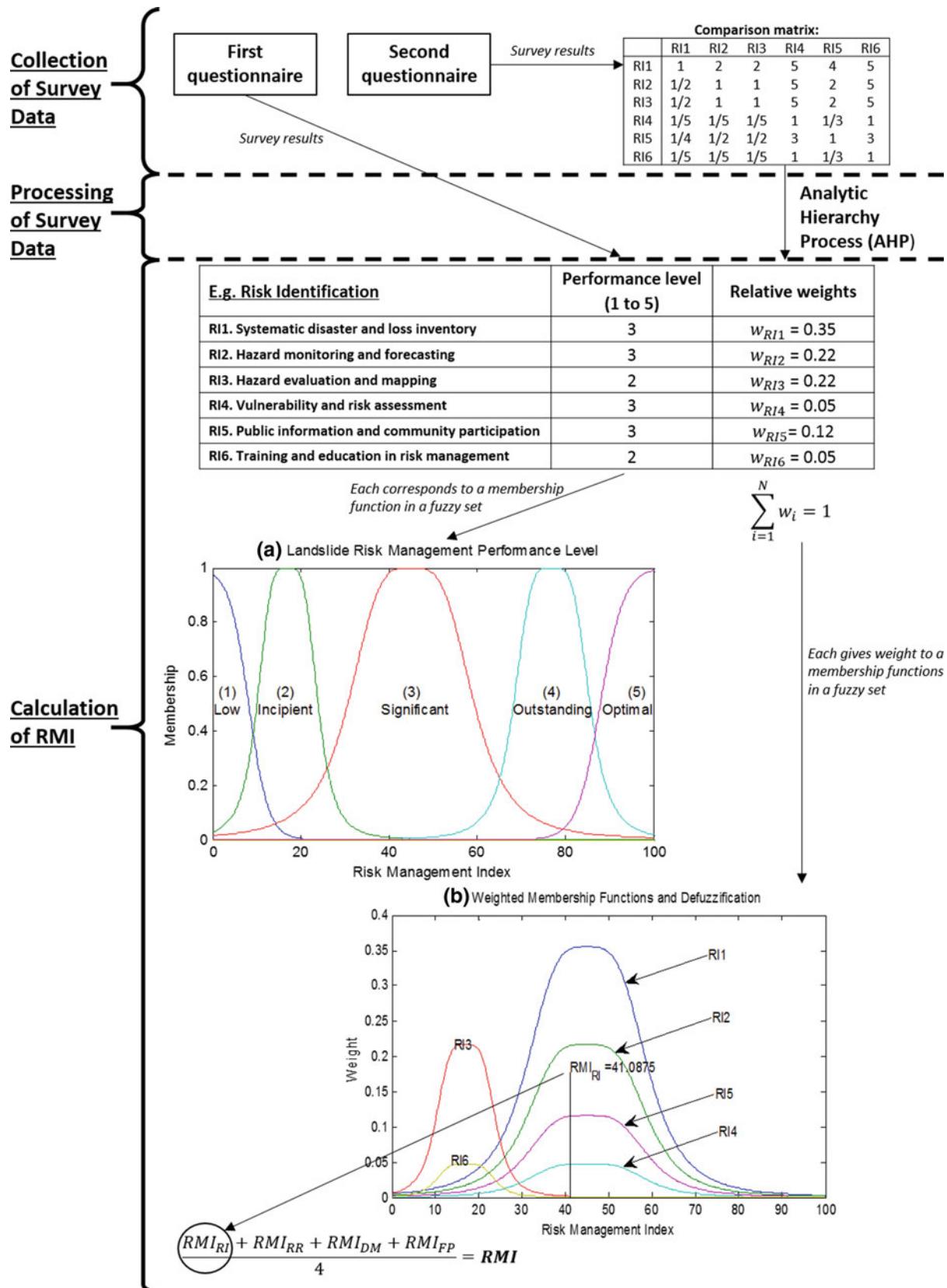
Fig. 2 Procedures for obtaining a policy index (e.g. RMI$_{RI}$) and RMI (adopted from Chiu and Eidsvig 2016; modified from Chiu 2015)
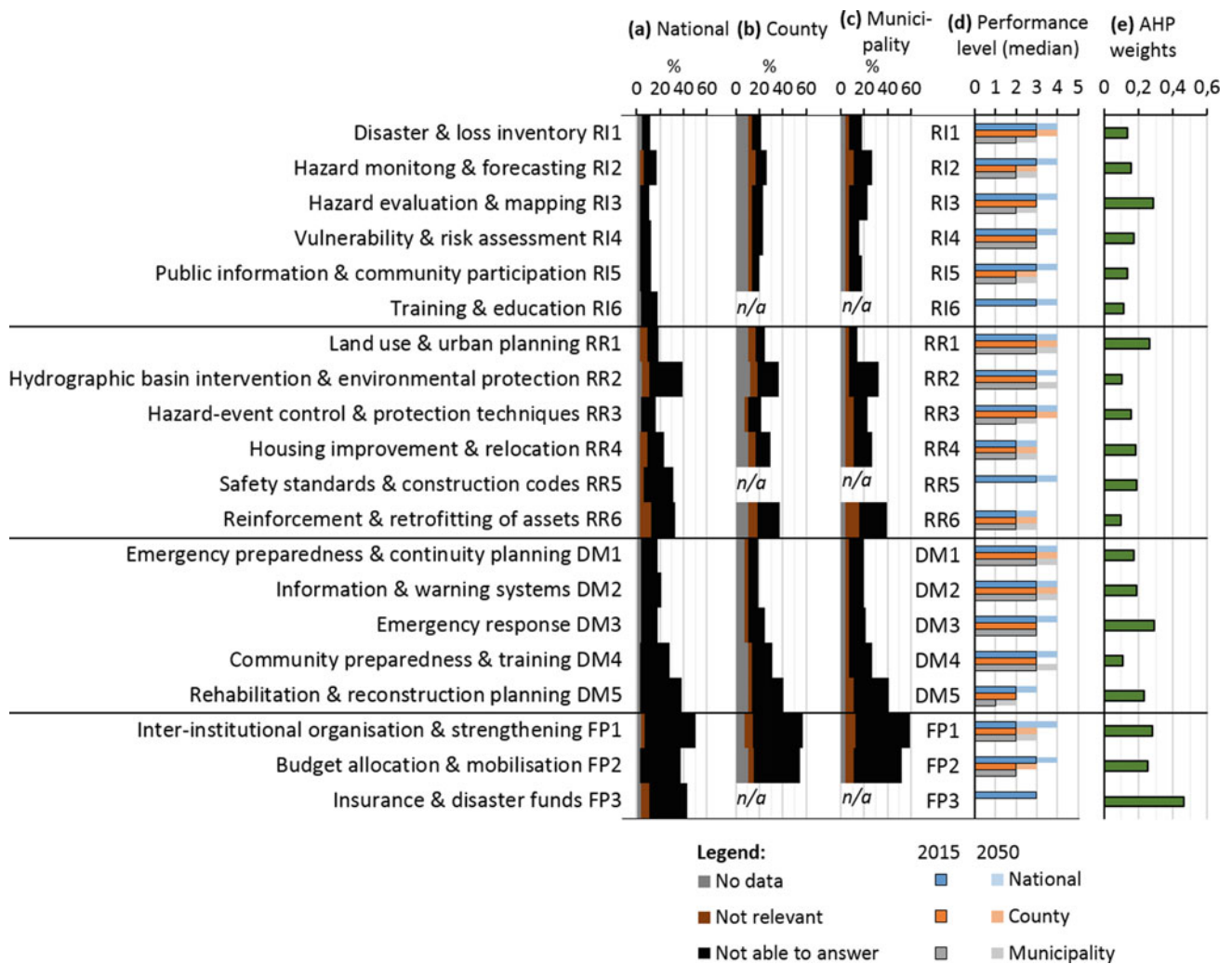
Fig. 3 Survey results—performance levels and relative weights (adopted from Chiu and Eidsvig 2016)
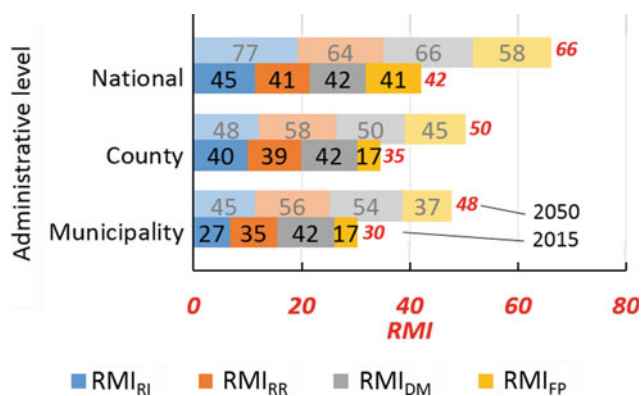

Fig. 4 Results of policy indices and RMI (adopted from Chiu and Eidsvig 2016)

RR6, and DM5) have the poorest performance in both years but also most answers for 'not relevant' or 'not able to answer'. This may reveal that these indicators are unfamiliar to many respondents or irrelevant/inapplicable in Norway.

The large increment from 2015 to 2050 obtained for RMI_{FP} may indicate the urge for improvement in today's inter-institutional organisation and allocation of financial resources for tackling landslide risk. However, results for RMI_{FP} have relatively large uncertainty since many respondents chose 'not relevant' or 'not able to answer' for FP indicators (Fig. 3a–c). The large number of non-performance level answers is probably due to limited knowledge in finance/insurance by most respondents.

The survey results also enable identification/prioritisation of direction of improvement by studying both the performance levels and relative weights. Indicators with poor performance but high relative weights may imply the need for more focus on improvement of these indicators. As shown in Fig. 3d, e, three such indicators can be identified: RI3. Hazard evaluation and mapping (relatively poor performance at municipality level), RR4. Housing improvement and relocation from prone-areas, and DM5. Rehabilitation and reconstruction training.

Perception for Future Scenario

Despite most respondents agree that climate change and urban development will likely increase landslide hazards in Norway in the future, a trend of improvement in landslide risk management is perceived. This may imply that respondents also believe that other factors such as knowledge and technology, risk perception and mitigation measures are the key to the adaptation of increasing landslide risk in the future.

Reliability of Survey Results

Degree of understanding of individual indicators, subjective perceptions, as well as the limited number of survey responses limit the reliability of the survey results. Therefore, extra care has to be taken while using the results. Nevertheless, results obtained from the present survey are still able to give examples of viewpoint from local practitioners on landslide risk management in Norway.

Applications

As demonstrated above, the method presented is useful for prioritisation of areas of improvement and decision-making in landslide risk management.

Rød (2013) mentioned that public's perceptions on the usefulness of risk information and risk communication may influence people's willingness to follow evacuation instructions. Since the public is the beneficiary of landslide risk management, their perceptions should also be considered. The current approach can thus be applied to survey public perceptions on landslide risk management in Norway. Perceptions from experts and the public can then be compared to assess if landslide risk communication between experts and the public is effective.

In addition, the survey can be regarded as a starting point to develop a common terminology/language in landslide risk management in Norway to facilitate mutual understandings among people with different backgrounds. In order to achieve this, a survey with simpler terms should be used so that the questions are easier to understand. Practitioners in local authorities, such as municipalities, should be consulted for appropriate terminology.

Conclusion

A method for surveying perceptions of landslide risk management in Norway at various administrative levels and time scenarios is presented. Respondents of the survey are practitioners in any stage of landslide risk reduction in Norway. The survey results reflect some viewpoints by these experts on landslide risk management in Norway in different spatial scales and time scenarios under a holistic framework. The investigation of factors respondents considered for assessing the future performance of landslide risk management also helps to understand how respondents project their expectations.

The survey results indicate that several aspects of landslide risk management in Norway can be improved. For example, landslide hazard evaluation and mapping should be prioritised in Norway. Upgrading and reconstruction of assets may also be included in the landslide risk reduction strategies in Norway. In addition, there should be more focus on inter-institutional organisation as well as allocation and use of financial resources for dealing with landslides. However, the survey results are associated with uncertainties and should be used carefully.

This paper also demonstrates how one can identify areas of improvement in landslide risk management in Norway based on the survey results. It is further recommended to expand the present approach by surveying public perceptions so as to compare perceptions between experts and the public. Such comparisons can help to assess the effectiveness of risk communication between experts and the public.

References

Cardona OD, Carreño ML (2011) Updating the indicators of disaster risk and risk management for the Americas. J Integr Disaster Risk Manag 1(1):27–47

Cardona OD, Hurtado JE, Duque G, Moreno A, Chardon AC, Velásquez LS, Prieto SD (2004) Disaster risk and risk management

benchmarking: a methodology based on indicators at national level. IDB/IDEA Program on Indicators for Disaster Risk Management, Universidad Nacional de Colombia, Manizales, p 101

Cardona OD, Hurtado JE, Duque G, Moreno A, Chardon AC, Velásquez LS, Prieto SD (2005) System of indicators for disaster risk management: program for Latin America and the Caribbean: main technical report. IDB/IDEA Program on Indicators for Disaster Risk Management, Universidad Nacional de Colombia, Manizales, p 216

Carreño ML, Cardona OD, Barbat AH (2007) A disaster risk management performance index. Nat Haz 41:1–20

Chiu JKY (2015) Landslide risk management perceptions in territories —comparative case studies of Hong Kong and Norway. MSc thesis, University of Oslo, Oslo, Norway

Chiu JKY, Eidsvig U (2016) Klima 2050 report no. 2 surveying perception of landslide risk management. SINTEF Building and Infrastructure, Trondheim. (ISBN 978-82-536-1509-7), p 75

Lahidji R (2009) Appendix G—measuring the capacity to cope with natural disasters. NGI report 20071600-1 risk assessment and mitigation measures for natural- and conflict-related hazards in Asia-Pacific. Norwegian Geotechnical Institute, Oslo, pp 139–151

Rød SK (2013) Risk communication in relation to an imminent rockslide and tsunami. PhD thesis, Norwegian University of Science and Technology, Trondheim, Norway

Saaty TL (1987) The analytic hierarchy process—what it is and how it is used. Math Model 9:161–176