



## Landslides and Society—A Foreword

Irasema Alcántara-Ayala

### Abstract

This chapter provides a general account of the contributions of the ICL community to the implementation of the Sendai Framework for Disaster Risk Reduction. By addressing the particular thematic issue of “Landslides and Society”, the ICL group is committed to face the big challenge of developing linkages between landslide science and decision making and practice. The chapter introduces all articles contained within this special issue. Some of the contributions of this suite of papers have hinted at additional challenges that need to be further addressed through the establishment of linkages between landslide science and policy making and practice.

### Keywords

Landslides • Society • Science • Disaster risk reduction • Decision making • Practice

### On the Nature of Landslide Hazards

As landslides involve the movement of materials down slope due to gravity, they are controlled by a series of natural factors and physical processes, and therefore can be considered as natural hazards. However, in recent decades the influence of human transformations on the slopes is so vast that nowadays it seems to be rather impossible to find landslides 100% of natural origin. Anthropogenic activities induce a series of constant disturbances on the slopes producing a lack of equilibrium and a higher susceptibility to landsliding that affect all kind of societies (Alcántara-Ayala 2016). Consequently, landslides can be regarded as socio-natural hazards, that is to say, resulted from the interaction between social practices and the environment (Lavell 2003).

Deficient or non-existing territorial planning, urbanization, degradation of the environment, exploitation of resources, deforestation and population growth are some of the main landslide disaster risk drivers that deserve attention and improved strategies for policy making and practice (Alcántara-Ayala et al. 2017).

This chapter brings together a series of manuscripts focused on different international initiatives directed towards the reduction of disaster risk associated with landslides.

The nine papers in this issue reveal different technical and practical perspectives to assess different aspects of landslide disaster risk under various spatio-temporal scenarios. Mapping approaches and results reflect a series of problems related to data availability at various scales, including local, national, regional and global levels, while social analysis are highly complex as landslide disaster risk perception is shaped through experience and is strongly influenced by context. Combining instrumentation, monitoring and awareness has been also depicted as a major strategy for the preservation of World Heritage Sites, although this approach can be with no doubt, applied to Geoparks, Geomorphosites and other relevant sites that require protection.

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I. Alcántara-Ayala (✉)  
National Autonomous University of Mexico (UNAM),  
Institute of Geography, Circuito Exterior,  
Ciudad Universitaria, Coyoacán,  
04510 Mexico City, Mexico  
e-mail: irasema@igg.unam.mx

## Landslides: Space and Time

Understanding landslide disaster risk requires the comprehension of its occurrence through time and space. Under such approach, da Silva Pereira et al. (2017) prepared a large database of landslides that occurred in Portugal from 1865 to 2015. These records were used to analyze the spatio-temporal occurrence of damaging landslides; the frequency and patterns of fatal landslides, in order to further explore the distribution of landslide fatalities in space and time. Likewise, they also identified the most deadly landslide types, the gender tendencies in landslide mortality, and evaluated the individual and societal risk. By analyzing the data, the authors came to the conclusion that in Portugal, the spatial patterns of landslide mortality can be associated with the heterogeneous distribution of landslide controlling factors, changes in the land use and exposure, as well as social vulnerability to landslide hazards.

Landslide mapping is fundamental for hazard and risk assessment. It has to be undertaken at different scales being the national level quite significant for decision making and policy development. Landslide inventory mapping in the fourteen Northern provinces of Vietnam was carried out by Hung and collaborators (2017). Five difficulties were identified in terms of interpretation of aerial photographs and field surveys: (1) lack of availability of multi-date air-photos; (2) the need of human resources with high expertise on interpretation of aerial photographs; (3) field validation in remote sites (4) lack of historical records of small or medium size events; (5) Unavailable means to update field surveys. Recognition of such constrains leads to improvement and also offers the possibility to identify the actual contributions to map landslides in time and space. The most important achievement was the development of the landslide inventory, which includes 10,149 landslides: 50% are of small volume, 33% are moderate, 16% are large, and 0.30% is of very large volume. Based on the inventory, different maps were printed out as well as published on a landslide national WebGIS. Information regarding historical and spatial extent of landslides has been provided to local communities and authorities. The inventory will be used as a basic input for the development of susceptibility and hazard mapping.

Safe and sustainable transport is a major concern for the Federal Ministry of Transport and Digital Infrastructure of Germany. Under such framework, Klose and collaborators (2017) focused on the assessment of the landslide hazard potential for the federal transport system under the influence of climate change. On a Geographical Information System Platform, they combined a landslide susceptibility map with regional climate change projections. The general strategy is based on landslide identification and inventory mapping; landslide hazard mapping; landslide impact and vulnerability assessment; and hazard communication. Specifically, they

investigated three landslide sites situated in west and northwest Germany. Linkages between rainfall, temperature, and landslide activity were analyzed in order to be combined with the available climate projections. Owing to future climate scenarios, results suggest a potential increase in the occurrence of shallow landslides and debris flow activity in the summer, whereas in winter, a raise in landslide and rockfall activity is expected.

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## Preserving Nature and Culture

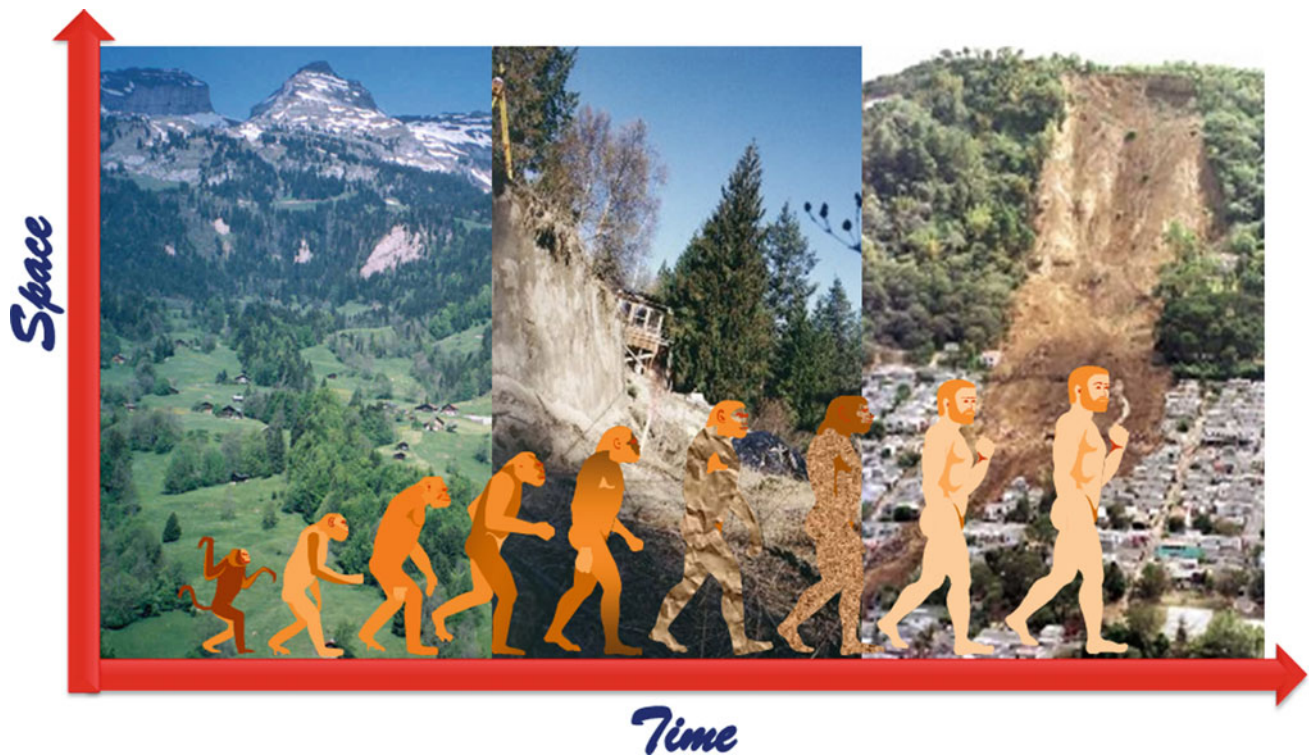
Cesaro et al. (2017) have provided a comprehensive analysis to portray the essential role that risk identification, monitoring and awareness can play to address the challenges faced by The Petra Archaeological Park, a World Heritage Site established since 1985. In addition to the reconstruction of geomorphological dynamics and monitoring of active slope processes, particular attention is paid to the potential contribution of stakeholders and local communities in terms of managing a geo-archaeological site, as a significant endeavor for disaster risk reduction. Specific goals included the implementation of landslide risk mitigation measures by promoting capacity building for national authorities and the delineation and accomplishment of a strategy on hazard awareness. Accordingly, public awareness and communication on natural hazards can be regarded as a very useful non-structural technique for the management and mitigation of landslide risk in World Heritage Sites, such as Petra.

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## Landslides, Knowledge, Awareness and Management

From an historical perspective, Wohlers and co-workers (2017) examined the occurrence of landslides in the highway network of the Lower Saxon Uplands, NW Germany. Their investigation aimed at understanding the interactions between landslide risk, and public and private landslide risk awareness. Landslide events were categorized and classified in terms of landslide types, processes, damages, and executed mitigation measures. Results indicated that the increasing frequency and magnitude of landslides have led to the amplification of public landslide risk awareness in last 20 years, which has been expressed through the implementation of structural mitigation measures as local decision makers have invested in expensive long-term stabilization projects, including soil anchoring, rock nailing, and steel-reinforced concrete walls.

Chiu and Eidsvig (2017) measured the perception of landslide risk management by adapting and applying the Risk Management Index (RMI) developed by Cardona et al.



**Fig. 1** Human agency as a main contributor for landslide occurrence

(2004) to local practitioners in landslide risk reduction in Norway. Two time scenarios, 2015 and 2050, and three administrative levels, national, county, and municipality, were included. Results of the investigation suggested the need of improving various aspects of landslide risk management, including the prioritization of landslide hazard evaluation and mapping, improvement and reconstruction of damaged assets, and more importantly, enhancing inter-institutional organization, allocation and use of financial resources for landslide management.

Undoubtedly, landslide susceptibility maps are a cardinal tool for land use planning and civil protection emergency management. However, quite frequently they are neglected as decision making and practice are not always based on scientific contributions. Bad and good experience regarding this issue must serve as a reference for future strategies. In Portugal, for instance, concerns about land use planning and emergency management have induced a series of regulations regarding practice, prevention and risk management, which have been lately promoted through diverse legal instruments. Following this criteria, Oliveira and colleagues (2017) developed a landslide susceptibility map for the Loures municipality, on which, exposed elements and their associated potential risk were also identified and included. Science and decision making linkages have proved to be good enough so that these documents have been included in the Loures Municipal Master Plan, and are currently used by the

Municipal Civil Protection Service to produce estimations of people exposed to landslides.

Landslides occur under different environments and societal conditions. Nonetheless, people's awareness plays a key role in all types of societies as hazard understanding can be regarded as the first step towards prevention and management. To this regard, Piangiamore and Musacchio (2017) addressed the significance of education to merge knowledge and understanding as a requirement for disaster risk reduction. By using a participatory approach—a non structural measure—they presented two study cases from Italy, to document effective dissemination and communication on hydrometeorological hazards by using educational tools and engagement initiatives to raise public awareness and hazard understanding. They developed this strategy particularly by means of engaging students and teachers on a disaster risk reduction attitude for a resilient community.

Last, but undoubtedly not least, Sapač and colleagues (2017) advocate for “More Room for Landslides”, a campaign claiming for more space for control of potential landslides induced by anthropic activities; more space for torrents; more space for water and sediment storages and a reduction on the impact on the stability of slopes, which also means a higher security for societies. By depicting three study cases from Slovenia, the authors illustrate the way improperly designed or maintained forest roads and skid trails have involved a greater landslide exposure and

damage. This situation has been exacerbated particularly in the last 20–30 years, as the number of skid trails and forest roads has increased considerably nationwide.

## Concluding Remarks

The human influence on the landscape during the last decades has provided enough evidence to understand that to a great extent, human agency can be regarded as a main contributor for landslide occurrence (Fig. 1). This suite of papers presented in this chapter. “Landslides and Society” highlights the contribution of the International Consortium on Landslides to the Sendai Framework for Disaster Risk Reduction. Some of the contributions have hinted at additional challenges that need to be further addressed through the establishment of linkages between landslide science and policy making and practice. These challenges include development of integrated and transdisciplinary landslide disaster risk science, landslide capacity building for disaster risk management, enhancing participatory community approaches to guarantee the co-production of risk knowledge, and promoting territorial management, and the establishment of associated legal frameworks.

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