Science and judgment - Landslide risk research in British Columbia – The last 30 years

Oldrich Hungr
Earth and Ocean Sciences, University of British Columbia, Vancouver

ABSTRACT
On October 27, 1981, the wooden trestle bridge crossing M-Creek on the Squamish Highway (B.C. Highway 99) was destroyed by a "flood". In the rain and darkness, several vehicles fell into the open chasm and nine people perished. Two months later, on December 4, 1981, another "flood" damaged the Charles Creek bridge a few km away and another person died. A sense of fear took hold in the media and among ordinary people. Even specialists began to ask: "what is this apparently new natural phenomenon that is suddenly causing such dramatic accidents?

With the B.C. Ministry of Transportation and Highways taking the lead, a systematic program of study was launched. Representatives from the study team travelled to Japan and several European countries to study methods of debris flow protection. By 1983, a summary report by Thurber Engineering provided a description of debris flow along Highway 99, as well as basic, simple and practical methodology for assessment of debris flow hazards (e.g. Hungr et al., 1984, VanDine, 1985). Subsequently, a range of protective structures were designed and built. It was then finally realized that debris flow is a ubiquitous process across B.C. and the new methodology was further expanded and applied in other locations. Today, many of the insights into debris flow science developed in B.C. are studied and used abroad.

In February, 1982, a large boulder detached from the natural cliff above a rock cut at Argillite Cut, also on the Squamish Highway. The subsequent legal proceedings were a catalyst for innovative research into the probabilistic risk posed by rock fall (Bunce et al., 1997). Studies of rock fall mechanics followed and, again, unique new methodologies were developed (e.g. Lan et al., 2007).

Public backlash against poor management of slopes used for timber harvesting culminated during the late 1990's with the controversy regarding the Clayquot region on western Vancouver Island and other areas. The Forest Practices Code, introduced by the NDP government in the 1990's established new standard for hazard assessment, as well as harvesting and road building practices in British Columbia. Although the Code is no longer in force, harvesting practices in B.C. continue to be guided by its principles. As well, of course, extensive body of research regarding landslide hazards on forest slopes remains available to researchers and practitioners alike (see e.g. Fannin et al., 2005).

Due to the Frank and Hope Slides, as well as several unique landslides that occurred in the Garibaldi Volcanic Belt and at Mt. Meager to the north, awareness of the risks posed by major landslides has always been relatively high in British Columbia. Several detailed studies of such major risks have been conducted, which serve as key case histories (e.g. Hardy et al., 1978). At present, the extensive and highly innovative program of slope monitoring at the Frank Slide in Southern Alberta represents the state-of-the-art (e.g. Froese et al., 2005).

Pioneering geomorphological studies of glacier outbursts and related hazards have also been pursued in British Columbia (e.g. Clague and Evans, 2000).

One major aspect of landslide hazard research and practice concerns large hydroelectric dams. B.C. Hydro reservoir landslide hazard studies are on a world class level (e.g. Moore et al., 1997). This work includes all aspects of landslide science and engineering practice, from mapping, detailed site investigations and stability analyses, consequence modeling, risk evaluation, monitoring to the development and design of sophisticated landslide stabilization schemes.

As population of the region increases and development pressures mount, geotechnicians and geoscientists began to realize that, in addition to better technical understanding of landslide processes, more effective means of translating our findings into public policy are also required. Pioneering applications of probabilistic hazard analysis and Quantitative Risk Analysis have now appeared in B.C. and Alberta and the field is rapidly developing (e.g. BGC, 2006). The 2005 Vancouver Conference on Landslide Risk Management was a major international event in this field.

To summarize, in a little more than 3 decades, Western Canada moved into the forefront of landslide hazard and risk science and practice.

BGC Engineering Inc., 2006. Berkley Landslide Risk Management, Phase 1 Risk Assessment. Unpublished report to the District of North Vancouver, British Columbia, 30pp. (Available on www.dnv.org –natural hazards programs and reports).

Bunce, C.M., Cruden, D.M., and Morgenstern, N.R. 1997. Assessment of the hazard from rock fall on a highway. Canadian Geotechnical Journal, 34: 344–356.

Clague, J.J. and Evans, S.G. 2000. A review of catastrophic drainage of moraine-dammed lakes in British Columbia. Quaternary Science Reviews, 19, p. 1763-1783.

Froese, C.R., Murray, C., Cavers, D.S., Anderson, W.S., Read, R.S., Cruden D.M. and Langenberg W., 2005. Development and implementation of a warning system for the South Peak of Turtle Mountain. In Proceedings, Landslide Hazard Management, Vancouver Conference, Hungr, O., Fell, R., Couture, R. and Eberhardt, E., Eds., Francis and Taylor, Ltd.

Hardy, R.M., Patton, F.D. and Morgenstern, N.R., 1978. The Rubble Creek Panel Report. B.C. Ministry of Transportation and Highways (unpublished).

Hungr, O., Morgan, G.C. and Kellerhals, R., 1984. Quantitative analysis of debris torrent hazards for design of remedial measures. Canadian Geotechnical Journal, 2l: 663-667.

Fannin, R.J., Moore, G.D., Schwab, J.W. and VanDine, V.D., 2005.
Landslide risk management in forest practices. In Proceedings, Landslide Hazard Management, Vancouver Conference, Hungr, O., Fell, R., Couture, R. and Eberhardt, E., Eds., Francis and Taylor, Ltd.

Moore, D.P., Imrie, A.S. and Enegren, E.G., 1997. Evaluation and management of Revelstoke reservoir slopes. Proceedings, 19th. ICOLD Congress, Florence, Italy.

Lan, H., Martin, C.D. and Lim, C.H., 2007. RockFall analyst: A GIS extension for three-dimensional and spatially distributed rockfall hazard modeling. Computers and Geosciences, 33: 262-279.

VanDine, D.F., 1985. Debris flows and debris torrents in the southern Canadian Cordillera. Canadian Geotechnical Journal. 22. (1): 44-68.