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Engineering Geology 83 (2006) 120–143
ENGINEERING GEOLOGY
www.elsevier.com/locate/enggeo

An overview of recent large catastrophic landslides in northern British Columbia, Canada

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Accepted 24 June 2005
Available online 4 November 2005

Abstract

At least thirty-eight, large, catastrophic landslides, each either larger than 0.5 M m^3 or longer than 1 km, have occurred in northern British Columbia in the last three decades. The landslides include low-gradient flowslides in cohesive sediments, long-runout rock slides (rock avalanches), and complex rock slide-flows. The flowslides have occurred in a variety of sediments, including glaciolacustrine silt, clay-rich till, and clay-rich colluvium. The rock failures have happened in weak shale overlain by sandstone and volcanic rocks. The frequency of large landslides in northern British Columbia appears to be increasing, suggesting a link to climate change.

Keywords: Large landslide; Climate change; Permafrost degradation; Northern British Columbia

1. Introduction

At least 38 rapid landslides larger than 0.5 M m^3 or with runouts longer than 1 km have occurred in northern British Columbia since 1973 (Fig. 1). They include long-runout landslides in rock, unconsolidated sediment, and in both rock and sediment (Fig. 2, Table 1). With one exception, the large rock slides have happened on slopes above glaciers ($n=10$), on sedimentary dip slopes ($n=2$), and on slopes below deforming mountain tops ($n=2$). The exception is a rock slide from a cliff face at low elevation on the outer BC coast. Soil landslides include flowslides (rapid earth flows) in glacial marine sediments ($n=2$), glacial lake sediments ($n=6$), and diamicton (till or colluvium) ($n=10$). Landslides involving both rock and sediment include rotational rock slide–earth flows ($n=2$), rock slide–debris flows ($n=2$), and a rock slide–debris avalanche. Our data set excludes debris flows, debris avalanches, and all landslides either less than 0.5 M m^3 or less than one kilometre in length. The number of large landslides that we have catalogued is a minimum for the number that have occurred in the last three decades due to the remoteness of the study region.

Infrastructure and resources at risk from these large landslides include settlements, forest roads and highways, pipelines, fish habitat, forests, and farmland. One rock avalanche came to rest within 2 km of the Alaska Highway, and another terminated within a few kilometres of a ranch house. Landslides have ruptured

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doi:10.1016/j.enggeo.2005.06.028

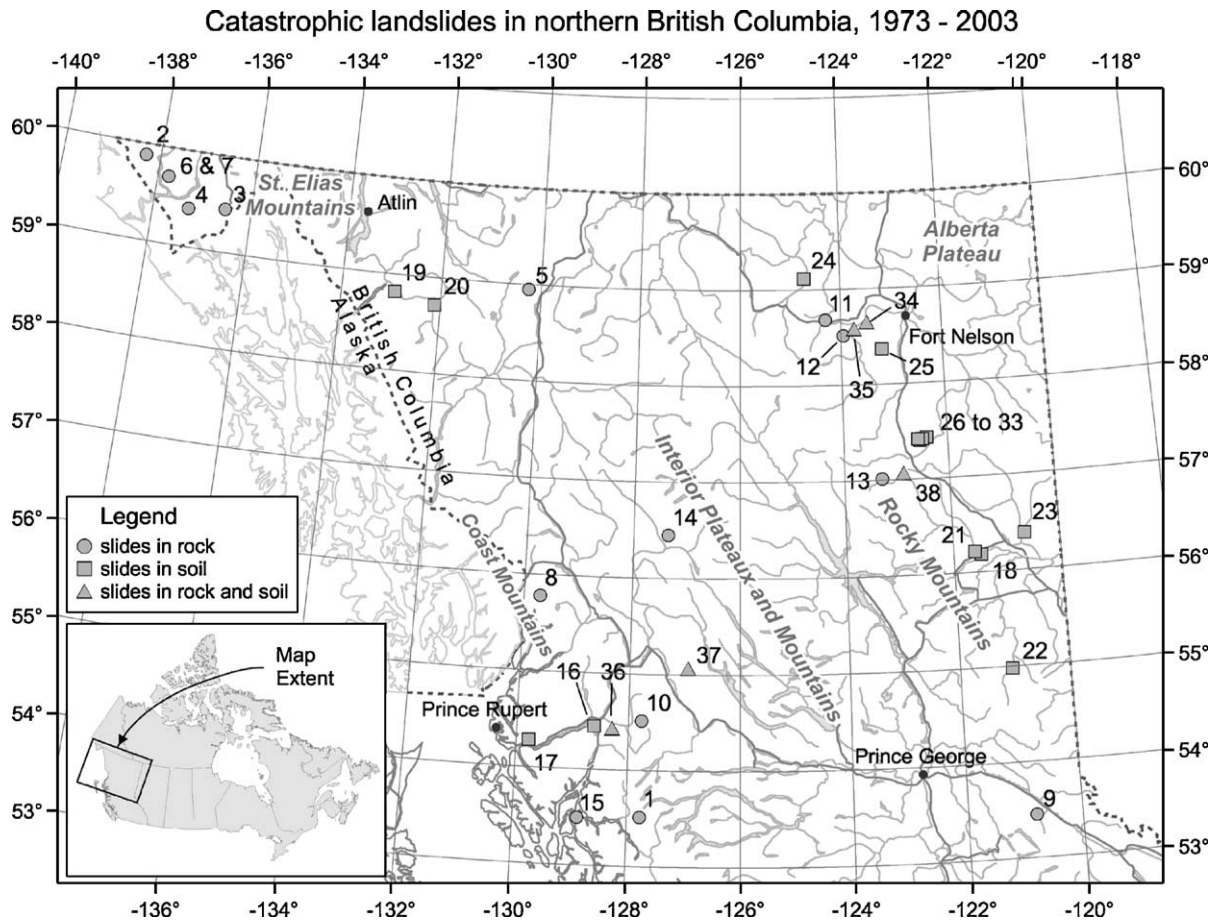

Fig. 1. Map of northern British Columbia showing locations of large, long-runout landslides between 1973 and 2003. See Table 1 for information on individual landslides.

natural gas pipelines in northern British Columbia in 1978, 1999, 2002 (Schwab et al., 2003), and 2003 (Schwab et al., 2004; Boultbee et al., 2006-this issue). Many of the landslides have impounded streams or rivers, thus the hazard associated with upstream inundation and catastrophic dam failure must also be considered (Clague and Evans, 1994).

Large landslides are apparently becoming more frequent in northern British Columbia. The increase may be due to climate change (Evans and Clague, 1999; Huscroft et al., 2004) and perhaps to glacial debuttressing (Holm et al., 2004) and permafrost degradation, as demonstrated in the European Alps (Davies et al., 2001; Bottino et al., 2002).

The objectives of this paper are to provide a brief overview of these large, long-runout landslides, examine the trend of increasing landslide frequency, and discuss the potential impacts of climate change on landslide occurrence in the region.

2. Setting

Northern British Columbia is a vast area, nearly 600 000 km^2 between 53° and 60° latitude, with a great diversity of landscapes (Holland, 1976), ecosystems (Meidinger and Pojar, 1991), climates, and surficial materials (Clague, 1989). On the west are the Coast and Saint Elias Mountains, which have a maritime climate and an extensive cover of snow and ice. East of the Coast Mountains are a series of plateaux and mountains with a more continental climate and less ice cover. Rivers in the interior flow in valleys that are incised into the plateaux and mountains. Most valleys contain thick fills of Quaternary sediments, which themselves have been dissected, leaving behind steep slopes bordering rivers. The plateau and mountain areas of the interior are bordered on the east by the northern Rocky Mountains, which mark the easternmost part of the western Cordillera. Still