CATASTROPHIC FAILURE OF A BEAVER DAM AT CHUDNUSLIDA LAKE, EAST CENTRAL BRITISH COLUMBIA

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Abstract

Some time in July or August 2000, a failure of a beaver dam resulted in catastrophic lowering of Chudnuslida Lake in east central British Columbia. The beaver dam impounded an unnamed stream below the outlet of the lake and raised the level of the lake about 2 m. The unnamed stream drained from Chudnuslida Lake into Chuyazega Creek. The beaver dam failure resulted in the catastrophic discharge of about 2 million m^3 of water. This lowered the lake level and scoured the stream channel up to 4 m depth over a distance of 4 km. The flood caused considerable bank erosion and slope failure along the stream channel. Up to 80,000 m^3 of sediment was deposited in bars in the lower, wider portion of the channel, and as a fan into Chuyazega Creek and its floodplain.

Beaver dams are common in interior British Columbia. The potential flood risk posed by failure of beaver dams can be significant and should not be overlooked in planning forest resource development.

Résumé

À un moment de Juillet ou Août 2000, l'échec d'un barrage à castor a résulté en un abaissement catastrophique du Lac Chudnuslida dans le centre-est de la Colombie-Britannique. La barrage à castor endiguait un ruisseau sans nom sous l'embouchure du lac et éleva le niveau du lac de 2 mètres. Le ruisseau sans nom se déversait du Lac Chudnuslida dans le ruisseau Chuyazega. L'échec du barrage à castor a résulté en une décharge catastrophique de 2 million de mètres cubes d'eau. Ceci a abaissé le niveau du lac et érodé le canal du ruisseau jusqu'à 4 mètres de profondeur sur une distance de 4 kilomètres. L'inondation a causé de l'érosion considérable des bords du ruisseau et des affaissements le long du lit du ruisseau. Jusqu'à 80,000 mètres cubes de sédiments ont été déposés en barres, sur les portions basses et larges du canal, et en éventail dans le ruisseau Chuyazega et sa zone inondable.

Les barrages à castor sont communs dans l'intérieur de la Colombie-Britannique. Le potentiel d'inondation posé par l'échec de barrage à castor peut être significatif et ne devrait pas être négligé lors de la planification du développement des ressources forestières.

1. INTRODUCTION

Some time in July or August 2000, a beaver dam on an unnamed outlet stream of Chudnuslida Lake (Figures 1 and 2) failed, resulting in lowering of the lake. The resultant flood scoured and aggraded the unnamed outlet stream (hereafter referred to as "the creek") over a distance of 4 km, and formed a gravelly fan where it entered Chuyazega Creek (Figure 2).

Records of catastrophic beaver dam failures are scant in the literature. Hillman (1998) describes a 1994 flood associated with a beaver dam failure in northwestern Alberta. Butler (1989; 1996) also provides reviews of beaver dam failures and their consequences.

The purpose of this paper is to document a large catastrophic flood resulting from a beaver dam failure northeast of Prince George, British Columbia.

2. SETTING

Chudnuslida Lake is located in northeastern British Columbia, approximately 120 km northeast of Prince George (Figure 1). Chudnuslida Lake is situated in a rolling topography in the northern Rocky Mountain Trench (Holland 1976) in the Sub-Boreal Spruce biogeclimatic zone (Meidinger and Pojar 1991). The lake is situated at an elevation of 850 m while the unnamed creek draining the lake drops 70 m over a distance of 4 km where it enters Chuyazega Creek at an elevation of 780 m (Figure 2). The area around Chudnuslida Lake was burned by wildfire in 1961 and subsequent to this has been modified by salvage logging and silvicultural brushing and mounding.

Bedrock underlying the northern Rocky Mountain Trench is of Precambrian and Lower Palaeozoic age. However, in the Chudnuslida Lake area, bedrock outcrops are relatively rare as the northern Rocky Mountain Trench is generally covered with thick surficial deposits (Ingimundson 1996).

According to Rutter (1976) the northern Rocky Mountain Trench was subjected to multiple glaciations, which included the Early and the Late Portage Mountain glacial advances followed by the Deserters Canyon glacial advance. The multiple glaciations significantly influenced the distribution of the surficial deposits present in the trench. In many places, tills overly preglacial sands and gravels.

Borehole records obtained from water well drilling in nearby Mackenzie indicate that the glaciofluvial sand and gravel are water-bearing aquifers confined between layers of till and/or glaciolacustrine silt and clay. Aquifer recharge studies in the vicinity of Mackenzie show that the groundwater levels in the area are highly variable and do not have direct hydraulic connection to the relatively large Williston Lake reservoir. Instead, seasonal precipitation influences the groundwater levels in the trench (Ingimundson 1996).

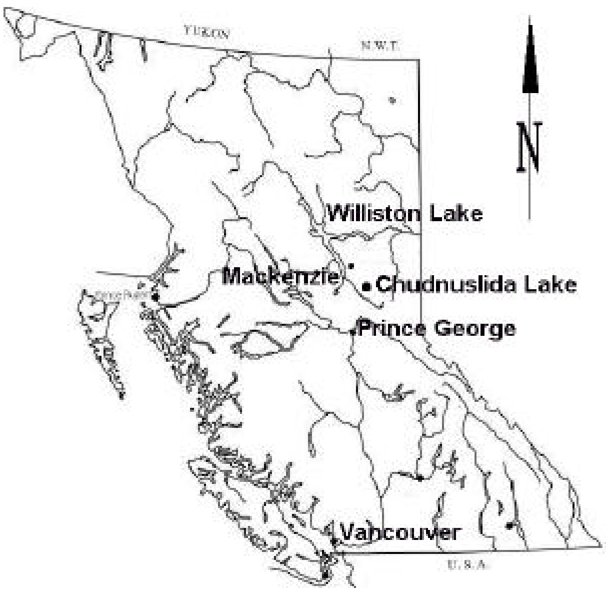

Figure 1. Key map.

3. BEAVER DAMS

Beaver dams are common in interior British Columbia and can impound large volumes of water. We routinely encounter the results of floods from beaver dam failures in our work.

Beavers depend on a local food supply of deciduous trees and shrubs. This food supply generally lasts 6 to 10 years (BC Ministry of Environment, n.d.). After the food is exhausted, beavers abandon their lodges and dams for areas with a greater food supply. Abandoned beaver dams are vulnerable to collapse, as the dams are no longer repaired.

4. FIELD WORK

On August 31, 2000 Peter Egyir and Brent Case visited the Chudnuslida Lake area and assessed the flood damage. They walked along the gully to the lake and assessed the gully wall conditions. They noted the surficial material exposed along the gully as well as the seepage, drainage and the vegetation. In addition they noted the conditions of the lake and its surroundings in the vicinity of the flood damaged creek. Finally they completed the field assessment with a low-level helicopter flight of the area. The creek was at a relatively low flow at the time of the field visit.

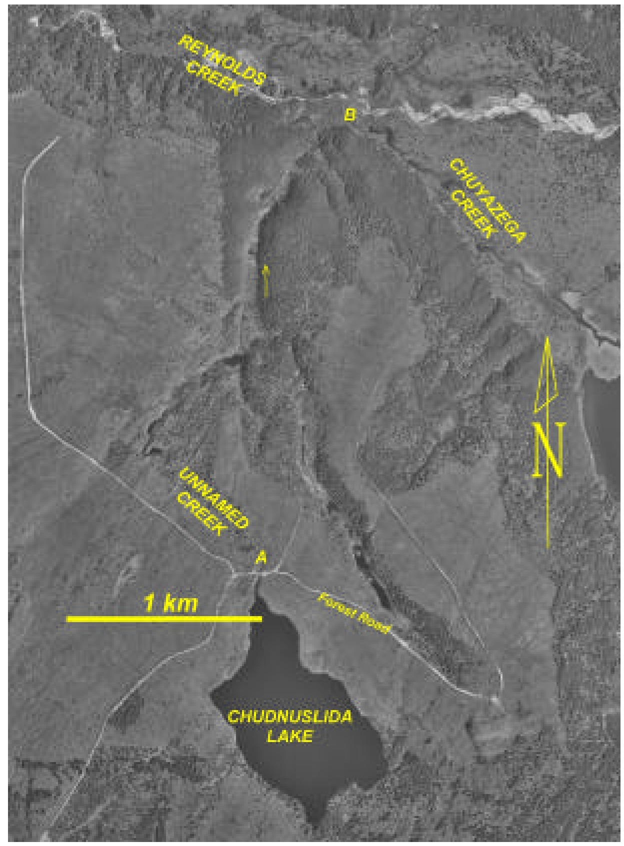

Figure 2. Orthophoto showing Chudnuslida Lake and area. Letters A and B denote the locations of the beaver dam and the fan, respectively.

5. TIMING OF THE FLOOD

Ministry of Forests (MOF) personnel first noticed the flood event during a low level helicopter flight over the site in mid August 2000. It is estimated, based on earlier flights over the area by MOF personnel and by new vegetation growth along parts of the scoured areas along the creek, that the event occurred in July or early August of 2000.

Catastrophic beaver dam failures are generally preceded by unusually high rainfall, or high spring runoff (Hillman 1998). Figure 3 shows the precipitation recorded at a MOF weather station near Table River, approximately 30 km from the study area during July and August 2000. The graph indicates a fairly heavy rainfall of 34.1 mm on July 7, 2000, suggesting the dam failure may have occurred subsequent to July 7, 2000.

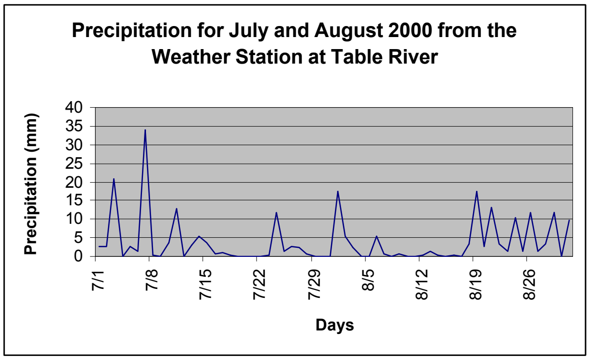

Figure 3. Daily record of precipitation for July and August 2000 MOF weather station near Table River

6. CATASTROPHIC FLOODING

Failure of a beaver dam triggered a catastrophic flood down the outlet creek of Chudnuslida Lake. A beaver dam was evident on 1988 and 1997 aerial photographs (BCB97009: 59 – 60; and BCB88036: 243 -244) between a forest road crossing, the creek, and the lake (Figure 2). An abandoned beaver lodge was also located near the outlet of the lake (Figure 4).

Figure 4. Photo showing an abandoned beaver lodge at the head of the outlet stream.

Dead vegetation (Figure 5) and abundant coarse woody debris on the lakeshore (Figure 6), especially in the vicinity of the creek, mark the high water level of the lake. Evidence of the high water marks suggests the beaver dam raised the lake level 1.5 m to 2.5 m. Given that Chudnuslida Lake has an approximate surface area of 1 km^2 the dam increased the volume of the lake between approximately 1.5 and 2.5 million m^3. It follows that this was the volume of water that flowed down the unnamed creek.

The catastrophic release of the impounded water scoured out the creek channel (Figure 7) and the valley slopes in the outside bends (Figure 8) from Chudnuslida Lake down to where most of the debris was deposited in a fan at Chuyazega Creek (Figure 9). The event left numerous unstable slopes along the valley sides over much of the creek below the road crossing (Figure 10). It was evident that some old landslides along the valley side slopes were reactivated by bank erosion during the flood.

Figure 5. Photo showing dead vegetation around the edge of the lake indicating drowning upon submergence.

Figure 6. Photo showing stranded log debris and a scoured channel at the outlet of Chudnuslida Lake.

The creek bed was scoured between 1 and 4 m deep. The scouring was more pronounced at the confined, upper reach of the creek. Based on the thickness of the gravel and organic debris deposited along the creek channel, it is evident that the depth of the flood ranged up to 5 or 6 m.

Soils exposed along the gully walls and the scoured creek bed consisted mainly of till overlying glaciofluvial deposits (Figure 10). Sand and gravel containing variable amounts of silt, clay, and cobbles were the dominant soils.

The flood left a 15 m deep washout at the location where the existing forest road crossed the creek (Figure 11). At the road crossing the creek originally flowed through a

900 mm culvert, which was displaced during the flood. Sections of the culvert were found at three differet places, downstream of the original culvert location.

With the scour along the creek and the landslides along the valley slope, we estimate that 30,000 to 80,000 m^3 of sediment was deposited in bars in the lower, wider portion of the channel, and as a fan into Chuyazega Creek and on its floodplain.

Figure 7. Photo showing the scoured creek channel near the outlet of Chudnuslida Lake.

Given the volume of water between 1.5 and 2.5 million m^3 and displaced soil of 30 to 80 thousand m^3, we estimate a volumetric sediment concentration between 1 and 5 %.

This places the flow well within the streamflow category (Pierson and Costa 1987). It is conceivable that sediment concentrations rose as the flood abated. It is therefore possible that the streamflow, changed to a hyperconcentrated flow, and eventually to a debris flow during the waning stages of the flood. However, we did not examine the fan to determine whether the various modes of flow occurred.

Figure 8. Photo showing the unstable gully wall of the creek, and flood triggered instability.

Figure 9. Photo showing the debris fan at Chuyazega Creek.

7. SITE REMEDIATION

We did not recommend any mechanical slope stabilisation along the creek gully due to access limitation. In addition, we judged that any attempt to mechanically stabilise the gully walls could cause more environmental damage to the unnamed creek and surrounding terrain.

The relatively high walls created from the road embankment washout presented a significant safety concern to traffic. We prescribed that the side of the remaining road embankment that was accessible be pulled back to no steeper than 2 horizontal: 1 vertical. The material derived from the re-sloping was to be used in constructing a berm across the width of the adjacent road. The berm was intended to prevent vehicle or equipment access past the washout area. We also recommended that the rest of the road downchainage of the creek crossing be deactivated provided the road is not required for any industrial or recreational use.

Figure 10. Photo showing diamict overlying sorted sand and gravel in an area where the creek bed was down cut.

Figure 11. Photo showing the depth of the washout at the original road crossing. Note persons for scale.

8. CONCLUSIONS

Beaver dams are common in interior British Columbia and can impound large volumes of water. We routinely encounter the results of floods from beaver dam failures in our work.

Since beaver dams tend to be abandoned after a period of 6 to 10 years, many dams may be in a weakened state, prone to collapse. Consequently, many sites may be susceptible to catastrophic outburst flooding.

Flood damage to forests, infrastructure, fish habitat and stream channel stability due to dam failure can be significant. The potential hazards associated with beaver dam failures should therefore not be overlooked.

ACKNOWLEDGEMENTS

We thank Les Higgs for preparing Figures 1 and 2, and Louis Gagné for translating the abstract.

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