Types of Geohazards in the Youbou Area

Within the project area, geohazards were assessed with a focus on debris flows. Debris flows as a hazard type exist within a spectrum of geohazards from fall (e.g., rock avalanches) to liquid flow (e.g., clearwater floods) that is characterized by several parameters as shown in Figure 8.

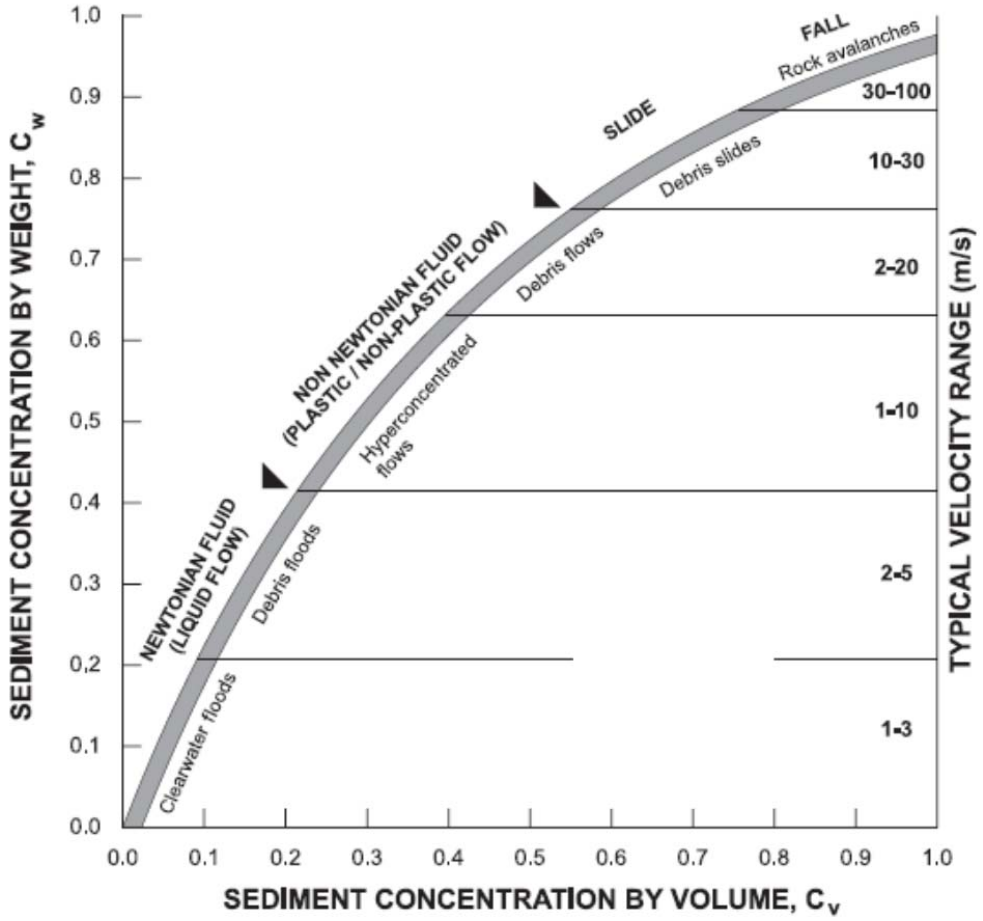

Figure 8: Watershed morphometrics graph (Jakob and Jordan, 2001).

There are three parameters that characterize these hazards along the spectrum, including velocity, sediment concentration by weight, and sediment concentration by volume. It is, however, very difficult to measure these characteristics directly and so typically other parameters, including the slope and watershed size, are used for classification. To define watershed morphometrics[5] the parameters used are watershed size, watercourse length, and watercourse slope. Many studies have been done using these methods in BC, and it has been found that for 90% of the cases, the Melton ratio correctly predicted debris flow (Wilford *et al.*, 2004).

In addition, while there are individual definitions and classification criteria for debris flow, debris flood, and clearwater floods, these events exist on a continuum, and exact differentiation of these processes

[5] Morphometrics describes measures of the shape or form of the watershed.

can only be achieved through direct sampling. Even with direct sampling, some of the relevant thresholds can be difficult to detect. It should be kept in mind, therefore, that classification indicates the dominant process in a given watershed, not the only possible process (Jakob, 2016).

While debris flows are the focus of this project, several geohazard or landslide types were identified in the project area as part of the landslide inventory of historic aerial images. These hazards include debris flow, debris slides, rock falls, and rock slides, and are briefly described below.

3.4.1 Debris Flows

Debris flows are rapid mass movements of saturated surficial material and organic debris, which can be a mixture of rock, sand, and/or soil. The high water content of debris flows allows them to flow downhill as slurry, often resembling wet concrete. This category includes debris torrents, also known as "channelized debris flows". Channelized debris flows commonly grow larger through entrainment of in-channel material.

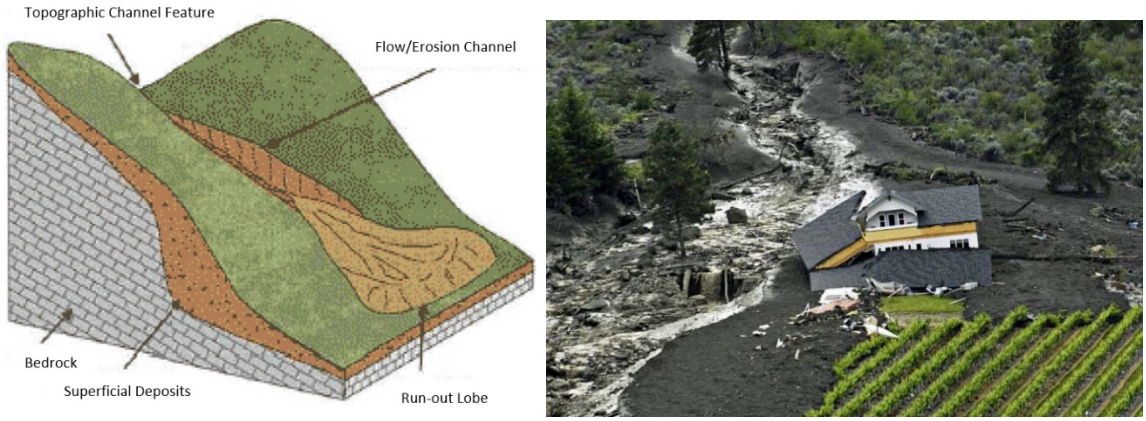

Figure 9: Channelized debris flows (Smith, 2004).

Debris flows can initiate from other movement styles, such as rock slides—as those masses disintegrate and release internal water or entrain other material, they can form debris flows. This is the most common hazard in the project area.

3.4.2 Debris Slides

Debris slides are rapid sliding masses of surficial material. These typically have a shorter runout length than debris flows and move as a solid rather than a liquid or a slurry. Debris slides are common where slopes have been steepened or undercut by road building.

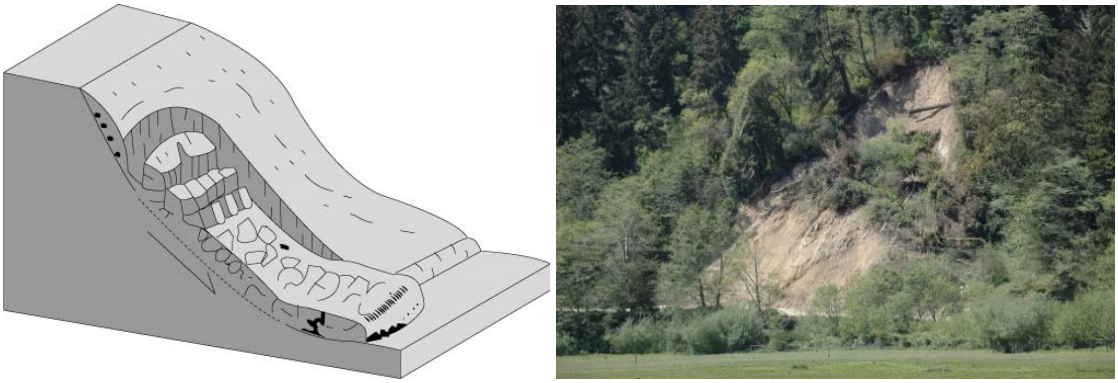

Figure 10: Debris slides (Smith, 2004).

3.4.3 Rock Falls

Rock falls occur when detached masses of bedrock move by falling, bouncing, or rolling. Rock falls typically have small volumes, but may occur with a high frequency. These occur on steep bedrock slopes and cliffs.

Figure 11: Rock falls (Smith, 2004).

Rock falls occur on steep slopes and can be caused by a number of factors, such as the structure of the rock mass, weathering, ground and surface water, freeze-thaw dynamics, root wedging, and external stress.

3.4.4 Rock Slides

Rock slides are large disintegrating masses of bedrock moving downslope by sliding. Rock slide volumes can vary greatly. The largest landslides in Canada are rock slides (e.g., Frank Slide near Hope, BC, pictured).