

Post-Wildfire Risk Analysis, Fire N50196, Perry Ridge – further details

Peter Jordan, P.Geo., MFLNRO, Nelson 15 Aug 2013

Introduction and methods

This memo gives further information of the Perry Ridge fire, and debris flow risks on the Benninger Creek fan. A summary of the risk analysis is given on the accompanying form.

The Perry Ridge fire burned 64.5 ha near the headwaters of Benninger Creek, beginning July 24, and was substantially contained by August 6. At the request of the Southeast Fire Centre, I did a natural hazards risk analysis of the fire.

From previous mapping of terrain and natural hazards in the Perry Ridge area, it was apparent that the Benninger Creek alluvial fan is subject to debris flow and flood hazards. Therefore, on July 31 I sent a preliminary alert to the Regional District of Central Kootenay, to notify residents of potential hazards.

On August 7, I did a field review of the fire. This consisted of taking photographs from the air, and a ground traverse across the burned area and along the fuel-free lines. I also inspected the Benninger Creek fan at its apex above Wishloff Road, and lower down at the creek crossing on Kazakoff Road.

Burned area observations

Figure 1 is a map of the Benninger Creek watershed, and of the fire showing burn severity, mapped from photographs taken from the helicopter (Photo 1) and ground data. The fire occupies 11.6% of the watershed area, of which about 12% of the fire (or 1.4% of the watershed) is burned at high severity. The table below summarizes the burned area and burn severity by sub-watershed.

Watershed:	Benninger Creek	north fork	middle fork
area (ha)	557	226	100
elevation range (m)	650-2000	1090-2000	1160-1910
relief ratio*	0.57	0.61	0.75
burn area (ha) [% of watershed]	64.4 [11.6%]	37.2 [16.5%]	27.2 [27.1%]
H severity	7.9 [1.4%]	5.2 [2.3%]	2.7 [2.7%]
M severity	21.0 [3.8%]	11.8 [5.2%]	9.2 [9.2%]
L severity	35.5 [6.4%]	20.2 [8.9%]	15.3 [15.2%]

* The Melton relief ratio is the elevation range divided by the square root of area. A relief ratio over 0.6 can indicate a watershed is susceptible to debris flows.

These estimates of burned area do not include the areas cleared for fuel-free lines and helipads. These could add (very approximately) about 5 ha to the total affected area.

Ground observations of burn severity showed that water repellent soils were present in high severity burned areas, but they were patchy in nature. It was estimated that strong water repellency occurred over about 40% of high burn severity areas, and less than 10% of moderate burn severity areas. Over much of the high burn severity areas, some remnants of charred duff (forest floor) remained. Compared with other fires that have caused problems with post-wildfire debris flows (for example, the 2007 Springer fire and the 2003 Kuskonook fire), soil burn severity in this fire is somewhat less.

There is very little soil disturbance due to firefighting activities. The fire lines are fuel-free only (there was almost no construction of excavated lines), and the forest floor and understory shrubs are mostly undisturbed.

Debris flow and flood hazards

Debris flows and floods following wildfires can occur in summer as a result of high-intensity rainfall on water-repellent soils (for example, the 2004 Kuskonook Creek debris flow which followed the 2003 fire). This hazard is greatest in the one to two years after the fire. Debris flows and floods can also occur during spring runoff as a result of rapid snowmelt in burned areas (for example, the debris flows in Middle Van Tuyl, South Van Tuyl, and Memphis Creeks which occurred in 2008, 2009, and 2010, following the 2007 Springer fire). This hazard is due to increased snow accumulation, more rapid snowmelt, and higher groundwater levels in burned areas, and can persist for many years until revegetation occurs.

In Benninger Creek, a debris flow as a result of high-intensity, short-duration rainfall is unlikely due to the limited extent of high burn severity and water-repellent soils; however, it could occur in an extreme rainfall event. A debris flow is more likely during spring snowmelt, as a more substantial area (about 15% in the middle tributary, including fuel-free lines and helipads) is in a near-clearcut condition (high and moderate severity, plus other openings).

Benninger Creek is already subject to debris flow hazard. Existing terrain mapping and stream channel surveys indicate that class 4 terrain (potentially unstable) occurs in much of the lower part of the watershed, and that the channel is subject to debris flow initiation and transport. Deposits of old debris flows on the uppermost part of the fan indicate that debris flow return periods may be in the order of several hundred years, and individual recent debris flow events cover a small part of the fan at its apex. This level of hazard is typically considered “moderate”. It is possible that previous debris flows have occurred as a result of past wildfires, although there is no way to confirm this. The present wildfire has increased the likelihood of a debris flow to some extent, but probably not greatly. The incremental hazard due to the wildfire is considered to be “low”, while the overall hazard remains “moderate”.

Debris flow and flood risks on the Benninger Creek fan

In simplest terms, *risk* is the product of *hazard* and *consequence*. For the purpose of post-wildfire risk analyses, only *partial risk* is considered; this is the probability that a hazardous event (e.g. a debris flow) will occur and that it will reach or affect the site of the element at risk (e.g. a house or water intake). Other components of risk, such as spatial and temporal probability, and value or vulnerability of the elements at risk, are not considered. Subjective terms (low, moderate, high) are used to describe hazard and risk, based on generally accepted definitions used in British Columbia in other risk analysis studies and mapping projects. A simple qualitative risk matrix is used (Figure 2).

The Benninger Creek alluvial fan is mostly a glaciofluvial fan, formed during or shortly after deglaciation by debris flows and by deposition of sand and gravel by the stream. The average fan gradient is about 14%, which is typical of debris flow fans. Most of the fan surface appears (based in a quick inspection while driving the two main roads) to be inactive. The creek flows in a channel which is incised about 5 m below the old fan surface. There are several abandoned channels, indicating that the creek has changed course in the past. The upper part of the fan is subject to continued debris flow deposition under modern conditions. The present channel follows the right (west) edge of the fan, and there is very little freeboard (only about 1 m) on its left bank, which indicates that the creek is subject to avulsion (change of course) in a future debris flow event. If this were to occur, the creek could flow down one of its former channels, or be diverted down Wishloff Road. Several old roads and trails, built for water lines or past logging, approach the fan apex on an ascending grade, increasing the likelihood of such diversions.

There appear to be two properties near the apex of the fan, which could be directly affected by a debris flow; these properties and the houses on them are considered to be at high risk. (I visited one property closest to the water intakes at the fan apex; otherwise, I only drove Wishloff and Kazakoff Roads.) Other properties lower on the fan are unlikely to be directly affected by debris flows; however, they could be affected by flooding. Whether an individual house is at risk or not depends on local site factors, especially its location relative to old channels on the fan.

Water intakes and water quality

Water license data shows 10 domestic licenses and 9 irrigation licenses on Benninger Creek. There is a collection of water intakes at the fan apex, which are subject to burial or destruction in the event of a debris flow. The pre-fire hazard and risk to water supply infrastructure is therefore moderate and high respectively. The hazard has been slightly increased by the fire.

Following a fire, there may be some adverse effects on water quality, due to ash and fine burned material (charcoal) washed into the creek during heavy rains or spring snowmelt. This fire-related sediment can also clog sand filters at water intakes. Past experience from fires in the West Kootenays indicates that these effects are usually minor and of short duration. Following wildfires, levels of nitrate and phosphate can be slightly elevated for several years, but have rarely been found to exceed water quality guidelines. Nitrate, ammonium, and phosphate can

also be introduced from fire retardant, but these effects are of short duration, and have rarely been found to exceed water quality guidelines. These substances occur naturally in soil and water, and can increase in concentration due to vegetation and soil changes following wildfire.

Recommendations

1. Residents of the Benninger Creek fan should be informed of the debris flow risk that exists on the fan. This applies especially to residents of properties on the upper part of the fan.
2. Residents should be alert to changes in streamflow or sediment in the creek. If extremely high levels of turbidity, or large quantities of ash or charred material, are observed in the creek during heavy rains or snowmelt, this could indicate that a debris flow may occur. Unusual stream behaviour, such as surging or pulsing flow, or a sudden drop in streamflow, could indicate that a debris flow is imminent.
3. No recommendations are made for rehabilitation of areas disturbed by the fire or by fire suppression activities, other than normal rehab procedures.
4. Salvage logging of standing timber is not recommended, as this would substantially increase the equivalent clearcut area (ECA) of the burned area, and could increase the debris flow hazard.

Figures

Figure 1. Map of Perry Ridge fire and Benninger Creek watershed. (at end of report)

$P(HA)$, annual probability <i>(likelihood) of occurrence of a specific hazardous landslide and it reaching or otherwise affecting the site occupied by a specific element</i>		$P(S:H) \times P(T:S)$ Probability (likelihood) that the landslide will reach or otherwise affect the site occupied by a specific element, given that the landslide occurs		
$P(HA) = P(H) \times P(S:H) \times P(T:S)$		High	Moderate	Low
P(H), annual probability (likelihood) of occurrence of a specific hazardous landslide	Very high	Very high	Very high	High
	High	Very high	High	Moderate
	Moderate	High	Moderate	Low
	Low	Moderate	Low	Very low
	Very low	Low	Very low	Very low

Figure 2. Example of a qualitative risk matrix. From Wise et al (2004).

Photos: on following pages

References

The following information sources specific to Perry Ridge were reviewed:

Apex Geoscience Consultants Ltd. 1998. Geological Hazards Mapping of the Slocan Valley, Phase 1. Report prepared for BC Ministry of Forests, Arrow Forest District.

Boyer, D., Jordan, P., and VanDine, D. 1999. Perry Ridge Risk Assessment. Report prepared for the Perry Ridge Local Resource Use Planning Table, Winlaw, B.C.

S. Chatwin Geoscience Ltd. 1999. Perry Ridge Stream Channel Survey. Report prepared for BC Ministry of Forests, Arrow Forest District.

The following are general references or reports for nearby locations:

Curran, M.P., Chapman B., Hope G.D., and Scott D. 2006. Large-scale Erosion and Flooding after Wildfires: Understanding the Soil Conditions. BC Ministry of Forests and Range, Technical Report 030.

Jordan, P. 2012. Post-wildfire landslides in southern British Columbia. Proceedings, 11th International & 2nd North American Symposium on Landslides, Banff, Alberta, Canada, 3-8 June, 2012, pp. 1637-1642.

Jordan, P. 2012. Sediment yields and water quality effects of severe wildfires in southern British Columbia. Wildfire and Water Quality: Processes, Impacts and Challenges. IAHS Publ. 354, pp. 25-35.

Jordan, P. and Gluns, D. 2007. Sitkum Creek Fire, 2007, N70347, Post-Wildfire Risk Analysis. Report prepared for BC Ministry of Forests and Range, Southeast Fire Centre, Southern Interior Forest Region, and Kootenay Lake Forest District, 17 September, 2007.

Nicol, D., Jordan, P., and Deschenes, M. 2007. Springer Creek Fire Number 50372 Post-Wildfire Risk Analysis. Report prepared for BC Ministry of Forests and Range, Southern Interior Forest Region, 14 September, 2007.

Wise, M.P., Moore, G.D., and VanDine, D.F. (eds.) 2004. Landslide Risk Case Studies in Forest Development Planning and Operations. BC Ministry of Forests, Land Management Handbook 56.



Photo 1. Central part of fire N50196 from the air.



Photo 2. High burn severity (foreground) – needles and small branches consumed; understory, fine fuels, and forest floor consumed. Moderate and low burn severity in background.



Photo 3. Moderate burn severity – trees killed but needles remain; understory and forest floor are partly consumed.



Photo 4. Low burn severity – trees, understory, and litter partially burned; duff and mineral soil are unaltered.

N50196 Perry Ridge

1 : 20,000

Benninger Creek
Watershed

Lower

Fan

North fork

Middle fork

South fork

- Fire N50196
- Fire line
- Watersheds
- Alluvial Fan
- Heli Pad
- Burn Severity
- H
- L
- M

0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2.0 Kilometers

