Report on 2023 monitoring of the Johnsons Landing landslide

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Monitoring of the potentially unstable area above the Johnsons Landing landslide continued in 2023. A site visit was undertaken on June 28, 2023 by Sarah Crookshanks and Will Miller. Reflectors along the headscarp were surveyed in October by Kodiak Measurement Services. No visible changes to the headscarp area were observed.

Slope displacement measurements

Eight measurement sites are located along the crack that bounds the top edge of the potentially unstable area (see Figure 1 for measurement locations labelled Site 1 through 8). One of these (Site 1) is a line of 6 metal pins, with the top pin drilled into bedrock above the crack. This site is the most reliable measurement location. The other sites consist of two or three wooden stakes driven into soil above and below the crack. The distance between the stakes is measured manually with a tape measure. Unfortunately, many of these wooden stakes have been damaged or slanted because of rockfall and snowload; therefore, the wooden stake measurements in the past few years have become less accurate or have been destroyed.

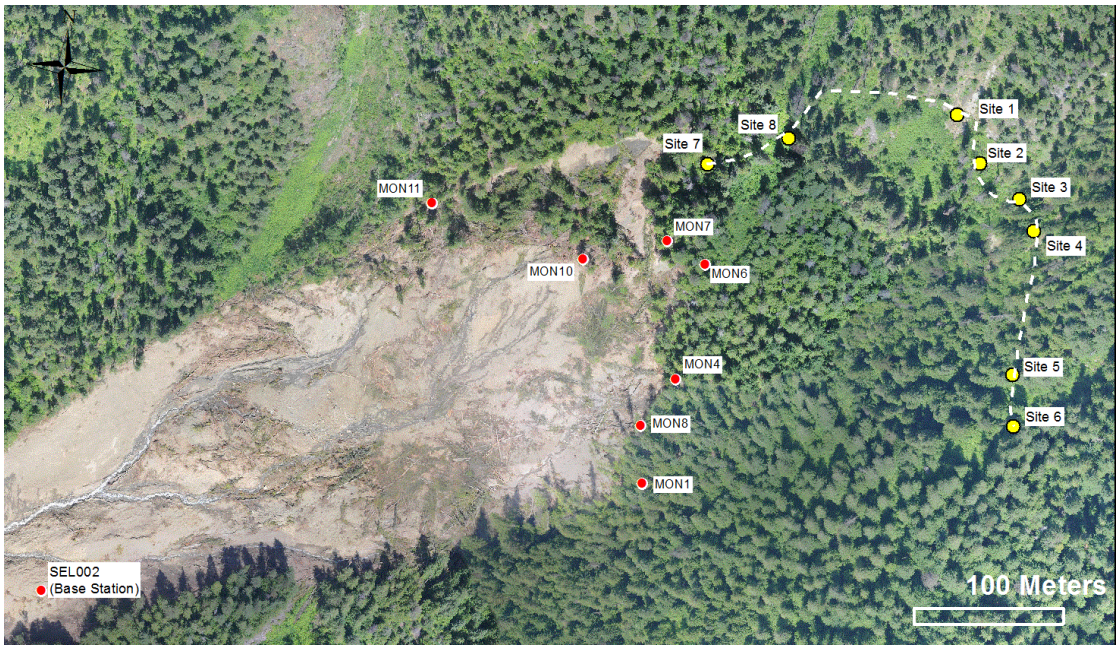

Figure 1. Measurement locations that are measured manually are identified in yellow, and measurement sites surveyed by from a base station are shown in red. The dashed line shows the approximate location of the upper crack that bounds the top edge of the potentially unstable area.

For 10 years following the landslide, the measurement of the displacement of the upper crack has shown progressive movement at the apex of the tension crack (Figure 2), and inconsistent and/or minimal movement towards the outer edges. However, in 2023, no movement was measured at any of the sites for the first time since monitoring began.

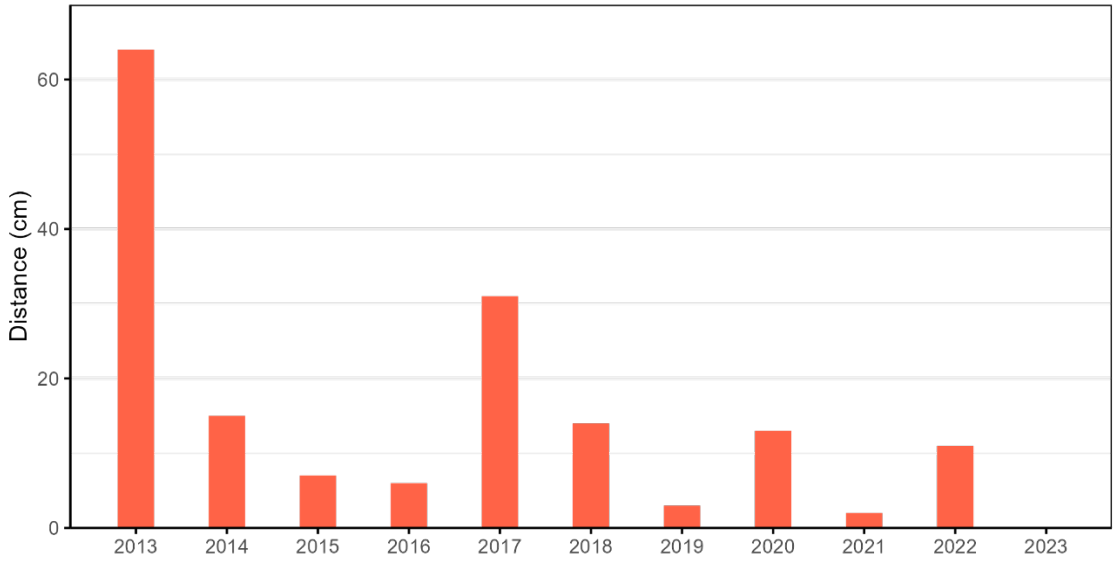

Figure 2. Annual downslope movement of the upper crack at Site 1 (see Figure 1 for site location). Downslope movement was measured as the distance between stakes spanning the crack.

Weather record

The regional rainfall in the spring of 2023 was about normal (Figure 3), and the snowpack on April 1 at Upper Gray Creek was also about normal (Figure 4). The snow melted much earlier than usual; on June 1 there was no snow remaining at the Upper Gray Creek snow pillow site at 1930 m elevation, whereas normally there is over 500 mm of snow water equivalent remaining on that date.

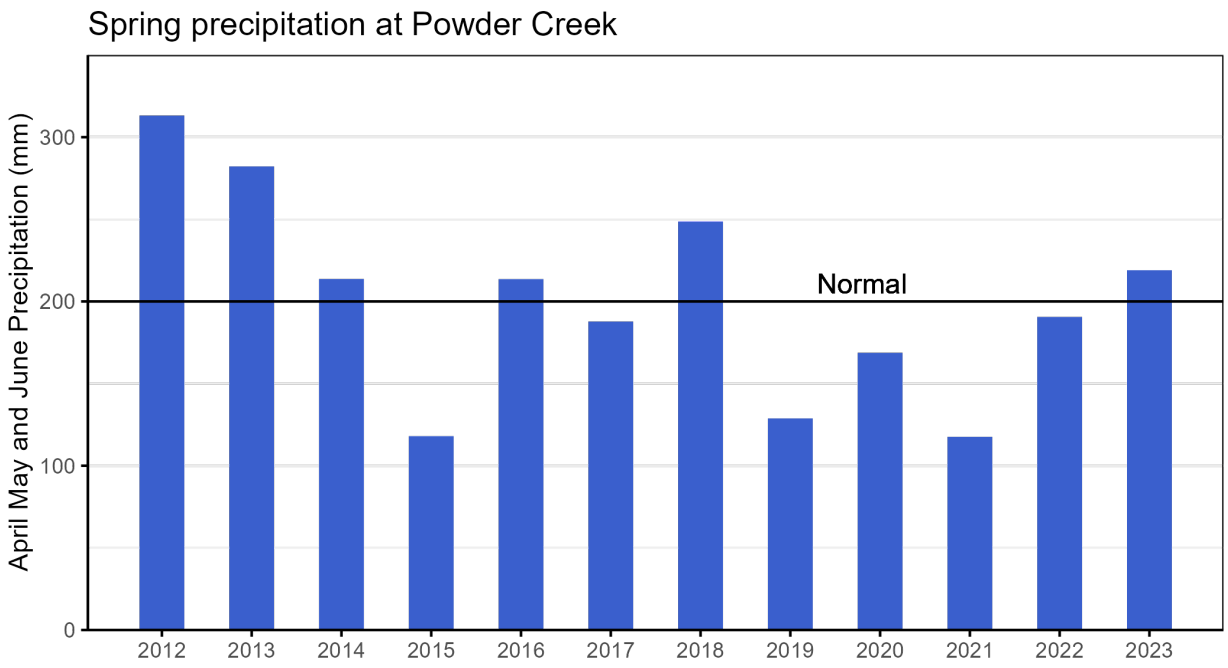

Figure 3. Total precipitation for April, May and June at Powder Creek BC Wildfire Service weather station from 2012 to 2023. The normal precipitation estimate is for the Kaslo Environment Canada weather station.

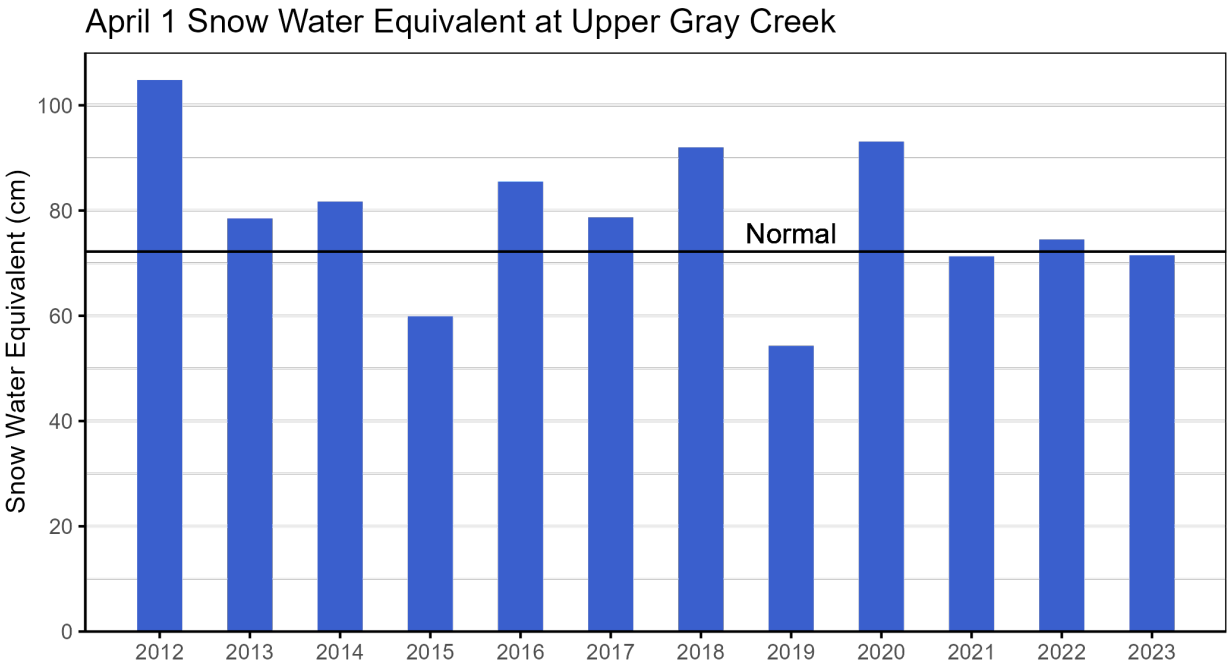

Figure 4. Snow Water Equivalent on April 1 at the Upper Gray Creek Ministry of Environment automatic snow pillow site.

Survey of Reflectors at the Headscarp

A set of reflectors were installed on the rim of the headscarp in 2014. Sproulers' Enterprises Limited (SEL) measured the reflectors once a year until 2021. Kodiak Measurement Enterprises performed the measurements in 2022 and 2023. See Figure 1 for reflector locations.

The spatial and temporal pattern of movement of the surveyed reflectors along the headscarp rim indicates that there has been some minor (20 - 30 cm) westerly movement of the headscarp over the past 10 years. This corresponds to an average annual displacement of approximately 2 to 3 cm per year. Less overall movement has been observed at MON10 (the reflector on the dropped block), and no movement (within measurement error) has been observed at MON11, which is located on stable ground outside the landslide source area. This year, no headscarp movement was measured during the survey in October.

Conclusions and recommendations

I recommend that monitoring continue next year, though if no movement is observed in the coming years, then I would recommend discontinuing monitoring at this site.

Table 1. Annual upper scarp movement (at Site 1), spring precipitation totals at both the Environment Canada Kaslo station and the BC Wildfire Service Powder Creek station, and April 1 snowpack at the Upper Gray Creek station. Years with above normal values are highlighted in pink and years with below normal values in green.

Year	Upper Scarp Movement (cm)	Kaslo Precipitation (% Normal)	Powder Creek Precipitation (% Normal)	Gray Creek April 1 Snowpack (% Normal)
2012	NA	NA	158	145
2013	64	141	136	109
2014	15	107	100	113
2015	7	59	47	83
2016	6	107	97	118
2017	31	94	86	109
2018	14	124	112	127
2019	3	NA	64	75
2020	13	NA	84	129
2021	2	NA	59	99
2022	11	NA	95	101
2023	0	NA	110	99

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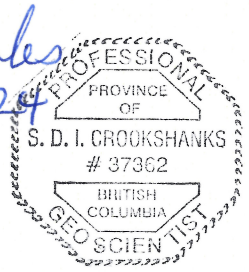

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