

Highlights for British Columbia from the preliminary Canadian Landslide Database



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Abstract

The preliminary Canadian Landslide Database is a publicly available compilation of existing landslide inventories and new mapping. Version 13 of the database contains 28,000 national entries of which 14,520 are from British Columbia. These entries include both landslide events (discrete recorded periods of movement) and landslide features (e.g., slopes with a morphology consistent with past or ongoing movement). The occurrence and distribution of different types of landslides reflect the interaction between geological materials, relief, and other contributing factors (e.g., river erosion, timing with respect to wildfires), and triggers (e.g., weather events, seismicity, and anthropogenic activity). The database fills a gap in our overall understanding of landslide processes and provides common baseline knowledge to local governments, practitioners, and researchers. It also provides interested parties with initial desktop-level information of known landslides in an area and helps to identify priorities for further work.

Keywords: Landslide, hazard, mass movement, lidar, InSAR, inventory

1. Introduction

It is important to understand the distribution of landslides in British Columbia because they represent a risk to infrastructure (e.g., Hungr et al., 1999) and public safety (Strouth and McDougall, 2024). Four types of landslide maps are recognized in the professional practice guidelines on landslide mapping developed by Engineers and Geoscientists British Columbia: inventory, susceptibility, hazard, and risk (EGBC, 2025). The guidelines define inventory maps as depicting the locations or spatial extents of past and active landslide occurrences, or the distribution of morphological features within a single landslide or landslide complex. Landslide inventories provide basic data that, when used in conjunction with other terrain, material, and trigger information, can be used to identify susceptible terrain where future events could occur. Landslide inventories are typically compiled for a specific area (e.g. Bornaetxea et al., 2022) but they can also be prepared for specific triggers such as earthquakes (Barth et al., 2020) and storms (Hancock and Wlodarczyk, 2025) or type (e.g., glaciomarine, Geertsema and Millard, 2025).

Although the need for a Canadian landslide database has long-been recognized (Cave et al., 1992), and efforts were initiated to develop a database structure (Grignon et al., 2004), it was not until September 2022 that the initial version of the preliminary Canadian Landslide Database was made publicly available. The database, being developed by a group of volunteer geohazard experts from the public, private, and academic sectors, is available at no cost at the open data

repository Zenodo (Brideau et al., 2026). It contains landslide point locations and attributes as a .csv file which can be imported in GIS software and as a .kmz file for visualization using Google Earth. While it represents the best information currently available, the database should be considered a preliminary characterization of landslides in British Columbia because it is not based on systematic mapping across the province and it is predominantly based on remote sensing observations. This paper introduces the methods used to compile the database, outlines the landslide classification used, presents highlights for British Columbia, and discusses potential applications and limitations.

2. Methods

Landslide locations in the database are provided as point features and include attributes for a unique landslide identifier, landslide name, location coordinates (latitude and longitude), landslide type (see section 3 for more details), material type (surficial, rock, anthropogenic), point location type (headscarp, source, transport, deposit), qualitative location confidence (low, moderate, high), and an attribute for tracking the database version when an entry was last updated. Where available, additional attributes such as volume estimate, date of occurrence, trigger, contributing factors, interpreted historical interferometric synthetic aperture radar (InSAR)-based displacement, and reference to previous work are also provided.

Most landslides in the database were identified using Google

Earth and publicly available imagery and lidar. Online mapping applications such as HazMapper (Scheip and Wegman, 2021) and Arctic Landscape EXplorer (ALEX; Lübker et al., 2024) have also been used to identify landslides based on the changes in multi-spectral indices derived from satellite-acquired datasets. Starting with Version 12 of the database, InSAR-based displacement information from publicly available regional projects (e.g., Choe et al., 2021) was incorporated in the reference and comment attributes for individual entries. The recent availability of NASA's Observational Products for End-Users from Remote Sensing Analysis (OPERA; NASA, 2025) and Natural Resources Canada's pilot national-scale maps of active deformation processes (NRCan, 2024) allowed for the addition of deformation information to existing database entries along with the identification of new landslides.

3. Landslide types mapped

Following an approach similar to Varnes (1978) and Hungr et al. (2014), landslide types in the database are classified based on material type (bedrock, debris, soil/earth, water/ice) and predominant transport mechanism (fall, topple, slide, flow, spread, deformation). This basic classification was modified to incorporate landslide types specific to regions underlain by permafrost (e.g., Wolfe et al., 2025). Where associated with events of significant magnitude or impact, large ice falls resulting in cascading hazards and glacial lake outburst floods (GLOF) have been included (Table 1).

Snow avalanches, common in mountain areas of British Columbia, are not included, and debris cones that may form at the base of snow avalanche paths are not mapped because they are assumed to be deposited by snow. Rock glaciers are only included if their geomorphology indicates they originated as a consequence of a landslide or if material in the rock glacier subsequently failed as a landslide. Alluvial fans are formed by a combination of processes, including rock falls, debris flows, debris floods, and floods (e.g., de Haas et al., 2024). Although alluvial fans are distinct landforms that can be mapped, they are only included in the database where specific events have been observed and documented (e.g., debris flows).

4. Highlights for British Columbia

Due to its landslide-prone mountainous terrain, British Columbia accounts for about half of the Canada-wide entries in Version 13 of the database. This may also reflect an observational bias because most contributors have regional expertise in the province.

The spatial distribution of landslide occurrences and types (Fig. 1) reflects the interaction between geological material, relief, climate, and seismicity and has long-been recognized (Eisbacher, 1979; British Columbia Geological Survey, 1993; Guthrie, 2005). In the Insular Mountains (Haida Gwaii, Vancouver Island) and Coast Mountains, debris flows, debris floods, debris avalanches and debris slides are prevalent (Fig. 1), which we attribute to the combination of steep terrain and wet climate. In particular, the wettest coastal

areas have steep organic soil failures not observed elsewhere (e.g., Campbell et al., 2010). In the central Interior Plateau and northeastern British Columbia, earth slides are spatially associated with glaciolacustrine deposits (Geological Survey of Canada, 2014), which are particularly susceptible to failure (e.g., Bobrowsky and Dominguez, 2012). Earth flows in the central Interior Plateau are spatially associated with the weathered Cretaceous to Eocene sedimentary and volcanic geological units (Bovis, 1985). Rock slides (undifferentiated, translational, irregular, and rotational) and rock falls in the Purcell and Rocky mountains are spatially associated with layered sedimentary units.

Bovis and Evans (1996), Hensold et al. (2010), and Clayton et al. (2017) have described mountain and rock slope deformation (as defined in Hungr et al., 2014) in British Columbia. The province-scale distribution (Fig. 1) shows mountain and rock slope deformation in all mountainous regions of the province, consistent with the global literature indicating that they develop by a range of mechanisms (Kinakin and Stead, 2005; Agliardi et al., 2012). Although mountain and rock slope deformation can occur in unglaciated landscapes, formerly glaciated mountains are especially susceptible (PANEK et al., 2015).

The role of wildfires contributing to increased landslides in British Columbia has previously been recognized (e.g., Jordan, 2016), particularly in cases where a recently burnt region was affected by atmospheric rivers (Hancock and Włodarczyk, 2025). The increased landslide susceptibility of post-wildfire landscape is due to changes in soil properties which in turn impact water infiltration and the rainfall thresholds at which landslides occur (Gartner et al., 2024). Version 13 of the database contains 1300 entries with wildfires interpreted as a contributing factor.

Version 13 of the database is leveraging ongoing interpretation of InSAR-based deformation maps (NASA, 2025; NRCan, 2024) to identify 344 slopes with landslide morphology that were likely active between 2016 and 2024 (Fig. 2). Although province-scale deformation areas had previously been generated using multiple SAR sensors (ALOS-1, Sentinel-1, RADARSAT-2) to identify potential landslides (Pichierri et al., 2019), the previous deformation areas were not publicly available and had not been reviewed to confirm they corresponded to landslide morphology.

5. Applications and limitations

Even in a preliminary form being continuously updated, the database provides a starting point for desktop-level landslide hazard and risk assessments. Reference to the database can provide non-specialists with regional overviews of geohazards. Other applications for the database include geospatial analysis to investigate attributes (e.g., geology, slope, aspect) at landslide initiation zones. Preliminary exposure assessments have been facilitated by cross-referencing the database with specific asset and infrastructure layers such as roads, transmission lines, railways, or pipelines (e.g., Journeay et al., 2022). Although the absence of mapped features does not indicate an absence of

Table 1. Landslide classification scheme used in the preliminary Canadian Landslide Database (Version 13).

		Rock	Surficial		Water	
			Debris ¹	Earth ¹		
Movement Type	Fall	Rock fall	Debris fall	Earth fall	Ice fall ²	
	Topple	Rock topple				
	Slide	Rock slide undifferentiated				
		Rock translational slide	Debris slide			
		Rock rotational slide		Earth slide		
		Rock irregular slide				
		Deep-seated permafrost landslide ³				
	Flow	Rock avalanche	Debris avalanche	Flowslide		
			Debris flow	Earth flow		
			Debris flood	Mud flow	Flood ²	
			Glacial lake outburst flood ²			
			Active layer detachment ³	Retrogressive thaw slump ³		
	Slope deformation	Mountain slope deformation				
		Rock slope deformation				
	Spread	Rock spread		Earth spread		
	Complex	Rock complex ⁴				

¹ 'Debris' contains between 20% and 80% material coarser than 2 mm, with the remainder being less than 2 mm, and 'Earth' contains greater than 80% material finer than 2 mm (Varnes, 1978).

² Geomorphic processes that resulted in cascading hazards including landslides.

³ Permafrost-specific landslide type.

⁴ Complex failure refers to slopes where multiple movement types are present.

landslides, the known features provide a baseline that additional assessments can improve on.

Observational biases include those imposed by the quality of imagery and sensor data and by proximity to populated areas. The use of Google Earth imagery results in a bias towards more recent events. Large landslides persist as landforms that may be visible on imagery for hundreds to thousands of years, particularly in low-vegetation areas such as Arctic and alpine environments. In contrast, on the Pacific coast of British Columbia, debris slides and debris flows may only remain visible for several years before becoming revegetated and hard to discern (Guthrie and Evans, 2007). Historical event inventories taken from media sources such as Septer (2007a, b) have biases towards places where people lived or worked relative to remote or uninhabited places. Historic air photos

provide important documentation of historical events, but it can be costly and time consuming to generate comprehensive databases from them. Consequently, many of the debris flows, debris avalanches, and debris slides recorded in the database are relatively young (<30 years) and older events are underrepresented.

The recent availability of InSAR-based deformation information provides improved interpretation of slope processes that can be used to update landslide inventories and hazard characterizations. Nonetheless, InSAR techniques have limitations (e.g., Wu and Madson, 2024) and hazard characterization needs to consider the impact of radar wavelength, stack depth, processing algorithm, topography, vegetation, snow cover, satellite line-of-sight relative to slope movement, and rate of surface displacement. This means that

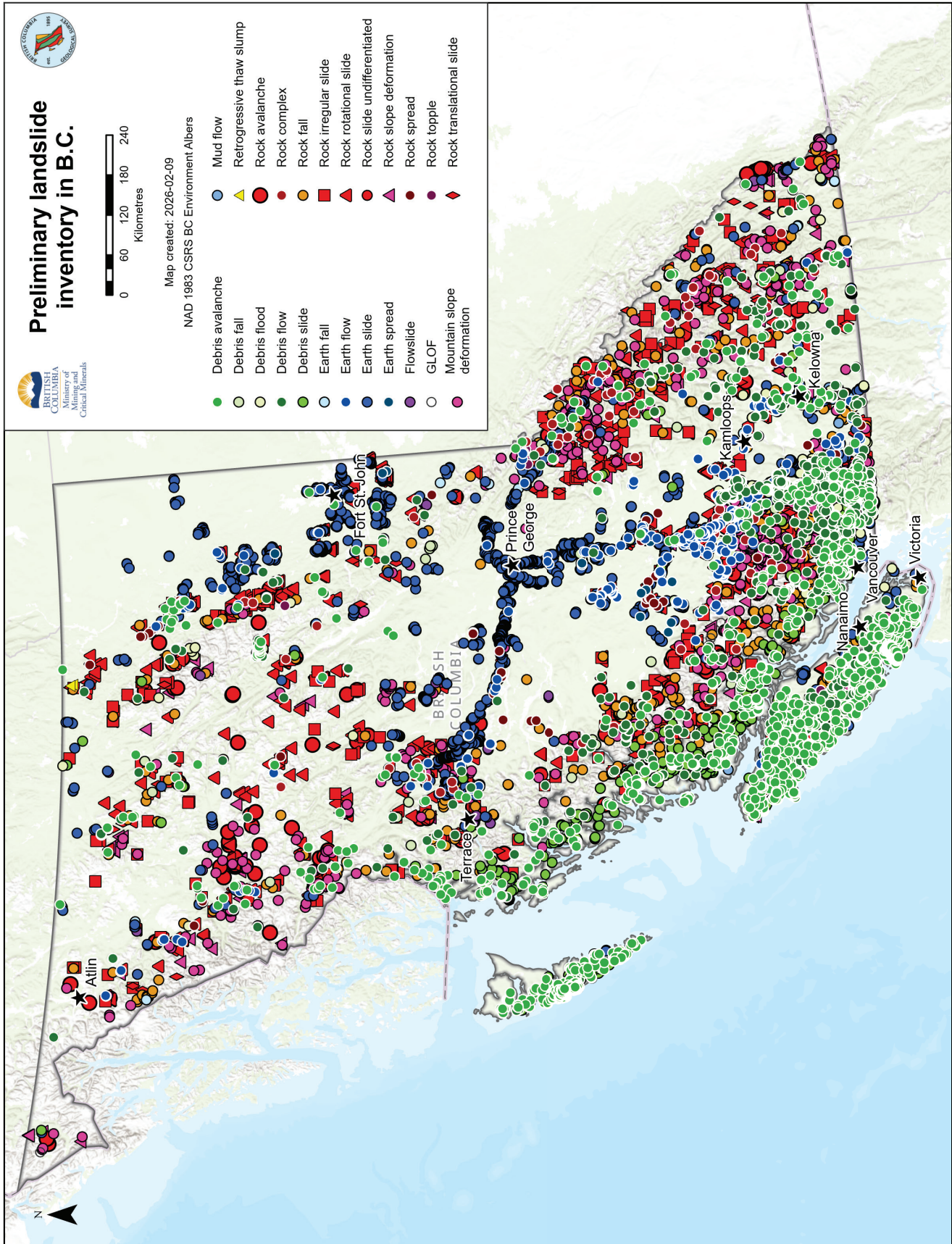


Fig. 1. Map of 14,520 British Columbia landslides from Version 13 of the preliminary Canadian Landslide Database. Points are symbolized according to landslide type. Data from Brideau et al. (2026).

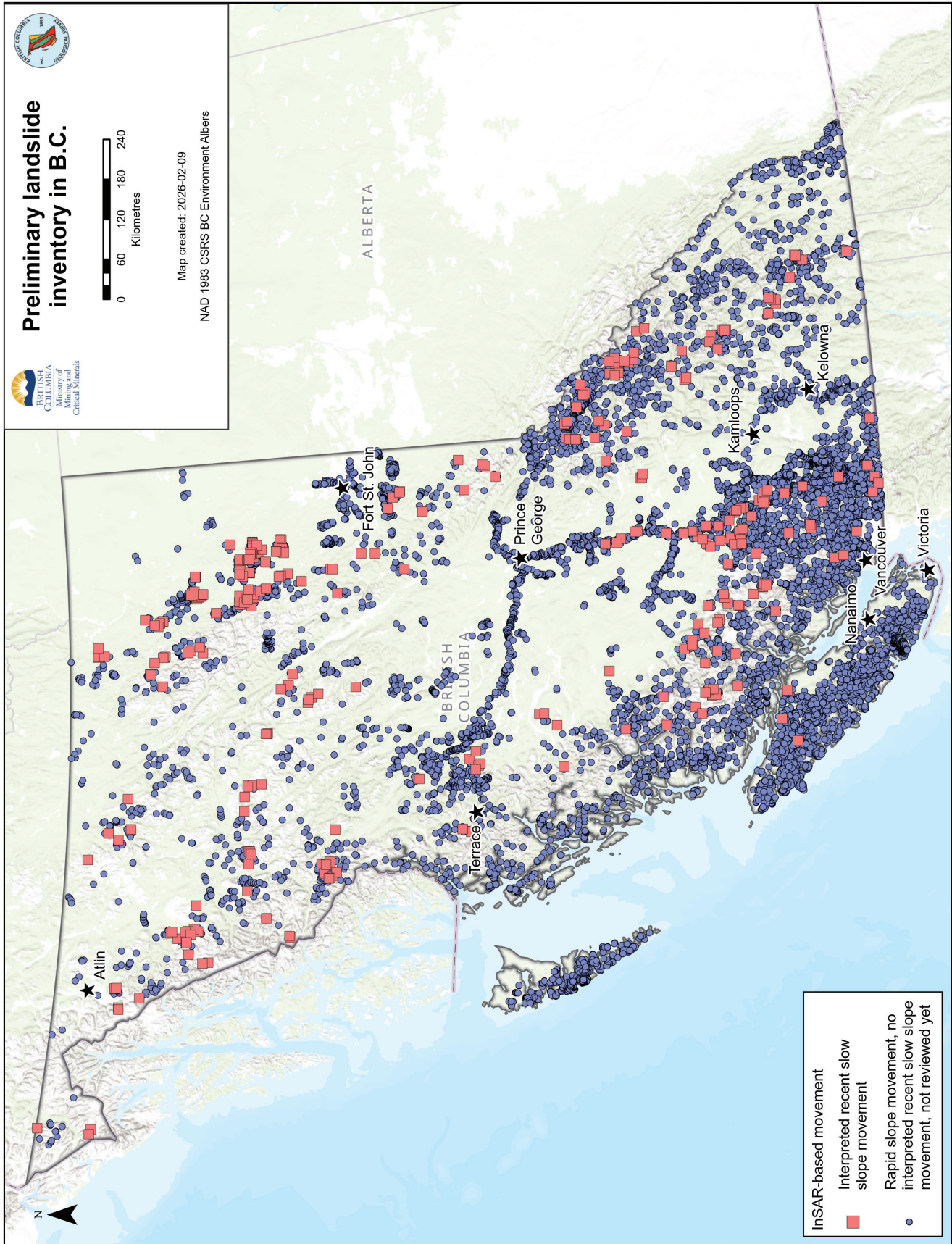


Fig. 2. Map of 14,520 British Columbia landslides from Version 13 of the preliminary Canadian Landslide Database. Points are symbolized based on interpreted slow slope movement from InSAR-based deformation maps. Uncertainties and limitations of this in-progress interpretation are discussed in the text. Data from Brideau et al. (2026).

large (>100,000 m³), very slow (<160 mm/year; Porter 2023), unvegetated, east-west moving landslides are preferentially captured in the InSAR data. As a result, the number of presently moving slopes in the province with the potential to cause damage is expected to be significantly greater than captured in the database. The database entries with attributes recording interpreted historical InSAR-based deformation pattern are also based on records that stopped in 2024 (NASA, 2025; NRCan, 2024) or earlier (Choe et al., 2021). Their current state of activity and hazard needs to be confirmed by site-specific investigations.

6. Conclusion

The preliminary Canadian Landslide Database is a freely and publicly accessible inventory of landslide point locations across Canada compiled since September 2022 on a volunteer basis by a group of geohazard experts from the public and private sectors. Version 13 of the database contains 28,000 entries including 14,520 in British Columbia. Although the database currently provides the best publicly available characterization of landslide distribution at the national and provincial scales, it has temporal and spatial biases such as recent landslides near infrastructure being better represented than old landslides in remote locations. The current database supports previous experienced-based interpretations of landslide distribution and type in British Columbia. InSAR-based deformation maps of 344 slopes have identified movements at very slow rates between 2016 and 2024.

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References cited

Agliardi, F., Crosta, G., and Frattini, P., 2012. Slow rock-slope deformation. In: Clague, J.J., and Stead, D., (Eds.), *Landslides: Types, Mechanisms and Modeling*. Cambridge University Press, pp. 207-221.

- Barth, S., Geertsema, M., Bevington, A.R. Bird, A.L., Clague, J.J., Millar, T., Bobrowsky, P.T., Hasler, A., and Liu, H. 2020. Landslide response to the 27 October 2012 earthquake (MW 7.8), southern Haida Gwaii, British Columbia, Canada. *Landslides* 17, 517-526.
- Bobrowsky, P.T., and Dominguez, M.J., 2012. Landslide susceptibility map of Canada, Geological Survey of Canada, Open File 7228, 1:6,000,000 scale.
- Bornaetxea, T., Blais-Stevens, A., and Miller, B., 2022. Landslide inventory map of the Valemount area, British Columbia, Geological Survey of Canada, Open File 8926.
- Bovis, M.J., 1985. Earthflows in the Interior Plateau, southwest British Columbia. *Canadian Geotechnical Journal*, 22, 313-334.
- Bovis, M.J., and Evans, S.G., 1996. Extensive deformations of rock slopes in southern Coast Mountains, southwest British Columbia, Canada. *Engineering Geology*, 44, 163-182.
- Brideau, M-A., Brayshaw, D., Hancock, C-A., Lipovsky, P., Cronmiller, D., Lewkowicz, A., Blais-Stevens, A., Guthrie, R., Geertsema, M., Goetz, J., McGregor, C., Tannant, D., Friele, P., Clarke, J., Steelquist, A., Wong-Teichoeb, H., Ring, C., and Wells, G., 2026. Preliminary Canadian Landslide Database (Version 13.0) [Dataset]. Zenodo. <<https://doi.org/10.5281/zenodo.18216956>>
- British Columbia Geological Survey, 1993. *Landslides in British Columbia*. British Columbia Ministry of Energy, Mines and Petroleum Resources, British Columbia Geological Survey Information Circular 1993-07, 2 p.
- Campbell, D., Millard, T., Schwab, J., and Roberts, B., 2010. Landslides in organic soils on forested slopes. Extension Note 99, British Columbia Ministry of Forests and Range, 7 p.
- Cave, P.W., Church, M., Jackson, L.E., Jr., Lister, D.R., and Skermer, N., 1992. Recommendations of the Geologic Hazard Workshop-by the steering committee on geologic hazards. In: Bobrowsky, P., (Ed.), *Geological Hazards in British Columbia*. British Columbia Ministry of Energy, Mines and Petroleum Resources, British Columbia Geological Survey, Open File 1992-15, pp. 1-6.
- Choe, B-H., Blais-Stevens, A., Samsonov, S., and Dudley, J., 2021. Sentinel-1 and RADARSAT Constellation Mission InSAR assessment of slope movements in the southern interior of British Columbia, Canada. *Remote Sensing*, 13, article 3999, 17 p. <<https://www.mdpi.com/2072-4292/13/19/3999>>
- Clayton, M.A., Stead, D., Kinakin, D., and Wolter, A., 2017. Engineering geomorphological interpretation of the Mitchell Creek Landslide, British Columbia, Canada. *Landslides* 14, 1655-1675.
- de Haas, T., Hancock, C-A., and Ventra D., 2024. Debris-flow watersheds and fans: morphology, sedimentology and dynamics. In: Jakob, M., McDougall, S., and Santi, P., (Eds.), *Advances in Debris-Flow Science and Practice*, Springer-Verlag, pp. 9-73.
- EGBC (Engineers and Geoscientists British Columbia), 2025. Professional practice guidelines, landslide mapping. Version 1.0, July 16, 2025, 78 p. <<https://tools.egbc.ca/Registrants/Practice-Resources/Guidelines-Advisories#natural-hazards>>
- Eisbacher, G.H., 1979. First-order regionalization of landslide characteristics in the Canadian Cordillera. *Geoscience Canada*, 6, 69-79.
- Gartner, J.E., Kean, J.W., Rengers, F.K., McCoy, S.W., Oakley, N., and Sheridan, G., 2024. Post-wildfire debris flows. In: Jakob, M., McDougall, S., Santi, P., (Eds.), *Advances in Debris-flow Science and Practice*, pp. 309-345.
- Geertsema, M., and Millard, T., 2025. Sensitive clay landslides in British Columbia-an update. *Earth and Environmental Science* 1523, article 012015, 15 p. <<https://doi.org/10.1088/1755-1315/1523/1/012015>>
- Geological Survey of Canada, 2014. *Surficial geology of Canada*. Geological Survey of Canada, Canadian Geoscience Map 195, 1:5,000,000 scale.

- Grignon, A.G., Bobrowsky, P.T., and Coultish, T., 2004. Landslide database management philosophy in the Geological Survey of Canada. Proceedings of the 57th Canadian Geotechnical Conference, 5th Joint CGS/IAH-CNC Conference, GeoQuebec2004. Session 3C, pp. 37-41.
- Guthrie, R.H., 2005. Geomorphology of Vancouver Island: Mass wasting potential. British Columbia Ministry of Environment, Victoria, British Columbia. Research Report No. RR01, 24 p.
- Guthrie, R.H., and Evans, S.G., 2007. Work, persistence, and formative events: The geomorphic impact of landslides. *Geomorphology*, 88, 266-275.
- Hancock, C-A., and Wlodarczyk, K., 2025. The role of wildfires and forest harvesting on geohazards and channel instability during the November 2021 atmospheric river in southwestern British Columbia, Canada. *Earth Surface Processes and Landforms*, 50, article e6065, 15 p.
<<https://onlinelibrary.wiley.com/doi/10.1002/esp.6065>>
- Hensold, G., Stead, D., Clague, J., Moretti, D., and Sturzenegger, M., 2010. Deep-seated gravitational slope deformation at Handcar Peak in the southern Coast Mountains of British Columbia. Proceedings of the GeoCalgary 2010 Conference. pp. 922-931.
- Hungr, O., Evans, S.G., and Hazzard, J., 1999. Magnitude and frequency of rock falls and rock slides along the main transportation corridors of southwestern British Columbia. *Canadian Geotechnical Journal*, 36: 224-238.
- Hungr, O., Leroueil, S., and Picarelli, L., 2014. The Varnes classification of landslide types, an update. *Landslides*, 11, 167-194.
- Jordan, P., 2016. Post-wildfire debris flow in southern British Columbia, Canada. *International Journal of Wildland Fire*, 25, 322-326.
- Journey, J.M., LeSueur, P., Chow, W., and Wagner, C., 2022. Physical exposure to natural hazards in Canada. Geological Survey of Canada Open File 8892, 95 p.
- Kinakin, D., and Stead, D., 2005. Analysis of the distributions of stress in natural ridge forms: implications for the deformation mechanisms of rock slopes and the formation of sacking. *Geomorphology*, 65, 85-100.
- Lübker, T., Nitze I., Laboor S., Irrgang A., Lantuit H., and Grosse G., 2024. Presenting land surface changes through the web-based Arctic Landscape EXplorer (ALEX) to permafrost communities-a permafrost service. Proceedings of the International Conference on Permafrost (ICOP 2024), pp. 43-44.
<https://epic.awi.de/id/eprint/58864/1/LuebkerEtAl-2024_ICOP-Whitehorse_ALEX.pdf>
- NASA, 2025. OPERA Surface Displacement from Sentinel-1 validated product (Version 1) [Data set]. NASA Alaska Satellite Facility Distributed Active Archive Center.
<<https://doi.org/10.5067/SNWG/OPL3DISPS1-V1> (last accessed December 2025)>
- Natural Resources Canada (NRCan), 2024. Pilot national scale maps of active deformation processes in Canada. Government of Canada; Natural Resources Canada; Canada Centre for Mapping and Earth Observation (CCMEO).
<<https://app.geo.ca/en-ca/map-browser/record/1da588c1-0dc6-45e4-9e63-9acf2fdc353a> (last accessed December 2025)>
- Panek, T., Mentlik, P., Dichburn, B., Zondervan, A., Norton, K., and Hardecky, J., 2015. Are sackungen diagnostic features of (de)glaciated mountains? *Geomorphology*, 248, 396-410.
- Pichierri, M., Pon, A., Mackenzie, D., Alipour, S., and Guman, P., 2019. A landslide inventory for British Columbia (Canada) using SAR interferometry. American Geophysical Union, Fall Meeting 2019, Abstract H11H-1574.
- Porter, M., 2023. Predicting annual displacement probability of slow-moving landslides through Markov chain and Monte Carlo simulation. Proceedings of the 3rd JTC1 Workshop on Impact of Global Changes on Landslide Hazard and Risk, 4 p.
- Scheip, C.M., and Wegmann, K.W., 2021. HazMapper: A global open-source natural hazard mapping application in Google Earth Engine. *Natural Hazards Earth System Sciences*, 21, 1495-1511.
- Septer, D., 2007a. Flooding and landslide events, northern British Columbia, 1820-2006. British Columbia Ministry of Environment, 216 p.
- Septer, D., 2007b. Flooding and landslide events, southern British Columbia, 1808-2006. British Columbia Ministry of Environment, 140 p.
- Strouth, A., and McDougall, S., 2021. Historical landslide fatalities in British Columbia, Canada: Trends and implications for risk management. *Frontiers in Earth Science*, 9, article 606854, 8 p.
<<https://doi.org/10.3389/feart.2021.606854>>
- Varnes, D.J., 1978. Slope movement types and processes. In: Schuster, R.L., and Krizek, R.J., (Eds.), *Landslides, Analysis and Control*. Transportation Research Board, Special Report 176, pp. 11-33.
- Wolfe, S.A., Duchesne, C., O'Neill, H.B., Parker, R.J.H., Young, J.M., Rudy, A.C.A., Steedman, A.E., Lantz, T.C., and Kokelj, S.V., 2025. A database of thermokarst and related landform observations in Canada (1961 to 2024). Geological Survey of Canada, Open File 9296c.
- Wu, Y-Y., and Madson, A., 2024. Error sources of interferometric synthetic aperture radar satellites. *Remote Sensing*, 16, Paper 354, 37 p.