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Spatial variability in periglacial terrain conditions, northwestern Canada

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Throughout much of northern Canada there is an inadequate knowledge of permafrost and periglacial terrain conditions, which impedes development of climate-resilient northern infrastructure, identification of potential geohazards, decision making regarding resource development, and inferring past and future landscape evolution. Using a land systems approach to better understand formation of landscapes and thaw-sensitive terrains of northern Yukon and northwestern Northwest Territories, we aim to describe the permafrost-related landform-sediment assemblages that exist in the region. Permafrost is continuous in the region, but variations in geology, landscape history, climate, relief, ecology, and other natural processes have produced a diverse range of permafrost conditions and landforms. Using the 875 km-long Dempster and Inuvik-to-Tuktoyaktuk highway corridors (DH-ITH) as a regional transect, and high-resolution satellite imagery, a robust methodology was implemented to identify and digitize (at 1:5000 scale) 8793 landforms (589 km^2) within a 10 km-wide corridor (8530 km^2) and classify them according to main formational process (hydrological, periglacial, and mass movement). Surficial geology data were extracted from available data sets. Landform densities in all feature classes vary substantially along the transect according to physiographic region and surficial geology. The northern 39% of the corridor is characterized by generally rolling or planar relief, numerous waterbodies (19%), and the remaining land area by mostly morainal (67%), glaciofluvial (12%), lacustrine (7%), and alluvial (7%) deposits. By count, it contains 53% of mapped features and the majority of periglacial (67%) and hydrological (70%) features. In particular, the Tuktoyaktuk Coastlands, Peel Plain, and Mackenzie Delta, contain the greatest density of mapped landforms within the corridor, which cover nearly 23%, 15%, and 15% of the land area of these physiographic regions, respectively. These extents reflect the amount of ground ice and level of permafrost-thaw sensitivity of these regions. In contrast, the physiographic regions of the southern 61% of the study area are characterized by high relative relief, few waterbodies (0.2%), and the land area mainly by colluvial (63%), alluvial (18%), and morainal (14%) deposits. Most mass movement features occur here (85% by count), and are concentrated in the Ogilvie Mountains (n = 1027; 108 km^2). This feature inventory provides the basis for developing spatial models of landscape-thaw susceptibility, which can inform risk assessment and improve decision making regarding public safety and environmental management.