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Snow avalanche hazard mapping using Geographic Information Systems

D. Delparte (1), N. Waters (1) and B. Jamieson (2)

(1) Department of Geography, University of Calgary, Canada (ddelparte@selkirk.ca / Fax: 403 282-6561), (2) Department of Civil Engineering, University of Calgary, Canada

Snow avalanches are a significant natural hazard that impact roads, structures and threaten human lives in mountainous terrain. Snow avalanche hazard mapping has the potential to reduce this risk by modeling, mapping and visualizing hazardous terrain using Geographic Information Systems (GIS). The Rogers Pass area in Glacier National Park, British Columbia, Canada provides an ideal location for studying over 100 well documented avalanche paths that impact the Trans-Canada Highway. Interruptions to transportation on the highway due to avalanches are estimated to cost a few millions of dollars each year. Modeling of terrain in a GIS is typically done by utilizing a digital elevation model (DEM). DEM resolution has traditionally been a limiting factor in the evaluation of terrain at a slope scale. The best available DEM data for this area has a resolution of 25 m. Using a procedure of digital stereo photogrammetry, an improved DEM of up to 5 m resolution was generated for this research. This technology allows a GIS operator wearing stereo goggles to digitally resample surface heights using stereo-photo pairs. Topographic parameters such as slope, confinement, aspect, curvature and distance from ridges were derived from the DEM. To evaluate what terrain parameters are most likely to contribute to high frequency avalanche paths, expert knowledge from known avalanche paths was documented and statistically evaluated for these key factors. In addition, the alpha-beta statistical model was adapted for estimating maximum snow avalanche runout in the Rogers Pass area based upon the detailed avalanche record from the highway corridor. Along roadways or in areas where there is a human presence, details of avalanche runout distance are often recorded; however areas in the backcountry typically traveled by recreationists may not have a recorded history of avalanche activity or runout distances. Patterns from well known avalanche occurrences along the highway corridor were transferred to

map avalanche hazard in more remote areas of the region using the derived terrain characteristics, runout model and an expert system to map avalanche terrain into clear categories of hazard. The results are useful in supplementing traditional field based methods of avalanche hazard mapping as well as providing a tool for risk assessment.