DEVELOPING APPLICATIONS: AVALANCHE PATH HAZARD ASSESSMENT

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ABSTRACT: Located in the Coast Mountains, Bear Pass comprises of extensive avalanche terrain impacting Highway 37A with significant potential to isolate coastal communities. To successfully monitor and mitigate avalanche hazard, daily avalanche path per path forecasting has been employed which allows forecasters to maintain a record of the variability of each avalanche path's previous weather and snowpack conditions, natural avalanche occurrences and mass reduction from explosives control. The interactive application has been developed to geospatially highlight areas of concern and conveys expected avalanche activity character, size and subsequent consequences at the highway-avalanche path interface. Alongside daily assessment, it provides the opportunity for continuous and instantaneous geospatial updates to hazard, expected avalanche activity, avalanche hazard trend, character, previous occurrences and control. It further facilitates an easily accessible communication platform for program forecasters, which can then aid in communications with stakeholders, emergency response agencies and maintenance contractors by providing detailed guidance on how, where and why highway incidents and maintenance can be managed within operational procedures.

KEYWORDS: avalanche, forecasting, application

1. INTRODUCTION

Bear Pass is located on Highway 37A in British Columbia with approximately 45km of the 62km long highway being affected by avalanches. Up to 89 avalanche paths have the potential to close the highway, isolating the coastal communities of Stewart, BC and Hyder, AK. Avalanche paths range in elevation from 0m to 2400m, spanning kilometers, include natural icefalls, all elevation bands and aspects.

To successfully monitor and mitigate avalanche hazard, the Ministry of Transportation and Infrastructure's (MoTI) Bear Pass avalanche program uses explosives control when necessary and largely forecasts for natural occurrences and their expected impact at the highway-avalanche path interface. As long as effects remain manageable, this allows the highway to remain open while operating on an elevated hazard and thus minimizes closure hours (MoTI, 2010). To improve forecasting in our area where the variance of weather conditions, subsequent snowpack and avalanche activity between Meziadin Junction and Stewart can be substantial, each avalanche path is considered and forecast for separately among paths of like-character. This allows forecasters to keep detailed records of current and previous weather and snowpack conditions, natural avalanche occurrences and mass reduction from explosives control that affect each path. The geospatial integration of path per path forecasting allows for a more visual incorporation of terrain as shown in Figure 1, as well as an interactive communication platform that facilitates geospatial verification and calibration of forecasts to ensure they remain accurate and to minimize the required highway closures.

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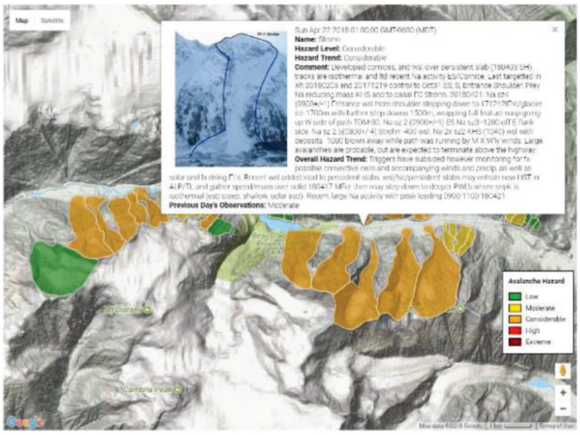

Figure 1: Website display, geospatially delineating extent of expected avalanche activity and detailing avalanche hazard trend, character, previous occurrences and mitigation.

2. METHODOLOGY

To develop the geospatial interface of the path hazard application, the existing path hazard assessment was integrated with historical events from MoTI's Snow Avalanche and Weather Systems (SAWS) software where each avalanche occurrence is recorded to the Canadian Avalanche Association's Observation Guidelines and Recording Standards for Weather, Snowpack and Avalanches (OGRS) (CAA, 2014). Each path was assessed to determine the acceptable and expected effects at the highway-avalanche path interface for a given forecast hazard level using recorded parameters such as toe distance mass (SAWS, 2018) alongside previous forecast hazard levels and in accordance with MoTI's avalanche specific operational procedures (MoTI, 2010). Based on this, affected areas were delineated geospatially to combine the data and apply it to the terrain. The end interface employs a network-linked Google Earth file within which each path shows a different affected area based on the path's specified forecast hazard level as seen in Figure 2. The forecasts are updated daily as part of the forecasting process, and the application's network-link allows for instantaneous reflection of any further changes.

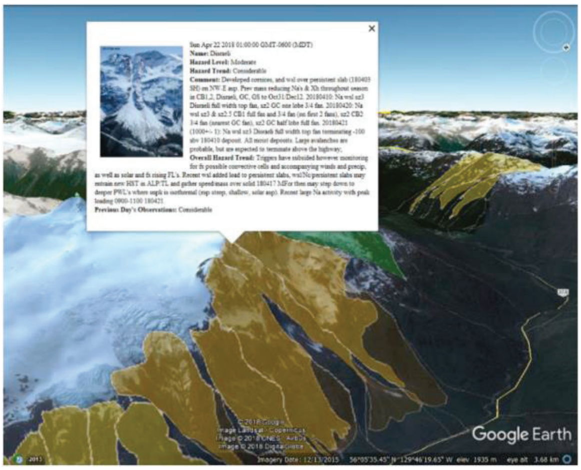

Figure 2: Network linked .kmz Google Earth file allowing for continuous and instantaneous geospatial updates on expected avalanche activity with interactive detailing on avalanche hazard trend, character, previous occurrences and mitigation.

3. USAGE

The daily usage of the application involves forecasters synthesizing the previous, current and forecast weather conditions, the previous and current snowpack conditions, avalanche activity, and mass reduction from avalanche control, then combining and applying these factors to terrain to determine forecast avalanche activity and its effects at the highway-avalanche path interface. It also allows forecasters to account for the different elevation bands, aspects, and terrain features of each avalanche path all of which are factors that significantly impact the expected avalanche activity from a given path and areas of concern under a given set of meteorological and snowpack conditions. The versatility allows forecasters to highlight each avalanche path's most important factors pertaining to future required mitigation.

Forecasts show the morning's hazard level and a trend throughout the day based on forecast conditions. The end product also allows forecasters to integrate daily forecasting with fieldwork, to better convey observations and results and to geospatially verify and calibrate forecasts to ensure they remain accurate and minimize the required highway closures.

4. RESULTS

The chief expectation from the application was to provide an easily accessible communication platform and documentation for the daily forecasting process. In addition to this the application also provides geospatial guidance to aid forecasters in working with stakeholders, emergency response agencies and maintenance contractors to determine how, where and why highway incidents and maintenance can be managed within operational procedures in accordance to forecast hazard levels.

A more quantitative way of determining the impact of the application is highway closure hours. Since the implementation of SAWS software in 2003, avalanche related closure durations per month from November to May average 12.6hrs. Snowpack, weather, and consequent avalanche control may greatly fluctuate between avalanche seasons. The more extensive development of path hazard forecasting is relatively recent and more data is necessary to show conclusive significant results – however recent closure hours per month averaged 2.1hrs.

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