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A new approach for estimating the probability of catastrophic drainage from moraine-dammed lakes

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Outburst floods from moraine-dammed lakes occur in glacierized mountains worldwide. In British Columbia, Canada, resource extraction from, and development of, mountain valleys are increasing the need for a systematic, remote sensing-based method for making preliminary assessments of the risk of moraine-dam failures. Such hazard assessment requires an estimation of outburst flood magnitude and probability. Although numerous empirical relations exist for estimating outburst flood magnitude, no standardized, objective methods have yet been developed for estimating the probability of such floods.

We propose an approach for estimating the probability of moraine-dammed lake outburst floods that does not require field investigation and is based on statistical analysis. Multivariate statistical analysis of remotely measured lake characteristics has helped to identify conditions that predispose a particular moraine dam to failure. The analysis is based on a differentiation of lakes that have drained catastrophically from apparently stable lakes. The advantages of using a statistical analysis to predict the probability of catastrophic drainage are assessment objectivity, repeatability, and simplicity. The success and robustness of a statistical approach, however, depend on the number and quality of data on which the statistics are based.

An inventory of all moraine-dammed lakes larger than one hectare in the southern Coast Mountains of British Columbia was made using aerial photographs and maps. Aerial photographs were used for moraine-dammed lake detection and measurement because they are relatively inexpensive, have high resolution, and are regularly used

in hazard assessments. Observations and measurements from nearly 250 identified moraine-dammed lakes were compiled into the database for statistical analysis.

A multivariate statistical analysis technique called logistic regression was used to identify the most important predictor variables and to generate a formula for the probability of catastrophic moraine-dammed lake drainage. Logistic regression is most appropriate where the response variable is binary (e.g. outburst or no outburst) and predictor variables are both continuous (e.g. lake freeboard) and categorical (e.g. local bedrock geology). A forward stepwise logistic regression reduced the initial list of about 15 predictor variables to only the most important. The probability of catastrophic drainage of a moraine-dammed lake in southern British Columbia can be calculated by substituting remotely measured values of the predictor variables into the logistic regression equation.