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Limitations in the Use of Past Datasets for Future Hazard Analysis

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Frequency-magnitude relations derived from historic and prehistoric datasets underpin many natural hazard risk assessments. For example, probabilistic estimates of seismic risk rely on instrumented records of past earthquakes, in some cases supplemented by prehistoric seismicity inferred from proxy geologic evidence. Yet, there are several problems in these datasets that compromise the reliability of derived frequency-magnitude relations. In this presentation, I briefly discuss these problems. First, historic records of past events are temporally biased. Using seismicity as an example, earthquake catalogues are complete only for the past several decades, the period during which seismic networks have been sufficiently extensive to capture all events. During the first half of the twentieth century, small and even moderate earthquakes went unrecorded, and farther back in time, the occurrence of even large earthquakes is limited to eyewitness accounts. Prior to the last century, there is only limited knowledge of rare, but large events with low average return periods. Yet, low social and political tolerance for risk requires knowledge of events with return periods of hundreds to thousands of years. Temporal biases of this type result in huge uncertainties about the future occurrence of events with large return periods. A second limitation, which applies particularly to prehistoric events, is the large uncertainty in the times and magnitudes of events inferred using geologic proxy data. The example I use in this talk is the large debris-flow prone Cheekye River fan in southwestern British Columbia. Relatively small debris flows have happened on the fan in the historic period, and there is geologic evidence for several much larger prehistoric events during the Holocene. A new residential subdivision has been proposed for the apex of the fan, requiring that geologists estimate the sizes of debris flows with return periods up to 10,000 years. The Cheekye fan has been better studied than any other fan in western Canada, yet there are very large uncertainties in the sizes and times of events that are more than 100 years old. Event times are imprecise because radiocarbon ages carry inherent uncertainties of several decades to centuries. Furthermore, the geologic record of past events is incomplete. The frequency-magnitude curve for debris flows on Cheekye fan is 'better than nothing', but the very low societal tolerance for risk in Canada means that decisions about development on the fan likely will be based on worst-case scenarios of long return-period events that are poorly grounded in science. A third limitation that I highlight in my presentation pertains to weather-related hazards (floods, severe storms, and many landslides). An assumption made when using frequency-magnitude relations to evaluate hazard and risk is that the past can be applied to the near-future. This assumption is invalid for weather-related hazards, because climate is changing. Climate non-stationarity implies, for example, that historic hydrometric data, upon which flood frequency analyses were based in the past century may be of

limited use in planning for future extreme floods.