



Determining the physical vulnerability of roads to debris flow by means of an expert judgement approach

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The physical vulnerability of roads to debris flow is expressed through fragility functions that relate flow volume to damage probabilities. Fragility relationships are essential components of quantitative risk assessments (QRA) as they allow for the estimation of risk within a consequence-based framework. To the best of the Authors' knowledge this is the first time that fragility curves have been produced in order to provide the conditional probability for a road to be in, or to exceed, a certain damage state for a given debris flow volume.

Preliminary assessments were undertaken by means of a detailed questionnaire. A total of 47 returns were received from experts in 17 countries: 32% academia, 51% the commercial sector and 17% governments. Fragility curves have been defined for three damage states (limited damage, serious damage and destroyed) for each of low speed and high speed roads in order to cover the typical characteristics of roads vulnerable to debris flow. The probability of any given damage state being met or exceeded by a debris flow of a given volume (10 to 100,000m³) was derived from the mean of the responses received.

Inevitably there was a degree of scatter in the results and the treatment of such variation, or 'experimental errors', was crucial to understanding the data and to developing the fragility curves. Both qualitative and quantitative methods of arriving at these preliminary fragility curves were utilised. The nature of the data is such that unless all respondents return that value the average probability at the largest flow volume cannot reach unity; as a result the upper ends of each curve were forced to unity and in order to account for larger potential volumes manual extrapolation was undertaken to 1,000,000m³.

In addition to an assessment of the probabilities of given damage states being exceeded respondents to the questionnaire were polled as to their level of experience and confidence in their ability to provide a valid and coherent set of answers to the questions posed.

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