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Simple rules to minimize exposure to coseismic landslide hazard

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Landslides constitute a hazard to life and infrastructure, and their risk is mitigated primarily by reducing exposure. This requires information on landslide hazard at a scale that can enable informed decisions about how to respond to that hazard. Such information is often unavailable to, or not easily interpreted by, those who might need it most. To address this shortcoming, we seek simple rules to identify landslide hazard that are understandable, communicable and memorable, and that require no prior knowledge, skills or equipment to evaluate. We examine two common metrics of landslide hazard, local slope and upslope contributing area as a proxy for hillslope location, and we introduce and test two new metrics: the maximum angle to the horizon and the hazard area, defined as the upslope area with slope >35˚ that reaches a location without passing over a slope <15˚. We then test the skill with which each metric can identify landslide hazard - the probability of being hit by a landslide - using inventories of landslides triggered by five recent earthquakes. For each inventory we use frequency ratio analysis, logistic regression, and receiver operating characteristic curves to quantify hazard discriminant skill. We find that the maximum horizon angle and hazard area provide the most skilful predictions and these results form the basis for two simple rules: 'minimize your maximum angle to the horizon' and 'avoid steep (>15˚) channels with many steep (>35˚) areas that are upslope'. Because local slope alone is a skilful predictor of landslide hazard, we can formulate a third rule as 'minimise local slope, especially on steep slopes and even at the expense of increasing upslope contribute area, but not at the expense of increasing horizon angle or hazard area'. Upslope contributing area, by contrast, has a weaker and more complex relationship to hazard than the other predictors. Our simple rules complement, but do not replace, detailed site-specific investigation; they can be used for initial estimation of landslide hazard or in the absence of any other information.