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Coastal cliff retreat rates: a probabilistic approach fed by Terrestrial Laser Scanner monitoring data

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Cliff retreat is a major concern for coastal communities and coastal risk management. The stochastic nature of cliff collapse prevents predicting and forecasting these events. Repeated terrestrial laser surveys of a cliff face enable the compilation of an inventory of all rockfall events occurring in a given period and afford a fine geometric description of them. Using this inventory, it is possible to examine the frequency distribution of different geometric properties. In this study, we focus on assessing the recurrence of individual cliff retreat events in an attempt to establish a probabilistic relationship between amount of cliff retreat and return period. The analysis is based on a catalogue of more than 8500 events that occurred between December 2005 and April 2008 on the 750-m-long Mesnil Val coastal chalk cliff, Normandy. Individual rockfall thickness are comprised between 0.03 m and 19 m. The cumulated complementory distribution function (CCDF) of rockfall thickness describes erosion hazard and was computed for all events. The CCDF fits a power law but with different scaling exponents according to retreat range. Power laws for rockfalls thinner than 10 cm or thicker than 1 m scale with an exponent close to 2, while that of events between 10 cm and 1 m thick scale with an exponent close to 1. We suggest that rockfalls of the intermediate range (0.1 – 1m) are constrained by the geological structure of the massif (bedding and joints/faults). Thinner or thicker events do not see these structures and behave in a different way. The practical application is this relationship is to determine the return period of hazardous rockfalls. For instance, rockfalls with a thickness of 10 m may occur at Mesnil Val every 14 months which is an information readily usable by urban planners and the civil security.