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Detecting Mass Movements using Fractal-based algorithm

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Rapid climate change is triggering an increase in the frequency and magnitude of catastrophic mass movements on the Earth's surface. Real-time detection of these hazards can improve existing early warning systems and mitigate risks to both humans and society. However, effectively isolating seismic signals from mass movements within continuous seismic recordings remains a significant challenge due to persistent background noise interference. Therefore, It is essential to develop robust detection algorithms for automatic detection. To address this issue, this study proposes the utilization of fractal geometry, which offers a quantitative description of the intricate structures and patterns within a signal across different scales. By using fractal dimensions, this approach aims to differentiate the seismic signal from background noise, because noise typically has a higher fractal dimension than the seismic signal. Two methods, namely, i) variogram estimator and ii) detrended fluctuation analysis, are investigated and applied to the continuous seismic data recorded in the Illgraben catchment in Switzerland to compute the fractal dimension. The findings demonstrate that both methods exhibit power law behaviors in spatio-temporal data, unveiling consistent patterns across scales. The observed variation in fractal dimensions along the seismic traces suggests the reliability of this approach, showcasing reduced susceptibility to false positive detection errors even in the presence of high noise levels. Furthermore, this study also aims to categorize various types of mass movements. This involves defining distinct ranges of fractal dimensions derived from measured data, facilitating the differentiation of various types of mass movements.