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Statistics of rocky coast erosion and percolation theory

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The dynamics of rocky coasts is an erratic phenomenon featuring numerous small erosion events, but sometimes large dramatic collapses. In this sense, its study should not limit or rely on average erosion rates. Recent studies, based on historical as well as recent data, have indicated that the frequency of magnitude of erosion events display long tail distribution, similar to what observed in landslide. In other words the time evolution of a coast morphology does not enter the classical category of Gaussian process, but rather that of critical systems in physics. We recently proposed a minimal dynamical model of rocky coast erosion which is able to reproduce the diversity of rocky coast morphologies and their dynamics. This model is based on a single, simple ingredient, the retroaction of the coast morphology on the erosive power of the sea. It follows from the idea that erosion can spontaneously create irregular seashores, but, in turn, the geometrical irregularity of the coast participates to the damping of sea-waves, decreasing the average wave amplitude and erosive power. The resulting mutual self-stabilization dynamics of the sea erosion power and coastal irregular morphology leads spontaneously the system to a critical dynamics. Our results indicate then that rocky coast erosion and the statistical theory of percolation are closely related. In this framework, the sometimes fractal geometry of coastlines can be recovered and understood in terms of fractal dimension of the external perimeter of a percolation cluster.
From a more practical point of view, the analogy with percolation interfaces means that the coast constitutes a strong, but possibly fragile, barrier to sea erosion, emerging from a self-organised selection process. Accordingly, the effect of a slow weathering degradation of the rocks mechanical properties, as well as other perturbations from natural or human cause, can trigger random and large erosion events difficult to predict and control. To the extent that these ideas apply, natural coasts should be â[U+0080][U+009D]preservedâ[U+0080][U+009D] and managed with care.