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Adel SEPEHR

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Adel SEPEHR

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Co-President of the Scientific Committee

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Non-Linear Equilibrium Points in geomorphology

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The concept of "*equilibrium*" is quite basic to system theory and is considered here to imply a complete adjustment of the internal variables to external conditions. The external conditions usually change in two statuses: catastrophic and gradual changes. The response of a geomorphic system to these statues is different, although in the two statuses, change towards equilibrium points is main goal of geomorphic system. The geomorphic systems are complexity systems with properties of open system. In these open systems the threshold is a bifurcation point. The path followed by the thermodynamic branch beyond the threshold may involve further thresholds and hence bifurcations. In passing through a bifurcation point, the system loses its structural stability and undergoes a sudden or catastrophic change to a new form. The new equilibrium point has new energy status. The energy flow creates patterns in the geomorphic system which can be an early warning signal to find thresholds and resilience limitation of geomorphic system to response geo hazards. In this article has been analyzed these equilibrium points in the geomorphic systems. If the constraints are strong then the system may change smoothly along a thermodynamic branch into non-equilibrium states in which the theorem of minimum entropy production still applies. At a certain distance from equilibrium, called the thermodynamic threshold, non-linear relationships emerge and the steady states along the branch are not of necessity stable. Beyond the threshold, the solutions of the equations governing the dynamics of the system may no longer be unique: the system may enter one of several new regimes. The results and discussion of this article can be a new conceptual paradigm in the geo-hazards risk management.

Keywords: non-linear equilibrium, early warning signals, Thresholds, thermodynamics

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Development of experimental landforms with rainfall-erosion and uplift of various rates

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A series of experiments with rainfall-erosion and uplift of various rates suggests the existence of threshold uplift rates, across which experimental landforms show different aspects of development. A mixture of fine sand and kaolinite compacted in a square-prism-shaped container (60x60x40cm) is pushed out at a constant rate from a flat ground surface under the artificial mist-type rainfall. In the experiment with a low uplift rate below the lower threshold, a certain low characteristic relief determined by the mound erodibility and rainfall intensity develops with exclusively fluvial erosion under the detachment-limited condition. In this case erosion may slightly exceed uplift to slowly lower the surface. When the uplift rate becomes higher than this lower threshold, uplift exceeds erosion in the upstream area where fluvial erosion works less. Hills grow and slope processes start working. While slope failures inside the uplifted area do not lower the average height unless the sediments are carried away by fluvial processes, the increased sediment supply from slopes helps streams become steeper with uplift and enhances their transport ability. Uplift and erosion then become balanced under the transport-limited condition to keep average height roughly constant and landscapes similar. The uplift of higher rate makes hills grow higher and increase the sediment supply from slopes more, and this works to keep average height higher corresponding to the uplift rate. The experimental landform seems to attain a certain steady state with the equilibrium between uplift and erosion. If the uplift rate becomes even higher and crosses the possible upper threshold, uplift overwhelms erosion and hills grow into high mountains until the relief hits the limit probably determined by the threshold slope. Whenever the uplift ends, the experimental landform starts decreasing its height and relief exponentially, and a peneplain-like surface develops in a long period of erosion.