The transition between grassland and desert in a theoretical grassland ecosystem

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The effects of human activities on the transition between grassland and desert in a theoretical grassland ecosystem are investigated by the approach of conditional nonlinear optimal perturbations (CNOPs). CNOPs are the initial perturbations representing the human activities and (or) natural factors, whose nonlinear evolutions possess the maximal effects on the abrupt changes. It is shown that when the moisture index is between the two bifurcation points, a large enough finite amplitude perturbation can induce a transition from the grassland (desert) state to the desert (grassland) state. The thresholds of such transition along the bifurcation diagram of the moisture index are also given by the CNOP approach. The results demonstrate the nonlinear characteristic of grassland ecosystem to the human activities and yield a primary insight into the management of human activities. The results also support the viewpoint of Zeng et al. that it is of importance to investigate the shading effect of wilted biomass on the grassland ecosystem.