Hyperbolic reaction-transport equations in dryland ecological modeling

Giancarlo Consolo

1. Abstract

In the last centuries, climate changes and human actions have been bringing Earth to undergo abrupt shifts versus catastrophic scenarios, such as rising of global temperatures, desertification processes, more and more frequent periods of drought [1]. As a consequence of that, it is believed that dryland areas will greatly increase their extension in the very next future. To this aim, scientists have been focusing their attention on the description of those phenomena that are considered as the precursors of the desertification of a given area, such as the emergence of vegetation patterns. Identifying the complex mechanisms which rule the formation and the stability of these structures becomes, thus, crucial to predict the evolution of dryland ecosystems [2],[3],[4].

However, the geographical remoteness and the long timescale over which such phenom- ena occur make in-situ experiments quite prohibitive, so that the possibility of acquiring a better understanding on the involved mechanisms is generally relied on mathematical models [5]-[7].

In this talk, we will discuss some of our recent results on the dynamics of stationary and non-stationary vegetation patterns emerging in 1D and 2D hyperbolic reaction-transport systems where patterns arise from the interaction between water and vegetation biomass. Differently from classical parabolic models, inertia exhibited by both vegetation and water is here explicitly taken into account into balance equations for the dissipative fluxes. It will be shown the role of inertia is manifold and not limited to the transient regime. Indeed, it may: enlarge the region of the parameter plane where patterns may be observed; modify the critical parameters at onset (wavenumber, migration speed); alter the (supercritical or subcritical) dynamical regime in which patterns emerge; affect the transitions between different patterned states; mask future deterioration in ecosystem condition; favor the per- sistence of a patterned state even after a perturbation is expired and improve the resilience of ecosystems, leading to a more favorable configuration [3],[4],[8].

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