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A recipe for desert : analysis of an extended Klausmeier model

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6 Outlook

We briefly outline future research topics, motivated by the results presented in this thesis.

Stability of 2D patterns

In Chapter 2 and 3, following [147, 199] we have extended the stability analysis from spatially homogeneous vegetation to banded vegetation patterns. Banded patterns are periodic in one space dimension and constant in the other. For assessing the stability of these patterns against perturbations we have applied a Floquet-Bloch decomposition in the dimension of periodicity and Fourier analysis in the other.

Spotted patterns are periodic in two space dimensions. A next important step is to determine stability of spotted patterns, which requires the application of Floquet-Bloch decomposition in two space dimensions. The stability of these patterns is crucial for the understanding of the final steps in the desertification process.

Observability of dashed vegetation patterns

In Chapter 3 we have seen that under increasing environmental stress banded vegetation tends to break up in dashed vegetation: spots aligned in stripes. The power spectrum (or periodogram, obtained after Fourier transformation) of dashed vegetation shows similarity both to striped patterns and more hexagonal distributions of spots.

In existing observational studies dashed patterns could have both been identified as banded or spotted patterns [12, 35, 193]. An observational framework in which dashed patterns can be identified separately would help in the validation or falsification of the banded vegetation breakup process.

Gapped patterns in advective reaction-diffusion systems

In Chapter 3 we have shown that for a very general two-component reaction-advection-diffusion system, the spatially homogeneous state is first destabilized by perturbations in the direction of advection. Although this doesn't exclude the possibility of observable gapped patterns on slopes, their observation for a wide range of rainfall parameter values for all relevant slopes [12] is interesting. Analytical analysis near the onset of pattern formation for reaction-advection-diffusion systems in two space dimensions may shed light on the origins of gapped vegetation patterns.

Field data input for the modeling of grazing

In Chapter 4 a framework has been introduced to include nonlocal grazing in arid ecosystem modeling. Based on the extended Klausmeier model, several qualitatively distinct changes in vegetation pattern stability have been presented, depending on which modeling choices are made.

Because the framework allows for different implementation possibilities, extraction of foraging responses (distributional, numerical and functional) from field data is desired to make an informed decision about the modeling choice.