Nonlin. Processes Geophys. Discuss.,
https://doi.org/10.5194/npg-2018-36-RC1, 2018

Nonlinear Processes in Geophysics
Discussions
Open Access
EGU

Interactive comment on "Role of nonlinear interaction between water and plant in stability analysis of nonspatial plants" *by* Guodong Sun and Xiaodong Zeng

Anonymous Referee #1

Received and published: 5 November 2018

General Comments:

The paper examines linear and nonlinear stability of steady-state equilibria in a system of ODEs that correspond to the "reaction terms" of the Klausmeier model for banded dryland vegetation patterns on a uniform hillslope. The work shows that two linearly stable states, the desert state and uniform vegetation state, can be linearly unstable. Optimal perturbations, in the sense defined by the CNOP method used, are found that can switch between these states. The work also claims that the nonlinear terms play a more important role than the linear ones in forcing transitions between the states.

At a mathematical level, this work seems like a straightforward application of estab-

Printer-friendly version

Discussion paper

lished methods. If this is an incorrect assessment, I would advise the authors to highlight novelties in the approach used.

I also have a hard time seeing the value in these results from an ecological perspective. The Klausmeier model was specifically designed to address the appearance of banded vegetation patterns, and neglecting (1) the water transport term and (2) the seed dispersal term in a study of stability seems questionable to me. These are two key processes that the model posits as leading to linear instability of the uniformly vegetated state. In the full model, the uniformly vegetated state is not linearly stable all the way to the saddle-node bifurcation, but is unstable to finite wavelength perturbation through a Turing-Hopf bifurcation. Moreover, the kinds of perturbations suggested in the study correspond to spatially uniform perturbations, whereas it seems more ecologically plausible to expect spatially localized perturbations.

One main result stated in the abstract is that the nonlinear terms play a more important role in the transitions between the states than the linear ones. The authors should provide more explanation as to why this is important, especially given that the specific choice of nonlinearities associated with these terms are perhaps the most questionable assumptions in regards to the fidelity to the hydrological processes being modeled. I would intuitively expect any nonlinear term to be more important to perturb away from a linearly stable state than a linear term, is this intuition correct? Also, how important is the restriction to spatially uniform perturbations to this result?

I believe that a similar study that considers nonlinear stability of the full model and addresses ecological implications may be of interest, but I do not find enough merit in the current work as it stands to warrant publication.

Specific Comments:

Fig. 2-3: This may be a naive question, but why do you show time evolution? Aren't you computing an initial perturbation u_σ for a given equilibrium? It seems more informative to plot u_σ as a function of parameter a for the equilibria.

Fig. 5: Maybe I am misinterpreting this figure, but it does not seem believable. I would expect the asymptotic state for full model (Eq. 2) to be a banded pattern with stripes aligned transverse to the advection direction instead of a spotted pattern.

Interactive comment on Nonlin. Processes Geophys. Discuss., https://doi.org/10.5194/npg-2018-36, 2018.

Printer-friendly version

Discussion paper