

Interactive comment on “Eco-geomorphology and vegetation patterns in arid and semi-arid regions” by P. M. Saco et al.

Anonymous Referee #1

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This paper presents a new model for the interacting dynamics of soil water, and vegetation in arid areas which extends a previous model (Rietkerk 2002) to include both seed transport and soil erosion processes. Both extensions are novel in this class of models and lead to interesting results: respectively stationary vegetation bands and hillslope profiles which are in agreement with observations. The paper is well written, it discusses appropriately the literature and it is in general clearly structured. For these reasons I recommend its publication, but some changes in order to respond to the comments below could, in my opinion, improve the manuscript:

The introduction leaves the impression that the only relevant process for vegetation pattern formation is the runon-runoff process. In general these patterns are recog-

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nized to emerge from both competition and facilitation feedbacks (such as increased infiltration under vegetation patches, but also through competition for the limiting resource through the root system). Both mechanisms alone have been found to be able to generate patterns in models.

Section 1.2 mentions field observations that incised rills and gullies lead to the disappearance of banded vegetation. The model presented would seem to be an ideal tool to explore this issue, but it is not further discussed in the paper

At the beginning of section 2: the vegetation model presented is more than only 'partially' based Rietkerk et al 2002. It is basically an extension of this model apart from the different form of the overland flow equation. The reasons for modifications could be discussed briefly (such as the introduction of a flux term in the overland flow equation, which is needed in order to have a flow to use for seed transport and erosion).

I do not expect any significant difference, but how sensitive are the results to the fact that the lateral soil moisture diffusion term was neglected?

Vegetation bands are found to be stable if an appropriate value for the parameter regulating seed transport, c_2 , is chosen. This is an interesting and novel result. But how fine-tuned is the particular choice presented? Would even higher values lead to downslope migrating bands? In general the particular choices of c_1 and c_2 should be justified.

The results presented in section 5.3 show the organization of the hillslope profile into a series of steps, similar to profiles observed in the field. Is the profile presented at $t=500$ an asymptotic, almost stationary solution? (n.b. There is an obvious loss of elevation over time due to the absence of a tectonic uplift term and other source terms such as dust deposition, but if this is neglected are the steps stationary?) If so this should be said. If, as I suspect, it is not, why was this particular time chosen for the comparison, and what is the evolution of the hillslope on longer times? At least some discussion should be devoted to this issue.

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The coupling of vegetation bands with soil erosion does not seem to be explored to its full potential: The authors report that migrating bands lead to flat topography. This is an interesting issue, is there a critical value of c_2 over which the steps appear? There is a clear separation between the vegetation timescales and the erosive timescales using the parameters considered by the authors: if these were closer, or if different values of c_2 were chosen, could coupled migrating modes appear?

Minor typos and remarks:

P9: after eq. 2 : fiction → friction

P9, third line from bottom: the constant is called C_n here and c_n in eq. 3.

P11/P12 End of section 2.1: what is the reason for discussing the unphysical case $W_0 > 1$? Stating that $0 \leq W_0 \leq 1$ should be enough.

Eq.6 : The Laplacian operator Δ needs to be defined as such, as it was not introduced before.

- There is a strange mix of units in the paper, with both mm and m being used at the same time. Using only one of them would be advisable (maybe choosing always SI units for mass and length)

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