Earth Surface Dynamics Discussions

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Comment on esurf-2021-76

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Referee comment on "Comparing the transport-limited and ξ–q models for sediment transport" by Jean Braun, Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2021-76-RC1, 2021

This manuscript addresses the general problem of the propagation of a sedimentary signal between a source and a basin. Jean Braun compares the predictions of two theoretical sedimentary basin topography models, one (old) corresponding to the transport-limited model and the (more recent) E-q model of Davy and Lague (2009) which belongs to the family of under-capacity models. It shows clear differences of the E-q model compared to the TL model, among which the possibility of transmitting all the frequencies of variations from the source to the basin. It is also clear that the response time is longer with the E-q model than with the TL model and its different scaling with river length is also non intuitive. Finally, this analysis shows that both models result in the same equilibrium topographic profile, with a linear upstream portion and a more distal concave portion, which results from the downstream increase of runoff by accumulation of rainfall on the piedmont. The manuscript is dense but very clear and well illustrated. It will be of interest to a broad community of sedimentologists and geomorphologists working on source-to-sink issues, shedding new light on the dependence of the interpretation of the sediment record on the transport model in the transfer zone. I have already read and commented on a pre-submission version of this manuscript. I feel that the present version is almost in a good shape, although I have several questions:

The demonstration that the shape of the topographic profile of the foothills has two parts, one linear and the other concave, is an advance that allows a better understanding, for example, of the observed scaling relationship between alluvial fan surface and watershed surface. However, river slope also depends on grain size in nature and in theory (e.g. Parker et al., 1998). Preferential deposition of coarse sediment upstream can influence the variation of this slope. The experiments of P. Delorme (Delorme et al., Earth Surf. Dynam., 5, 239-252, 2017) using two grain types of different mobilities show a longitudinal slope transition associated with the deposition of these two materials. Since grain size decrease is observed in natural systems, I wonder what the influence of downstream grain size variation on Lo might be in the model.

I am probably influenced by arid environments, but in these settings, rainfall and evaporation distribution may be strongly influenced by elevation, so that the runoff does not increase significantly along the piedmont and further downstream. This would correspond to a nearly constant drained area Ao in the model. This would influence the shape of the equilibrium profile, and perhaps the transient dynamics. Is it possible to discuss this from the scaling relationships established in this theory?

The weak influence of subsidence on the longitudinal profile at equilibrium is clearly demonstrated. However, during an increase in sediment flux or a change in precipitation, part of the flux would be trapped by subsidence. I anticipate that this will not fundamentally change the rather "upward" or detachment-limited behavior of the E-q model compared to the "downward" behavior of the TL model, but can it change the conclusions regarding the transmission of all frequencies of source variations in the E-q case?

A constant width w is assumed in the model. Is there a way to anticipate how possible variations of w during sediment flux or rainfall variations (with potential entrenchments and infill) may affect the transfer of source signals?

Given the density of information in this manuscript, I wonder if a summary table or diagram showing the differences between the two models would not be useful to facilitate dissemination to a large audience.

The Fastscape simulations are very promising. In my own experience of such kind of simulations with CIDRE using also the E-q model and multiple flow algorithm, the rivers move a lot on the piedmont, as observed in Fastscape, with avulsions and ephemeral confluences in particular when adjacent catchments in the mountain feed adjacent fans in the basin that merge downstream, which is different from a one-point source. I wonder if this dynamics can be merged along a line in average, but as Jean Braun writes in the conclusion, this is for another story.

Specific comments

Line 51 : latex tipo «Theta »

Line 197 parenthesis lacking

Line 220 is it and "=" or a "propto" in this equation?

Line 240 I do not understand where does this formula of L come from.

Lines 241-245 Could you define a bit more what you mean by linear and non-linear systems here?

Line 445 about the Whipple's experiments :It seems to me that it corresponds better to the TL model in Figure 6d rather than the E-q model in Figure 6a… Maybe the experiments of P. Delorme et al. «Growth and shape of a laboratory alluvial fan", Physical Review (2018) may help the discussion here.

Line 485 : I think the correct paper here is Carretier et al. Earth and Planetary Science Letters 546, 116448 (2020).

Line 565 tipo in Table's reference

Figure 20 caption: indicate what the dashed line is

In many figures there is tipo on the “xi-q model” (“zeta-q” is used instead)

Best regards,

Sebastien