Hydrology and Earth System Sciences Discussions

Interactive comment on "Spatial variability in channel and slope morphology within the Ardennes Massif, and its link with tectonics" *by* N. Sougnez and V. Vanacker

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General comments

In this study the links between some geomorphometric indexes and the uplift rate of a low relief study site are evaluated. The morphometric indexes are relative to hillslope morphology, basin shape and river channel morphology. The study is based on a digital terrain model of moderate spatial resolution (20 m) derived from photogrammetric derived levelling curves, suited for 1:10000 cartography. From the area investigated 10 catchments covering various tectonic domains were selected to perform the anal-

ysis. The authors conclude that the morphometric analysis could give information on the transient adjustment of rivers to tectonic uplift, above all considering the characteristics of knickpoints. In regard to the other morphometric indexes it seems difficult to draw a clear conclusion. This could be related to the fact that in regions of low or moderate uplift rates other factors or processes (geo-structural heterogeneity, climate spatial-temporal variability, etc.) superimpose their effects on surface morphology. The paper meets the topic of this special issue on the quantitative analysis of digital elevation models and the study is very interesting and stimulating. The paper is well written but some sections (see specific comments) need to be expanded and some more details on the geo-structural setting of the area should be given. I think that after some restructuring the paper will be worth publishing.

Specific comments

P6983 line 2-5. "The development . . . " I think that the wide use of morphometric data is also related to the wider availability of topographic digital data of moderate and high resolution.

P6983 line 18-20. See general comments in relation to this point.

P6983 line 25-29. "For these. . . ." I'm not sure about the meaning of this sentence. In particular what you mean with "hill slope processes"? While these hillslope morphogenetic processes are mainly related to uplift and not to geo-structural heterogeneity or other local factors?

P6984 line 8. Change "indices" with "morphometric indices".

P6984 line 9. I have not clear the meaning of "geomorphic response profiles".

Section 2.1 Study area. I think that a simplified geo-structural map of the area should be given; this because of the geo-structural setting is, in general, a very strong factor affecting solid earth surface morphology. It could be interesting to understand how different, from this geo-structural perspective, are the selected catchments. Moreover,

a more clear idea of the main river network should be given (maybe a map with the river network overlapped to a shaded relief map).

P6985 line 17-18. Here I have two questions. 1) How you can say that the climatic conditions during the quaternary were spatially uniform (i.e. what elements)? 2) If the climatic conditions have temporal variations, can we can expect that the non "steady state" character of river morphology is partially related to this change in conjunction to active tectonic?

P6985 line 25. Here some points should be clarified: 1) Why only 10 catchments? According to which criteria have you chosen these basins? Could you describe shortly the "various tectonic domains" characterizing the basins?

Section 2.2 Topographic and tectonic uplift data. This section has to be expanded and clarified; more specifically:

P6986 line 7-8. "We reconstructed the original levelling curves. . ." I don't understand the point here: if the DTM has artefacts how you can pick up correctly the levelling curves? Maybe here you mean that you re-interpolated the original levelling curves.

P6986 line 9. Here I avoid to ask you why you used "topo to raster" tools but you have to say something more about the method and about the interpolation parameters that you used (this considering the topic of the special issue).

P6986 line 10 The depitting method should explained better (considering that the mentioned paper is not in English).

Figure 1b. If the profiles are normalized the distance should not have the unit of measure.

P6986 line 12-13. I think that you should say that you used a D8 flow direction algorithm to derive drainage area. Then, the way in which you derived river profiles is not clear. In particular: did you derived a drainage network from the DTM? If yes, with which method (area threshold, slope area, etc. . .)? This is a very important point.

P6986 line 25. It could be useful to remind the readers what is local relief.

P6987 line 3-5. "For each catchments .." The procedure followed to pick up longitudinal and transversal profiles is not clear (this also in relation to the comment on river network derivation). What you mean when you say "based on original levelling curves"? Did you not used the derived DTM?

P6987 line 14. I think that it is a matter of taste but from my side I prefer "downstream distance" to "distance to source".

P6987 line 14 -22. The discussion on knickpoints is very important considering that part of your conclusions is based on these features. You should explain how you selected the knickpoints of tectonic origin and discarded the ones related to geo-structural heterogeneity or other factors.

P6988 line 5–8. Viewing the things from a geological perspective, I think that channel steepness represents the balance between net uplift and erosion only in particular conditions (i.e. in absence of geo-structural heterogeneity, local oscillations of base level, etc. . .).

Section 2.4 Statistical analysis. This section should be expanded and explained.

P6990 line 12. "within" Could you say more about the morphological heterogeneity characterizing the single catchments?

Section "3 results" and "4 discussion":

1) I think that dividing 10 samples (the 10 catchments) in 3 classes could be questionable. This in the sense that for defining the characteristics of each cluster you have only 3 or 4 samples. But 4 samples are few for calculating also simple statistical moments such as the mean or the standard deviation. Then, looking at table 2, I'm wondering if you normalized data before performing the clustering.

2) Figure 2b and text at pages 6990-6991. Is not clear if and why you excluded from

the regression the points inside the circles. Then how do you derived Figure 2d?

3) Figure 4. I have the feeling that the number of catchments are too few to justify a quadratic polynomial relation.

Section 5 "Conclusions".

In regard to the conclusion that the river morphological properties are better indicator of recent tectonic activity than the morphometric parameters of hillslopes should discussed in more detail. This because of the limited resolution of the dtm used as well as the limited number of indexes you use to pick up the morphology of hillslopes. I'm wondering if the same happens if you use higher resolution dtm and/or other morphometric indexes such as roughness or indexes related to channel network density. Another conclusion of your paper, from my point of view, is that in this case an index based on expert knowledge (i.e. the selection of knickpoints) seems to fit better with uplift data than "automatic" calculated indexes. In particular, the selection of knickpoints is mainly based on expert knowledge and on a visual analysis of longitudinal profiles; differently, the other morphometric indexes are calculated automatically and objectively (well, neglecting the subjective choice of calculation parameters) from the dtm. Makes sense to put together in the analysis these two family of indexes?

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