

To the Associated Editor of ESurf

Dear V. Vanacker

Thank you for your last comments on the revised version of our manuscript “Drainage reorganization and divide migration induced by the excavation of the Ebro basin (NE Spain)”.

We are pleased to resubmit a revised version of this manuscript

In the following we respond to the three main remaining questions you addressed as well as to the minor comments.

Sincerely yours,

Stéphane Bonnet on behalf of the co-authors

1) In section 3.3, you use a stream power method to analyse differences in specific stream power between the present-day and ancient Duero river (L380-394). This is somehow surprising, as you state in section 3.4 that the results of stream power analyses can be biased by the quality of the topographic data - slope measurement on low-resolution DTM data. Is your argument in section 3.3 robust, or can you rephrase this argument based on the results of the X-analyses?

This is actually a problem of spatial scale of investigation. We first applied a stream power analysis to the Duero profile to investigate large-scale morphology of this river. Here the DEM resolution is sufficient to capture these large-scale features. On the opposite DEM resolution matters for the analysis of the landscape morphology near the Ebro-Duero divide, because we investigated here very detailed spatial variations in morphology that can be biased by the DEM resolution. That is the reason why we applied a X-analysis, which is not sensitive to DEM resolution through slope measurement (Perron and Royden, 2012), rather than a slope-area analysis. We agree that it was potentially confusing in the previous manuscript.

The X-analysis is now frequently used in the community of Earth Surface Processes to infer landscape disequilibrium and divide migration. Actually the reviewers asked us to reduce the presentation of this method in the revised ms. Then we do not think necessary to justify for its use in our study and we modified the ms accordingly:

Previous ms (lines 400-408):

The comparison of the shape of longitudinal profiles of rivers across divide is a way that has been proposed recently to infer disequilibrium between rivers and the potential migration of their divide (Willett et al., 2014). Although the slope-area analysis of channel profiles (e.g. Whipple and Tucker, 1999; Kirby and Whipple, 2012) is potentially a powerful tool to evidence differences in the equilibrium state of rivers across divide, and then to infer their migration (Willett et al., 2014), this method is limited and even biased by the quality of the topographic data. Indeed, both a low-resolution of the DEM and corrections brought to the DEM (filling or carving), lead to substantial uncertainties that are automatically transferred to the slope-area data. To avoid slope measurements, Perron and Royden (2012) proposed a procedure based on a coordinate transformation allowing linearizing river profiles...

New ms (lines 399-404)

The comparison of the shape of longitudinal profiles of rivers across divide is a way that has been proposed recently to infer disequilibrium between rivers and the potential migration of their divide (Willett et al., 2014). The χ -analysis of river profiles (Perron and Royden, 2012) is a powerful tool to evidence differences in the equilibrium state of rivers across divide, and then to infer their migration (Willett et al., 2014). This method is based on a coordinate transformation allowing linearizing river profiles (Perron and Royden, 2012)...

2) In the discussion, you comment on the link between tectonic activity and landscape evolution. Given that the landscape response time can be (very) long in these systems, can we make a firm statement yet on the drivers of landscape incision (tectonic vs. climate patterns: L501-503)?

At the scale of Northern Iberia, the main driver of incision was likely the change from endorheic to exorheic drainage condition (lines 61-67; lines 102-109; lines 113-114; section 4.2). We extensively discuss this phenomenon in section 4.2. On lines 501-503 (section 4.1; now lines 498-500), we discard the role of local tectonic activity on the pattern of migration of divide that we document. Then, we do not think necessary to add any statement here, as the role of the change from endorheic to exorheic condition in driving incision is further discussed in the next section (4.2)

3) The climate pattern in the wider region is studied based on modern precipitation data (Fig. 6). How relevant are such maps when we look at long-term processes, certainly when considering the climate changes mentioned in L181-206? A short discussion on the relevance of the data for reconstructing past climate change would be welcome - for example L505-519.

On lines 505-519 (now 502-518), we report that our analysis shows that there is still a landscape disequilibrium along the Ebro-Duero divide and that in the absence of modern precipitation contrast there, we conclude that the present divide migration is unlikely driven by difference in climate:

Lines 511-513 of the former revised ms (now lines 508-510) : “we suggest that the **present day** climatic condition is unlikely to control the general pattern of **current** drainage reorganization between the Ebro and Duero basins”.

Proxies (section 2.4, lines 181-206) indicate past climatic variations in northern Iberia but they do not allow to infer past precipitation differences along the Ebro-Duero divide. We then add the following sentence in the new ms (Lines 512-514):

(Lines 512-514) “Existing paleoclimate proxies do not allow to evidence past precipitation differences along the divide that could explain the reorganization of the drainage there.” Moreover, there is no clear evidence of important glacier development and related ...

Some detailed comments

L44-45: "drop in the location of drainage divide". Do you mean "elevation"?

No, spatial position: "location" changed to "spatial position"

L50: Would you characterise the X-method as an analytical approach? Check, and rephrase - if necessary

Yes

L63: Would be good to have a reference here

OK -> Riba et al., 1983; Garcia-Castellanos et al., 2003

L72-73: Rephrase sentence

“Then, these two adjacent basins are characterized by contrasting preservation of their endorheic stages and represent an ideal natural laboratory to evaluate the mechanisms that caused differential post-orogenic incision at the origin of divide migration”

Rephrased (Lines 71-73):

“Then, these two adjacent basins are characterized by differences in incision and in the preservation of their endorheic stages. They thus represent an ideal natural laboratory to evaluate divide migration in response to differential post-orogenic incision.”

L175-180: The precipitation map is relevant to study modern precipitation patterns (Fig. 6). What about long-term patterns? Are they expected to be steady over this time period?

As modern precipitation does not show significant contrasts along the Duero-Ebro divide (except in the Cameros area as discussed), it is unlikely that some major contrasts existed in the past

L34-L63-L234: Check for consistency and uniform wording in the text (X-method, chi-analyses, X-Analysis, etc.).

Line 34, now line 28: "*Chi-analysis of river profiles*" changed to "*χ-analysis of river profiles*"

Line 63: "*χ-method for analyzing longitudinal profiles of rivers*" changed to "*χ-analysis of longitudinal profiles...*"

Lines 234 and 429: "*χ Analysis*" changed to "*χ-analysis*"

Lines 482, 572: "*χ analysis*" changed to "*χ-analysis*"

L244-246: Rephrase sentence, not clear

"They pointed out several chronostratigraphic evidence that allow them to build a relative chronology of capture events in the Jalon network history."

Changed (lines 245-246):

"They used chronostratigraphic evidence to build a relative chronology of capture events in the Jalon area ."

L275-276: Rephrase

"However despite a similar bedrock we cannot ruled out some local influence of the lithology on the shape of these knickpoints"

Changed (276-277):

"However we cannot ruled out some local influence of the lithology on the shape of these knickpoints"

L484: What do you mean with "X predictions"?

"χ predictions" changed to *"χ evidence"*

Supplementary materials: Can you move your text with the figure caption (now on page 4) to the heading of the S2 section (top of page 3)? As such, we can read directly in the heading of S2 what we should see on the figures below.

The text has been moved as requested.