Answer to reviewer 2

February 5, 2016

Note: Bold text indicates the reviewer's comments.

1 General comments

The manuscript by Metivier and co-workers reports on channel geometry, discharge and grain size data collected from the Bayanbulak Grassland, China, during two field campaigns. The manuscript is generally well written and contains valuable data on gravel-bed rivers, complementing currently existing data. The data is presented in a smart format allowing for comparison to other datasets and systems of all sizes.

The manuscript could be significantly improved by defining key terms used throughout the manuscript. This includes the terms 'meandering' and 'braiding', which are distinguished throughout the manuscript, in the graphs, and also a conclusion hinges on this distinction, while it remains unclear to the reader how a meandering and braiding river is defined in this study. Other improvements may arise from a more detailed explanation of the measurement strategy and protocol, and the inclusion of a discussion section to better develop the ideas the authors may have on the key findings of this study. We wish to thank reviewer 2 for his/her positive comments. We hereafter provide detailed answers.

The manuscript would benefit from a definition of the different terms used to describe channel forms throughout the manuscript. A plethora of terms describing channels forms such as 'rivers', 'streams', 'channels', 'reaches' and 'threads'. A clear definition of all terms will help the reader understand what is meant exactly, how the terms link different hierarchical morphological forms (i.e. rivers and threads within rivers), and will ensure consistency throughout the manuscript. A graph with a visual representation of all the mentioned channel forms and their terms as used in the manuscript would be highly insightful for this purpose. This graph would be well placed in the beginning of the introduction where many terms are already mentioned, or could be placed in the Method section. We have added a figure in our introduction to clarify the definition of the terms used. To summerize, "rivers" and "streams" correspond to the same definition, they include the channel and its floodplain. We now use "river" only. The channel corresponds to the flow that is enclosed between its banks. The threads correspond to the places where the flow occurs. In a meandering river there is only one channel and one thread. In a braided river there is usually one channel composed of many threads separated by bars or islands. As much as possible we try to be coherent with previous work from Métivier and Barrier (2012) and (Gaurav et al., 2015).

A crucial element missing from the current manuscript is a definition of meandering and braided rivers. What definition was used to determine whether a river was meandering or braiding? It seems likely to use the sinuosity to quantify the degree of meandering and a braiding index to quantify the degree of braiding. And how was this measured? For example, along what kind of basin length was the sinuosity measured? Was this done consistently for all

reaches reported on? Also, how many transects were used to quantify the braiding index, and was this done consistently for all reported reaches? Such quantification of river pattern will be helpful to substantiate qualitative statements like 'highly meandering' on p. 1293, line 9. In addition, formal quantification of the reported river patterns may also provide additional understanding on the reported similarities between the termed meandering and braided rivers. For example, are only the statistical distributions for lower sinuous meandering rivers similar to braided ones, and maybe not the highly sinuous (sinuosity ¿ 1.5) meandering rivers? This latter analysis allows for a more sophisticated analysis of the collected data and would also allow the authors to align their work with previous work on this topic where distinctions between river patterns could be made based on the degree of sinuosity, see for example Kleinhans and Van den Berg (2011). Meandering rivers are single-thread rivers whose sinuosity is higher than some arbitrary value. On average the sinuosity of single-thread channels is 1.5 ± 0.2 near the measurement sites (measurements were performed on 1 km-long stretches). Hence most of our rivers are highly meandering if one refers to the classification of Schumm (1977).

The differenciation between braided and meandering rivers was very clear on the field, as quoted by the reviewer below. All the braided rivers we surveyed had a large number of threads flowing in a large, non-vegetated, channel enclosed within natural banks. In all cases the total braiding index would be more than 3.

Finally, given the small number of mildly sinuous channels we did not try the split the dataset into subsets. We now explicitely state these points in the revised manuscript

A more detailed explanation of the measurement strategy and protocol would help the reader better understand the collected channel geometry, discharge and grain size data. A number of questions that a revised manuscript should answer at minimum are: The answers below are included in the revised version of the manuscript.

How many cross-sections were measured to represent a specific river? Each thread was measured at one to six locations.

What were the criteria to choose a cross-section, knowing that channel width variations along a river can be substantial. Were cross-sections always made at a similar location (e.g. middle of bend) in the river? Please motivate. The reaches were chosen according to their accessibility and the sections were chosen at random. Our purpose here is not to study one particular river at any particular given position, but rather to sample as many possible section types on as many streams as possible to test whether a consistent picture emerges

How were the reported average values on flow velocity, water depth and grain size calculated? Is this a stream cross-sectional average, or does it represent a single (maximum?) flow velocity in the middle of the stream? Please specify this for the two methods used (ADCP profiles and manual measurements). We try to be more explicit in the revised version.

When we used an ADCP, we mounted the instrument on a raft and performed cross-sections from which we extracted both the geometry and the discharge of the thread. For manual measurements, we used rulers and ropes to level the topography of the section. We then calculated the average width and depth. We measured the average surface velocity using floats. The average velocity was derived from the surface velocity using a classical correction factor (Sanders, 1998)

How many counts of grain size were used to calculate a D50 and D90 for each crosssection? We used the Wolman's counting method and procedure (Wolman, 1954; Bunte and Abt, 2001). Depending on the surface exposure of gravels, the count number ranged from 200 to 500.

Along which length were the long profiles and slopes of the streams measured? Does this align with the length across which an assessment of the degree of meandering and braiding was made? The length of topographic profiles varies from 100 m for braided threads to more then 3 km for one meandering channel. We measured the sinuosity of meandering channels using topographic profiles, when available, or Google images. In the latter case, we obtained the sinuosity from 1 km long profiles centered on the measurement sites. We now mention this explicitely.

The manuscript is currently lacking a discussion. The conclusion is currently partly functioning as a discussion, which is rather confusing and which also hampers a detailed reflection of the authors on how their results fit into earlier work. Such a discussion would allow the authors to expand on key findings of the study such as the observed geometrical similarities between meandering and braided rivers and the resultant lack of a transition from braided to meandering channels as reported in other work, and the extension of their findings from gravel-bed to sand-bed environments. Therefore, I encourage the authors to include a dedicated Discussion section in the revised manuscript in which they expand upon the aforementioned key findings. Other findings that may be expanded upon are the notion of the relationship between sediment load and channel aspect ratio, and how flume experiments and numerical models can be used specifically to further this work. Adding such a discussion will also involve a rewrite of the current conclusion section, which is highly speculative in nature as it stands. We understand the reviewer's concern and have accordingly expanded the conclusion. We acknowledge that the conclusion on the influence of the sediment flux on the aspect ratio is still speculative at this point, and we have made it clear.

2 Technical corrections

p. 1291, line 21: Much more work has been done on this topic and should be referenced here in addition to Schumm 2005. For example, Leopold and Wolman (1957), Ferguson (1987) and Kleinhans and Van den Berg (2011) to name a few. Following the comment we added the suggested references.

p. 1291, line 21: 'supported by laboratory experiments' seems inappropriate here and is not supported by the listed references, which all focus on theoretical rivers or field data. Thank you for this quote. In fact Fredsøe (1978) includes a comparison with experimental data, but we added a reference to the experimental work of Fujita and Muramoto (1985) for alternate bars, and Ashmore (1991) for the development of braid bars.

p. 1291, line 23: developed Done.

p. 1291, line 23: pattern Done.

p. 1292, line 2: What do the authors mean with 'sediment discharge'? Sediment load, sediment type, sediment concentration, or a combination of these? Please expand. By the sediment discharge we mean the total sediment flux (or load as quoted by the referee).

p. 1292, line 5: The authors may also want to refer to Braudrick et al (2009) and Van Dijk et al (2013) to cover recent work on the interaction between coarse-bedded rivers and vegetation. We included these references.

p. 1292, lines 12-14: 'In sandy. . ..same environment'. This sentence requires a reference. This statement corresponds to the work of Gaurav et al. (2015) that is cited elsewhere. We now cite it here.

p. 1293, line 8: I suggest changing Figure 5 to Figure 2 as it is introduced here as the second graph. Done.

p. 1293, line 9: Please define 'highly meandering'. Is this a sinuosity above 1.5? Same holds for a braided pattern: how is it defined? What kind of braiding index is typical? As mentioned earlier, the notion of high sinuosity is arbitrary. The reviewer seems to place it above 1.5 whereas it has traditionally been placed around 1.3 by others (Schumm, 1977). The meandering streams of Bayanbulak have a sinuosity of 1.5 on average, so they can safely be considered as highly meandering. We now mention this explicitely in the text

p. 1293, line 10: Figs 2 and 3 show examples of a meandering pattern and braided stream, but not a transition from one to the other. I suggest to place the reference to the figures after the first part of the sentence. We place the figures at the end of the sentence in order not to cut the latter with references to figures, tables or bibliography. We believe the reader can safely find his/her way.

p. 1293, line 13: 'is certainly only mild'. Please change to 'is only mild'. Done.

p. 1293, line 14: Why is referred to Hey and Thorne (1986) here? Hey and Thorne (1986) do not specifically look at the influence of vegetation on the river morphology in the studied basin, and the reference therefore seems out of place. Please remove or expand to motivate why Hey and Thorne (1986) should be referenced here. We cite Hey and Thorne (1986) because they disclose data on the riparian vegetation that has been widely used in fluvial geomorphology studies. (Metivier and Barrier, 2012), for example, use this data to discuss the influence of vegetation on the aspect ratio of gravel-bed rivers. We added references to our earlier work and to the well known work of Andrews (1984).

p. 1294, lines 21-22: The maximum reported channel widths and discharges do not correspond with the data reported in Table 3 and Table 4. In these tables, the maximum channel width is only 35 m (not 77 m) and the maximum discharge is only 51 m3/s (not 100 m3/s). This is a mistake. The reviewer is right and the values correspond to those in the table. The Kaidu river when it leaves Bayanbulak has a width of 77m and a discharge of 100 m^3/s but the d_{50} of its bed is sandy so it was not included in the study. The figures are unaffected.

p. 1294, line 23: please change 'average' to 'median'. Done.

p. 1295, line 2: 'morphology' should be changed to 'geometry'. Done.

p. 1295, lines 2-3: Please clarify that this statement is derived from the threshold theory lines as depicted in Figure 6. This statement is not derived from the threshold theory. It is awaited since single-thread channels all exhibit a power law relationship with discharge.

p. 1295, lines 3-4: Please clarify where this can be seen and what is meant with 'isolated' here. Looking at Figure 6, I am assuming that 'isolated' refers to meandering but I am not sure. We changed "isolated" to "meandering" in the text.

p. 1295, line 7: Please remove '(Sect. 4)'. Done.

p. 1295, lines 8-9: This statement is true for the width and depth data, but not so much for slope where a lot of scatter is present and 'gathering around a straight line' seems an inadequate description of the presented data. This is confirmed later on when calculating fitting coefficient in Table 1. We agree with the refereee. Based on the sole dataset we acquired, the gathering is not obvious. There the GBR dataset is useful as it shows that there is indeed a trend and that the Bayanbulak dataset accords with it. We have clarified this point in the revised version.

p. 1295, line 19: wider with respect to the grain size. Not wider in terms of absolute values. This could be made more explicit. We added this explicitely in the text

p. 1297, line 12: The dashed lines on Fig. 6 represent Eqs. (2) – (4). Done.

p. 1298, line 18: supports. Done.

p. 1298, line 14: please change 'morphology' to 'geometry'. Done

p. 1299, line 1: Which mean are the authors referring to? We are referring to the means of the distributions of rescaled variables. We have clarified this point in the text.

p. 1299, lines 7 - 8: This statement needs more clarification and motivation. At a minimum, it should be explained to the reader how 'meandering' and 'braiding' are defined and measured. Also, the term 'morphologically' may need to be changed to 'geometrically' because channel width, depth and are geometrical properties. In contrast, the morphological pattern of the provided examples of meandering and braided rivers from satellite images seem qualitatively very different. We have modified the text at several places to clarify the distinction between meandering and braiding. The measurement methods are now described in more details. We changed "morphologically" to "geometrically" and added a sentence to clarify this.

p. 1299, lines 11 - 12: There are no correlation coefficients reported in Table 2, in contrasted to what is suggested here. The correlation coefficients are indeed not reported in Table 2. They are all smaller then 0.01, not 0.1. We mention this in the text.

p. 1299, line 19: please change morphologically to geometrically. Done

p. 1299, lines 23 - 25: This sentence signals a large extension of the results from gravel-bed systems to sand-bed systems and should be expanded to better develop the authors' reasoning here. The reference to the sand-bed systems is based on work on the Kosi megafan, so does it only apply to these fan environments or do the authors see application in other sand-bed systems as well? I believe that this sentence is not suited for the conclusion but would be well placed in a Discussion section, which is currently lacking. This may also provide a better place to the develop the authors' ideas on the similarity between the geometry of meandering and braiding channels, rather than making it part of the conclusion. The extension to sand-bed rivers is based on previously published results (Gaurav et al., 2015). We have modified the conclusion to clarify our claims.

p. 1299, lines 26 – p 1300 line 2: it would be very helpful to know what the authors mean exactly with the terms 'a braid', 'individual threads', and 'isolated channels' in this sentence. The aforementioned definition graph of channel forms may be useful. We have clarified the text to avoid confusions and added a figure to specify the terms used.

p 1300 line 18: Bertoldi and Tubino (2007) is not mentioned in the main text. p 1300 line 20: Bolla Pittaluga et al (2003) is not mentioned in the main text. p 1301 line 6: Devauchelle et al (2011) is not mentioned in the main text. p 1301 line 28: Mackin (1948) is not mentioned in the main text. p 1302 line 3: Paola (2001) is not mentioned in the main text. p 1303 line 9: Zolezzi et al (2006) is not mentioned in the main text. We removed all non-cited references.

Figure 1: Could the writing in the white rectangles be enlarged to aid the reader? Also, the smaller rectangles are hard to see, a larger contrast or different colour may be needed. Done

Figure 2: Could the corresponding meander bend in the satellite image be indicated? Also, what is the location of the braided stream picture within the satellite image? The pictures were not georeferenced. This is why we did not try to point at the precise position on the stream were the image was taken. Furthermore, the Google images were not from the same year as the field images.

Figure 4: Please change 'normed' to 'normalised'. Tables 1-4: I suggest introducing Tables 3 and 4 before Tables 1 and 2, mainly because Tables 3 and 4 contain the actual data while Tables 1 and 2 contain variables derived from the data reported in Tables 3 and 4. Done

References

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