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Interactive comment on "Morphometric properties of alternate bars and water discharge: a laboratory investigation" *by* Marco Redolfi et al.

Marco Redolfi et al.

marco.redolfi@unitn.it

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We thank the referee for the interesting questions and for the extensive grammatical and structural corrections. In the revised manuscript, we have included nearly all the minor corrections.

Here we provide the response to the five general comments:

1. From a technical point of view, bars are actually a particular kind of bedform, as they are the product on an altimetric instability of the bed. Specifically, they are often referred as large-scale bedforms (e.g. Jaeggi, 1984; Fujita and Muramoto, 1985; Church and Rice, 2009). For example, this it clear from the paper of Colombini and Stocchino (2012), titled "Three dimensional river bed forms",

which includes alternate bars, diagonal bars (i.e. 3-D oblique dunes), and 2-D dunes in a unified theoretical framework. However, we understand that the use of the word "bedforms" interchangeably may create confusion, as in most cases this term is adopted to indicate small scale-bed features. To find a compromise between being consistent with previous literature and avoiding confusion, we followed the approach proposed by the Referee #1, employing a more neutral term when possible.

2. In general the two-dimensional Fourier analysis can be used to study any spatial signal, and has been often employed in river morphodynamic studies (e.g., Repetto et al., 2002; Porcile et al., 2020). Probably the main peculiarity of our methodology is rather the definition of the "ensemble bar" as the average topography of multiple bar wavelengths, which is then analysed through the Fourier transform. In the revised manuscript, we have added a sentence in the last point of the Conclusions, to highlight the usefulness of the approach for different applications.

3. From theoretical works, it clearly appears that the key parameter controlling the formation of alternate bars is the channel width-to-depth ratio (e.g., Fredsoe, 1978; Colombini et al., 1987). This is because in relatively narrow channels the effect of the lateral bed slope on the bedload transport is proportionally more important, and it acts as a stabilizing effect that tends to flatten the bottom. Other parameters (especially the Shields number and the relative roughness) are also important, but bars are expected to form for a wide range of these parameters, provided the width-to-depth ratio is sufficiently large (see Figure 6 of Colombini et al., 1987). Specifically, there is not an upper limit of the Shields number for the formation of alternate bars. As a consequence, alternate bars are definitely expected to form in sand bed rivers (e.g., Bertagni and Camporeale, 2018), often coexisting with dunes, as also highlighted by the Referee #1.

   Far less information exists on conditions for the existence of diagonal bars. However, the analysis of Colombini and Stocchino (2012) suggests that diagonal bars (i.e. 3-D oblique dunes) tend to form when the sediment is relatively coarse, while classic, 2-D dunes are expected in sand bed channels. This is also consistent with the experimental results of Jaeggi (1984), showing formation of diagonal bars in conditions that are typical of gravel bed rivers.

4. Alternate bars and diagonal bars are not relegated to just bedload transport conditions. We agree that increasing discharge in our experiments would induce significant suspended transport (see values of the Rouse number we have added to Table 1). However, as explained above, there is no reason to associate suspended load with the disappearance of bars. Moreover, at high transport rates the stabilizing effect of the transverse slope becomes weaker (see our Eq. (8)), which tends to even promote the formation of bars. Therefore, interpreting the disappearance of bars we observed at high discharge with the capacity of the flow to “flatten” the bed is not correct. In general, bar formation is crucially dependent on the width-to-depth ratio. For this reason, it is not possible to identify limits merely based on transport rate, slope, or relative roughness.

   We agree with the referee that a higher transport rate lessens the time to equilibrium conditions. This can be an important factor when studying the bar adaptation to unsteady flow conditions, but not for determining the equilibrium bar properties.

5. The width-to-depth ratio is the key controlling parameter. Therefore, it is not possible to reach identical results with a different width-to-depth ratio and other conditions equal. In more practical terms, we can say that the bars dynamics crucially depends on the channel width. Specifically, varying the channel width by keeping the other conditions (slope, water depth, Shields number) fixed would result in a very different response of bars.

   We understand that thinking in terms of discharge may help to simplify the problem. However, knowing the percentage of bankfull discharge is not sufficient,

because this parameter does not take into account the channel width. This is the reason for which we introduced the scaled discharge $\Delta Q^* = (Q - Q_{cr})/(Q_{cr} - Q_i)$. Since the critical discharge Q_{cr} highly depends on the channel width, the scaled discharge ΔQ^* contains the essential information needed to measure the possibility of bars to form.

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