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Interactive comment on "Morphology of bar-built estuaries: relation between planform shape and depth distribution" *by* Jasper R. F. W. Leuven et al.

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This paper provides a useful examination of along-channel variations in channel width hypsometry. The paper is well organised and clearly written. The data used and method of analysis are, in themselves, sound. However, I would like to suggest a few changes that would give the paper a more precise focus. These relate to the methodology and what it can be said to be examining.

The method of Strahler is adopted without any substantive explanation. However the Strahler equation was proposed for terrestrial landscapes and is based on plan areas as a function of elevation. The paper considers submerged (or at times partially submerged) bodies in terms of the cross-section width. The basis of this transposition is

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not explained and the definitions of the terms in Equation 1 are not particularly clear. My reading is that 'h' is the proportion of total section height, and that 'y' is the proportion of the total section width. This does however omit the basis of r (which is a function of minimum and maximum plan area in Strahler) and makes it a fit parameter. This is useful strategy but Equation 1 is now simply a fitted shape function.

In the literature other authors (e.g. Boon and Byrne, 1981; and Townend, 2008) have adapted Strahler for use in the marine environment. The authors here have preferred the original (terrestrially based) Strahler equation. Given that they are all empirical relationships this may be entirely appropriate but some discussion as to why would provide a stronger link with the existing literature.

In the light of the above, I would suggest that it might also be appropriate to add the word empirical to both the title and the section entitled 'Relation between morphology and hypsometry'.

My other main concern relates to the use of the word 'ideal' in relation to the width of the channel. The study is essentially a geometric one, extracting width information from detailed bathymetries in four estuaries. Without consideration of some other metric such as tidal elevation/velocity, energy dissipation or the energy flux in the system it is not possible to assert a "state" of the system relative to equilibrium and hence to define what constitutes an "ideal" system, as classically defined. Whilst the authors make clear how they have defined their ideal plan form (width at the mouth and river) this only serves to compound a prevailing myth that the ideal is based on convergent width. If the cross-sectional area is exponentially convergent the estuary meets the basis of Pillsbury's original definition for an ideal estuary. If it happens that the hydraulic depth is constant along the channel then the CSA convergence length equates to the width convergence length.

There is some evidence from UK estuaries that width-depth variations provide a degree of system redundancy, allowing the system to adapt and so do minimum work, whilst

maintaining the CSA convergence. This is illustrated in the attached figure for the Humber, where the CSA is clearly exponentially convergent. The corresponding width and depth values vary about the exponential fits (seemingly in an inverse manner that it has been suggested is linked to overall channel sinuosity). Importantly in this context the width is invariably narrower and deeper at the mouth for a number of reasons (geology, drift, etc). Consequently, I would reason that the authors have examined the variance from the minimal width convergence. This does not detract from the results but it is important not to confuse a valid conclusion relating to along channel variation in width hypsometry, with assertions relating to an ideal system and its state relative to equilibrium. For the latter, I am of the opinion that we need a physically based determination of the hypsometry, rather than an empirical one.

Finally a point of detail. In the discussion, you refer to whole system hypsometry as an oversimplification. However, these whole system descriptions are consistent with the original Strahler concept of a basin hypsometry based on plan area. In a landform context these remain entirely valid descriptions. In terms of estuary dynamics they do not capture the along channel variations. As you note, there can be a significant variation of the high a low water surfaces along the estuary. Consequently, the along-channel cross-section hypsometry should not be assumed to be relative to a fixed vertical datum. Interpreting these along channel variations remains an open question because of the reasons outlined above.

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Figure 1 – Variation of width at peak discharge

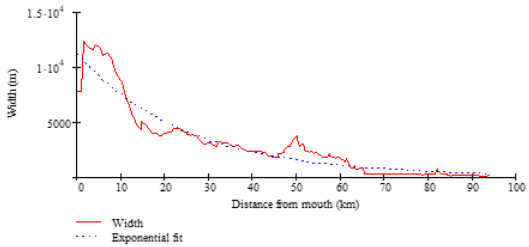

Figure 2 – Variation of maximum depth at peak discharge

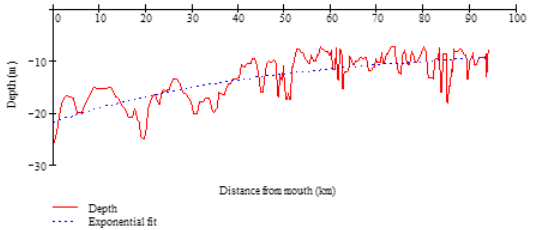

Figure 3 – Variation of cross-sectional area at peak discharge

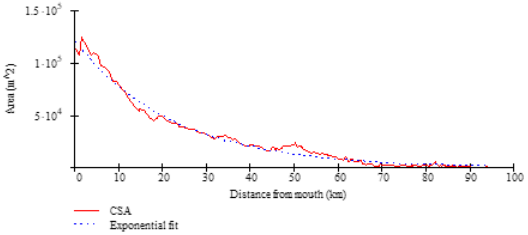

Fig. 1. Illustration of along-channel width depth variation

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