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Hydrology and Earth System Sciences Discussions

Interactive comment on "Using flushing rate to investigate spring-neap and spatial variations of gravitational circulation and tidal exchanges in an estuary" *by* D. C. Shaha et al.

Anonymous Referee #2

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The study relies on an extensive data set of salinity in the Sumijn River Estuary. The estimated flushing rates for various values of the discharge rate are used to understand the dynamics of the estuary.

My main concerns have already been stressed by H.H.G. Savenije (Review RC C228) but I think that it is appropriate to reformulate then here.

The first problem is related to the applicability of the flushing rate theory. According to this approach the system is assumed to be at steady state and perfectly mixed. These two hypothesis should be carefully checked here (for both the whole estuary and the selected small segments) because their violation could affect the validity of

the conclusions. This is for instance one of the immediate explanation for the large range of variability of the flushing-rate observed in some plots of figures 7 and 8. The results presented in figure 2 demonstrate such a variability. In section 4.1 it is said that "the difference between two subsequent high tides was approximately 3 psu due to **variation in the tidal amplitude**". One the one hand, this demonstrates that the system is far from steady state. On the other hand, I doubt that the variation of the tidal amplitude is the explanation for this variability; the tidal amplitude varies only slowly in 12 hours.

The second issue that needs some clarification is the kind of simplified circulation model that is implied by the use of the flushing rate. For years, many authors have been using the very same term "flushing rate" with many different physical meaning. For this reason, it would be useful to explain the physical interpretation that must be given to the "flushing rate" here. Is it related to some rate of advective exchange between the different estuarine segments, to the flow rates between the segments ? Does it include mixing ? A kind of schematic model of the exchange within the estuary with quantification provided by the flushing rate theory would clarify this issue.

The third issue is related to the poor statistical treatment of the results in figures 7 and 8, which form the core of this manuscript. In most of this figures, the regression line has no statistical significance. The form of the relationship (i.e. linear vs exponential) does not matter. A quick look at the two panels of figure 7 reveals a very wide range of flusing rates for low discharge situations and these cannot be reconciled with any reasonable statistical model. In particular, the value of F_{int} cannot be defined by regression or only within a very broad confidence interval. One could even claim that the tidal exchange should be identified from the analysis of the results for very low discharge, i.e. disregarding the flushing rate values computed for high discharge. The picture appears then even more confused and the correlation coefficient decreases drastically.

As a result, the amounts in excess, indicating the gravitational circulation exchanges

(G_c) cannot be defined either using these data sets. (By the way, the value of G_c varies with the discharge rate. So, what is the meaning of the single value printed in figure 7 ?)

Minor comments

The presentation of the data set should be clarified. From lines 13-29 on page 1625, it is very difficult to understand that two kinds of data have been collected : longitudinal profiles and time-series at fixed stations. Especially the transition between lines 17 and 18 is unclear.

A couple of statements are given without any rigorous justification or are even wrong.

- At line 2, page 1629, it is said that the flood phase last for more than 5 hours while the ebb phase takes about 2.5 hours. Such a dissymmetry is not apparent in figure 2.
- Line 10, page 1629 : "The difference in the vertical salinity at high water during neap tide was smaller **due to** an 85% lower river discharge. . . " There is no argument to support this claim/conclusion.
- Line 25, page 23 : "The flushing rate increased in the central and inner regimes during neap tide relative to spring tide **due to** enhancing the gravitational circulation". Idem

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 1621, 2010.