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Hydrology and Earth System Sciences Discussions

Interactive comment on "Salt intrusion in multi-channel estuaries: a case study in theMekong Delta, Vietnam" *by* A. D. Nguyen and H. H. G. Savenije

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The authors would like to thank Referee #2 for the detailed and clear review. We fully appreciate that the referee has carefully examined our paper and provided us a number of valuable comments.

We would like to respond to the referee's review on several main points.

1. General comments:

Indeed, our paper provides a modification to the existing method of Savenije (1993). However, we do think that our paper not only provides a "slight" modification to the existing method, it also presents some new things. As we state in the paper, this is the first time that the method of Savenije (1993) is applied to a multi-channel estuary, therefore several adjustments and assumptions are made. Our main conclusion (for this type of multi-channel estuaries) is that the system behaves as an entity. Hence we are able to combine 2 branches into 1 single estuary, and furthermore to apply the modified method to compute salinity distribution along the estuary. The computed results are good; better than if we consider the branches separately. We feel that the assumption on the behavior of the multi-channel system as an entity and modifications on several important parameters (e.g. average depth and width convergence length) are significant.

2. Specific comments:

2.1. The lack of details in the methodology and the lack of the description of the data sets:

The referee provides a concise review on this issue. We missed to clarify a number of details. In the revised paper, we shall definitely add the information.

2.2. We would like to answer some of the referee's questions, which we consider most relevant. (of course in the revised paper, we shall address several minor corrections as well).

2.2.1. How to determine or define width and area convergence lengths? The width has been measured at normal high water (HW). The convergence length, the length scale of the exponential function is obtained by calibration of Eqs. (10) and (11). Unfortunately we made a typing mistake writing a Log function instead of and Exponential function. The correct formula is B=B0exp(-x/b) and A=A0exp(-x/a).

2.2.2. How are the values of K, Van der Burgh's coefficient and the dispersion coefficient "obtained through calibration" calibration against what? K (van der Burgh's coefficient) and the dispersion at the estuary mouth (D0) are obtained through calibration against a measurement longitudinal salinity distribution at HWS or LWS.

2.2.3. How are the tide averaged cross section areas obtained? Tidal averaged cross-section area and width obtained from the measured data, defined at the tidal averaged water level (this level is close to mean sea level).

2.2.4. Details on the moving boat method: To obtain the salt intrusion curve at HWS or LWS one has to travel at the same speed as the tidal wave. Before the measurement we identify clearly recognizable points along the estuary at about 3 km interval (inlets, piers, churches, temples, gauges, etc.). We also use a GPS device to get the exact co-ordinate of the locations. We start at the mouth, anchored, and wait until slack occurs. Then we do the first measurement. Traveling at a velocity of 30-35 km/h one can arrive at the next location just a few minutes before slack. One then stops the boat and waits until the slack moment occurs (either by anchoring or by closely watching the shores as one drifts). One then does a quick measurement over the full depth at one meter intervals starting from the bottom with a conductivity meter with a 10-m cable. Measurements are done in mid-current.

2.2.5. Alpha (m-1), the mixing coefficient: The fresh river discharge Qf is one of the most difficult parameters to determine in an estuary. Fortunately, Qf always occurs in the same term as the dispersion coefficient (see Eqs. (2) and (4)), which permits them to be combined into only one variable, the mixing coefficient α (m-1).

2.2.6. Page 11, figure 6: calibrated results mean that the results have been obtained from fitting the model to observations (measured data).

2.2.7. Figure 5 to 8: How are the values of K and alpha calculated? They are computed from curve fitting, and later they are checked with the predictive values from Eqs. (7) and (8) (calibrated values of 0.55 and 0.50 versus predictive values of 0.40 and 0.45 for the Hau and the Co Chien - Cung Hau estuaries, respectively). K has a fixed value for a given estuary, while alpha varies with the discharge and the tidal range. As we state on page 14: " We should realise that the predictive equation for K is still rather weak and may have to be improved in the future. Therefore, the calibrated K values for

HESSD

3, S287–S291, 2006

EGU

the Hau and the Co Chien - Cung Hau estuaries are considered to be the most reliable ones. “.

2.2.8. Page 13: is 18 days really a fast adjustment time? Yes, it is. The adjustment time depends on the flushing velocity of the river discharge. Savenije (2005, page 175, table 5.6) indicates that in some estuaries, the adjustment time is very long, for example: The Gambia estuary 2269 days, the Incomati (Mozambique) 26 days, the Thames (U.K.) 46 days etc. In relation to the low variability of the discharge during the dry season and the long dry season in the Mekong estuaries, 18 days can be considered as a fast adjustment time. This is due to the relatively large fresh water discharge in the Mekong in proportion to its cross-section.

2.2.9. Page 16: The discharge ratio between the Hau and the Tien river is important because it determines the values of discharge in the Tien and Hau rivers. The discharges relate to the dispersion coefficient, especially at the mouth (D0) (Eq. 4), which affects salinity distribution in the estuary.

Is this because you are using only one data source to infer the discharge of the other river? No, indeed in the Tien and Hau rivers, we have 2 data sources (stations) for the discharges in the Tien and Hau, located at Tan Chau (Tien river) and Chau Doc (Hau river) (see Fig. 2). Normally, the discharge at Tan Chau is 3 to 5 times larger than the discharge at Chau Doc. One special thing is that just 20 km downstream of Tan Chau and Chau Doc, there is a river called Vam Nao, which conveys water from the Tien river to the Hau river. The discharge ratio between the Hau and the Tien river after the Vam Nao river changes dramatically. Unfortunately, we do not have sufficient measurement data to get the actual discharge ratio between the Hau and the Tien after Vam Nao connection. However, there are several existing numerical models that give us an estimation of the ratio. The estimated value of the ratio lies between 60/40 to 53/47 (Tien/Hau).

3. Technical corrections:

We shall definitely try to make figures to be more informative and clear to read. To answer the question of the reviewer about “Figure 3 and 4, why there are so many points on Fig. 3 compared with Fig. 4?” we would like to emphasize that it is not the technical mistake, but it is because of the available data. The Hau river (Dinh An and Tran De branches) (See Fig. 3) topography data has been obtained from the biggest measurement campaign sponsored by the Finnish government in 1991. The measurement was carried out mainly in the Hau river, which is the main transport waterway of the Mekong delta. Therefore detailed data is available. However, there is not much detailed topography data on the Co Chien and Cung Hau branches.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 3, 499, 2006.