Dear Prof. HHG Savenije,

We are grateful for your valuable and fruitful comments that will assist us to improve our manuscript (hess-2010-39). The responses to each comment can be found in "*italic*" font below the comment.

Specific comments:

1. The most important issue is the definition of the flushing rate F. The way it is defined in the paper (based on Officer and Kester, 1991; and Dyer, 1997) is in my view not completely correct. If we consider the salt balance near the estuary mouth, then this reads:

$$FS_0 = RS_1 + FS_1$$

where S_0 is the salinity at the seaward boundary and S_1 the salinity in the segment.
Furthermore:

$$\frac{S_1}{S_0} = 1 - f$$

and

$$S_0 - S_1 = fS_0$$

This leads to a new equation (4a):

$$F = \frac{R}{f}(1 - f)$$

The difference with Eq.(4) is the factor (1-f). Near the estuary mouth, this difference is not likely to be large, since there (1-f) ≈1. However, the asymptote of Eq.(4) for upstream segments is wrong (R=F) whereas in the river part F should be zero. The equation derived above (4a) has the correct asymptote, in the sense that F=0 if the water is completely fresh (f=1). Eq.(4) yields F=R if f=1, which is clearly not correct. I don't know if this makes a lot of difference in the calculations made, but it would be worthwhile trying it out.

Answer:

As per the above new equation (4a) which includes the factor (1-f), the flushing rate was calculated and then plotted against the river discharge. The factor was about 1 (1-f ≈ 1) *near the mouth that did not make large difference with the previous result near mouth i.e. the flushing rate increases with increasing river discharge and is many times greater than that of the river alone (Fig.1). This is dynamically appropriate where the exchange flow is amplified by a factor of 2-34 over the river flow (MacCready, P and Geyer,W.R.: Advances in Estuarine Physics, Annual Review of Marine Science, 2, 35-58, 2010). However, Eq.4a shows reverse result for upstream end. Where flushing rate decreases with increasing river discharge. As the water in the upstream end is completely fresh with increasing river discharge, it yields F=0. When the water in the upstream end is not completely fresh i.e. river discharge decreases, F gives a flushing rate of ranging 0.5~4.5* m^3s^{-1} *during spring tide and 0.5~ 2.0* m^3s^{-1} *during neap tide. The dynamics is that if river discharge increases, the exchange rate should be increased. However, in the upstream case, the result calculated with Eq.(4a) counteracts with that dynamics.*

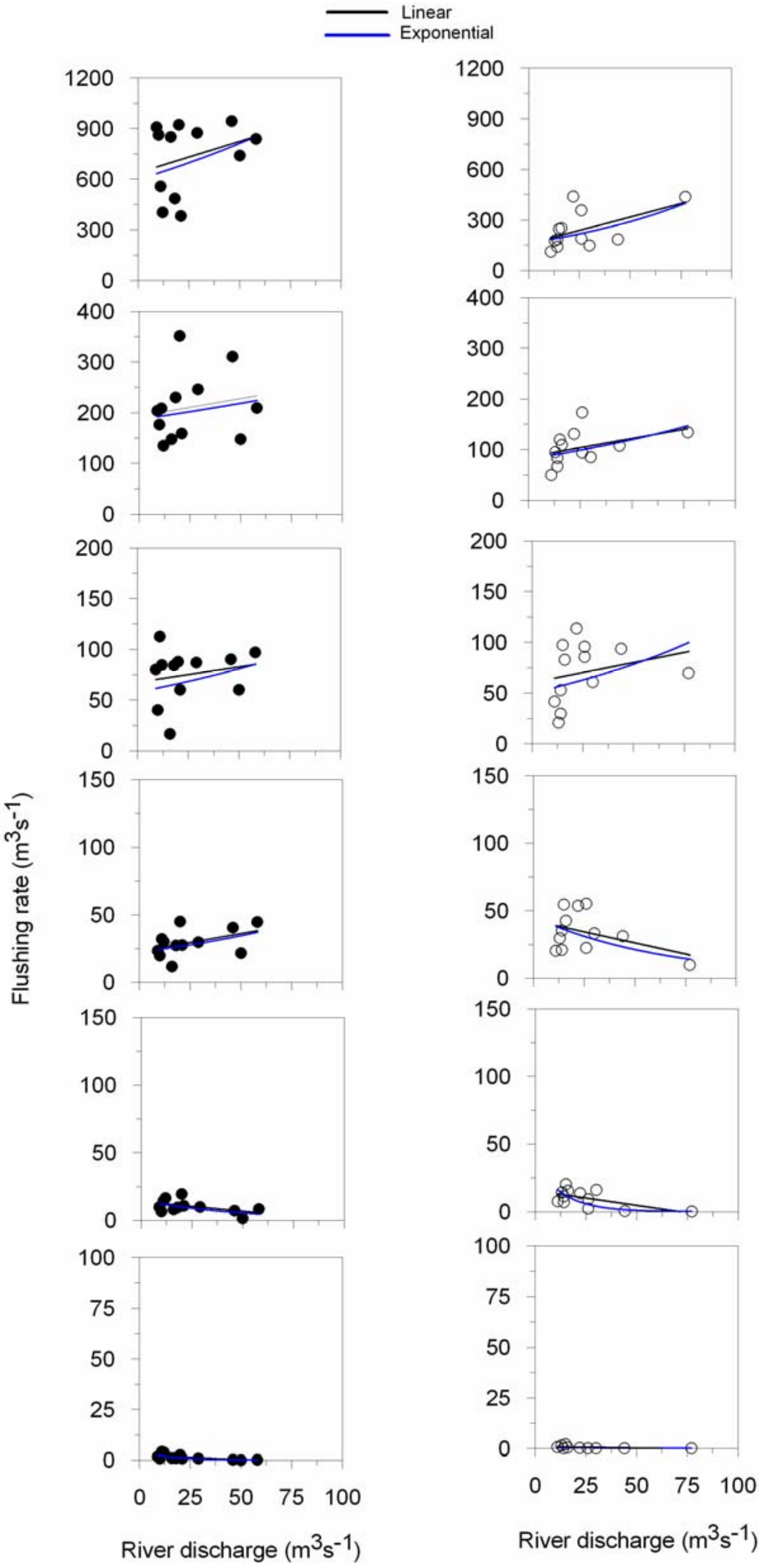

Fig.1. Flushing rate versus river discharge where flushing rate calculated using Eq. (4a) during spring and neap tide.

Why the factor (1-f) in Eq. (4a), which comes from the considering salt balance near the estuary mouth ($FS_0 = FS_1 + RS_1$*), makes this difference? To find out this difference, attention was paid to the conservation in volume and salt fluxes in an estuary. A steady balance in which volume is conserved has volume fluxes*

$Q_1 = Q_2+R =F$

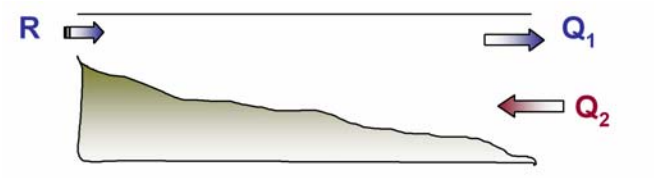

Fig. 2 conservation of volume in an estuary

If salt flux through the mouth is dominated by the exchange flux, then the net salt balance is

$Q_1S_1=Q_2S_0$

where S_0 *is the salinity at the seaward boundary that enters into estuary and* S_1 *the salinity in the segment that leaves the estuary after mixing. Since river discharge (R) does not add salt to the system, the salt balance contains only two term, the incoming salt flux and the outgoing salt flux. The volume and salt conservation equation together give the following salt balances near the mouth*

$FS_1 = (F-R) S_0$

$FS_0 = FS_1 + RS_0$

The considering salt balance equation ($FS_0 = FS_1 + RS_1$*) near the mouth from where new equation (4a) has developed with the factor (1-f) is not consistent with the above salt balance. Therefore, the reverse result upstream may arise due to adding this factor that comes from* $FS_0 = FS_1 + RS_1$*. If there is any more suggestion regarding this by Referee #1 that should be added in our final revision paper, we can do that.*

2. Regarding the Figures 7, 8 and 9. It is not clear to me what the value of Gc mentioned in the graphs refers to. Surely the value is related to a certain discharge. It looks as if it relates to the maximum discharge observed. I suggest the authors select one particular discharge (say 50 m3/s) and provide the Gc of that particular discharge. Furthermore, the linear regression line presented seem to me as arbitrary. Realising that, on the basis of Eq.4, the relationship found should asymptotically approach the line F=R for large values of R, maybe a regression curve of the following type should be tested:
$F = F_{int} \exp (R/a) + R$
The discharge scale 'a' defines the slope of the curve. If however the proposed Equation (4a) is used, then the line should approach F=0, and the relation would become:
$F = F_{int} \exp (R/a)$
Obviously this changes the definition of Gc. I am curious to hear what the authors think of this. Moreover, I think the steepness of the line for spring tide in segment 1 is too steep, leading to a far too high value of Fint for that segment. Of course the large scatter makes it difficult to draw a reliable line, but maybe the suggested regression equation performs better.

Answer:

G_c *shown in Figures 7, 8 and 9 was calculated by considering the maximum discharge observed during spring and neap tide, respectively. As per the valuable comment of Referee #1,* G_c *was recalculated by considering the river discharge of 50* m^3s^{-1} *during both spring and neap tides to clarify* *it. This new calculation result will be inserted in the final revised paper. This result has also been shown in Fig. 3 here. The linear regression line presented was compared with the exponential function, and linear regression yielded higher coefficient of determination (r^2). Therefore, linear regression was selected to calculate F_{int} and G_c. The values of r^2 for both linear and exponential function are shown in Fig.3 for more clarification. We found a bug at input file of graphics at SEG1during neap tide; this bug will be fixed at final revision, also shown in Fig. 3 here.*

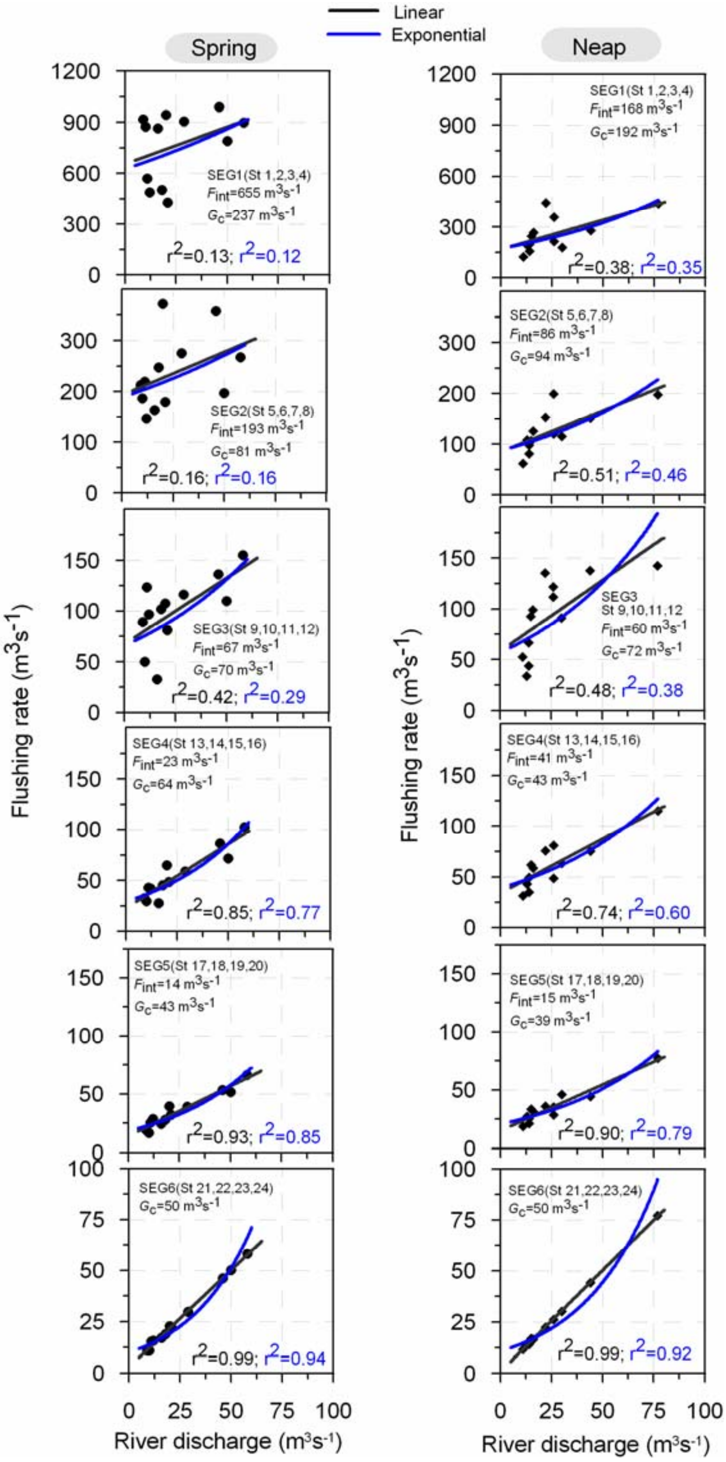

Fig. 3 Flushing rate versus river discharge showing a comparison between linear regression and exponential function.

3. In Figure 10, it is not mentioned to which point along the axis this refers. I presume it is for the mouth of the estuary (segment 1?)

Answer:
The estuarine parameter v was calculated for both each segment and the entire estuary. The estuarine parameter of each segment shown in Table 2 was averaged for twelve samples. The estuarine parameter for the entire estuary is shown in figure 10 to examine the effect of different river discharges on the dominancy of the gravitational circulation and tidal exchanges in the Sumjin River Estuary. The tidal exchange dominated when river discharge is less than 20 m^3s^{-1}*. We will clarify this in the final revised paper.*

4. Overall, it is not clear what the distance to the mouth is of the different segments. I recommend you include the distance to the mouth in Table 2.

Answer:
We inserted the distance in Table 2 to indicate the location that will be found in final revised paper..

5. Finally I have some editorial corrections and suggestions:

Answer:

All editorial corrections and suggestions have been followed properly as given by Referee # 1 and have inserted in the manuscript that will be found in the final revised paper. We would like to request the Referee #1 about the insertion "p.1628 l.18: write "of the tidal exchange and the gravitational circulation exchange,". Could you please check the page or line no. so that we can insert it properly?