Response to Reviewers #2 Comments (Major review): Manuscript NHESS-2013-167

The authors thank the reviewer for their helpful comments and suggestions. In the document below we have listed the reviewer's comments in italics. This is followed by our response in non-italic text in the 2nd column. In the revised manuscript the green highlighted text indicates where the manuscript has been modified to address the comments of Referee #2.

General Comments:

Reviewers comment	Author response
Generally this paper needs an extensive English edit. The language makes it very difficult to read. Particular attention should be paid to joining words like "the" and plurals.	The manuscript text has been thoroughly reviewed and the English has been improved.
The introduction in some cases is too detailed with a lot of definitions. It would read easier if it pointed more towards how the studies cited are relevant to the work here. *The introduction refers a lot to the HGS model. I think it would be better just to refer to the model as a physically based model and explain the use of HGS in the methods section.*	The introduction starts with explaining the general concept of floodplain salinization and the important drivers. Then a real world case is introduced (Lower River Murray) followed by brief description about SW-GW interactions. Also, the authors tried to make a clear statement regarding the evolution of numerical models and justify the numerical modelling approach. However, in the revised version some less relevant statements have been removed as suggested by the reviewer. In particular, on page 3 of the original manuscript, Lines 19 to 23 and 28 to 29 have been deleted and on page 4, lines 3 to 5 have been deleted. Also the manuscript now refers to a physically based model rather than specifically to HGS in the Introduction section.
The first paragraph of the numerical model section (section 3) has too much irrelevant information. It just needs a brief description of the code, not a detailed version history.	Section 3 has now been reworded as recommended. **"**The HydroGeoSphere (HGS) model is capable of simulating fully coupled surface/sub-surface flow and transport. The subsurface module is based on the University of Waterloo and Université Laval three-dimensional (3D) subsurface and transport code FRAC3DVS (Therrien, 1992). The surface module is based on the Surface Water Flow Package of the MODHMS simulator, which is itself an enhancement of the popular U.S. Geological Survey code MODFLOW (Brunner and Simmons, 2012). HGS requires pre- and post-processor tools in order to handle input preparation (complex topography and grids) and visualization of the outputs. In this study, Grid Builder (McLaren, 2005) and Groundwater Modelling system (GMS) (AquaVeo, 2011) were used as pre-processors to generate the input grid

	domain. Also, GMS was applied as a post-processor to visualize the model results. The next section describes the governing equations of the model. The governing equations of the HGS model are described in Therrien et al. ([2010]).**"**
Additionally, most of section 3.1 is repeating the user's manual so it may be better just to point the reader to this (the user's manual) for further information.	We agree and Section 3.1 has now been deleted.
The solute boundary conditions are not stated in the model set up section.	These have now been added to the 5th paragraph of the Model Set-up section. "To represent the solute boundary conditions, first-type (Dirichlet) or constant concentration boundary conditions were assigned. Observed groundwater TDS concentrations at the observation wells in the floodplain and river ranged from 30,000 mg L-1 to 200 mg L-1. Hence, constant values were applied at the porous media boundary (representing the regional saline aquifer) and the river nodes accordingly"
Section 3.3 - paragraph 1. This paragraph needs more clarity. It states that two approaches were used for calibration however it does not make it clear what these approaches are. Also - how is plume mass determined from discrete bore locations?	Section 3.3 has been reworded as recommended. "The flow dynamic was calibrated against the absolute observed groundwater levels at the observation wells. But for the solute dynamic, given the difficulty associated with the quantification of the solute transport model parameters, the solute was calibrated to the observed general salinity patterns of the floodplain aquifer."

Specific comments:

Reviewers comment	Author response
"A" combination of...	This has been changed.
"water-tables"	Changed to "water-tables".
"forcing" not "forced"	Changed to "forcing".
"The South Australian Government"	This has been changed.
reword sentence starting "This is to..."	Reworded to "The aim was to reduce the hydraulic gradient that drives the regional saline groundwater towards the River Murray".
"salt off the salt" - makes no sense	Reworded to "Overbank floods leach salt from the upper soil layers to the groundwater, wash salt off the soil profile and add fresh water to the floodplain soils".
"storages instructions" - makes no sense	Changed to "storage infrastructure".
1st sentence - this needs to be two sentences. The first sentence is about regulation and the second could give the example of how it has impacted salt removal.	This has now been split into two sentences. "The highly variable nature of surface flow in arid/semi-arid regions has led to regulation of rivers by weirs and storage infrastructure (Jolly

	et al., 1996). This has affected surface-groundwater interactions in the floodplains"
Reword: Maybe "Prior to 2011, a high river flood event had not occurred for 13 years. However, salt accumulation has continued over this period."	Changed as suggested.
how have the sediments also induced salt problems?	This sentence has now been deleted.
change "their recommendation 1" to "their 1st recommendation"	Changed as suggested.
"The" South Australian Government"	Changed as suggested.
"periods of shut down"	Changed as suggested.
these two sentences need to be joined better.	These sentences have now been reworded. "For instance at Clark's Floodplain, field investigations have shown that significant salt accumulation and vegetation dieback has occurred. This is due to evapotranspiration from rising floodplain water-tables, altered flow regimes and increased irrigation in the surrounding highlands on this floodplain (Doble, 2004)"
"impacts" not "impact"	This has now been changed. "Groundwater extraction is an important process that affects the exchange flux between surface water and groundwater".
The two statements separated by a semi-colon seem unrelated. I suggest starting a new sentence.	This has now been split into two sentences. "For instance, river depletion resulting from groundwater extraction is delayed by time lags that range from days to hundreds of years. Likewise, the extent of the groundwater extraction activity may vary along a river reach thus leading to gaining and losing sub-reaches"
"Moreover, HGSs..." remove "the"	Removed.
" a HGS..."	Changed.
the last sentence doesn't make sense	This sentence has now been deleted.
add space between "potential" and "evaporation"	Space added.
This section needs joining text to indicate you are now talking about the soils.	A joining sentence has now been added as recommended.
the same information is repeated in two sentences. Remove one.	One of the sentences has been removed.
"electrical conductivity"	Changed.
"A more detailed..."	Changed.
This sentence may be better if it states that the model is capable of simulating fully coupled surface/ sub-surface flow and transport.	Changed.
"generated at a 10m"	Changed.
Maybe these sentences could say that "A 10m grid size was used for computational purposes. However this grid size was adequate to model the processes in the floodplain."	Reworded as suggested.
Paragraph lines 1 - 10. Explain 1) the choice of	1) The vertical discretization was chosen to meet

vertical discretisation. 2) Did sublayers correspond to the sediments.	the balance between the required computational time and sufficient representation of the two soil layers 2) The top five sub-layers correspond to Coonambidgal Clay and the lower 15 sub-layers to Monoman Sand. These have now both been clarified in the revised manuscript
buttum should be "bottom"	Changed.
"overlain", not overlaid.	Changed.
Long sentence, suggest breaking the sentence after the reference to Doble et al. (2006).	Reworded as recommended.
"conditions" (add s)	s added.
"so the model was divided into the main channel (river) and the floodplain"	Changed.
What was different about the properties?	These are now shown in Table 2.
"river bank occurred" remove has.	Removed.
are the surface properties insensitive to the model or are the model results insensitive to the surface properties?	Reworded to "so the model results are insensitive to the surface properties".
"conditions" add s	Added.
maybe add these different areas of vegetation to figure 3	Added to Table 3.
need space between include and specified. Maybe change the sentence to " specified head boundaries in the porous domain were implemented at the end of the floodplain"	Reworded as recommended.
Did you simulate pumping of did you use specified heads to lower the water table? This isn't clear	Specified heads were used to lower the water-table This has now been reworded in the revised manuscript.
consistent not consistence	Changed.
was this using specified head boundaries?	Yes. Added to the revised manuscript. "Observed river levels for the surface domain were set at the river side of the model using specified heads"
"the stress period" add "the"	Added.
"covers a 30yr" add "a"	Added.
What are the more sensitive parameters?	soil hydraulic conductivity, porosity and dispersivity This has now been added in the revised manuscript.
do you really try to minimise goodness of fit. Maybe minimise errors between observed and simulated values.	This has now been reworded in the revised manuscript. "Seeking to optimise the goodness-of-fit by minimizing errors between the observed and simulated values, or to achieve a specific predefined value of goodness-of-fit"
These statements are not backed up by anything quantifiable. Maybe the EM31 data should be	Figure 6 has been added to support the statement

included so these statements can be confirmed.	
remove the words "at the same time"	Removed.
need a space between "interactions" and "induced"	Added.
It is unclear if the levels in figure 7 were a model input or an observation. *If they were a model input they should be in the methods. If they are observed this should be made clear.*	They refer to input groundwater heads at the boundary of the model. However, according to the overall set-up of the paper, placing Figure 7 here seems to be right as they are explaining the scenarios.
change "accurate" to "accurately"	Changed.
Are the groundwater heads water balance components? Are these just a reflection of the amount of water in the porous media, or do they indicate the ability of the model to re-produce these storages spatially.	These refer to groundwater heads at the location of each observation well.
"along transect B1" (Add spaces)	Added.
"rate for" (Add space)	Added.
Are these varying heads or constant heads?	The heads are constant only in the "without-SIS scenario" This is clarified in the revised manuscript.
"stop" remove s.	Removed.
need to make it clear what you are referring to. In the context of SW-GW interaction losing generally refers to SW discharging to gw.	This is clarified at the end of the 1st paragraph of Results and Discussion section
further on the above comment in figure 9 it appears that at all times there is a flux from the river to the floodplain being a losing condition.	Same as above
This paragraph may be better supported if the pumping and bank infiltration were on the same graph. for example, the change in accumulation should be the difference between inputs and outputs to the system.	Figure 9 has been modified as recommended
replace "less" with "a smaller"	Replaced.
"was the same"	Changed.
This paragraph would be better if river levels were plotted on figure 10	Figure 10 has now been modified as recommended.
"Following the SIS..."	Changed.
Here and elsewhere, you refer to a bore relative to the river level. You should refer to the groundwater level at the location of the bore, rather than the level of the bore.	Reworded as recommended.
As above	Reworded as recommended.
If this is the case, why does the flux in figure 9 not reverse?	As shown in Figure 9, when the SIS pumps were shut down between February and April 2007, the river became a gaining one (due to a rising water-table in the floodplain). Hence, the flow flux from the river to the floodplain became almost zero.

"increases with time" - add an "s"	Changed.
In figure 12, it looks like the floodplain salinity decreases in the "with SIS" scenario, not stays stable as the text states.	The "stability" refers to keeping the floodplain relatively less saline and preventing a salinity increase compared with the beginning of the SIS operation.
"Except when the SIS". The two sentences starting at line 23 may be better written along the lines of "In contrast, salinity levels were reduced for the with SIS scenario with the exception of the period of time when the SIS was shut down."	Reworded as recommended.
following on from above, this would read better as "This was due to an increased flux of river water induced by the SIS, in addition to the removal of saline groundwater."	Reworded as recommended.
the sentence starting "Overall," seems un-necessary (Removing saline groundwater causes a less saline floodplain).	Removed.
Maybe state in this sentence that these observations were at the same field site.	This has now been amended.
"in the with-SIS" and "while the without-SIS"	Added.
"in the without-SIS"	Added.
"The unsaturated zone"	Added.
I think "compartment" should be "component"?	Changed.
"Particularly in areas...". Also, I'm not sure if this should be a new sentence or a continuation of the previous one.	This has now been combined into a single sentence and the English has been improved. "The unsaturated zone may act as an essential component of the solute mass stored in the floodplain aquifer, particularly in an area such as the study site where salinity is driven by increased discharge of saline groundwater and reduced leaching of salts from the soils"
"in the with-SIS". Check for this everywhere. "the" should be used as a joining word before the scenarios...	Checked and changed as required.
Sentence starting "In fact,..." is un-necessary - lowering the water table increases the unsaturated zone.	This sentence has been removed.
The talk of nodes is not useful. Maybe phrase it as volumes.	Reworded as recommended to volume percentage.
For this sentence, just focus on the relative removals of each scenario. As above, nodes are hard to understand.	Reworded as recommended to volume percentage.
"configurations"	Changed.
this sentence (about ratios) is confusing and does not add anything	The authors believe this needs to be clarified in the text, as areas with different hydrogeology and topography can be completely different from this case.
"Illustrates the solute mass"	Changed.
"In fig. 13a the distribution"	Changed.
Remove "It seems" from the start of the sentence	Changed.

and insert "the" before "SIS" and "middle"	
"the SIS"	Changed.
Remove "as could be expected", add "been" before "stored".	Changed.
"a less saline..."	Changed.
"and the decrease"	Changed.
"analysis" not "analyse"	Changed.
"showed" add "ed"	Added.
switch "fresh" and "river"	Changed.
"Also, a deeper"	Changed
remove ";"	Removed
"In terms of the solute balance, the SIS results in a less saline floodplain aquifer, as evidenced by the reduced amount of solute stored in the with-SIS scenario."	Reworded as recommended.
once again, this is not consistent with typical terminology. Gaining suggests GW flowing to SW and losing the opposite	This is clarified at the end of the 1st paragraph of Results and Discussion section
Figure 13 - Remove the mesh. It makes it hard to see the colours.	The mesh has been removed as recommended.