Response of comments from reviewers

On the manuscript
Groundwater-surface water interactions, vegetation dependencies and implications for water resources management in the semi-arid Hailiutu River catchment, China – A Synthesis by Y. Zhou et al.

General response: The associate editor and two reviewers have critically checked the manuscript and made many constructive comments and useful suggestions which will be acknowledged in the revised paper. The authors have taken considerations of all comments and will revise the manuscript accordingly. We have already done major revisions in quantitative analysis of temperature measurements and in modifying figures.

Comments from referee No.1

Anonymous Referee No.1
Received and published: 23 March 2013

I have remarks on three main topics: (1) Description of methods and instruments: The authors should carefully check their manuscript to make sure that all measurements can be clearly connected with the respective analysis and results. In some parts of the article I have the impression that the different described analysis stand a bit isolated from each other, rather than they are supporting each other. (2) Thermal methods: What is shown in the manuscript is not a quantitative analysis and therefore does not justify stating that temperature methods are used to quantify groundwater-surface water interaction! However in my opinion with the presented data a very easy quantitative analysis of groundwater-surface water interaction using temperature data could and should be performed. (3) Figures: I think most figures need substantial improvement. What and how results are presented is often contradictory, unclear or simply incomparable with other results.

Reply to comments by referee No.1:

We appreciate the critical review and constructive comments which will help us to improve the manuscripts.

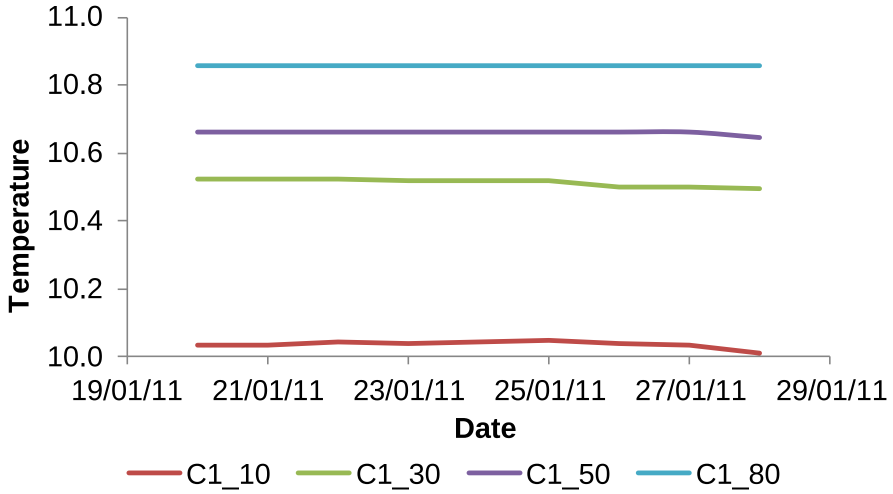
(1) Description of methods and instruments

Response: we described various methods and instruments which were used for identifying and quantifying groundwater-surface water interactions, and vegetation dependency on groundwater depth. Groundwater is the link between surface water and vegetation. We will rewrite the Section 2 Materials and methods. A general paragraph will be added to explain which methods and related instruments were used for studying groundwater-surface water interactions, and for studying vegetation dependency on groundwater, respectively. Only methods and instruments will be described, results will be moved to the sections followed thereafter.

(2) Thermal method

Response: we took the recommendation and have done quantitative analysis. Here we describe the methods and the results of the quantitative analysis of temperature measurements.

We selected the temperature measurements from Jan. 20 to 28, 2011 for the analysis (see Figure below).



C1_10 is the temperature sensor 10 cm below the riverbed, C1_30 is the temperature sensor 30 cm below the riverbed, C1_50 is the temperature sensor 50 cm below the riverbed, and C1_80 is the temperature sensor 80 cm below the riverbed. Since the temperatures at various depths are stationary in this period, the steady state heat transport equation satisfies (Bredehoeft and Papadopulos 1965):

$$\frac{\partial^2 T}{\partial z^2} + \frac{c_w \rho_w v_z}{k} \frac{\partial T}{\partial z} = 0 \tag{1}$$

Boundary conditions are:

$$T|_{z=0} = T_0$$
$$T|_{z=L} = T_L \tag{2}$$

Where:

T= Temperature (K)

T_0=Temperature at the top boundary;

T_L=Temperature at the bottom boundary;

c_w=specific heat capacity of water (J kg^{-1} K^{-1})

ρ_w=density of water (kg m^{-3})

v_z=vertical groundwater flow velocity (m s^{-1})

k=thermal conductivity of the soil-water matrix (J s^{-1} m^{-1} K^{-1})

The solution of the above equations is as follows (Arriaga and Leap 2006):

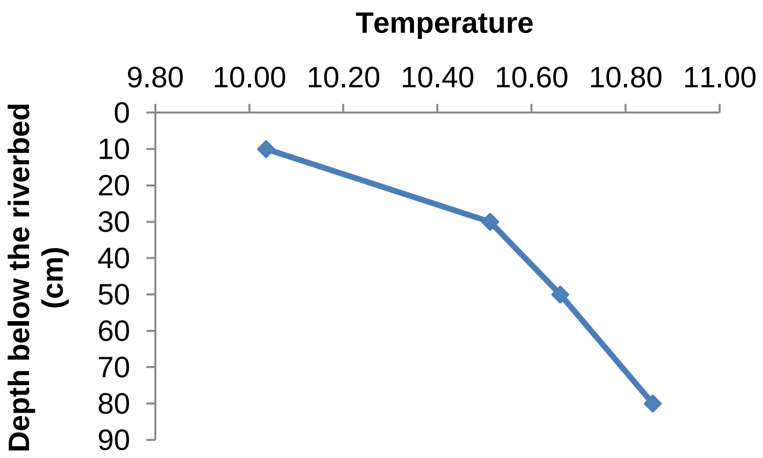
$$\frac{T_z - T_0}{T_L - T_0} = \frac{e^{\beta(z/L)} - 1}{e^{\beta} - 1} \tag{3}$$

Where:

$$\beta = \frac{c_w \rho_w v_z L}{k} \tag{4}$$

L is the vertical distance between the top and the bottom boundaries.

We took the average temperature from Jan. 20 to 28, 2011 and the changes of temperature with depths are shown in the figure bellow:



When C1_10 is defined as the top boundary (T_0) and C1_80 as the bottom boundary (T_L), the left side of equation (3) can be computed with the average temperatures in the profile and listed in the column 2 of the table below.

Relative depth (cm)	Measured	Computed	Difference	Squared difference
0	0	0	0	0
20	0.5792819	0.533697	0.045585	0.002077992
40	0.7606543	0.811569	-0.050915	0.002592342
70	1	1	0	0
			Minimizing	0.004670334

The right side of the equation (3) can be computed once the β is found. The sum of squared difference between the left and right sides of (3) can be minimized to find the optimal value of β as used by Boyle and Saleem (1979):

$$\min F(\beta) = \sum_{z=1}^{L} \left[\frac{T_z - T_0}{T_L - T_0} - \frac{e^{\beta(z/L)} - 1}{e^{\beta} - 1} \right]^2 \tag{5}$$

We used the Microsoft Excel Solver to perform the minimization and the optimal value of β was found to be -2.2843. The computed values of the right side of equation (3) are listed in the column 3 in the table. The difference is very small, the minimized sum of squared differences is only 0.00467.

The vertical groundwater flow velocity can then be computed with equation (4) as:

$$v_z = \frac{k\beta}{c_w \rho_w L} \quad (6)$$

The parameters used and computed velocities are shown in the table below. The velocity is negative indicating upward groundwater discharge to the river. The estimated velocity is 12.1 cm d^{-1} corresponding to the fine sand of the river deposit. This value is on the high side of groundwater discharge velocities estimated by Anibas et al. (2011). The value is much larger than the infiltration velocity estimated by Arriaga and Leap (2006).

Parameters	Value	Unit	Computed velocity (cm d^{-1})
Density of water ρ_w	1000	kg m^{-3}	
Specific heat capacity of water c_w	41800	J kg^{-1} K^{-1}	
[a]Thermal conductivity of fine sand k	1.8	J s^{-1} m^{-1} K^{-1}	-12.1
[b]Lower limit k	1.4	J s^{-1} m^{-1} K^{-1}	-9.4
[b]Upper limit k	2.2	J s^{-1} m^{-1} K^{-1}	-14.8

a) from Anibas et al. (2011)

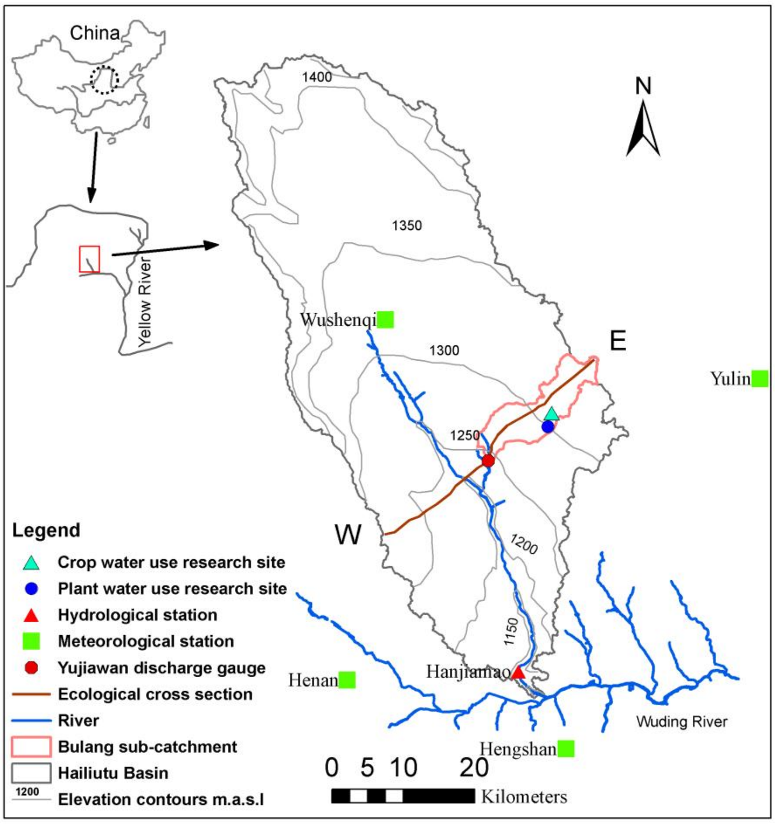
b) from Stonestrom and Blasch (2003)

(3) Figures

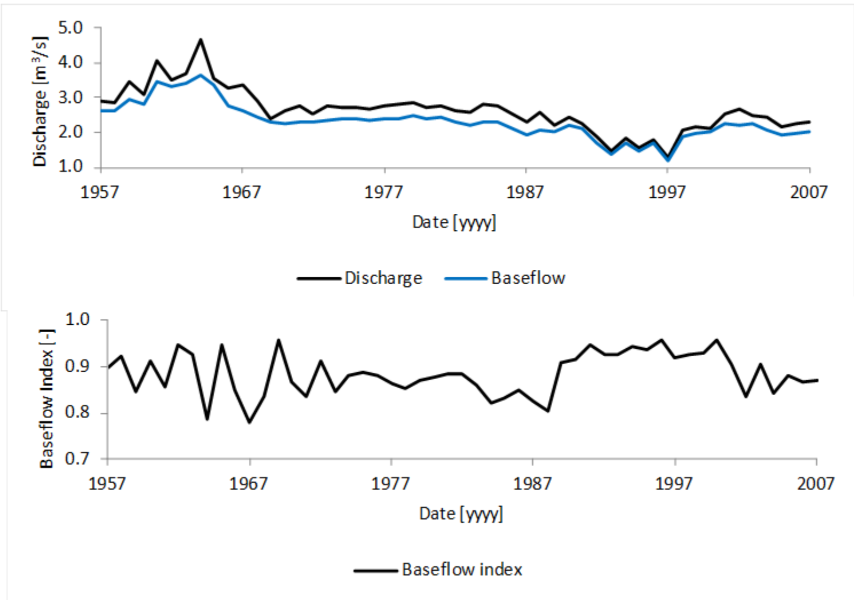
Response: we followed the specific comments on figures and made the following revisions:

- All grid lines in figures 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14 have been removed.
- The figures 2 and 3, figures 8, 9, 10 and 11, as well as figures 12, 13 and 14 have been combined in order to safe space.
- The suggested specific changes of figure 1 and 3 have been considered and figures were revised accordingly.
- Regarding the suggested combination of figure 4 and 5 we disagree with the comment that a combined figure would be beneficial. The fact that the temperature data stops earlier is negatively affecting the informative value of a combined graph.
- The suggested specific changes of figure 7, 8, 9, and 10 have been taken into consideration and figures were revised accordingly.
- The horizontal axes of figure 12 has been modified, but we would like to keep a detailed date format (MM-DD hh:mm) to differentiate the four seasons. An explanation of the dates in the figure caption would be too confusing for the reader.
- All mistakes in the figures were corrected.

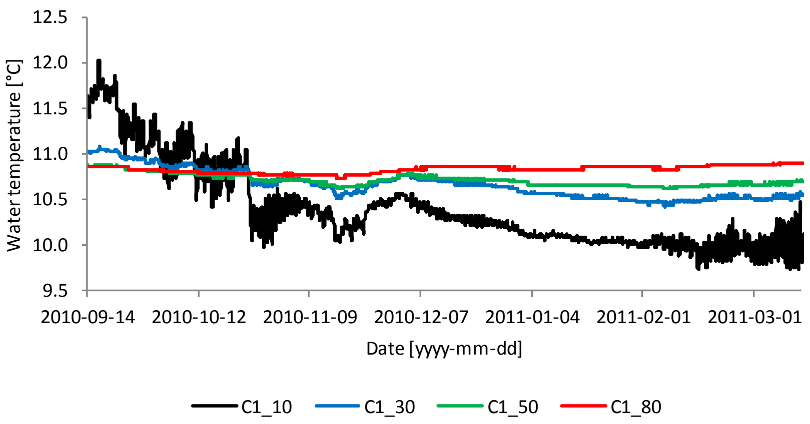
The revised new figures are as follows:



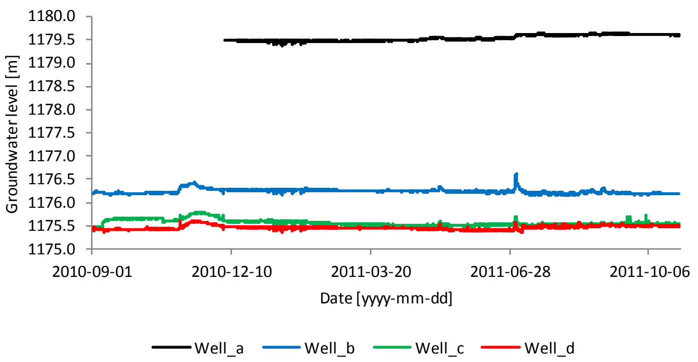
New Figure 1(old figure 1)



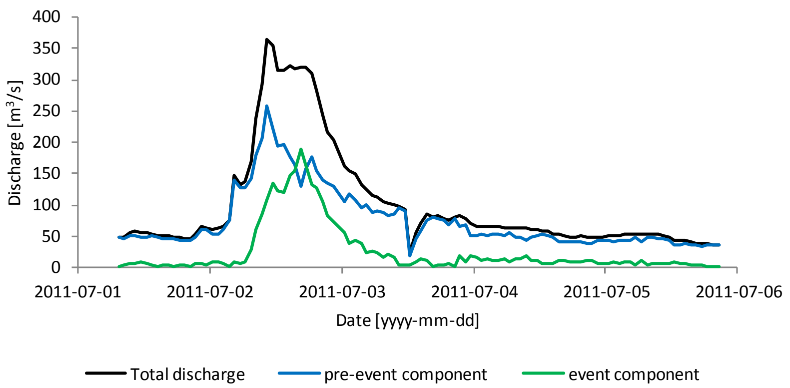
New Figure 2 (combined old figures 2 and 3)



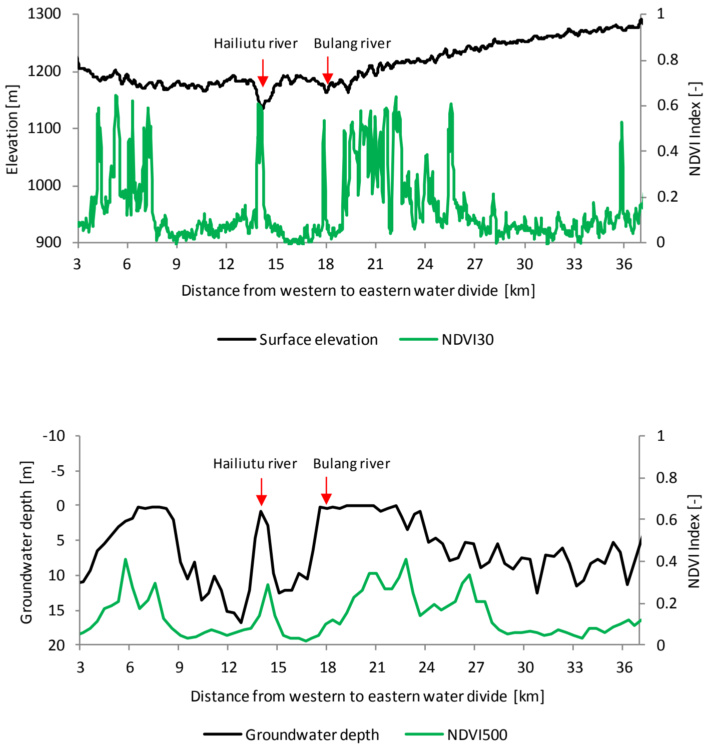
New Figure 3 (old figure 4)



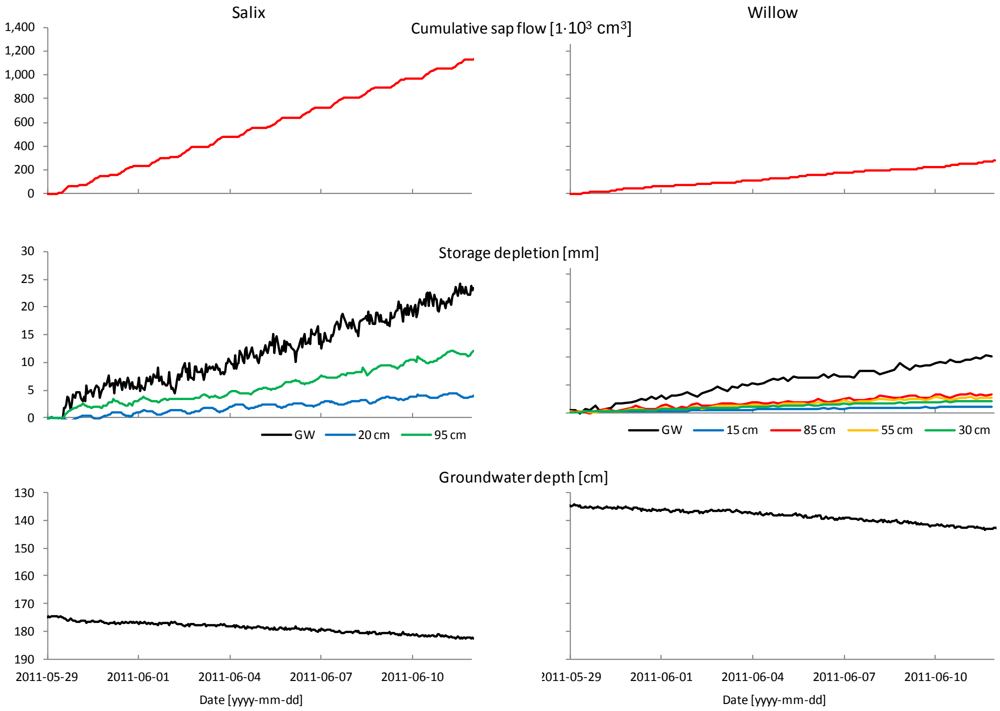
New Figure 4 (old figure 5)



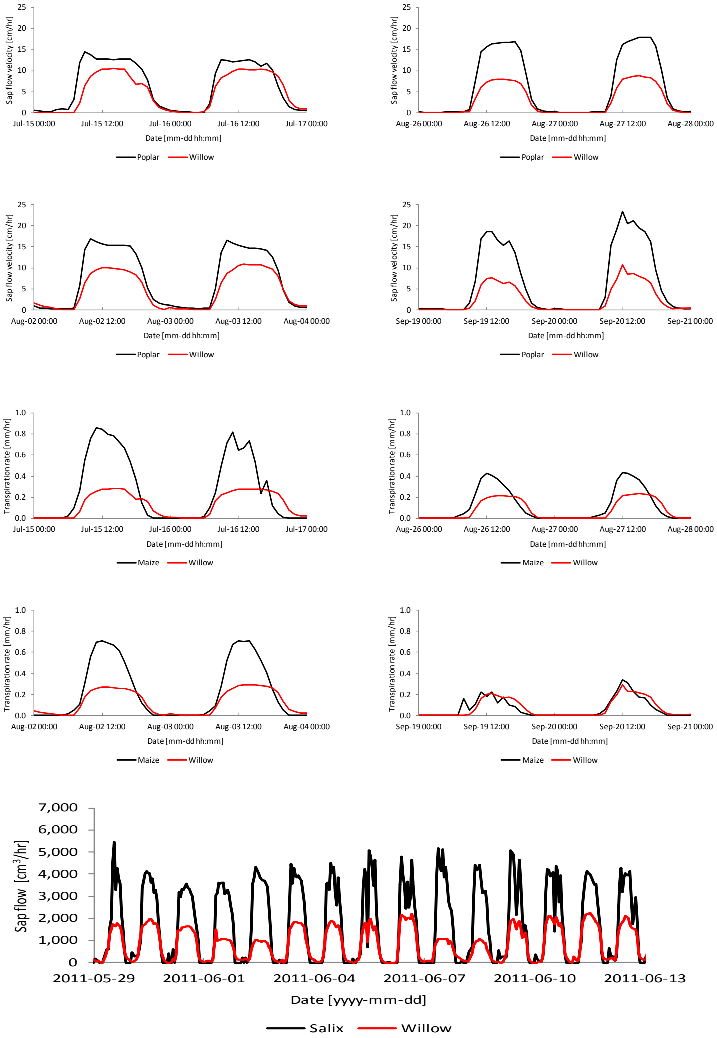
New Figure 5 (old figure 6)



New Figure 6 (old figure 7)



New Figure 7 (old figures 8, 9, 10 and11)



New Figure 8 (old figures 12, 13, and 14)

(4) Specific comments in supplement

we will revise the text accordingly following all specific comments provided in the supplement.