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Hydrology and Earth System Sciences Discussions

Interactive comment on "Characterizing interactions between surface water and groundwater in the Jialu River basin using major ion chemistry and stable isotopes" *by* L. Yang et al.

L. Yang et al.

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General comments:

1. The study has its focus on effects of river water on the groundwater quality, which given the many pollution sources for the river water could be a problem for the groundwater quality. The problem is that the sampling of the groundwater is based on existing wells- and evidently the existing wells are, in general, too far from the river to be

affected by river water - actually only one out of the 8 wells, 30 m from the river is affected. To what extent this makes sense is hard to say, as there is very little information on the groundwater levels compared to river water levels, and also information on the hydraulic conductivity is missing. Is this a losing or a gaining river - probably depends on where and when. The only general data that are given is the precipitation. Given the average precipitation, it appears that the sample year has been rather extraordinary with two single events exceeding the monthly rainfall - some comments on this would be appropriate. Information on evapotranspiration and net inïňĄltration would also be useful.

Reply: The study has its focus on the interaction between river water and groundwater on the basin scale, so the water in the existing wells was sampled. In the revised manuscript, the historical precipitation, shallow groundwater and surface water level data were collected from Annual Hydrological Report of the People's Republic of China. The groundwater levels measured at two sites (Zhongmou site (W1)) and Xinzheng site (W2)) in the Jialu River Basin over the period 1972–1973 were extracted from the Annual Hydrological Report. The precipitation and surface water levels corresponding to the groundwater were measured daily from Zhongmou and Xinzheng gauging station. At Zhongmou site, the level of the ground water was higher than that of the river for most of the study period, including the period of the major flood. At the Xinzheng site, the level of the groundwater was 5.5-7.2m higher than the river level. Overall, the river in this area is probably a "gaining" river for the most of the time. By comparing it to the water level in the Jialu River, it is apparent that the water level responded by an almost 0.7 m rise to rainfall that was more than 50mm at Zhongmou site during the flood season. Diffuse recharge by inïňĄltrating rainfall may explain an essential component of the water table rise. The mean annual potential evaporation is 1910 mm yr-1(from 1955 to 2001) at Zhengzhou station, which far exceeds rainfall for the area. Potential evaporation is lowest from December to January (64∼72 mm month-1) and highest from May to June (245∼275 mm month-1).

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2. Based on the presented data it would seem that main interaction was that groundwater ïňĆows into the river, but this is actually impossible to say. In principle there could be a wide zone, the next closest well is 70 meters from the river - and the next is 170 m away) around the river with frequent exchange of water - the sampling is just not capable of showing this due to the large distance to the river. To gain further insight based on the presented data a more careful scrutinizing of the data seems to be needed. Probably adding in information on rain water chemistry would help. Using this it might be possible to ïňĄnd out the amount of evaporation affecting the groundwater - it would also make it possible to see how much of the sulfate is derived from sulfate in the rainwater derived from SOx'es in the atmosphere. The suggestion on possible pyrite oxidation as the source of sulfate is not really backed up. It is the same for the Na and Cl - which are suggested as coming from urine, but this is again not backed up in any way. Also for the isotope data we are told that there is evaporation - but how much - and does this ïňĄt with what to expect in this area.

Reply: The primary focus of the study was to examine the interaction between surface water and groundwater. Based on the presented data it can be sure that groundwater ïňĆows into the river on the basin scale. It is very especial and different from most basins in the world. It is the first step, and in the next step monitoring wells will be installed at cross-section of the Jialu River bank near the river. In that way, the sampling is capable of showing the frequent exchange of water. Two rain water samples were collected in the first campaign after the flood event (July, 2010). The average concentration of sulfate was 8mg/L, which was far less than that of the waters in the upper stream. Although the isotope data we are told that there is evaporation, the increasing of chloride and sulfate were out of proportion to the evaporation of rain. It would make it clear that the sulfate is derived from pyrite oxidation. In the same, the average of the concentrations of the Cl and Na were 4mg/L and 1mg/L, respectively, which were also less than that of the waters in the river. The untreated sewage waste (average 37 ton/day between 2007 and 2009) in Zhengzou was eventually discharged into the Jialu River. The higher Cl and Na in the river could be coming from sewage wastes.

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3. It might be possible to make some sort of mass balance on the river water - to see if the groundwater component is there during ïňĆood events - or whether these events are completely dominated by surface runoff. It would have been nice with a data set reïňĆecting base ïňĆow conditions.

Reply: It is very helpful to sample the rain water during flood event. However, the rain water during flood event was not collected. If it were collected, I might make some sort of the river water using mass balance. As to the base flow, it is necessary to collect the water samples in the next step.

4. More could be done with the groundwater chemical data. Given the nice data it would be appropriate to make a speciation using e.g. PHREEQC to see whether any minerals are controlling the chemistry, my guess would be that aragonite or calcite is controlling the Ca and carbonate content - and given the ïňĆuctuations in Na - there might also be some ion exchange going on in the system. The SY14 sample from Sept. 2010 appears to have an interestingly low Na/Cl ratio that ïňĄts with a high Ca/Alkalinity ratioindicating that Na is exchanging for Ca on the exchanger of the sediment.

Reply: The PHREEQC was used to compute the saturation indices (SI). The saturation indices with respect to calcite of surface water are between -0.19 and 0.66, whereas for groundwater they range from 0.08 to 0.46. The surface water showed an oversaturation with respect to calcite (SI=0.37∼1.03) during the flood event, while some of water were undersaturated (SI=-0.19∼ -0.01) after the flood event. The SI values with respect to calcite indicate that the groundwater is slightly saturated with respect to this solid phase. The aragonite or calcite is controlling the Ca and carbonate content according to the PHREEQC. It has a low Na/Cl ratio that ïňĄts with a high Ca/Alkalinity ratio in the SY14 samples from July and Sept. 2010, which indicates that Na is exchanging for Ca on the exchanger of the sediment.

Specific comments:

p.1 l.14: Transitional - what is meant by this?

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Reply: Transitional means that the river water can be exchanged with the groundwater.

p.1 l.18: "would" - should probably be "should"?

Reply: It has been revised.

p.1 l.24: COD is Chemical Oxygen Demand

Reply: Yes. It has been revised.

p.2 l.19: was -> were

Reply: It has been revised.

p.2 l.20: ïňĆood processing ? - does this mean during the ïňĆooding event ?

Reply: it means ïňĆooding event.

p.2 l.20: "after the? ïňĆooding period"

Reply: after the ïňĆooding event.

p.3 l.15: this -> the (two occurences)

Reply: They have been revised.

p.3 l.27 - p.4 l.5: This is very difïňĄcult to follow and needs a rewrite

Reply: the sentences rewritten: The ïňĄrst campaign was during the ïňĆood event. Water samples were taken in upstream of Zhengzhou before rain. The rest samples were collected after rain. The river water SY9 and SY20 had been sampled when ïňĆood peak did not reach the locations. However, river water (location J10, SY12, and SY15) had been sampled when ïňĆood peak passed.

p.4 l.22: It must have been some sort of "multimeter" if the same instrument could also measure pH???

Reply: Temperature, pH value and electrical conductivity of each sample were mea-

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sured in situ using an EC/pH meter (WM-22EP, Toadkk, Japan).

p.5 l.6: Edmond et al. not in reference list - please check

Reply: Edmond JM, Palmer MR, Measures CI, Grant B, Stallard RF.: The fluvial geochemistry and denudation rate of the Guayana Shield in Venezuela, Colombia, and Brazil. Geochim Cosmochim Ac, 59, 3301-3325, 1995

p.5 l.10: this -> the

Reply: It has been revised.

p.6 l.4: "meteoric WATER? line" - most frequently the word "water" is included

Reply: meteoric water line

p.6 l.5: "giving accurate information on the input signal" What does this mean?

Reply: “giving accurate information on the input signal” means that the information is given when the rain infiltrate into the river and the groundwater.

p.7 l.15: oxidation -> oxidizing

Reply: It has been revised.

P.7 l.20 The TDS is generally not very high - and with a relatively high evaporation and calcite dissolution under high PCO2 conditions the concentrations are not that high?

Reply: The TDS in sample location J20 (groundwater in the Fugou) is higher than that in the other groundwater.

P.9 l.10 How much urine does the measured values present - what is the concentration in precipitation - corrected for evaporation? More background and backup information is needed. If the Na and Cl is from urine - then some other speciïňĄc compounds should follow ?

Reply: The average of the concentrations of the Cl and Na were 4mg/L and 1mg/L,

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respectively, which were far less than that of the waters in the river. The untreated sewage waste (average 37 ton/day between 2007 and 2009) in Zhengzou was eventually discharged into the Jialu River. The higher Cl and Na in the river could be coming from sewage wastes. Chloride and sodium are major electrolytes in human urine and are therefore concentrated primarily in untreated waste water.

p.9 l.25 animal breeding?? - do you mean grazing??

Reply: animal feeding

p.10 1.2 "improper proportions" - this sound strange, I would like to think that if you go through the trouble of making artiïňĄcial fertilizer you would try to make it "proper" if not perfect?

Reply: delete “ improper”.

p.11 l.13 could -> can

Reply: “could” has been changed into “can”.

p.12 l.22 it appears that things are turned around in this sentence.

Reply: The groundwater (SY3 in September, 2010) was approximately composed of 60–70% river water. Thus the groundwater was composite of contaminated river water if the river water is severely polluted.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 5955, 2012.