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Hydrology and Earth System Sciences Discussions

Interactive comment on "Structured hydrological analysis for targeting fallow evaporation toimprove water productivity at the irrigation system level" *by* S. Khan et al.

Anonymous Referee #2

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The paper intends to use a novel hydrological analysis applied to an irrigation system by exploring remote sensing (RS) and groundwater (GW) modelling, which is of great interest. However the paper is not successful in doing so because the case study area requires a more in-depth characterization. In other words, the study is not mature for publication.

General comments: a) land use classification is much more complex than the approach used that produced a single map. Land use varies seasonally. During winter there is a dominant land use that is irrigated wheat, which is followed by several summer crops, generally rainfed by the monsoon rains. At least 2 maps, one for winter and another for

summer should be considered; eventually more than 2 if the analysis focus fallow land as referred in the title. Therefore, a single map is very much insufficient and is misleading when the water budget is performed. b) Using RS is quite difficult because of the parcelling in the area.. In a recent project in Yellow River (YR) basin, my colleagues in charge of RS had a lot of difficulties with land use classification due to small parcelling, roads, canals, villages, etc. In the Material and Methods section no difficulties are recognizable nor the special characteristics of land use and parcelling that should have lead to adopt a particular approach well adapted to the existing conditions. c) Authors focus fallow land as a source of problems. However they do not define what they considered fallow and, moreover, they do not explain why fallow exists. YR lands are among those in the world receiving the highest pressure for cultivation. The farming area by family is $<$ 1 ha, very often around 0.5 ha. Thus farmers do not leave land under fallow if they are not obliged to do it. If there is water, not a single plot is uncropped. To my experience, fallow occurs in winter in areas where water is not enough to irrigate wheat. Farmers wisely irrigate well the portions of land for which they have enough water and leave fallow the remaining. Fallow occurs in summer where salinity exceeds the threshold for summer crops. Without a good identification of fallow land conditions the paper should not focus fallow. The amount of fallow land identified is extremely large according to my experience which probably relates with referred difficulties for land use classification. d) In the title and objectives, authors focus increasing water productivity. However, when farm areas are so small, the farmers objective is land productivity and water productivity comes as a consequence. Nowadays everybody speaks about water productivity but do not realize which are the constraints of a farmer. e) For the water accounting RS was used for estimating ET. The same difficulties due to the small areas of plots/pixels should be apparent. No reference to seasonality of crops is evidenced and ET results are presented as a bulk value. Relationships between NDVI and crop coefficients are not referred. SEBAL is a good model but it will not give good results if input values are not true. f) Results in tables and figures relative to water accounting , ET and irrigation do not refer to the winter and summer seasons in separate. However,

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discharges are larger in the rivers during summer and autumn due to summer monsoons. By the spring, when irrigation is crucial for wheat and for establishing cotton, discharges are quite small. Diversions and seepage vary with time as well as land use and related ET. I understand that performing water accounting seasonally is difficult but it is necessary. g) The seepage inflow estimation is not described as it is also not described the GW outflow from the area. Comparing both GW in- and out-flow it seems that we are we two very different aquifers. The fact is that GW modelling parameterization is not enough accurate. Land created by deposits of YR during many thousands of years is very rich in silt, which probably do not favour such a high seepage that equals the river diversions in the area. Exploring a GW model without adequate parameterization may lead to large errors. Boundary conditions are not defined. References to the hydrogeological conditions are also not given, thus nothing explains the assumptions of very large seepage upstream and very low outflow downstream. h) Water productivities (WP) must have to be related with the season. For winter, WP refers to wheat irrigation; for summer they refer to irrigated rice and cotton and to rainfed maize and other. There is no sense in mixing everything. i) The paper lacks a good review on studies on the YR and North China irrigation.

Specific comments: 1. pg. 330, line 12: the term irrigation water use efficiency is inadequate; water use efficiency is the ratio biomass to transpiration, often used as a poor synonymous to water productivity. What do you intend to say? irrigation efficiency, that is referred above as a term to be avoided, or water productivity? 2. 330, 14-15: The affirmation water-table depths less than 1 m significantly decrease yields of crops with the exception of rice is not entirely true. What about e.g. shallow rooted crops? 3. 330, 15-16: the sentence without enough lateral recharge to lowland ground water needs some reference that explains the geohydrologic conditions and some explanation about the quantities of water that are applied and produce such effects. 4. 330, 20-23: the sentence There is an urgent need to save a substantial amount of water lost from fallow evaporation and crop transpiration in the ARL side of LIS, and introduce more surface water supplies in the ground water-dependent areas through improved water

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management strategies. Is a conclusive one (despite the reference to Khan given after, and is inappropriate for introduction. How can one explain an urgent need to decrease crop transpiration? Everywhere in the world when crop T is decreased assimilation and yields also decrease! How you may say that more water is need ed if above no computations of crop water requirements are presented or referred? 5. 330, 26: water lost is referred: yes if it is fallow ET but water pathways also concern water into GW, which is not lost 6. Fig. 1: the map of the YR basin is too small to understand where is the basin and how far is the YR, which is said to produce an enormous seepage into the area. It could be good to have an idea to realize this assumption. Anyway, some description and references to hydrogeological conditions are required. 7. 331, 21-25: the sentence Due to intensive local groundwater pumping within the BRL area, the lateral outflow of the aquifer is very small compared to lateral seepage into the area. is confuse. Above is said that GW raised and more pumping is required; here is said that excess pumping reduces outflow of the aquifer. Conversely, in the ARL the ground water aquifer is already full and there is risk of soil salinisation if hydraulic loading due to rice is reduced, what is meant with hydraulic loading? Soil leaching? But there are solutions that do not require an excessive leaching and these are known in China! 8. 331. 27: when you say that this area is a net salt sink it may be true but a salt balance is required as well as an understanding of improving paddy rice management and leaching. Some studies on this matter should be known and quoted. 9. 332, 8-11: this paragraph is difficult to be understood. Start saying that Ěwas completed, (Ě) was closed, is less good. Please rephrase. 10. 332, Hubei station: give coordinates and explain were it is located relative to the LIS. Look that Hubei is the name of a Province, not a town or a location. Moreover, it must be underlined that you approach the water balance of 40000 to 50000 ha with data of a single weather station without recognizing if there are spatial variations, mainly during the monsoons rains. 11. 332, 17: It is the first time in my life that I see rainfall given as a volume and not in mm. This is not admissible! 12. 332, 22: how were Kc selected? Which was the source? 13. 333, 2: if diverted water is also given in volume and the area is not

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given, how a poor reader can understand what is going on? 14. 333, 9: INFLOW - OUTFLOW = Change in groundwater storage could be acceptable if you could explain how both terms are computed 15. 333, 11-12: why the specific yield of the aquifer is assumed as 0.15? could you give some reference or justification? 16. section 3.2.1: in a recent project in YR basin, China, my colleagues in charge of RS had a lot of difficulties with land use classification due to small parcelling, roads, canals, villages, etc. in this section no difficulties are recognizable nor the special characteristics of land use and parcelling. I am astonished and I consider those that worked there very good professionals/scientists (they do not belong to my institution or country) 17. Sections 3.2.2/3. it is also atonishing for me that the very great parcelling and mix of crops during the summer did not cause difficulties since the respective pixel is much smaller than satellite resolution. Tasumi et al. (2001) are referred but they applied the methodology for large parcels. Relating the ETc=Kc.ETo referred above with the RS data would have been expected since RS data relate well with Kc or better with Kcb. 18. 337: water accounting indicators could have been somewhat better explained since thy are not usually known by common readers, 19. 338, 13-15: appropriate references to model MODFLOW and the MT3D solute transport simulator should be given, eventually identifying the version of the models; also an explanation on the PMWIN environment should be given. Note that every abbreviation or acronym used in a paper must be identified prior to be used. 20. 338, 25: what kind of water levels are referred? GW levels? Where measured? How and how often measured? Observation of water levels is not mentioned in material and methods. 21. 339, 3: a combination of PEST and UCODE methods is mentioned but nothing is explained nor a single reference is given 22. Table 2: a productivity for Soybean of 85-120 kg/ha is an error. May be it refers to mu and not ha. 23. abbreviation is ha and not Ha. 24. 339, 13-15: it is said that The lateral seepage from the Yellow River ranges from 85 to 95 MCM/year. The yearly surface water diversions from the Yellow River range from 7 to 162 MCM. Could one believe that seepage from YR equals the average diversions from that river? Soil deposited for thousands of years is a silty soil which has not such a high permeability.

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Have you measured soil hydraulic properties in the vadose zone? Have you checked these data against data collected by other authors and the YR Water Commission? 25. Table 3: it is not readable without a calculator: why MCM are used instead of dividing the volume by the area and giving results in mm? Anyway, I could not follow the comments in the text page 339. 26. 339, 17: You mention that fallow evaporation and runoff out of the area (Ě) can be in the range of 50% of the total inflow. However, the fallow land is not well identified, particularly its variation in time and space, and no causes for runoff are identified or discussed. 27. 339, 21: you mention Lateral outflow of groundwater is minimal and is in the vicinity of 1% of the total outflows from the system. Comparing with the lateral inflow referred above it could only be justified by an extreme change in boundary conditions or a computation error. For the first, it is not given any well based justification. 28. Fig 3 is not well readable for the purpose of authors but allow to see how far the YR is (see item 6 above) 29. Fig. 4. Land use classification map of LIS area for 1990-1991 is not readable in greyscale. A colour image is required. 30. Section 4.2. refers to difficulties in land classification but this should have been mentioned in material and methods as referred above. More important, in this section some explanation about bare soil and fallow should be given. To my experience in China you may have fallow in winter if there is no enough water to irrigate wheat or if you have saline soils. Bare soil occurs during limited periods of land preparation. Thus the fig 4 being given without a date and an explanation is misleading. The title of the paper refers specifically to fallow evaporation; therefore particular attention should be given to identify when and why fallow occurs in a country were land is probably the most rare production factor in agriculture. 31. Fig. 5 shows a very large spatial variation in ET data; comparing with Fig. 4 a reader does not find any explanation. We know that SEBAL provides good results but these depend on many methodological approaches. The discussion in the text is poor. I am surprised. I can not say this is true or not but I am not confident in these mapped results. 32. Fig. 6 refers to Epan but pans were never mentioned in Material and methods. Where was it located? How was it the pan site? Was a Kpan used? Using data of a single

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pan to validate ET data from RS is useless and misleading! Please delete that part and fig. 33. the section on water productivities must be oriented for season crops and irrigated and rainfed crops, not all together 34. section 4.5 needs to be revised in light of appropriate characterization of the hydrogeological conditions in the area 35. with so much assumptions not proved and less accurate estimations. There is no sense in producing a section on future scenarios.

The paper seems to be proposed for publication before authors could produce an in-depth reflection about results and discuss these with others or international conferences. I suppose that the manuscript bases upon updated methodologies but is not mature for publication. Terminology could also be improved. Moreover, a deeper discussion on causes for fallow, times when they occur, as well as for bare soil is required. The boundary conditions of the aquifer must be well recognized. Rewriting the paper and submitting later is advised.

In your evaluation please take into account the following aspects:

1) Does the paper address relevant scientific questions within the scope of HESS? yes 2) Does the paper present novel concepts, ideas, tools, or data? yes 3) Are substantial conclusions reached? no 4) Are the scientific methods and assumptions valid and clearly outlined? no 5) Are the results sufficient to support the interpretations and conclusions? no 6) Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? no 7) Do the authors give proper credit to related work and clearly indicate their own new/original contribution? no 8) Does the title clearly reflect the contents of the paper? no 9) Does the abstract provide a concise and complete summary? yes 10) Is the overall presentation well structured and clear? no 11) Is the language fluent and precise? no 12) Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Abbreviations and symbols are often not defined 13) Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? yes 14) Are the number and quality of references appropriate? no 15) Is

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the amount and quality of supplementary material appropriate? n/a

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