Hydrol. Earth Syst. Sci. Discuss., 9, C2880–C2893, 2012
www.hydrol-earth-syst-sci-discuss.net/9/C2880/2012/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Regional effects of vegetation restoration on water yield across the Loess Plateau, China" *by* X. M. Feng et al.

X. M. Feng et al.

fengxm@rcees.ac.cn

Received and published: 11 July 2012

Comments from reviewer #1:

General Comments 1:

The paper is generally well-written, though there are several minor errors that I assume will be caught in copy-editing (now that copy-editing is standard). The title clearly reflects the contents of the paper. Though clear, the abstract suggests that the authors will compare regional to plot scale results directly, which does not happen in the paper. The structure of the paper makes sense overall; however, I think that the description of the ET model on p. 4171 (lines 12-22) should be moved to the methods section.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

Response: We appreciate the reviewer's suggestions. We have removed the suggestion of comparing regional to plot scale results from the abstract. We have also moved the description of the ET model from the result to method section.

General Comments 2:

I have two basic concerns with this paper. The first concern is that the authors state: "We assume that the climatic effect on water yield during the post restoration period is the difference between Scheme 2 and Scheme 1 with recognition that climate-land cover feedbacks during the entire study period" (p. 171, lines 6-9). Because of the non-linearity in hydrologic response, it is highly unlikely that the difference between scheme 2 and scheme 1 gives the climatic effect on water yield. It gives the climatic effect on water yield given the observed changes in vegetation. Simply rephrasing this would suffice. I also suspect that the land cover change was impacted in part by climate, i.e., rates of growth respond to climatic conditions, such that even the fixed climate simulation includes some degree of climate response. I do not expect the authors to be able to deconvolve this response; however, I would like for them to address in the paper the degree to which they might expect this to impact their results. One approach that would help to clarify the climate vs. vegetation impacts would be to do a simulation with fixed vegetation and variable climate. The second concern is that the authors do not perform any significance testing on their trend results. In general, I think that the conclusions presented are justified by their results; however, if the trends in water yield are not statistically significant or if the difference between the fixed and variable climate cases is not statistically significant, the conclusions may not be justified. The paper discusses regional versus point-scale estimates of afforestation impacts on water yield, but the results are all given at individual grid cells. Although the spatial variability is quite interesting, it would be worthwhile to also report the basin wide trends.

Response: We rephrased the words according to the reviewer's suggestions. In the case of the Loess Plateau, vegetation has been changing, thus assessment of climatic effects must consider vegetation change. Related work indicted that plant growth (rep-

HESSD

9, C2880–C2893, 2012

Interactive Comment

resented by NDVI) of the Loess Plateau has been increasing even though there is no significant climate change detected during 1999-2007. The implementation of GFG was the driving factor of this increase. We have added information about GFG-driven land cover change during the study period. As recommended, we have added significance testing on the trend and the difference analysis between two schemes in the paper. More descriptions of the revision related to the above concerns can be found in the following response of specific comments. We agree with the reviewer that it is worthwhile to report the trend at a basin scale. However, we expect that we will come to similar conclusions either at cell or basin scale.

Specific comments 1:

p. 4170, line 4: The break in the data sets for different vegetation sensors coincides with the timing of the GFG. What impact could this have on the results?

Response: We have added more description of the impacts. "NDVI data were compiled from different sources because of the limitation of data availability for different time periods. GIMMS AVHRR-NDVI data were used to describe vegetation conditions in the period 1980–1999, while SPOT VEGETATION data was used in the period 1999–2007. The two data sets were applied on different stages of model work. GIMMS AVHRR-NDVI was important model inputs for the calibration and validation. It was approved to be well-suited for vegetation studies of arid and semiarid areas (Fensholt et al., 2009), which make it helpful in building regional ET model. SPOT VEGETATION NDVI was used in model application before and after GFG project. It was considered an improvement over AVHRR GIMMS especially in spatial resolution (Fensholt et al., 2009). The uncertainty caused by using different vegetation sensors was reduced by the following trend analysis of model application."

Additional References Fensholt, R., Rasmussen, K., Nielsen, T.T., Mbow, C.: Evaluation of earth observation based long term vegetation trends - Intercomparing NDVI time series trend analysis consistency of Sahel from AVHRR GIMMS, Terra MODIS

and SPOT VGT data, Remote Sens. Environ. 113, 1886–1898, 2009.

Specific comments 2:

p. 4171, lines 8-9: The response is likely non-linear. Why not run a simulation with observed climate and fixed vegetation? Also, what is the anticipated impact of climate on the observed vegetation changes? (as commented above)

Response: We have added some description. "Related work showed that plant growth (indicated by NDVI) of the Loess Plateau has been increasing despite insignificant climate change during 1999-2007, and the implementation of GFG project was the driving factor (Xin et al., 2008; Zhang et al., 2011). In the case of the GFG –driven land cover change, the individual influences of vegetation restoration and climate variability were separated by comparing the model outputs of two schemes. . .. . .."

Additional References Zhang, B.Q., Wu, P., Zhao, X.N.: Detecting and analysis of spatial and temporal variation of vegetation cover in the Loess Plateau during 1982-2009, Trans. CSAE, 27(4), 287–293, 2011. (in Chinese)

Xin, Z.B., Xu, J.X., Zheng, W.: Spatiotemporal variations of vegetation cover on the Chinese Loess Plateau (1981-2006): Impacts of climate changes and human activities, Sci. China Ser. D, 51(1), 67–78, 2008.

Specific comments 3:

p. 4173, lines 7-9: What type of trend test did you perform? And which "regression statistical tests" did you perform?

Response: We have moved this part to the method and materials section (Section 2.4) and added some description concerned on the regression statistical tests. "We used the MATLAB Program to detect the trend of modeled annual water yield for each pixel by conducting linear regressions relating water resource with time (year). Regression coefficient was used to predict rate of annual water yield variations before and after GFG project. A positive or negative value predicts an increase or decrease rate of

HESSD

9, C2880–C2893, 2012

Interactive Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

annual water yield. If the regression coefficient passes through the significance test ($P < 0.05$), it shows an "significant" ascending or descending trend."

Specific comments 4:

p. 4176, lines 4-8: Give the % decrease in runoff from this study over the Heihe catchment as a point of comparison.

Response: The % decrease in runoff over the Heihe catchment has already be given in the paper. We have rephrased the sentence to make it clearer. "Using a process based hydrological model (SWAT), Li et al. (2009) quantified the combined and individual influences of land use change and climate variability in the Heihe catchment located in our study region. Their studies concluded that land use change and climate variability reduced runoff by 9.6% and 95.8% respectively during 1981-2000."

Specific comments 5:

p. 4177, lines 15-18: What mechanism explained higher baseflow rates despite higher ET in the southeastern U.S.?

Response: We have revised the description to make it clearer. "A recent regional study by Price et al. (2011) found that undisturbed forested watersheds in southeastern U.S. with high precipitation had higher baseflow rates than areas with less forest covers in spite of the higher ET rates in forests. The authors attributed the higher baseflow in forests to higher infiltration rates."

Specific comments 6:

Figure 4: In 2006 (average year), modeled ET is almost always higher than precipitation. Please comment on reasons for this in the paper. Also, the font on the axis labels is hard to read.

Response: We have modified the figure and added some comments in the result section (section 3.1). "Our regression models showed that ET accounted for 90% of pre-

HESSD

9, C2880–C2893, 2012

cipitation (Fig. 4). Especially in 2006, modeled ET was much higher than precipitation because the temperature was relative high in this year."

Specific comments 7:

Figures 5 and 6: Which, if any, of these trends are statistically significant? I'd rather see the regions with insignificant trends masked out. Also, it would make more sense when reporting % of basin area with decreases in water yield to report % of basin area with statistically significant decreases in water yield. Where were the differences between vegetation change only and vegetation change with climate significantly different? A map showing the difference in water yield trend between scheme 1 and scheme 2, masked out in areas where differences are insignificant, would provide a good summary of these results.

Response: We have added the statistically significant analysis on water yield change and had created the map showing the difference in water yield trend between scheme 1 and scheme 2. We have added descriptions of testing the significance of the difference in water yield trend between scheme 1 and scheme 2 in the method section (section 2.4). We have also revised the result section (section 3.2) and figure 5, 6.

Descriptions on the method (section 2.4): "Paired sample T-test (two-tailed) was carried out with MATLAB Program for each pixel to detect significant differences of annual water yield for 1999-2007 between scheme 1 and scheme 2. The level of significance was set as $p<0.05$."

Revision on the results (section 3.2): "3.2 Spatial Variability of Annual Water Yield 3.2.1 Effects of Land Cover Change Only The results of trend analysis suggested that vegetation restoration only during the study period caused annual water yield to decrease as much as 1.6 mm per year on average across the Loess Plateau (Fig. 5a). Divided the trend in water yield over the period 1999-2007 by the baseline conditions in 1999, change in water yield can also be expressed in a relative term (Fig. 5b). About 26% of the study region located in the southeast portion (i. e., southern Shaanxi and Shanxi

Provinces) had a significant decrease trend (P<0.05, T-test) in water yield with a range of 1–48 mm per year, among which a small portion (6%) experienced a decrease trend greater than 10 mm per year. About 19% of the study region located in the north portion (i.e., northern Shaanxi and Inner Mongolia Province) experienced less but also significant decrease (P<0.05, T-test) (Fig. 5a, Fig 5c, Fig. 6a). Because of the low baseline in these dry areas, the decrease less than 1 mm per year caused a relative value greater than 100% in water yield (Fig. 5b, Fig. 6b). 3.2.2 Effects of Land Cover Change + Climate Variability The combined water yield responses to land cover change and climate variability during 1999-2007 decreased by 1.0 mm per year on the Loess Plateau as a whole. The significant difference in water yield trend between the combined scenario and land cover only occurred in northern Shaanxi, Shanxi and Inner Mongolia Province (Fig. 5g). Because of the climate effect, the previous significant decrease in water yield in these areas became to an insignificant increase with a range of 1-10 mm per year (Fig. 5d). As expected, small changes in water yield amount resulted in a large relative change in the dry portion (northern Shaanxi, northwestern Shanxi and Inner Mongolia Province) due to their low background (Fig. 5e, Fig. 6c). Because of the climate effect, about 37% of the study area saw a decrease in water yield within a range of 1–54 mm per year. Only 4% of the study region (southern Shaanxi Province and southwestern Shanxi Province) has undergone a significant decrease (P<0.05, T-test) in water yield of more than 5 mm per year (Fig. 5f, Fig. 6a)."

Specific comments 8:

This section of the review is meant to point out places in the manuscript where methods or interpretations are not entirely clear as written. In these cases, simply re-writing or adding a bit of detail will address the question. p. 4168, lines 14-16: change "Where, Ld is the average daytime length of each month, RHOSAT is the saturated vapor density (g m-3) at the mean air temperature (T); and where T is the monthly mean air temperature (°C);" to: "Where, Ld is the average daytime length of each month, RHOSAT is the saturated vapor density (g m-3) at monthly the mean air temperature(T, °C);"

HESSD

9, C2880–C2893, 2012

Response: Revision has been made.

Specific comments 9:

p. 4169, line 8: It would be much more intuitive to call "Watershed-ET" method something more like "Water-Balance-ET."

Response: We have revised it including figure 3.

Specific comments 10:

p. 4170, line 4: should be NDVI, not NDIV.

Response: revision made.

Specific comments 11:

p. 4170, line 23: should be "ET is affected by both land cover and climate change, and, therefore, so is water yield."

Response: revision made.

Specific comments 12:

p. 4171, lines 2-4: rework for clarity: ". . .the water yield model was run with a fixed climate of 1999, when the GFG project was first initiated, and land cover in the model was changed gradually during 1999–2007 to mimic the observed changes. . ." Was the vegetation in the fixed climate model the same as in the second model?

Response: We appreciate the reviewer's comment and had made the revision. "1) to determine the hydrologic effects of land cover change, the water yield model was run with a fixed climate of 1999 when the GFG project was first initiated and land cover has changed gradually during 1999–2007; 2) to determine the combined effects of both the climate and land cover, the water yield was calculated by changing the fixed climate in scheme 1 to the observed annual precipitation and temperature."

Specific comments 13:

HESSD

9, C2880–C2893, 2012

Interactive Comment

p. 4174, lines 3-5: Early in the paper, the authors state that 1999 is the pre-GFG period, and 2000-2007 is the post-GFG period. When calculating relative change, do you use 2000-2007 average minus 1999 water yield? Or is "relative change" the trend in water yield over the period 1999-2007 divided by the baseline?

Response: We appreciate the reviewer's comment and had made the revision. "Divided the trend in water yield over the period 1999-2007 by the baseline conditions in 1999, change in water yield can also be expressed in a relative term"

Specific comments 14:

p. 4174, lines 11-12: "Temporal water yield change for the entire Loess Plateau region was defined as the water yield amount in post-vegetation restoration period minus that under the baseline condition (i.e., in 1999)." Does this mean "Temporal water yield change for the entire Loess Plateau region was defined as the water yield amount in each year of the post-vegetation restoration period minus water yield under the baseline condition (i.e., in 1999)."?

Response: following revision made. "Temporal water yield change for the entire Loess Plateau region was defined as the water yield amount in each year of the post-vegetation restoration period minus water yield under the baseline condition (i.e., in 1999)."

Specific comments 15:

p. 4176, lines 20-24: Grammar on "Regional veg- etation restoration, especially in water-limited northwest Loess Plateau areas, should consider long term climate trends so the influence of land cover and land use change on water availability by humans and ecosystems (i.e. water use by plant and aquatic biota in streams)." Try something like: "Long-term climate trends [and variability?] should be considered when planning regional vegetation restoration, especially in water-limited northwest Loess Plateau areas, so that the land cover and land use changes do not limit water availability beyond

HESSD

9, C2880–C2893, 2012

Interactive Comment

what can sustain human and ecosystem uses."

Response: revision made.

Specific comments 16:

p. 4176, line 27: I think "flush stormflow" should be "flash stormflow."

Response: revision made.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 4161, 2012.

HESSD

9, C2880–C2893, 2012

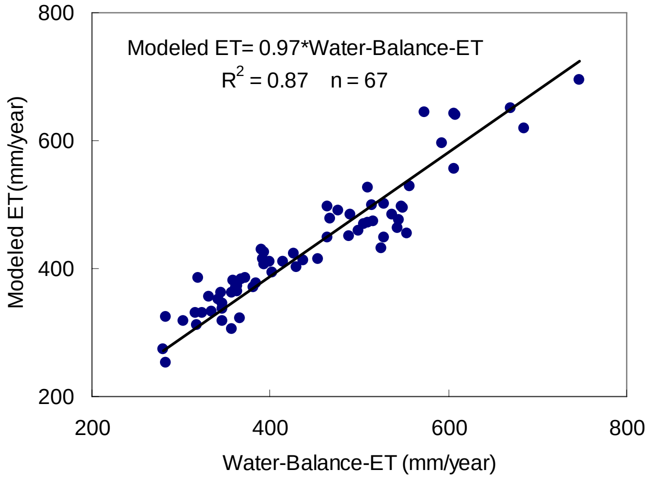

Fig. 1. Revised figure 3

HESSD
9, C2880–C2893, 2012

Interactive Comment

HESSD

9, C2880–C2893, 2012

Interactive Comment

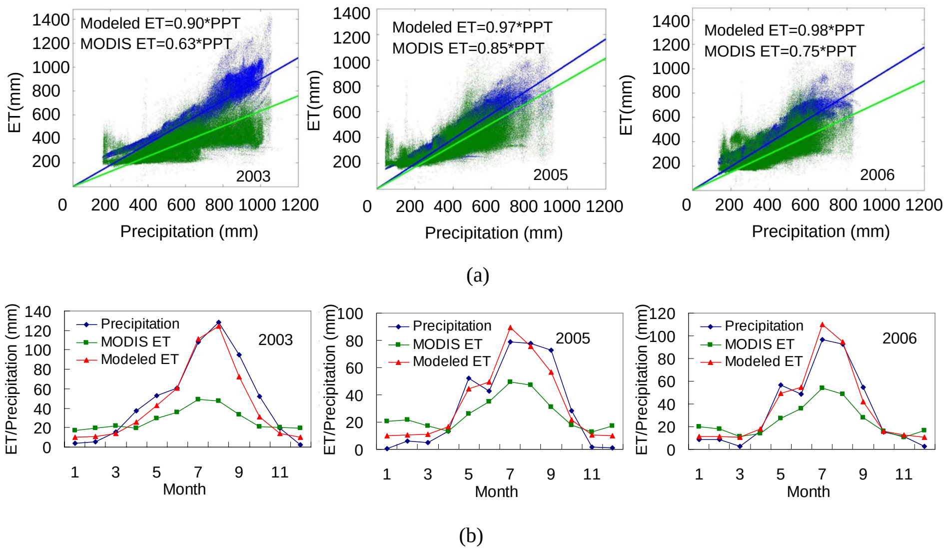

Fig. 2. Revised fgure 4

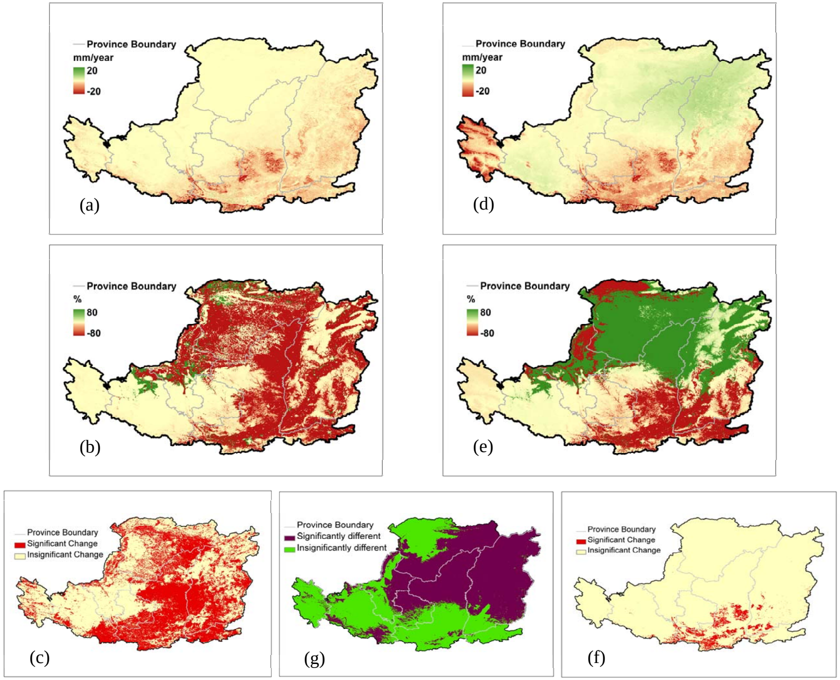

Fig. 3. Revised figue 5

HESSD
9, C2880–C2893, 2012

Interactive Comment

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

HESSD

9, C2880–C2893, 2012

Interactive Comment

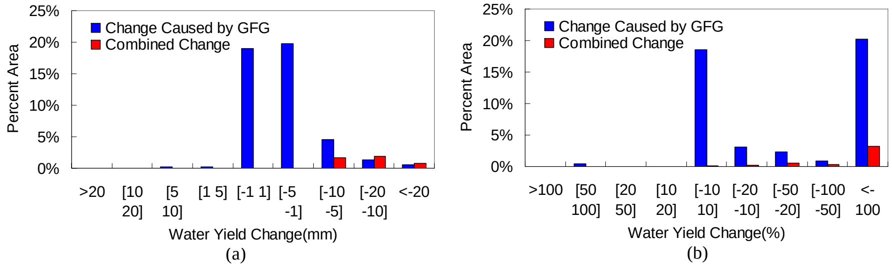

Fig. 4. Revised figure 6

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper