Response to Anonymous Referee #1

We appreciate the thoughtful and constructive comments from reviewer #1; our responses appear below in italics:

This manuscript describes how historical landscape developments formed the current hydrology of 2 watersheds in Illinois. The manuscript relates hydrograph characteristics to catchment properties such as size, reservoirs, precipitation variation and landuse. I found this an interesting and informative manuscript as it clarified several questions I had when I looked at US discharge datasets. For example: why is evapotranspiration decreasing in central Midwestern US during the past 50 years? A drawback of the manuscript are the relative short time series (20 years) used for this analysis, which prevents studying actual changes in the time series. Instead, a place for time substitution is used (in total 12 subwatersheds within the 2 main watersheds are analyzed) to infer the influence of historical landscape development on river discharge. Furthermore, in the conclusions the contribution of the results presented in this manuscript to an improved understanding of the relation between historical changes and the current hydrology (objective) does not become clear. Overall, this manuscript presents a comprehensive overview of past and current landuse developments and how they influence hydrology in central Midwestern US. Therefore I recommend this paper for publication after revisions.

Since the reviewer reiterates the main points presented above in the comments below, we will address them there as well. However, we do wish to clarify here that in total 24 subwatersheds are studied, 12 in each of the two main watersheds.

Major comments:
Your objective states: “The purpose of this study is to examine the legacy of past changes in two typical Corn Belt watersheds to gain a deeper understanding of the watershed response in order to better predict the response under the proposed changes” When I read your conclusions I don’t clearly see the new contribution of your work. You mostly refer to other studies or make recommendations: In your results you don’t show that ET decreased: you don’t show Miscanthus uses more water than row crops. In the conclusion I would like to read how your results contributed to a deeper understanding, instead of what others already found. I find your conclusion too general.

The reviewer makes an excellent point here. Upon further reflection it appears that the majority of the Conclusions section (with revisions) would be better served as part of the Discussions section. In addition, since the first part of the Discussions section contains the main conclusions of the analyses presented in the Results section, this will be moved to the Conclusions..

The Discussions section will be revised to contain 3 subsections addressing
- historical impacts as manifest in current hydrologic response of each watershed
- implications of this for the proposed land use change (biofuels)
- limitations of a data-based study and the need for modeling prediction based on the coupled human and natural system dynamics (future work)

A modified version of the Conclusions section, containing the pertinent portion of the current

Discussions is presented below to address the reviewer's concerns about the conclusions:

"Analyses of hydrologic signatures have revealed three main controls on the hydrologic response of these two watersheds:
First, the precipitation inputs themselves are spatially and temporally variable in this region and this area effect can be seen in both the annual and average monthly precipitation. At smaller time scales, this increases the heterogeneity of the catchment response due to the intensity of small convective storms common to this region. Second, the storage effects of the large reservoirs play a role in the catchment response, especially in Kaskaskia, where they are instrumental in reducing nutrient output from the watershed as well as reducing flow variability on the main-stem. Third, at the scale of this study, tile drainage plays an extensive role in the catchment response in both watersheds, especially in the Sangamon, where a higher proportion of the land is tile drained. These effects manifest as a homogenous regime curve, increased heterogeneity in the low flows, and a higher BI relative to less-tiled areas. However, because tile drainage in this region is also generally associated with intensive row-crop agriculture, it may the combined effect of these land modifications that is being observed.

Analysis of the histories of the case study catchments shows that impacts and modifications have been layered on top of each other through time: fire, prairie conversion, surface drainage, subsurface (tile) drainage, reservoirs, intensification of row cropping, erosion, fertilizer, etc. Spatially, this layering does not always follow watershed boundaries, but often human ones; resulting in the formation of a different mosaic of layers in each watershed. These mosaics of change, combined with the controls identified by analysis of the hydrologic signatures, is manifested in the summer low flow behavior, where greater variability in duration, frequency, and relative magnitude is associated with the deficit periods in Sangamon compared to those in Kaskaskia. These differences would affect the suitability of certain sub-watersheds for growing Miscanthus, and thus must be taken into account in future plans for biofuels expansion to avoid worsening or creating water stress conditions."

Page 6518: Because you historical overview is comprehensive I propose to make section 1.1 section 2. A literature overview of historical impacts also fits well with your objectives.

The paper will be modified as proposed; this also may address the minor comment below about the overall flow of this section.

Page 6539: In your conclusions, you finish with a very ambitious outlook to include in hydrological models human adaptation to changes caused by humans in the first place. Do we not first need our models to see what we can do about the current problems? To me page 6539 lines 5 to 10 are too vague.

In addressing the reviewer's first major comment, the section in question will be moved to the Discussions as the subsection addressing limitations of the study and future work, albeit in a modified form as described below.

We agree that we can apply models to the task of predicting possible solutions to current problems. However, as history has shown, while humans may wish to focus on one problem at a

time, the environmental system continues to respond to all changes humans have imposed on it. The attempt to capture these interactions and feedbacks between human and environmental systems in order to gain understanding about their co-evolutionary dynamics is one of the main ideas behind the field of socio-hydrology, the topic of the special issue to which this paper has been submitted. This understanding may then be used to obtain more realistic long-term predictions of the state of the system, thereby, we hypothesize, providing more sustainable solutions to current problems. However, since this is still a developing field, perhaps the description in the passage the reviewer describes is a bit of a stretch/speculation and not really relevant to the main issue of the paper. We can modify the passage to only mention this idea as a way to gain further understanding of the dynamics of the system in the context of a continuation of the work done in this paper, and not as a proposal for changing the current modeling paradigm.

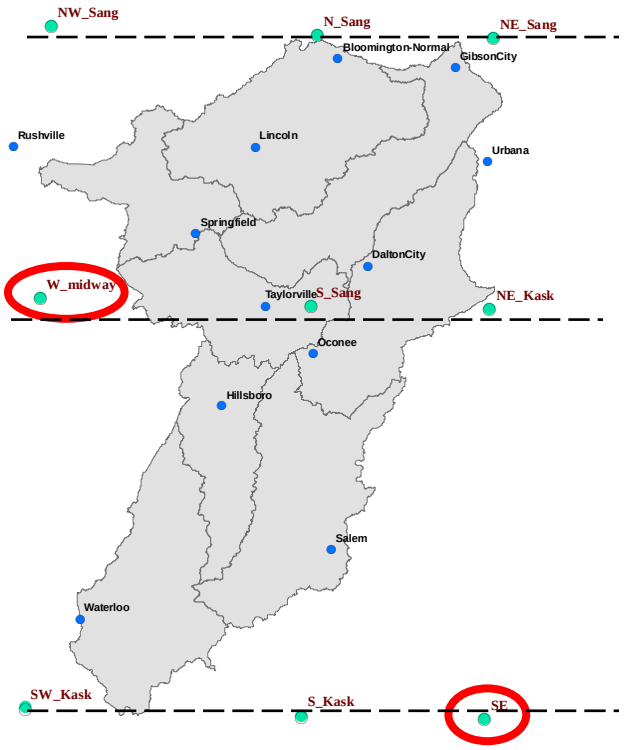
Minor comments:
Page 6524 lines 11 to 20: This overview section of the paper is unexpected. I expected it after the objectives.

In response to the major comment above, we have moved the overview section to the end of the Introduction, after the objective. We agree that the paper flows much better this way.

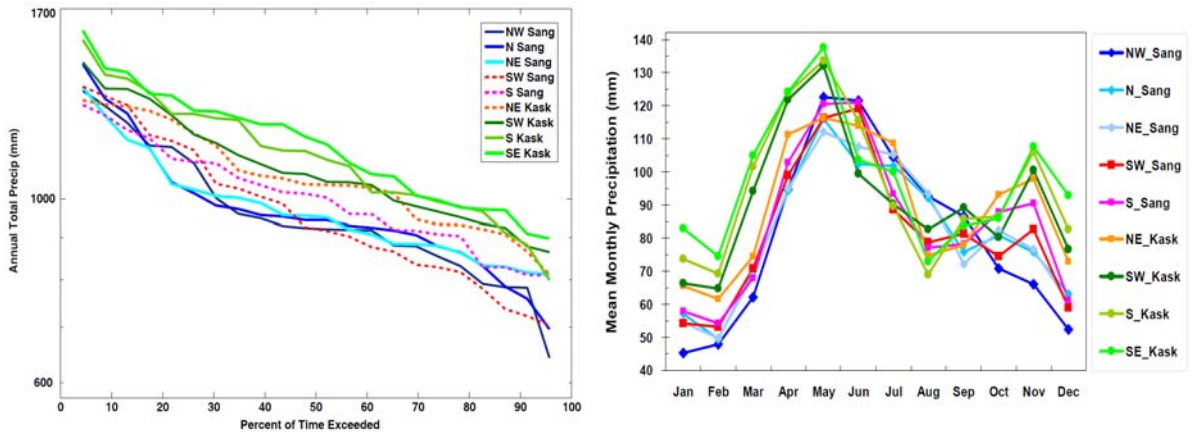
In Figs 5 and 7 you show W_midway and SE Where are these? They have not been mentioned before.

These points are described, but not mentioned by name, on page 6529, lines 13 – 17:
"Lastly, to gain an quantitative idea of the spatial and temporal variability of precipitation in this region, annual and monthly precipitation data was obtained from the PRISM 15 dataset (Table 1) at three east-west transects across the two watersheds – three points across the northernmost region of Sangamon, three points across the divide between the two watersheds, and three points across the southernmost extent of Kaskaskia."

The points described are shown in the map presented below in this response:



For clarity, the point "W_midway" can be renamed "SW_Sang" the point "SE" can be renamed "SE_Kask" in Fig. 5 and Fig. 7, as shown below.



Figs 8 and 9: Why is fig 8 in monthly water yield (mm) and figure 9 in daily water yield (mm). In addition the dimensions should then be mm/month and mm/day.

Fig. 8 shows the monthly regime curve, defined on page 6527, lines 19 – 20:
"The regime curve (RC) plots the monthly average streamflow over the year and shows the seasonal streamflow patterns within the year."
Fig. 9 shows the flow duration curve, defined on page 6527, lines 20 – 22:
"Lastly, the flow duration curve (FDC) plots daily streamflow magnitude (on a log scale) as a function of the percent of time it is exceeded."
Because the average instantaneous rate of discharge was converted to units of depth per time,

the term "water yield" was chosen instead of streamflow or discharge. In the manuscript, the definition of the two hydrologic signatures can be expanded to include water yield and precipitation as well as streamflow, since it is these variables that are examined in this way. Fig. 8 and 9, will be modified as suggested; the updated figures are shown below.

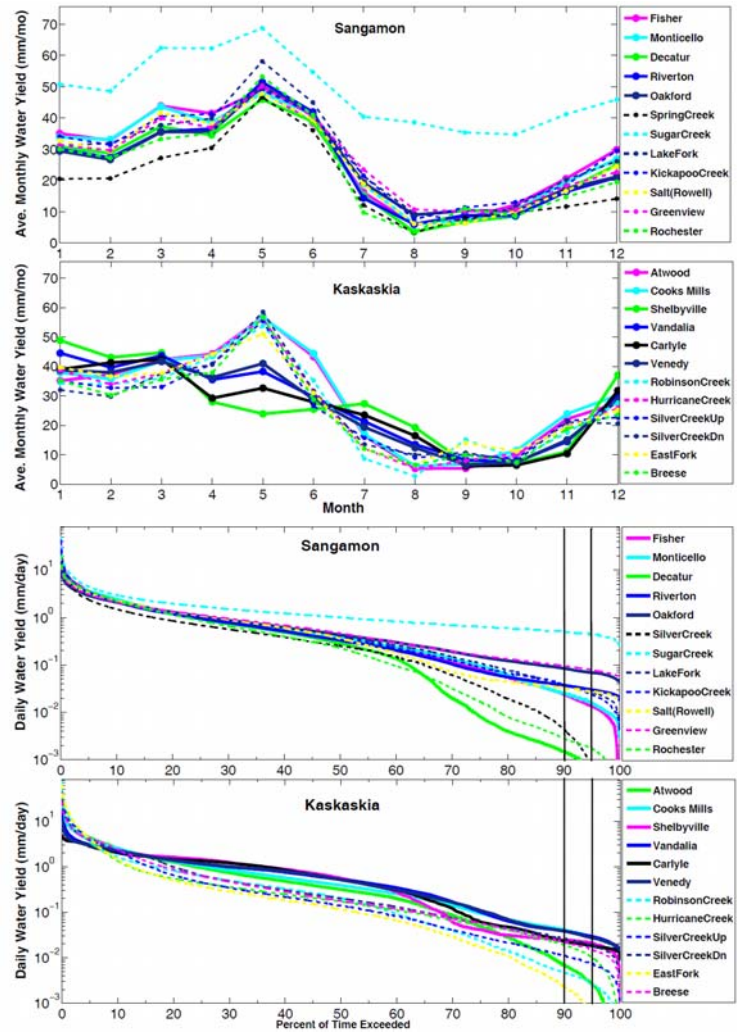


Figure 10: what does the circle mean?

The circle contains the low flow percentiles for the outlier gauge on Sugar Creek that has been mentioned several times throughout the paper; for the description of Fig. 10, this can be found on page 6532, lines 10 – 14:
"The interesting outlier in this figure is the Sugar Creek catchment where streamflow has been artificially increased due to discharge of treated wastewater. Since there is less variability in human water use, streamflow variability decreases, seen here in the circled portion of Fig. 10a, and as a much flatter FDC compared to less-disturbed streams (Fig. 9)."

After revisiting the above paragraph we see that the reader would be better served if mention of the circled portion of Fig. 10a is moved to the beginning of this passage, which we have changed

to now read as follows:
“The interesting outlier in this figure, shown in the circled portion of Fig. 10, is the Sugar Creek catchment, where streamflow has been artificially increased due to discharge of treated wastewater. Since there is less variability in human water use, overall streamflow variability decreases; this was also seen previously as a much flatter FDC compared to other streams in the watershed (Fig. 9).”

We can also note it in the figure caption for further clarity; we thank the reviewer for bringing this to our attention.