Responses to comments from Student Reviewer 3

Key:

SC3 – Comments from Student 3

AC – Author comments

General comments

SC3: I have some questions about the inventory of the trees using aerial photography. If I understand correctly, all trees with a stem size in the 5 cm diameter class and larger were tallied in 1991 and included in the survey, these were assumed to be alive prior to hurricane Hugo. A series of georeferenced aerial photos of WS77 and WS80 taken in the winter of 1983 were compared to data of the 1991 tree inventory to estimate the possible error in the tree inventory totals. In the results is described that the mean count was not significantly different between the two inventories, but the aerial photography showed fewer pine trees per plot than those counted by tree inventory data. And subsequently is stated that with the tree inventory data a few more trees were included than with the aerial photograph interpretation. But with aerial photographs the stem sizes are not visible, so how can you be sure that all trees above the 5 cm diameter class are included? Why were winter photographs used for the aerial photograph interpretation? Winter photographs have serious downsides for vegetation inventories. Summer photographs would have been better for determining the species and to see the foliage as was done in the research of Valinger et al. (FAO, Forestry department).

AC: I'm not sure the reviewer understood the rational for this analysis. The field inventory of trees in 1991 produced solid information of the vegetation on watershed 80 for both before and after the Hurricane. However, watershed 77 was treated like the remainder of the Santee Experimental Forest and high value dead oaks and pines were removed to salvage some of the value in the forest in the fall and winter of 1989-90. Valuable dead trees were present on slightly more than 50% of the area of watershed 77. Sixty - two of the 119 inventory plots were in this portion of the watershed. Therefore, the inventory data from these plots did not represent all of the trees present prior to the hurricane. In order to produce a meaningful comparison of the watersheds some method was needed to estimate the number and size of trees removed from those plots.

The only information available was a set of color infra-red aerial photos taken in the winter of 1983. Fortunately the 1991 inventory plots were well surveyed and marked, allowing us to determine the location of the plot centers and boundaries in a modern GIS system. The GIS allowed transfer of the plot boundaries to the 1983 photographs. The question was- Could the photographs be used to estimate the number of trees removed from the 62 plots that had been salvaged. If yes, then adjusted plot data on watershed 77 could be used as a direct comparison to watershed 80 prior to the hurricane.

As the reviewer notes, only crown projection can be seen on a photograph so one has no way to determine if all trees over 5cm can be seen. Also most southeastern hardwoods are deciduous and present a poor signature on winter photographs. However, winter color infra-red enhanced photographs do present very distinct red patches for pines and less distinct blue patches of hardwoods. Large hardwoods and pines are relatively easily seen but there is a high likelihood smaller trees, especially small hardwoods will be missed.

Since the 1991 inventory counted all living and dead trees on the plot, one would expect all the trees were also present on the 1983 photographs. For the 57 plots that were not salvaged, the number of trees counted on the photographs should equal the number of trees counted during the inventory. As you might expect, the data in 4.4.1 indicated that pines could be counted well with only a few trees missed on the photographs, 6.74 tree/plot vs 7.6 trees/plot measured and an R= 0.70. For hardwoods the difference was larger and the correlation poorer, indicating that photographic interpretation was not as useful for hardwoods.

When we did the same thing for the 62 plots that had been salvaged the results were different. The photo interpretation resulted in a poor correlation for pines and more trees on the photos than measured on the inventory plots (section 4.4.2). Both of those results are consistent with salvage increasing the error of photo interpretation. If one or several large trees were removed from a plot prior to inventory, one would expect the number of trees identified on the aerial photo may be larger than the inventory. An average 2.32 trees per plot were visible on the photos but missing from the inventory. Given that all of watershed 77 was on a single photo there is no reason to believe that photo interpretation of the salvage plots should be any different than those that were not salvaged. Therefore, the difference between the trees identified on the photos and the number measured on the plot in 1991 was a conservative estimate of the number of trees removed by salvage.

As in this case, available aerial photographs may be the only method to obtain information on forests in retrospect. Fortunately for this study, both the photos and the inventory were done to high standards, allowing GIS location of plot boundaries with sufficient accuracy that measured and aerial photographic interpreted number of pine trees per plot were comparable. Also fortunately, most of the forest on watershed 77 was pine and most of the salvaged trees were also pine, allowing the available winter photographs to be used.

SC3: In section 3.5 is described that the MOSUM test (moving sum of recursive residuals) was implemented in R to determine which watershed's hydrologic regime shifted due to hurricane Hugo and thus changed the historical hydrologic relationship between the two paired watersheds, which is part of the main goals of this article. Therefore I was surprised to see that the way the structural change point in the monthly streamflow and the corresponding 95% confidence interval was explained without giving much detail. For the reader would it be better if the MOSUM test was explained more clearly in the article. It is not a very common used method in the HESS articles or in many other scientific articles. Figure 4 is also difficult to read. In section 3.5 is stated that only one single break date is assumed by hurricane Hugo as major climatic event, therefore I do not understand why figure 4 describes three different break dates. The vertical dotted lines are the estimate change dates with corresponding 95% confidence intervals. But nowhere is explained why the vertical dotted lines are placed at those locations.

AC: Refer to responses to Student Reviewers #1 and #2. Briefly, section 3.5 has been re-written in the revised manuscript to address points raised by the reviewer.

SC3: I also have a few general comments on the discussion by the authors. Personally, I would not start with the negative part of a research in the discussion, i.e. the recent criticisms of the paired watershed technique by Vogl and Lopes, 2010. For a positive image of this research it would be better to discuss the recent criticisms later on.

AC: We agree with the reviewer and this comment has been raised by several other reviewers. We plan to rewrite this section with a more positive tone. This response is elaborated upon in the Response to Anonymous Referees document.

SC3: In the discussion the authors state that the changes in discharge can be attributed to transpiration without studying this or supporting this statement strongly with literature. The exact distribution of observed changes in evapotranspiration over transpiration, soil evaporation and interception evaporation is not relevant for the results. Following this, why would transpiration be the only explanatory process? Canopy and forest floor interception also important in forests (Gerrits et al. 2010). And Pypker et al. (2006) points the importance of understory vegetation in the interception process. The in situ processes differ a lot on the catchment scale. Therefore I would like to point out that the reference to the letter of Jasechko et al. (2013) in the introduction is less relevant for this article. Jasechko et al. uses isotope effects of transpiration and evaporation from a global dataset to demonstrate that the transpiration is the major component of the total evapotranspiration processes. The study area used for this paper (two paired watersheds in coastal Southeastern USA) is not a part of the global dataset used and the relative input per terrestrial vegetation type in not equal in this research.

I recommend to include an extensive paragraph in the discussion to the different evaporation processes and to reconsider or remove the statements about transpiration in the introduction.

AC: The authors agree that there were no measurements of ET nor were the measurements of its distribution. However, we have provided adequate information in two previous responses to students' similar comments. Here we provide one additional recent work by Sun et al. (2010) who found seasonal interception loss varying from 10 to to 32%, with an average of about 15% of average rainfall (1238 mm for the 2005-07) for an intensively managed pine forest in coastal NC north of our study site. The average annual ET that includes soil evaporation varied from 70% to 113% of the total precipitation which was 1087 mm, of which about 186 mm (or only 17.1%) was interception, leaving about 83% for transpiration and soil evaporation. Soil evaporation is negligible due to high leaf area index (LAI) of these managed pine forests. Same may be true for regenerated forest stands at WS77 and WS80 with LAI somewhat lower than the managed pine forests. Certainly, future studies should address the partitioning of the total ET in this forest ecosystem. We will restate the introduction to include this other study and emphasize the basis for our claim that transpiration a major component of the hydrologic balance.

Sun, G., A. Noormets, M. Gavazzi, S.G. McNulty, J. Chen, J-C Domec, J. King, D.M. Amatya, and R.W. Skaggs. 2010. Energy and Water Balances of Two Contrasting Loblolly Pine Plantations on the Lower Coastal Plain of North Carolina, USA. For. Ecol. And Managem. 259 (2010), 1299-1310.