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Interactive comment on "Hurricane impacts on a pair of coastal forested watersheds: implications of selective hurricane damage to forest structure and streamflow dynamics" *by* A. D. Jayakaran et al.

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Note for the authors and editor

The following review was written by one of the students of the MSc programme Earth and Environment at Wageningen University. As part of the course Integrated Topics in Earth and Environment, students are asked to prepare a review of a scientific paper. I supervised this review process, and submit this comment on behalf of the student that produced it. The manuscript by Jayakaran et al. was one of the manuscripts that was selected for this exercise. The review is written as an official review in order to comply with the course guidelines, but it should be considered by the authors as a regular comment which they can use to improve the manuscript. I hope that this comment will positively contribute to the review process and that it will help the authors to revise their manuscript for possible publication in HESS.

Summary

The manuscript “Hurricane impacts on a pair of coastal forested watersheds: implications of selective hurricane damage to forest structure and streamflow dynamics” is interesting . The objectives of this work are to quantify the magnitude and timing of changes including a reversal in relative streamflow-difference in two paired watersheds associated with Hurricane Hugo and to examine the selective impacts of the hurricane on the vegetative composition and its potential contribution to altered watersheds streamflow through evapotranspiration. This paper conclude that rather older pines were damaged by the hurricane. The authors believe that due to damaged and dead trees, caused by the hurricane, the water use by the vegetation was lowered. This resulted in increased outflows for both watersheds. One of the two watersheds was able to recover to pre-hurricane levels of canopy transpiration at a quicker rate due to the greater abundance of pine seedling and saplings.

This paper has potential to make a valuable contribution to the hydrology because firstly this paper tries to evaluate the forest change impact on runoff in a paired watershed. Land cover impacts on runoff generation are still poorly understood in low-gradient forested wetlands. Secondly, these watersheds in the south-eastern forested wetlands represent a large area that has a large potential to be struck by tropical cyclones. These storms can cause extreme floods to severe drought. Due to the potential threat of future disturbance it is important to understand the hydrology of forested wetlands for the protection and management of these ecosystems (Harder et al., 2007). Furthermore I would like to say that the authors did a great job with making proper results and conclusion with having so few data available. Overall this paper is very interesting and is a contribution to the hydrology of forested wetlands, but I recommend some minor changes, which I think will improve the paper.

General comments

The paired watersheds technique cannot differentiate between water loss by transpiration and evaporation from wet surfaces, including canopy surfaces. Even though transpiration is the major component of the total evapotranspiration processes in global water cycle according to Jasechko et al. (2013), other terms of evapotranspiration can exceed transpiration locally. According to Savenije (2004), interception is one of the most underestimated processes in rainfall-runoff analysis. Evaporation from interception is a considerable proportion of the total evaporation, especially in warm climates. The effect of interception is maybe small compared to transpiration, but the effect of interception becomes larger during storm events, which are not rare in this region (Fohrer et al., 2001). Shuttleworth (1993) observed that above forest turbulent diffusion is much more efficient than for other vegetation. Interception in forests exceeds most of time the evaporation from open water. So because this paired watershed is forested with a climate that is specified as humid subtropical (Harder et al., 2007), it is necessary to take interception into account in the discussion and interpretation of the results, as it provides a plausible alternative explanation in addition to transpiration.

The authors concluded that one watershed was able to recover to pre-hurricane levels of canopy transpiration at a quicker rate due to the greater abundance of pine seedlings and sapling in that watershed. The term canopy transpiration is used wrong. Moore et al. (2004) showed that transpiration indeed decreases with forest age but he also showed that canopy interception is proportional to forest age. So before the hurricane, when there were more old trees, interception probably contributed more to the total evapotranspiration than after the hurricane, when there were proportionally more younger trees. The role of transpiration became larger after the hurricane, due to more transpiration of younger trees. Transpiration is part of evapotranspiration, therefore they can only conclude that one watershed was able to recover to pre-hurricane levels of evapotranspiration instead of transpiration.

Another comment concerns the work by Harder et al. (2007), who investigated the hydrology and quantified the water budget for the WS80 watershed for the years 2003 and 2004. They concluded that the daily outflows were sensitive to rainfall event size, their frequency distribution and to the antecedent water table positions. Temporal distribution of the rainfall is important for the magnitude of the outflow because if there is large period with less or no rainfall between two major storm events (like 2004) the water tables will decline significant due evapotranspiration. When there is rainfall again, the rainfall is first used to replenish soil water deficits or it will be lost as evapotranspiration before it can take part of the runoff. In the discussion nothing is said about these factors, only transpiration is mentioned. All of these processes shouldn't be neglected, they play an important role for the runoff. Maybe these processes become less important in research which is done over several years, but they should still be mentioned.

According to the paper of Harder et al. (2007) 2003 was an extremely wet year (300 mm above average rainfall) and nearly half of annual rainfall was lost from the watershed through stream flow. Also the amount of average rainfall in 2003 was the second highest recorded amount of average rainfall in the last 15 years in this region. However 2004 was an extremely dry year (400 mm below average), where the total outflow was only 8% of the annual rainfall and most of the watershed losses where through evapotranspiration. In the transition of the extremely wet year to the extremely dry year the flip era has started. Now is my question if the large difference in rainfall amount between these years has any influence on the break dates in this period? Do the two watersheds react different on severe drought and extreme wetness after the hurricane? Have the other structural change points also a large difference between the amount of rainfall between the years? My suggestion is to add a few lines in the discussion which can answers these questions or a small part which can tell if this should be taken into account or not.

MOSUM is a method that not every scientist is using on a daily basis, so more explanation of this method is preferred. In fact, the authors explain more about CUSUM, the method that was not used for analysis, than the method that is used. Also the graphs obtained from MOSUM (Figure 4 and 5) are confusing. At the moment it is unclear why the structural breaks are not consistent with when the line is crossing the 95% confidence interval, as mentioned as the criterion for a structural break beneath Figure 4. Especially the third structural break in Figure 4 is very unclear where it comes from. A more clearer description is necessary. Furthermore the x-axis of Figure 4 and 5 is linear, instead of non-linear. The amount of years which the x-axis represents is not linear. It is a good idea to indicate where the missing data are in Figure 4 and 5, so it is easy to see where the data is 'glued' together.

The method used for estimating the structural change point in the monthly streamflow (breakpoint or break date) assumes a predefined number of breakpoints (see section 3.5). The authors assume that there is only a single breakpoint, because Hurricane Hugo was the major climatic event that might have caused a shift in post event response of monthly flows on either WS77 or WS80. But in the results (section 4.1) there are suddenly more structural changes. How is this possible if there must be a number of predefined breakpoint? Is this a typo or is this adjusted further one in the research, or are break dates and breakpoints not the same as structural change points as suggested in line 11 on page 11527? At the moment it is unclear and more explanation is necessary.

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Specific comments

A few technical corrections for the improvement of the paper are listed below:

Page 11522, line 8: 'most of the temperate knowledge a 1938 hurricane that struck Harvard Forest (foster, 1988a, b)'. Improvement: 'most of the temperate knowledge came from a 1938 hurricane that struck Harvard Forest (foster, 1988a, b)'.

Page 11530, lines 27–28: 'During the flip era (mid-1992 to end-2004) however, mean monthly flows from WS80 exceeded WS77by 15.7 $+/-$ 3.2 mm month^{-1}.' According to Table 1, 2004 is already the flop era and the average monthly flow difference is according to Table 1 in the flip era 17.1 $+/-$ 3.4 mm. Page 11531, line 3: '...60% greater than in 1989–1992 and...'. According to Table 1, this period is from 1989 to 1991 instead of 1992. The time periods in the text are different than in Table 1, this results in confusion.

Page 11533, line 12. The reference is to Table 9, this must be Table 2.

Page 11533, line 15. In one sentence there are two different methods used for writing the units.

Page 11546, Table 1. The years of the flip and flop era are wrong.

Page 11554, Figure 6. In column 4, for the period 1992–2003, no treatment is listed.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 11519, 2013.