

RC1: 'Water-Use Dynamics of an Alien Invaded Riparian Forest Within the Summer Rainfall Zone of South Africa', Anonymous Referee #1, 2 July 2018

HESS-2018-227

Anonymous referee #1 (AR1) is thanked for their thorough review. The comments and suggestions provided were insightful and beneficial to the progress of this paper.

1. AR1 stated that the description of the sampling design and its rationale needs more detail in the text. Papers should be written to allow some level of replicability of the method to other sites. The comments relating to up-scaling are itemised as follows:

- How and why were sites, species, and particular trees chosen?
- *This has been detailed in Chapter 2.2 which leads into the new Chapter 2.6.*

- How did sites differ topographically, distance from river, soil properties, etc?
- *All sites were in close proximity to one another and the river. There were no variations in soils, climate and access to water. This has been mentioned in Chapter 2.2.*

- Why were different numbers of trees of different species chosen?
- *This was due to availability of equipment and the associated budget constraints. Additionally, some trees which need to be in close proximity to the logger, do not provide good flow measurements. This limitation has been mentioned in Chapter 2.6.*

- What is the likely or known age range or age structure in the indigenous and the invasive trees at the sites?
- *The growth stage of each tree has been included in Table 1.*

- Are the indigenous trees necessarily older?
- *The growth stage of each tree has been included in Table 1. However, the authors were measuring the current state and therefore the water-use of the stand as it was during the measurement period. The selection of different size classes was more important than the age of each tree in this regard. Water-use does change with age but the size and LAI are more relevant to water-use. The state of the forest is addressed in the next comment.*

- How did the species and the size classes of the trees compare to that of mature indigenous Eastern Mistbelt forest?
- *A description of the typical pristine composition and characteristics of Mistbelt forest has been provided in Chapter 2.1.*

- Are any early successional?
- *The growth stage of each tree has been included in Table 1.*

- What is the typical composition of Eastern Mistbelt forest in terms of the proportion of trees that are deciduous?
- *Provided in Chapter 2.1. The proportion of deciduous species is variable in this forest type but the forest has been classified as Mistbelt forest.*

- Deciduousness effects the water use of the trees. Was this proportion mimicked in the selection of trees to monitor?
- *Approximately 10% of species in the forest are deciduous, with the remainder being evergreen and semi-deciduous. The sampling design used this proportion in the selection of trees to monitor.*

- Were the Acacia and Eucalyptus trees near maturity?
 - *The growth stage of each tree has been included in Table 1.*
2. **Two of the three Acacia's and one of the two Eucalyptus trees measured had larger diameters than the indigenous trees, except for the *L. sericea*. Is statement on pg 7 ln 11 that "the introduced species used 2.4 times more water than the indigenous species" made by comparing individual trees of similar sizes or of similar ages?**
 - This was a general statement based on an average water-use of each species. The size differences are noted and the results represent the *status quo* of how much water the stand was using during the measurement period. The statement provides an indication of what the invasion is using in comparison to typical indigenous trees that it has replaced.
 3. **The description of how the scaling up from individual tree water use to stand scale water use also needs more detail. Was the water use from different indigenous trees measured and applied across all trees of all species and size classes across the stand?**
 - This reiteration of the previous comments has been addressed by Chapter 2.6 and links to the selection of trees and sampling design.
 4. **Were water use figures of the individual measured trees applied to trees of the same species and/or functional group (e.g. deciduous or not, similar growth form or not, similar wood density) or similar size class?**
 - Yes, as described in the new Chapter 2.6, water-use was extrapolated per representative size class and species class identified in the density measurements.
 5. **Wouldn't water use of mature trees be different to the young ones measured in this study?**
 - Yes, however the objective was to capture the age and size distribution of the stand and measure this as accurately as possible with the available equipment.
 6. **What was assumed to be the size class distribution in the invaded and restored scenarios? The same as current or larger more mature trees assumed?**
 - The hypothetical scenarios used the existing size class distribution for each species class and extrapolated this based on an assumed invasion level.
 7. **These aspects need to be described in the methods and the effects of the assumptions made, and alternatives, discussed in the discussions. As such the figures of species level and stand level water use should also have some estimates of likely uncertainty.**
 - Comment no. 6 was described in the text as per this recommendation in Chapter 3.4. Due to the number of trees measured in each species class, the statistical level of uncertainty was not practical to include.

Specific Comments

1. **Pg 2, Ln 21-23: unnecessary to cite the paper twice in the sentence.**
 - Corrected.
2. **Pg3, Ln 35-37: The statement "invasive species use 189% more water than indigenous dominated stands" needs more clarification: this number is too specific to apply to all three of the cited studies. Was this the highest or lowest value from these three studies? Perhaps give the range of values across multiple studies. Does this only refer riparian forests compared to invaded stands?**
 - This was made more clear in the text. This was a global literature review of published studies. It provided a baseline from which the findings of this paper are compared to. "*At the ecosystem scale, a comprehensive review of numerous internationally published studies indicate that invasive species use up to 189 % more water than indigenous dominated stands,*

particularly in tropical moist forests (Nosetto et al., 2005; Yopez et al., 2005; Fritzsche et al., 2006). These findings, typically outside of South Africa are limited to mostly herbaceous species with very few recent studies focusing on measurement of introduced trees.

3. **Pg4, Section 2.2 requires more details in the text as to the numbers of trees of different species and why they were chosen as well as how the scaling up calculations were done.**
 - A new chapter in the Methods (2.6) has been added to provide detail on the up-scaling approach.
4. **Pg 7 Ln 43 There is no citation for Everson et al 2016 in the reference list.**
 - This has been added to the reference list.
5. **Pg 8 ln 4 typo: “bcome”.**
 - Corrected.
6. **Pg 15 Table 1 – typo: “Eucalyptus nitens”.**
 - Corrected.

RC2 & RC3: 'Water-Use Dynamics of an Alien Invaded Riparian Forest Within the Summer Rainfall Zone of South Africa', Anonymous Referee #2 / T. Dube, 3 October 2018

HESS-2018-227

Anonymous referee #2 (AR2) is thanked for their thorough review. The detailed comments and suggestions provided were appreciated by the authors.

8. **AR3 stated that the title requires rephrasing. I failed to understand why the authors emphasize on the “SUMMER RAINFALL ZONE OF SOUTH AFRICA”. Does this have anything to do with the spread of invasive or water use by these plants?**
 - The authors used the term “summer rainfall zone” so that direct comparisons could be made to the companion paper (hess-2016-650) that measured the water-use in a winter rainfall zone. This term provides a broad climatic location, which is important when comparing the water-use to the climate of the study area. The inclusion of this statement prevents readers from taking the findings out of the climatic context. The authors have not changed the title as it would prevent the linkage to the companion paper.
9. **Abstract-general well written but I would recommend that authors include the objective of the study. As it is one has to speculate the direction of the study.**
 - This comment was noted and the following sentence was added to the abstract: *The objective of this study was to investigate the water-use (transpiration rates) of a selection of introduced and indigenous tree species and quantify the hydrological benefit that could be achieved through a suitable rehabilitation programme.*
10. **Introduction- This section is very weak and to general besides reading like a technical report. I would recommend that authors strengthen the motivation and support their argument with relevant literature. Authors should intensively interrogate literature and highlight scientific research strides that have been made as well as the gaps in knowledge that still need to be addressed. So far, this is totally missing. It is therefore very difficult for one to understand whether this is a technical report or a scientific study.**
 - A motivation was added to the introduction, discussing the problem, a potential solution and the reasoning behind the research approach. The authors have reviewed the literature citations in the paper and feel that it significantly covers the background of the study methods, the

reason for undertaking the research and a comparison of the findings to documented findings. This should be considered in light of the fact that there is limited research on the riparian vegetation water-use, which the research findings should be compared to.

11. Methods – are poorly packaged and this makes it difficult for one to follow. I would, therefore, recommend that authors improve on this.

- A new chapter was included detailing water-use up-scaling. Further comments on the methods from two other referees were addressed. Internationally accepted methods were not discussed in detail as it would be a repetition of documented literature.

12. The study area may be poorly drawn beside been illegible. A great improvement is required.

- The authors feel that the study area is clearly legible. The location of the site within the catchment has been included.

13. Results and discussion - although these sections read well they are very shallow and lack objectivity. The discussion is weak like the introduction; there is a lack of rigorous engagement of literature. Surprisingly there are too many references in the bibliography but the manuscript content does not demonstrate a thorough interrogation of literature.

- The authors appreciate the comment but feel that the context of the study has been provided (through an extensive literature review), the key findings are clearly discussed and future research provides a way forward for subsequent studies.

RC4: 'Water-Use Dynamics of an Alien Invaded Riparian Forest Within the Summer Rainfall Zone of South Africa', Anonymous Referee #3, 17 October 2018

HESS-2018-227

Anonymous referee #3 (AR3) is thanked for their thorough review. The thorough comments and suggestions provided were appreciated by the authors.

14. AR3 stated that the authors report that the hydrological campaign was conducted in conjunction with an ecological study (page 2, lines 6-7). However, the present study does not report on the ecological implications of the study. Are the ecological results to be reported in a separate study? Or is this the paper by Everson et al. (2016) that the authors refer to at a later stage in the manuscript?

- Although this study was undertaken in conjunction with an ecological study. Direct discussions with this component have been removed. Rather this paper is compared to a companion paper (hess-2016-650) that measured the water-use in a winter rainfall zone. The ecological findings are not reported on in this paper. However, more detail has been provided on the sampling strategy, density measurement and water-use up-scaling. The reference to Everson *et al.* (2016) has been updated in the reference list.

15. Despite the potential relevance of the species-specific water use measurements, the real added value of these data lies in their potential to indicate ecosystem benefits gained from removing or promoting the establishment of specific tree species relative to others. However, the current hydrological data set does not provide sufficient information to support such decisions. I therefore advise the authors to include data from their ecological study in the present hydrological study to interpret the hydrological differences between pristine and (heavily) invaded sites in terms of ecosystem functioning.

- This comment, much like comment 1, requests more emphasis on the ecological component. The authors feel that providing detail on the ecological study would make paper too broad and require the inclusion of extensive literature, methods and results. This would detract from the quantitative findings provided in this study. As such, the authors have included only the

necessary ecological methods and findings required to select the monitoring site, species and assist in up-scaling. The findings show a hydrological gain and not the changes in ecosystem functioning and other services.

Specific Comments

7. Reference list appears incomplete.

- Checked and updated.

8. Reported wood density in table 1 is in tonne m⁻³, not kg m⁻³

- The values were corrected to g.cm⁻³ which is consistent with documented studies within South Africa and abroad.

9. Please report standard deviations alongside the averages in tables 1 and 2 to provide some information on the variability of the data underlying the average.

- The standard deviations have been added to table 2 for each tree (calculated for the extent of the measurement period).

10. Please provide some more information on how the water use at the tree level was upscaled to the forest level. This is not described in the methods section at al.

- A new Chapter (2.6) has been included detailing the up-scaling process. This Chapter also links to relevant Chapters on sampling design and species selection.

11. Please analyze and discuss in more detail which plant functional traits determine the difference in water use between native and indigenous species.

- Although the functional traits that determine variations in water-use was not the focus of the study, it is an important component to discuss in this study. For example, *“The greater sapwood area in introduced species, as well as their fast establishment, tree density and rapid growth, results in a greater transpiration rate than indigenous species per unit area.”* was included as a finding in this study.

12. Please indicate in figure 1 where exactly the site is located, perhaps by adding a dot in the lower right panel.

- The location of the site relevant to the catchment and its elevation has been provided (yellow marker).