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Discussions

Interactive comment on "Riparian evapotranspiration shapes stream flow dynamics and water budgets in a Mediterranean catchment" *by* Anna Lupon et al.

Anonymous Referee #1

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The paper investigates the effect of riparian zones on hydrometric streamflow responses and catchment water budgets with a particular focus on riparian evapotranspiration. The authors use a semi-distributed conceptual bucket-type model to simulate a Mediterranean catchment with different setups. First, they demonstrate that the inclusion of a riparian compartment improves the model performance, especially during the vegetation period. Second, they demonstrate that the catchment response is sensitive to the evapotranspiration parameters of the riparian zone during the vegetation period. Third, they performed several climate scenario simulations to discuss the effect of riparian evapotranspiration on water budgets with climate change. Overall, the article is well structured, the text reads fluently and figures and tables are clear. I read

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Discussion paper

the paper with great interest. It nicely demonstrates that riparian zones and their ET should be considered in catchment models and I think studies like this are necessary to raise the hydrological model community's awareness for the role of riparian zones in a catchment. However, while reading I came across two major issues that concerned me several times throughout the text. These two major concerns and several minor issues should be addressed and clarified before publication.

Major issues:

1) The first issue is related to the aim of the study and the chosen approaches to accomplish it. In the introduction it is stated that it is known from several studies that riparian ET has in impact on stream flow dynamics and water budgets, but that there is a lack of respective studies at catchment scale. This suggests that the study focusses on the aspect of the catchment scale (such as the seasonal influence of riparian ET on hydrological connectivity between uplands and stream networks (cf. l.77-78) or the discussed percentage contribution of riparian ET to total catchment water depletion). Yet, large parts of the paper analyze and discuss the impact of riparian ET on stream flow dynamics without a clear relation to catchment scale specific aspects. Model validation follows the unusual idea of validating the performance of the riparian ET over the same period that was calibrated against discharge (and also some ET characteristics), instead of validating the performance of the calibrated response (discharge) for another period than the calibration period. I think this approach is valid since the performance of riparian ET is of specific interest for this study. Certainly, a validation of the discharge response would be good as well, especially since the model is used for climate scenario simulations where it is of interest that discharge (and ET) simulates well also under different conditions than experienced in the calibration period. However, my bigger concern is that model validation relies on the idea that daily variations of stream flow can be used as proxy for riparian ET. If the relation between riparian ET and streamflow dynamics is already approved enough to be used for the creation of validation data, this necessarily raises the question why the effect of riparian ET on

streamflow dynamics has to be analyzed in additional studies. Again, the introduction states that this effect is known, but title and large parts of the paper (partly even the introduction, cf. l. 71) read as if this is one of the main points of the study. Especially in the discussion section the results are mainly compared to agreeing studies of riparian ET and I missed a clear delineation in which way this study brings up new insight in the role of riparian ET for catchment water budgets and streamflow responses. In addition, the authors often use the inclusion/exclusion of the riparian compartment as equivalent to an inclusion/exclusion of riparian ET (l.22-23, l.143-145, l.158-160, l.326). In my opinion, the inclusion of the riparian compartment can only be used to analyze the effect of the riparian zone as a total, since the riparian compartment represents more fluxes than only ET. It is true that the model mainly improved during the vegetation period and that this suggests a major influence of riparian ET. However, at least the RDV improved also during the dormant season, which could be explained by the additional storage/buffer component of the riparian compartment. Moreover, a different parameterization of the riparian ET (less strong riparian ET compared to upland ET during the vegetation period) might have a different effect (e.g. similar improvement of the model during vegetative and dormant period). My suggestion would be to keep the presented methods and results unchanged, but to shift the focus in the discussion and introduction (and other explanations throughout the text) from the role of riparian ET on discharge dynamics to 1) the role of riparian zones and its ET for hydrological modelling of catchments and 2) how this might vary under different climate conditions.

2) The second main issue concerns the model setup. I especially had problems to understand how the three subcatchments were defined. According to the namings of the subcatchments (e.g. downstream subcatchment, downstream site), Table 1 and the way how validation data were calculated (l.197-201), I understood the subcatchments as three individual parts summing up to the total catchment. According to the description of the calibration data (l.134-140), the aim of the study (influence of riparian ET in a catchment) and some applied methods and presented results, I guess the subcatchments include the total upstream drainage area (i.e. the downstream sub-

catchment is equivalent to the total catchment). Besides a clarification of the definition of the subcatchments in the text, I think a figure showing the conceptual setup of the models would be very useful. Such a figure would also make it easier to understand the differentiation between landscape units, layers and compartments and the flux connections between them (especially for l.145-160). Additionally, I missed a more detailed description of the model parameters and the represented fluxes. Since the study focusses on the influence of ET, at least the conceptualisation of ET and the related ET parameters (degree day rates, threshold temperature parameters) should be explained in more detail in the text and / or in a figure. For example, it is discussed that the length of the vegetative period increased in the climate scenarios at that this was mostly a consequence of a changed tree phenology, i.e. an earlier onset of the leaf out period, thus tree phenology (l.371-380). It is not clear to me if and how the length of the vegetation period and the tree phenology (e.g. leaf out period) were considered in the model structure and thus it is difficult to follow the argumentation.

Minor comments:

3) I suggest to change the title to: How riparian evapotranspiration shapes stream flow dynamics and water budgets in a Mediterranean catchment model, cf. comment 1)

4) l.25: Shouldn't it be the same value as in l.286?

5) l.28-29: I would consider more relevant that this increases the contribution of riparian ET to catchment water depletion by 1-2%

6) l.36-37, l.47-48: Please provide some references

7) L46-47: Why only in regions potentially suffering from water scarcity? An explanation is coming in l.58-59, maybe this can be put closer together (e.g. moving l.44-48 at the end of the second paragraph). A small rearrangement of the two first paragraphs of the introduction could also prevent that the sentence in l.49-50 seems somehow contradictory to the first part of the introduction (l. 36-39).

8) l.76-78: If I understood the functioning of the used model correctly, the connectivity between uplands and stream networks is mainly controlled by the riparian zone and its ET. In that case, the model setup (higher riparian ET during the vegetation period) makes this expectation somehow self-evident.

9) Figure 1: The color code in the legend (riparian zone = black) does not match the colors in the map (riparian zone = dark grey)

10) l.91: Upland means only the part covered by beech forests and heathlands or all the catchment except of the riparian zone? Please clarify

11) l.94: Increases 12-fold compared to what?

12) l.92 and l.97: Are there also B and C horizons?

13) l.98-107: This describes the subcatchments clearly as three independent subcatchments. If it is meant in a different way (cf. comment 2), please clarify in this section

14) l.114: 'other catchment water pools' is identical to landscape units? Or to soil layers? Or to the upland compartment? And which are the water fluxes represented in these other water pools, also subsurface flow and ET?

15) L.122-123 'a specified fraction of rainfall can be directly transported to stream runoff': Does this mean overland flow? Or is it direct precipitation on the stream? If it is the latter, shouldn't it also be accounted for during wet conditions?

16) l.152-157: From the description I understand that overland flow was basically disabled. Why is it then necessary to include a layer representing overland flow (l.149)?

17) l.176: I would expect different values for the riparian ET-related parameters than for the upland ET-related parameters in order to allow different ETs. However, in Table S1 the best riparian and upland ET-related parameters seem to be identical

18) l.184-185: Do you refer to all water fluxes other than ET? In addition, it is very

difficult to make use of the given information about the adapted parameters, without a more detailed description (cf. comment 2)

19) Both in section 3.4 and 3.5 it is not clear which of the 3 model instances including a riparian compartment are used. I assume it is the downstream sub-catchment (in the sense of being the total catchment, cf. comment 2), but please specify

20) l.202: This sounds like you refer to model calibration, however, it is confusing since you talk about validation in the paragraph above

21) l.210: Why the ET parameters are fixed to mean values of the landscape units instead of taking the optimal parameter for each landscape unit?

22) l.211-213: I do not understand the formulation ‘100 iterations of 1000 runs’. Does it mean you tested 100 times 1000 different parameter sets? If yes, what was the criteria to split the total of 100000 simulations in sets of 1000?

23) l.214-216: I think it is difficult to restrict this effect to riparian ET. It should be related to ET in general, both from the upland and riparian compartments, since the ET parameters were fixed for both compartments

24) l.253: I would be careful to say that the strong decline in stream flow is characteristic for the vegetative period only. In 2012 the stream flow is declining from the beginning of the year. Maybe it would be good to include the precipitation time series in Figure 2 in order to explain this behavior

25) l.256-257: Complementary there were underestimations at all three sampling sites for the dormant season, which were in similar RDV ranges for the up- and midstream catchment but much lower in the downstream catchment compared to the vegetative period. It would be great to mention and discuss this, also with regard to the improvements that were achieved for the vegetative and dormant season with the inclusion of the riparian compartment (cf. comment 1 and 32).

26) Figure 2 would be clearer with reduced sizes of the observation points

27) l.265: Please specify which the low flow periods are. This will also help to distinguish between the low flow periods (captured) and the lowest flows (not captured) (l. 329).

28) l.266: In Table 3, l.23 and l.326 you give a value of 26%. Even though, I am not sure that this is a correct formulation. It should be 'reduced daily stream flow by 26 percentage points' or 'reduced stream flow overestimations to 27 % during the vegetative period'. See also l. 340-342, where you give a different percentage value, which is actually the correct one when talking about a change in percentage compared to RDV = -0.53 as reference.

29) l.293: Also here I guess it should 1-2 percentage points?

30) l.294-295: Is your definition of the vegetative period really an ET rate > 0 mm/d ? During the dormant season there should normally also be days with ET > 0 mm/d. Moreover, for the model performance calculations you define the vegetative period as ranging from April-October (l.192).

31) Figure 5 and l.296-304: What about the 0.25 percentile and 0.75 percentile scenarios? Shouldn't the RCP 2.5 percentile 0.25 be the most moderate and the RCP 8.5 percentile 0.75 be the most extreme scenario?

32) l.321-322: For log(NS) I agree, for RDV I would say there was an improvement also during the dormant season. This could be related to riparian effects (fluxes and additional storage) other than ET (cf. also comment 1 and 25) and should be discussed.

33) l.340 'when riparian ET parameters were allowed to vary': Also the uphill ET parameters were allowed to vary or fixed (cf. comment 23). It should be discussed, why this setup allows to conclude on the riparian ET only.

34) L353-355: This sounds like if it is superfluous to consider the riparian compartment

35) l.405: You show that there is an effect of riparian ET on the catchment water budget (8-19%) and that this effect can slightly increase (1-2%), but I would not say that you

can call this a major control (cf. also your discussion l.381-389)

36) l.406-407: Maybe I missed it, but I cannot remember that you mentioned this before

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