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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Climate change, re-/afforestation, and urbanisation impacts on evapotranspiration and streamflow in Europe" *by* Adriaan J. Teuling et al.

Anonymous Referee #4

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General comments

This paper assesses the contributions of land use and climate changes to historical changes in streamflow and evapotranspiration in Europe. This is done using a stationary Budyko approach for water partitioning constrained by lysimeter observations and adopting historical land use reconstructions and gridded climate data at a high resolution of 1 km x 1 km. The resulting simulated changes in streamflow and evapotranspiration are in line with observed counterparts, although the comparison of streamflow changes is less straightforward. The contributions of land use change and climate change (through precipitation and evapotranspiration) are assessed for Europe and

analysed in detail for eight selected regions.

Overall, the paper is well written and presents interesting results for the European continent. The authors use informative and well-prepared figures to illustrate their results. Several issues need attention such as the use of the terms green and blue water, the use of one (high) value to adapt the potential evapotranspiration and the aggregation of positive and negative contributions of land use or climate change at continental or large river basin scale. These and other specific comments can be found below. The paper includes many typos, several examples and other technical corrections can be found below as well.

Specific comments

1. P2, L3-17: The terms green and blue water are not appropriately used here. The total evaporative flux also includes blue water from irrigation with surface water or groundwater (see e.g. Falkenmark, 2000; Oki and Kanae (2006); Falkenmark and Rockström, 2010) and hence the total evapotranspiration cannot be equated with the green water flux. Furthermore, the blue water flux does not only include streamflow (lines 15-16) but also groundwater flow (as briefly mentioned in line 5). The authors are suggested to remove the terms green water and blue water from the manuscript to avoid any confusion and to be consistent in terminology throughout the manuscript. There is no need to use the terms green and blue water (and water yield), since the focus is on streamflow and evapotranspiration.

2. P2, L11-12: Why is this in particular true for Europe? I would expect that uncertainties and limitations in observations and models in other parts of the world are at least comparable to those in Europe, but probably often larger.

3. P4, L30: The readability of section 2 and also section 3 can be improved by distributing the contents of these sections over a few sub-sections.

4. P5, L20-23: This sentence seems to be contradictory. The FLUXNET observations

are not used in this study, because they are assumed to be more reliable for long-term water balance assessments. However, this study also considers long-term water balances. This should be better explained.

5. P6, L10: A c-value of 1.8 is high and apparently seems to be used for all grid cells in Europe. This value implies that about 45% (0.8/1.8) of the energy used for evaporation is not included in the calculation of the potential evapotranspiration. Is this related to the simplified method (Thornthwaite) used to estimate the potential evapotranspiration? Which mechanisms (besides advection) are responsible for this? Is it reasonable to use the same c-value for all land use types? For instance, due to evaporation of intercepted water, you might expect higher c-values for forests compared to cropland and grassland. In summary, the use of a constant and high value for correcting the potential evapotranspiration seems to be doubtful and partly limits the conclusions which can be drawn based on this study.

6. P8, L5 and L14: The authors seem to mean something different with central-western Europe in these two lines, where firstly they seem to refer to Belgium and the Netherlands and secondly to Switzerland and Austria and parts of Germany and France. Try to be more specific here.

7. P8, L9-10: Is it logical that the mean evapotranspiration is highest due to pronounced topography? Although the term 'pronounced topography' is not completely clear, in general evaporation rates will decrease with altitude.

8. P9, 25-27: Is it sensible to determine the net effect of for instance precipitation by balancing positive contributions from the north with negative contributions from the south? The net effect obscures the real contributions and potentially associated problems; however, these net effects are an important element of the main conclusions and the abstract. I would recommend the authors to reformulate relevant parts of the manuscript and highlight positive and negative contributions rather than net contributions.

9. P10, L1-3: Is it useful to compare the sensitivity of streamflow to past land use changes with the effects of future changes? In order to interpret the differences between these two studies, the reader should at least have information on the magnitude of the future land use changes and the approach employed in the 2009 study. For instance, the way streamflow is determined in this study probably will be very different from the way streamflow has been determined in the 2009 study.

10. P11, L13-25: What is the role of other variables than temperature and radiation in the determination of PET (i.e. humidity and wind) and what is the effect of excluding these variables on the results?

11. P11, L26-28: The statement that socio-economic impacts relate more directly to blue water fluxes compared to green water fluxes is not correct. Green water is the main source of water to produce food, feed, bioenergy, etc. (e.g. Oki and Kanae, 2006) and as such changes in green water availability and fluxes will have a large socio-economic impact.

12. P25, Figure 5: Can streamflow be validated on the rate of change or only based on the patterns of change, since the units of c. and d. are different?

Technical corrections

1. P1, L12: 'Mediterranean' instead of 'Mediterrenean', see also e.g. page 2, line 22 and page 7, line 23.

2. P1, L15: The meaning of ET is not clear here.

3. P5, L12: "... the magnitude of this effect ..."; which effect is meant here?

4. P5, L17: 'coarse' instead of 'course'.

5. P6, L19: "... and lateral transport between ..."; between what?

6. P7, L10: 'purposes' instead of 'porpuses'.

7. P7, L23: ‘Iberian’ instead of ‘Iberina’.

8. P7, L27: ‘Romania’ instead of ‘Romenia’.

9. P8, L5: ‘increase’ instead of ‘increased’.

10. P9, L1: ‘separate’ instead of ‘separate’, see also line 26 on this page.

11. P9, L1: The rescaling of the contributions is not clear to me.

12. P9, L25: ‘Table 3’ instead of ‘Table 2’.

13. P9, L26: ‘precipitation’ instead of ‘prepitation’.

14. P9, L34: ‘4 kmˆ3/year’ instead of 4 kmˆ3’? And ‘-2 kmˆ3/year’ instead of -2 kmˆ3’?

15. P10, L16: ‘physical’ instead of ‘phyical’.

16. P26-27, Figure 6-7: ‘Table 3’ instead of ‘Table 2’.

17. P28, Table 1: How is it possible to use a reference from 1975 to obtain data from periods until 1996? This needs to be adapted.

18. P28-29, Table 1-2: Which minimum and maximum values are meant for **? And what is the unit? Where can we find the *** in the tables?

19. P30, Table 3: ‘kmˆ3 yˆ-1’ instead of ‘km yˆ-1’?

References

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