

Interactive comment on “The Hydrological response to climate change of the Lesse and the Vesdre catchments (Wallonia, Belgium)” by A. Bauwens et al.

Anonymous Referee #1

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This paper is about the impacts of climate change on the water balance and hydrological extremes in two catchments of the Meuse basin. Climate change scenarios are produced using a perturbation method and hydrological responses are assessed with a distributed, physically-based hydrological model (EPICGrid). The paper is moderately written, fairly well structured and within the scope of HESS. General comments, specific comments and technical corrections are given below.

General comments

- My first concern is the novelty of this paper. The authors apply an existing climate

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change scenario generator and an existing hydrological model to assess impacts of climate change on the water balance, hydrograph and high and low flows of two middle-sized catchments. Although the authors mention three points being new in this paper compared to the scientific literature (pages 7698-7699), it is difficult to assess whether those are really new and good contributions (points 1 and 2) or the point has only slightly been addressed and worked out (point 3). Points 1 and 2 are further explained in the following two general comments and could indeed have an added value when better described and explained in the paper. The added value of point 3 is unclear to me. There have been many climate change impact assessment studies for catchments of similar sizes and the ‘management from upstream’ (page 7699, line 6) is not further elaborated on in the paper.

- The structure, working and calibration (if any) of the EPICGrid hydrological model is not clear. A brief description is given on page 7700 and reference is made to an earlier application of the model (also for the Vesdre and Lesse catchments?). However, it is not clear which processes are covered in each grid cell and how routing of surface and sub-surface runoff is incorporated. More importantly, the authors do not describe whether the model has been calibrated (and validated) for the Vesdre and Lesse catchments and if so, how this has been done. If no calibration was necessary, at least validation results could be reported using common criteria such as the Nash-Sutcliffe coefficient and the relative volume error. This enables a comparison with results obtained with conceptual hydrological models for these catchments (see e.g. Booij, 2005; Booij and Krol, 2010) and might strengthen the conclusion that this study “shows the importance of the use of a physically based model . . .” (see page 7709, lines 16-18).

- The CCI-HYDR perturbation tool is used to create climate change time series apparently based on observed time series. How is this perturbation working? Is the monthly change in climate multiplied or added to observed rainfall and temperature series respectively? Shouldn't the method be classified as a delta-change approach or is it different? Are changes in all important climate statistics (e.g. besides mean,

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also variability, spatial and temporal correlation, multi-day extreme rainfall, wet-dry day distribution etc.), in particular relevant for high and low flows, taken into account in this method? How many perturbations (runs) have been done and which ones are used in this study? This part of the paper is weak and needs much more explanation and clarity.

- The level of English grammar and spelling should be improved and preferably checked by a native English speaking person. Several examples are included in the technical corrections.

Specific comments

Abstract

- p7696, l10: It's unclear from the abstract alone what the CCI-HYDR Perturbation Tool is, please clarify.

Introduction

- p7696, l24-25: Isn't a river always dependent on meteorological conditions?

- p7697, l7-9: These are very general statements and it is not clear to which area, period, extreme events, climate models etc. the authors are referring. Please specify and use references.

- p7697, l11-28: The literature review on impacts of climate change on hydrology is only about the Meuse basin. It would be interesting to also include relevant approaches and results from neighbouring river basins (e.g. the Rhine basin) and studies where also distributed hydrological models have been used in climate change impact assessment.

- p7698, l6: What do the authors mean with "... to manage the impacts from upstream ..."?

- p7698, l10-12: Are modifications in the physiological development of plants due to climate change relevant to estimate impacts of climate change on hydrology and in

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particular high flow events?

- p7698, l18: What kind of scenarios are meant here?
- p7698, l28-p7699, l4: This sentence is not clear and need to be clarified and reformulated.

Materials and methods

- p7699, l23-p7700, l2: There is no need to repeat the numbers presented in the tables.
- p7701, l2-3: How have the station observations of temperature and rainfall been spatially interpolated?
- p7701, l2-3 and l6: Does the meteorological database contain the daily observations of temperature and rainfall of the 4 weather stations?
- p7701, l15: Please give a reference for the CCI-HYDR Perturbation Tool.
- p7701, l22-23: Which regional climate model simulations have been extracted from the PRUDENCE database?

Methodology

- p7703, l16-17: “It consists . . . or simulated”; please formulate more precisely, e.g. “the parameters of the statistical distribution have been estimated based on annual maximum discharge values”.

Results

- p7704-7707: Why are only the results presented of the high (wet) and low (dry) scenarios and not the average scenario? Doesn't give the latter scenario a good indication of what most likely will happen in the future?
- p7704, l12: The maximum monthly rainfall?
- p7705, l22: “potential evapotranspiration” or “actual evapotranspiration”?

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- p7707, l3-5: Can you compare the results of this study with the results of the CCI-HYDR project?

Discussion

- p7707, l23-p7708, l3: This sentence is too long and unclear. Please split up and clarify.

- p7708, l4-6: It's not clear how many RCMs are driven by how many GCMs; what is the message here?

- p7708, l7-9: Can you clarify and prove this statement?

- p7708, l14-15: The statement that a non-physically-based (or conceptual?) model only predicts modifications in flow rates is not true. Conceptual models often conceptualize a catchment by a number of interconnected stores representing different water stores in a catchment and fluxes in between. Therefore, also modifications in these stores and fluxes can be investigated.

Conclusions

- p7709, l6-7: Where in the paper can we find quantitative information underpinning this statement?

- p7709, l16-18: Why is it important to use physically-based models to study the impact of climate change on the hydrological response of catchments? Where in the paper did you show/ prove that physically-based models have an added value for this type of studies?

References

- p7710-7712: The referencing is not very accurate (in text and reference list). References Brouyère et al. (2004), d'leteren et al. (2004), Dautrebande and Sohler (2006), GIEC: Bilan (2007), Lenderink et al. (2007), Ntegeka and Willems (2008a and 2008b) and Sohler and Dautrebande (2009) are missing in the text.

Tables and figures

- p7713: Which time period has been used to determine maximum and minimum flows?
- p7714: What is the source of these data?
- p7715: What is the source of these data? Why is it important to report these soil classes with so much detail and (apparent) accuracy?
- p7717: What is the meaning of the heading “Qsim” in this table? Furthermore, I don’t understand the water balance in this table; shouldn’t the annual input (rainfall) be equal to the annual output (direct runoff, interflow, actual evapotranspiration)? Please explain.
- p7721 and 7724: The figures are too small and difficult to read. Please improve.
- p7723: What is “Qsim” here?

Technical corrections

- p7696, l14: “seasonal” instead of “seasoning”
- p7696, l23: delete “no less than”
- p7696, l25: “When flow rates are high . . .” instead of “When flow rates are too important . . .”
- p7697, l2 and l13-14: “Driessen et al., 2009” (in text) or “Driessen et al., 2010” (in references)?
- p7697, l4: “IPCC, 2007” is not in the reference list
- p7697, l6: “Willems et al., 2008” (in text) or “Willems et al., 2009” (in references)?
- p7697, l6: “Goderniaux et al., 2008” (in text) or “Goderniaux et al., 2009” (in references)?
- p7697, l7: “. . . more precipitation is . . .” instead of “. . . more precipitations are . . .”

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- p7697, l13 and l19: “Booij et al., 2005” (in text) or “Booij, 2005” (in references)
- p7697, l26: “Teutschbein and Seibert, 2010” instead of “Teutschbein and Siebert, 2010”
- p7698, l15-16 and l19-20: “Hernandez-Santana et al., 2003” (in text) or “Hernandez-Santana et al., 2009” (in references)?
- p7703, l20: delete “no less than”
- p7708, l18: “seasonal contrast” instead of “seasoning constrat”
- p7708, l19: “broad” instead of “braod”
- p7708, l20: “width” instead of “breadth”
- p7709, l11: “more important” or “larger”?
- p7722: The figure title can be removed since it is explained in the caption of the figure.

References

- Booij, M.J. (2005) Impact of climate change on river flooding assessed with different spatial model resolutions. *Journal of Hydrology*, 303, 176–198.
- Booij, M.J. and Krol, M.S. (2010) Balance between calibration objectives in a conceptual hydrological model. *Hydrological Sciences Journal*, 55, 1017-1032.

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