

Response to comment of Davy Vanham

We thank Davy Vanham for his valuable comments and suggestions. Accordingly, the following revisions were made (our response is highlighted in blue and italic type):

The submitted manuscript is of scientific value and novel. It is well written. The methodologies are scientifically proof, the used model is state of the art. I recommend the manuscript for publication, however I have 1 general comment.

General comment

It is not clear why the high mountain or alpine climate zone has not been chosen amongst the European climate zones. The authors refer to high mountain ranges and/or the importance of mountain snow and ice a few times in the manuscript - p.9195 lines 20-21, p.9205 lines 6-9, p.9206 lines 24-26, p.9207 lines 23-26, p.9211 lines 4-8. However, specific mountain ranges function as water towers for surrounding lowlands, and therefore the inclusion of this climate zone and the effects of climate changes on its hydrology is essential in a work describing the "effects of climate change on river flows in Europe. I refer to Vanham (2012b), where the importance of the Alps as water tower for 4 of Europe's largest river basins (Danube, Rhine, Rhone and Po) is described as well as the effect of climate change on the Alpine mountain zone. The authors describe the high mountain ranges as local variant (p.9207, lines 23-26). However, further in the manuscript (p.9211 lines 4-8) they acknowledge that in the continental climate zone the widest ranges of change are observed, as this zone contains important European mountain ranges such as the Alps.

Response: We agree that mountains have a strong impact on river flow regimes. The goal of our analysis was to analyse the major climate zones of Europe as provided by the EUCA15000 map by a large-scale modelling approach. The mountainous climate zones in Europe comprise relatively small areas in comparison to the other major climate zones and possess local specifics which are difficult to represent in detail by a large-scale model, even WaterGAP3 calculates snow melt on sub-grid scale of ~1x1 km and considers a variable flow velocity. In addition, the spatial resolution of the climate data is too coarse for a specific analysis of small mountain ranges. The goal of our study is to identify hotspots of change in Europe and we recommend that for the hotspots identified, further analysis by regional models is required. Furthermore, mountains influence flow regimes in downstream direction far beyond the borders of the mountainous climate zone so that rivers in adjacent climate zones are still be impacted for some hundred kilometres. Thus, we decided not to include an explicit evaluation of mountainous climate zones in our analysis.

The comparison of the Dniestr river with a typical Alpine catchment is with this respect not very justifiable.

Response: The Dniestr River originates near the city of Drohobych in Ukraine at ~900m. While the eastern river shore is low and flat, the western one is high and hilly at least along the lower half of the Dniestr. Hence, higher mountain ranges influence the flow regime of the Dniestr to some degree. In regard to the comment, we exchanged the Dniestr River in our study by the Southern Bug River as typical example for the continental climate zone. The Southern Bug has also a central location in the climate zone, but originates only at ~320m elevation in the Volyn-Podillia Upland and is less influenced by high mountain ranges as the Dniestr River.

Specific comments

p.9196 line 4: "..irrigated agriculture, the largest water user worldwide ..." comment: It is by different authors now recommended to view rainfed agriculture as the largest (green) water user worldwide. Irrigated agriculture is the largest blue water user worldwide. It is referred to Vanham (2012a).

Response: To be more precise, the sentence was rephrased and a reference of a global-scale study was included.

Literature

Vanham, D. (2012a) A holistic water balance of Austria - how does the quantitative proportion of urban water requirements relate to other users? *Water Science & Technology* 66(3), 549-555.

Vanham, D. (2012b) The Alps under climate change: implications for water management in Europe, *Journal of Water and Climate Change* 3(3),197–206, doi:10.2166/wcc.2012.032.