Hydrol. Earth Syst. Sci. Discuss., 10, C3164–C3169, 2013
www.hydrol-earth-syst-sci-discuss.net/10/C3164/2013/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Evaluating the influence of long term historical climate change on catchment hydrology – using drought and flood indices" *by* I. B. Karlsson et al.

I. B. Karlsson et al.

ika@geus.dk

Received and published: 15 July 2013

Received and published: 22 April 2013

The reply for the comments of Referee #1 is also attached as pdf.

Anonymous Referee #1 Received and published: 22 April 2013 The manuscript present a relevant study based on a 133 year hydrometeorological (1875-2007) serie of the 1055 km2 Skjern river catchment in western Danemark. A detailed trend analysis on meteorological and discharge data (available only for the period 1920-2007) is conducted. The analysis on observed data is completed by a model-based analysis using

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

a simple lumped hydrological model. With the series and the model, the authors reach some substantial conclusions on observed trends, simulated water balance, the ability of the model to reproduce the current trends and the ability of the model to evaluate the impact of climatic changes over the catchment. They also discuss the link with climate change over the basin and NAO, SCA and AMO. This paper is potentially very reach, however some points or part need to be improved as they are not supported by enough evidence, or some important points are still missing. The paper is relatively long and some of the important data and results are scattered over all the paper. I suggest to strengthen the paper by adopting a clearer structure and improve the scientific quality of the demonstration. I'll develop below the main points that need to be improved.

General comments: 1. Observed data: The authors did not mentioned how the quality control of the data was done, in particular if the data have been previously homogeneized (i.e. corrected from any ruptures in the serie due to instrumental change, relocation of the stations, ...). This practice is common and mandatory in the analysis of climate trends. Note the Mann-Kendal is not sensitive to rupture (as a rupture affect only one element of the serie), however, a rupture has an influence of the value of the trend. Hence, the use of non-homogeneized data can lead to large errors in trends and the authors should be careful about this point.

Response: We appreciate the advice to test for homogeneity. In consequence the four main stations have been tested using the Standard Normal Homogeneity Test, SNHT (Alexanderson 1986). A previous study by the Danish Meteorological Institute (Cappelen et al. 2008; Frich et al. 1996) tested the two stations 21100 and 25140, north and south of the catchment, using the SNHT on monthly time series and found that both stations were homogeneous. This fact was verified by testing of the two stations against one another.

The initial test using the two homogenous stations as reference stations showed that all four main stations were in fact affected by at least one in-homogeneity. Using correction factors based on the fraction between the mean before and after the break, all

HESSD

10, C3164–C3169, 2013

series were adjusted and subsequently re-tested. Two of the stations were found to be homogeneous after the first correction. The two remaining stations were re-tested using the method described in Easterling and Peterson (1995) for multiple breaks; here the precipitation series are divided into subsections before and after the break. Each subsection is hereafter tested to identify additional breaks. The procedure is repeated until no breaks are found. One station with 5 breaks and one with 3 breaks were found, and the breaks were corrected starting from the youngest break (in time). After homogenization the trend in precipitation was reduced; from 46% to 26% (for the catchment precipitation). The change in the precipitation series requires that the hydrological model should be re-run and the extreme indexes should be updated. The results and the steps of the SNHT-analysis will be included in the article.

2. ETP: The Thornthwaite ETP is a rather crude estimate of the ETP which is based only on temperature. The Penman-Monteith estimate is of better quality but need more data, this is the reason why it has been used only for the period 1990-2009. The correlations shown in Table 1 are rather low (e.g. For June, only 49 . . ..

Response: We agree that the correlations are rather low. For some months the correlation is even not statistically significant, and we have therefore only based the ETP on Thortwaite's formula for months where we have found a statistical significant correlation. We have tested a number of alternative ETP formulas that could be used with the limited data available and Thorntwaite's formula was the best one, although it is far from perfect.

3. Non stationarity of the basin, and general treatment of the uncertainties : In a general manner, the authors do not take enough into account the uncertainties. Some are discussed (e.g. in §5.2.2), a balanced treatment is needed (e.g. taking into account ETP). The non stationarity of the basin is discussed in several paragraphs (e.g. 2.1), but not in a coherent manner with the other sources. One of the best ways to improve this point would be to reorganize the manuscript in order to treat the uncertainties issues in a coherent way and provide some kind of error bars to results.

HESSD

10, C3164–C3169, 2013

Response: We agree that the discussion of historical changes (the non-stationarity of the basis) was too dispersed in the original manuscript. The revised manuscript will be reorganized such that this discussion will be collected in a single paragraph (in the discussion section) and compared to other uncertainty sources. We did consider quantifying the uncertainties through, e.g., error bars. However, it was found difficult to obtain reliable estimates of all uncertainties. Hence, we prefer to only include a discussion of this subject in the revised manuscript.

4. Link with climate: I must say that this part of the manuscript (part 7 and 8) is not really convincing. Most of the arguments are not supported by enough material. I given only the example of §8.2 which should be deleted or significantly improved. The discussion on NAO and climate drivers are rather confuse, and at the end the reader has difficulties to make it own opinion.

Response: We agree that the discussion on the link to possible climate change drivers was not adequate in the original manuscript. Since this subject is not essential for the main objectives of the article and the original manuscript was too long it has been deleted.

Specific comments:

1. The title is is not very specific and could be changed to more reflect the content of the paper (i.e mentioning the catchment, what are the "changes") Response: The title has been changed to: “Historical trends in precipitation and stream discharge at the Skjern River catchment”

2. Page 2375, lines 10-14: please be more specific Response: The paragraph has been changed to: “However, it might be problematic to differentiate between the effects of climate change and the impact of direct anthropogenic undertakings such as river regulations, water abstractions, irrigation, fertilization, etc. The influence of these changes should therefore be considered with care when trying to disassemble the climate change impact signal.”

HESSD

10, C3164–C3169, 2013

3. Page 2376, line 11: please explain the threshold method Response: An additional paragraph has been included: “The threshold method is a common scheme used when analysing discharge series for droughts; each observed discharge series is evaluated with respect to a threshold calculated as a percentile of the flow duration curve.”

4. Page 2376, line 14: please, explain what is your definition of "short period" Response: The line is removed

5. Page 2377, line 6: a presentation of the outline of the paper is lacking at the end of the introduction Response: An outline is included: “The article is organised as follows: in section 2 the catchment is introduced, including the available climate data and the measures applied to evaluate the quality of the input data. Section 3 describes the methods employed in the analysis of the data; including the statistical tests; the hydrological model and the threshold method. Section 4 to 6 contains the results from all analyses; where section 4 covers the analysis of the trends of the climate data; section 5 contains the hydrological model results; and section 6 describes the extreme index results. Finally, in section 7 and 8 the results are discussed and conclusions are listed.” Page 2378, line 14: the time period investigated in the study is not defined at this stage of the paper Response: The description of the historical changes has been moved to chapter 6.2 in the revised manuscript. Hence, the period investigated is known when this section is read.

6. Page 2387, line 16: "spacial" is misspelled Response: “spacial” has been replaced by “spatial”

7. Page 2389, lines 1-6: this paragraph is not clear Response: The section describing the change in precipitation events have been omitted to reduce the length of the paper.

8. Page 2404, lines 6-12: this paragraph is really unclear Response: This paragraph has been removed from the manuscript as it was decided that the analysis of climate change was too weak and not necessary for the central part of the article.

HESSD

10, C3164–C3169, 2013

9. Page 2406, line 9: The authors might consider refereing to Stahl et al. (2010), Streamflow trends in Europe: evidence from a dataset of near-natural catchments, HESS. Response: The reference is included.

10. Tables and Figures: the Tables and Figures are clear, but the legend should be more precise, in order to avoid to systematically refer to the text to understant it. Response: The legends have been more carefully formulated in the revised manuscript.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/10/C3164/2013/hessd-10-C3164-2013-supplement.pdf

---

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 2373, 2013.