Hydrol. Earth Syst. Sci. Discuss., 10, C7054–C7060, 2014
www.hydrol-earth-syst-sci-discuss.net/10/C7054/2014/

Hydrology and Earth System Sciences
Open Access
Discussions

HESSD
10, C7054–C7060, 2014

Interactive Comment

Interactive comment on "Comparing impacts of climate change on streamflow in four large African river basins" *by* V. Aich et al.

Anonymous Referee #1

Received and published: 5 January 2014

General comments: The paper presents an analysis of climate change impacts for some selected river basins of Africa, and is among a few that give a detailed comparative analysis of the impacts on a regional basis. The manuscript is well structured and technically sound, although there is a need for more clarity on many statements included, which sometimes prove to be false. The text, especially on the description of the study sites and the methods, could be significantly revised to avoid repetition and contraction of ideas.

Specific comments:

P13009, L10-14: This paragraph needs to be clarified with more evidences to prove the veracity of the statements included. "The basins of the Niger, Upper Blue Nile, Ubangi

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

and Limpopo were chosen because they cover most of the African climate zones". Which climate zones are you referring to and based on which classification? Could you please show these climate zones and how the basins chosen represent them all? This is very important as it determines the validity of the comparative analysis done in this study.

"In addition, they are all highly dependent on the weather conditions, as their economy is mainly based on the primary sector". I do not understand this. You may want to rephrase the sentence to clearly explain the idea.

P13009, L15-18: This entire paragraph is very confusing and contradicting. Please note that heterogeneity is often related to media properties or physical features of the natural system such as topography, soil characteristics, geology and vegetation, and not to fluxes.

P13009, L19-L26: Again another contradiction with regard to the previous paragraph in which you talk about the uniqueness of the hydrological regime for each of the basins under study. Here I think there is need for you to revisit the classification of both climate zones and hydrological regimes for the basin under study. There is need for you to clearly prove that these basins are representative of most of the climate zones in Africa. P13010, L7: You may want to use Oubangui as it appears in many official documents.

P13010, L7: This information is not true. Please note that the Congo Basin has four main tributaries, namely: Oubangui (north east), Sangha (north west), Lualaba (south east), and Kasai (south-west) which all pour flows into the main trunk of the Congo River, and Oubangui is far from being the second largest, both in terms of discharge and the drainage areas. Please see Tshimanga (2012), and Tshimanga and Hughes (2012) for more information. P13010, L10: Please be more explicit here. What do you refer to as regional rainy season? P13011: Mm−3, what is this?

Section 3: Methodology

P13012, L3: The desired spatial scales, I presume! P13013, L1: You previously stated “the desired scales” and here you mention/limit to “mesoscale”, sounds confusing!

P13013, L3-4 “It allows the simulation of all interrelated processes within a single model framework” the sentence appears to be a tautology within the paragraph as there is already another statement: “SWIM is process-based and simulates the dominant eco-hydrological processes at the mesoscale such as evapotranspiration, vegetation growth, runoff generation and river discharge, and also considers feedback among these processes”, which seems to be more precise and informative.

P13013, L15: Simulating percolation to the deep aquifer would imply a good understanding of the geological setting of the sub-basins, which I do not see in this study.

P13013, L26: Insert the appropriate reference for the SRTM dataset.

Section 3.1: I suggest you insert a graphical representation of the processes included in the model for a better illustration. The text could be rewritten to avoid repetition of ideas.

It is important to show the parameters and the structure of the model and how it handles the various hydrological processes as mentioned in this section.

P13014, L2: Insert the appropriate reference for the Global Land Cover dataset. 13014 L12: The recommended reference for GRDC data is Fekete et al. (1999.

13014 L13-17: In addition to bias correction, there is an important step to consider for choosing a GCM to be used in climate change analysis; that is the skill test (see IPCC-TGICA, 2007, Tshimanga and Hughes, 2012). I do understand that for the purpose of comparison you have to maintain the same GCMs for all the study sites but bear in mind that the uncertainty due to a relative performance of GCMs in reproducing historical patterns of variability in climate for a given site will be ignored in this case.

13015 L1: I would have expected to see a description of the procedures used to delineate the sub-basins included. How did you delineate these sub-basins, it is not known.

In this table (Table 3) the period for validation is given but not calibration!

13015 L6-7: Please specify the terms sub-basins and sub-catchments to avoid confusion from your readers. Please state how you merged the 1923 sub-basins to form 18 sub-catchments.

13015 L7-9: Adding the process of flood plains into model is, to my understanding, a crucial part of the paper and the procedures used should be adequately described. How does this component work and how was it formulated, should be clarified. Please note that there is now a growing interest in understanding hydrological processes of floodplains/wetlands of Africa (Hughes et al., 2013) and modelling approaches that enable this understanding should be promoted.

P13015, L27-28 until P 13016, L1-4: I disagree with the authors on this aspect. The Oubangui drainage system, with an area of about 500 000 km2, is characterised by large variation in soil and land cover types as well as a transitional tropical climate. The dominant soils include a variety of Ferralsols, Arenosols, Regosols, Nitosols, Gleysols and Lithosols, with areas of shallow and deep soils across the sub-basins (up to 400 cm of soil depth for Orthic ferralsols, see webb et al., 1991). Similarly, there is a large variation in the distribution of the vegetation types in the Oubangui, which consists of mosaic vegetation and broadleaved deciduous or evergreen forest/ woodland. So stating that Oubangui is more homogenous appears to be very subjective and does not reflect the reality. In addition, the source of streamflow data used by the authors (GRDC) contains a good coverage of gauging stations for the Oubangui and limiting your analysis to only one station on the basis of the homogeneity in the basin is not really convincing.

Section 4.1: It is a bit surprising that you only present the results for validation and not calibration. How do you justify this? You may want to clarify what you mean by validation as the term is generally used in conjunction with calibration, and in practice applied to check if the model is able to reproduce the right simulation with the same parameters used for calibration but in a different period.

P 13017, L3: I believe you should have determined an initial threshold for the model evaluation using PBIAS criteria, and if so how do you justify the model performance given large variation of the PBIAS (from 2.1% in the Niger and 39% in the Upper Blue Nile)?

P 13017, L5: Although not clearly stated, it seems that your model has been conditioned at daily time step, but the simulation results (Figure 2) are presented at monthly time step. How do you justify this?

Section 4.2: I do not understand to which conclusion you would like to reach with the comparisons made in Figures 4 and 5, using the mean climate variables (temperature and precipitation) in the far projection period (2070–2099) relative to the base period (1970–1999) for RCP 8.5 for five bias-corrected model projections (colored lines), the uncorrected ESMs (colored dashed lines) and 14 ENSEMBLE ESMs (grey dashed lines). My understanding is that you started by choosing the bias-corrected climate models to be used for your analysis, thus eliminating part of uncertainty due to climate input. However, it appears that you are here using those uncorrected climate models and the 14 ensembles in the analysis. Please be more explicit here as these comparisons seem to bring confusion.

P13019L5-6, I presume mm month-1

P13021, L15-21: This is very contradictory as you previously mentioned that due to unrealistically high precipitation values produced by WFD for the Ubangi, this dataset has been replaced by the GPCC data (see P13016, L3-6). So, which dataset did use to force your model in the Oubangui? WFD or GPCC?

Section 4.4: Impact of climate change on discharge and seasonality:

In this section, the impacts of climate change on river flows are, understandably, analysed with regard to the trend in rainfall (section 4.2). What about the role of evapotranspiration which could be very important due to increase in air temperature, and thus influence greatly on the availability of water resources? In this respect, Tshimanga and Hughes (2012) found that there was a decrease in runoff for the near-future projections in the Oubangui due to very little change in rainfall from the historical conditions but with major increase in evapotranspiration. Therefore, the change in evapotranspiration was a key element of climate change impacts on water resources availability.

How do you correlate the climate trends as shown in section 4.2 and the trends in discharge due to the impacts of climate change as shown in section 4.4? I think, this could illustrate which component of the climate has more influence on streamflow variation.

P13022, Fig 7: The figure could be transformed into a table for a better readability.

P13022, L8-9: There is a need to be clear on the time step used for modelling. Is it daily or monthly? This is really confusing. You processed the forcing data WFD at the daily time step and if they were aggregated to fit the model at the monthly time step, this should be mentioned.

Section 5.3 Changes in hydrological extremes: If your model has been conditioned at the monthly time step, then it will be difficult to convincingly quantify hydrological extremes.

P13029, L6: "These two parameters" Which parameters are you referring to? P13029, L8-9: It is not demonstrated in your paper, hence you cannot bring it into discussion here.

P13029, L16-19: The methods used are supposed to have been defined earlier in the methods' section and not here in the discussion. You cannot start to bring the methods in the discussion.

Reference cited

Fekete, B.M., Vorosmarty, C.J., Grabs, W., 1999. Global, composite runoff fields based

HESSD
10, C7054–C7060, 2014

on observed river discharge and simulated water balances, GRDC Report 22, Global Runoff Data Center, Koblenz, Germany.

Hughes, D.A., Tshimanga, M.R., Sithabile, T., Tanner, J., 2013. Simulating Wetland Impacts on Streamflow in Southern Africa Using a Monthly Hydrological Model. Journal of Hydrological Processes DOI: 10.1002/hyp.9725.

Tshimanga, R.M., 2012. Hydrological uncertainty analysis and scenario based streamflow modelling for the Congo River Basin. PhD thesis, Rhodes University repository. South Africa.

Tshimanga, R.M., Hughes, D.A., 2012. Climate change and impacts on the hydrology of the Congo Basin: the case of the northern sub-basins of the Oubangui and Sangha Rivers. Physics and Chemistry of the Earth 50–52 (2012) 72–83.

Webb, R.S., Rosenzweig, C.E., Levine, E.R., 1991. A global data set of soil particle size properties, NASA technical memorandum 4286. NASA Goddard Institute for Space Studies, New York, USA.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 13005, 2013.