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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Climate change impacts on river discharge in West Africa: a review" *by* P. Roudier et al.

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Review of Roudie, P., A. Ducharne, L. Feyen, Climate change impacts on river discharge in West Africa: a review

Review by Andrew J. Guswa, aguswa@smith.edu

Overall Evaluation

This paper presents a thoughtful synthesis of a large number of studies that examine potential impacts to major rivers in West Africa. The paper points out that most of the research carried out to-date focuses on the effects due to climate change (via precipitation, temperature, and potential evapotranspiration), while a few also examine the

effects of changes in water withdrawals, land-use, and atmospheric CO2 concentration. The paper pulls together the results from many studies and provides insight to the state of our understanding of potential changes to West African rivers.

Below, I offer a few suggestions to provide additional context for the synthesis and improve the communication of the results and implications. Overall, I think the paper makes a valuable contribution to our understanding of West African hydrology.

Specific Suggestions

To help orient the readers who may be less familiar with West African rivers, I recommend that the authors Include a table with some basic information about the river basins. Specifically, I recommend that they include: river name, mean annual flow, watershed area, river length, mean annual precipitation over the basin, and average aridity index (PET/P). Such information will be especially helpful when interpreting the results that are presented river-by-river.

Additionally, I think the discussion of the sensitivity of river discharge to changes in precipitation would be improved if put into the context of some theory. Specifically, Budyko-type curves provide a first-order estimate of river runoff as a function of mean annual precipitation and PET. Using such a curve could provide a theoretical prediction of what the sensitivity of discharge to precipitation might be, and the results from the range of studies (as expressed in figure 6) could then be discussed in reference to that theory.

Specifically, the relatively simple curve of Schreiber, 1904, provides a relationship between mean annual runoff (R), precipitation (P), and potential evapotranspiration (PET):

$R = P * \exp(-PET/P)$

Using this equation, the sensitivity of runoff to changes in precipitation can then be expressed as

HESSD

11, C1304–C1307, 2014

(dR/R)*(P/dP) = 1 + PET/P

The left-hand-side represents the ratio of the percent change in rainfall relative to the percent change in precipitation – the slope of the lines given in figure 6. Those slopes could then be compared to the term on the right-hand-side and differences or similarities discussed. And, of course, one could use the Budyko curve (1974) or other formulation instead of the equation from Schreiber. This would provide a nice theoretical framework for the interpretation of the variability among the river basins.

Language and Technical Correctness

Overall, the paper is well written. There are a few places where the use of language could be improved (see some specific examples below). I also offer some comments on how the figures might be enhanced as well.

Figure 5: As I understand it, the goal of this figure is to present the relationship between changes in river discharge to changes in temperature and rainfall. Visually, however, the primary message is a relationship between changes in temperature and changes in rainfall, and only secondarily about discharge. I suggest eliminating this figure and replacing it with one that is similar to figure 6, but which plots change in discharge versus change in temperature. Doing so would reveal the clear dependence of discharge on precipitation and the lack of dependence of discharge on temperature in a more effective way.

Figure 6: In addition to the general conclusion that runoff is sensitive to rainfall, the authors might wish to quantify (perhaps right on the figure or in a separate table) the sensitivities and their variability among rivers. That would enable the reader to compare among the basins in a quantitative way, and compare those values to the river characteristics (see comment about adding a table) and theory (see comment about Budyko-type curve)

Figure 7 – I interpret the warm colors to mean a reduction in monthly flow and the

HESSD

11, C1304–C1307, 2014

greens to indicate an increase; I recommend that it be articulated explicitly in the caption which colors indicate a increase and which a decrease.

In the abstract and conclusions, I recommend that the phrase “much more” be eliminated – the contrast is between positive and negative, not positive and much more positive.

In section 2.1, line 15 I believe this statement is intended to be about intra-annual variability (not inter-annual variability). If so, I recommend eliminating the phrase “variations in” and replacing inter-annual with intra-annual.

In section 2.3, I recommend separating the first paragraph into two (with the separation coming just before the phrase, “To create the database. . .”). I also recommend that the first part of that section be expanded a bit to give the reader a clearer sense of the overarching approach – that the studies related to climate are integrating into a database and assessed quantitatively, whereas the works addressing water withdrawals and carbon are treated more as case studies.

Throughout – rather than the phrase “contrasted climatic and hydrological conditions”, I recommend “varying climatic and. . .”

References

Budyko, M. I. (1974), Climate and Life, Academic, San Diego, Calif.

Schreiber, P. (1904), Über die Beziehungen zwischen dem Niederschlag und der Wasserführung der Flüsse in Mitteleuropa, Z. Meteorol., 21(10), 441 – 452.

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