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Hydrology and
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Sciences
Discussions

Interactive comment on "Infrastructure sufficiency in meeting water demand under climate-induced socio-hydrological transition in the urbanizing Capibaribe River Basin – Brazil" *by* A. Ribeiro Neto et al.

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We appreciate the comments. They are very helpful review comments.

1. SPECIAL ISSUE

The authors will evaluate if the feedback in coupled human-water systems may be represented in the estimate of the future water demand considering the referee's suggestion: water allocation changing as a result of changes in water availability.

2. CONCEPTS

This is helpful. We have now cited: Loorbach, D. and J. Rotmans (2010). The practice of transition management: Examples and lessons from four distinct cases. Futures 42 (2010): 237–246.

3. CLIMATE

Chou et al. (2012) exhibits two ways of estimating uncertainties in model simulation. One way is through the multi-model ensemble method. An advantage of this method is that a wide variety of model designs and configurations form the ensemble. The other method follows the perturbed physics ensemble (PPE) approach which is designed to quantify the modeling uncertainty in the simulation or projections of climate that depends on the way processes are represented in the model, i.e. in their physics parameters. To take into account the uncertainty in the climate simulation, we can use the PPE according to Chou et al. (2012). Primarily, we have used just the first member, but we can include the other three members from HadCM3 runs.

4. MODELLING

"Modelling paper of this type should robustly validate the model; the more so if the model is applied to scenarios that fall outside the parameter range for which it was calibrated. This is so because the reader should be convinced that the model yields the correct results because it simulates the important processes correctly. Unfortunately this was not done in this paper."

The model has been calibrated in the CRB using a wide range of streamflow values (from zero to peak flows). If the model has a good performance in a watershed with this characteristic of streamflow regime, we could, in a certain way, say that the model can simulate climate scenarios with low precipitation. In the correction of the paper, we will exhibit a verification of the calibration using new periods of data at the three stream gauges used in the calibration. In addition, we will use discharge time series from other stream gauges located in other sections of the Capibaribe River and its tributaries. This may aid to validate the calibration of the model parameters.

“In fact, and in so far as I can verify, there have been no papers in international peer-reviewed journals about the hydrological model applied (MODHAC).”

The MODHAC is similar to other models widely used for synthetic runoff generation such as Soil Moisture Accounting (SMA) present in HEC-HMS model (HEC-HMS, 2000), SMAP present in the MIKE 11 model (MIKE 11, 2009) and Tank model (Sugawara, 2012). All these models, including MODHAC, use reservoirs which represent the main processes responsible for rainfall–runoff transformation: interception, evapotranspiration and runoff generation, i.e., determination of the volume of water that will either be infiltrated into the soil or flow on the surface. The results of MODHAC in Brazilian semiarid watersheds encourage its use in similar regions like CRB.

“Further, the fact that the hydrological model requires (only) three types of input variables, namely “mean rainfall, potential evapotranspiration and streamflow”(p. 2803 line 27), and that the “model has 14 parameters that can be calibrated automatically” (p.2804 line 4) leaves one wondering: isn’t this a typical case of equifinality.”

If we consider the “premise that there is no single best parameter set that represents the watershed for a range of rainfall-runoff responses, but rather that a range of different sets of model parameter values may represent the rainfall-runoff process equally well” (Melching, 2012), any hydrological model will have the characteristic of equifinality. To avoid this, it would be necessary the application of techniques such as GLUE.

“Moreover, I find it strange that streamflow is used as an input variable.”

In fact, the streamflow is not used as an input variable. MODHAC needs continuous series of rainfall and potential evapotranspiration from the whole simulation period as input and in addition observed monthly discharges for calibration. The sentence has been corrected to clarify this.

“It is not clear that the streamflow data used for the modelling exercise (refer to Table 3) have been corrected for upstream abstractions (i.e. have been naturalised). Further, it remains unclear why the periods for which the three drainage areas have been calibrated are as they are. The authors should be straightforward in explaining what data are available. I do not understand the explanation given on p. 2805 lines 20-22.”

The time series available at the three stream gauges do not have exactly the same time span. For this reason, it was needed to use different period of time in the simulations. This sentence will replace the explanation given on p. 2805 lines 20-22. From the mid-1980s onwards the construction of reservoirs affected natural regime of discharge and it is not possible to take off this effect because there is not information enough about inflow, storage and outflow in the reservoirs. So, the streamflow was not naturalized. There are two alternatives to diminish the effect of the reservoirs in the natural discharge: i) to subtract the discharge between two consecutive stream gauge; ii) and to avoid the use of data measured after the construction of the reservoirs. However the most important is that the parameters should be calibrated for each part of the basin. We can say that the three stream gauges represent the hydrological characteristics of, respectively, the upper, middle and lower CRB. This is important because we run MODHAC in the drainage area of the reservoirs located in each part of the basin. Depending on the reservoir location, the simulation uses the parameters calibrated for that part of the basin.

“The model performance during the calibration period is not critically discussed in section 4. In fact Table 3 should lead to some serious discussion – why does the model perform so badly in the lower part of the basin?”

The calibration of the lower part of the basin was the most difficult due to the presence of four reservoirs that affected the streamflow regime. The time series used in the calibration starts in 1990, which corresponds to the presence of the reservoirs. For this reason, we expected a worst result than that we’ve got. It is possible to complement the verification of the calibration in the lower CRB using other stream gauges located at tributaries and without reservoirs that affect the flow regime. To do so, we will simulate the tributaries with MODHAC using the parameters calibrated at S.L. da Mata. The evaluation of the model using discharge at a site different of the calibration is a rigorous test.

5. RESULTS

“What a missed opportunity that no literature on this interbasin transfer project is referred to and discussed (see e.g. Pena de Andrade et al. 2011). It is not clear whether the additional water availability of this IBT has been included or excluded in the model.”

We will include a discussion about the São Francisco interbasin project and its impact on the society in those regions that will receive water. We intend to evaluate the impact of São Francisco interbasin transfer project on the water allocation in CRB. We may anticipate this analysis and include it in the paper.

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