<u>REFEREE#1</u>

1. SPECIAL ISSUE

The paper thus develops two linked models, but it should be realised that this link is unidirectional. Thus hydrology and water allocation are not dynamically linked: water allocation does not evolve and change as a result of changes in water availability.
Given the above I conclude that this paper does not make a significant nor original contribution to the theme of the special issue to which it has been submitted – it does not contribute to a better understanding of how societal and natural systems are dynamically linked and how this coupling can be modelled.

We have described the bidirectional linkages of human impacts on hydrology and hydrological condition and infrastructure on human settlements. Modeling has also been upgraded to account for adaptive responses to hydrological conditions.

2. CONCEPTS

Central in the title and the introduction of the paper is the concept of "socio-hydrological transition" (p.2796 line 10; p. 2798 line 21; p. 2811 line 3), and "climate-inducedsociohydrological transition" (p. 2799 line 25). I find it problematic that this potentially very interesting but at the same time complex concept is not defined in any way….Another concept used in the title is "Infrastructure sufficiency". This concept is onlyused once in the text (p. 2799 line 24) but is not explained.
There is also no reference to a rapidly growing body of scientific literature on "transitions" (e.g. J. Rotmans).

This is helpful. We have now described socio-hydrological transition and added new citations including:

Van der Brugge, R., Rotmans, J. and Loorbach, D. The transition in Dutch water management. Reg Environ Change, 5, 164-176,2005.

Loorbach, D. and J. Rotmans (2010). The practice of transition management: Examples and lessons from fourdistinct cases. *Futures* 42 (2010): 237–246.

3. CLIMATE

Chou et al. (2012) exhibit 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 have used the PPE according to Chou et al. (2012).

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 exhibited a validation of the calibration using different periods of data at the four streamgauges used in the calibration. In addition, we have used discharge time series from other streamguages 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 onthe 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 streamgauges do not have exactly the same time spans. For this reason, it was needed to use different period of time in the simulations. This sentence has been replaced the explanation given on p. 2805 lines 20-22.

From the mid-1980s onwards the construction of reservoirs affected streamflow natural regime 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. An alternative to diminish the effect of the reservoir storage is to subtract the discharge between two consecutive streamguage 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 four streamgauges 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. We decided to calibrate the model using two streamgauges in tributaries without reservoirs that affect the flow regime instead of using S.L. da Mata located in the main course.

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 have included a discussion about the São Francisco interbasin project and its impact on the society in those regions that will receive water. We have evaluated the impact of São Francisco interbasin transfer project on the water allocation in CRB. The Pena de Andrade et al. reference has been included in the revised manuscript.

REFEREE#2

General Comments

The paper addresses important hydrologic questions, particularly in regards to hydrology under possible climate change scenarios. The use of a network flow model, with inputs from hydrologic models, is especially important to allow the paper to be considered for inclusion in the special issue "Predictions under change: water, earth, and biota in the Anthropocene." The Conclusions section is fairly long, and I suggest the authors consider incorporating some of the discussion in the Conclusions section into the Discussion section. Towards the end of the Conclusions section there are some useful suggestions as to how individuals, water managers, and policy makers might deal with less water in the future.

We have modified the Conclusions accordingly. Several of the outcomes of the study we consider to be more than just discussion points and thus we have left them in the Conclusions.

However, I wonder if a brief mention as to thepredominant types of crops/agriculture under irrigation, as well as types of industry,might be mentioned in the Study area section (and then perhaps be referred to againin the Discussion or Conclusions in terms of possible changes/transitions with lessavailable water)? I think this is worth considering in order to make the paper morerelevant to a broader academic audience.

We have described the predominant types of crops and industry.

Specific Comments

All the specific comments have been taken into account and the correction has been done. Two specific comments need an extra explanation.

If Recife is in the interior of the basin, why is it located outside of the river basin map of Figure 1?;

Recife is partially inside the basin and partially outside the basin. We have changed the Figure 1.

p. 2808, lines 19-20: not sure what this last sentence in the paragraph is based on; the Australia study(?) – even though seems their study did not run a scenario towards "the end of the 21st century");

By the end of the twenty-first century and considering the tendency for 2030, the change estimated by Vaze et al. (2011) could meet the values obtained in CRB.

<u>REFERENCES</u>

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