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Hydrology and Earth System Sciences Discussions

Interactive comment on "Urbanization and climate change impacts on future urban flood risk in Can Tho city, Vietnam" *by* H. T. L. Huong and A. Pathirana

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We thank Dr. Heiko Apel for his insightful short comment. The comments are particularly valid, for Dr. Apel is intimately familiar with the study area, mainly due to his involvement in the project "Water-related Information System for the Sustainable Development of the Mekong Delta (WISDOM)". Below we attempt to respond to the issues raised.

1 General Comments

First of all, due to the difficulty for the international reader to download the report (Impact of climate change on water resources and adaptation measures, hereafter referred to as IMHEN-CC) from the IMHEN web-site we have (with the permission of IMHEN) mirrored the report at the following URL : http://assela.pathirana.net/Vietnam:_Impact_of_climate_change_on_water_resources_and_adaptation_measures and invite the readers to download it from there. Sea-level rise and river flow increase are calculated based on standard global climate change scenarios (B1, B2, and A1F1) and therefore difficult to assign probabilities without addressing the uncertainties in the future emission picture – which is clearly beyond the scope of this paper. IMHEN-CC employed largely statistical downscaling with MAGICC/SCENGEN (Wigley, 2008) supplemented with dynamic downscaling using PRECIS (Jones, 2004). They used such downscaled rainfall to compute the increase of runoff in the large river basins including the Mekong. SWAT (Neitsch, 2002) was used to compute rainfall runoff and ISIS (a proprietary hydrodynamic model) for hydrodynamic simulation. In the present study we did not employ hydrodynamic modelling of the riverine system for the impact of sea-level rise or the increase of upstream flow, but the results provided in IMHEN-CC were used as boundary conditions for the urban flow model.

2 specific Comments

2.1 DEM source and Quality

Terrain property of objects in schematic outline was determined on DEM with resolution 15mx15m. DEM was digitized from topographic maps, obtained from the Department of Geodesy and Cartography, Ministry of Natural Resources and Environment, Viet-

HESSD

8, C5680–C5684, 2012

nam. While the resolution of the DEM was 15m, the actual precision of the data was much crude, more like 30-40m. As the commentator rightly pointed out, the quality of DEM is a major issue impacting the accuracy of the results.

2.2 'future 2009 event'

When assessing the impacts of urbanization on rainfall, we used the historical rainfall event of 2009, causing high flood for Can Tho city. We estimated the future urban flood with the following conditions:

1. Same large-scale atmospheric forcing as 2009 (effectively we do not consider climate change impact on large-scale forcing and hence on extreme rainfall. Strictly, this is not correct. But, there are no reliable, simple ways to link the local extreme rainfall enhancement due to climate change induced large-scale forcing.) We used the FNL dataset of NCAR, USA for the event forcing.
2. City grows and hence the changes in micro-climate causes extreme rainfall to change, with the same large-scale forcing as 2009.
3. City growth cause the impervious fractions to increase, this also causes (urban) run-off increase.
4. River level increases both due to increase of upstream flow and sea-level rise (both due to climate change, obtained from raw results of IMHEN-CC)

As seen from above points, we DID NOT consider the full implications of climate change on the projection. Boundary forcing on the riverine system was considered, but large-scale forcing on the atmospheric system was ignored. We included the local growth impacts (microclimate change and imperviousness).

HESSD

8, C5680–C5684, 2012

It is fare to consider our attempt as one of a 'sensitivity study' rather than a bona-fide prediction. However, it is worth pointing out that most climate prediction results available today also can be effectively considered as 'sensitivity studies' (Jones, 2001) (what will be the sensitivity of the atmospheric system to a particular emission scenario) rather than predictions (Georgi, 2005). In our case too we included several possible future impacts of global and local change, but not all.

2.3 Water levels

We used the results from IMHEN-CC. Because of space limitations, we could not present details of the method used in the project. They use ISIS hydrodynamic model with downstream sea-level, and upstream flow boundary conditions to predict the flood situation throughout the Mekong Delta. However, it should be noted that IMHEN-CC does not give the specific water heights at Can Tho station. These were obtained from the raw ISIS model data used for IMHEN-CC, available at IMHEN.

2.4 Interpreting our results

It is because the study is an attempt to integrate the impacts of several drivers of future change and therefore involves a complex chain of analysis. Such analyses invariably generate significant degree of uncertainty in the final outcome. Each stage of simulations/estimations (both what we have done and what we have used as boundary conditions) has its own sources of significant uncertainties.

2.5 Flood protection vs. living with flood

Yes, we advocate "flood protection" as the primary approach in this case. While "living with the floods (LWF)" as well as Sustainable Urban Drainage (SUDS) type solutions

HESSD
8, C5680–C5684, 2012

definitely an important ingredient in a comprehensive flood mangement plan, in this particular case, there are certain "basic essentials" of urban flood management (e.g. a drainage system) that is lacking here. In our opinion , it is irresponsible for us to discuss LWF, SUDS etc., without first discussing the basics that are lacking. We agree with the reviewer that 100% flood protection is an illusion. We have to go above and beyond the basic flood protection.

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