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Hydrology and Earth System Sciences Discussions

Interactive comment on "Staged cost optimization of urban storm drainage systems based on hydraulic performance in a changing environment" *by* M. Maharjan et al.

M. Maharjan et al.

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We thank both the reviewers (#2 and #3) for their comments. General and specific aspects of each review is addressed below:

1 Review #2

1.1 Appropriateness of HESS/D for the subject matter

Here we beg to differ on the opinion of the reviewer due to following reasons The subject of the current manuscript spans over several disciplinary areas including, Urban drainage, urban hydrology (in the context of SuDS), responding to Global change (non-stationarity). In making the decision on which journal is appropriate we had to look at an outlet that has focus on all these areas as opposed to an engineering journal that is specific to urban drainage and sewerage. In our opinion such journals include HESS, Journal of Hydrology among others. We decided that the theme "Hydrology and Engineering Applications" and sub theme "Urban Water Cycle" includes the subject matter of the current manuscript.

1.2 Other general comments

We agree with other two comments (language, length of conclusion) and will edit the manuscript accordingly.

1.3 Specific comments

1.3.1 Simplifications, Accuracy and Uncertainty

When detailed data is available, it is useful and interesting to analyze the urban systems in finer detail. However, in the present case study the available resolution of data limits the meaningful spatial detail of the hydraulic/hydrologic model. The main sources of data were the urban drainage master plan (Bemfica 1999, published in Portuguese), a previously published masters thesis (Gersonius, XXXX) and experience of

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some site-visits. It is true that a large uncertainty is introduced as a result of sparse data availability. However, many cities of the developing countries where rapid urbanization is a problem has similar data problems.

In our opinion, the major sources of uncertainty in this study arise from the assumptions made on the future changes in parameters of population growth and rainfall change and the assumptions made on the relationship of impervious fraction to the population density. While attempts were made to tap the best available resources to estimate these quantities, it should be stated that a large degree of uncertainty remains. In the presence of such uncertainties it is questionable whether it is useful to consider better spatial precision in the model.

We agree that the uncertainties (what the reviewer has mentioned and what we have listed above) need to be discussed and such discussion will be added to the new Discussion section preceding the Conclusions.

1.4 GA parameters

The number of variables is the only GA parameter that is explicitly related to the physical problem (it is equal to the Number of stages multiplied by number of storage options). This will be explained.

Selecting evolution parameters for a particular GA, optimization problem largely depends on experience based trial and error, apart from several broad guidelines (e.g. Very large mutation rates could make the evolution to be non-progressive and the opposite could make the solution stranded in local optima).

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1.5 Non-inclusion of model parameters in the sensitivity analysis

We agree with the reviewer on the sensitivity of the results on the model parameter selection. However, this involves a very large number of parameters (both for hydrologic models for sub-catchments and hydraulic models for the conveyers) and presentation of hydrological/hydraulic model results would be detrimental to the focus of the manuscript.

GA computations in this involve a considerably large computing burden. For example, the computation involved in a single chromosome needs 160 (20 multiplied by number of return periods considered) runs of the SWMM model. This implies that the number of SWMM runs needed for one scenario like the one presented in Fig. 7 is about sixteen million. Even with a lightweight model like SWMM, this works against introducing many sensitivity studies.

1.6 Technical Corrections

All are noted and attended in the final draft.

2 Review #3

We agree with the reviewer that there are major simplifications in the fundamental steps of the procedure. However, these are inevitable in the light of 1) the level of knowledge gaps that exist in the process of reasoning that is necessary in linking causes of change to their ultimate future impact in hydrologic cycle. These include a) uncertainties in rainfall, demographic, landuse modeling, b) linking average increase of rainfall to the changes in extreme values, etc., 2) in order to keep the focus on the 'proof of concept' in applying WLC approach for sewer networks.

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We accept the need to shorten the conclusion (as suggested by both the referees) and will be done.

2.1 Specific Comments

2.1.1 Choice of design storm duration

The response times of various sub-catchments, observed at different nodes of the network vary from 15 min to 45 min. This was the reason to select 1h design storm.

2.1.2 Eq. 8 and Fig. 4

Eq. 8, computes intensity in mm/h, for a duration t (t need not to be equal to hour, e.g. it can be 1min - then we compute rainfall intensity for the 1min duration in units of mm/h. If we need this in mm/min, need to divide by 60.) In figure 4, the values are given in rainfall depth (mm) not as a rate (mm/h). The caption of figure 4 will be extended to clarify this.

2.1.3 Circles in Fig. 5, Fig. 6

Fig. 5. Potential locations for detention storage. Fig. 6. Flooded locations in the original network with 50yr(1h) rainfall at present circumstances. The figure captions will be extended to represent these clearly.

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2.2 ‘Trials’

Yes, they represent different (random, based on system time) seeds for the random number generator of the GA. However, the x-axis title should be changed as "Number of generations" (trials are represented by each different line). 10 Trials are done to test the robustness of the GA.

2.3 Staged approach vs. Static Design

Compared with ’do nothing’ option the total cost between staged and static designs are fairly small. At the currently anticipated rate of growth (population, rainfall) the latter difference in negligible. However, if the rates are larger than estimated, then there will be a distinct savings from a staged approach. Taken together with the flexibility offered by the staged approach, we consider this as a considerable advantage.

We revise the sentence (p. 1482 line 16/17)as follows: Then we present ... and show that due to significant flexibility offered by staged-design at no additional cost, it is indeed a better design paradigm compared to traditional “implement once and operate” sachems.

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