R1_0

The manuscript "Temporal downscaling of precipitation time-series projections to forecast green roofs future detention performance" presented by Pons et al. describes the procedure to simulate rainfall through multiplicative random cascades. Six downscaling models, with time-scale, depth, and temperature dependency, have been developed to simulate time-series based on RCP8.5 to be applied on two green roofs with different properties and in different locations in France and Norway. Two green roofs have been modelled. Results show that the green roof performance shift due to climate change highly depends on the location.

Although the manuscript presents an innovative methodology and interesting results, it needs few minor adjustments and modifications before publication in an international journal such as HESS.

Thank you for this comment, we appreciate your interest in our manuscript. Modifications will be done according to the reviewers' comments in order to improve the quality of the current manuscript.

R1_1

Green infrastructure, and in particular green roof, description could be more detailed in the introduction, explaining why green roofs have been chosen for this study and better highlighting the potential benefits of this work. Meaning and implications of RCP8.5 projections should also be included in the introduction.

We will add details about green infrastructure and green roofs. In particular, we will further highlight the necessity to model future performance of green infrastructure in consistence with the objectives of robust decision making and to achieve a resilient city from a stormwater management perspective.

The green roofs have been chosen to be modelled for 3 main reasons: *i)* green roofs are one of the various Nature Based Solutions to be further developed in the next decades to contribute to a more integrated and sustainable urban water management, and thus exploring how their design and performance may be affected by future climate conditions is of particular interest. The work presented in this paper is part of a more global research project dedicated to the evolution and transition from existing grey infrastructures (sewer pipes) to blue-green infrastructures (NBS, etc.) or mixed infrastructures for future urban water management at the city scale, *ii)* both retention and detention are key processes in the hydrologic behaviour of green roofs, which implies that the adequate and realistic modelling of detention requires minute resolution time-series, generated by means of the downscaling approach, and *iii)* given the extreme *in situ* tests we performed (Hamouz et al., 2020), it was possible to calibrate a highly reliable and fast model accurate for both low and extreme events, which was of particular interest for simulation of future climate.

About the potential benefits form this work in modelling future performance of green infrastructure, a paragraph about robust decision making and climate change adaption in the context of stormwater management will be added.

R1_2

The use of abbreviations should be reviewed: sometimes abbreviations are not introduced, or not used. An abbreviation and symbol list could help the reader.

The abbreviation will be reviewed, and a table as you suggest will be added in order to help the reader.

Abbrev.	Meaning	Change made	Reason
GI	Green infrastructure	-	-
MRC	Multiplicative Random Cascade	-	-
IDF curves	Intensity Duration Frequency curves	-	-

NVE	Norwegian Water Resources and Energy Directorate	-	-
MET	Norwegian Meteorological institute	-	-
S	Temporal coherence indicator at time-step i and time-scale $2j$	$S_{i,2j}$	Avoid confusion
d	Depth at time-step i and time-scale $2j$	$d_{i,2j}$	Avoid confusion
w	minimum weight at time-step step i and time-scale $2j$ from aggregation of time-step $\{2i, 2i+1\}$ at time-scale j	$w_{i,2j}$	Avoid confusion
S			-
MC	**MRC** model with only time**S**cale dependence	MRC_S	-
MCS	**MRC** model with time**S**cale dependence and **S**tochastic 2-**E**lement **P**ermutation	MRC_{S-SEP}	-
MCD	**MRC** model with time**S**cale and depth/**I**ntensity dependence	MRC_{SI}	-
$MCDS$	**MRC** model with time**S**cale, depth/**I**ntensity dependence and **S**tochastic 2-**E**lement **P**ermutation	MRC_{SI-SEP}	-
$MCDT$	**MRC** model with time**S**cale, depth/**I**ntensity and **T**emperature dependence	MRC_{SIT}	-
$MCDTS$	**MRC** model with time**S**cale, depth/**I**ntensity, **T**emperature dependence, and **S**tochastic 2-**E**lement **P**ermutation	$MRC_{SIT-SEP}$	-
PET	Potential EvapoTranspiration	-	-
AET	Actual EvapoTranspiration	-	-
SMEF	Soil Moisture Evaluation Function	Removed	Used once
E-Green roof	Extensive green roof	-	-
D-Green roof	Detention based extensive green roof	-	-
WC_i	Water content in the roof at time i	Not in table	Equation variable
P_i	Precipitation depth at time i	Not in table	Equation variable
Q_i	Discharge released by the roof at time i	Not in table	Equation variable
T_mean	Mean daily temperature	Not in table	Equation variable
C	Calibrated factor accounting for Crop factor and maximum storage capacity	Not in table	Equation variable
S_K	Smoothing factor	Not in table	Equation variable
K	Conductivity slope	Not in table	Equation variable
WC_K	Starting delay	Not in table	Equation variable
DREAM	**D**iffe**R**ential **E**volution **A**daptative **M**etropolis	Not in table	Used once
RCP8.5	Representative Concentration Pathway scenario with an 8.5 W/m2 radiative forcing in 2100	-	-
NSE	Nash Sutcliffe Efficiency	-	-
VM	Variational Method	-	-

Figure 1: Review example of the different abbreviations

R1_3

The paper is overall well structured, although it could benefit from a review to catch typos (double or missing spaces etc.)

We will review the manuscript in order to catch the typos.

R1_4

[Abstract] Please avoid unnecessary abbreviations in the abstract

Ok, unnecessary abbreviations will be removed from the abstract.

R1_5

[1, 9-10] Please add an explanation for this result

A synthetic explanation of this result will be added.

This is linked to local effect of climate change depending on cities. In general, in Norway the precipitation tends to increase, which leads to more frequent high values of initial conditions when a rain occurs. It thus tends to lead to a decrease of the capabilities of green infrastructure to manage stormwater under future conditions. In France the precipitation does not tend to increase while temperature increases. It leads to lower values of initial conditions in green infrastructure for day-to-day rain, which tends to increase their performance.

R1_6

[1, 14] What's a?

This typo will be fixed, sorry for the inconvenience (it should be 'a soil moisture evaluation function, and a crop factor'). Please also note that the two cited references on AET estimation equations are limited to the equations used in our model, other models can require more variables functions and data, which is beyond the scope of this paper.

R1_7

[1 ,15] Evaporation processes time-scale could be higher than 24 hours, please add a reference to this sentence.

This sentence refers to the data required to generate potential evapotranspiration estimates. Thornthwaite equation for instance can provide Daily or monthly estimate based on monthly temperature profile (Stovin et al., 2013). For the actual evapotranspiration, it is typical to use hourly (Stovin et al., 2013) or daily (Kristvik et al., 2019) precipitation values in the water balance solver. This information on daily data was mentioned here since future timeseries from euro-cordex are available at daily resolution which can be sufficient to estimate actual evapotranspiration. To avoid mis-interpretation, it will be clarified, and the sentence can be rewritten as follows: "In urban hydrology, typical time scales of processes are heterogeneous: from minutes to hours for rainfall, from hours to days for evapotranspiration".

R1_8

[1, 20-24] What is the temporal resolution of these data? daily scale?

Those data are available at daily scale, it will be clarified.

R1_9

[2, 40] Please use the previously introduced abbreviation MRC

The abbreviation will be used. As replied to comment R1_2, we will review the abbreviations and conduct a careful edit of the text to clarify their use.

R1_10

[2 ,45] Reference written twice

We will remove duplicate.

R1_11

[2, 54] What is MC? This abbreviation has not been introduced before

It refers to the 1st multiplicative random cascade model developed in this study which was introduced later. We will replace it by the general abbreviation MRC and clarify.

R1_12

[2, Introduction] Please consider adding some background for green infrastructures and in particular for green roofs.

It will be done, as detailed in reply to R1_1

R1_13

[3, 66] and in Marseille? what data are available?

In Marseille, similarly to Lyon data are available at 0.2 mm depth resolution with 6 -min time-step. It will be clarified. The rain gauge model, similar to the model in Lyon and most of the rain gauges used by Météo France, is a Précis-Mécanique tipping bucket rain gauge (1000 cm^2 and a tipping bucket of 0.2 mm capacity).

R1_14

[3, 69] Climate projections in France have the same temporal resolution and length of the Norwegian projections? please specify

The length of the timeseries depends on the climate model (GCM/RCM combination used to make available the timeseries from the EURO-CORDEX), some climate model only provides estimates until 2099. The lower boundary, 2071, was chosen at an earlier stage of the study to have a timeseries with similar length to the current timeseries and to focus on the last part of the century in order to apply it in a climate timeseries with a stronger shift in order to assess the robustness of the downscaling models. It was decided to use the same period for other locations. The time-scale is the same for all projections used in this paper: daily time-scale.

R1_15

[5, 100] The acronyms used here have not been introduced before

Indeed, they are introduced in the following sentence. Those are the names we decided to give to the different models. The table for acronyms will be provided and the paragraph will be clarified. A mentioned in R1_2, the name will be reviewed according to the table provided to clarify.

R1_16

[8, 170-174] This paragraph fits better in the model description

We agree that it could be debated were to place this paragraph. However, even though this model is a non-linear reservoir, its structure and calibration method (based on artificial rain) have not been introduced in previous paper. This is why the analysis of the model behaviour compared to the understanding of the green roofs from previous studies was presented in this section. Nonetheless the paragraph will be reviewed to clarify that the analysis is done by comparing the result of the validation period to the knowledge we have from previous field study; The sentence (l. 169) “The model is limited as it lumped processes and neglects dynamical effect: the wetting of the aggregates and substrate and the spatial distribution of water content within the roof (Hamouz et al., 2020).” does not depends on the results therefore can be moved.

R1_17

[9, Figure 2] Please include in the figure the green roof type

The green roof type will be added, and the figure will be improved.

R1_18

[9, 175-185] Consider adding the results related to all locations in the appendix, to help the reader understanding the results

We will add those results. More specifically, a new figure will be provided the appendix showing fig 3 a for all locations and fig 3 (b) for other locations and another scale (currently scale = 48 min). The authors agree that not only the location but also the scale might limit the understanding in the current manuscript.

R1_19

[17, Paragraph 3.5] It would be interesting to have some considerations also for the French case studies

The original objective of this part was to investigate the possible benefit of such a downscaling model from an application point of view. In the design perspective section, Trondheim was selected as one example among the 8 locations and linked to existing local guidelines. It is not our objective to proceed to the same application for the other cities, as in some of them, there are no detailed regulation or design rules for green roofs. For example, in Lyon, the stormwater regulation (dated 16 Dec. 2019) requires retaining the first 15 mm of rain and that, beyond these 15 mm, the maximum outflow from a parcel should be 3 L/s/ha, without indication of return period. In some specific areas in Greater Lyon with high risk of pluvial flooding, three levels are defined, corresponding to minimum 45, 55 and 70 mm of retention per event, or, respectively, lower retention if the infrastructure allows to manage the runoff for return periods of 5, 10 and 30 years. This Greater Lyon regulation remains unfortunately general, and no specific rule is directly suitable for the demonstration with a green roof that detain water. Indeed, the precipitation is delayed and attenuated but not permanently retained (except the evapotranspirated fraction which returns to the atmosphere).

Keeping the threshold defined in local guidelines for the city of Trondheim, the result using IDF curves for Lyon will be analysed and if it provides some relevant insight, it will be commented and added in appendix. In both case the choice of the location in this part will be clarified and discussed.

Bibliography

Hamouz, V., Pons, V., Sivertsen, E., Raspati, G. S., Bertrand-Krajewski, J.-L., & Muthanna, T. M. (2020). Detention-based green roofs for stormwater management under extreme precipitation due to climate change. *Blue-Green Systems*. https://doi.org/10.2166/bgs.2020.101

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Stovin, V., Poë, S., & Berretta, C. (2013). A modelling study of long term green roof retention performance. *Journal of Environmental Management*. https://doi.org/10.1016/j.jenvman.2013.09.026