Manuscript: HESS-2021-99

General notes:

The manuscript: "Advanced sensitivity analysis of the impact of the temporal distribution and intensity in a rainfall event on hydrograph parameters in urban catchments: a case study" proposed by Fatone et al., introduces a sensitivity coefficient to study the impact of the variability of hydrodynamic model parameters depending on rainfall distribution and intensity. Results, determined for a SWMM model of an urban catchment in Kielce (Poland), show the influence of rainfall distribution and intensity on the sensitivity factors

Although the paper is quite interesting and it has the potential to be published in HESS, it needs some minor adjustments.

Review 1

In particular, the novelty and innovative aspects of the work could be better highlighted in the abstract and introduction.

Comment 1

Thank you for your valuable comment. The abstract has been corrected to read: Knowledge of the variability of the hydrograph of outflow from urban catchments is highly important for measurements and evaluation of the operation of sewer networks. Currently, hydrodynamic models are most frequently used for hydrograph modeling. Since a large number of their parameters have to be identified, there may be problems at the calibration stage. Hence, the sensitivity analysis is used to limit the number of parameters. However, the current sensitivity analysis methods ignore the effect of the temporal distribution and intensity of precipitation in a rainfall event on the catchment outflow hydrograph. The article presents the methodology of construction of a simulator of catchment outflow hydrograph parameters (volume, maximum flow). For this purpose, uncertainty analysis results obtained with the use of the GLUE (Generalized Likelihood Uncertainty Estimation) method were used. A novel sensitivity analysis of catchment hydrodynamic models was also developed, which may find application in the analysis of the performance of sewer networks and underground infrastructure facilities. Using the logistic regression method, an innovative sensitivity coefficient was proposed to study the influence of variability of hydrodynamic model parameters depending on the temporal rainfall distribution, rainfall genesis (in the Chomicz scale) and uncertainty of the estimated simulator coefficients on the outflow hydrogram parameters. The developed model makes it possible to analyze the influence of identified parameters of the Storm Water Management Model (SWMM) on the outflow hydrogram taking into account local rainfall conditions, which has not been analyzed so far. Compared to the currently developed methods, the influence of uncertainty of identified coefficients in the logistic regression model on the results of sensitivity coefficient calculations was included in the analyses. So far, this aspect has not been taken into account in the methods of sensitivity analysis despite the fact that in this approach the reliability of simulation results is analyzed. The results indicated a considerable influence of rainfall distribution and intensity on the sensitivity factors. The greater the intensity and of rainfall, the lower the impact of the identified hydrodynamic model parameters on the hydrograph parameters. Additionally, the calculations confirmed the significant impact of the uncertainty of the estimated coefficient in the simulator on the sensitivity coefficients. The results obtained in the context of sensitivity analysis have a significant effect on the interpretation of the relationships obtained. The approach presented in the study can be widely applied at the model calibration step and for the appropriate selection of hydrographs for identification and validation of model parameters. The results of calculations obtained in the study indicate the advisability of including the rainfall genesis in the sensitivity analysis and calibration of hydrodynamic models, which results from different sensitivity of models for normal, heavy, and torrential rainfall types. In this context, it is necessary to first separate the rainfall data by genesis, for which the analyses, including the sensitivity analysis, and calibration will be performed. Bearing in mind the obtained results of calculations at the step of identification of hydrodynamic model parameters and their validation, it is necessary to take into account the rainfall conditions, as much smaller values of sensitivity coefficients have been found for the rainfall caused by heavy rainfall than for torrential rainfall. Considering the obtained values of sensitivity coefficients, model calibration should not include only the episodes of high rainfall intensity, which may lead to calculation errors at the step of model application in practical considerations (assessment of sewer network operation conditions, design of reservoirs, flow control devices, green infrastructure, etc.).

Also within introduction novelity and innovatine aspect of the work was highlighted. (line 124 – 127 and 150 – 156)

Review 2

Moreover, only the temporal rainfall variability is evaluated, without considering the strong connection with the spatial rainfall distribution, especially in a small urban environment (see Schilling, 1991, Berne et al., 2004; Ochoa-Rodriguez et al., 2015, Cristiano et al. 2017). This aspect should be at least discussed in the conclusions.

Comment 2

Thank you for your valuable comment. Indeed, the spatial distribution of rainfall has a strong influence on the parameters of the outflow hydrogram. In small urban catchments, the spatial distribution of rainfall has a negligible effect on the hydrogram, so it was not included in the present analyses. The spatial distribution of rainfall in the catchment is referred to in the introduction and summary.

Review 3

The methodology needs to be restructured. Elements like SWMM and the GLUE are described only at the end of the methodology section, while they should be moved to the introduction or in an additional section "Theoretical background" before the study case description.

Comment 3

Thank you for your valuable comment. As requested by the reviewer, the introduction refers to the introductory data regarding the GLUE method.

"To understand the modeled processes in urban catchments and to determine the influence of the interactions between identified parameters on simulation results, uncertainty analysis (GLUE - Generalized Likelihood Uncertainty Estimation) is performed. This method is widely used in the analysis of stormwater quantity and quality for models of urban catchments, agricultural catchments (Dotto et al. 2012, Mirzaei et al. 2015), storage reservoirs (Kiczko et al. 2018), wastewater spillage (Fraga et al. 2016), etc., which is confirmed by a large number of studies in this field. In this approach, the empirical distributions of parameters identified in hydrodynamic models (e.g., catchment retention, roughness coefficients of impervious and pervious areas, channels, etc.) as well as a confidence interval (e.g., 95%) are determined, including the data obtained from measurement results".

"Despite the limitations of the local sensitivity analysis method and the complex implementation of global sensitivity analysis, in both cases, the aspects related to local rainfall conditions are considered to a limited extent. Recent studies of urban catchments indicate that the temporal and spatial distributions of rainfall are very important factors that strongly influence the catchment response (Schilling, 1991, Berne et al., 2004; Ochoa-Rodriguez et al., 2015, Cristiano et al. 2017). However, a number of issues have not been fully clarified. The current methods ignore the influence of rainfall genesis on the results of sensitivity analysis. It is not clear how the model sensitivity (maximum flow, hydrogram volume) changes for rainfall events resulting from high (convective) or low (low) intensity rainfall. The LSA and GSA methods ignore the influence of the temporal distribution of rainfall on the sensitivity coefficients, which is contrary to the literature (Schilling 1991) performed for various urban catchments. This is important, from the point of view of selecting catchment outflow hydrograms for parameter identification and validation in the context of rainfall conditions (rainfall genesis, rainfall intensity, temporal distribution). It is also of great methodological importance in the context of modifying the currently used methods for sensitivity analysis of catchment hydrodynamic models. In the methods of sensitivity analysis based on statistical models, the influence of uncertainty of estimated coefficients on sensitivity coefficients is neglected. From the point of view of reliability of the obtained analysis results, it is important when deciding on the choice of the method of parameter identification in hydrodynamic models (GIS, maps, etc.) in order to reduce the uncertainty of simulation results''

Review 4

The sections Methodology and Results would benefit from a short intro describing the structure of the section, to guide the reader.

Comment 4

Thank you for your valuable comment. The methodology includes a description that discusses the subdivision of the manuscript. "Due to the extensive nature of the analyses carried out, the manuscript has been divided into several sections covering: characteristics of the object of study; methodology, which presents an innovative algorithm for the construction of a logistic regression model and subsequent computational steps, i.e. determination of the hydrodynamic model of the catchment, identification of the threshold values of hydrogram parameters of catchment outflow by means of the hydrodynamic model, uncertainty analysis by means of the GLUE method, development of the logit model and verification, analysis of the influence of rainfall genesis and temporal distribution of rainfall on the calculated sensitivity coefficients, and assessment of the influence of uncertainty of identified coefficients in the logit model on the values of sensitivity coefficients".

"The developed methodology for sensitivity analysis of hydrodynamic models includes several independent steps, which include: preparation of data for model development and model performance, conducting uncertainty analysis by GLUE method, development of a logit model for certain threshold values of hydrogram parameters and model verification, calculation of sensitivity coefficients considering rainfall genesis, temporal distribution of rainfall, evaluation of the effect of uncertainty of the identified coefficients in the logit model has the results of sensitivity analysis".

Review 5

The manuscript is overall clear; however, it would benefit from a native speaker revision to improve the English quality.

Comment 5

Thank you for your comment. The manuscript has been proofread by a specialized language proofrading service (AJE).

Review 6

Title: I'd suggest rephrasing and shortening it. Otherwise, at consider adding "…the temporal distribution and intensity OF PRECIPITATION in a…." and removing ": a case study".

Comment 6

Thank you for your valuable comment. The article title has been modified.

Review 7
Abstract: The aim and the novelty of the work could be better highlighted in the abstract. Please avoid unnecessary abbreviations in the abstract.

Comment 7
The abstract has been modified.

Review 8
[2,3] “there is the need to model the runoff generation”
[2, 52] “As shown in the literature (…), the analysis…”

Comment 8
Thank you for your comments. Language corrections were made in the manuscript.

Review 9
[Introduction] consider to add a short paragraph that describes the structure of the paper with the aim to better guide the reader.

Comment 9
Thank you for your valuable comment. In the introduction, a brief paragraph was included to describe the layout and content of the manuscript. “Due to the extensive nature of the analyses carried out, the manuscript has been divided into several sections including: characteristics of the study object; methodology, which presents the innovative algorithm for the development of the logistic regression model and subsequent computational steps i.e. determination of a hydrodynamic model of the catchment, identification of the threshold values of hydrogram parameters of outflow from the catchment by means of the hydrodynamic model, uncertainty analysis by the GLUE method, development of a logit model and verification, analysis of the influence of rainfall genesis and temporal distribution of rainfall on the calculated sensitivity coefficients, assessment of the influence of uncertainty of the identified coefficients in the logit model on the values of sensitivity coefficients”.

Review 10
[5, Methodology]: please check the section numbers

Comment 10
Thank you for your comment. The numbers of the sections have been corrected.

Review 11
[5,137]: Please add a reference and motivation for this choice. Why 4 h has been chosen as threshold for independent events?

Comment 11
Thank you for your comment. The literature on the identification of independent rainfall events in rainfall time series has been completed (Dunkerley 2008; Joo et al. 2014).

Dunkerley D., (2008). Identifying individual rain events from pluviograph records: a review with analysis of data from an Australian dryland site, Hydrol Processes, 22, 5024-5036.
Joo, J., Lee, J., Kim, J.H., Jun, H., Jo. D.: Inter-Event Time Definition Setting Procedure for Urban Drainage Systems, WATER, 6, 45 – 58, https://doi.org/10.3390/w6010045, 2014.

Review 12

[5, 42] Info regarding the length of the dry period is already mentioned in section 2. Please restructure this part and put all the data regarding the study case in Section 2, and leave only the methodology description in Section 4.

Comment 12
The data for independent rainfall events and the dry period were separated, i.e., methodology and results.

Review 13
[6, 164] No need to repeat Storm Water Management Model

Comment 13
The comment was introduced in the manuscript.

Review 14
[7, 165] Sentence not clear. Please rephrased it.

Comment 14
The suggestion was introduced in the manuscript.

Review 15
[7, 171] GLM is defined only in page 9, line 214. Please add here the extended name.

Comment 15
Thank you for your comment. GLM - Generalized Likelihood Model

Review 16
[8, 172] The GLUE is well described only in Section 4.5. Here it is mentioned as abbreviation without description before. Please fix this issue and refer to section 4.5 and to some references for a description.

Comment 16
Thank you for your comment. In the current version of the manuscript, the GLUE method is described in the introduction (line 74 – 80) and the sections where the methodology is described (Section 3.6).

Review 17
[17, 387-389] I assumed these lines are related to the table? In case, please include them in the caption (and rephrase them).

Comment 17
Thank you for your valuable comment. It has been implemented in the manuscript.

Review 18
[Methodology, 5.4] please avoid brackets in the titles of the subsections.

Comment 18
Thank you for your valuable comment. It has been implemented in the manuscript.

Review 19
[23, 516] representS

Comment 19

Thank you for your valuable comment. It has been implemented in the manuscript.

Review 20

[23, 516-517] why? Please justify this sentence

Comment 20

The original sentence was: "It is necessary to search for methods that will yield reliable results reflecting the reality as well as possible on the one hand." to make it clear we rephrased it:

"It is necessary to search for the methods that will yield reliable results reflecting the reality as well as preserve the physical interpretation of its equations and parameters".

Review 21

[Conclusions] Please add in the first paragraph of this section the motivation and the questions that this study aimed to answer, and include a discussion about the possible limitations, impacts and possible improvements.

Comment 21

Thank you for your comment. The following paragraph was added in Conclusions: "The computational methodology proposed in the manuscript is universal and can be applied to any urban catchment. The simulation results presented in this paper refer to a single catchment. Therefore, further analyses are advisable to verify the model for the catchments with different physical and geographical characteristics. Thus, it is advisable to determine the scope of applicability of the developed computational model. Considering the usefulness of the obtained relations and the great influence of rainfall genesis and temporal distribution of rainfall on the sensitivity coefficients, further studies are necessary. The purpose of these analyses is to extend the developed methodology of sensitivity analysis to additionally take into account the shape, area of the catchment, type of development, path of the sewer network, retention of the sewer network. The analysis of the effect of temporal distribution of rainfall, together with the spatial distribution, seems to be a particularly interesting issue, especially that both distributions strongly depend on the rainfall genesis. However, the design of an appropriate experiment seems challenging".

References:

Berne, A., Delrieu, G., Creutin, G., and Obled, C.: Temporal and spatial resolution of rainfall measurements required for urban hydrology, J. Hydrol., 299, 166–179, https://doi.org/10.1016/j.jhydrol.2004.08.002, 2004.

Cristiano, E., ten Veldhuis, M.-C., and van de Giesen, N.: Spatial and temporal variability of rainfall and their effects on hydrological response in urban areas – a review, Hydrol. Earth Syst. Sci., 21, 3859–3878, https://doi.org/10.5194/hess-21-3859-2017, 2017.

Ochoa-Rodriguez, S., Wang, L., Gires, A., Pina, R., Reinoso- Rondinel, R., Bruni, G., Ichiba, A., Gaitan, S., Cristiano, E., Assel, J., Kroll, S., Murlà-Tuyls, D., Tisserand, B., Schertzer, D., Tchiguirinskaia, I., Onof, C., Willems, P., and ten Veldhuis, A. E. J.: Impact of Spatial and Temporal Resolution of Rainfall Inputs on Urban Hydrodynamic Modelling Outputs: A Multi- Catchment Investigation, J. Hydrol., 531, 389–407, 2015.

Schilling, W.: Rainfall data for urban hydrology: What do we need?, Atmos. Res., 27, 5–21, 1991.

Manuscript: HESS-2021-99 https://hess.copernicus.org/preprints/hess-2021-99/hess-2021-99.pdf

General notes:

Review of the manuscript: “Advanced sensitivity analysis of the impact of the temporal distribution and intensity in a rainfall event on hydrograph parameters in urban catchments: a case study” by Fatone et al.

This manuscript assesses an interesting and pertinent topic. The research proposes a method to determine a novel sensitivity coefficient to assess the variability in hydrodynamic model outflows for calibration purpose based on rainfall intensity and distribution as well as the uncertainty in model parameters. The analysis is based on the application of a SWMM model of the southeastern part of the city of Kielce (Poland). The authors provided an extensive literature review of their topic and methodology, and systematically compared their results to previous works, which add a broader perspective on their research results and increased the value of their results.

I recommend the publication of this paper in HESS, however, some improvements in the manuscript structure and discussion as described below could help improve its quality and clarity.

Additionally, the paper should be reviewed thoroughly by a Native English speaker in order to improve its style and clarity. I am not a native English speaker, but below are some adjustments I do suggest.

Review 1

Be more specific on how your results can improve real-world applications of hydrodynamic models in order to further highlight the benefits of your results in the field of hydrodynamic modeling.

Comment 1

Thank you for your valuable comment. The following fragment was introduced into manuscript: “The original version of the manuscript has been modified. The results of the calculations obtained in this paper indicate the desirability of including rainfall genesis in the sensitivity analysis and calibration of hydrodynamic models, which results from the different sensitivity of models for normal, heavy, and torrential rainfall types. In this context, it is necessary to first divide the rainfall data by genesis, for which analyses – including sensitivity analysis and calibration – will be performed. Bearing in mind the obtained results of calculations at the stage of identification of hydrodynamic model parameters and their validation, it is necessary to take into account the precipitation conditions, as much smaller values of sensitivity coefficients have been found for heavy rainfall than for torrential. Considering the obtained values of sensitivity coefficients, model calibration should not include only the episodes of high rainfall intensity, which may lead to calculation errors at the step of model application in practical considerations (assessment of sewer network operation conditions, design of reservoirs, flow control devices, green infrastructure, etc.).”

Review 2

Study object: Can you be more specific on how the water is flowing in your SWMM model, i.e. water from pervious area flow toward impervious area or is it the contrary?

Comment 2

Stormwater runoff is modeled independently for impervious and pervious areas. The total outflow from the catchment to the sewer nodes is the sum of the flow for the impervious and pervious areas. Specific information was added into manuscript in lines 369-371.

Review 3

Regarding the sensitivity of the model sensitivity coefficient to the rainfall spatial distribution and intensity; the section 4.2 (p. 6) describes well the first aspect, but the method describing how the rainfall intensity was assessed only come later.

Comment 3

The manuscript details aspects related to the description of the influence of rainfall genesis and mean rainfall intensity on the results of the sensitivity analysis. "Sumner's classification is universal in its nature and – like the Chomicz classification – it expresses the qualitative relationship between the category of rainfall and its intensity. Hence, belonging to the appropriate rainfall class can be associated with the average rainfall intensity. The rainfall classes at the Sumner scale determine the extremely different hydraulic conditions prevailing in the stormwater network, which may not always be used in practice for measurements and calibration. In the case of the Chomicz classification, a number of rainfall categories were introduced, ranging from normal to heavy rain and ending with torrential rain. This approach makes it possible to identify the operating conditions of the stormwater network and facilities located in it, taking into account the rainfall data, i.e., rainfall duration (t_r) and rainfall depth (P_{tot}) within the appropriate range of variability. This is important because it enables the identification of the average intensity of rainfall ($i=P_{tot}\cdot t_r^{-1}$) as a parameter connected with the operation of the stormwater system, which can be associated with runoff from the catchment and hydrograph parameters (volume and maximal flow rate).

In the present study, the reference rainfall values determined at the regional classification scale proposed by Chomicz (1951) were the basis for the selection of threshold values (maximum instantaneous flow and hydrograph volume) in accordance with the following equation:

$$P_{tot} = U = \alpha_0 \cdot \sqrt{t_r} \quad (1)$$

where t_r is the rainfall duration, P_{tot} is the rainfall depth equal to its efficiency, and α_0 is the rainfall efficiency coefficient taking into account the normal, heavy, and torrential rain types.

Based on the Chomicz (1951) classification of rainfall, outflow hydrographs were calculated, their parameters (Q_m and V) were determined, and classification variables were defined. The outflow hydrographs and their parameters (volume and maximum flow rate) were calculated for the set values $P_{tot} = f(t_r, \alpha_0)$, which matched the assumed categories of rainfall and the temporal distribution of rainfall in the rainfall episode".

Review 4

Can you review the structure of the text to present how the variability of the different rainfall parameters are taken into account and compared closer together? Maybe you could start by presenting the general methodology applied, and then be more specific in each section.

Comment 4

The following sections discuss the subsequent computational steps: "In the deterministic solution, the values of the sensitivity coefficients (S_{xi}, where: x_i is α, n_{imp}, d_{imp}, n_{sew}) are calculated from equation (4) for the successive parameters included in the calibration in the SWMM model for the assumed rainfall characteristics (section 5.1), the temporal distributions of rainfall and the boundary values of xi set in such a way that p = 0.50. For the solution taking into account the uncertainty of the estimated coefficients in the logistic regression models, the values of the sensitivity coefficients are also calculated from equation (4). In addition, the error of the estimated coefficients (standard deviation) is taken into account and MC simulations are performed for subsequent parameters included in the calibration, sensitivity coefficients are calculated and empirical distributions are determined."

Review 5

Can you explain why the pervious coefficients had smaller impact on the results and were not calibrated?

Comment 5

To explain mentioned issue the following fragment was introduced into manuscript: "Computer simulations (Szeląg et al. 2016) conducted using the considered catchment model (SWMM) integrated with MATLAB, in which the GLUE + GSA method was implemented (involving global sensitivity analysis and uncertainty analysis), indicated that the Horton model parameters, retention depth and Manning's roughness coefficient of pervious areas have a negligible effect on the modeled catchment outflow hydrogram. These results were also confirmed through the simulations carried out by other researchers (Thorndahl. 2009; Fu et al. 2011; Fraga et al. 2016) for urban catchments in Belgium, Great Britain, Italy, etc. using the methods of local and global sensitivity analysis. These results were also confirmed by the analyses conducted by Zawilski (2010) and Mrowiec (2009) for the catchments in Poland. The dependencies between the parameters calibrated in SWMM and the modeled outflow hydrogram parameters are complex and depend on numerous factors, i.e. spatial distribution of impervious areas, geometry and retention of the stormwater network, catchment surface etc. (Razavi and Gupta, 2015). Due to the catchment size, limited outflow from pervious areas in relation to the impervious areas (Szeląg et al. 2016, as well as the Manning roughness values and retention of impervious area showed their negligible impact on the catchment outflow hydrogram compared to the remaining parameters calibrated in SWMM"

Review 6

Can you move the section 4.6 closer to the case study section as those two are related.

Comment 6

Thank you for your comment. The hydrodynamic model section has been moved closer to catchment characteristics.

Review 7

Can you further discuss why the parameters sensitivity varies from one SWMM parameter to the other according to the type of rainfall distribution (Fig. 4. e)-h)

Comment 7

To discuss mentioned issue the following fragment was introduced into manuscript: "The curves in Fig. 4e-4h show that apart from the rainfall origin (average rainfall intensity as a result of normal, heavy, and torrential rainfall), the temporal distribution of rainfall has an impact on the values of the determined sensitivity coefficients. This result is the effect of the fact that the temporal distribution of rainfall and the intensity of rainfall have a significant impact on the values of the modeled maximum flow rates, which was confirmed by the analysis by Schilling (2011). The obtained curves (Fig. 5) prove that the volume of the outflow hydrograph depends on the origin of rainfall and hence the variability of the determined values of the sensitivity coefficients for normal, heavy and torrential rainfall."

Review 8

Usually, modelers should calibrate hydrodynamic models for rainfall events that are relevant to the water management/design problems that the model will be applied to solve. For instance, if the model is used to simulate intense rainfall events for pipe design, the calibration should take into account these types of events. How your results relate to the type of rainfall events that will be used in modeling applications? In other words, are your results more relevant for hydrodynamic models calibrated with less intense rainfall events, such as those used in the design of green infrastructure and/or for simulation work based on more intense rainfall events such as those used in the design of pipe diameter or storage tank volume? Can you develop on real-world applications in your discussion or conclusion?

Comment 8
To discuss mentioned issue the following fragment was introduced into manuscript: "The analyses performed in this work showed that the origin of rainfall and the temporal distribution of rainfall in the event have a large impact on the sensitivity of the model. However, this aspect has been neglected until now in sensitivity analytical methods. The results of the calculations showed that the lowest values of the sensitivity coefficients were obtained for the outflow hydrographs resulting from heavy rainfall, while the highest values of the sensitivity coefficients were obtained for normal rain. In the context of the currently used methods of sensitivity analysis and calibration, it seems advisable to modify them by introducing an additional calculation step consisting of the classification of the measured rainfall data in terms of the origin of rainfall (accounting for average rainfall intensity) and the temporal distribution of rainfall. For this purpose, it is possible to use unsupervised machine learning methods (e.g., hierarchical cluster analysis, Kohonen neural networks, etc.). In the context of the obtained calculated results, it is advisable to select the rainfall-runoff events for calibration and validation in such a way that the determined sensitivity coefficients do not show significant variability. It is important for the appropriate selection of the values of calibrated parameters and their potential correction at the stage of model validation."

Review 9
[1, 24-25] In the abstract, you use the term "greater the intensity and temporal distribution of rainfall". What do you mean by greater temporal distribution?

Comment 9
Thank you for your comment. It has been introduced in the manuscript.

Review 10
[2, 40-50] Introduction: This paragraph presents some redundancies and could be shortened.

Comment 10
We tried to make the introduction clearer, but addressing other reviews, we failed in shortening it.

Review 11
[4,101] Study object: Rename the section as "Case study".

Comment 11
The comment was implemented in the manuscript.

Review 12
[9, 207] All rainfall events are 15 minutes in duration? It seems short even for small catchment. Can you justify this choice?

Comment 12
Assuming the rainfall intensity values corresponding to normal ($P_{tot,u}$=3.7 mm), heavy ($P_{tot,m}$=5.8 mm), and torrential ($P_{tot,g}$=21.9 mm) rain, the outflow hydrographs were determined for t_r=15 min; the Q(t) values were determined with at 10s resolution. "The abovementioned assumption is made because the area under consideration is a small urban catchment, where the time of stormwater runoff is relatively short, and the stormwater retention time is limited due to the significant slope in the channels, reaching 3.9%. Moreover, the stormwater system model is simplified and limited to the main channels. In the context of the adopted assumptions (catchment retention resulting from land development and topography), the value of the rainfall duration (t_r = 15 min) theoretically including the concentration time, the pipe retention time seems to be representative for small urban catchments, considering that the measure of the influence of rainfall origin on the model sensitivity is primarily to be differentiated by the mean intensity of rainfall (Meynink and Cordery, 1976; Watt and

Marsalek, 2013; Krvavica and Rubinić, 2020). Appropriate selection of the duration of rainfall and classification of rainfall for calculation purposes may result from the local rainfall parameters and the climatic conditions shaping the dynamics of rainfall-runoff processes”. Marked by “” fragment was introduced into manuscript.

Review 13, 14, 15
[14, 344] Can you further explain this sentence: “The poorer performance for 30 July 2010 results from the bias of the model output, whereas the maximum stormwater flows were predicted correctly”.

[1, 26-28] In the abstract, please reformulate and clarify this sentence (maybe use two sentences): “Additionally, the calculations confirmed the significant impact of the uncertainty of the estimated coefficient in the simulator on the sensitivity coefficients, which has a significant effect on the interpretation of the relationships obtained. ‘’

[2, 33] Introduction: “[...] there is a need to runoff model.” Replace by something like “there is a need to apply runoff models”.

Comment 13, 14, 15
Thank you for comments. They have been included in the manuscript.

Review 16
[3, 85] Introduction: Please add the word “and” in the parenthesis: “(maximum instantaneous flow, hydrograph volume)”.

Comment 16
Thank you for your comment. It has been implemented in the manuscript.

Review 17
[3, 90] Introduction: Change paragraph when starting the sentence “Summing up, […]”

Comment 17
Thank you for your comment. Changes has been implemented in the manuscript.

Review 18, 19
[5,116] Study object: Use a hyphen to presents the Manning coefficient range rather than using the symbol of division. Please review as other division signs were found later in the text.

[5,142] Same as above. Change the symbol ”÷” for “-“ when presenting a range of values.

Comment 18, 19
Thank you for your comment. It has been implemented in the manuscript.