Urban Flood Prediction and Modelling

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ABSTRACT: The importance of the acquaintance of cutting edge PC innovation with configuration, examination, operation and control of sewer frameworks amid downpour is investigated. With new instruments come new essential ideas and new designing criteria for execution. The most critical advancements are: the ability to compute surcharging and flooding, instead of simply identifying with funnel limit execution criteria; the capacity of figuring long arrangement of downpour record so as to determine legitimate measurements on the contamination load on nature; lastly the capacity of powerfully controlling the framework progressively keeping in mind the end goal to diminish the contamination load by streamlining of the utilization of capacity at downpours littler than the outline downpour, without expanding the danger of surges. The use of models to reinforce examination of wastewater aggregation structures and headway of outlining decisions to address existing and future needs can give huge focal points. These focal points may consolidate paramount capital and operational venture stores, and more altogether a confirmation that any courses of action completed will perform the concentrated on destinations. Understanding the execution of a wastewater social affair system, including recognizing confirmation of issues and the related purpose behind each issue incorporates various capricious methods which are uncommonly instinctive and variable.

KEYWORDS: GIS analysis, Model Build Analysis, Flood modelling; overland flow; storm sewer Model validation analysis pluvial flooding; urban drainage.

1. INTRODUCTION

The Romans could fabricate and oversee noteworthy water driven frameworks, regardless of various pressure driven misguided judgments. These included structures for the seepage of complete sewerage which was another idea got from the need to stay away from pestilences of water borne ailments, not an auxiliary advancement. In any case, the information of fundamental water power has enhanced essentially since the Romans. Truth be told, through the rest of a century ago the essential ideas for the outline of urban sewers formed into configuration methods that stood the test of time and practice until just two decades back, when the advanced PC innovation presented totally new potential outcomes. We are as yet pondering the new devices during the time spent building up the enduring ideas on which to base new principles of practice for the configuration and operation of urban sewer frameworks. In spite of the fact that the foundations of depleting populated ranges can be followed back to the old Mesopotamian Empire, advanced urban seepage ideas have their beginning in the eighteenth and nineteenth century as the huge urban areas in Europe was undermined by pestilence plagues because of inadequate waste and wastewater transfer. Three fundamental goals brought on the working of sewer frameworks and those three destinations are still the essential standards to be watched today (Butler and Davies, 2004)

a. Protection from sanitary risks in urban areas by providing acceptable hygienic circumstances
b. Flood protection
c. Prevention from receiving water pollution

1. In addition to that three main objectives design and building of sewer systems of course also has to be sustainable and cost-effective.

2. Because urban areas and human activity have an impact on the natural water cycle two types of runoffs have to be handled by drainage systems: (1) wastewater – water that has been polluted for domestic or industrial use and (2) storm water – water from rainfall (or another type of precipitation) that has been fallen on urban areas and is (at least
partly) polluted due to its contact with the catchment surface and the human activity in the urban areas. Two different concepts of sewer systems ensuring the drainage from urban areas are

a. Separated sewer systems (SSS) in which wastewater and stormwater is drained separated in different sewer pipes
b. Combined sewer systems (CSS) in which wastewater and stormwater is drained together in the same sewer pipes

Due to the complexities of wastewater collection system hydraulics and the myriad of variables which can impact system performance, appropriate application of models can be essential to the development of cost effective solutions which will achieve targeted goals. In fact the highest potential of generating capital and operational savings that has been polluted for domestic or industrial use and (2) stormwater – water from rainfall (or another type of precipitation) that has been fallen on urban areas and is (at least partly) polluted due to its contact with the catchment surface and the human activity in the urban areas.

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II. AIM AND SCOPE

This Paper has two main purposes: The first objective is the analysis of commonly used urban drainage models from different application areas with respect to their behaviour due to different sources of uncertainties. The methodologies presented should assist model users and model developers to gain a deeper insight to model performance, identify relevant calibration parameters, and estimate possible model uncertainties and their impact on model results and to appraise a model’s simulation results with taking into account model uncertainties. The second objective is to demonstrate how model calibration in practical model applications can reduce model uncertainties. Additionally the question which data is necessary for reasonable model calibration is covered with taking into account impact of duration of measurement campaigns, location of measurement sites in a spatially

III. RELATED WORK

(Kleidorfer et al., 2009b) deals with uncertainties due to data availability for calibration of a conceptual sewer model. In addition to all sources of uncertainties in data collection due to the measurement methods itself, it is a key question which data has to be collected to calibrate a hydrological model, how long measurement campaigns should last and where that data has to be collected in a spatial distributed system as it is neither possible nor sensible to measure the complete system characteristics. In this paper we address this question by means of stochastic modelling. Using Monte Carlo Simulation different calibration strategies (selection of measurement sites, selection of rainfall-events) and
different calibration parameters (overflow volume, number of overflows) are tested, in order to evaluate the influence on predicting the total overflow volume of the entire system. This methodology is applied in a case study with the aim to calculate the combined sewer overflow (CSO) efficiency. It can be shown that a distributed hydrological model can be calibrated sufficiently when calibration is done on 30% of all existing CSOs based on long-term observation. Event based calibration is limited possible to a limited extend when calibration events are selected carefully as wrong selection of calibration events can result in a complete failure of the calibration exercise.

(Kleidorfer et al., 2009a) deals with impact of input–data uncertainties on urban stormwater models and with sensitivity of model parameters to input–data. It has been recognised that often more than one set of calibration parameters can achieve similar model accuracy. A probability distribution of model parameters should therefore be constructed to examine the model’s sensitivity to its parameters. With increasing complexity of models, it also becomes important to analyse the model parameter sensitivity while taking into account uncertainties in input and calibration data. In this study a Bayesian approach was used to develop a framework for quantification of impacts of uncertainties in the model inputs on the parameters of a simple integrated stormwater model for calculating runoff, total suspended solids and total nitrogen loads. The framework was applied to two catchments in Australia. It was found that only systematic rainfall errors have significant impact on flow model parameters. The most sensitive flow parameter was the effective impervious area, which can be calibrated to completely compensate for the input data uncertainties. The pollution model parameters were influenced by both systematic and random rainfall errors. Additionally an impact of circumstances (e.g. catchment type, data availability) has been recognised.

(Dotto et al., submitted) presents a Bayesian approach for performance evaluation of stormwater models based on long-term high-resolution measurement data. Therein two rainfall / runoff models (MUSIC and KAREN) and two stormwater quality models (Regression model and Buildup-washoff model) with different level of complexity (number of processes covered, number of parameters involved in the simulation process) are compared. The models are tested with a comprehensive quantitative and qualitative dataset collected in urban stormwater systems at five sites of different landuse in Melbourne, Australia. Sensitivity analysis was carried out using a Bayesian approach. Essentially this investigation aimed to answer: (a) How do these models reproduce the measured data, i.e. the catchments’ responses? (b) How sensitive are these models to their parameters? (c) What is the impact of catchment characteristics (land-use) on parameter sensitivity? By answering these questions this study provides insights on model choice, parameter significance and correlation. The rainfall/runoff models tested performed very similar suggesting that a simple model may be used for urban catchments without compromising the results. The effective impervious fraction is the most important parameter in both models and special attention should be paid to its value. Even with the robust calibration and parameter sensitivity approach used here, the water quality models tested, poorly represent reality and result in a high level of uncertainty. The study developed was very important to verify the efficiency of the calibration and sensitivity analysis approach. The method presented seems to be promising in terms of generating the posterior parameter distributions and also gives some valuable information on parameter interaction.

(Kleidorfer et al., 2009c) deals with “long-term prediction uncertainties” which occur when trying to predict long-term environmental change effects (e.g. landuse, climate, population). Design and construction of urban drainage systems has to be done in a predictive way, as the average lifespan of such investments is several decades. The design engineer has to predict many influencing factors and scenarios for future development of a system (e.g. change in land use, population, water consumption and infiltration measures). Furthermore, climate change can cause increased rain intensities which leads to an additional impact on drainage systems. In this paper the behaviour of different performance indicators of combined sewer systems is compared when taking into account long-term environmental change effects (change in rainfall characteristics, change in impervious area and change in dry weather flow). By using 250 virtual case studies this approach is - in principle - a Monte Carlo Simulation in which not only parameter values are varied but the entire system structure and layout is changed in each run. Hence, results are more general and case-independent. For example the consideration of an increase of rainfall intensities by 20% has the same effect on the investigated performance criteria as an increase of impervious area of +40%. On the other hand such an increase of rainfall intensities could be compensated by a reduction of impervious area by 30% (e.g. by infiltration measures).
IV. ARCHITECTURE

Fig Typical Urban Forecasting System

IV. PROPOSED SYSTEM MECHANISM

3.1 Network Definition - Determine network extent
To determine the extent of the sewer system to be modeled, the catchment boundary must first be defined. The sewer system database and background mapping shall be loaded into DM and a large scale plan covering the complete catchment shall be plotted. At this stage the location of all known overflows, bifurcations, Pumping Stations, Inverted Siphons, other hydraulically important ancillaries and known hydraulic deficiencies, such as flooding, within the catchment shall be identified and marked on this plan. Soil types should also be indicated to avoid the possibility of mixing 2 or more soil types within the same contributing area.

3.2 Network Data Clean Up
The modelled network should be divided into a series of long sections using GIS tool. These long sections shall be defined and numbered consecutively in a logical order to ensure that none are missed. All long-sections shall be produced and stored in the appropriate directory. The depth of flooding should be evaluated from the predictions of volume and area. Where possible, the location and/or frequency of flooding should be verified by reference to flooding reports.

3.3 Identify Ancillary Structures
Before cleaning up long sections, ancillary structures such as overflows, bifurcations, pumping stations and inverted siphons should be identified. These may appear to give rise to anomalies in long sections with steps up at pumping stations, possible steps up at overflows and bifurcations. Long section traces through the overflows, and dips in the long section may be evident and if the long section traces through an inverted siphon. Defining the extent of the network and the contributing areas that are to be included in the model.

3.4 Cover Levels
Cover levels can often also be derived approximately from sewer record plans by looking for benchmarks, road spot levels or manholes from other systems located nearby. Where no information is available, cover levels shall be derived based on the assumption of a uniform gradient between known locations. Cover levels shall not be interpolated in at flooding.

3.5 Invert Levels
The long sections allow negative gradients or steps upward in invert levels to be easily identified. Missing invert levels can sometimes be derived from alternate databases due to the way in which different databases store information. For
manholes where no invert levels can be found directly, levels shall be derived based on the assumption of equal soffit levels in the first instance and a uniform gradient between known locations. Care is required to identify where backdrops occur, as they may not be correctly shown in the sewer manhole database.

3.6 Catchment Asset Parameters
Catchment asset parameter inputs are handled will depend on two factors. One is the data available and the format that is in i.e. GIS, database or other. The second is the model build/modelling package to be used.

3.7 Population derived flows
Domestic dry weather flow will generally be assigned using population estimates. The preferred method of assigning population would be by using postcode centroid data and postcode address point data. The postcode centroid data contains details of the number of properties assigned to the postcode and the average occupancy.

3.8 Commercial Flows.
An additional column again

3.9 Infiltration
where levels of infiltration into the system are significant seasonal variations should be investigated. Long-term flow data can be used to investigate the seasonal and rainfall induced variations in infiltration.

3.10 Rainfall Profile Indices
This section describes two methodologies for defining rainfall profiles. The rainfall profile field must then be populated based on the numbering of the rain gauge profiles within the rainfall files and software used to model the system.

3.11 Headloss Coefficients
Secondary headlosses within a sewerage system are primarily caused by changes and losses of momentum due to changes in direction within the vertical and horizontal plane. An approximation for headloss coefficients shall be automatically calculated based on the angle of approach of the incoming and outgoing pipes to each manhole in the modelled network.

3.12 Additional Manhole Storage
During the simplification from full catchment to modelled network, manholes are removed from the modelled network. These manholes, and the pipes, gullies and house connections associated with them, provide a volume of storage during surcharging which must be represented to model.

3.13 Sediment Depth and Pipe Roughness
It is important that the hydraulic effect of sediment, blockages, root intrusion, and high roughness is correctly represented in the model. They directly affect the capacity of the network and will influence the frequency of surcharging, flooding and CSO operation. Sediment depths and pipe roughness can be derived from the results of a CCTV survey and in sewer flow survey.

3.14 Flood Types
Flood type 1 is generally applicable to surface water and combined systems. Flood type 2 is generally applicable to foul systems, where floodwater is assumed to enter an adjacent surface water system. It may also be applied to combined and surface water systems where it is known that the topography is such that flood water will not return to the system network. For storm system generally flood type would be the lost and for foul system flood type stored would prefer and for combined flood type storage generally used in the modelling. To accurately predict flooding the model must take account of the point at which the effluent will leave the sewer system. This may be lower than the cover level of the manhole at the upstream of the sewer length. Individual commercial properties are usually metered. If this data is available in GIS format then the total average daily commercial flow in each contributing area can be found and entered in the additional foul flow. This additional flow will have the same diurnal pattern assigned the population generated flow. If population has been assigned using postcode or seedpoint data then the commercial properties will have been assigned a population and hence a flow.

V. CONCLUSION

In this proposition was demonstrated that effect of vulnerabilities is huge. Exceptional consideration must be payed to worldly and spatial accessibility of adjustment information. It was demonstrated that as most pessimistic scenario – a model could appear to be adjusted adequately on few single occasions or on few estimation locales, yet totally comes up short in anticipating outside the alignment period. In any case, these instabilities are unequivocally identified with vulnerabilities of input-data or to instabilities because of spatial precipitation dissemination, separately. While it can obviously be seen that irregular precipitation blunders identified with estimation vulnerabilities of the downpour gage have just minor effect on model results and deliberate precipitation mistakes are remunerated amid alignment, in
functional model applications there are various precipitation occasions where the enormous disparity between measured information and reproduced information can scarcely be clarified. The most conceivable method for clarifying those instabilities is the impact of spatial precipitation appropriation where the precipitation measured by the downpour gage is not trademark for the precipitation of the whole catchment. As more estimation destinations are utilized and as longer the time period utilized for alignment is, the greater is the opportunity to "adjust" those vulnerabilities. That implies, that still different (single) precipitation occasions remain where measured information is not steady with reenacted information but rather in long–time normal the spatial precipitation dissemination is adjusted. Consequently if the restricting qualities to be watched are identified with a long–time normal those instabilities are adequate.

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