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Abstract

Over the dramatically expansion of urbanization and population booming, the highly densified city is at great flood risk, especially under the circumstances of global warming. In cloudburst situation where huge run-off volumes are generated quickly, spill-over from the blue spots on higher elevations increase flooding vulnerability to the low lying urban spaces. To get a better understanding of the flooding hazard from upstream in urban, a network model needs to be organized to clarify this hydro-connectivity relation for surface runoff. In the research, a GIS based surface runoff sub-model generation method is proposed, constructing the different hydrological runoff network sub-model based on the high resolution DEM with specific customized modelling objectives.

The method is composed of a GIS and a SWMM component. For the GIS part, the main goal is aiming at achieving the screening and simplification of input data for SWMM through sub-model generation and blue spots classification. Additionally, all the input data are collected and assembled based on the hydrological distributed data model derived from the DEM. For the SWMM part, the main attempt is to realize the hydrodynamic quantification in each blue spot. Both 1D and 2D flooding representation approach are proposed to give different extents of detailed descriptions for water level variations inside the blue spots and water diffusion throughout the entire network.

Currently, the model is divided into 8 sub-modules. Three of them are adapted from the hydrologic screening method created by Thomas Balstrøm. Initially, it identifies the blue spots at the drainage basin level. Secondly, it locates the pour point inside each unit. Thirdly, it screens the blue spots according to a classification method. Fourthly, it dissolves the local watersheds and aggregates minor blue spots. Fifthly, a geometric network is generated with pour points and stream features. Sixthly, it identifies the urban flooding objects. Seventhly, it creates the sub-model by using customized trace tool. Finally, it aggregates and assembles the information based on a sub-model, then imports all the information into SWMM engine to expose the hydrodynamics in 1D and 2D.

This study shows a unique GIS approach to describe the urban overland runoff in an innovative way. Compared with traditional modelling, it prioritizes the surface runoff instead of pipe flow in cloudburst scenarios. Secondly, with maximum reservation of the DEMs accuracy at the basin level, the GIS screening method was used for many times to simplify the input data into a data load which SWMM is easily capable of. This suggests a high resolution modelling approach with power of simplification. Besides, the distributed data model creates a feasible data schema to subdivide the landscape information under basin from hydrology perceptions enabling it to fit into real hydrology conditions.

Urban heterogeneity is also integrated in the distributed model opening a gate to even wider coverage of hydro-modelling related datasets to be involved. Furthermore, unlike a ‘one for all’- modelling strategy, the customized sub-model generation method makes it possible to produce diverse individual stormwater model depending on different customized target rainfall events and flooding objects. It provides a feasible modelling approach to adapt dynamic world. Also, multiple hydrology scale analysis was applied in the model. All the sub-models generated from the whole drainage basin is not only providing a trustworthy boundary for hydrology modelling but also achieve the hydrology downscale conversion, reaching a comprehensive flooding prevention understanding based on basin view. Automatic procedure in a GIS module with little manual inputs will reduce massive workloads for input hydraulic model.

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