Introduction

Urban catchments are often characterized with a rapid response to rainfall events, high surface runoff, and poor runoff water quality. Exciting opportunities to study issues related to urban environments are provided by the constantly increasing availability of open environmental data and computational models. URCA project studied the linkages between precipitation, runoff, stormwater quality, and land use in urbanized areas. Aalto University developed model descriptions for the Helsinki research catchments using the openly available Stormwater Management Model (SWMM). In addition, possibilities of open tools and open data in facilitating high-resolution urban rainfall-runoff assessments were explored.

Methods

An open source subcatchment generator GisToSWMM5 was developed to automate the laborious model construction process in SWMM. The generator divides the investigated area into subcatchments using a uniform computation grid and connects the grid cells together and to the underlying stormwater network, significantly accelerating the model construction process. The simulated discharge results from three automatically generated models with varying grid cell resolution (2×2, 4×4, and 8×8 m²) were compared to measured cells together and to the underlying stormwater network, significantly better to resort to openly available weather radar data, whose quality can be improved using gauge correction and advection interpolation. For the open gauge data to be useful, the measurement point should be very close to the studied urban catchment. Otherwise, it may be better to resort to openly available weather radar data, whose quality can be improved using gauge correction and advection interpolation.

Concluding remarks

An openly available tool for automated construction of the linkages between subcatchments and the underlying drainage network was developed and tested. The tool accelerates considerably stormwater modelling studies with SWMM.

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More information


GisToSWMM5 is available from https://github.com/AaltoUrbanWater/GisToSWMM5

Results

Fig. 1. Pihlajamäki and Veräjämäki catchments. Catchment outlets (blue triangles), as well as on-site rain gauges and the FMI rain gauge in Kumpula (KUM) (red circles) are depicted. FMI weather radar in Vantaa (VKR) is depicted with an orange triangle. The arrow points to Vaisala Oyj Kerava research radar (KER) 18 km north-east from the area.

Fig. 2. Comparison of routing and flood size characteristics between manually constructed and automatically generated models (2×2, 4×4 and 8×8 m²) in Pihlajamäki.

Fig. 3. Runoff simulation results in Pihlajamäki (18-19 Jul, 2015). a) Simulation results between manual and 2×2 model are similar. b) Coarser grid resolution saves computation time but results in lower peak flows.

Fig. 4. Mean performance statistics (2×2 model) in Pihlajamäki for different rainfall input data sources. a) Mean absolute volume error (VE) and b) mean Nash-Sutcliffe efficiency (NSE). Black dots indicate the mean values and vertical lines the range of the performance statistics.

Fig. 5. Runoff simulation results (2×2 model) in Pihlajamäki (22-23 Sep, 2014) for different rainfall input data sources. On-site gauge (GR1) yields best performance while other gauges (GR2 and GO) suffer from convective rain cell induced rain outside the catchment. Radar data sources (RR, RO1-RO4) perform well, with mean field bias correction and advection interpolation improving the performance.