Evaluation of the Stormwater Capture Potential of New York City Soils: Implications of Infiltration Rate Variability on Urban Runoff Predictions

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Background

The properties used to characterize soils and, more specifically, those that are used to describe the rate at which water infiltrates into them, are key parameters in most rainfall-runoff models. Because these parameters are known to be highly variable, they are a known source of uncertainty in predicting runoff from pervious surfaces.

Research Goals

The goals of this study were to a) characterize the heterogeneity in soil and infiltration characteristics in specific types of pervious surfaces found in New York City, and b) to study the potential effect of this heterogeneity on prediction of the total volume and peak rate of runoff from specific rainfall hyetographs.

Methodology

Characterization of soil and infiltration characteristics, utilizing a Cornell Sprinkle Infiltrometer, was performed at a variety of sites throughout NYC during Summer and Fall 2009.

- NYCDPR Green streets (11 tests)
- Tree pits (5 tests)
- Vegetated Courtyards (7 tests) - Backyards, traffic islands, courtyards

Statistical Analysis

As expected, statistical analysis of the infiltration data, which includes nearly two dozen individual tests, showed high variability and statistically significant differences (t-testing) between land surface types.

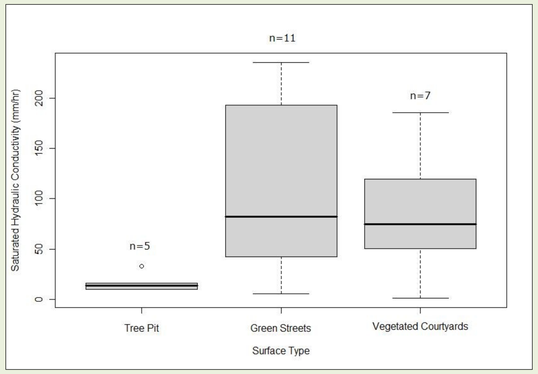
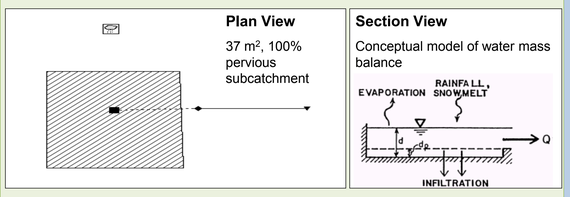


Chart 1 – Ranges of hydraulic conductivity for different surface types

SWMM Modeling

The USEPA Stormwater Management Model, (SWMM) an industry standard, was then used to examine the impact of this heterogeneity on predictions of peak flow and total runoff volume for a design storm.



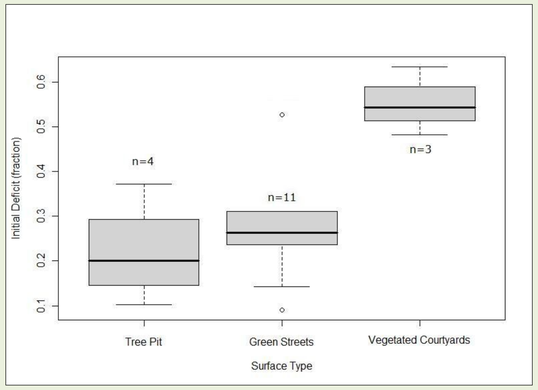


Chart 2 – Ranges of initial soil moisture deficit for infiltration testing in different surface types

SWMM Modeling (continued)

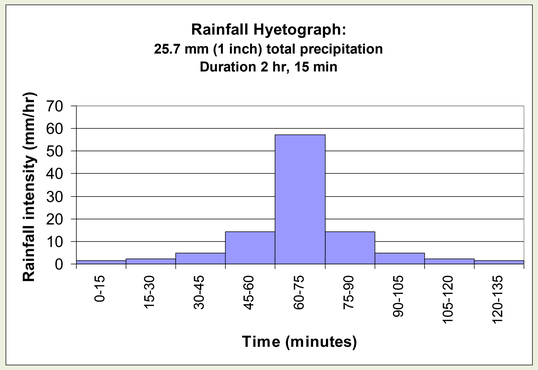


Chart 3 – Rainfall hyetograph utilized for SWMM testing

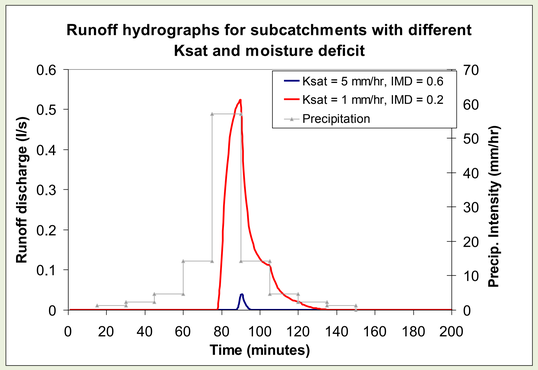


Chart 4 – Comparison of SWMM results for varying hydraulic conductivity and initial moisture deficit

SWMM Results

The preliminary results of this work suggest that although soil and infiltration properties are highly variable, only a small portion of this range can significantly alter the runoff predictions obtained from SWMM using this particular design storm.

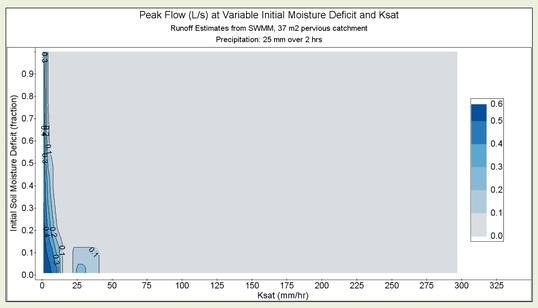


Chart 5 – SWMM results (peak flow) with varying hydraulic conductivity and initial moisture deficit

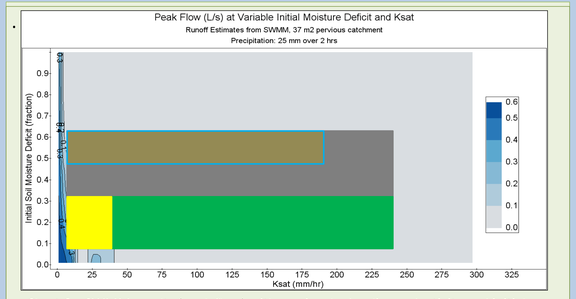


Chart 6 – SWMM results (peak flow) with varying hydraulic conductivity and initial moisture deficit

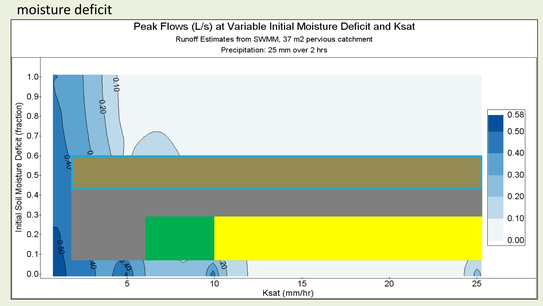


Chart 7 – SWMM results (peak flow) with varying hydraulic conductivity and initial moisture deficit

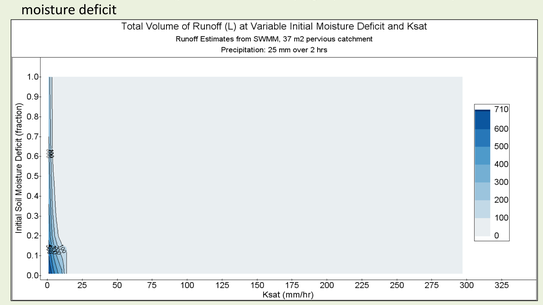


Chart 8 – SWMM results (total volume) with varying hydraulic conductivity and initial moisture deficit

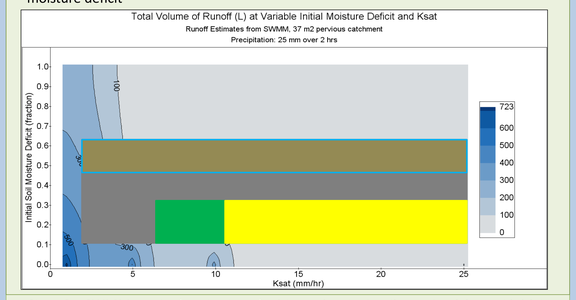


Chart 9 – SWMM results (total volume) with varying hydraulic conductivity and initial moisture deficit

Future Research

Future research will address the significance of the variability in runoff predictions given a more diverse set of storm events for more generalizeable results.

Acknowledgements: Bram Gunther and Jackie Lu of the New York City Department of Parks and Recreation (NYCDPR) are acknowledged for their integral role in supporting various aspects of the experimentation. Nandan Shetty and Sandra Yaeger of the NYCDPR, Tatiana Morin of the NYC Soil and Water Conservation District, and Lindsay Reinhardt and Richard Shaw of the USDA-NRCS NYC Soil Survey are acknowledged for their vital aid and participation in performing field testing at numerous sites.

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