Analytical Probabilistic Analysis for Urban Runoff Quality

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OBJECTIVE
The Objective of this research is to develop an Analytical Probabilistic Models for Urban Stormwater Quality analysis. As an alternative approach to continuous simulation, analytical runoff quality models have been proposed for estimating runoff pollutant loads. Based on concepts from statistics and probability theory, these models have been derived. These models are more computationally efficient and much less cumbersome than continuous simulation modeling, and overcome the limitations imposed by single event modeling through the use of long-term rainfall records.

METHODOLOGY
The methodology utilizes Probability Density Functions (PDFs) of rainfall event characteristics, a runoff coefficient based rainfall-runoff transformation and commonly used pollutant buildup and washoff processes representations. Employing derived probability distribution theory, analytical probabilistic runoff quality models are derived using exponential buildup and washoff functions.

⇒ Rainfall Analysis
An Inter Event Time Definition (IETD) is defined to discretize the long-term rainfall record into individual storm events each having four characteristics: volume, duration, average intensity and interevent time. Histograms are prepared from the time series and PDFs fitted.

⇒ Urban Catchment
Catchments are characterized by a Runoff Coefficient and Depression Storage:

⇒ Derivation of Models
Expected Event Washoff Load Per Event
\[ \text{Washoff Load} = \text{Event Volume} \times \text{Pollutant Load} \]

⇒ Urban Pollution Processes
It is assumed that pollutants build up between the storm event and washed off during the event and they are represented by exponential functions as follows:
\[ R(t) = M \left[ 1 - e^{-at} \right] \]
\[ I(t) = \text{Rate of washoff} \]

MODEL VERIFICATION
The models were verified on the basis of an urban watershed in Greater Toronto Area

POTENTIAL MODEL APPLICATION
⇒ Application of Model for TMDL Analysis
The technical analysis of Total Maximum Daily Load (TMDL) requires estimation of pollutant loads from both point and non-point sources. The estimation of pollutant loads from steady point sources is relatively straightforward. In contrast, the estimation of loads from non-point sources particularly from urban watersheds is complex due to many factors that include the random variations of rainfall, runoff, pollutant buildup and washoff and the overall complexity of the watershed. The estimation of pollutant loads from urban stormwater runoff remains critical in establishing TMDL for urban receiving waters. The analytical probabilistic models can be used to estimate the pollutant loads from watershed non-point sources.

TAKE HOME MESSAGE
In this research, analytical probabilistic models are developed for urban storm water quality analysis using the derived distribution theory. These models are computational efficient, simple to use compared to continuous simulation models. These models can be applied to estimate pollutant loads from urban watersheds in the Metropolitan Washington DC area which is a necessary step in identifying the priority areas for storm water management and Long- term Control Plan.

LITERATURE CITED