2015-41TS
Published October 2015

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TECHNICAL SUMMARY

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LRRB PROJECT COST:
$150,000

The TIA for a watershed may include sidewalks and other areas not connected to a stormwater inlet.

MINNESOTA DEPARTMENT OF TRANSPORTATION

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New Method for Determining Impervious Areas Saves Time and Money

Researchers developed a practical method to determine the effective impervious area of a watershed using readily available data instead of more time-consuming and expensive methods, enabling more accurate stormwater modeling and cost-effective investments.

What Was the Need?

Urbanization increases impervious surfaces such as roadway pavements, parking lots and rooftops. Rainfall that runs over these surfaces can pick up pollutants like chemicals and sediment, which then make their way to lakes and rivers.

To combat this situation, public entities implement stormwater control measures and best management practices. Planners and designers of stormwater control infrastructure have traditionally used the total impervious area of a watershed, a relatively easy parameter to estimate, as the primary indicator in measuring the urban disturbance. The TIA is used to help determine total runoff, which is then modeled and used in the design of stormwater infrastructure such as storm sewers or retention ponds.

Recent studies have indicated a much better parameter than TIA: the effective impervious area. The EIA represents the portion of the TIA that's hydraulically connected to the storm sewer system. In other words, the EIA comprises only the impervious pathways over which water contributes directly and almost immediately to runoff without having an opportunity for storage or infiltration.

The EIA of a watershed can be significantly less than its TIA. That means using the TIA can lead to overestimating runoff volumes and rates as well as pollutant loading levels, which can ultimately lead to the overdesign of stormwater infrastructure. The EIA can be estimated from monitoring actual stormwater volumes over one or more seasons, but this can be expensive and time-consuming, and still carries a level of uncertainty. Also, most watersheds are unmonitored, and gauged data is simply unavailable for stormwater modeling.

Given how crucial the EIA parameter is in developing stormwater infrastructure, stormwater professionals needed a more efficient, cost-effective method to develop an accurate EIA.

What Was Our Goal?

The primary goal of this project was to develop an efficient method for accurately estimating the EIA for ungauged watersheds by using readily available data.

What Did We Do?

Researchers reviewed the literature for previous attempts at developing EIA for ungauged areas and found that estimation techniques were generally dependent on costly, time-consuming field investigations.

Next, they gathered rainfall-runoff data from 40 gauged watersheds for which EIA, TIA and other stormwater-related statistics had been obtained, and performed statistical analyses to determine EIA and other parameters. Then they developed and tested a new method for estimating EIA for ungauged watersheds based on the integration of existing geographic information system data and Natural Resources Conservation Service data

continued

"The results from this report provide an alternative method for finding the EIA parameter—one that's simpler and more straightforward than other methods—leading to better decision-making for stormwater control measures."

—Scott Anderson,
Assistant Utilities Superintendent, City of Bloomington

"Using the TIA as a parameter can create false runoff projections. EIA is a much better parameter to use, though it's more difficult to determine. This research indicates that within a given accuracy, it's possible to establish the EIA for ungauged watersheds."

—John Gulliver,
Professor, University of Minnesota Department of Civil, Environmental, and Geo-Engineering

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Unlike a sidewalk, the street is part of the watershed's EIA, which represents a portion of the TIA and is a better parameter for establishing stormwater control measures than the TIA.

(primarily curve number, which is a parameter used to determine runoff that integrates soil type, infiltration rate, land cover and precipitation data).

Finally, researchers compared the new method's results for establishing the EIA for the 40 watersheds with the gauged-based EIA estimates.

What Did We Learn?

The new method's EIA measurements closely matched the gauged-based estimates. Based on the study's positive results, researchers concluded that stormwater professionals can estimate EIA for ungauged watersheds. Because the new method establishes EIA using existing GIS information and watershed curve number, there is no need to determine the percentage of connected surfaces, analyze the storm sewer collection system, employ a digital elevation model or employ other more time-consuming methods.

The new method doesn't supplant other strategies; rather, it provides an alternative tool that may be more appropriate depending on the situation.

The study also found the EIA of urban watersheds to be significantly less than the TIA, confirming that the use of EIA rather than TIA as a modeling parameter can provide a much more accurate analysis of total runoff and pollutant loading.

What's Next?

Various organizations involved in the design of stormwater management, pollution prevention and transportation infrastructure can benefit from this research.

Public entities that must adhere to stormwater regulations are required to estimate pollutant loading as well as design and maintain best management practices based on those estimates. The project report proposes methods that could make those efforts more manageable and also improve the decision-making for the planning, designing and construction of stormwater infrastructure, ultimately reducing expenditures, while meeting water quality and quantity goals.

Workshops would help encourage the use of EIA rather than TIA for determining stormwater control measures and would help promote the use of this more efficient and cost-effective way to establish the critical parameter of EIA.

This Technical Summary pertains to the LRRB-produced Report 2015-41, "Determination of Effective Impervious Area in Urban Watersheds," published July 2015. The full report can be accessed at mndot.gov/research/TS/2015/201541.pdf.