Slowing urban sprawl, adding forests curb floods and help rivers

WEST LAFAYETTE, Ind. - Controlling urban growth and increasing forested land are the most effective ways to decrease future water runoff and flooding, according to a Purdue University study.

Bryan Pijanowski, an associate professor of forestry and natural resources, used a model to simulate Michigan's Muskegon River watershed runoff rates from 1900 through the present and forecast them 30 years into the future. Several scenarios, including forest regrowth, urbanization, and buffers between development and streams, were analyzed to estimate their impact on rivers and streams.

"Changes in the land's surface feed back to runoff. Urban sprawl and impervious surfaces are the biggest culprits," Pijanowski said. "If you're able to control development, it is the most effective way to save our river ecosystem."

Pijanowski said urban areas in the United States would double in 20 years at the current rate. In the model predictions, doubling the urban area in the Muskegon River watershed would increase runoff by 1 1/2 times.

Excess runoff can have several consequences, including flooding, increases in agricultural nutrients and urban pollutants entering nearby water and affecting aquatic life, increases in water temperature in rivers and streams that can affect aquatic life, and changes in the apportionment of water to wetlands and groundwater.

Pijanowski's findings, published in the early online version of the journal *Environmental Management*, suggest that slowing the rate of urban sprawl would be the most effective way to reduce or control runoff. Adding forest near rivers and streams and requiring buffer zones between those waterways and development also could help.

Pijanowski used historical data - including census information, aerial photos and housing statistics - to build historical landscapes back to the early 1900s. That data was fed into the Land Transformation Model, developed at Purdue, to determine historical runoff rates. Predictions from the present through 2030 also were created using the model. Assumptions for those predictions were created by local governments, state agencies and non-governmental groups working around the Muskegon River based on their knowledge of development and other area trends.

The findings included some good news: Pijanowski found that the landscape in the Midwest has improved since rapid deforestation in the late 1800s and early 1900s, with the best balance of urban and forested land since then occurring in the 1960s.

Rebuilding efforts after the Great Chicago Fire of 1871 caused heavy deforestation. But the federal government reforested farmland that it took possession of in the Great Depression, leading to the balance observed in the 1960s.

"The past is the worst we'll ever see over a 140-year period. Even the worst-case scenarios show that the landscape won't be as bad as what we had in the 1890s and early 1900s," Pijanowski said. "The lesson here is

that with time and care, these systems can be restored. Recovery is possible."

Pijanowski's future work will include examining the role landscape changes play in climate change and determining tipping points at which landscape changes impact rivers and streams.

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ABSTRACT

The Impact of Future Land Use Scenarios on Runoff Volumes in the Muskegon River Watershed

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In this paper we compared the response of surface water runoff to a storm event for different rates of urbanization, reforestation and riparian buffer setbacks across 40 subwatersheds of the Muskegon River Watershed located in Michigan, USA. We also did these comparisons for the forecasted and historical land-use scenarios (over 140 years). Future land-use scenarios to 2040 for forest regrowth, urbanization rates and stream setbacks were developed using the Land Transformation Model (LTM). Historical land-use information, from 1900 at 5-year time step intervals, was created using a Backcast land-use change model configured using artificial neural network and driven by agriculture and housing census information.

We show that (1) controlling the rate of development is the most effective policy option to reduce runoff; (2) establishing setbacks along the mainstream are not as effective as controlling urban growth; (3) reforestation can abate some of the runoff effects from urban growth but not all; (4) land use patterns of the 1970s produced the least amount of runoff in most cases in the Muskegon River Watershed when compared to land use maps from 1900 to 2040; and (5) future land use patterns here not always lead to increased (worse) runoff than the past. We found that while 10 of the subwatersheds contained futures that were worse than any past land-use configuration, 25 (62.5%) of the subwatersheds produced the greatest amount of runoff in 1900, shortly after the entire watershed was clear-cut. One third (14/40) of the subwatersheds contained the minimum amount of runoff in the 1960s and 1970s, a period when forest amounts were greatest and urban amounts relatively small.