Research links decline in hemlock forests to changes in water resources

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An insect infestation that is killing hemlock trees in New England forests is having a significant impact on the water resources of forested ecosystems that provide essential water supplies to one of the nation's most populous regions, according to research by Indiana University geographers and colleagues at three universities in Massachusetts.

The study is the first to show an increase in water yield—the amount of water reaching streams and rivers—resulting from forest damage caused by an insect pest called the hemlock woolly adelgid. Insect-damaged trees use less rainfall and allow more water to reach the ground and run off into waterways. With less foliage, the trees return less moisture to the atmosphere via transpiration and evaporation.

"We observed a 15 percent increase in annual water yield," said Taehee Hwang, an assistant professor in the Department of Geography in the IU Bloomington College of Arts and Sciences. "But there are a lot of issues involved with this subject. Water quality may suffer as rainfall runs off more quickly from forested areas and carries higher concentrations of nutrients. The long-term picture may change as hemlocks are replaced with broad-leaved trees that have a different impact on water resources."

Hwang and Jihyun Kim, a postdoctoral researcher in the Department of Geography, are the first two authors of the study. The research was conducted at Harvard University's Harvard Forest in Petersham, Massachusetts, about 75 miles west of Boston. The locale adds significance to the findings.

"Surface water resources are very important across the Eastern U.S., and forests are important sources for clean water," Hwang said. "The study site for this research is in the headwater area for the main water supply reservoir for the greater Boston area."

Eastern hemlock trees are large, attractive evergreens that are found from Canada to Georgia, often growing in cool regions on slopes and near streams and rivers. In many areas they are a foundation species, playing a key role in structuring the ecological community.

But hemlock forests in the Eastern U.S. have been devastated by the hemlock woolly adelgid, a tiny insect that feeds on the twigs of hemlock, near the base of the foliage. The adelgid, an invasive species from Japan, has largely wiped out hemlock forests in the Southern Appalachians.

The pests reached New England by the mid-1980s and two decades later infested the Massachusetts forests where the study was conducted. The northward spread of the infestation has been slowed by cold winter temperatures, which kill many of the adelgid, but the spread is likely to accelerate as a result of climate change, Hwang said.

In the study, the researchers used various measures to understand the impact of the hemlock woolly adelgid on freshwater yields. They charted the flow of water in streams and observed changes in the health of hemlock trees. They also measured the movement of water to the atmosphere via evaporation and transpiration from the hemlock-dominated canopy region, and then they modeled the net effect of the adelgid infestation using various methods.

They found that evaporation and transpiration decreased between 24 percent and 37 percent in a 10-year period. Comparing a watershed with more hemlock trees to a similar watershed nearby with fewer hemlocks, they found a 15.6 percent increase in annual water yield over

approximately the same period.

Hwang said more study is needed to determine whether the increase in streamflow is a long-term feature or whether it will reverse as hemlock trees die and are replaced by broad-leaved trees. More research is also needed, he said, to evaluate the effect of losing hemlock trees on water quality.

The article, "Increased water yield due to the hemlock woolly adelgid infestation in New England," was published in the journal *Geophysical Research Letters*.

More information: Jihyun Kim et al, Increased water yield due to the hemlock woolly adelgid infestation in New England, *Geophysical Research Letters* (2017). DOI: 10.1002/2016GL072327

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