

## **A Multi-Stage Stochastic Programming Approach to the Optimal Surveillance and Control of Emerald Ash Borer in Cities**

Esra Buyuktahtakin Toy, New Jersey Institute of Technology

Emerald ash borer (EAB), a wood-boring insect native to Asia and invading North America, has killed untold millions of high-value ash trees that shade streets, homes, and parks, and caused significant economic damage in cities of the United States. Local actions to reduce damage include surveillance to find EAB and control to slow its spread. We present a multi-stage stochastic mixed-integer programming (M-SMIP) model for optimization of surveillance, treatment, and removal of ash trees in cities. The objective is to allocate resources to surveillance and control over space and time to maximize public benefits. We develop a new cutting plane algorithm to strengthen the M-SMIP formulation and facilitate optimal solution. We calibrate and validate our model of ash dynamics using seven-years of observational data and apply the optimization model to a possible infestation in Burnsville, Minnesota. Proposed cutting planes improve the solution time by an average of seven times over solving the original M-SMIP model without cutting planes. Results from optimally solving our M-SMIP model imply that, under a belief of infestation, it is critical to apply surveillance immediately to locate EAB and then prioritize treatment of minimally infested trees followed by removal of highly infested trees. This study is a joint work with Drs. Robert Haight, Kathleen Knight, and Charlie Flower from the U.S. Forest Service and former doctoral student Dr. Eyyub Kibis from the Huether School of Business of the College of Saint Rose.