A sophisticated mathematical modeling, optimization and decision-making system, that is helping to preserve scenic Lake Rotorua in New Zealand, earned international honors for the Multi-Criterion Decision Making Team at the Michigan State University BEACON Center for the Study of Evolution in Action.

A team from the BEACON Center was presented the prestigious Wiley Practice Prize on June 20 during the 22nd International Conference on Multiple-Criteria Decision Making in Málaga, Spain.

Kalyanmoy Deb, Erik Goodman and Oliver Chikumbo were recognized at the conference for their approach to stopping the eutrophication of beautiful Lake Rotorua in New Zealand. The team is using multi-criterion optimization to identify optimal tradeoff choices that will help Rotorua stakeholders create a 50-year plan to balance dairy, forestry, tourism and other interests with the environmental, economic and social concerns in the region.

“The environmental problems arise because the most economically favorable use of some of the farmland surrounding Lake Rotorua is traditional dairy operations,” said Erik Goodman, director of BEACON Center. “The runoff from farming operations is changing the ecosystem of Lake Rotorua. The algal blooms and a declining appeal to use the lake as a recreational resource are seriously impacting tourism and economic development.”

Deb, Goodman and Chikumbo -- who is based at Scion, a research organization in Rotorua -- worked for two years to develop the mathematical tools that are helping the Maori leaders and local residents better understand their land-use options. BEACON’s multi-criterion decision-making process allows individual stakeholders to express their relative preferences, and then rank four solutions to help identify the most compatible solution for all. The team was assisted by Daniel Couvertier, a BEACON graduate student in computer science and engineering at MSU, and Hyungon Kim, a graduate student in the Human Interface Technology Lab at the University of Canterbury, New Zealand.

“We explored the tradeoffs with 14 objectives, including productivity, profitability and environmental damage factors,” Goodman explained. “The team's sophisticated mathematical modeling of the 14 objectives allows them to calculate the outcomes of a huge number of possible land use plans. Each plan shows any change in usage of 315 plots of land during a 10-year period, with the outcomes extended out for half a century. That is, each plan generates projected annual values for each of the 14 objectives for the whole 50-year period.

“Each stakeholder has his/her own idea of what are the best outcomes, of course,” he continued. “Up to now, a tool to calculate optimal tradeoff solutions (called Pareto-optimal solutions) has been impossible to calculate for a space with
about 100**315 solutions. Progress in multi-objective optimization by the BEACON team has made it possible for them to find many such Pareto-optimal solutions, drawing on the enormous power of evolutionary multi-objective optimization.”

Goodman noted that the team’s paper was one of four finalists presented at the conference.

The $1,000 Wiley Practice Prize is presented once every two years by John Wiley and Son, publishers of the Journal of Multi-Criteria Decision Analysis, for the best paper describing a real-life application of multi-criterion decision making.

BEACON Center for the Study of Evolution in Action approaches evolution in an innovative way, bringing together biologists, computer scientists and engineers to study evolution as it happens and apply this knowledge to solve real-world problems. BEACON is an NSF Science and Technology Center, headquartered at Michigan State University with partners at North Carolina A&T State University, University of Idaho, University of Texas at Austin and University of Washington.

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