C.W. & Modene Neely Foundation Supports NWRI Fellow at U. of Arizona

Summer 2006 -- Through the generous support of an Arizona-based private foundation, graduate student Kristopher Kuhlman received a fellowship from NWRI for his innovative research to develop a more efficient groundwater modeling tool.

Kuhlman, 30, was selected as the NWRI-C.W. & Modene Neely Fellow because of his research project on the "Extension and Implementation of the Laplace Transform Analytic Element Method (LT-AEM) for Efficient Simulation of Groundwater Resources." He is a first-year Ph.D. student in the Department of Hydrology and Water Resources at the University of Arizona.

Funding for this special Fellowship was provided by the C.W. & Modene Neely Charitable Foundation, which focuses on supporting projects to alleviate human suffering. Some of the Foundation's most recent projects include sponsoring the construction of a new dental clinic in Flagstaff, Arizona, for the indigenous population, as well as supporting a program that helps acquire pharmaceuticals for seniors who cannot afford to fill their own prescriptions.

"The Foundation is an advocate of developing technologies and practices that benefit people around the world, such as producing genetically engineered maize that is heat and drought resistant," said Foundation representative Richard Morrison, a former water rights lawyer. "We also know that people everywhere need to know the location and quantity of available clean water supplies. NWRI is helping people figure that out, and we see that work as critically important to human health and survival. Since the Foundation prefers to assist students who will do research that addresses human needs, it was only natural that we sponsor a Fellowship."

A native of Fremont, Nebraska, Kuhlman spent his youth camping, biking, or hiking whenever he had the chance. When it came time to go to college, he chose to major in geological engineering because "it was an excuse to go outside and get credit for it."

His most memorable experience at the Colorado School of Mines, where he studied as an undergrad, was when he spent 6 weeks at a summer field camp working at different locations in Southern Colorado and Utah to learn hands-on geologic field mapping. "We spent a lot of time looking at the geology on the surface and trying to determine how it relates underneath, where you can't see," he said. "It's like putting together a puzzle." He also enjoyed hiking up and down mountains or through forests to trace the movements of an ancient glacier or to determine how volcanic activity had affected the region over the course of time.

Another area of geology that Kuhlman enjoyed puzzling through was groundwater modeling, something he spent a lot of time doing as an undergrad because of an interest in hydrology. Groundwater modeling is used to predict the response of an aquifer to natural and hydraulic activities, like pumping water out of wells or tracking

contamination. The models can vary from simple equations to complex computer programs.

Kuhlman worked mostly with computer models, which he said "basically create an electronic version of the groundwater basin" using historical data. "The computer model is actually a mass balance for a whole bunch of little elements," he added. "You have to break the basin into hundreds of thousands of little pieces, like sugar cubes, and then you solve equations for every little cube and put them back together to get your answer."

Groundwater modeling soon became his specialty when, after graduating in 1998, he accepted a job with a hydrology consulting firm in Claremont, California. He quickly became the main groundwater modeler, working mostly with MODFLOW and transport modeling. However, because he wanted to learn more about modeling, specifically how to apply the models better, Kuhlman decided to earn his Ph.D. at the University of Arizona.

Now a full-time graduate student, he spends most of his days at the university, writing computer programs for his research project on using the LT-AEM to better simulate models of groundwater resources, which was co-developed by the USGS.

According to Kuhlman, his project is "an application of applied mathematics to hydrology to solve a problem in an efficient or elegant way."

"The work that I did as a consultant," he said, "used a program that takes a divide-and-conquer, brute-force approach to modeling, where you divide the domain into hundreds of thousands of little pieces and you solve a really simple equation for each piece. What I'm doing is a little more complicated in the beginning, but you just solve one equation to get the information you need and in a shorter amount of time. It is a different way of doing things."

Because the approach would allow for quick and simple groundwater simulations, Kuhlman hopes that it would be useful as an instructional tool for students and as a "what if" scenario tool for consultants and designers who need fast answers. "It's not meant to replace all the other groundwater models out there," he added. "It's actually meant to be like another little blade in your Swiss Army knife."

With the help of the Fellowship, Kuhlman is progressing with his research and has been invited to give his first presentation on the subject at the *2006 International Conference on Computational Methods in Water Resources* in Denmark. He expects to graduate within the next 2 years.

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