RESEARCH STATEMENT

BENJAMIN DYHR

My primary research interest in hydrology is the development of stochastic methods in subsurface hydrology for tomography of groundwater processes that exhibit both temporal and spatial stationarity. As a mathematics PhD student, hydrological science with an emphasis in stochastic methods has been a major substudy within the trajectory of my mathematics education. Although my dissertation research is involved in a fairly theoretical area of mathematics, the mathematical content of my research involves several branches of mathematics commonly used by hydrologists including stochastic processes, mathematical probability, and analysis of partial differential equations, both deterministic and stochastic.

After years of surveying research methods and subdivisions within the hydrological sciences, I have settled into a primary focus on stochastic methods in subsurface hydrology. My principal mentor in this subject is Dr. Jim Yeh of the University of Arizona Department of Hydrology and Water Resources. Dr. Yeh has an excellent research group of graduate students, and our meetings for his course in subsurface hydrology are much more in the style of an interactive discussion of a research group than of a traditional lecture format. This approach has proved to be a highly effective method of incorporating my expertise in mathematics with the more practical goals of hydrological scientists in attendance, and the experience has been the main driver of my specific research interests in stochastic methods in hydrology.

As soon as my PhD defense is complete, this summer, we plan to use the summer to collaborate on a publication, regardless of my ultimate job placement for the 2009-2010 academic year. Our current research plan involves the development of numerical methods for inverse problems in parameter estimation of subsurface processes. The subsurface processes we are interested in involve hydrological processes that are variable in both space and time, and the inverse problems associated with parameter estimation of such processes are inherently complex and typically ill-posed. It follows that results in this subject are often best supported by numerical experiments that implement various mathematical approaches estimating the solutions of the underlying stochastic partial differential equations.

We are hopeful that we can acquire funding for a postdoctoral position that allows me to research under Dr. Yeh as a mentor. In such an event, our long term research plan is to develop a new aquifer characterization method at basin-scales based on the aquifer's responses to naturally induced mechanical stresses which include but are not limited to rainfall events. This is an innovative approach for estimating hydrological parameters in large scale systems where traditional methods of conducting pumping tests are impractical. Institution of this method entails analysis of field evidence of an aquifer's drained responses following rainfall events and formulation of research hypothesis to guide the development of a new precipitation-driven basin-scaled aquifer characterization method.

We hope to develop a conceptual model that improves our understanding of response of heterogeneous aquifers. Based on the conceptual model, a stochastic parameter estimation procedure combines surface and subsurface information and physical processes to characterize basin-scale aquifers. Fundamentally, we are building upon the tomography concept of inducing stress in the aquifer at observation locations, and subsequently estimating parameters using geo-statistically based methods. The tomographic nature of the spatially variable processes we are interested in has not been identified and exploited previously.

The broader impact of the research is the provision of decision support for state and federal agencies regarding policies for development and water resources management. The proposed project will also expand the scope of remotely-sensed hydro-meteorological data and aid surface hydrologic models by providing an independent method for verifying spatial and temporal distribution of hydro-meteorological forcing.