UNCERTAINTY OF HYDROLOGIC EVENTS UNDER SOUTH DAKOTA'S CHANGING CONDITIONS: A RESEARCH AGENDA

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ABSTRACT

Widespread flooding across South Dakota in 2011 has spurred a new look at the institutional, regulatory, and mathematical models used to manage the Upper Missouri River Basin as it affects all aspects of life in South Dakota. An SD EPSCoR planning grant was awarded to a team of local, national and international researchers, who produced a strategy to create a research infrastructure with the goal of developing conceptual and mathematical models to understand and describe the uncertainty of hydrological events (HE) across South Dakota.

The strategy involves two main tasks: 1) planning for study of the uncertainty of HE in the Upper Missouri Basin (Shmagin, B. 2011. Missouri River watershed: the object for hydrological study and uncertainty of models. Available from Nature Precedings at <http://precedings.nature.com/documents/6537/version/1>. [Accessed Oct 3, 2012].)

and 2) developing concepts for communicating uncertainty of HE for wider use outside the professional community. The plan brings together a variety of disciplines, and outlines the development of an artificial intelligence approach to analyzing the interaction of HE, engineering installations and social systems in South Dakota.

The focus of study is the system hydrological researcher – mathematical modeler – stakeholder, and the process considered is the interaction of knowledge with uncertainty in application to HE. Uncertainty in HE will be defined using concepts broader than hydrology (such as statistical learning) and linked to the concerns of all social, cultural and economic sectors in South Dakota.

Considering this system of interacting participants allows focusing on the principal stages in tackling uncertainty, from developing the research task and obtaining the hydrological results to communication between researcher and stakeholder. Mathematical models are the universal language in scientific research and will be adapted to bring the results to stakeholders. Three mathematical approaches to modeling HE and impacts to South Dakota will be considered: 1) distributed system interactions, 2) statistical learning and 3) cellular automata.

Specific concepts of uncertainty for modeling watersheds and describing the time-space variability of water cycles and budget for regional hydrologic study were developed. These concepts include remotely sensed data use, scale and influence of drainage and irrigation on the groundwater regime and hydrology of wetlands and lakes in the Missouri River Valley and Prairie Pothole Region. Additional necessary concepts concern risk assessment and HE interaction with the sociology and economy (e.g., types and scales of regionalization of the physical and human environment), and the design of interactive simulation models (e.g., cartographic presentation and simplified educational modeling after A. Voinov [Voinov, A. 2008. Systems Science and Modeling for Ecological Economics. Academic Press, NY. 432 pages.]) of HE in the natural landscapes and industrial/changed conditions in South Dakota.

South Dakota's economy and the wellbeing of its citizens depends greatly on natural conditions and events, thus South Dakota will benefit from a program working for improved evaluation and visualization of the risk associated with HE and improved reliability of information pertaining to irrigation and drainage, water management, and crop insurance. The first results obtained in dealing with uncertainty for HE via the planned research infrastructure will be expanded to fully include socio-economic research.

Given the developed regional, sub-regional and site specific information and specification, we propose that South Dakota create a research infrastructure integrating the intellectual potential dispersed in the state's academic institutions: 1) to seek out and apply new developments from federal agencies and from international bodies, adopting these methods to natural and socio-economic conditions and industries specific for the state; 2) to trace the effect of HE on the history

of socio-economic relations and changes and present the scale of those changes; and 3) to develop new media to visualize HE and their associated dangers and then to bring those developments to communities, K12 educational institutions and USDA Extension Service to explain the effect of HE and the concept of risk in dealing with them.