**Annual Report (9-1-11 to 5-31-12)**
**NOAA grant NA11OAR4310147**
**awarded to**
**The Center for Research on the Changing Earth System (CRCES)**
**P.I. Vikram M. Mehta**
June 20, 2012

**Proposal title:** Interannual to Decadal Climate Variability Information for Risk Assessment, Urban Water Policy, and Decision Support: Case Studies of Kansas City, Lincoln, and Great Falls Urban Areas within the Missouri River Basin

The scientific objectives of the research are:

1. To identify quantitative and qualitative impacts and indicators of interannual and decadal climate variability on water supply and demand (thus water security) in the three selected urban areas;
2. To characterize the potential vulnerability of municipalities across the Missouri River Basin (MRB) to interannual and decadal climate variability, and to assess potential adaptive responses;
3. To calibrate a hydrologic model against observations of stream flow and ground water recharge for use in anticipating the impacts of various scenarios of future interannual and decadal climate variability in decision support systems;
4. To identify ways in which information on interannual and decadal climate variability in the MRB can be incorporated into urban water policy, decision support, and management systems.

CRCES met the first-year goals of this project as described briefly below.

## • Formation of Expert Advisory Committee

An Expert Advisory Committee (EAC) has been formed to advice and assist the project team. The role of the EAC is:

• To advise about information and data gathering (such as surface and ground water data, and water demand and usage data in the three case-study regions);
• To generate information needs for decision support in urban water security and evaluate applicability of results from this project;
• To advise in writing a guide book for urban water managers, based on results of this project; and
• To advise and help in dissemination of results.

Members of the EAC are:
Mike Jacobson; Manager, Great Falls Public Works Utility Plant; Great Falls, Montana
Jake Kandelin; Hydrologist, Montana DEQ Public Water Supply, Helena, Montana
Jerry Obrist; Chief Engineer of Water Works, Lincoln Water System, Lincoln, Nebraska
Tom Schrempp; Water One, Kansas City, Kansas
Andy Ensz; Water Modeler, Kansas Water Office, Topeka, Kansas

Bob Peters; Water Resource Engineer**,** Denver Water System, Denver, Colorado
Laurna Kaatz; Climate Scientist**,** Denver Water System, Denver, Colorado
Dr. Bruce Dvorak; Interim Director, UNL Water Center; and Professor, Biological Systems Engineering, University of Nebraska-Lincoln**,** Lincoln, Nebraska
Tim Felchle; Chief of Reservoir Operations**,** Bureau of Reclamation**,** Great Plains Region, Montana Area Office, Billings, Montana

In addition to the three case study areas included in the project proposal, we have also included Denver, CO, as an example of a large urban area in the project.

The project team held a webinar meeting with the EAC on 17 April 2012 to discuss the project and solicit data and information about the EAC members' respective urban water systems. A member of the project team also conducted follow-up questionnaires and telephone interviews with the EAC members. These interactions have resulted in the development of profiles of the three case-study water systems, detailing their operating attributes, sources of water supply, vulnerability to climate variability and other stresses, and water demand data. Attributes of the four urban water systems are given in Table 1 and the systems' vulnerability to climate variability is summarized in Table 2. It is clear from Table 2 that the urban water systems under study are vulnerable to droughts and floods associated with climate variability. One-day workshops are being planned in each of the case-study areas in October 2012 for further discussions with urban water experts in these areas.

We have obtained preliminary water supply and demand data for the four water systems from the EAC members and are analyzing them in conjunction with climate and hydro-meteorological data for the MRB.

- **Analyses of climate, hydro-meteorology, surface water, and ground water data**

We have climate and hydro-meteorology data for the MRB from our previous SARP-funded projects. In the present project, we have obtained surface water and ground water data from the U.S. Geological Survey for many sites in and around the case study areas. We are now analyzing these data to identify climate variability signals in surface and ground water data, and will subsequently assemble observations-based scenarios of climate variability linkages to water supply and demand in the four urban areas under study.

- **Employment**

One research associate, Ms. Katherin Mendoza, is employed part-time under this grant. The PI, a senior scientist (Dr. Norman Rosenberg), and CRCES's Administrative Officer (Ms. Janet Wood) are also partially supported by this grant in CRCES. A Water Resource Scientist (Dr. Cody Knutson) and an Outreach Specialist (Ms. Kelly Smith) are employed part-time under this grant in the National Drought Mitigation Center, University of Nebraska – Lincoln.

- **Dedicated web page development**

A dedicated page for this project (http://missouri.crces.org/research4.php) has been developed on a web portal (http://missouri.crces.org) for CRCES's Missouri River Basin projects.

**Table 1: Attributes of the Case Study Urban Water Systems**

| City | Number of people served | Number of water connections | Daily max. delivery capacity (Million gallons) | Customers by type of use | | | |
|---|---|---|---|---|---|---|---|
| | | | | Residen. | Commer. | Indust. | Irrig. |
| Great Falls, MT | 64,000 | 21,000 | 56 | 15,700 (73%) | 2,300 (11%) | 6 (0.03%) | 1 (0.005%) |
| Lincoln, NE | 262,672 | 79,187 | 100 | 74,347 (94%) | ← | 4,627 (6%) | → |
| Kansas Water Office, KS | 1,000,000 | | 451 | | | | |
| Johnson County, KS | 405,000 | 138,468 | 200 | (60%) 130,597 (94%) | 7,572 (5.5%) | (20%) 287 (0.002%) | (20%) 0 |
| Denver, CO | 1,135,000 | 309,272+ | 715 | 209,151 (68%) | 20,077 (6.5%) | 282 (0.1%) | 3,062 (1%) |

* Includes 829 (0.27%) government, 58 (0.02%) non-potable irrigation/industrial, and 75,954 (25%) other resale (residential and commercial)

**Table 2: Vulnerability of Urban Water Security to Climate Variability in Case Study Areas**

| City | Effects of droughts | Effects of floods |
|---|---|---|
| Great Falls, MT | Low flows and warmer temperatures; additional energy needed for pumping; higher probability of high algae concentrations, water taste and odor problems | Higher turbidity increases water treatment costs; lower alkalinity makes water more difficult to treat; higher dissolved carbon level makes more difficult to meet disinfection byproduct requirement; higher water rates charged to customers if extended wet period |
| Lincoln, NE | Much lower water delivery rate (65 MGD compared to normal 100 MGD); possible increase in arsenic level in water; increased naturally occurring chemicals (manganese, total organic carbon, iron) and bacteria; water taste and odor problems due to lower recharge of aquifer and use of chlorine as disinfectant; affected sectors nurseries, car washes, golf courses, and high water use industries | Increase in turbidity and dissolved solids; increase in microbial growth; increased probability of pesticide concentration; increase in bacteria; affected sectors parks, housing, and businesses |
| Kansas Water Office, KS | Water taste and odor problems; affected sectors municipal (water quantity and quality, unusable intakes), industrial (water quantity, unusable intakes), agricultural (water quantity), and recreational (low reservoir levels) | Transport and deposition of large amounts of sediments in reservoirs; harmful algal blooms; affected sectors municipal (localized flooding, water quality), industrial (localized flooding), agricultural (flooding of large areas of floodplain), and recreational (high reservoir levels, algal blooms) |
| Johnson County, KS | Access to Missouri River surface water supply affected due to water levels below intakes; high concentrations of chlorides; higher concentration of wastewater; higher cost of watering lawns | Higher turbidity |
| Denver, CO | Lower levels of water withdrawal from various water sources; higher concentrations of background pollutants and warmer temperatures necessitate changes to treatment processes; contaminated runoff from wildfire-burned areas; increased total organic carbon and decreased alkalinity make compliance with disinfection rules more difficult; affected sectors landscaping, manufacturing, food and beverage, car washes, public parks, water-based recreation | Increased sediments and other constituents affect water quantity and quality; localized flooding and property damage |