Upper Missouri River Basin

UMRB – Plains Snow and Soil Moisture Monitoring Network

Background

After the historic 2011 Flood, and in response to one of the six recommendations from the Independent Review Team, the U.S. Army Corps of Engineers (Corps) and various basin agencies developed a framework (2013 Recommendation) for the establishment of an Upper Missouri River Basin Soil Moisture and Plains Snow and Soil Moisture Monitoring Network (UMRB Monitoring Network). The Corps is collaborating with federal, state, and tribal partners to implement the 2013 recommendation.

Description

The Corps uses plains snowpack and soil moisture data in its runoff forecasting for reservoir operations. The Corps and other federal agencies have found limitations in this data. For example, the independent technical review panel, which assessed the Corps operation of the Missouri River mainstem reservoir system during the 2011 flood, found that modeled information on snow water equivalent is available, but observational data is sparse and not always representative of basin-wide conditions. WRRDA 2014 included a requirement that the Secretary of the Army, in coordination with other specified agencies, carry out snowpack and soil moisture monitoring in the Upper Missouri Basin. WIIN 2016 Section 1179(b) designated the Corps as the lead agency for this effort.

Value to the Corps and the Upper Missouri River Basin

The data obtained from the network will be available for all federal, state and local agencies to improve existing products and/or the development of new products (e.g., NWS river forecasts and flood outlooks, National Drought Mitigation Center drought monitor and outlooks, U.S. Bureau of Reclamation (USBR) and U.S. Department of Agriculture’s (USDA) National Resource Conservation Service (NRCS) water supply forecasts, various federal and state fire hazard reports). Specifically for the Corps, the data will be used by the National Weather Service’s (NWS) National Operational Hydrologic Remote Sensing Center (NOHRSC) to improve the plains snow map. That map is a direct input into the river and runoff models used by the NWS and the Corps. Those river and runoff models also use soil moisture data to model the impacts of melted plains snow and rainfall to estimate the inflows in the Corps’ reservoir projects.

Total Number of Monitoring Stations - 540

The plains area of the UMRB (above Sioux City, IA) in the U.S. totals 270,000 square miles. Ongoing discussions with the soil moisture experts (NRCS and USDA-National Soils Lab) and plains snow and river forecasting experts at the NOHRSC and NWS’s Missouri Basin River Forecast Center (MBRFC) has revealed that a soil moisture and plains snow monitoring station should be installed in every watershed (see Figure 1) at a density of 1 in every 500 square miles (540 monitoring stations total). A monitoring station includes all sensors – soil moisture and temperature, snow depth, wind speed and direction, solar radiation, relative humidity, precipitation, and air temperature. In addition, during the December-March period, onsite weekly snow depth and snow water equivalent measurements should be collected at each station and conveyed to the Corps, NOHRSC and MBRFC for integration into their respective models.

Existing (172) and New (368) Monitoring Stations

There are approximately 172 existing soil moisture (NOTE: these do NOT include plains snow monitoring equipment) stations in the upper basin. Of these 172 stations, 148 are owned and operated by the five state Mesonet offices (MT, WY, ND, SD and NE); the other 24 are owned and operated by the USBR (AgriMet). The Corps is actively working with the five Mesonet offices to modify their existing stations to be part of the UMRB Monitoring Network. To complete the 540-station network, approximately 368 new stations will need to be installed.
Work Completed through FY21

The Corps completed the following actions to start retrofitting existing stations and provide established capability to execute when additional funding is received:

- South Dakota State University (SDSU) was funded for an instrumentation study that was completed in August 2019.
- Awarded a purchase order for three “pilot” stations in Montana, Wyoming, and South Dakota to better understand the requirements and processes.
- Awarded five Single Award Task Order Contracts (SATOCs) with the following universities: University of Montana (UM), University of Wyoming (UW), North Dakota State University (NDSU), SDSU, and University of Nebraska Lincoln (UNL). Task Orders have been awarded to each university with a combined total of $5.7 million to retrofit or install 75 stations. The contracts provide known costs for installation and operation and maintenance (O&M) over a five-year period.
- Contracted with the UM’s Center for Integrated Research on the Environment (CIRE) for Mesonet Coordination Services. CIRE is developing the site selection methodology for new stations, a GIS-based database, and coordinating among the numerous basin stakeholders including the state Mesonets.
- Funded NRCS through an Economy Act Order to complete soil sampling and characterization.

FY22 Work Plan

- The total combined SATOC capacity with the five universities is $51M with $45.3M remaining.

The following table shows the tasks identified for execution in FY22:

<table>
<thead>
<tr>
<th>Task</th>
<th>Execution Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omaha District Labor</td>
<td>In-house execution</td>
</tr>
<tr>
<td>Soil Characterization</td>
<td>Economy Act Order with NRCS</td>
</tr>
<tr>
<td>Cultural Clearance and NEPA RECs</td>
<td>IDIQ Task Order</td>
</tr>
<tr>
<td>Mesonet Coordination Services (Year 3)</td>
<td>CIRE Contract</td>
</tr>
<tr>
<td>Station Installation (55 stations)</td>
<td>SATOC Task Orders</td>
</tr>
</tbody>
</table>

The Corps PDT committed to award at least 55 stations and is planning to complete cultural clearance and National Environmental Policy Act (NEPA) contracts to award up to 96 total stations.

FY23 Work Plan

In FY23, the Corps will award task orders for the installation of approximately 100 stations that are scheduled to be operational by September 2024. Additional soil characterization and coordination services will also be funded. USACE and the Mesonets will identify additional “candidate sites” and initiate Section 106 and NEPA in preparation for task order award in FY24.
**Upper Missouri River Basin**

**UMRB – Plains Snow and Soil Moisture Monitoring Network**

**Funding and Capability**

The following table identifies the funding capability, funds received, and description of work based on the funding capability for each fiscal year. Funding for the first year of O&M is included in the cost estimates and station installation. The first year of O&M includes station commissioning and equipment validation, as well as data collection. Long-term O&M funding will be needed after the first year of installation for each of the stations.

<table>
<thead>
<tr>
<th>FY</th>
<th>Funding Capability</th>
<th>Funding Appropriated</th>
<th>Funding Obligated</th>
<th>Description of Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>$100,000</td>
<td>$100,000</td>
<td>$100,000</td>
<td>Initiate the planning process and contract with SDSU for the equipment test bed (completed).</td>
</tr>
<tr>
<td>19</td>
<td>$1.5M</td>
<td>$1.5M</td>
<td>$1.5M</td>
<td>Purchase and install equipment at 3 existing Mesonet stations (1 per state) stations for “proof of concept”, finish NEPA documentation, fund the Mesonet coordination contract (year 1 of 5), and awarded SATOCs and Task Orders purchase equipment for approximately 45 existing Mesonet stations.</td>
</tr>
<tr>
<td>20</td>
<td>$3.0M</td>
<td>$3.0M</td>
<td>$2.99M</td>
<td>Purchase and install equipment at additional existing and new stations, additional soil sampling, and Section 106/NEPA for future stations.</td>
</tr>
<tr>
<td>21</td>
<td>$5.0M</td>
<td>$4.95M</td>
<td>$3.42M</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>$5.0M</td>
<td>TBD</td>
<td>TBD</td>
<td></td>
</tr>
</tbody>
</table>

**Real Estate**

Real estate access was obtained for the existing 148 stations by the Mesonets. The Mesonets will acquire the needed real estate instruments to ensure access for installation and for new stations.

**Issues**

- The monitoring stations currently measure snow depth and use related data to estimate snow water equivalent (SWE). SWE instrumentation is considered emerging technology and is currently being field-tested by various research entities to determine accuracy, reliability, and durability. USACE is conducting market research to determine what instruments are available and may fund additional studies in the future.
- The primary partner agency and source of O&M funding are unknown.
- Omaha District identified and briefed a recommended course of action (COA) for the Corps to conduct installation of the stations, then O&M would be funded by the National Oceanic and Atmospheric Administration (NOAA) through an agreement with the Mesonets.
- The 2020 WRDA provides additional authorization to coordinate with NOAA, NRCS, USGS, and USBR for continued installation of the network. WRDA also requires NOAA to establish a pilot program to include UMRB data within the National Mesonet Program.

**Current Status**
