

THE NATIONAL COORDINATED SOIL MOISTURE MONITORING NETWORK



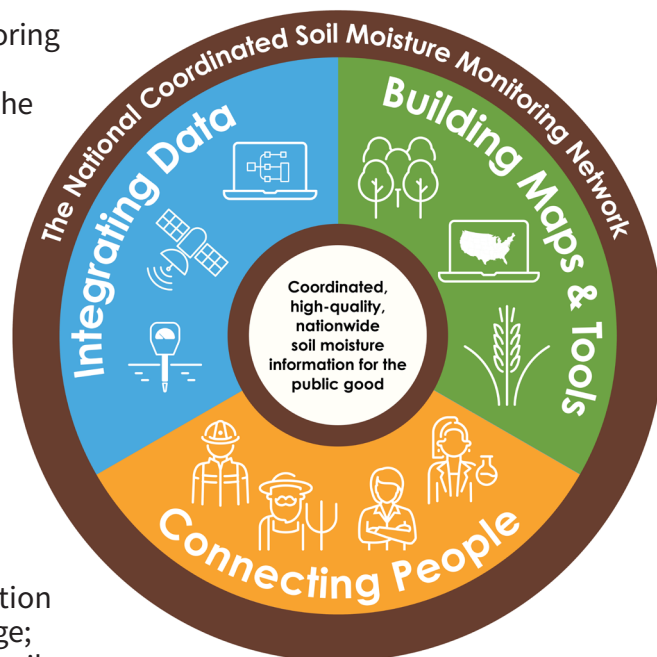
An accurate depiction of soil moisture conditions can provide valuable insights for agricultural conditions monitoring, weather prediction, and drought and flood early warning. NOAA's National Integrated Drought Information System (NIDIS), working in collaboration with the U.S. Department of Agriculture (USDA) and other partners, is leading the effort to implement the National Coordinated Soil Moisture Monitoring Network (NCSMMN): a multi-institutional initiative to integrate soil moisture data from across the country and to capitalize on its transformative potential across sectors of the economy.

Mission and Goals of the Interagency National Coordinated Soil Moisture Monitoring Network

The mission of the National Coordinated Soil Moisture Monitoring Network (NCSMMN) is to provide **coordinated, high-quality, nationwide soil moisture information for the public good**. The NCSMMN will deliver this by (1) integrating soil moisture data from a wide range of federal and state in situ monitoring networks into a consistent set of data products; (2) merging these in situ data appropriately with remotely sensed and modeled hydrologic data; and (3) producing high-quality, easy-to-understand decision support products for soil moisture to inform drought, flood, and fire early warning systems; improve crop production and resilience; support hydrologic and climate modeling; and benefit other natural resource applications.

The goals of the NCSMMN to realize this mission include:

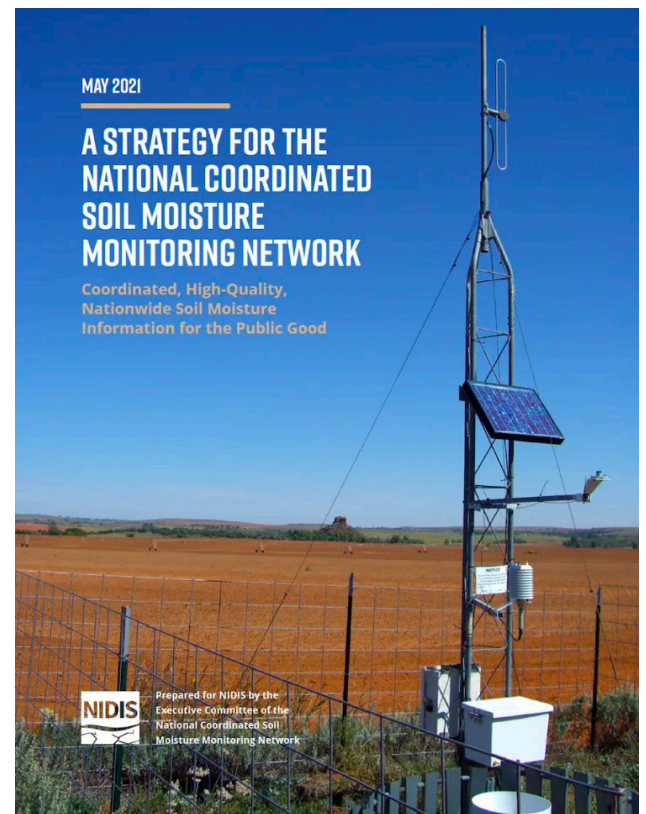
- **Establishing a national “network of networks”** that effectively demonstrates data and operational coordination of in situ soil moisture networks and fills gaps in coverage;
- **Building a community of practice and expertise** around soil moisture measurement and interpretation—a “network of people” that links data providers, researchers, and the user community; and
- **Supporting research and development of innovative techniques** to merge in situ soil moisture data with remotely sensed and modeled hydrologic data to create near-real-time, gridded, user-friendly soil moisture maps and associated tools.



National Coordinated Soil Moisture Monitoring Network (NCSMMN) Strategy

A key early success for the NCSMMN was the release of the Congressionally directed NCSMMN Strategy in 2021, which provides a road map forward and specific recommendations to realize a national network. This strategy, developed by a NIDIS-led interagency committee, includes the following nine recommendations:

- Determine a home agency and management structure for the NCSMMN
- Establish a web presence and formalize communication and outreach planning for the NCSMMN
- Formalize partnerships with the National Mesonet Program and existing monitoring networks
- Develop a set of criteria for high-quality data sources
- Support research necessary to develop or improve NCSMMN methodologies
- Increase in situ soil moisture monitoring nationwide
- Explore increasing partnerships with the private sector
- Engage with the citizen science community
- Develop, release, and promote NCSMMN products



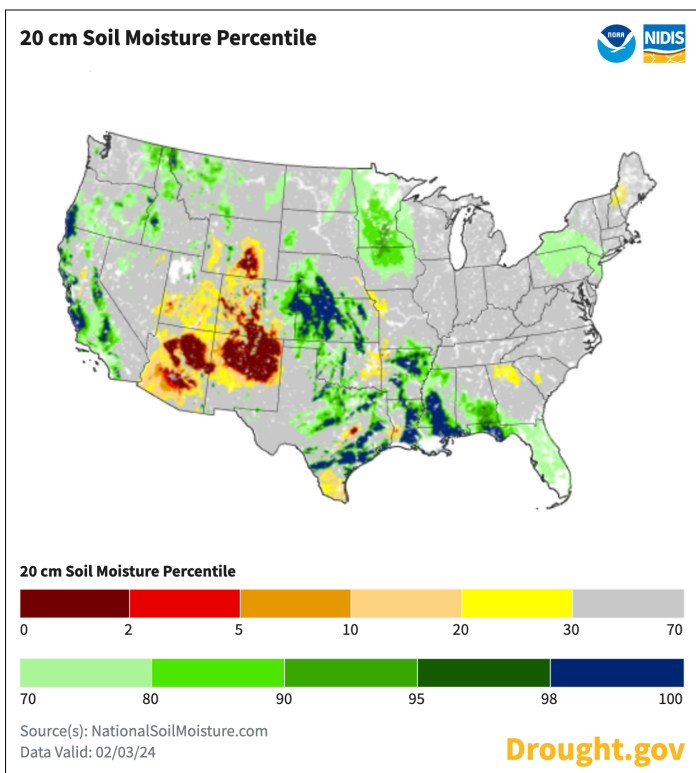
What is Soil Moisture?

Soil moisture—sometimes also called soil water—represents the water in land surfaces that is not in rivers, lakes, or groundwater, but instead resides in the pores of the soil. The level of soil moisture is determined by a host of factors beyond weather conditions, including the type of soil and associated vegetation. In turn, soil moisture levels affect a range of soil and plant dynamics. Surface soil moisture is the water that is in the upper 10 cm of soil, whereas root zone soil moisture is the water that is available to plants—generally considered to be in the upper 200 cm of soil.

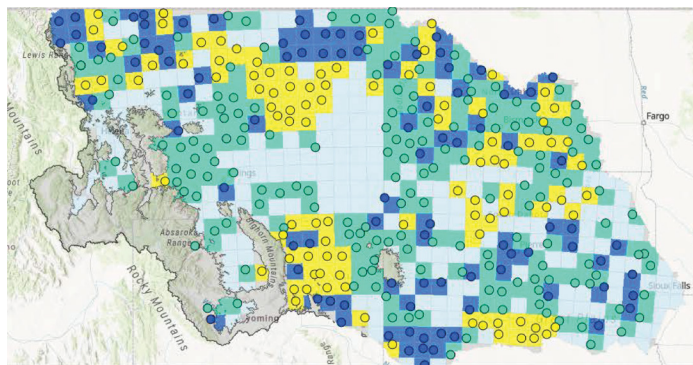
The amount of soil moisture can have significantly different implications depending on location, season, soil type, and depth. For example, the same level of soil moisture can indicate a serious drought in the Southeast, while it represents normal soils in the Southwest. Interpreting soil moisture data requires assessing and maintaining a range of other “metadata,” particularly soil characteristics. It also means that more than one unit of measure may be needed to adequately describe conditions, including not only “volumetric water” (the volume of water present), but also anomalies (“how different is this value from the average for this time of year”), daily ranking percentages (“where does this value fall in a ranking from lowest observed to highest observed for this time of year”), etc.

Early Successes of the National Coordinated Soil Moisture Monitoring Network (NCSMMN)

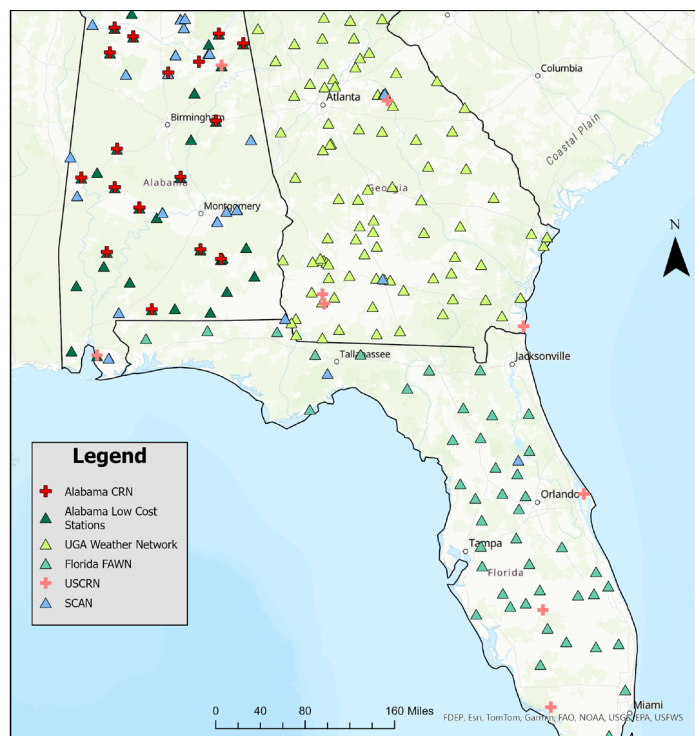
- Coordinated soil moisture network expansions in the Upper Missouri River Basin and in the Southeastern U.S., both areas that were previously underrepresented
- Development of proof-of-concept gridded national soil moisture maps that blend in situ, satellite, and modeled data
- Active stakeholder engagement and interaction through the annual National Soil Moisture Workshop, special topic workshops and webinars, and other venues
- Initiation of a Forest Soil Moisture Monitoring Network, under the leadership of the U.S. Forest Service



Drought.gov integrates soil moisture data from various sources to provide accessible maps to support decision making.



The NCSMMN supports a major soil moisture monitoring network expansion of 540 stations across the Upper Missouri River Basin. In the map above (January 2024), completed stations are shown in teal, stations in process are in blue, and candidate sites are in yellow. Map: U.S. Army Corps of Engineers



With funding from a NOAA Weather Program Office grant, state universities in Alabama, Georgia, and Florida are collaborating to enhance their soil moisture monitoring networks and develop soil moisture crop-support and other tools. This map shows soil moisture monitoring stations within the region. Map: University of Alabama in Huntsville/Alabama State Climatologist Office.



Participants gain experience with mobile soil moisture probes at the 2023 National Soil Moisture Workshop Hands-on Field School at the U.S. Department of Agriculture Beltsville Agricultural Research Center in Maryland.

Looking Forward

With the Strategy as a guide, NIDIS and our partners will focus on the following types of activities over the next few years:

Delivering technical assistance to data providers. Activities include development of an Installation Protocol for In Situ Soil Moisture Data Collection, and an upcoming Soil Moisture Data Quality Guidance Document, along with hosting a Soil Moisture Field School to provide “hands in the dirt” experience with in situ soil moisture monitoring.

Increasing monitoring in data-sparse areas. The US Forest Service has begun active planning for expanded forest monitoring. In addition, soil moisture (and other weather and climate) monitoring on tribal lands is limited, despite the significant area these lands represent.

Addressing the soil moisture and wildfire nexus. There is an emerging opportunity to use soil moisture information to help natural resource managers anticipate and manage wildfire risks, including by updating the National Fire Danger Rating System to include soil moisture.

Developing a curated “kiosk” for soil moisture products. Through NCSMMN listening sessions, users have called for a better way to navigate through existing products; for example, a central location where details on latency, coverage, methodology, and other metadata information are documented and user-friendly tutorials are provided.

Delivering soil moisture information to the U.S. Drought Monitor. The U.S. Drought Monitor is a national map that comes out every Thursday, showing where drought is and how severe it is. There is widespread recognition that the use of soil moisture information could provide a higher level of confidence in determining drought status.

Conducting a Data Value Study to assess new soil moisture and snowpack data. This congressionally directed effort will assess the value of soil moisture (and snowpack) data from the U.S. Army Corps of Engineers project in the Upper Missouri River Basin for improved drought and flood forecasts and other applications, with broad implications for other soil moisture monitoring efforts.

Community building and engagement. This includes continued support for the annual National Soil Moisture Workshop as well as sector-based and regional workshops, research seminars, national educational webinars, and other outreach opportunities. An active network of subject matter experts and data users ensures that NCSMMN efforts in data generation, delivery, and application will best meet the needs of the Nation in improving natural hazard early warning systems.

Key Partners

- National Oceanic and Atmospheric Administration (NOAA)
 - National Integrated Drought Information System (OAR-NIDIS)
 - National Centers for Environmental Information (NCEI)
 - National Weather Service (NWS)
- U.S. Department of Agriculture (USDA)
 - Office of the Chief Economist (OCE)
 - Agricultural Research Service (ARS)
 - Natural Resources Conservation Service (NRCS)
 - U.S. Forest Service (USFS)
- National Aeronautics and Space Administration (NASA)
- United States Geological Survey (USGS)
- U.S. Army Corps of Engineers (USACE)
- State mesonets from across the country
- Academic institutions, including the Ohio State University, Oklahoma State University, University of Nebraska-Lincoln, and others
- Community Collaborative Rain, Hail and Snow Network (CoCoRaHS)
- Private-sector companies (e.g., soil moisture sensor vendors)