National Aeronautics and Space Administration

NISAR: The NASA-ISRO SAR Mission

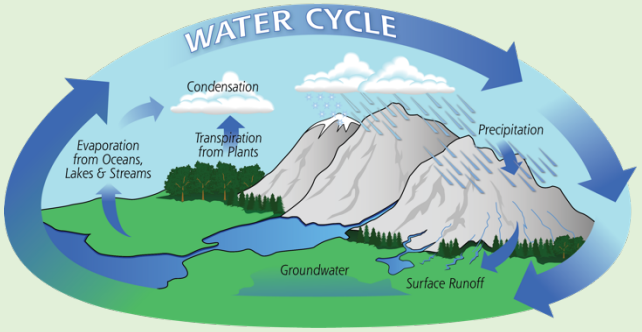
Water: Vital for Life and Civilization

NISAR will provide maps of surface soil moisture globally every 6 to 12 days at the spatial scale of individual farm fields. This offers unprecedented detail and is vital for monitoring the habitats of plants, animals and humans.

Surface soil moisture

Water is critical to life on Earth. The health and continued existence of all life on Earth depends on having access to water. The amount and timing of surface water can vary in ways that significantly affect quality of life. On the one hand, excess water can lead to flooding, landslides, crop failures and outbreak of vector-borne disease. On the other hand, water shortage causes drought, wildfires and stress on farming activity.

Adapting to surface water conditions requires information, from regional scales down to the scale of an individual field. Maps of soil moisture provide essential information, because they help link the major components of the Earth's water cycle among precipitation, evaporation, storage, and runoff. Field-scale maps are required to identify the fine spatial details needed for agriculture.



Photos : USDA (left), USGS (right)

Surface Water and Soil Moisture

Soil wetness affects a large part of human life and civilization. The impact of either excess or inadequate surface water can be devastating, and even seemingly small variations can have a large impact on crop yield and insect populations. Soil moisture, measurable from space with synthetic aperture radar, is an excellent indicator of surface water availability and is widely used in agriculture and forest resource and fire management.

The NISAR Mission – Reliable, Consistent Observations

The NASA–ISRO Synthetic Aperture Radar (NISAR) mission, a collaboration between the National Aeronautics and Space Administration (NASA) and the Indian Space Research Organization (ISRO), will provide all-weather, day/night imaging of nearly the entire land and ice masses of the Earth repeated 4-6 times per month. NISAR's orbiting radars will image at resolutions of 5-10 meters to identify and track subtle movement of the Earth's land and its sea ice, and even provide information about what is happening below the surface. NISAR will also provide information on crop area and forest biomass over time and with enough detail to reveal changes on field scales. Products are expected to be available 1-2 days after observation, and within hours in response to disasters, providing actionable, timely data for many applications.

Floods: Floods cause devastation in many parts of the world every year. Soil moisture information helps in predicting the flood potential. Although floods are triggered by heavy rainfall, saturated soil vastly increases the chances of flood because the soil can no longer absorb rainwater. Floods can occur within a watershed when rain that is not absorbed by the soil drains through a narrow outlet too slowly to accommodate the rate of rainfall. Because watersheds can be very small (10 ha, or 0.1 km^2), the currently available spaceborne soil moisture maps at ~25 km spatial resolution are not adequate for many watersheds. NISAR's field-scale mapping capability (200m resolution) will alleviate this problem.

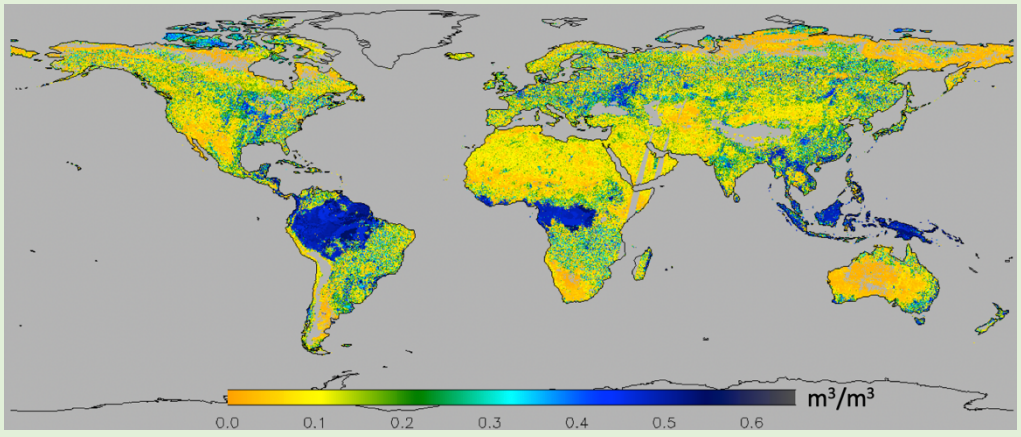
Landslides: Landslides often develop abruptly, leaving little time for residents to escape. Landslides are often preceded by wetting of the soil, which causes the soil to become loose (less cohesive). Considering that areas of landslide can be small and that they occur on sloped terrain, improving the spatial resolution of soil moisture maps is critical if they are to be used for landslide hazard identification.

Wildfires: In recent years, wildfires have caused numerous catastrophes, especially in the western U.S., and the problem is apparently becoming more severe. Not only can NISAR monitor the current condition of a major wildfire by characterizing the vegetation, but surface soil moisture plays an important role in predicting the probability of a fire outbreak, because a prolonged dry condition is often one of the prerequisites of fire outbreak.

Vector-borne disease: According to the World Health Organization, vector-borne diseases account for more than 17% of all infectious diseases, causing more than 700,000 deaths annually. Wet soil conditions are highly correlated with the extent of stagnant water that encourages insect disease vectors. These waterbodies are often too small to directly detect from space. Therefore, the high-resolution soil moisture can be an effective indicator of the likelihood of the vectors and the presence of disease.

Agriculture: Accurate information of soil moisture at the scale of a single agricultural field allows for efficient irrigation, water use, and fertilization. Efficient irrigation conserves water resources, which are increasingly depleted in the U.S. and world-wide due to drought and the growing demand for food. Optimized fertilization reduces cost and prevents excess nutrients from polluting a river system. Soil moisture conditions have been reported traditionally by field agents, and NISAR aims at providing for the first time the information at these field scales in an automated, uniform, and reliable way.

Radar imaging of soil moisture



Global map of surface soil moisture imaged by the radar onboard NASA's Soil Moisture Active Passive satellite (SMAP) at 3-km spacing over an 8-day period in May, 2015. NISAR radar will operate in a similar way of the SMAP radar but at enhanced spacing to allow soil moisture mapping at the field-scale. From Kim, S.B., et al., Surface soil moisture retrieval using the L-band synthetic aperture radar onboard the Soil Moisture Active Passive (SMAP) satellite and evaluation at core validation sites, *IEEE Trans. Geosci. Remote Sens.*, *55*, 1897 - 1914, 2017