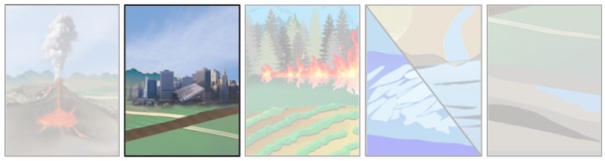
National Aeronautics and Space Administration

NISAR: The NASA-ISRO SAR Mission



Levees and Dams: Flood Defense for U.S. Communities

A vast network of dams and levees protect communities throughout the U.S. from floods. Maintaining these structures is absolutely critical and requires constant vigilance. Radar remote sensing with NISAR can provide early warning of movement and seepage in time to prevent disaster.

Dams & Levees: Flood Prevention, Water Conservation, Energy Generation, and Sports and Recreation

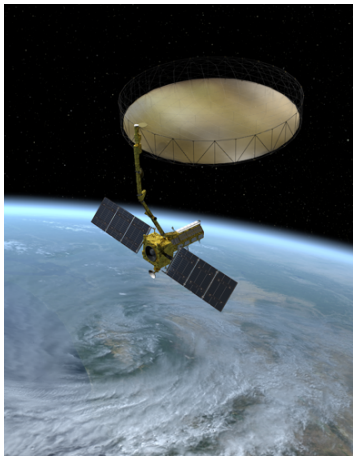
Levees and dams serve multiple functions besides their primary function of flood prevention. Dams provide hydroelectric power, store and protect the water supply, and provide recreation areas where people relax, and where fish, birds, and game live and breed. Levees don't just keep water from inundating the land, but also channel water to communities and businesses where it is needed.

Monitoring levees and dams is time-consuming and personnel intensive, causing infrequent monitoring of most areas. Remote sensing with NISAR can increase inspection, imaging the entire U.S. several times a month regardless of season, light, and weather, to detect changes before they become disasters.

Photos (clockwise): California DWR, USACE, USACE, NASA/JPL-Caltech

Levee and Dam Monitoring from Earth Orbit

The U.S. is protected by tens of thousands of miles of levees and hundreds of dams, most of which were built in the last century. This aging infrastructure requires both routine monitoring and maintenance and intensive survey following stress from floods or earthquakes. Today, by and large, the integrity of the dams and levees is determined from visual inspections made by experienced personnel from vehicles or on foot, infrequent ground-based land elevation survey of small sections, and very limited semi-permanent instruments installed in-ground.



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. Its repeated set of high resolution images can inform resource management and be used to detect small-scale changes before they are visible to the eye. 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.

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Modern radar remote sensing methods can revolutionize the way that levee and dams are monitored, significantly increasing the spatial coverage, frequency of measurement, and consistency of the observation methods. Remote sensing can improve upon and augment the traditional methods of detecting slope failures, subsidence, and seepage, all of which are indicators of the health of the infrastructure.

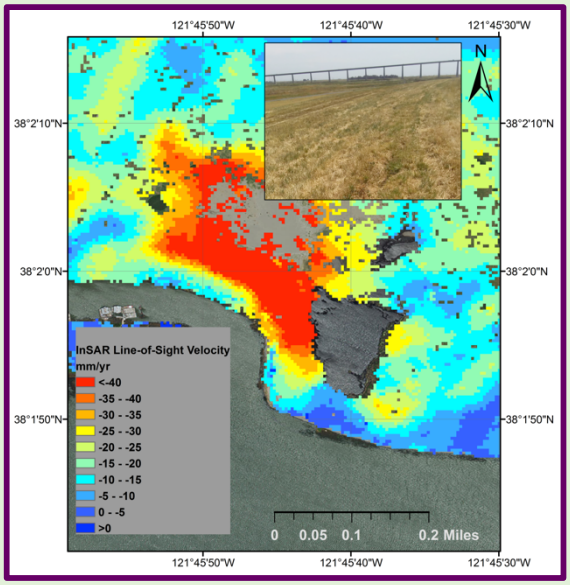
Instead of determining ground movement from a change in two or more measurements of elevation, it is possible using NISAR to measure surface movement directly without knowledge of absolute surface elevation. The technique used to measure ground displacement relies upon repeat imaging of an area with a high-resolution synthetic aperture radar (SAR) instrument and performing a specific type of processing known as interferometry (InSAR). This technique measures changes in the distance between the radar antenna and the ground along the direction of radar illumination, at the scale of a fraction of the radar wavelength, which for NISAR is 24 cm. Synthetic aperture radar interferometry is a remote sensing method that can be used to measure surface deformation directly across large areas at one time with far greater accuracy than is possible with traditional ground-based leveling surveys or LiDAR differencing. Radar has additional advantages over those methods, including the ability to see through clouds, smoke, and haze, and to image the surface day or night without relying on solar illumination. SAR can also be used to detect developing seeps through changes in soil moisture, which can be very useful during flood response where no baseline, pre-flood imagery is available.

NASA's space-based Earth observing radar instrument will be an effective tool for both long-term failure mitigation and short-term rapid response in emergency situations. Using NISAR, we can apply advanced technology to protecting levees and dams in the U.S. through frequent, repeated and consistent imaging. Space-based resources such as this could be routinely used to guide decision-makers and commercial interests alike in order to more effectively and efficiently target repair and upgrades.

Radar-based Measurement of Levee Conditions

Observations of the Earth's land surfaces from space using active microwave sensors enable reliable and repeated measurements to be made throughout the year, building up a baseline set of observations that show typical change in the general vicinity of flood protection structures (e.g., dams, levees, spillways) from which abnormally large localized movement or rapidly changing parts of the structures can be identified. Information like this is used to quantify the status of all levees and dams that are imaged from space, both in urban communities and remote from populated areas. This valuable information will enable smart targeting of resources for maintaining dams and levees, and will provide rapid reassessment of their health following a stressor event, such as increasing flood water level, earthquakes, or human-initiated threats.

Shown at right is a land movement map derived from images acquired by UAVSAR, the NASA airborne instrument that is the prototype for NISAR. These data were collected to develop new remote sensing methods for levee monitoring, and are being actively used today to target ground observations and levee repair and to prepare for emergency response to levee breaks in the future.



Map showing rate of ground movement along one of the levees that prevents flooding of an island in the Sacramento-San Joaquin Delta [Deverel 2016]. The inset photo shows a view looking east towards the area of most rapid movement (red/orange color). The signal, clearly visible to the radar, is not obvious to an observer on the ground.