

National Land Imaging Program

Introduction

Changes taking place across the Earth’s land surface have a daily effect on people, economies, and the environment. Our Nation’s economic security and environmental vitality rely on continuous monitoring of the Earth’s continents, islands, and coastal regions to record, study, and understand land change at local, regional, and global scales.

The U.S. Geological Survey (USGS) National Land Imaging (NLI) Program helps meet this need by ensuring the continuous availability of moderate-resolution satellite imagery and other remotely sensed and geospatial data. A key responsibility of the NLI Program is providing worldwide access to data acquired since 1972 by the USGS flagship Landsat satellite series (figs. 1 and 2).

Furthermore, the NLI Program contributes nationally and internationally to the advancement of land remote sensing technologies and applications. To complete these goals, the NLI Program relies on partnerships with the National Aeronautics and Space Administration (NASA) and other Federal agencies and continually grows cooperative relationships with industry, foreign space programs, and international consortia.

The NLI Program focuses on the following activities to maximize the public benefit of land imaging: (1) documenting and addressing user needs for land imagery data; (2) sustaining and enhancing acquisition of those data for government and public use; (3) preserving the Earth data record and ensuring continued data access; (4) developing new technologies, applications, and Landsat-derived science data products; and (5) supporting development of national and international policy on Earth observations and land imaging.

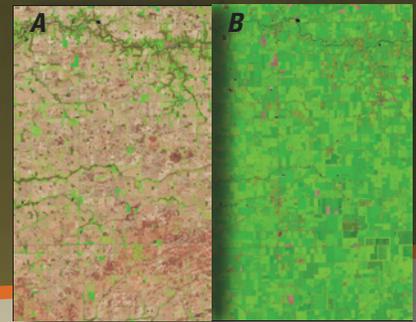


Figure 1. A pair of images from Landsat 8 showing agricultural land near Indianapolis, Indiana. *A*, before planting; *B*, during the growing season.

Focusing on User Needs

User needs determine the type of land-imaging data the NLI Program generates and acquires. The NLI Program manages a process to collect and analyze users’ land-imaging needs, focused on specific measurement parameters rather than on any particular observing system. It helps inform land-imaging system development, determine appropriate data purchases, and prioritize partnerships for access to data from non-USGS land-imaging satellite missions. These activities ensure NLI Program priorities are closely coupled with evolving user needs for a wide range of land-imaging data.

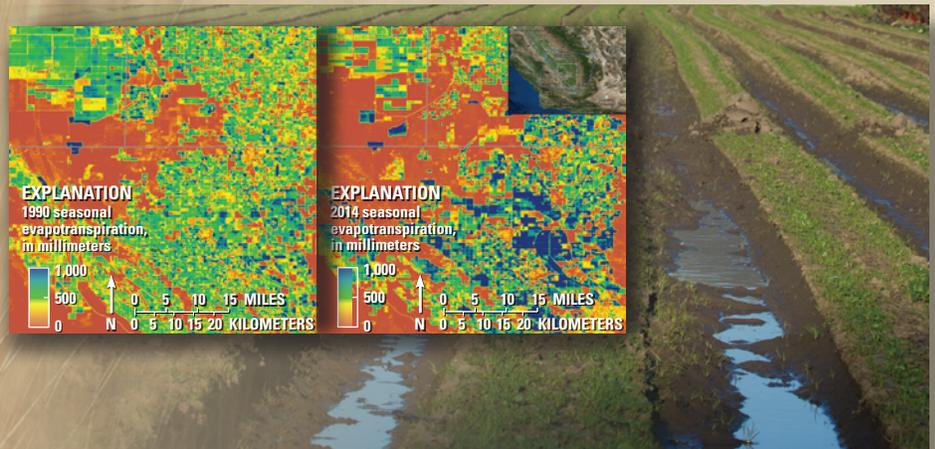


Figure 2. This pair of seasonal evapotranspiration maps (May–September) shows crop water use in the San Joaquin Valley, California, in 1990 and 2014. The colors correspond to millimeters of water returned to the atmosphere through evapotranspiration—the transfer of water from the land to the atmosphere by evaporation from soil and other surfaces—and transpiration from plants. Fields that are green and blue show the highest evapotranspiration values. More water was used on those irrigated fields. Orange hues are areas that have very little evapotranspiration, such as sparsely vegetated desert.

Sustaining and Enhancing Land Imagery Data Acquisition

Continuous land imaging from space is vital to accurately assess the impacts and implications of global land change, now and in the future. Landsat imagery has been used for almost 50 years for looking at crop health and production, tracking water use, documenting urban growth, mapping wildfires, monitoring the well-being of forests, assessing the impact of industrialization, and informing efforts to reduce hunger globally.

Since 2000, the USGS and NASA have shared responsibility for managing the Landsat program. NASA oversees the construction and launching of the satellites. The USGS NLI Program, via the USGS Earth Resources Observation and Science (EROS) Center in Sioux Falls, South Dakota, directs Landsat flight operations; oversees the building and testing of the satellite flight and

ground systems; coordinates the operational ground receiving station network; and manages the acquisition, production, calibration, validation, and distribution of Landsat data and derived products for users worldwide.

Following the successful launch of Landsat 8 in 2013, and the recognition that Landsat is the most widely used land remote sensing data source within Federal civil agencies, the U.S. Government formally acknowledged the importance of continuing the Landsat program and its invaluable, uninterrupted data stream. It proposed and funded the design and implementation of a spaceborne system to acquire continuous, global Landsat-quality imagery of the Earth's land areas for the next 25 years.

The USGS NLI Program shares responsibility with NASA to develop and execute a strategy for sustainable land imaging (SLI) to ensure continuity of Federal civil land-imaging capabilities beyond the currently deployed Landsat

systems (fig. 3). As part of the SLI effort, NASA and the USGS are collaborating to develop the space and ground systems for Landsat 9, scheduled to launch in 2021. They also are developing a follow-on mission, known as "Landsat Next," which will provide new, advanced observing capabilities to meet an even broader range of user needs for Earth system monitoring, assessment, and prediction. Landsat Next will capitalize on new technologies and likely will include new commercial and international partnerships.

The joint USGS/NASA SLI initiative, though foundational to the NLI Program, is not expected to meet all U.S. Federal civil community user needs by itself. The NLI Program therefore conducts additional activities to meet user needs. These activities include the following:

- Supporting the interagency Civil Applications Committee and overseeing the USGS National Civil Applications Center, enabling Federal civil agency access to U.S. National Systems data, and distributing unclassified information products from classified sources;
- Serving as the Federal Geographic Data Committee Imagery Theme Colead, ensuring Federal, State, and local access to high-resolution airborne data and evaluating new imaging technologies;
- Facilitating access to non-USGS satellite data from a variety of international and commercial partners;
- Providing unmanned aircraft system (UAS) funding to the USGS National UAS Project Office, which works with Federal agencies and external stakeholders to support the use of rapidly advancing UAS technology for scientific research and environmental monitoring.

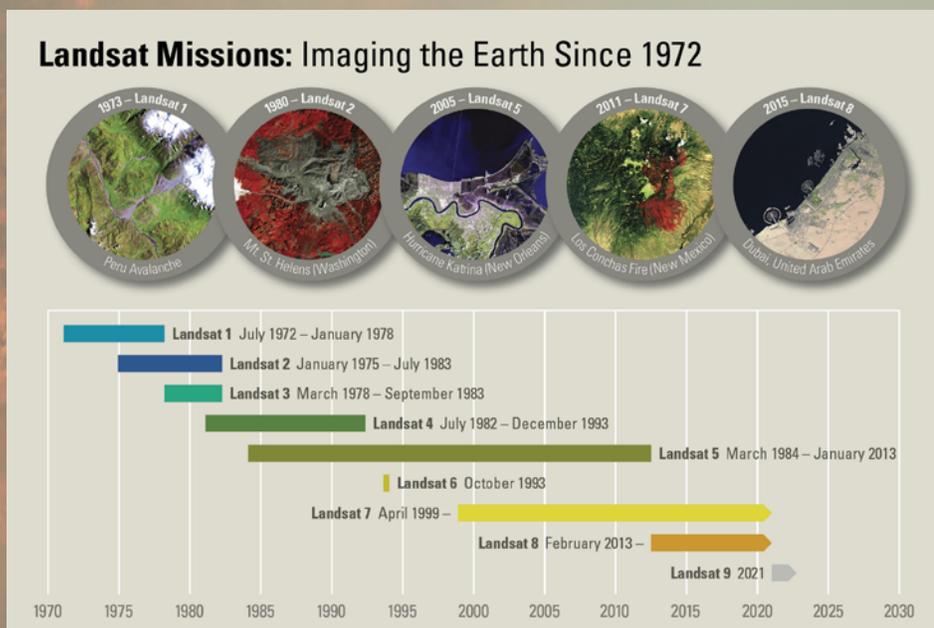


Figure 3. Since 1972, Landsat satellites have continuously acquired space-based images of the Earth's land surface, providing uninterrupted data that help land managers and policymakers make informed decisions about our natural resources and the environment.

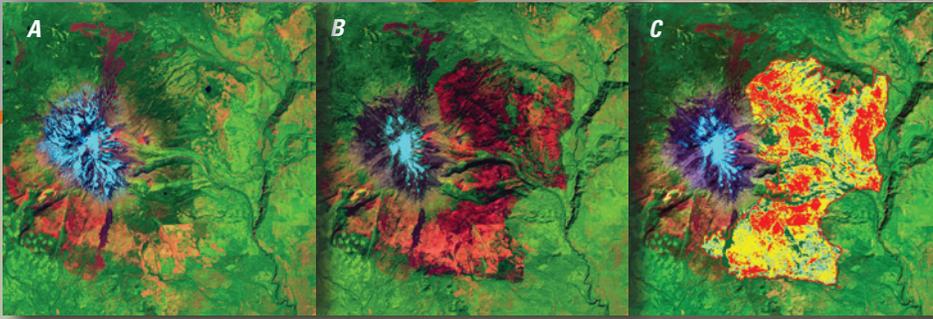


Figure 4. Landsat 8 helped map destruction caused by the Cougar Creek fire near Mount Adams, 75 miles northeast of Portland, Oregon. The postfire image from September 11, 2015, shows where the previously green vegetation south and east of the mountain is now charred and appears in shades of red. In the burn severity map, dark green is unburned, light blue is low burn severity, yellow is moderate burn severity, and red is high burn severity. *A*, image from August 7, 2014; *B*, image from September 11, 2015; *C*, burn severity map.



Preserving the Earth Data Record and Ensuring Continued Data Access

Through the passage of the Land Remote Sensing Policy Act of 1992 (Public Law 102–555; recodified in 2010 as Public Law 111–314), Congress endorsed the need for continuous monitoring of the Earth’s land surface and creation of a dynamic repository of relevant data and information about the status of the Nation’s land resources and environment. To implement the Act, the NLI Program maintains and populates vast collections of digital satellite imagery and millions of aerial photographs and specialized collections, including radar and light detection and ranging (lidar) data (fig. 4). These datasets are located at and managed by the EROS Center and constitute the world’s largest public domain archive of land-imaging data.

The NLI Program ensures unrestricted access to these unique, remotely sensed data collections by web-enabling them in user-consumable formats that are available for download via the internet at no or low cost. Landsat data, for example, have been available free of charge to users worldwide since 2008. Millions of automatically preprocessed Landsat images are downloaded from EROS servers each month, and even more are redistributed via commercial cloud service data providers. These and other land-imaging data provide critical input for understanding changes in land cover and land use, accurately monitoring water

resources and ecosystem health, improving agricultural productivity, assessing the availability of energy and mineral resources, supporting requirements for disaster risk reduction and response, shedding light on the role of the environment and wildlife in human health issues, and understanding the effects of climate variability.

Developing New Technologies, Applications, and Data Products

In addition to acquiring, archiving, and making the vast amounts of remotely sensed data of the Earth’s land surface easily accessible, the NLI Program works to advance the use of numerous types of remotely sensed data and technologies throughout the U.S. Department of the Interior and other Federal agencies and among various user communities across the United States and around the world.

The NLI Program supports research in remotely sensed land data collection, access, distribution, and applications from current and future data sources. It sponsors scientists and engineers who investigate new types of satellite systems and sensors, studying promising new government and commercial data sources, developing new data acquisition mechanisms, and assessing the potential for new data applications. The NLI Program also seeks ways to make use of the Landsat data archive to aid land change monitoring and decision making. The USGS Land Change Monitoring, Assessment, and Projection (LCMAP)

is a key science initiative being implemented to characterize historical and current land change at any location across the Landsat record for the United States. LCMAP provides information on when, where, and why the planet is changing and provides projections to help support evaluations and decisions relevant to environment management and policy. LCMAP is expected to support other key USGS activities like the National Water Model and USGS integrated science and predictive modeling activities.

The NLI Program strives on many fronts to respond to the needs of users for land imagery data and applications. Appropriate data sources and tangible data products are required to create objective, scientifically valid land observations that support land resource management decisions.

Supporting Development of National and International Policy

The NLI Program is actively engaged with other agencies in the development of national and international policies to advance civil Earth observation and land-imaging applications. It supports development and implementation of National Space Policy and the National Plan for Civil Earth Observations. The NLI Program’s role as cochair of the U.S. Group on Earth Observations ensures continued interagency Earth observation coordination with NASA, the National Oceanic and Atmospheric Administration, the U.S. Department of Agriculture,



Example applications for the Land Change Monitoring, Assessment, and Projection (LCMAP) annual product suite.

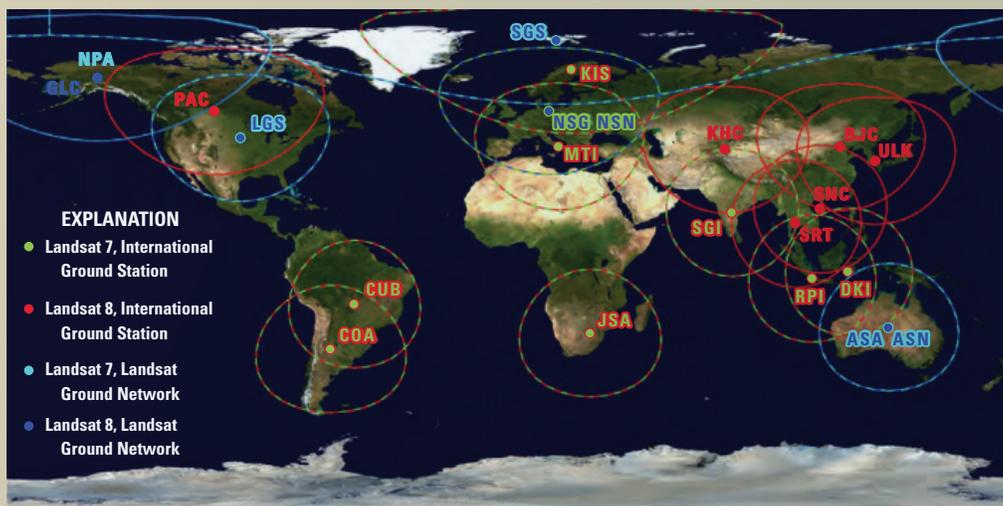


Figure 5. Locations of all ground stations operated by the United States and international cooperators for the direct downlink and distribution of Landsat data. The circles show the approximate area over which each station has the capability for direct reception of Landsat data, and three-letter network station designations.

and other agencies. The NLI Program is actively engaged with the international Group on Earth Observations and the international Committee on Earth Observation Satellites, leveraging international capabilities and related partnerships to better address U.S. land-imaging needs. It supports management of the international Landsat ground station network, collaborating with foreign partners on Landsat data receipt and repatriation of historical Landsat data to the USGS (fig. 5). It supports USGS participation in the International Charter for Space and Major Disasters, enabling rapid access to foreign and commercial satellite data for disaster response and recovery efforts worldwide.

For more information about how the USGS National Land Imaging Program is fostering the use of land remote sensing technology to meet local, national, and global challenges, please visit:

- <https://www.usgs.gov/land-resources/national-land-imaging-program>
- <https://usgs.gov/>
- <https://www.usgs.gov/centers/eros>
- <https://www.usgs.gov/land-resources/nli/landsat>
- <https://landsat.gsfc.nasa.gov/>
- <https://www.usgs.gov/lcmap/>

Available Satellite Imagery	Available Aerial Imagery
<p>Data Collections</p> <ul style="list-style-type: none"> Moderate Resolution (EO) <ul style="list-style-type: none"> Landsat (OLI/TIRS, ETM+, TM, MSS, Film Only) EO-1 (ALL, Hyperion) Terra ASTER Sentinel 2 ISRO SPOT NADB** SPOT Historical** High Resolution (EO) <ul style="list-style-type: none"> Declassified-1/2/3 Commercial Imagery (IKONOS-2) Commercial Imagery (OrbView-3) Commercial Data Purchases (CDP)** Low Resolution (EO) <ul style="list-style-type: none"> Terra MODIS AVHRR HCMM Radar <ul style="list-style-type: none"> SIR-C IFSAR ORI Alaska Other <ul style="list-style-type: none"> Heat Capacity Mapping Mission (HCMM) Image Collections <ul style="list-style-type: none"> CalVal Reference Sites GEOGLAM Global Fiducials Global Forest Observation Initiative (GFOI) Global Land Survey (GLS) JECAM Sites Landsat Legacy Landsat MRLC LIMA Image Mosaic of Antarctica NALC NLDC TerraLook VIIRS Derived Products <ul style="list-style-type: none"> Landsat WELD ASTER Derivatives MODIS Derivatives NASA SRTM <p><small>** RESTRICTED DISTRIBUTION</small></p>	<p>Data Collections</p> <ul style="list-style-type: none"> Photography (Airborne) <ul style="list-style-type: none"> NAIP NAPP NHAP DOQ High-Resolution Orthophotography Single Frame Records Aerial Photo Mosaics (Photo Index) South Dakota NRCS Photography Antarctica Single Frame Records Photo Index Maps <ul style="list-style-type: none"> Antarctica Flight Line Maps (Flight/Photo Index) Photography (Space) <ul style="list-style-type: none"> Space-Acquired Photography UAS <ul style="list-style-type: none"> Variety of Sensors Multispectral/Hyperspectral Images <ul style="list-style-type: none"> Aircraft Scanners ASAS Radar and Radar-Derived <ul style="list-style-type: none"> SLAR AirMOSS Light Detection and Ranging (LIDAR) <ul style="list-style-type: none"> LIDAR (see "Elevation")
	<p>Available Elevation Products</p> <p>Data Collections</p> <ul style="list-style-type: none"> United States <ul style="list-style-type: none"> NED LIDAR IFSAR Alaska Global <ul style="list-style-type: none"> ASTER GDEM GMTED2010 SRTM GTOP030 HYDRO1K

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