

and Landsat

As the Nation's northeastern-most state, Maine's reputation is that of rocky coastlines, rich maritime history symbolized by lighthouses dotting the ocean bluffs, and wondrous nature areas like the granite and spruce islands of Acadia National Park.

But Maine is a place of changes, too. The state has warmed about three degrees Fahrenheit in the last 120 years. Spring is arriving earlier, bringing more precipitation. Heavy rainstorms are more frequent, and summers are hotter and drier. With sea level rising, severe storms increasingly cause floods that damage property and infrastructure.

In the coming decades, as the changing climate continues to increase flooding, harm ecosystems, and disrupt fishing and agriculture, here are four critical areas where Landsat satellite systems can be valuable tools in monitoring those changes and their impacts, on the land and in the water.

National Land Imaging Program Benefits: Maine

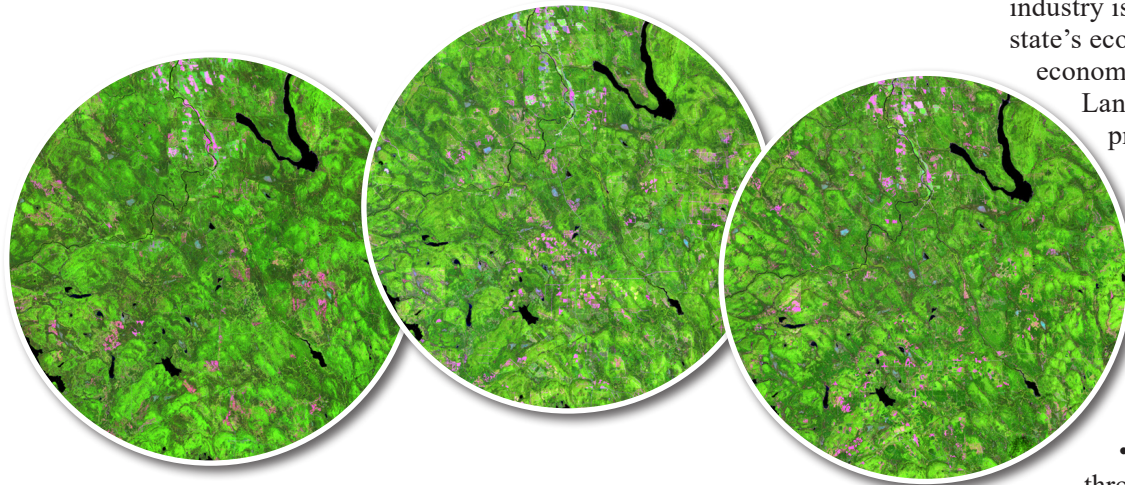
The U.S. Geological Survey's (USGS) National Land Imaging (NLI) Program provides to government, commercial, academic, and public users a wide range of satellite imagery and other remotely sensed and geospatial data. These activities include worldwide access to Landsat satellite data through the NLI-funded USGS Earth Resources Observation and Science (EROS) Center.

Forest Health and Changes

With 89% of its territory classified as forest, Maine is the most forested state in the Nation. The forest industry is a driving force in the state's economy, with an annual economic impact of \$8.5 billion.

Landsat time-series imagery provides a valuable asset to the forestry industry. When use with county-level Forest Inventory and Analysis estimates, it is particularly effective in helping decision makers to:

- Analyze forest distribution;
- Identify forest cover loss through harvests, fire, disease, or other disturbance;
- Provide forest gain through regeneration.



These three Landsat images, from the summers of 1985, 2002, and 2019, show areas in northeastern Maine where forest clearcuts are occurring over time. The pink areas in the upper center and upper right are from agriculture. The green in all three images is forest. Throughout the lower and center part of the images, areas of pink are where forests have been cleared.

Fishing and Farms

Researchers from the University of Maine have demonstrated that Landsat 8 data are useful in aquaculture site selection. Each summer, the state closes areas of coastline to shellfish harvesting due to harmful algal blooms. Analyzing validated Landsat temperature and water quality fields enables the siting of such things as promising oyster aquaculture areas. Landsat surface reflectance data can also help to differentiate between nutrient deficiencies and insect/weed problems in farm fields. Site-specific farming using Landsat can increase farm income and resolve environmental issues, thus easing farm management decisions.

In Maine, where potatoes are an important crop, Landsat surface reflectance data can help to differentiate between nutrient deficiencies and insect/weed problems in farm fields. (Credit: Maine.gov)



Water quality

Sensors on Landsat are used to monitor and predict potentially harmful algal blooms in Maine's many freshwater lakes. Researchers have developed a variety of algorithms that establish different mathematical relationships between Landsat 8's reflectance bands to estimate chlorophyll concentrations. Road runoff, lawn treatments, and agricultural chemicals fuel algal growth and affect water quality. Algae then blanket a lake's surface, cut off sunlight and oxygen, and smother aquatic species. Forecasting algal blooms can help managers warn swimmers and other lake users to avoid contact with the water. It also informs treatments that can prevent a bloom and protect aquatic life.

Coastlines and Wetlands



Landsat images are used to create Digital Elevation Models (DEMs) that can help identify where storm surges are becoming higher, eroding shorelines, and making coastal cities more vulnerable to storms. (Credit: Maine.gov)

Rising sea level erodes Maine's wetlands and beaches. It increases damage from coastal storms. Geographers and remote sensing scientists use Landsat to create Digital Elevation Models (DEMs) to map the elevations and help inform state and local authorities on:

- Where human activities, such as filling tidal wetlands, not only impact habitat for bird and fish species, but remove an important line of defense against coastal flooding;
- Where storm surges are becoming higher, eroding shorelines, and making coastal cities more vulnerable to storms;
- Where community infrastructure, such as highways, rail lines, wastewater treatment plants and more are threatened by sea level rise and future storm surges.

This information can be used by state and local decision-makers and citizens alike to safeguard life and property, and protect Maine's wondrous land and seascapes for future generations.

The Landsat series is a joint effort of USGS and NASA. NASA develops and launches the spacecraft; USGS manages satellite operations, ground reception, data archiving, product generation, and data distribution. Funding for the National Land Imaging Program's Landsat operations and data management is provided through USGS.

Landsat: Critical Information Infrastructure for the Nation

Landsat is the most widely used land remote sensing data source within Federal civilian agencies. Local, State, and Federal agencies use Landsat to monitor and forecast a wide range of land surface phenomena. Information from Landsat contributes to day-to-day decisions on land, water, and resource use that protect life and property, safeguard the environment, advance science, technology and education, and grow the U.S. economy. Landsat's imagery provides a landscape-level view of land surface, inland lake, and coastal processes, both natural and human-induced. Landsat enables us to better understand the scope, nature, and speed of change to the natural and built environment.

Businesses draw upon Landsat data to provide customer-specific applications to improve logistics, resource allocation, and investment decisions. Commercial space imaging firms leverage Landsat data to refine product offerings and support new information services. A 2017 USGS study found ***the total annual economic benefit of Landsat data in the U.S. to be \$2.06 billion***, far surpassing its development and operating costs.

Landsat 7 and Landsat 8 provide eight-day repeat coverage of the Earth's land surfaces. Landsat 9, which will replace the aging Landsat 7, is under development for launch in 2021. NASA and USGS are currently reviewing the findings from a joint Architecture Study Team, which will inform the design and implementation approach for Landsat Next, the follow-on mission to Landsat 9. Landsat 9 and its successors will provide a sustainable, space-based system to extend the nearly 50-year Landsat series of high-quality global land imaging measurements—the world's longest time series of the Earth's land surface.

The long-term availability of consistent and accurate Landsat data, combined with a no-cost data policy, allows users to analyze extensive geographic areas and better understand and manage long-term trends in land surface change. New cloud computing and data analytics technologies use Landsat data in a wide range of decision-support tools for government and industry. Much like GPS and weather data, Landsat data are used every day to help us better understand our dynamic planet.

For additional information on Landsat please contact:

Tim Newman
Program Coordinator
USGS National Land Imaging Program
12201 Sunrise Valley Drive
Reston, VA 20192
tnewman@usgs.gov
(703) 648-4405