

MINNESOTA

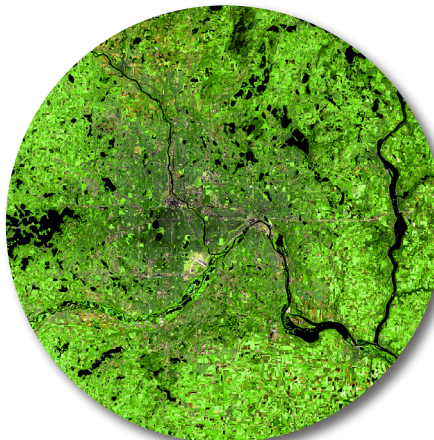
and Landsat

Minnesota, the “Land of 10,000 Lakes”, treasures the beauty of its natural environment. Yet the state is also home to a wide range of agriculture, services, manufacturing, tourism, and natural resource industries. Minnesotans understand the need to grow their economy and manage their resources in an environmentally sustainable manner. As such, the state requires accurate and timely environmental information to help its citizens understand and manage the changing landscapes where they live, work, and play.

The Landsat series of land-imaging satellites underpins public and private sector decisions in the state and across the nation for effective adaptation to changing landscapes through: enhanced agricultural productivity, smart urban development, sustainable forest management, inland lake water quality monitoring, increased disaster resilience and risk assessment, effective water use, climate research, and other applications. Three examples for the State of Minnesota follow below.

Smart Urban Development

The Twin Cities of Minneapolis and St. Paul are home to approximately 54% of Minnesota’s population. Municipal authorities need to know how to manage continued economic development and resulting urban growth in harmony with the surrounding environment. Landsat sensors are ideally suited for detecting the impact of people on their surrounding landscape. For cities, that translates into the monitoring of urban sprawl and land-use efficiency, measuring impervious surface area (e.g., buildings, roads, parking lots), observing heat island effects, and linking urban growth and rainfall pattern change.



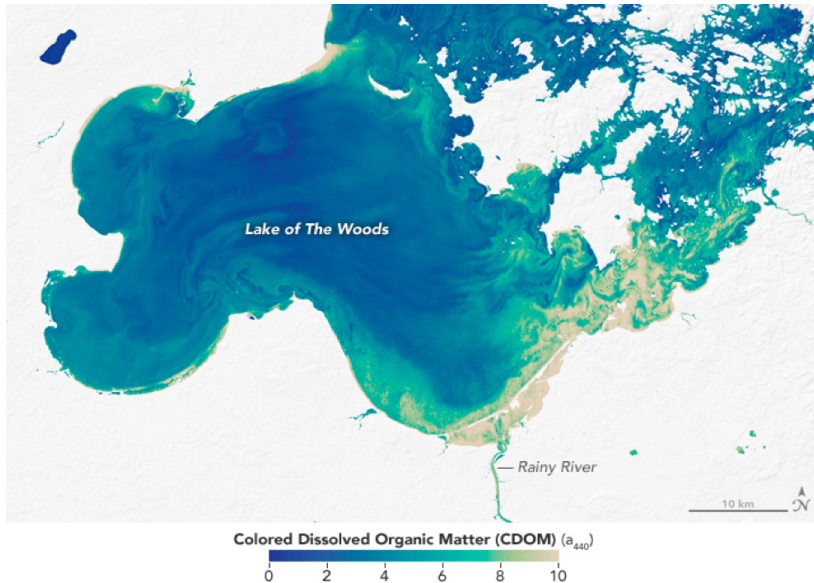
Urban and suburban growth in the Twin Cities area over the past 32 years. The image on the left is from August 1986 and the image on the right is from August 2018.

National Land Imaging Program Benefits: Minnesota

The U.S. Geological Survey (USGS) National Land Imaging 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.

Water Quality Monitoring

Minnesota's numerous inland lakes are sources of pride, respite, and recreation for its citizens. State and local authorities need to protect lakes' water quality for recreational, consumptive, and environmental purposes. With so many lakes across so broad an area, it has proven impossible to assess even a small fraction of them through conventional field methods. The use of Landsat is a cost-effective way to gather the information needed for regional water quality assessments. Using Landsat, researchers at the University of Minnesota were able to classify the water clarity of more than 10,000 lakes across the state. Knowledge gained from this work can inform local authorities' water management and remediation efforts.



Color Dissolved Organic Matter in Minnesota's Lake of the Woods (source: NASA Landsat Image Gallery)

Precision Agriculture

Landsat data help farmers to make decisions on optimal livestock rotation, understand current crop conditions, and vary their application of fertilizer and seed. AWG Farms in Minnesota have used Landsat imagery to monitor its fields' variable nitrogen content in beet leaves and soil tillage since 1997. With this knowledge, using GPS-enabled variable fertilizer application, AWG can save 60–70 pounds of nitrogen per acre and reduce effects on the environment from nutrient runoff and leaching caused by over-application of fertilizer.



On the hand-held tablet above: Landsat 5 imagery collected July 13, 2005, of a sugar beet field, show a true color composite (left), color infrared (center), and near-infrared band (right) processed to show vegetation status related to nitrogen. In the (right) image, magenta indicates vigorous growth and high nitrogen; lighter green indicates low nitrogen and plants under stress. In the case of sugar beets, slight levels of stress are desired because stress maximizes development of sugar content. (From Gary Wagner, AWG Farms)

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.

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