Statement of

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Landsat at 50 & the Future of U.S. Satellite-based Earth Observation

Chairman Hickenlooper, Ranking Member Lummis, Members of the Subcommittee and Committee, I am pleased to testify before you today during such a dynamic and innovative time in Earth observation science. The Department of the Interior (DOI) and the U.S. Geological Survey (USGS) have a long history of providing observations of the Earth, including its topography; biological, geological and water resources; and natural hazards such as earthquakes, volcanoes, wildfires, and coastal change. True to its mission, the USGS is providing science for a changing world.

History of Landsat

The USGS has been involved in the Landsat program since the late 1960s, when the DOI charted a bold vision for the use of space technology to sustainably manage the Earth's natural resources.

The first Landsat satellite was launched on July 23, 1972. It has been succeeded by a series of Landsat satellites that, over 50 years, have drawn a comprehensive portrait of our planet from 400 miles in space. The unique data from Landsat enable scientists and analysts around the globe to detect and monitor critical changes on Earth. Local, Tribal, state, and federal agencies all rely upon Landsat data to understand ongoing changes to their lands, surface waters, coastlines, ecosystems, and natural resources. Landsat is the most widely used land remote sensing data source within federal agencies to carry out their missions every day.

Landsat data provides enormous economic benefits in the U.S. and around the world, surpassing the investments in the Landsat technology. In the U.S. alone, Landsat is estimated to provide over $2 billion in annual economic benefits. When including benefits to other nations, Landsat's total annual economic benefits is estimated to be nearly $3.5 billion. Two unique attributes make Landsat the "gold standard" for all civil and commercial land imaging: 1) the accuracy and precision of the data, and 2) the long and unbroken record of this data.

The U.S. Group on Earth Observation-led Earth Observation Assessments have ranked Landsat's space system impact as second only to the Global Positioning System (GPS). Much like GPS

and weather data, Landsat data is used daily to help us better understand and sustainably manage our dynamic planet – and to improve our ability to combat climate change. In 2019, the U.S. Global Change Research Program identified Landsat as a "critical observatory for climate and environmental change research due to the unbroken length of the Landsat record and its ability to monitor remote regions with surface features such as glaciers, rainforests, permafrost, and coral reefs."

In recognition of the significant cross-government impact of Landsat, the DOI and the National Aeronautics and Space Administration (NASA) established the joint Sustainable Land Imaging (SLI) program in 2016 to provide continued, historically compatible, and operational land-surface observations for public science and services. The 2014 and 2019 National Plans for Civil Earth Observations both endorsed the SLI Program. In September 2021, NASA launched Landsat 9, the first mission in the SLI partnership. The next SLI Mission, known as Landsat Next, is in its planning phase and is intended to replace Landsat 8, which has been in orbit since 2013. The USGS has rigorously documented requirements for the next mission to meet users' ever-increasing need to monitor, understand, and predict complex changes to our nation's land and water surfaces. Landsat Next will also ensure that projected climate-change impacts on our landscapes can be rigorously measured, assessed, and sustainably managed.

Applications of Landsat Data

Landsat is incredibly versatile for a wide range of applications. In addition to the widely recognized benefits for the federal government and the commercial sector, Landsat is also used internationally. International space agencies use Landsat data and work with the USGS and NASA to align with our systems' data and products to be more interoperable for all users. International non-governmental organizations make use of Landsat data to provide local assistance for developing nations.

Landsat data is used for a wide variety of domestic applications. In Colorado, for example, Landsat has important applications for agriculture, water, forests, and development of natural resources. In Wyoming, Landsat's thermal infrared sensor collects data on Yellowstone National Park's thermal areas, including those previously unknown. As seen with the recent hurricane in Florida, Landsat supports research and response efforts on hurricane and storm surge impacts including assessing tree loss and vegetation damage, structure damage, flooding, water quality, storm surge debris, coastline shift, and long-term vegetation recovery in urban and natural ecosystems. (See Appendix A for graphics/images of these applications.)

Partnership with the Commercial Sector

The commercial sector is a vital part of the Landsat program. Under government contracts and federal supervision, commercial firms build the satellites; build and launch the rockets that carry them into space; construct the ground systems that collect, archive, process, and distribute these data to users; perform the flight operations of the satellites in space; and host the data in the commercial cloud for users to gain better access.

Recently, there has been an exciting rise of commercially developed and commercially operated satellites. Today, the commercial industry has successfully built and deployed constellations of small, low-cost, low-orbiting satellites that provide high-resolution, high-revisit optical imagery. This data is useful for a wide variety of applications, some of which are available to federal agencies through existing commercial data contracts. This data can augment and complement the coarser-resolution, broader area coverage baseline measurements made by Landsat and other government-sponsored observatories.

However, commercially owned global satellite systems currently lack the complicated and expensive calibration capabilities to provide the long-term science-quality imagery required to fully meet government objectives. In 2020, the NASA/USGS SLI Architecture Study Team (AST) provided recommendations for an SLI architecture beyond Landsat 9. The AST found that Landsat's moderate-resolution shortwave infrared and thermal infrared imagery—crucial for meeting Landsat global survey applications—are not projected to be commercially viable in the next ten years, requiring a government-led solution to ensure data continuity. The AST also found that commercial data in the visible and near-infrared spectrum could augment Landsat data to satisfy additional user needs. Through multiple AST listening sessions, the commercial sector clearly conveyed its desire for the government to maintain its gold standard systems like Landsat for use in their commercial imagery calibration and new product development.

The AST's findings related to the value of Landsat's unique radiometric and geometric calibration standard to the commercial sector were echoed by the Landsat Advisory Group (LAG), a subcommittee of the Federal Geographic Data Committee National Geospatial Advisory Committee, which provides advice to the federal government on the Landsat Program and includes representatives of commercial Earth observation companies like Maxar and Planet. Multiple white papers published by the LAG in recent years have articulated the value of Landsat to the commercial sector, particularly as a trusted reference source to help calibrate their own sensors.

The Role of Federal agencies

The U.S. government has a vital role to play in prioritizing and applying science-quality Earth observations to support local, Tribal, state, and national decisions on sustainable land, water, and resource usage; especially in the face of extreme weather events and accelerating climate-change impacts. This role includes making this data freely and openly available in the public domain to serve as authoritative datasets for science conducted at the global, regional, and local levels. Landsat offers consistent, global, full-spectrum coverage, with observations calibrated consistently over many decades. Landsat notably includes spectral bands that may not be profitable in the commercial sector but that meet governmental and societal needs for global applications like monitoring consumptive water use, climate change, agriculture, and deforestation.

Another essential role for federal agencies is to continue to support development of standards and specifications that support the interoperability of Earth observations. The DOI and the USGS work closely with national and international organizations to improve the interoperability among governmental and commercial Earth observation data sources. This improved

interoperability will benefit all users and commercial providers by improving the ability to access multiple datasets to meet their science and operational needs.

Landsat participates and is well represented in numerous international forums including the Group on Earth Observations (GEO), the Committee on Earth Observation Satellites (CEOS), the International Charter: Space and Major Disasters, and has numerous bilateral partnerships around the world. In fact, Landsat has led the world through the development of its Analysis-Ready Data products being distributed in the commercial cloud. Landsat's Collection 2 data—a complete reprocessing of the entire data archive—was the very first to be certified as CEOS-Analysis Ready Data compliant. Analysis-Ready Data is the key to future interoperability of all Earth observation satellite data sets, greatly increasing their value for all applications.

Opportunities for Collaboration between the Federal Government and the Commercial Sector

The USGS is excited about emerging commercial data sources. Current commercial imagers cannot provide global, full-spectrum coverage with the science quality necessary to meet the needs of government users. As stated earlier, some commercial firms rely on the calibrated Landsat data as a trusted reference source to evaluate and improve their own systems' performance. There are ways for the government to work with the commercial Earth observation industry to benefit both sectors. Federal agencies continue to perform extensive evaluations of federal, state, local, and Tribal user needs, as well as the needs of international users and the public. These studies consistently identify an increasing potential for commercial data to provide imagery at higher resolutions and greater frequency than Landsat to address urgent and short-term environmental events such fires, floods, and other disasters. In addition, the USGS, NASA, NOAA, and other agencies work together with commercial data providers in an activity called the Joint Agency Commercial Imagery Evaluation (JACIE), which provides an independent characterization of commercial imagery and products and shares those results across the remote sensing community. This helps facilitate the use of commercial products while helping providers better understand how their products are used across the federal government.

The technologies for imagery collection, transmission, storage, processing, and dissemination continue to improve. In the future, the federal government will need to determine the optimal roles for commercial and government capabilities in these areas, taking into consideration the growing capabilities, potential lower costs, licensing approaches of commercial systems, and the broad range of requirements across the user community, to include data accessibility and redistribution. In addition to satellite systems, there is a growing potential for the commercial sector to provide ground stations and mission operations as services, potentially reducing or eliminating the need and associated costs for government-owned satellite operations centers and ground-station infrastructure. The federal government will also need to determine how commercial advancements best support data processing, long-term management, and distribution, with the federal government continuing to certify data authenticity and maintain the official, long-term public data archive.

The Future

Federal agencies continue to develop science-quality Earth-observing systems to provide the foundational data of a multi-source "data ecosystem" of U.S. government, U.S. commercial, and international sources. Commercial Earth observation systems will increasingly be licensed to provide new and improved data for all. Through these combined efforts, the U.S. continues to strengthen our global leadership position in the development, launch, and operations of Earth observation systems. Further, our ongoing efforts to develop standards and infrastructure support the goal of interoperability and widespread access to optimize the exploitation of all Earth observation data.

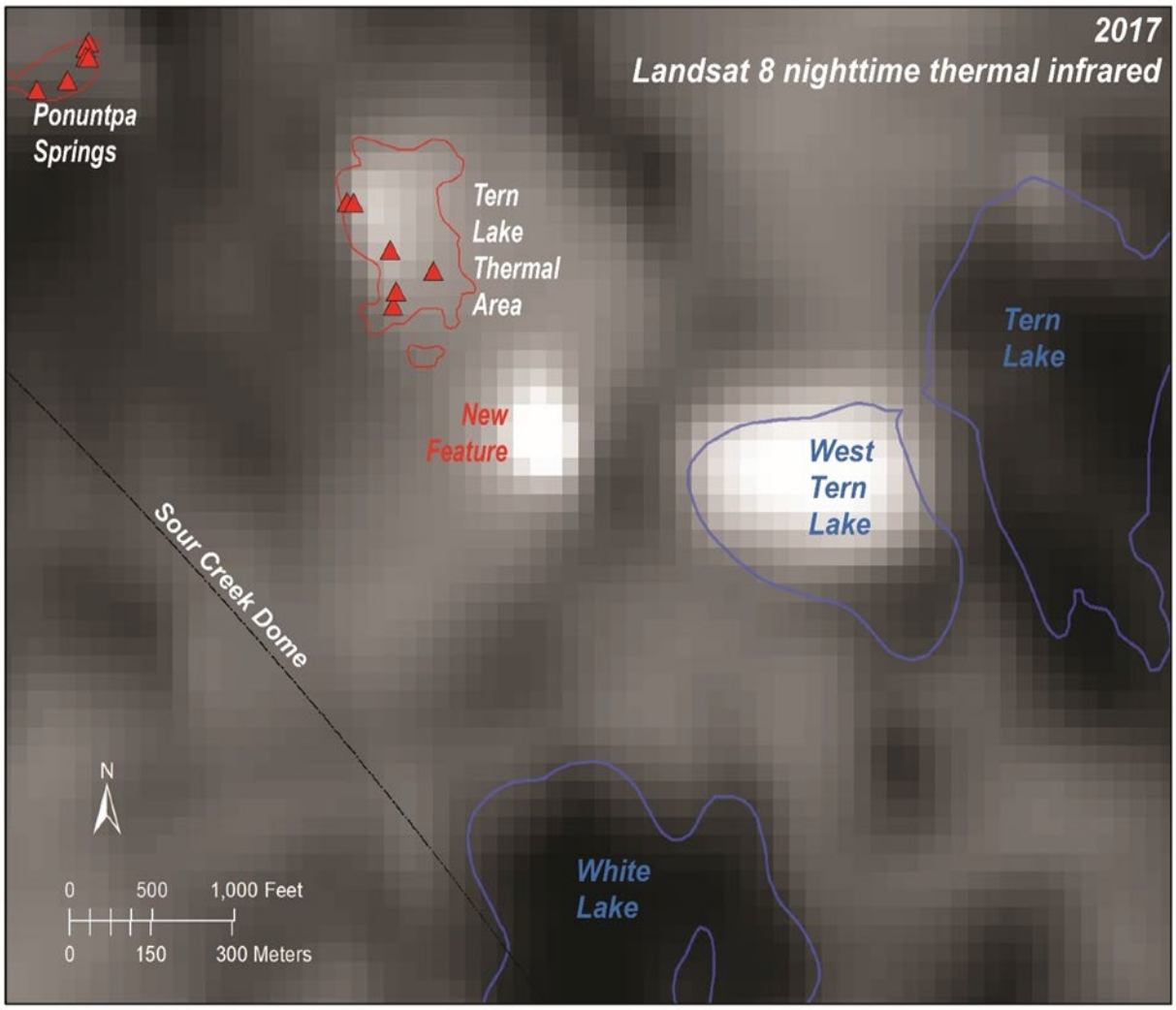
Landsat will remain the indispensable "tool in the toolbox" for decision support to government authorities and private sector decision-makers. Its precision will calibrate other government, commercial, and international observations. Its spectral and spatial characteristics will complement the data generated by others and support new information products and support services.

Landsat provides a domestic baseline capability that complements, rather than competes with, other international systems. While other systems may offer individual improvements in terms of spatial resolution, temporal revisit, or spectral performance, Landsat, with its five-decade record of robust collection, calibration and archiving, and its longstanding service as a global reference to cross-calibrate other missions, improves not only the quality of those systems but the overall quality of the global "system of systems".

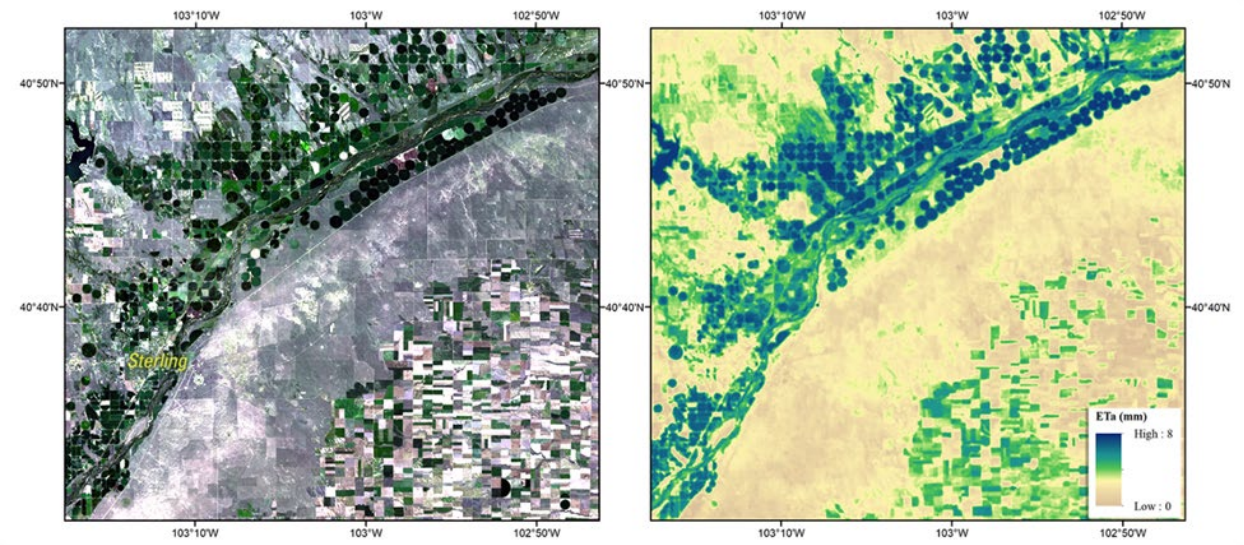
Conclusion

Landsat has experienced a remarkable surge in popularity and continued relevance. In 2022, the USGS has fulfilled more requests for Landsat data—at last count, more than 4 billion requests—than in the entire previous 49-year history of the program. That demand for Landsat data is linked to its global utility, free and open access in the cloud, and most importantly, the program's unrelenting commitment to maintaining the accuracy and precision of these data into the future. It is that commitment to data quality that will perpetuate Landsat's reputation as the gold standard for all civil and commercial land imaging in the foreseeable future. I am excited about the future of Landsat and appreciate the opportunity to speak with you all today. Thank you.

[Appendix A: Example Images of Landsat scenes]



WYOMING: This Landsat 8 image from the night of April 20, 2017, shows a newly emerged thermal area, labeled New Feature (white pixels indicate warmth), between the Tern Lake Thermal Area and West Tern Lake in Yellowstone National Park in Wyoming. Red triangles indicate individual mapped thermal features, such as geysers or springs. Image credit: U.S. Geological Survey.



COLORADO: These images, using data acquired by Landsat 8 on the morning of July 31, 2018, near Sterling in northeastern Colorado, show natural color surface reflectance of agricultural fields on the left and the actual evapotranspiration (ET) on the right. Evapotranspiration is the quantity of water removed from surfaces by evaporation and plant transpiration. The circles indicate center-pivot irrigation systems, and evapotranspiration measurements can help land and water managers make informed decisions about water use. Hay and corn are produced in the area, among other crops.

FLORIDA: Landsat 7 captured this image of the aftermath of Hurricane Ian in southwestern Florida, including floodwater and sediment in the ocean, on the morning of October 2, 2022. Sanibel Island is shown at the center with Fort Myers Beach and Cape Coral to the right. Naples is the gray urban area in the lower right.

FLORIDA: Landsat 9 captured this image of the aftermath of Hurricane Ian in southwestern Florida on the morning of October 6, 2022. Sanibel Island is shown in the center, with breaches in the Sanibel Causeway that connects the island with the mainland. (White clouds also appear in this image.)

FLORIDA: Landsat 9 captured this image of the aftermath of Hurricane Ian in eastern Florida on the morning of October 6, 2022. It shows the coast and New Smyrna Beach, which experienced extensive flooding.

GEORGIA: Landsat 9 captured this image of the aftermath of Hurricane Ian on the Georgia coast on the morning of October 6, 2022. It shows the area of Brunswick, Georgia (top left), and sediment spreading out from the shoreline.