

On December 1, the Senate Commerce, Science and Transportation Subcommittee on Space and Science held a hearing titled, "Landsat at 50 & the Future of U.S. Satellite-based Earth Observation." The hearing highlighted critical Earth Observation (EO) data provided by the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the United States Geological Survey (USGS). They discussed the rise of commercial providers, improving access to EO data to spur economic growth, and EO value-added services enabling precision agriculture, improved city planning, water management, wildland fire prevention and detection, and disaster response.

Subcommittee Chair John Hickenlooper (D-CO) noted in his opening remarks that EO data enables farmers to measure soil moisture and improve crop yields, and has assisted Colorado with two things that have become increasingly important: wildfire mitigation and drought management. He provided examples of Landsat images of recent wildfire burn scars in Colorado and of differences in Lake Powell water levels between 1999 and 2021. He acknowledged that the droughts have gone on for so long that some consider it aridification or desertification rather than drought. Subcommittee Ranking Member Cynthia Lummis (R-WY) said that the land in the West is a key part of our lives and culture, from agriculture to energy production, and having detailed data about how that land changes over time is extremely valuable and necessary to make informed decisions. She noted that since the Landsat program moved toward open data, it has become indispensable for individuals and businesses in Wyoming. Committee Chair Maria Cantwell (D-WA) remarked on how valuable the data are in Washington for agriculture and coping with wildfires.

Witnesses included: Kevin Gallagher, Associate Director, Core Science Systems, USGS; Steve Volz, Assistant Administrator for Satellite and Information Services and Acting Assistant Secretary for Environmental Observation and Prediction, NOAA; Kate Calvin, Chief Scientist, NASA; Daniel Jablonsky, President and Chief Executive Officer, Maxar Technologies; and Waleed Abdalati, Director, Cooperative Institute for Research in Environmental Sciences, University of Colorado.

Gallagher noted that the more than \$2B in economic benefits of Landsat data surpass the investments in its technology. He called it the gold standard for all civil and commercial land imaging due to the accuracy and precision of the data, and the long and unbroken record of the data since the first Landsat satellite was launched in 1972. He said: "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."

Gallagher acknowledged the rise in low-cost, low-orbiting satellites that are commercially developed and operated. While they provide high-resolution optical imagery that is useful for a variety of applications, he noted that they cannot replace the value that Landsat provides. "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." Landsat also provides moderate-resolution shortwave infrared and thermal infrared imagery that isn't expected to be commercially viable for another ten years. He noted the continued relevance and increased popularity of Landsat data: "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."

Volz noted that developing the next-generation satellites takes a decade or longer from concept to deployment, but that the programs to modernize data are already underway to provide enhanced observations into the 2050s. "Harnessing the advances in high performance computing, artificial intelligence/machine learning, and the cloud, NOAA will provide additional capabilities to process and deliver data and information

to users such as communities, emergency managers, and city planners to inform their activities and actions. The requirement to sense the atmosphere for temperature, pressure, and water vapor input for weather and environmental numerical models remains one of NOAA's top priorities for its next-generation systems. To provide needed protections to coastal communities, NOAA plans to add an ocean color imager in geostationary orbit that will complement and vastly augment capabilities in the polar orbit to detect harmful algal blooms.... To best facilitate user needs across orbits and observations, NOAA's next-generation satellite architecture includes three portfolios: geostationary observations, low Earth orbit, and space weather observation. The next-generation architecture also includes an evolved support system to operate the satellites and use the data.... NOAA's integrated next-generation observing system will leverage new and existing technologies and partnerships at all levels, and will combine data from various sources, allowing us to deliver significantly improved products and services to our users. The urgency of our changing environment requires action now to better fulfill NOAA's essential mission to protect lives, property, critical infrastructure, and our economy."

Calvin said: "NASA plays an essential role in supporting continuity of data records provided by our interagency partners' satellites.... For example, NASA has been working closely with USGS to finalize the next-generation system architecture for the Landsat Next satellite and will begin formulation activities for the mission activities shortly. NASA's goal has been striking a balance between incorporating the latest land imaging technologies with ensuring Landsat's continuous long-term record of land imagery and data within the budget that the Administration and Congress can provide. Landsat Next, now expected to launch as a 'triplet' configuration of three platforms, will join Landsat 8 and Landsat 9 on orbit in adding to the continuous long-term record of land imaging that began with the first Landsat in 1972."

Jablonsky testified on the value Earth observation technology provides to society, the important role of the commercial space sector, and steps industry and Congress should take to help ensure America's continuing leadership. Maxar designs, manufactures, and operates satellites, spacecraft and communications equipment. He stated, "We are here today to mark the 50th anniversary of the launch of the first satellite in the Landsat series by the U.S. Geological Survey (USGS) and NASA in 1972. The fifty-year archive of Landsat observations has supplied invaluable, empirical evidence that has helped build confidence in Earth observation technology and created a shared understanding of how the Earth is changing. Since that time, Earth observation technology and the U.S. space industrial base have advanced rapidly."

He continued: "Earth observation technology is key to solving some of the biggest problems facing humanity and enables a better understanding of the world around us. Earth observation capabilities help identify, monitor, and address problems that threaten the security and economic well-being of every American, and aid in the improvement of the lives of people across the globe."

Abdalati added: "As we continue to live in a world in which our relationship with the environment is critical to our success and prosperity, the value of knowledge about our environment has never been more consequential. Ours is a changing planet, and space-based observations of Earth not only provide us situational awareness that allows us to watch the story of that change unfold, but they provide us the information needed to understand the underlying causes, the evolution of their behaviors, and the implications for the future. They...are a critical element of our national informational infrastructure that helps us thrive in the face of environmental changes and challenges." See <https://www.commerce.senate.gov/>.

The WSWC submitted written testimony in support of the Landsat missions, satellite technology, and ground-truthing data collection programs, noting the value of the continuous record of data for water managers across the West.