USGS Update

National Academies of Sciences, Engineering and Medicine

Committee on Earth Science and Applications from Space

November 4, 2024

David Applegate

U.S. Geological Survey Director

Tim Newman

USGS National Land Imaging Program Coordinator

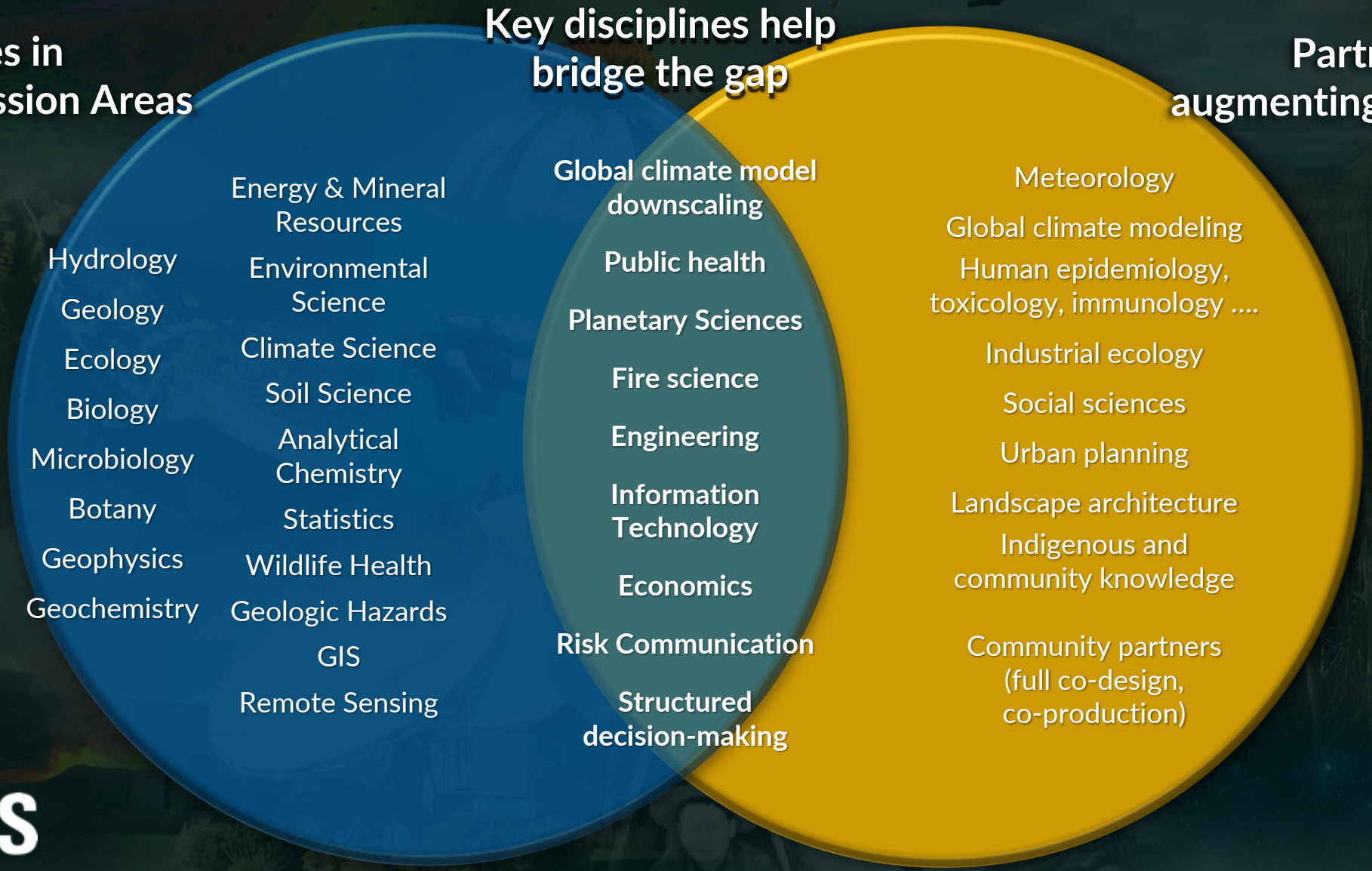
USGS Mission and Vision

The USGS mission is to monitor, analyze and predict current and evolving dynamics of complex human and natural Earth system interactions and to deliver actionable information at scales and timeframes relevant to decision makers.

Vision Statement: Lead the Nation in 21st-century integrated research, assessments, and prediction of natural resources and processes to meet society's needs.

USGS

USGS Science: Interdisciplinary and Transdisciplinary



USGS

Ensuring USGS science is used in decision making

We bridge the gap between science providers and science users by:

- Engaging stakeholders and end-users
- Working with underserved communities to support environmental justice
- Increasing participatory research and "co-production"
- Partnering with experts in other disciplines:
  - social and economic sciences
  - human-centered design thinking
  - behavioral psychology
  - anthropology

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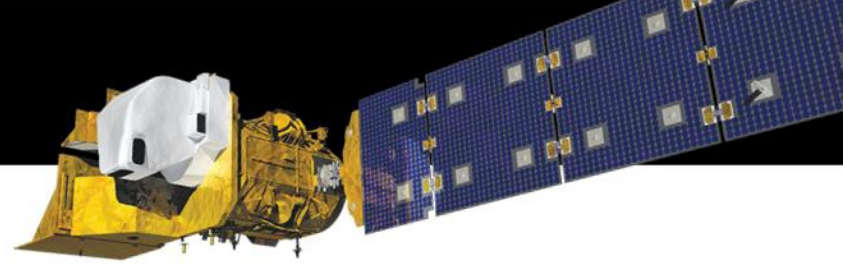
USGS by the Numbers



People

8,410 Employees

1,436 Contractors

591 Emeriti

198 Volunteers

Science and Monitoring

170,000+ Publications (since 1879)

54,000 7.5-minute Quadrangles (Topographic Maps)

1000+ At-Risk Species Studied

25 Active Patents (85 since 1996)

1 Research Reactor

~20,000 USGS-operated Groundwater Wells monitored for water level and water quality

11,800+ USGS-operated Streamgages

~4,000 USGS-operated Earthquake Sensors in U.S.

~70 U.S. Volcanoes Directly Monitored of 161 Considered Active

14 Geomagnetic Observatories

3 Satellites

201M Landsat data downloads

100% Interferometric Synthetic Aperture Radar (IfSAR) Data Collected in Alaska

94.7% National Coverage of 3DEP High-resolution Elevation Data

56% U.S. Coverage of Geologic Maps (Detailed to Intermediate Scale)

171 Geologic Provinces USGS Assesses for Undiscovered Oil and Gas Resources

~100 Mineral Commodities for which USGS Collects National Data for 180 Countries

Locations

391 Facilities

In all 50 states and 2 territories (Guam and Puerto Rico)

491 Laboratories

60 Science Centers *(7 Regions)*

22 Programs *(5 Mission Areas)*

10 Climate Adaptation Science Centers *(1 National - 9 Regional)*

43 Cooperative Research Units

54 Water Resources Research Institutes

Partnerships

4,300 Partners/Cooperators

5,157 Contracts, Cooperative Agreements, and Grants

Funding

$1,455M 2024 Enacted

$646M 2024 Reimbursables

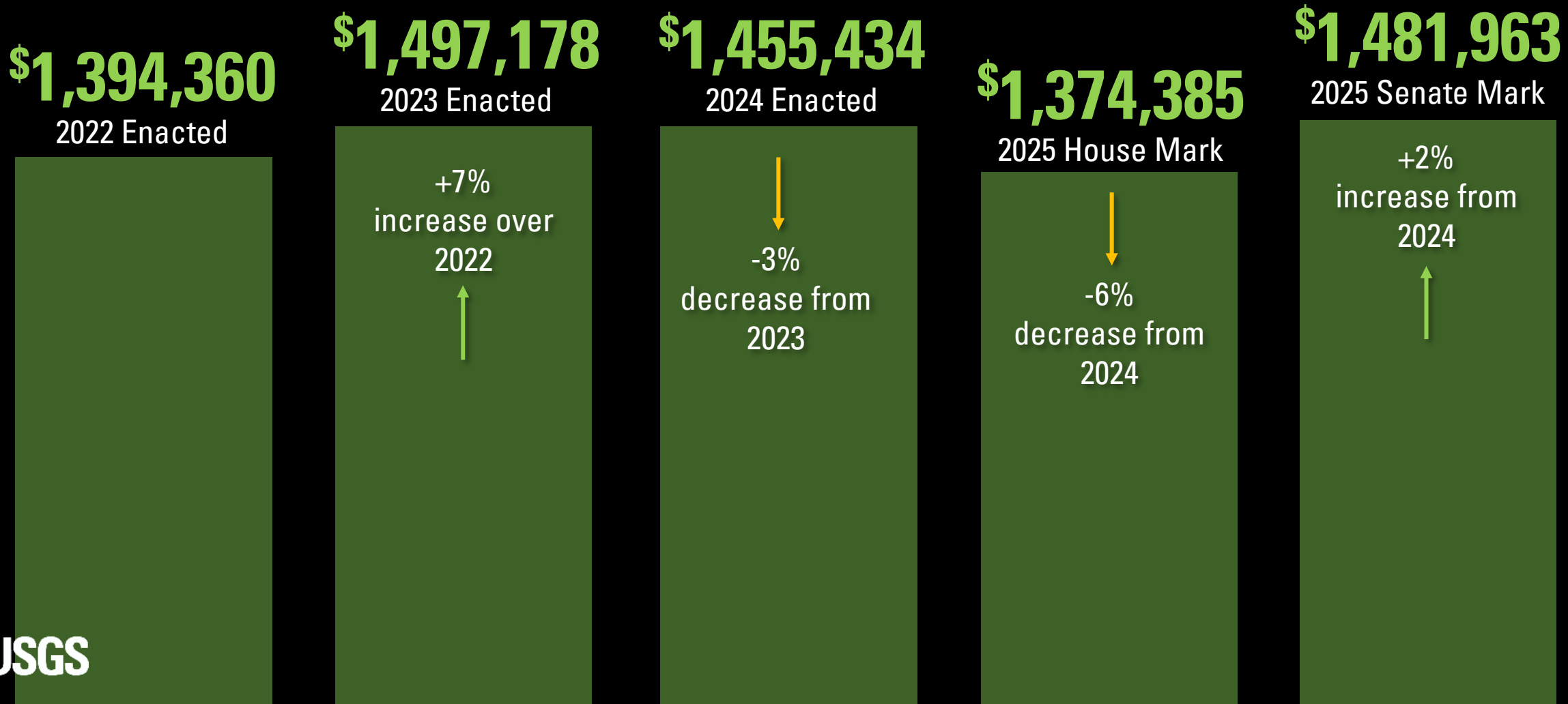
$69M 2024 Bipartisan Infrastructure Law (BIL)

USGS

August 2024

USGS Appropriations

Recent and Proposed



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USGS
science for a changing world

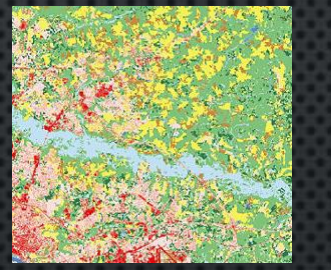
USGS makes extensive use of satellite data

NASA

Terra, Aqua, Landsat, Sentinel-2, JPSS (VIIRS): Use in land cover, mineral resources, volcanic activity, natural hazards, hydrology, snow cover, forests, urban environments

ECOSTRESS: Use in mineral mapping, land surface temperature, National Hydrologic M
fire, volcanic, cryospheric and land cover mapping
EnMAP, EMIT, AVIRIS: Use hyperspectral data in mineral resources mapping

Aura: Use in volcano hazards, coastal, marine geology, toxic substances, hydrology mapping



ICESat-2: Use in snow, ice, glacier, forestry applications

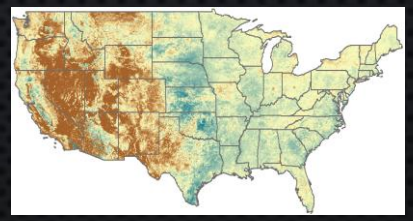
Grace-FO: Use in drought, hydrology, mass change characterizations

TSIS-1: Use in instrument calibration and validation activities

CALIPSO / CloudSat: Use in fisheries, streamflow, snow modeling, drought, ecology, contaminant, and soil mapping
Planet, MAXAR: High-resolution commercial imagery for agriculture, forestry, water and ecosystems studies

DSCOVR: Use in atmospheric characterization, geomagnetism programs

New and Upcoming US and International Missions: PACE, SWOT, NISAR, SBG, TSIS-2, LSTM, CHIME, TRISHNA



USGS is a user and provider of Earth Observation data

Civil Applications Committee – The Triple Junction

- Presidentially created, providing oversight and facilitation of Federal Civil agency use of Intelligence Community (IC) and Department of Defense (DoD) remote sensing data, tools, applications, and other capabilities
- Coordinates with Federal Civil Principals and leverages DoD/IC for disaster response/hazard tasking
- Chaired by USGS Director (Chartered by the Secretary of the Interior and the Director of National Intelligence)
- Engages with IC and DoD governance structures via the National System for Geospatial Intelligence (NSG) led by NGA Director as Functional Manager
- Establishes Working Groups with Terms of Reference and builds Communities of Interest on topics of geospatial concern

CAC Principals are federal civilian government agencies and use the GEOINT data within their statutory mission-space.
See: Civil applications committee | U.S. Geological Survey (usgs.gov)

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USGS Climate Science for Decision Making

Wildfire Mitigation

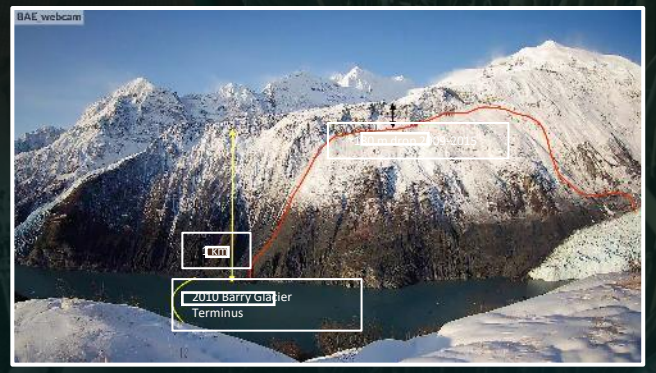
Water Management

Landscape Resilience

Drought

Carbon Sequestration

Coastal Erosion & Flooding



Thawing Cryosphere

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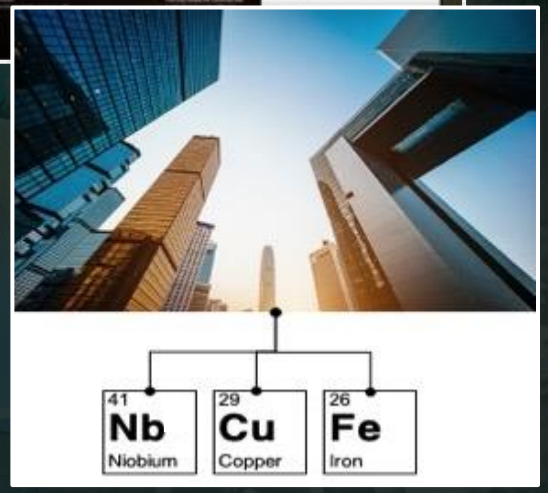
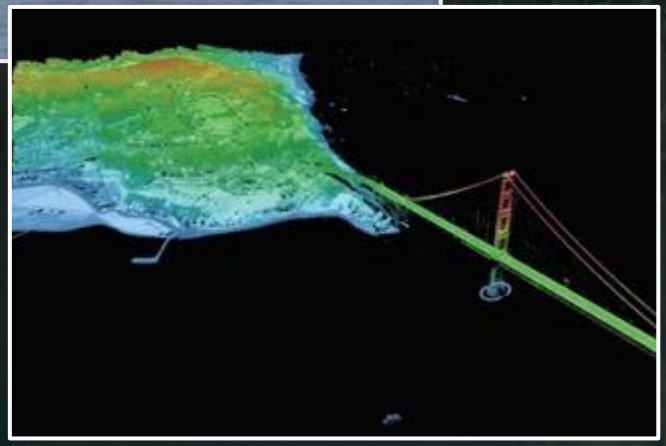
USGS Science to Inform Infrastructure Projects

Engineering & Safety Standards

Raw Materials



Surveys & Assessments



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Earth Mapping Resources Initiative (Earth MRI)
Mapping the Nation's Geology and Resources

- **Current focuses**
- Critical mineral resources
- Still in the ground
- Above ground in mine waste
- Construction resources (industrial minerals)
- Infrastructure hardening and disaster planning

- **Additional applications**
- Infrastructure
- Energy and water resources
- Natural hazards
- Land use planning

Partners

- State and Federal agencies
- Tribes
- Industry
- Non-Governmental Organizations
- Universities

Funding

- $10.8M in annual appropriations
- $320M over 5 years through Bipartisan Infrastructure Law
- $5M in Disaster Supplemental

Data

- All Earth MRI data are freely available to the public

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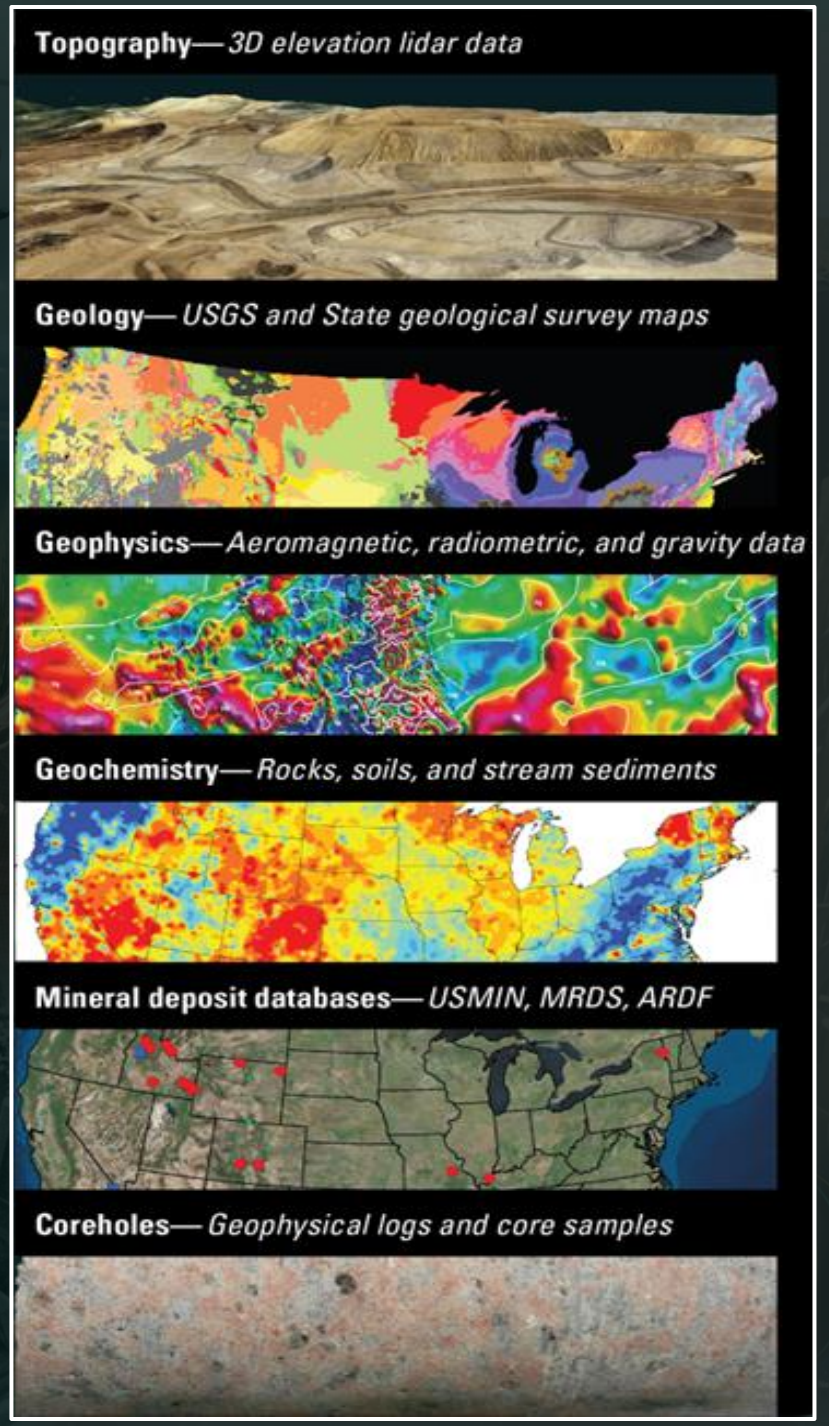
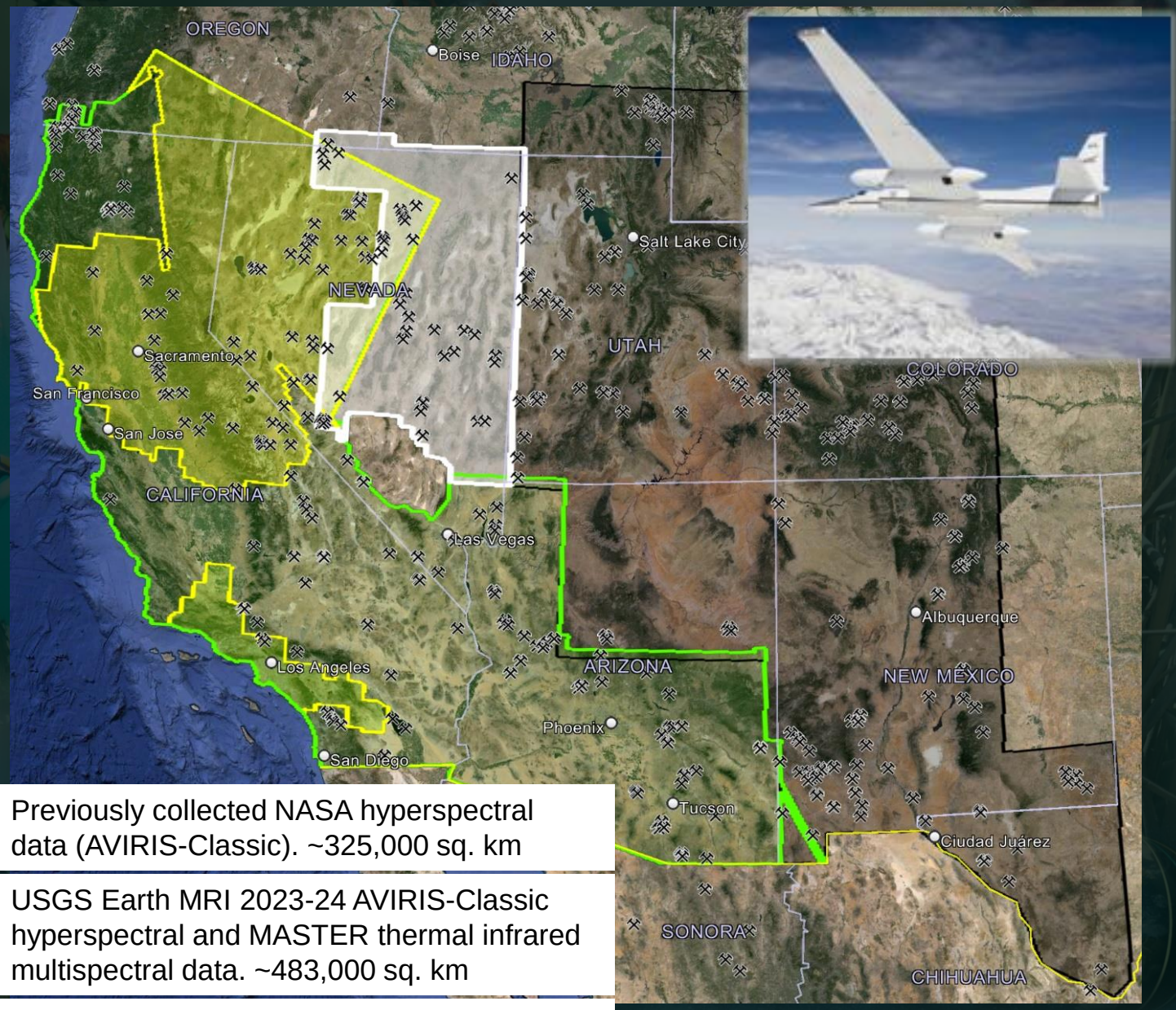


BIL-funded Earth MRI hyperspectral survey of the Southwest

USGS-NASA partnership:

- **Hyperspectral surveys help identify minerals at the surface**, such as in mine waste. These surveys are also useful for understanding **acid mine drainage, debris flows, agriculture, wildfires, biodiversity, and many other fields**.
- USGS Earth MRI funding is supporting NASA's airborne hyperspectral data collection.
- Largest area on Earth of contiguous hyperspectral coverage at such fine spatial resolution.
- Complete hyperspectral coverage of California and soon for Nevada and Arizona.



2018	Previously collected NASA hyperspectral data (AVIRIS-Classic). ~325,000 sq. km
2023 2024	USGS Earth MRI 2023-24 AVIRIS-Classic hyperspectral and MASTER thermal infrared multispectral data. ~483,000 sq. km
2025	Planned data collection for 2025

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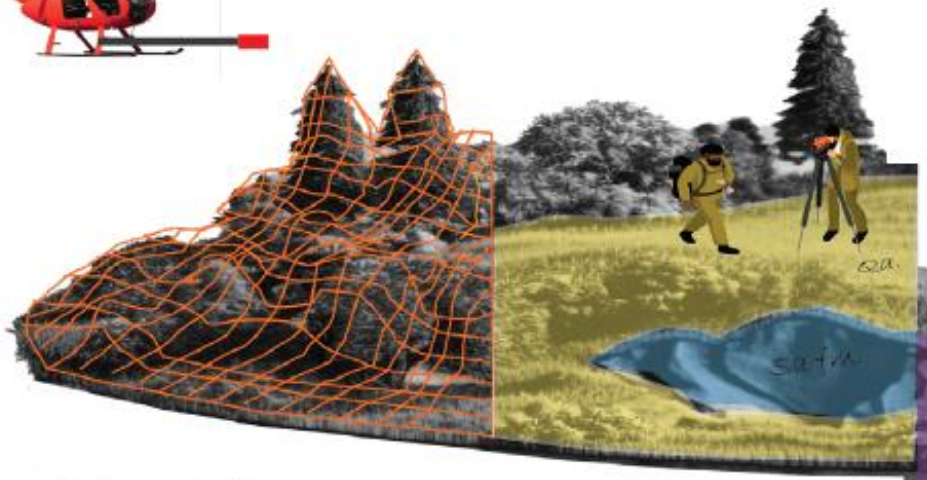
Earth MRI data collection

Topography



High-resolution elevation data help identify **geological structures,** estimate **volumes of materials** and model **how water moves** across the Earth's surface.

Geology

Geologic maps identify **rock types on the Earth's surface.** Earth MRI's geologic mapping advances understanding of areas with mineral potential.

Geochemistry

Laboratories measure **concentrations of minerals in rocks** and inform remediation by showing **how minerals interact with the environment.**

Geophysics

Magnetic and radioactive signatures of underground rocks can identify **buried minerals and large geological structures.**

Borehole Information

Old and new rock samples and drill cores help identify **rock types below the Earth's surface.**

...and more

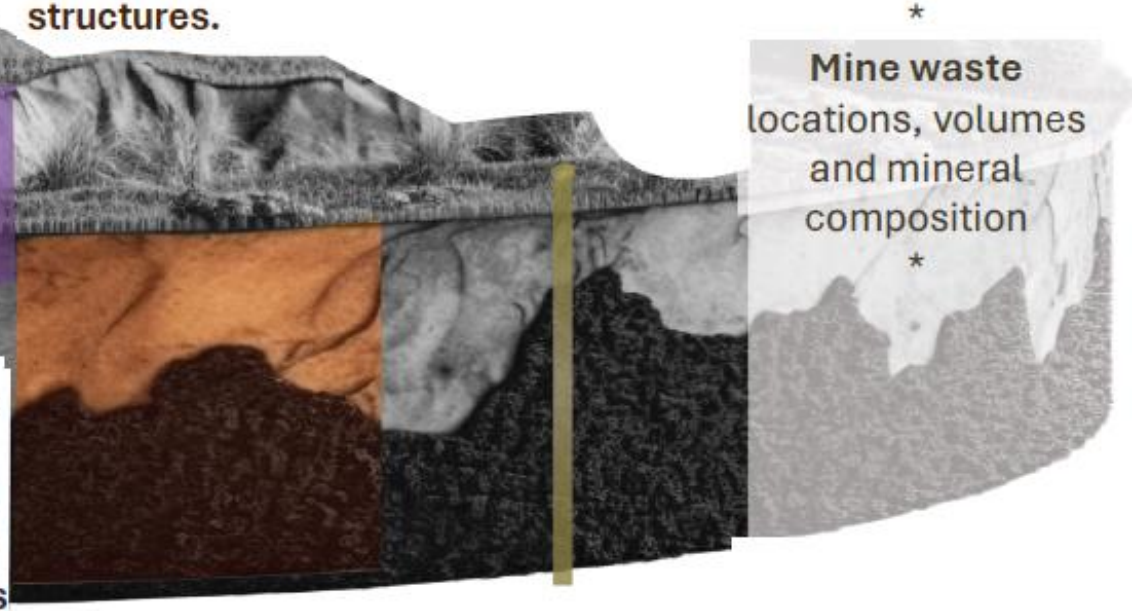
*

Hyperspectral imagery to identify minerals on the surface of the Earth and in mine wastes

*

Mine waste locations, volumes and mineral composition

*



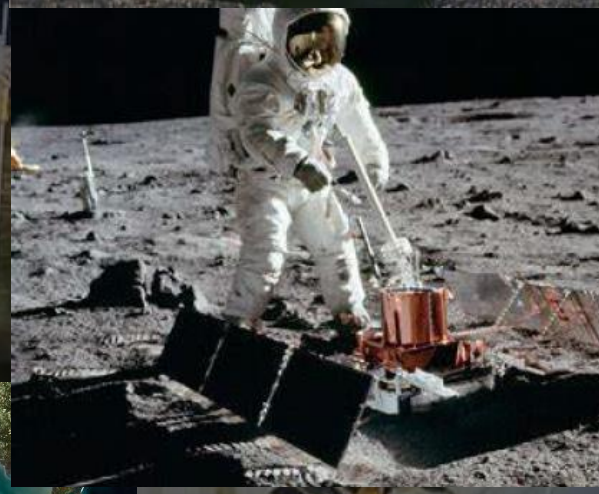
USGS science for a changing world

USGS: Long history of partnerships with NASA

USGS Astrogeology Science Center

- Started in 1961 to support the Apollo Program including astronaut training
- Supports robotic NASA missions including Mars rovers
- Supports Artemis -- return of humans to the Moon—with science, cartography, and astronaut training

- **Landsat**
  - Since 1972, a continuous record of images of the Earth's land surface to monitor natural- and human-induced change



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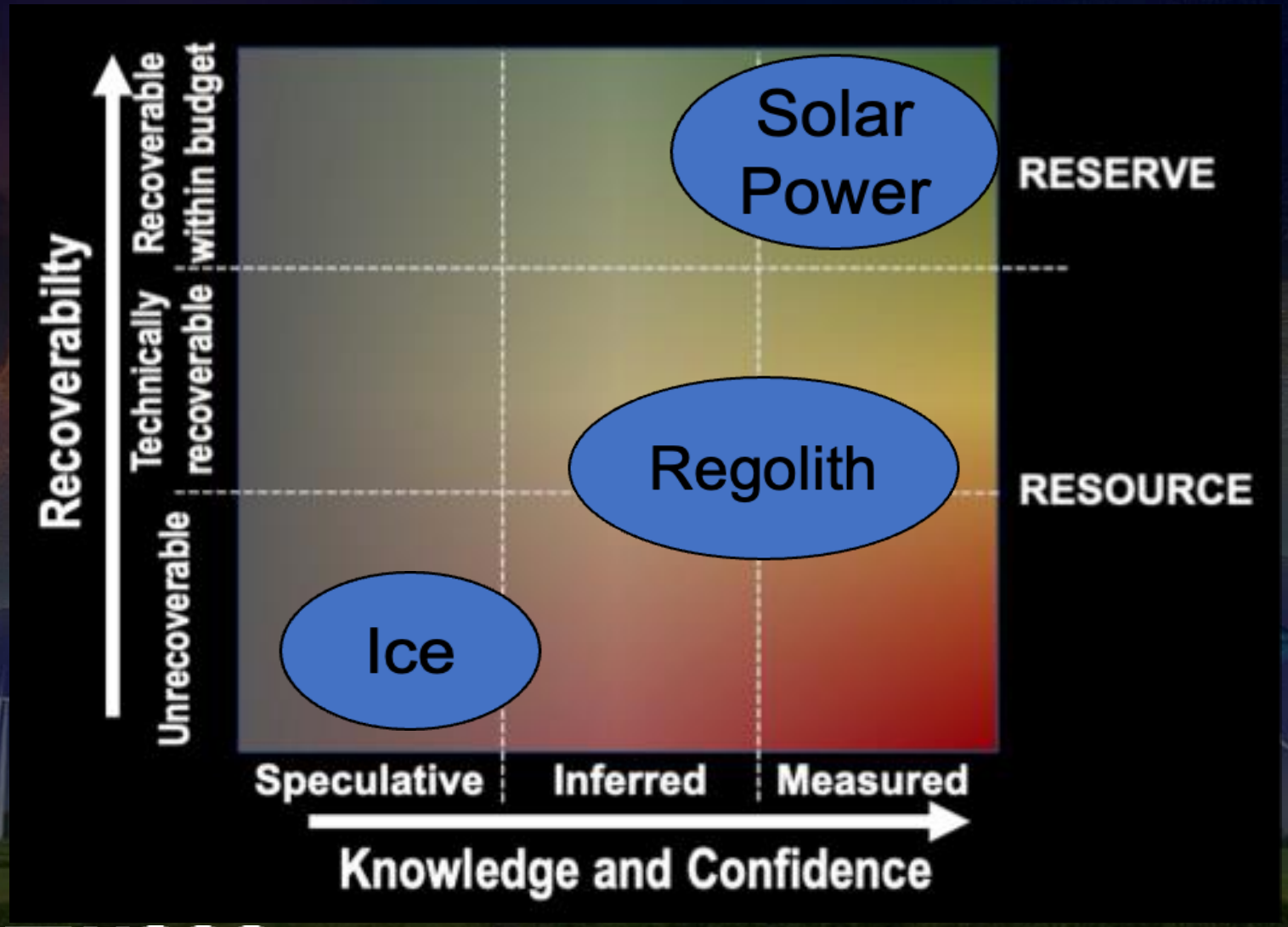
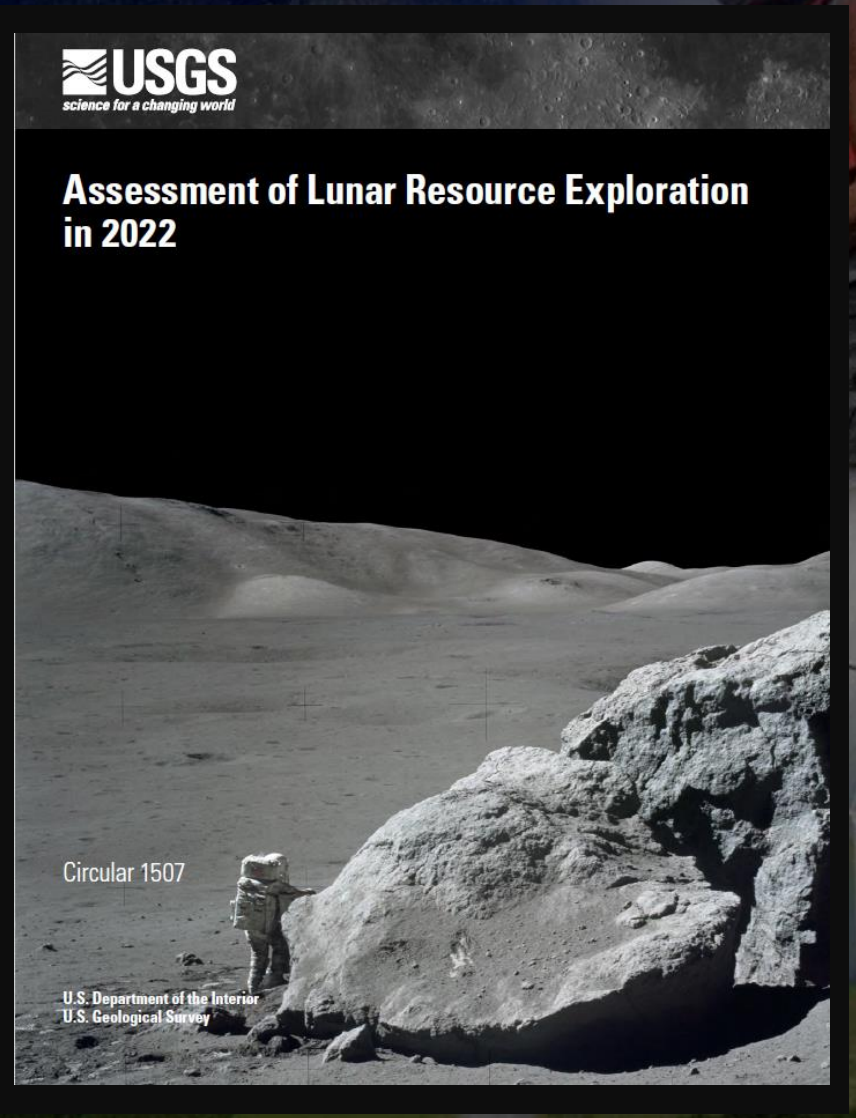
Using USGS methods to assess lunar resources





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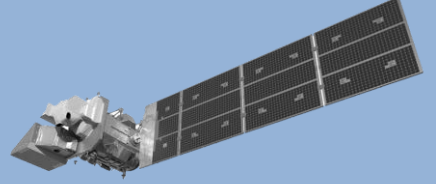
Landsat Operations Updates – Landsat 7, 8 and 9

USGS Core Science Systems – National Land Imaging Program



Mission Updates:

- **Landsat 7:** End of science mission; NASA refueling mission cancelled; initiating decommissioning.
- **Landsat 8:** Nominal operations; averaging 750+ images (~50 million square km)/day.
- **Landsat 9:** Nominal operations; averaging 750+ images (~50 million square km)/day.
- Landsat 8 and 9 together collect the equivalent of more than the Asian land mass every day

Landsat Archive Operations:

FY24 Statistics:
17.6 billion accesses via Commercial Cloud;
98 million product downloads;
49 thousand terabytes managed

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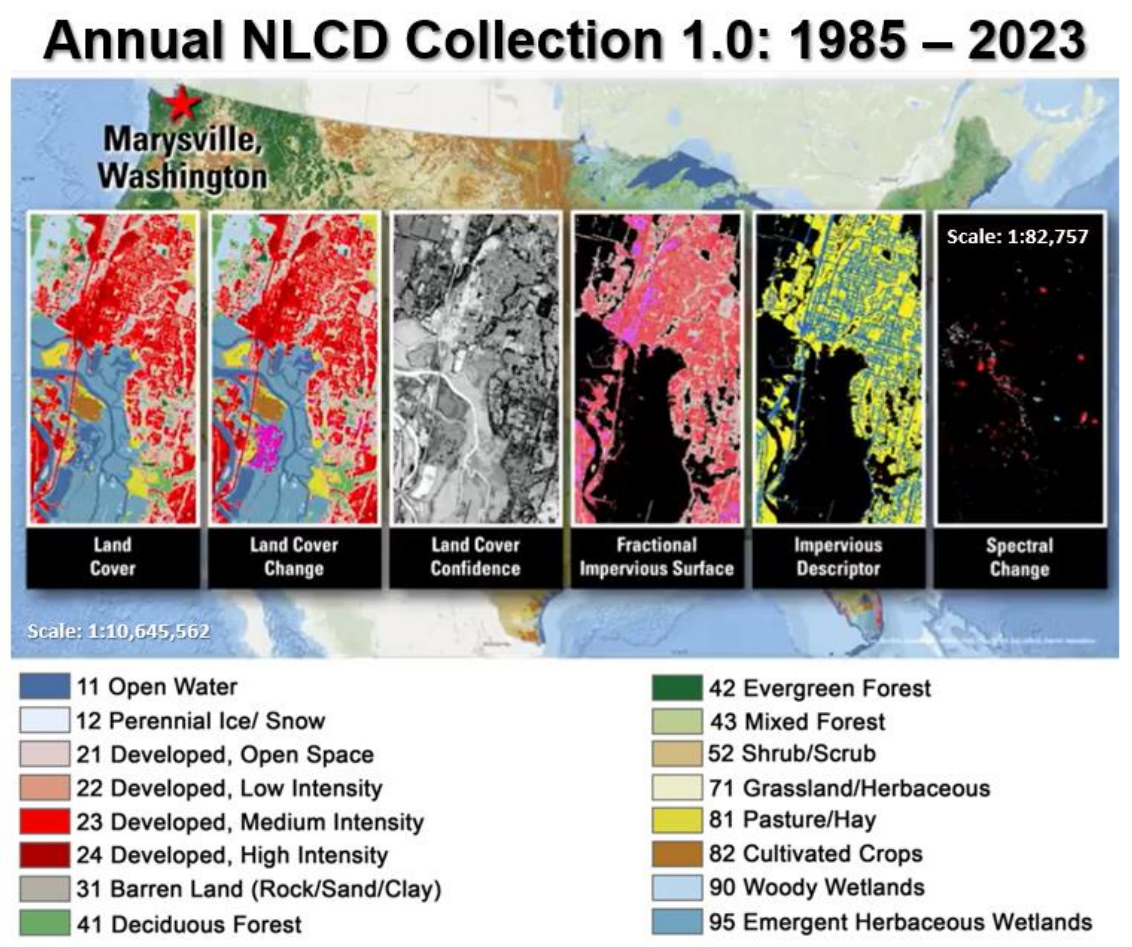
Landsat Science Update – Annual National Land Cover Database (NLCD) Release



Annual NLCD Collection 1.0 (1985-2023)

- Released October 24th, 2024.
- Landsat-based land cover and change product.
- Cover Conterminous United States (CONUS).
- Document how America's landscape changed over the past four decades.
- Map land cover, detect land change, characterize fractional impervious surface.
- Suite of 6 land cover and land cover change products for each year from 1985-2023 at 30m spatial resolution.
- Greatly advance science and operational applications and provide valuable insights to natural resource management.

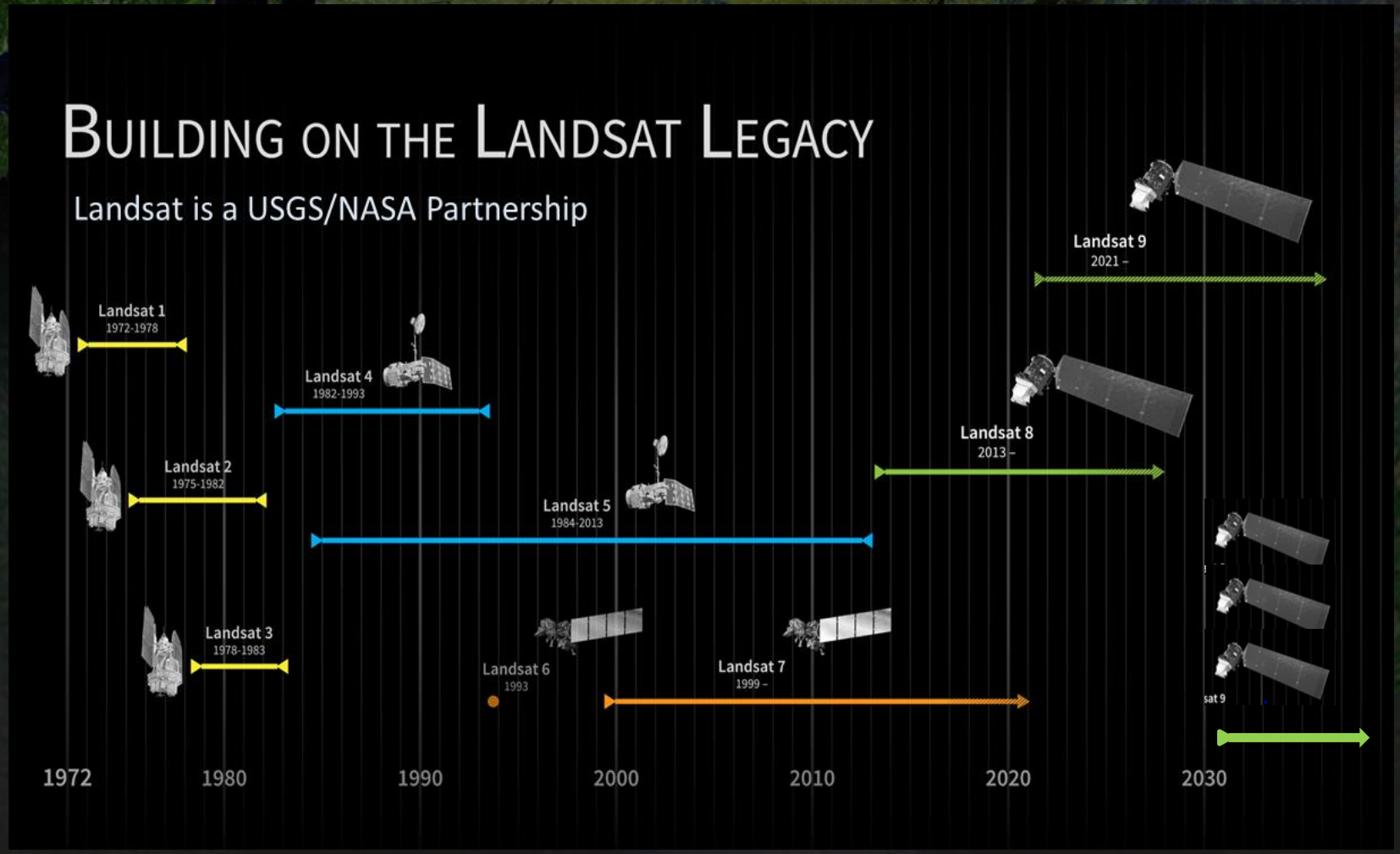
USGS

https://doi.org/10.5066/P94UXNTS

Interior-NASA Sustainable Land Imaging (SLI) program

A DOI/USGS – NASA partnership to ensure sustained access to high-quality, global, land-imaging measurements compatible with the existing 52-year Landsat record supporting public services and research

- DOI/USGS is responsible for establishing user needs, developing the ground segment, and flight and ground system operations
- NASA is responsible for developing the space segment, launch, and on-orbit check-out
- New 10-year SLI agreement signed in 2021
- Sustains collaboration between NASA and DOI/USGS in developing:
  - SLI program strategy and architecture
  - User needs
  - Mission requirements
  - Communications within the Executive and Legislative branches



The Interior/NASA SLI Joint Steering Group oversees Landsat development

Landsat Next – The Follow-on Mission to Landsat 9

- SLI Joint Steering Group (Interior and NASA senior leadership) in 2017 requested a NASA/USGS study to consider post-Landsat 9 options
- SLI Architecture Study Team completed detailed study in 2020 and the SLI Joint Steering Group approved a *multi-element* architecture, including Landsat Next
- NASA/USGS project teams studied many options and recommended the "Superspectral Triplets" option, which the Joint Steering Group approved in 2022
- NASA awarded the instrument contract in June; USGS conducting ground studies

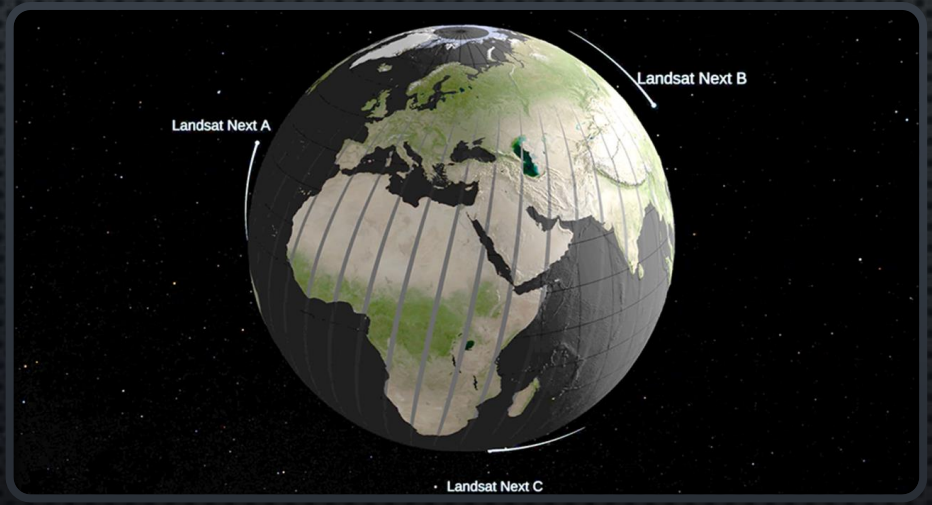
"Superspectral" Landsat Next will provide a completely new next-generation Landsat, meeting the users' needs for richer spectral information and improved spatial and temporal resolution.

- **FY 2025 is critical for Landsat Next**

Landsat Next

- **Landsat Next "Superspectral Triplets" mission**, the result of **six years** of joint agency needs assessment, technology investment, architecture studies and early project development, **provides a completely new next-generation Landsat**, **meeting the users' needs** for richer spectral information and improved spatial and temporal resolution and **maintaining U.S. leadership in Earth observation**
  - **Improved revisit frequency** to support applications requiring ~weekly clear views, such as crop health & productivity, water quality, snow/ice state, wildfire
  - **Higher spatial resolution** (10/20-meter data for VSWIR and 60-meter for TIR) to support monitoring of small agricultural fields, forest disturbance, urbanization, and other applications
  - **Additional spectral bands** to support emerging applications in water quality, snow hydrology, soil mapping, and other areas; improve atmospheric correction and surface temperature retrieval
  - **Maintaining radiometric quality** established by Landsat 8/9
- NASA and USGS Landsat Next project teams, established in 2020, are in development phase A and awarded the instrument contract in 2024

Landsat Next will provide more than twice as many spectral bands as Landsat 8/9, with spatial resolution improved by a factor of 2, and significantly improved repeat coverage



NASA "Landsat's Next Chapter" Video
https://svs.gsfc.nasa.gov/14262

New Landsat Value Study Released

The Native American Technology Corporation (NATECH) report "**Economic Valuation of Landsat and Landsat Next 2023**" was released by NATECH on Friday, September 13, 2024.

- Economists from Colorado State University and the company TerraWatch Space authored the study, which estimated the economic benefits of Landsat imagery to users who access Landsat data through USGS Earth Explorer.

Key Highlights:

- Landsat's value to users was estimated at **$25 billion** in 2023, based on the Contingent Valuation Method, an accepted economic approach for valuing non-market goods.
- NATECH also completed a multiple regression analysis to estimate the added value of improvements provided by Landsat Next and found that value to be approximately **$33 billion**. (These figures are conservative as they do not account for the value derived from indirect users of Landsat from non-USGS government platforms such as Google, Amazon, Microsoft, etc.)

Economic Valuation of Landsat and Landsat Next 2023

USGS

https://www.usgs.gov/news/featured-story/landsats-economic-value-increases-256-billion-2023

Landsat in Earth Observation Assessments

U.S. Group on Earth Observations (USGEO) Earth Observation Assessments (EOAs):

*2023 Agriculture and Forestry EOA (*released in July 2024*):* Landsat Multispectral was ranked **#4** and Landsat Thermal Infrared **#9** most-impactful of over **1,000** Earth observation data sources by over **600** Subject Matter Experts (SMEs) across 8 Federal agencies.

- Landsat core applications included evaluating/monitoring agricultural conditions, irrigation, natural hazards, fuel conditions, and land management.
- Landsat impacted all four Agriculture and Forestry sub-areas including: Enhancing Food Supply; Maximizing Productivity and Conservation; Improving Resilience to Disasters; and Supporting Regulatory Requirements and Decision-making.

2023 Climate EOA is to be released next month and is expected to reflect similar levels of impact for Landsat core applications included evaluating/monitoring coastal change, water resources, terrestrial ecosystems, and supporting climate assessments/land surface science

Landsat continues to be highly impactful across federal departments and agencies

Landsat in the News

Core Science Systems – National Land Imaging Program

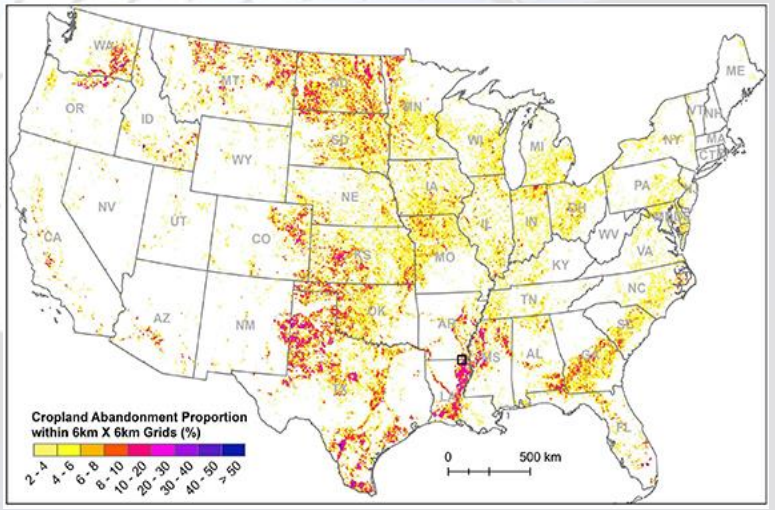
Tens of millions of acres of cropland lie abandoned, study shows

SOURCE: THE WASHINGTON POST

JUNE 8, 2024

[The biggest cropland changes were near Ogallala Aquifer, study shows - The Washington Post]

Abandoned cropland proportion 1986-2018



- About 30 million acres of U.S. cropland have been abandoned from 1986 to 2018
- The study uses cropland area data from USDA produced using Landsat
- Declining ground water from drought and excessive pumping led to hotspots in Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas and Wyoming

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Recent Landsat Next Endorsements

Department of Agriculture (June 21st Letter from Under Secretary of Agriculture for Research, Education and Economics and USDA Chief Scientist Jacobs-Young to Interior Principal Deputy Assistant Secretary Brain and NASA Deputy Administrator Melroy):

- *"USDA agencies provided significant inputs to the design of the Landsat Next Architecture."*
- *"Many USDA strategic objectives depend upon continuity and improvement of Landsat observations."*
- *"Across USDA research agencies, the Landsat Next architecture will enable new analyses in the health and vigor of crops; the needs of specific fields for fertilizer, irrigation, and rotation; the impacts of and responses to prolonged drought; and agricultural census assessments and mapping."*
- *"We in USDA endorse the timely development of Landsat Next as approved by the Interior-NASA Sustainable Land Imaging Joint Steering Group in February 2022 and appreciate and value our continued collaboration with the Department of the Interior and NASA."*

Department of State (Secretary Antony J. Blinken and Australian Foreign Minister Penny Wong signed a Joint Communiqué on the U.S.-Australia Landsat Next 2030 International Partnership Initiative Aug. 5th):

- Formally recognizes Australia as a partner in the Landsat Next satellite mission, which will provide critical insights into the Earth's land surfaces, surface waters, and coastal regions.
- Australia is expending $300 million over the next four years to provide critical ground station infrastructure, personnel, services, and science in support of the Landsat Next mission.

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Recent Landsat Next Endorsements

National Geospatial-intelligence Agency (NGA) (October 24th letter from NGA Director VADM Wentworth to Interior Principal Deputy Assistant Secretary Brain and NASA Deputy Administrator Melroy)

- *"…I support the development and acquisition of Landsat Next…"*
- *"The National System for Geospatial-Intelligence (NSG) relies on Landsat's unique capabilities to fulfill critical mission areas."*
- *"Landsat Next will provide improved applications such as increased resolution, six-day periodicity, and twice as many spectral bands that can identify and monitor agriculture, water use, crop health, and signs of food insecurity worldwide."*
- *"Having a sensor on orbit that collects unclassified data for sharing with customers will ensure the success of multiple DoD, IC and other national security missions."*

National Academies' "NASA at a Crossroads" report (June 2024)

- Appendix G identified Landsat Next as one of just two NASA Earth Observation missions deemed *"NASA 20-Year Critical Missions"*
- "*Increase in orbital frequency along with these new capabilities will provide significantly improved data on global environment change, natural resource utilization, and dynamic landscapes—all information needed to inform future policy decisions and to drive groundbreaking advances for multiple scientific disciplines."*

USGS

Recent Landsat Next Endorsements

Western States Water Council (WSWC) (August 16 Letter from Executive Director of the WSWC Tony Willardson to Interior Principal Deputy Assistant Secretary Brain and NASA Deputy Administrator Melroy):

- WSWC's mission *"is to ensure that the West has an adequate, secure, and sustainable supply of water of suitable quality to meet its diverse economic and environmental needs now and in the future."*
- *"The WSWC strongly supports Landsat Next. We urge you to give this investment a high priority in your FY2026 budget requests."*
- *"As we address the results of decades of drought in the West and continuing climate uncertainty, adequately and expeditiously funding preparations for the launch of Landsat Next and its operations is critical."*
- WSWC is *"particularly concerned with maintaining data continuity and integrity with Landsat thermal-infrared (TIR) and reflected light imagery given the aging Landsat 8 and Landsat 9."*
- *"Landsat spectral measurements are important – both thermal and reflected – with measurement accuracy and quality. Landsat Next will provide more and better data for water managers."*
- *"Much like weather observations and GPS, Landsat data is used every day to better understand our dynamic planet and adapt to its changing climate."*
- *"Landsat is the only operational satellite having both thermal data and a spatial resolution fine enough to map water-resources use at the level of agricultural fields."*
- *"There is an urgent need to accelerate, not delay, funding decisions in order to ensure there are no future data gaps."*
- *"The WSWC strongly supports a continuing National Land Imaging Program and expresses our strong support for the approval and construction of the Landsat Next mission without delay. Again, we ask that you give a high priority in your FY2026 budget requests for Landsat Next."*

USGS

NASA and USGS FY25 Funding for Landsat Next

Federal **Landsat Next** activities are funded from **two Congressional committees**:

- **Commerce, Justice, Science and Related Agencies** for NASA
- **Interior, Environment, and Related Agencies** for DOI/USGS

NASA Landsat Next funding is contained within the **NASA Earth Science Division (ESD)**

- Development of the space and launch segments – **Landsat Next** funding line
  - NASA FY25 request of $150M for Landsat Next is the largest for any single ESD mission

DOI/USGS Landsat Next funding is contained within the **National Land Imaging Program** of the **USGS Core Science Systems** Mission Area

- Landsat Next development & operations is in **Satellite Operations (+12M in FY25 request)**
  - Develop the satellite ground system enabling enhanced observing capabilities
- Landsat Science is in **Science, Research & Investigations (+9M in FY25 request)**
  - Support science research for algorithm development to translate data into information and decision support products to take maximum advantage of space system capabilities

Congressional Appropriations Language on Landsat Next

Interior: USGS National Land Imaging Program

- **House:** “The recommendation includes $124,071,000 for the National Land Imaging Program. The Committee recognizes the need for an on-time and on-budget delivery of the Landsat Next mission and provides $107,334,000, as requested, for Landsat Next to ensure the Service can meet the 2030 launch date” (**+$12M above FY24 Enacted**).
- **Senate:** “The bill funds Satellite Operations at $6,000,000 above the enacted levels for Landsat Next.” “The recommendation includes $121,882,000 for the National Land Imaging Program, of which $101,610,000 is for satellite operations;” (**+$6M above FY24 Enacted**).

NASA: Earth Science Division Landsat Next Program

- **House:** “The recommendation supports Landsat Next and directs NASA to submit a report, no later than 120 days after the enactment of this Act, that includes a plan to ensure the transition from the current Landsat spacecraft to the Landsat Next spacecraft remains on schedule and there is no disruption to the Landsat data record.”
- **Senate:** “Landsat Next.—The Committee recognizes the importance of on- time and on-budget delivery of the Landsat Next mission to ensure full data continuity with the Landsat 9 mission. The Committee provides $150,000,000 for Landsat Next and expects to be kept apprised if any issues arise with the current schedule.”

USGS

FY25 House & Senate Bill Language supports Landsat Next in both Interior & NASA’s budgets, however, it’s unclear whether this will carry through into the full-year budget.

NASA “Landsat’s Next Chapter” Video https://svs.gsfc.nasa.gov/14262

Thank You!

USGS science for a changing world