



# USGS Land Remote Sensing (LRS) Program

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# USGS Land Remote Sensing (LRS) Program

Delivers a national and global capability to ensure broad public and scientific availability of observations of the Earth's land surface:

- Create and preserve a long-term record of the Earth's land surface at local, regional, and global scales
- Expand scientific understanding and application of remotely sensed data to government and private users nationally and globally
- Support decision makers and policy officials in fulfilling their public responsibilities
- Guide National decisions about meeting current and future needs in land science and land observation
- Coordinate and integrate civil Earth observation with other sources of data including commercial and National Security space systems

**Fundamental goal: Ensure public availability of a primary data record about the current state and historical condition of the Earth's land surface**

# USGS LRS Program Business Drivers

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## **Land Remote Sensing Policy Act of 1992 (P.L. 102-55):**

Endorsed the need for continuous monitoring of the Earth and to maintain a readily available record of information displaying the status of the Nation's resources and environment; required DOI establish a permanent Government archive containing satellite remote sensing data of the Earth's land surface –and to make these data easily accessible and readily available for use in a broad array of applications

## **Presidential Decision Directive National Science & Technology Council (NSTC)-3 (2000):**

Directed NASA and DOI/USGS to partner in Landsat Program Management, assigning DOI/USGS the responsibility to operate the Landsat flight and ground systems, maintain the national archive, **coordinate future Federal-agency requirements** for civil operational land remote sensing data, and work with NASA and other agencies to develop a strategy for maintaining continuity of Landsat-type data

## **U.S. National Space Policy (NSPD) 49 (2006):**

*“The Secretary of the Interior, through the Director of the U.S. Geological Survey, shall collect, archive, process, and distribute land surface data to the United States Government and other users and **determine operational requirements** for land surface data.”*

## **U.S. National Space Policy (2010):**

*“The Secretary of the Interior, through the Director of the United States Geological Survey (USGS), shall:*

- Conduct research on natural and human-induced changes to Earth's land, land cover, and inland surface waters, and manage a global land surface data national archive and its distribution;*
- **Determine the operational requirements for collection, processing, archiving, and distribution of land surface data to the United States Government and other users;** and*
- Be responsible, in coordination with the Secretary of Defense, the Secretary of Homeland Security, and the Director of National Intelligence, for providing remote sensing information related to the environment and disasters that is acquired from national security space systems to other civil government agencies.*

*In support of these critical needs, the Secretary of the Interior, through the Director of the USGS, and the NASA Administrator shall work together in maintaining a program for operational land remote sensing observations.”*

# **USGS LRS Program Components**

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## **Develop and operate systems to acquire, produce, preserve, and deliver products and services to meet civil Earth observation research and operational requirements**

- Collect, archive, process & disseminate Landsat & Landsat-like data (L1-8, Sentinel-2)
- Operate the Landsat 7 and 8 satellites, calibrate and validate the incoming data
- Develop the Landsat 9 ground system in concert with NASA for 2020 launch
- Collect, maintain and analyze user requirements; inform 2018 Landsat 10 decision

## **Conduct science, research and technology investigations to improve upon and develop new products and services**

- Work with states, industry and universities to identify and promote new technologies to be applied to future Earth observation, data management and distribution activities
- Investigate potential Federal civil uses of unmanned aerial systems, hyperspectral, lidar, radar and other remote sensing technologies

## **Manage National Civil Applications activities, Civil Applications Committee**

- Provide National Security Space system geospatial data from two USGS centers to support a wide range of USGS missions including hazard warning and response, natural resource management, and scientific research
- Facilitate Federal civil agency use of National Security Space Systems through management of the Civil Applications Committee

# NASA/USGS Sustainable Land Imaging Program

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**2013 - National Research Council Space Studies Board Report:** The U.S. Government should establish a “Sustained and Enhanced Land Imaging Program” with persistent funding for current and future needs; a “comprehensive, integrated program that capitalizes on NASA and USGS strengths, maintains current capabilities, and enhances imaging capabilities and data products via emerging technology.”

**2014 - Sustainable Land Imaging Architecture Study Team Report:** Established trade space via expert knowledge, RFI responses; explored hundreds of architecture alternatives via several design cycles

**2015, 2016 - President’s 2016, 2017 Budgets:** The Sustainable Land Imaging program includes investments in technology and innovation to ensure a world class land imaging program for the next 25 years:

- Landsat 9 (fully Risk Class-B rebuild of Landsat 8) to launch in 2020/2021
  - Low programmatic risk implementation of a proven system, upgrades to bring system to Class B; intended to assure observational continuity of Landsat-Class data to the community
- Land Imaging Requirements Collection and Analysis
  - USGS is partnering with Federal agencies to document the uses of and requirements for Earth observation data, and map these requirements to a range of Earth observing systems
  - Enables the Nation’s future Landsat systems to be driven by the Nation’s land imaging requirements
- Land Imaging Technology and Systems Innovation
  - NASA is conducting instrument reduction studies, business model studies and other technology investigations to reduce cost and risk in next-generation Landsat missions
- Landsat 10 (Next-generation Landsat system) to launch in mid-late 2020s
  - Mission definition to be informed by Requirements and Technology investments in 2015 – 2018, leading to an Administration decision in 2018

# How Does USGS Determine Requirements?

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## USGS Requirements, Capabilities & Analysis (RCA) Activity

- Comprehensively understand US and International use of and needs for Earth observations
- Requirements elicitation identifies fundamental information needed by the user (what needs to be observed or measured): Geographic Coverage, Horizontal & Vertical Resolution, Sampling Interval, Accuracy, Length of data record, Data latency, etc.

## USGS Requirements Surveys

- USGS/NASA Landsat Applications Survey of 33 Landsat products (2012)
- USGS National Land Imaging Requirements Pilot Project with 12 federal agencies (2014)

## Landsat Science Team (Co-chaired by USGS and NASA)

- 21 scientists and engineers from the Federal Government, academia and international organizations

## National Geospatial Advisory Committee's Landsat Advisory Group

- Provides advice to the Federal Government on Landsat requirements, objectives and actions

## DOI Remote Sensing Working Group

- Team of remote sensing experts from all DOI bureaus working together to share expertise

## OSTP-led Activities

- National Plan for Civil Earth Observations (2014), Earth Observation Assessments (2012, 2016)

**Others:** NRC Reports, USGEO Satellite Needs Working Group, AmericaView, Case Studies, User feedback

# Landsat Science Team (LST)

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- Competitively-selected scientists and engineers, serving from 2012-2017, providing technical and scientific input to the USGS and NASA on issues critical to the success of the Landsat program.
- The LST plays a key role in ensuring that Landsat 8 is successfully integrated with past, present, and future remotely sensed data for the purpose of observing and monitoring national and global environmental systems.
- The LST members are recognized national and international leaders in land remote sensing. As such, they evaluate strategies for Landsat use needed to meet the needs of all Landsat users, including the needs of policy makers at all levels of government.

# LST Members and Projects (1 of 2)

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- Dr. Richard Allen, University of Idaho; Dr. Ayse Kilic, University of Nebraska; Dr. Justin Huntington, Desert Research Institute - Developing and enhancing Landsat derived evapotranspiration and surface energy products
- Drs. Martha Anderson and Feng Gao, USDA Agricultural Research Service – Mapping vegetation phenology, water use and drought at high spatiotemporal resolution fusing multi-band and multi-platform satellite imagery
- Dr. Alan Belward, European Commission Joint Research Centre – Understanding the global land-use marketplace
- Dr. Warren Cohen, USDA Forest Service – Ecological Applications of Landsat Data in the Context of US Forest Service Science and Operational Needs
- Dr. Dennis Helder, South Dakota State University – Landsat data continuity: advanced radiometric characterization and product development
- Dr. Jim Hipple, USDA Risk Management Agency – Integrating Field-Level Biophysical Metrics Derived from Landsat Science Products into a National Agricultural Data Warehouse
- Dr. Patrick Hostert, Humboldt University of Berlin – Synergies between future Landsat and European satellite missions for better understanding coupled human-environment systems
- Mr. David Johnson, USDA National Agricultural Statistical Service – Operational monitoring of US croplands with Landsat 8
- Dr. Robert Kennedy, Boston University – Using time-series approaches to improve Landsat’s characterization of land surface dynamics
- Dr. Leo Lymburner, Geoscience Australia – Multi-temporal Analysis of biophysical parameters derived from the Landsat series of satellites



# LST Members and Projects (2 of 2)

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- Dr. Joel McCorkel, NASA Goddard – Absolute radiometric and climate variable intercalibration of Earth observing sensors
- Dr. David Roy, South Dakota State University – Continuity of the Web Enabled Landsat Data (WELD) Product Record in the LDCM Era
- Dr. Crystal Schaaf, University of Massachusetts, Boston – North American Land Surface Albedo and Nearshore Shallow Bottom Properties from Landsat and MODIS/VIIR
- Dr. Ted Scambos, University of Colorado – Cryospheric Applications of the Landsat Data Continuity Mission (Landsat 8)
- Dr. John Schott, Rochester Institute of Technology – The Use of LDCM for the Monitoring of Fresh & Coastal Water
- Dr. Yongwei Sheng, University of California, Los Angeles – Developing Decadal High Resolution Global Lake Products from LDCM and Landsat
- Drs. Eric Vermote and Christopher Justice, University of Maryland – Development of Landsat surface reflectance Climate Data Records.
- Dr. Jim Vogelmann, U.S. Geological Survey – Ecological Disturbance Monitoring using Landsat Time Series Data
- Dr. Curtis Woodcock, Boston University – Better Use of the Landsat Temporal Domain: Monitoring Land Cover Type, Condition and Change
- Dr. Mike Wulder, Canadian Forest Service – Integrating the past, present, and future of Landsat
- Dr. Randolph Wynne, Virginia Tech – Making Multitemporal Work

# Landsat Advisory Group (LAG)

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The LAG develops advice and recommendations on Landsat-related issues for consideration by the National Geospatial Advisory Committee (NGAC), an advisory body to the 32-agency Federal Geographic Data Committee, including the following:

- Operational and scientific Landsat Program requirements.
- U.S. policies relevant to the Landsat Program, consistent with the economic, scientific, environmental, security, and foreign policy interests of the United States.
- Landsat imagery, data and information availability for all public, private and international purposes, including the means and methods of information access and distribution.
- The National Satellite Land Remote Sensing Data Archive as the primary U.S. Landsat data repository.
- Future Landsat Program plans and efforts in coordination with the National Earth Observations (NEO) Task Force, etc.
- Priorities and communication of the Landsat Program.

# Landsat Advisory Group (LAG) Membership - 2016

Name	Organization
Joanne Gabrynowicz (NGAC Member, Chair)	University of Mississippi Law School
Frank Avila (NGAC member, Vice Chair)*	National Geospatial-Intelligence Agency
Roger Mitchell (NGAC member)	MDA Information Systems, Inc.
Rebecca Moore (NGAC member)	Google, Inc.
Kass Green (former NGAC member)	Kass Green & Associates
Walter Scott*	Digital Globe
Roberta Lenczowski	AmericaView
Peter Becker	Esri
Jed Sundwall*	Amazon Web Services
Tony Willardson	Western States Water Council
Steven Brumby*	Descartes Labs

\*New Members

# **Landsat Advisory Group (LAG) Papers**

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## **2012:**

- ✓ 1) The Value Proposition for Ten Landsat Applications
- ✓ 2) Statement on Landsat Data Use and Charges

## **2013:**

- ✓ 1) Product Improvement
- ✓ 2) Cloud Computing: Potential New Approaches to Data Management & Distribution
- ✓ 6) Review and comment on the National Research Council report on Implementing a Sustained Land Imaging Program

## **2014:**

- ✓ 1) The Value Proposition for Landsat Applications – 2014 Update

## **2015:**

- ✓ 1) Analysis of Non-Federal Landsat User Requirements
- ✓ 2) Sentinel Data Use Policies

The LAG papers have had a significant impact on DOI/USGS policies related to Landsat

<https://www.fgdc.gov/ngac>

# How Does USGS Meet Requirements?

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## NASA

- Work with NASA on Landsat 9 and future Sustainable Land Imaging systems
- Use NASA earth observation systems like MODIS, ASTER, GRACE, Aura

## International

- Negotiate Bilateral agreements with European Union (for Sentinel-2 data)
- Leverage international agreements (for India's Resourcesat data)

## National Security Space Systems

- Use Civil Applications Committee to access National Security Space system data
- Digitize declassified imagery (Corona, Argon, KH-9) and make it publicly available

## Aerial systems

- Use USDA aerial imagery
- Operate unmanned aerial systems to collect data for many applications

## Commercial systems

- Leverage USGS Commercial Remote Sensing Data Contracts
- Use the Joint Agency Commercial Imagery Evaluation (JACIE) forum to assess satellite data

## USGS

- Make the datasets we have more accessible by enabling others to redistribute
- Expand our menu of products based on existing datasets: create Landsat-based products like:
  - Surface Reflectance and Surface Temperature Climate Data Records
  - Burned Area, Dynamic Surface Water, and Snow-Covered Area Extent Essential Climate Variables
  - LandsatLook (JPEGs)
  - Land Change Monitoring, Assessment and Projection (LCMAP)
- Conduct remote sensing research and technology investigations

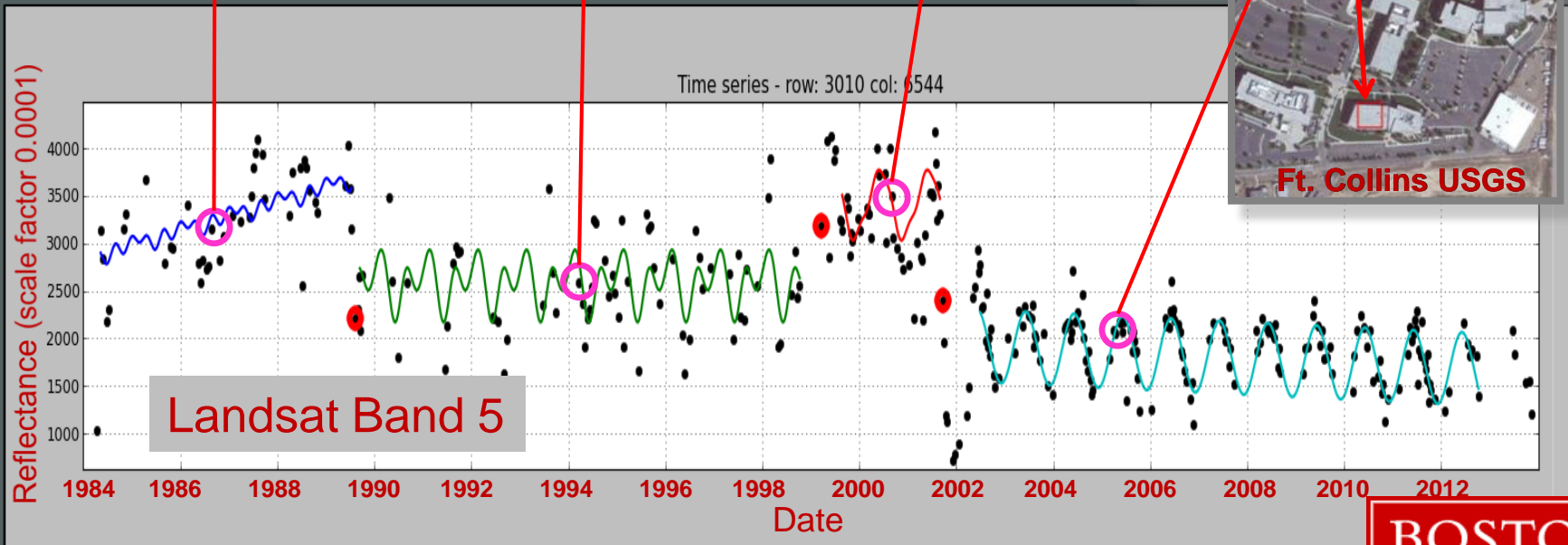
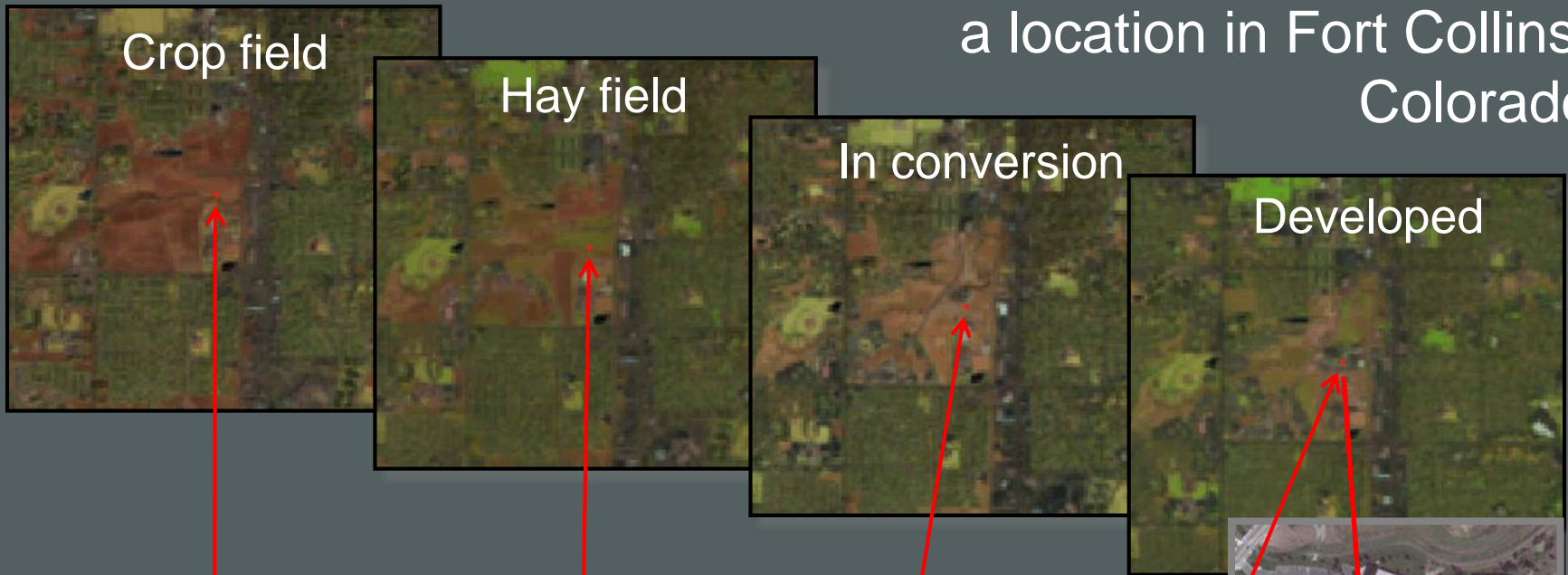
# Land Change Monitoring, Assessment & Projection

- Generation of science-quality land change products from current and near-real time Earth observations (e.g., Landsat).
- Land change detection system that:
  - Characterizes historical land change at any point across the full Landsat record.
  - Detects land change as it occurs.
- Includes an information delivery capability that (eventually) provides global, seamless, multi-temporal land change (cover and condition) products via the Internet.

Change analysis based on Zhu and Woodcock (2014) Continuous Change Detection and Classification (CCDC) methods.

**BOSTON  
UNIVERSITY**

# LCMAP - Spectral history of a location in Fort Collins, Colorado



Zhu, Z. and C.E. Woodcock. 2014. Continuous change detection and classification of land cover using all available Landsat data. Remote Sensing of Environment 144:152-171.

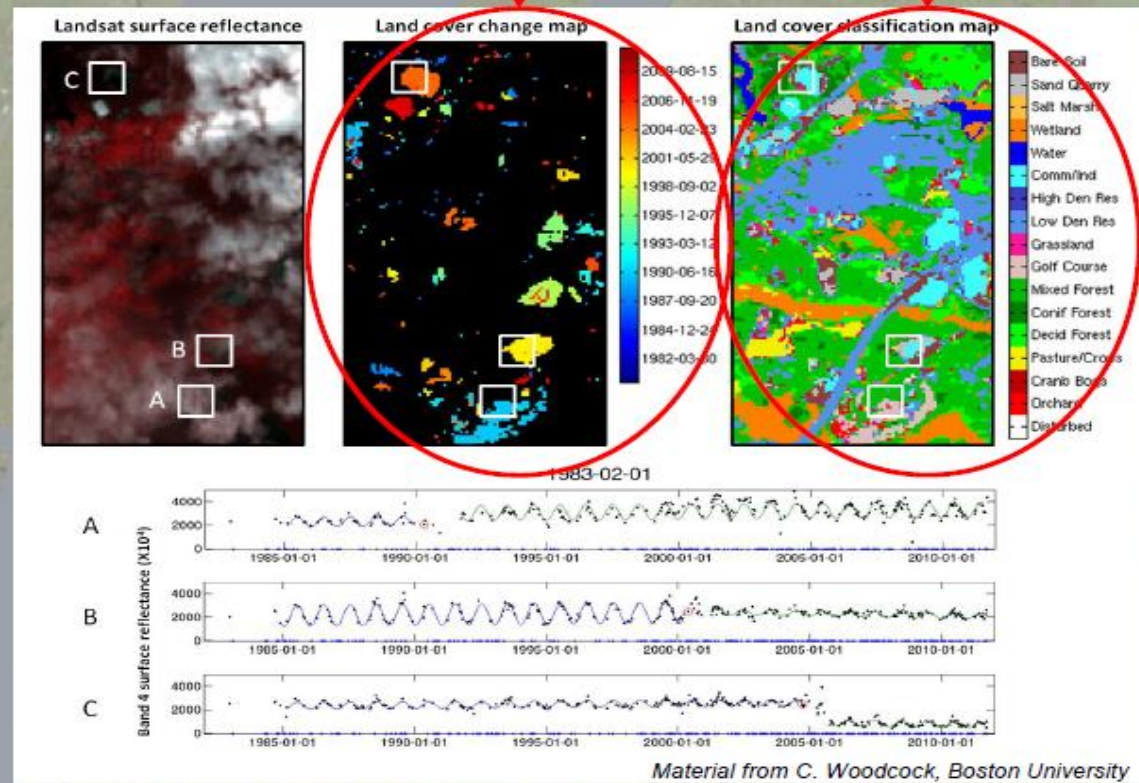


# USGS is Developing LCMAP; Initial Capability in 2017

With this approach we can:

Map the timing of change

Stop the clock at any time to generate a land cover map





# Key to LCMAP: Analysis Ready Data (ARD)

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- Significantly reduce the burden of processing on applications scientists
- Standard Level-1T products serve as the input used for generating ARD
- From scene-based, to seamless (gridded) access
- The ARD product consists of Landsat top of atmosphere reflectance, surface reflectance, and brightness temperature data that are consistently processed, gridded to a common cartographic projection, and accompanied by appropriate metadata to enable further processing while retaining traceability of data provenance.
- Products derived from the ARD include, but are not limited to: maps of land cover and land-cover change, spectral indices, temporal composites, and other geophysical and biophysical parameters

# USGS LRS Program Affiliations

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## **US Group on Earth Observations (USGEO)**

Vice Chair for the 13-agency NSTC subcommittee; coordinate, plan, and assess Federal Earth observation activities; foster improved Earth system data management and interoperability; lead US participation in international GEO

## **Landsat Science Team**

Comprised of 21 scientists and engineers from the Federal government, academia and international organizations

## **Federal Geographic Data Committee (FGDC)**

Co-lead (with USDA) on A16 Imagery Theme; promotes the coordinated development, use, sharing, and dissemination of geospatial data on a national basis; 32 members (DOI Chair/OMB Vice chair); formulate requirements across FGDC

## **National Geospatial Advisory Council (NGAC) Landsat Advisory Group**

Provides advice to the Federal Government on the requirements, objectives and actions of the Landsat Program

## **DOI Remote Sensing Working Group**

Team comprised of remote sensing experts from all DOI bureaus working together to share expertise

## **International Charter on Space and Major Disasters**

Combines satellite assets of various national and private space agencies to provide data acquisition and delivery for those affected by natural or man-made disasters

## **AmericaView**

A USGS-funded nationwide partnership of scientists and educators who support the use of Landsat and other remotely sensed satellite data for 40 participating "StateViews"

## **Committee on Earth Observation Satellites (CEOS)**

Promotes international coordination of civil space-based Earth observation programs and encourages exchange of data to optimize societal benefits



# LRS Challenges

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- Securing the Landsat 9 Ground System development budget
- Maintaining operational continuity of current Landsat missions to minimize break in 8-day revisit
- Establishing a joint-agency Sustainable Land Imaging program with NASA, responsive to user requirements
- Maturing and institutionalizing RCA processes to significantly expand user need satisfaction across USGS, DOI and the Federal Civil community
  - Enhance LRS products and services to satisfy more user needs
  - Secure new sources of data and information to meet customer needs
  - Drive LRS science and technology investigations
- Increasing utilization of National Civil Applications Center capabilities across the USGS and other Federal Civil agencies

# Landsat News

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- **Remote Sensing of Environment Landsat 8 Special Issue**

- Two dozen articles in the Remote Sensing of Environment special issue on Landsat 8 science impacts are now available with volume and page numbers at the following:

<http://www.sciencedirect.com/science/journal/00344257/185/supp/C>

- **50<sup>th</sup> Anniversary of Interior Secretary Udall's announcement of "Project EROS"**

- Celebration of the birth of the Landsat Program at Main Interior on September 21; speakers included Senator Udall, Deputy Secretary Connor, Mike Freilich

<https://www.usgs.gov/news/vision-observe-earth>

# Celebrating a Vision – 50<sup>th</sup> Anniversary Event

## Celebrating a Vision... 50th Anniversary

History ▾

*“A vision to observe Earth  
for the benefit of all.”*

Interior Secretary  
Stewart Udall, 1966

Fifty years ago, on September 21, 1966, Secretary of the Interior Stewart Udall announced his vision to create “a program aimed at gathering facts about the natural resources of the earth from earth-orbiting satellites.” It was an idealistic goal at the time, but came with encouragement and support from U.S. Geological Survey Director Bill Pecora. The announcement created “Project EROS”.

Over the past five decades, the Landsat Program and other international earth observation programs have matured. Udall’s vision gave the world the confidence to create satellite systems to help people understand the intricate nature of our planet with a new perspective.



*A vision to observe Earth...  
50<sup>th</sup> Anniversary Celebration*

**September 21, 2016**  
Washington, D.C.

*Water • Agriculture • Forests • Climate • Hazards • Ecosystems • Energy*