

USGS National Land Imaging Update

National Academies of Sciences,
Engineering and Medicine
Committee on Earth Sciences and Applications from
Space

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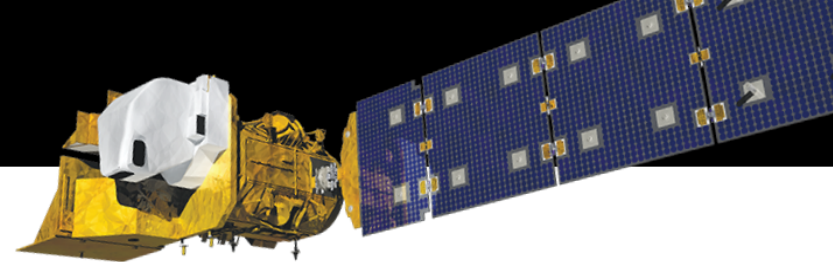
USGS Mission and Vision

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 by the Numbers



People

8,190 Employees

1,356 Contractors

564 Emeriti

257 Volunteers

Science and Monitoring

165,000+ Publications (since 1879)

54,000 7.5-minute Quadrangles (Topographic Maps)

200 Threatened/Endangered Species Studied

25 Active Patents (85 since 1996)

1 Research Reactor

~20,000 USGS-operated Groundwater Wells in U.S. to Deliver and Monitor Water Levels and Water-quality Data

11,500+ USGS-operated Streamgages

3,800+ USGS-operated Earthquake Sensors in U.S.

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

14 Geomagnetic Observatories

3 Satellites

150M Remotely-sensed Data Products Distributed (including Landsat)

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

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

55%+ 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

487

Laboratories

405 Facilities

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

68

Science Centers (7 Regions)

22

Programs (5 Mission Areas)

10

Climate Adaptation Science Centers
1 National - 9 Regional

Partnerships

4,300 Partners/Cooperators

4,675 Contracts (FY21)

43

Cooperative Research Units

54

Water Resources Research Institutes

Funding

\$1,578M FY25 President's Budget Request

\$646M FY23 Reimbursables

\$69.0M FY25 Bipartisan Infrastructure Law



USGS Science: Interdisciplinary and Transdisciplinary

Disciplines in Water, Ecosystems, Energy and Mineral Resources, Core Science Systems, Natural Hazards Mission Areas

Hydrology
Geology
Ecology
Biology
GIS
Energy/mineral resources
Geophysics
Remote sensing
Microbiology
Geochemistry
Wildlife health
Geologic hazards
Environmental science
Botany
Statistics
Climate science
Soil science
Analytical chemistry

Key disciplines used in smaller numbers to help “bridge the gap”

Global climate model downscaling

Public health

Planetary Sciences

Fire science

Engineering

Information Technology

Economics

Risk Communication

Structured decision-making

External disciplines we engage via our many partners

Global climate modeling

Human epidemiology, toxicology, immunology

Meteorology

Industrial ecology

Other social sciences

Urban planning

Landscape architecture

Indigenous and community knowledge

Community partners
(full co-design,
co-production)

Many others...

USGS National Land Imaging Program: Roles and Responsibilities

AS DEFINED BY **PUBLIC LAW** AND **NATIONAL SPACE POLICY**,
TO CARRY OUT THE PUBLIC INTEREST OF THE UNITED STATES:

- **Operate and maintain a National Land Imaging Archive** to house a Basic Data Set of global data – for historical, scientific, and technical purposes – includes data from U.S. civil, commercial and foreign satellite systems
- **Operate and maintain the Landsat** flight and ground systems
- **Collect, process, archive and distribute these data** as Public Domain holdings of the United States
- **Determine U.S. civil operational requirements** for global land surface data and to conduct a national program of civil-operational land imaging
- **Conduct science, research and development in the applications of remote sensing** in order to enhance the ability of the U.S. to manage and utilize its renewable and nonrenewable resources
- **Develop civil applications and information tools** using known standards and protocols and make them available to the general public; facilitate federal civil agency use of National Security Space system data via the Civil Applications Committee

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

What is Landsat?

The world's longest continuously operated land remote sensing satellite series and most widely used and cited land remote sensing data set, helping us understand and manage natural and human-induced landscape change via a multitude of land, water, and natural resource management applications.



Common Uses of Landsat data by Federal Agencies, States, and the private sector:

- | | | |
|------------------------------|-------------------------------|---------------------------|
| ● Agriculture and Forestry | ● Water Quality and Resources | ● Famine Early Warning |
| ● Regional Land Use Planning | ● Global Change Science | ● Carbon Assessment |
| ● Land Use/Land Cover | ● Flood Management | ● Drought Monitoring |
| ● Fire/Disaster Management | ● National Security | ● Transportation Planning |
| ● Energy and Mineral Mapping | ● Ecosystem Monitoring | ● Calibration/Validation |

Multi-spectral coverage in VNIR-SWIR-TIR**

-> to map surface composition & temperature

15 / 30 / 100 meter spatial resolution

-> to resolve human-scale land dynamics

16-day revisit frequency (8-days w/ two satellites)

-> global, seasonal coverage

Broad area collection => 12,000+ square miles per image

-> 1400 images/day = 20 million square miles/day

Highly calibrated “science quality” data

-> to resolve long-term trends & retrieve biophysical variables

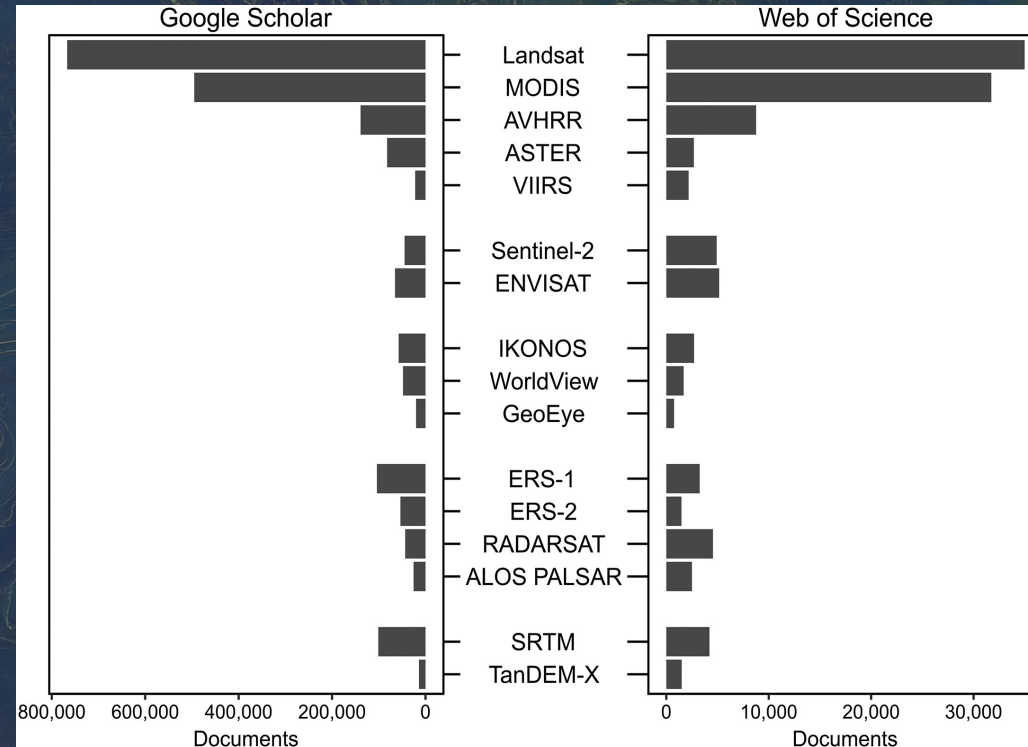
Free and Open Data policy since 2008

-> Over 100 million products distributed and billions of data accesses via Commercial Cloud in the last year alone

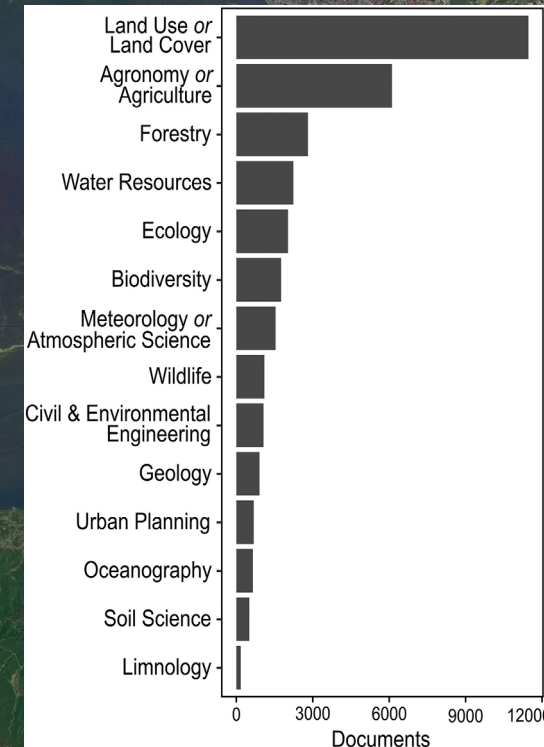
Landsat's Unique and Successful Characteristics

- Diverse uses and benefits to society.
- Global perspective at management-scale resolution.
- Long-Term record of rigorously calibrated observations.
- Consistent measurement of key observables, while at the same time introducing new measurement capabilities.
- Affordability and accessibility of the data.

Landsat Citations



Landsat Applications



"The opening of the Landsat archive to free, web-based access is like giving a library card for the world's best library of Earth conditions to everyone in the world."
(Adam Ferrand, UN-FAO)

Landsat's Economic Benefit

“The economic value of just one year of Landsat data far exceeds the multi-year total cost of building, launching, and managing Landsat satellites and sensors”

Earth Imaging Journal article (2015)

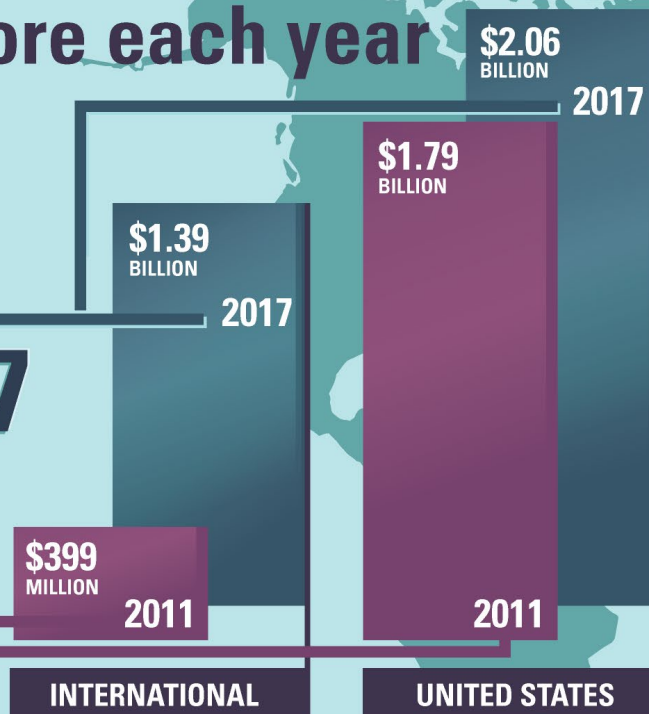
Users VALUE

Landsat more each year

\$3.45

BILLION 2017
economic benefit in

\$2.19
BILLION 2011
economic benefit in



Landsat Operations Status

Landsat 9 (2021 -)

Collecting more than 700 new scenes per day; full mission transitioned to USGS in 2022

Landsat 8 (2013 -)

Collecting more than 700 new scenes per day; night and off-nadir imaging of volcanos and fire imaging

Landsat 7 (1999 - 2024)

Lowered into storage orbit; awaiting NASA satellite rendezvous and refueling; recently stopped collecting new imagery



Earth Resources Observation and Science Center (EROS)

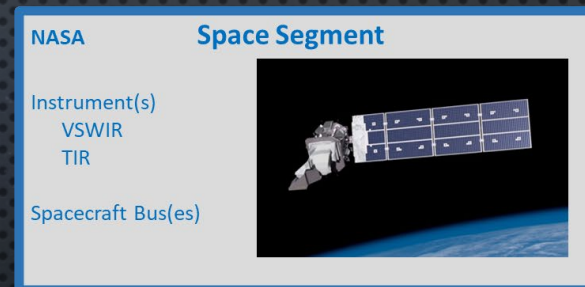
Landsat Archive Operations

Reprocessed Landsat “Collection 2” available in the Amazon Cloud.

On track for more than **14 billion** user accesses this year!

Landsat NASA/USGS Partnership - Sustainable Land Imaging (SLI)

- NASA and Interior/USGS partner to provide independently-funded joint-agency development and operations to sustain the Landsat series of measurements for federal, State, Tribal, local, academic, commercial, non-profit, and international users
 - Both agencies work together to plan for and jointly develop new missions
 - NASA is responsible for space segment (imaging instrument(s), spacecraft), launch and on-orbit checkout
 - Includes engineering support for mission operation readiness and support for on-orbit anomalies
- USGS builds and delivers the ground system, operates the observatories after the commissioning phase and provides data archiving, processing and distribution
 - Systems engineering support during development
 - Mission Operations Center (MOC) (and backup)
 - Ground Network
 - Data Processing and Archive System (DPAS)
 - Provide MOC development and Flight Operations Team



NASA and Interior/USGS SLI Partnership is Developing Landsat Next

Landsat Next – The Follow-on Mission to Landsat 9

- SLI Joint Steering Group in 2017 requested a NASA/USGS study to consider post-Landsat 9 options
- SLI Architecture Study Team completed detailed study in 2020
- SLI Joint Steering Group approved a *multi-element* architecture in 2020, including Landsat Next, and approved the Landsat Next “Triplets” mission concept in 2022
- NASA & USGS Landsat Next project teams on track for instrument award in 2024



“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.

- 2024 is a critical year for LNext

Landsat Next

- **Landsat Next “Superspectral Triplets” mission**, the result of **six years** of 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 on track for instrument award in 2024

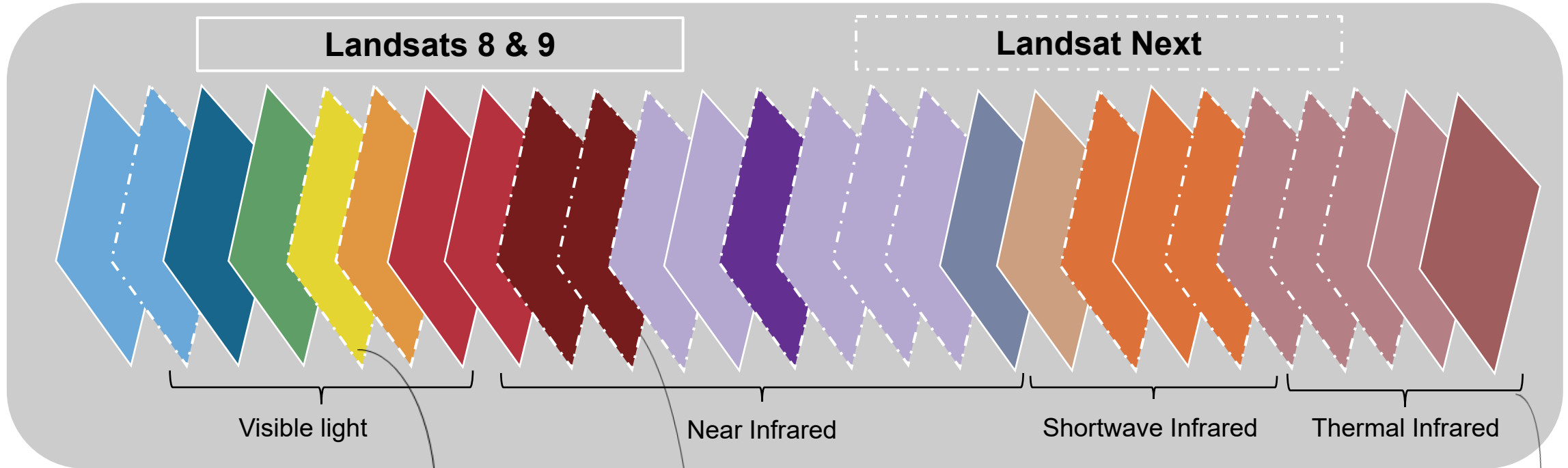
Landsat Next will provide more than twice as many spectral bands as Landsat 8/9, with spatial resolution improved by a factor of 2, and significantly improved repeat coverage



NASA “Landsat’s Next Chapter” Video

<https://svs.gsfc.nasa.gov/14262>

Landsat Next Adds Benefits for Science Applications



Bands: 6 - 7
Application Area: Water Quality
New Band Impact: Enhances detection of the specific organisms that cause harmful algal blooms.



Bands: 9 - 10
Application Area: Crop condition monitoring
New Band Impact: Improves early detection of crop stress.



Bands: 22 - 26
Application Area: Agriculture
New Band Impact: Improves monitoring of crop water use.



Key to Agencies

FAS: Foreign Agriculture Service
 FSA: Farm Service Agency
 NASS: National Agricultural Statistics Service
 NRCS: Natural Resources Conservation Service
 RMA: Risk Management Agency
 USFS: U.S. Forest Service
 BIA: Bureau of Indian Affairs
 BLM: Bureau of Land Management
 FWS: U.S. Fish and Wildlife Service
 NPS: National Park Service
 USGS: U.S. Geological Survey
 EPA: Environmental Protection Agency
 USAID: U.S. Agency for International Development
 NASA: National Aeronautics & Space Administration
 DOE: Department of Energy
 OSMRE: Office of Surface Mining Reclamation and Enforcement
 BOEM: Bureau of Ocean Energy Management
 BSEE: Bureau of Safety and Environmental Enforcement
 NOAA: National Oceans and Atmospheric Administration
 NIH: National Institutes of Health
 FEMA: Federal Emergency Management Agency
 BOR: Bureau of Reclamation
 USDA: U.S. Department of Agriculture
 DOI: Department of the Interior

	Climate		Landsat Heritage		Landsat Next
Science Applications and Agencies for User Needs Satisfaction	Climate Indicators	Critical Measures	L8+L9		Triplets
			8-day Revisit	16-day Revisit	6-day Revisit
Agriculture & Forestry (FAS, FSA, NASS, NRCS, RMA, USFS, BIA, BLM, FWS, NPS, USGS, EPA, USAID, NASA, DOE)	ST, LC	CT, CY, LAI, VC			
Emergency/Disasters (USGS, OSMRE, BOEM, BSEE, USFS, NOAA, USAID, NIH, FEMA, NASA, DOE)		AF, VA, SWE, OSE			
Public health/Water Quality (USGS, NPS, EPA, NOAA, NIH, NASA)	ST	UHI, WQWC			
Water resources monitoring (BOR, USGS, FAS, NASS, NASA, DOE)	ST	ET, WQWC			
Wildfire Response and Assessment (BIA, BLM, FWS, NPS, USGS, USFS, NRCS, NASA)	ST, LC	BABS, VC, LULC			
Cryosphere (BOR, USGS, NRCS, NOAA, NASA, DOE)	ST, GLI	GLI, SCE, SGS			
Ecosystems/Land Use (USDA, DOI, EPA, NOAA, USAID, FEMA, NASA, DOE)	ST, LC	fPAR, LULC, VC			

ST – Surface Temperature
 LC – Land Carbon
 GLI – Glacier & Ice Sheets

CT – Crop Type
 CY – Crop Yield
 LAI – Leaf Area Index
 VC – Vegetation Condition
 BABS – Burned Area/Burn Severity
 AF – Active Fires
 VA – Volcanic Activity
 SWE – Surface Water Extent

OSE – Oil Spill Extent
 UHI – Urban Heat Island
 WQWC – Water Quality/Water Chemistry
 ET – Evapotranspiration
 LULC – Land Use/Land Cover
 SCE – Snow Cover Extent
 SGS – Snow Grain Size
 fPAR – Photosynthetically Active Radiation

Reflects varying spatial and spectral capabilities

GREEN = > 2/3 of user revisit needs met
 YELLOW = 1/3 – 2/3 met
 RED = < 1/3 met



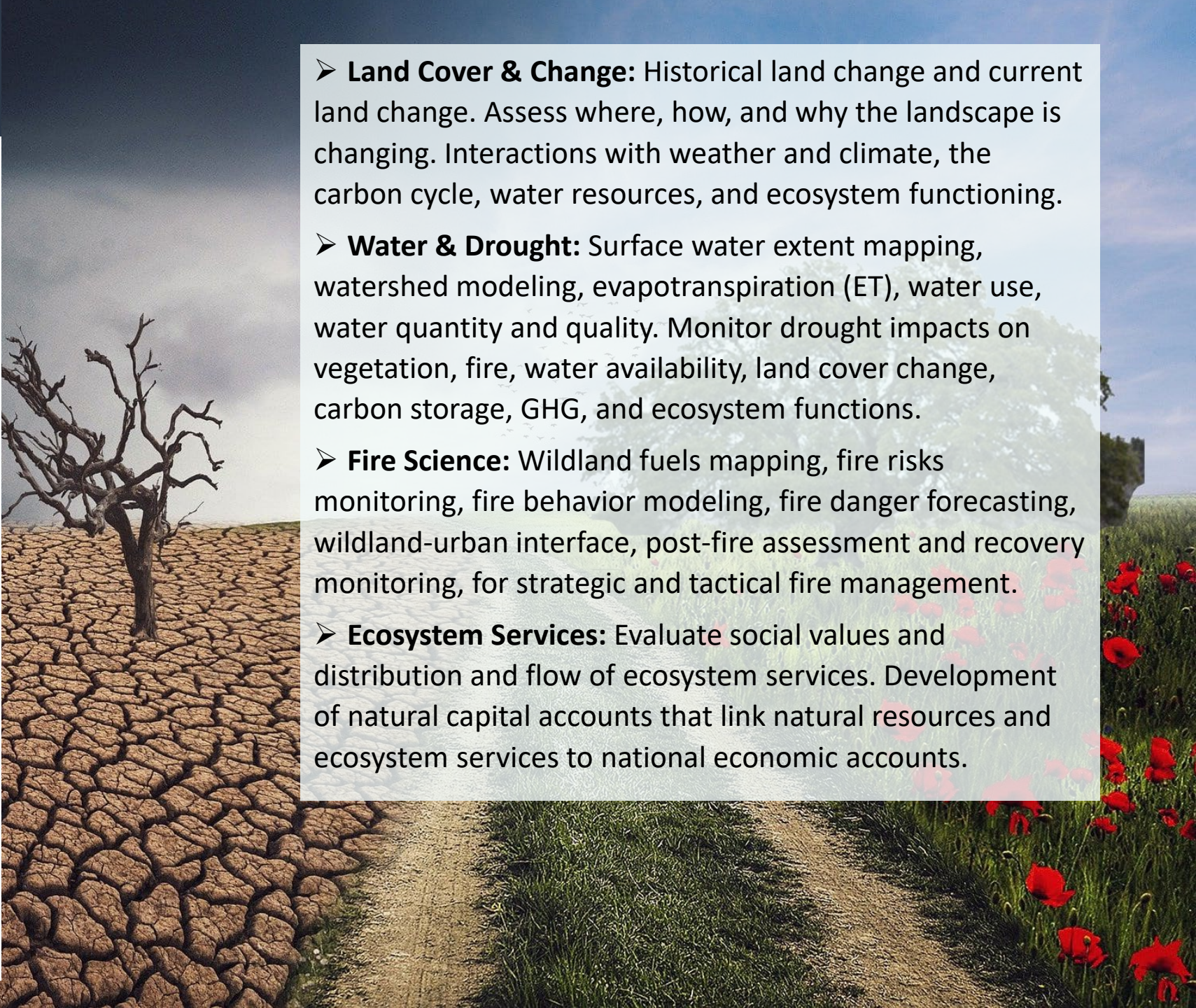
Driving Applications for Landsat Next

Societal Benefit Area	Application	Science Benefits from Landsat Next
Agriculture	U.S and global agricultural monitoring	Landsat Next will allow USDA Foreign Agricultural Service (FAS), Farm Service Agency (FSA) and National Agricultural Statistics Service (NASS) more precise observation of crop emergence.
	Crop residue monitoring/soil conservation	Landsat Next observations in the early growing season can allow USDA Natural Resources Conservation Service to detect cover crop and crop residue for soil conservation at the field-scale.
Forestry	Forest health monitoring	Landsat Next will aid USFS, BIA, BLM, FWS, NPS and USGS in the detection and identification of insect/disease agents for forest health monitoring, since symptoms are often seasonal and transient.
Water Resources	Evapotranspiration and water use	Landsat Next frequent observations of evapotranspiration (ET) are needed for field-scale ET estimates and continuous water use monitoring operationally by BOR, USGS, FAS, NASS and Western States.
Water Quality	HAB detection and monitoring	The new targeted spectral bands for water quality provided by Landsat Next will enable detection of specific organisms that cause harmful blooms.
Cryosphere	Snow/water availability	Higher temporal frequency and new targeted spectral measurement capabilities of Landsat Next will reduce cloud cover contamination while increasing detection.
Public Health	Monitoring urban heat islands	Landsat Next can help capture more frequent, intense, and longer heat waves as climate change indicators.
Wildfire	Pre- and post-fire assessment	Landsat Next higher temporal revisit is needed to capture the onset of more frequent wildfires and provide immediate post-fire response.

National Land Imaging Science Portfolio

The National Land Imaging science portfolio conducts research and delivers information products to:

- Improve understanding of rates, causes, and consequences of land change
 - Anticipate future landscape changes
- Deliver landscape change information to natural resource managers and stakeholders
- Mitigate adverse effects of environmental change

- 
- **Land Cover & Change:** Historical land change and current land change. Assess where, how, and why the landscape is changing. Interactions with weather and climate, the carbon cycle, water resources, and ecosystem functioning.
 - **Water & Drought:** Surface water extent mapping, watershed modeling, evapotranspiration (ET), water use, water quantity and quality. Monitor drought impacts on vegetation, fire, water availability, land cover change, carbon storage, GHG, and ecosystem functions.
 - **Fire Science:** Wildland fuels mapping, fire risks monitoring, fire behavior modeling, fire danger forecasting, wildland-urban interface, post-fire assessment and recovery monitoring, for strategic and tactical fire management.
 - **Ecosystem Services:** Evaluate social values and distribution and flow of ecosystem services. Development of natural capital accounts that link natural resources and ecosystem services to national economic accounts.

Latest National Land Cover Database Release

National Land Cover Database (NLCD) 2021: Conterminous U.S. Land Cover



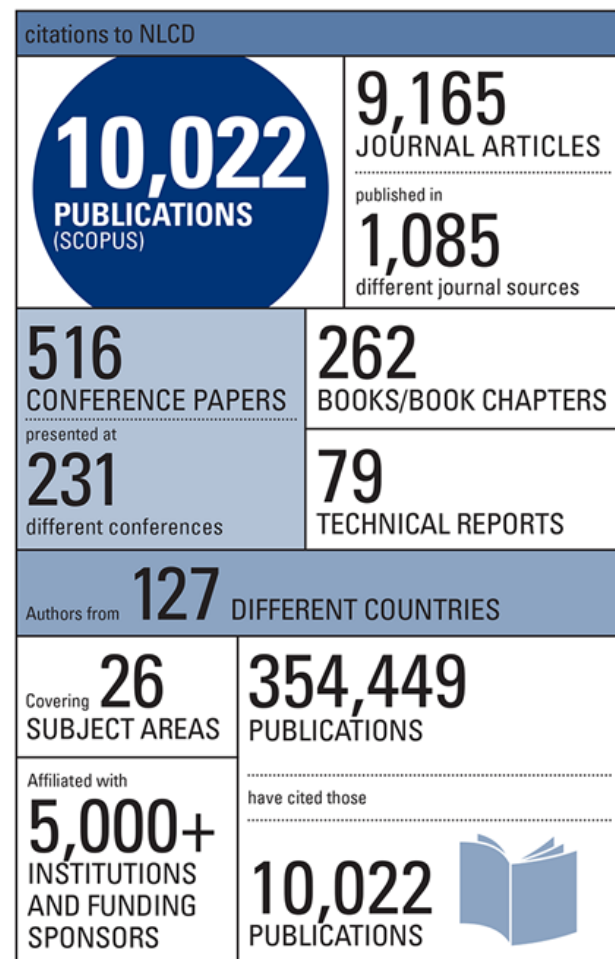
National Land Cover Database (NLCD) 2021 Released!

- Released July 31, 2023
- Product suite includes land cover, change, disturbance, and urban imperviousness at 30-meter spatial resolution
- Most widely used and cited national scale land cover data product for environmental monitoring, modeling, and land management
- NLCD 2021 characterizes land change from 2001 to 2021 (*Previous NLCDs: 2001, 2004, 2006, 2008, 2011, 2013, 2016, and 2019*)
- Moving towards the next-generation land cover and change product suite ***Land Cover Next (LC Next)***

30 Years of the National Land Cover Database (NLCD)

The NLCD stands as the definitive land cover database for the United States

IN SCHOLARLY LITERATURE



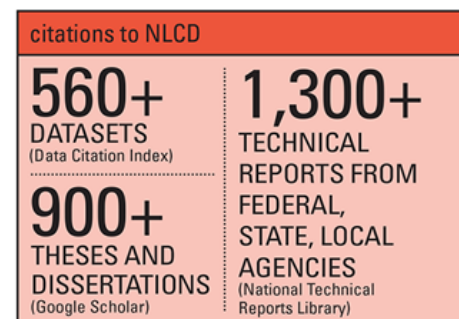
IN POLICY DOCUMENTS



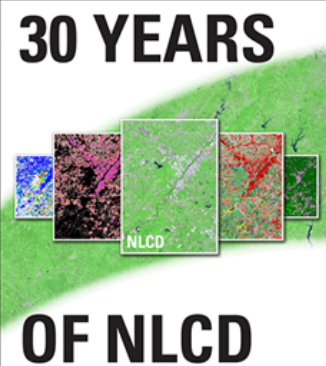
National Land Cover Database (NLCD) "by the Number"

- Scientific literature (>10,000 pubs)
- Citation: near 355,000 times
- Academia: >900 theses/dissertations
- Policy: >3,000 policy documents from >300 government/private entities
- Technical: >1,300 Federal, state, local reports
- News: >10,000 in the news

IN DATASETS AND GREY LITERATURE

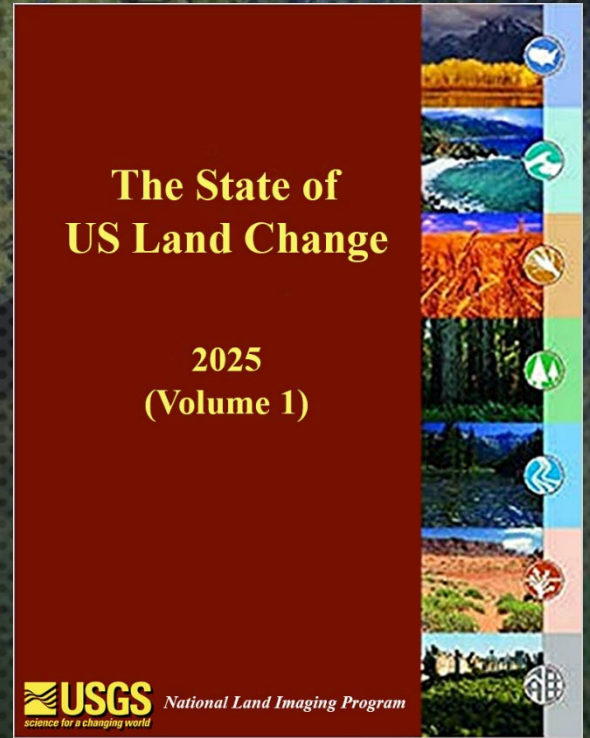
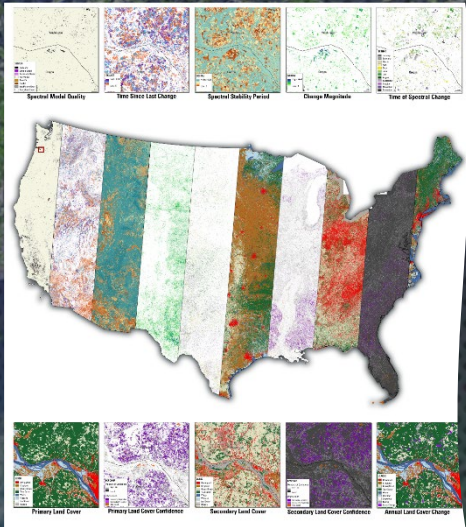


IN NEWS STORIES



U.S. Department of the Interior
U.S. Geological Survey

National NLI Operational Science Products



**Land Change
Monitoring,
Assessment and
Projection (LCMAP)**
1985-2021

**Focusing on change
and trends**

**National Land Cover
Database (NLCD)**
2001, 2006, 2011, 2016,
2019,
2021 (release in July 2023)

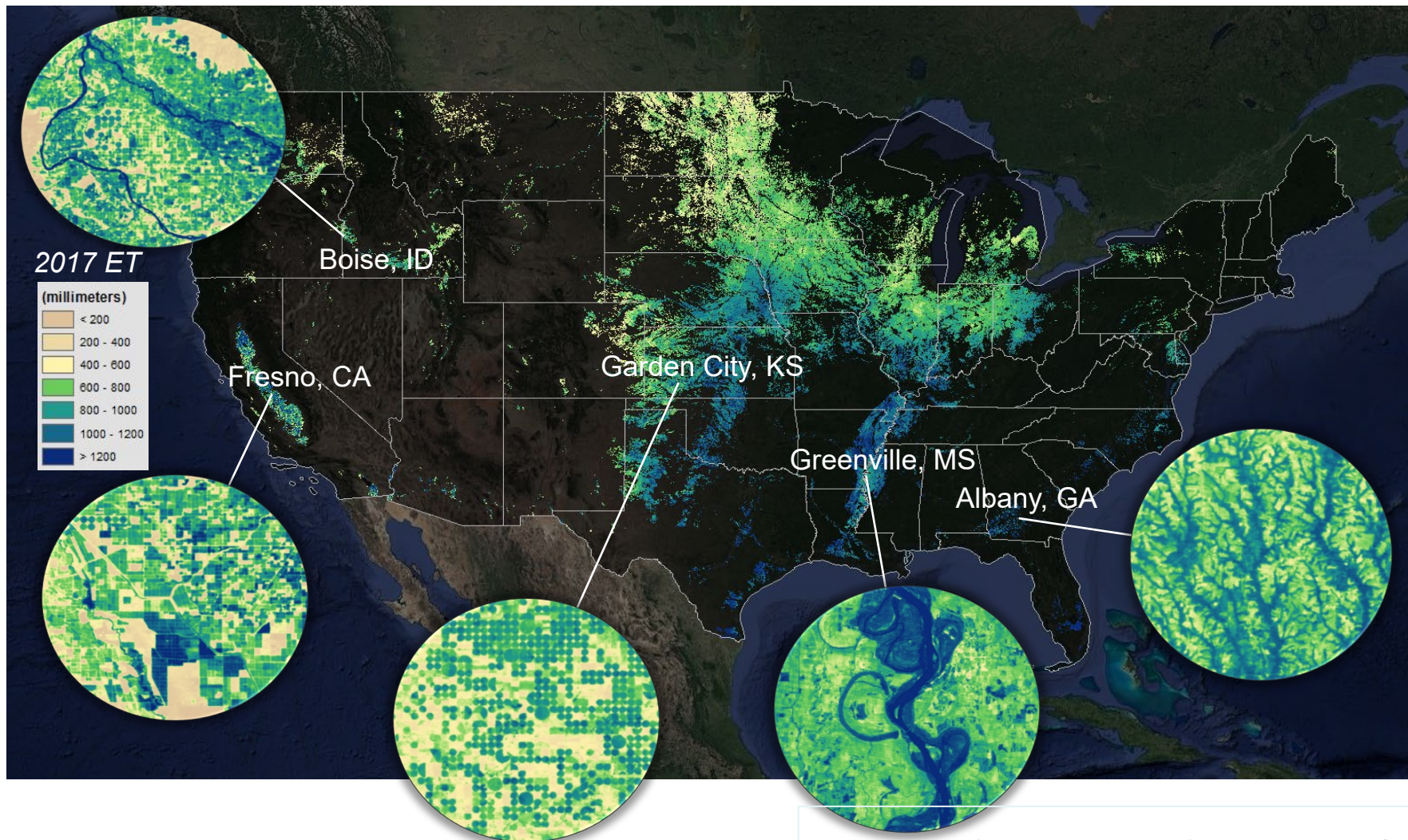
**Focusing on accurate
thematic cover**

Land Cover Next (LC Next)
1985-2024
2023 - Product Suite Definition
2024 - LC Next Product Release

**Landsat-based land
cover and change**

**Historical trends, current condition, drivers
of change, future risks and vulnerabilities**

Field Scale Evapotranspiration (ET) from Space



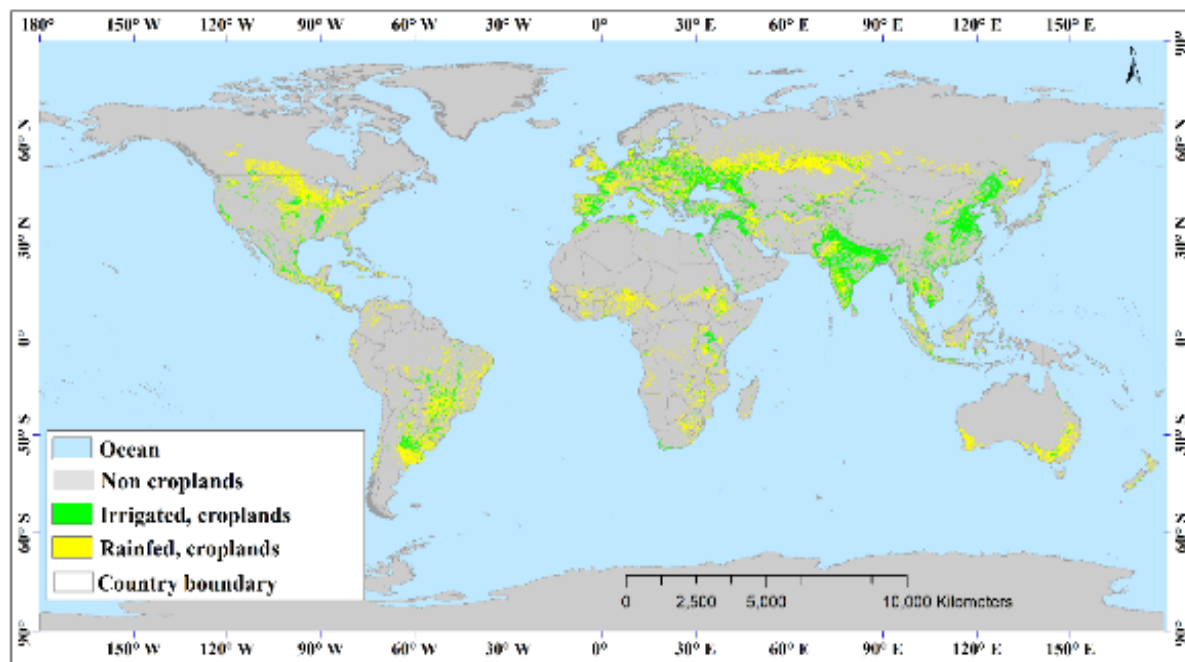
- Map crop water use for the nation
- Quantify water use trends since 1980s
- Improve water allocation and irrigation efficiency
- Monitor implementation of water management decisions

Landsat-based
Operational Simplified
Surface Energy Balance
(SSEBop) ET, 100 m

Landsat provides crucial thermal information for estimating evapotranspiration and water use

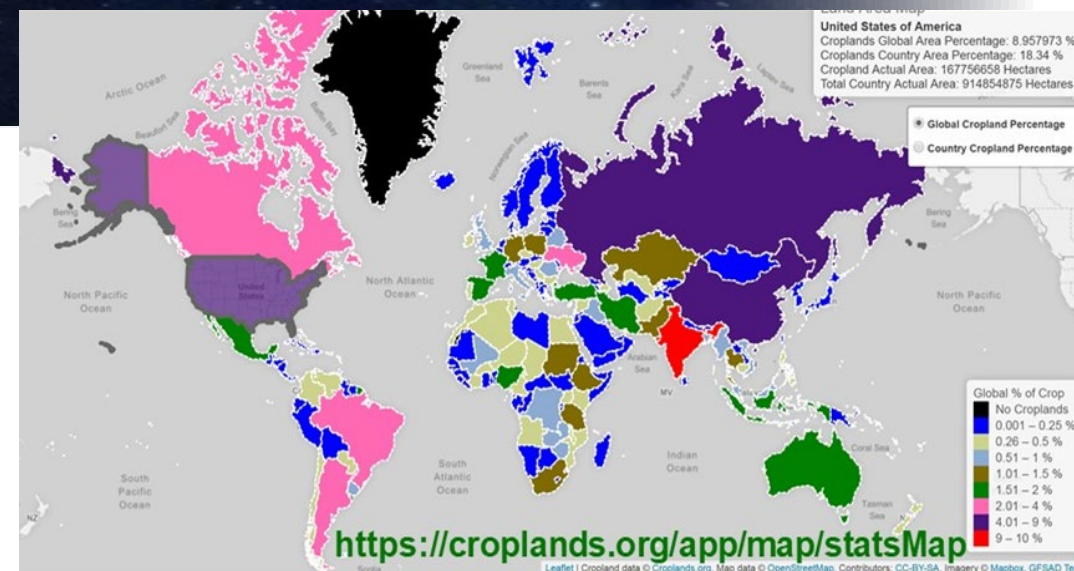
Global Food Security

- Global crop mapping, monitoring, assessments, and forecasting
- Leverage remote sensing data, AI/ML techniques and cloud computing to produce cropland extent and irrigated crop area.

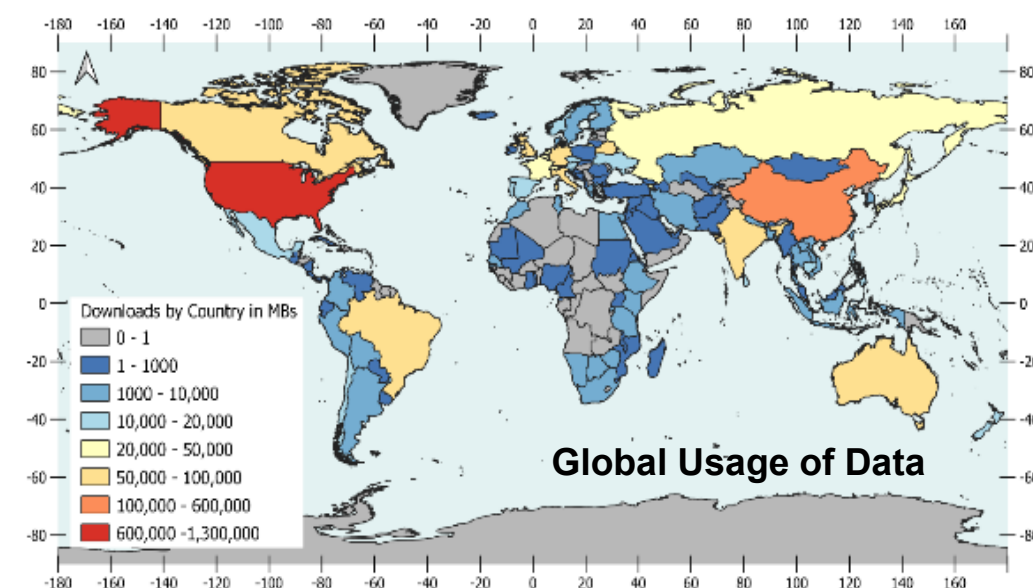


Global rainfed and irrigated-cropland product on LP DAAC

www.usgs.gov/wgsc/gfsad30; <https://www.usgs.gov/apps/croplands/app/map>
<https://lpdaac.usgs.gov/news/release-of-lgrip30-data-product/>



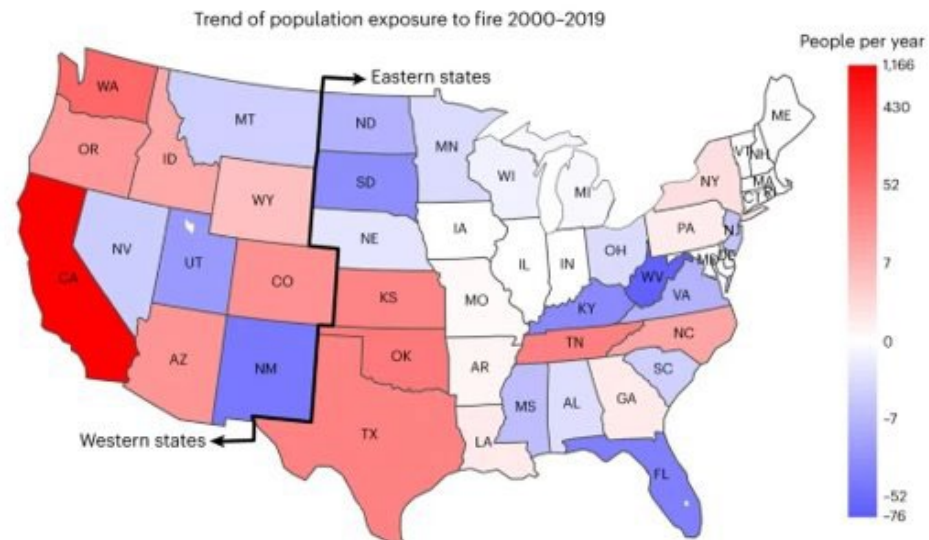
Cropland as % of the Country Geographic Area



Global Usage of Data

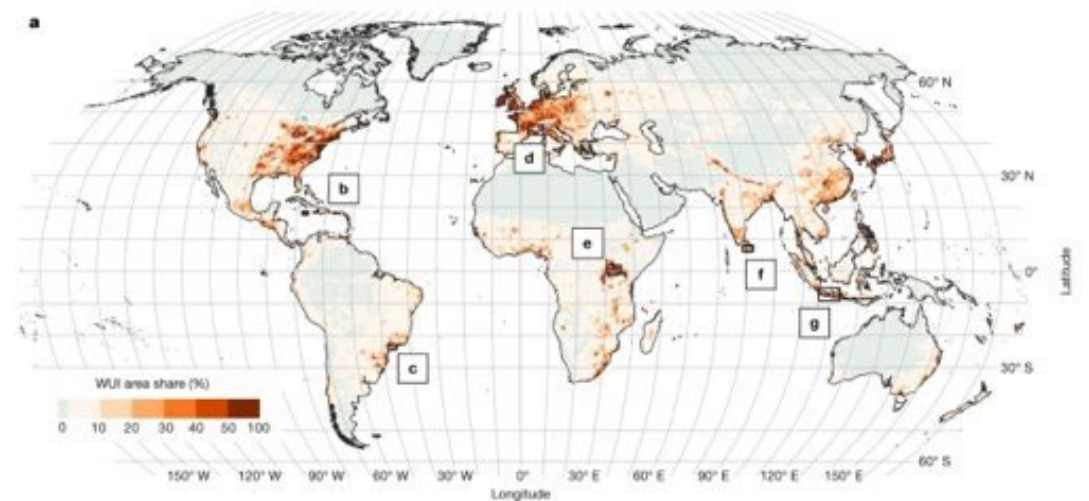
Fire Science Highlights

Human and infrastructure exposure to large wildfires in the United States. Nature Sustainability, July 2023



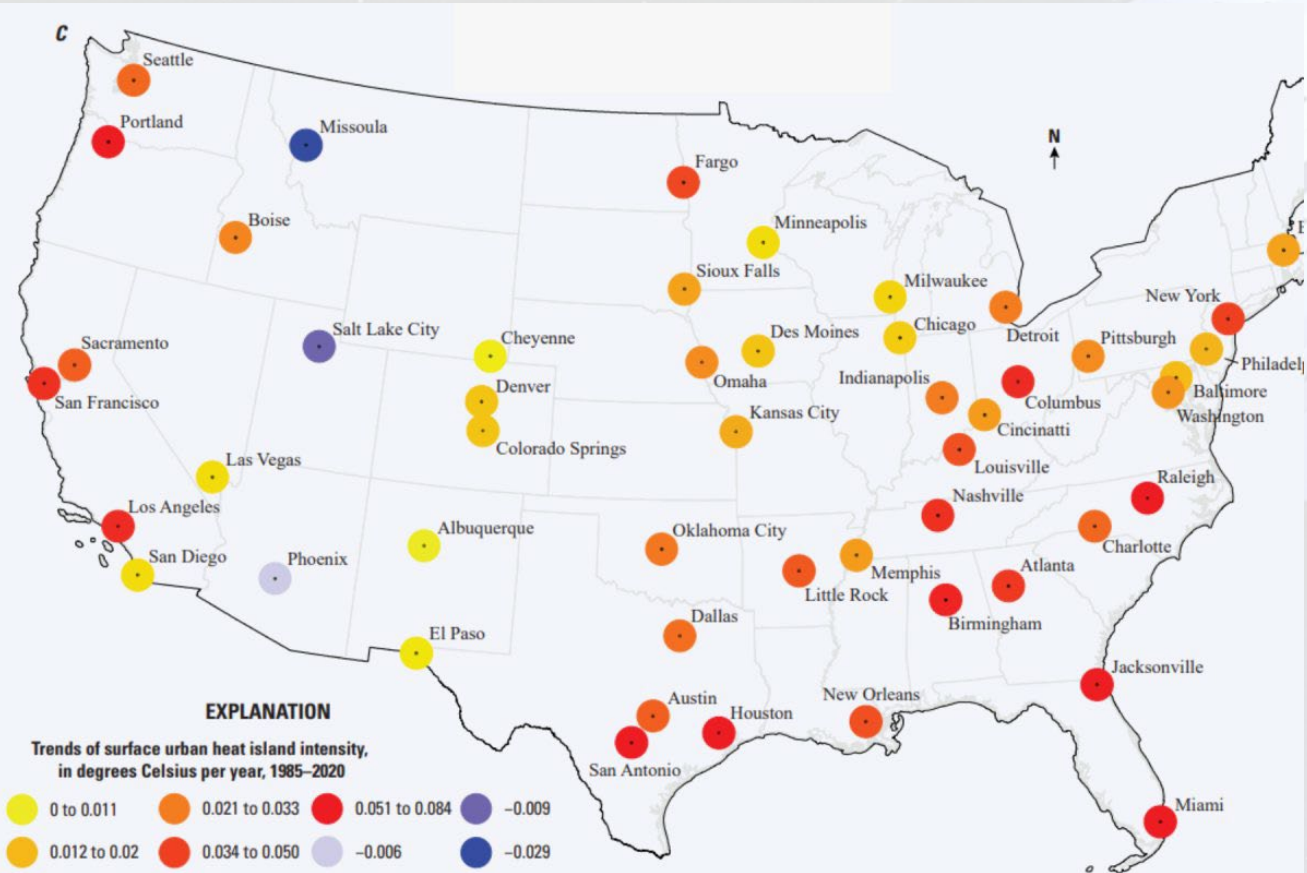
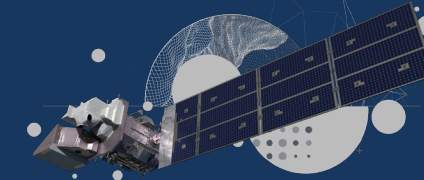
- Human exposure to large fires in the US from 2000-2019
- 82% occurred in the western US
- Increased wildfire extent drove increasing exposure trends

The global wildland–urban interface. Nature, July 2023

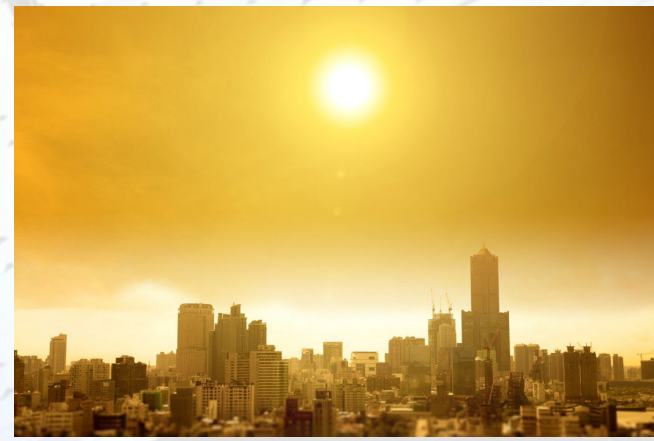


- First global Wildland –Urban Interface (WUI) map at 10-meter spatial resolution
- Uncovered many undocumented WUI hotspots
- WUI covers 4.7% of the global land surface, home to half of the world's population (3.5B)

Landsat in the News



[Newsweek.com](https://www.newsweek.com)



The study shows that the cities with the greatest rate of increase in heat intensity include San Antonio, Houston, Los Angeles, Portland, San Francisco, Miami, Jacksonville, Birmingham, Raleigh, Columbus, Jacksonville, Atlanta, and New York.

Many cities across the U.S. are getting hotter and hotter, new research from the USGS has found.

By Jess Thomson published 12/15/2023

These urban heat islands—representing hotspots that are warmer than the surrounding non-urban land—are increasingly getting warmer. This is [according to a study by the United States Geological Survey \(USGS\)](#), which found that 47 of 50 cities experienced significant warming between 1985 and 2020.

[Across all 50 cities](#), the study found an average warming of intensity of 5.19 degrees Fahrenheit, with the highest intensities being found near the West Coast and in the eastern third of the country.

Much of this increased heating may have come from changes to land use, as well as the effects of climate change. By removing green spaces and replacing them with infrastructure, the city becomes more prone to absorbing heat rather than reflecting it away.



Landsat Next and Landsat Science Increases in FY25 President's Budget

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

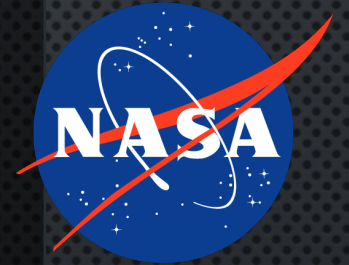
NASA Landsat Next funding is contained within the **NASA Earth Science Division**

- Development of the space and launch segments – **Landsat Next** funding line

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

NASA and USGS each requested funding increases in FY25 to develop the Landsat Next mission and science products



Dr. Mike Freilich, Sustainable Land Imaging and Landsat Next

The joint NASA/Interior Sustainable Land Imaging (SLI) program first envisioned by Mike Freilich in 2012 included a multi-tiered “sustainable” program with on-ramps for new technology designed to meet evolving user needs for observational continuity as well as emerging applications.

Mike’s vision for SLI successfully led to the development and launch of Landsat 9, invested in technology to be applied to Landsat Next, and was endorsed by Interior and NASA in December 2021 with a new ten-year SLI Interagency Agreement.

SLI user needs and technologies directly informed Landsat Next. Landsat Next will maintain Landsat’s historic radiometric quality while monitoring smaller agricultural fields and forests; provide more rapid clear views of crop health and productivity, water quality, snow/ice state and wildfire; and support emerging applications in water quality, snow hydrology and soil mapping.

NASA and USGS developed Landsat Next with the intent to capitalize on the savings inherent in block buys while creatively meeting Risk Class B standards with Class C instrumentation; each of the three new Landsat satellites will be developed and launched for 50% of the cost of historic missions. Collectively, the new mission will deliver 15 times the data of today’s satellites, deliver far more capability, and greatly increase the Nation’s Return on Investment.



Dr. Michael Freilich

Landsat Next is the logical culmination of the Sustainable Land Imaging program first envisioned by Mike Freilich, and in line with how Landsat continuity evolves, with each new mission enhanced with improved technology to better meet evolving user needs

USGS National Land Imaging (NLI) Program Budget

	2023 Enacted	2024 Enacted	2025 PB Request
NLI Total	\$115,921,000	\$115,071,000	\$143,800,000
Satellite Operations	\$92,184,000	\$95,334,000	\$110,507,000
Science, Research, and Investigations	\$23,737,000	\$19,737,000	\$33,293,000

FY25 President's Budget for NLI includes:

- Satellite Operations increases for:
 - **Landsat Next (+\$12,000,000)**
 - Commercial Data Pilot (+\$5,000,000)
- **Science, Research & Investigations increases for:**
 - Enhancing Landscape Measurements, Data, and Analysis (+\$3,700,000)
 - National Land Use Data Products (+\$1,500,000)
 - Natural Capital Accounting (+\$3,000,000)

A Satellite Operations increase to the USGS NLI base of \$12 million in FY25 is **critically needed** to allow the USGS to meet its Sustainable Land Imaging Landsat Next ground system development obligations.

The Landsat Next mission will result in the largest collection of new Landsat data in the history of the program, estimated at 15 times the data volume of today's missions.

This significant increase in data volume and quality will place an enormous burden on the ground segment of the mission, the segment USGS is responsible for designing, developing, testing and fielding.

Thank You!

Mr. Timothy Newman

National Land Imaging Program Coordinator

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BACK UP

Celebrating
50
YEARS
of Landsat
1972-2022

 **USGS**
science for a changing world

Joint Agency Commercial Imagery Evaluation (JACIE)

JACIE Partner Agencies



- Started in 2001, JACIE informs the Federal Government of the Quality of Commercial Satellite Imagery and works with Commercial Data Providers to improve their Quality
- JACIE brings together hands-on experts from the ever-expanding Commercial Sector, Academia, and domestic and international Agencies to truly advance technology
- Website: <https://www.usgs.gov/calval/jacie>



- **March 11-14, 2024 – USGS Headquarters – Reston, VA**
- **570 Participants (In-Person and Virtual)**
- **72 Presentations from Commercial Industry, Academia, and Government**
 - ❑ Future direction from all JACIE partner agencies and the European Space Agency
 - ❑ New mission updates from Commercial Providers
 - ❑ Technical Improvements, Tools from Combining Datasets, Improved Reference Data, AI/ML, Standards/Specifications, etc.
- **Vendor Exhibitions, Dedicated In-depth Side Meetings, and Networking Events**





Landsat in Science and Applications 2024

1,640 papers have been published in 2024 so far citing Landsat as one of their data sources
(Scopus, "Landsat" keyword search)

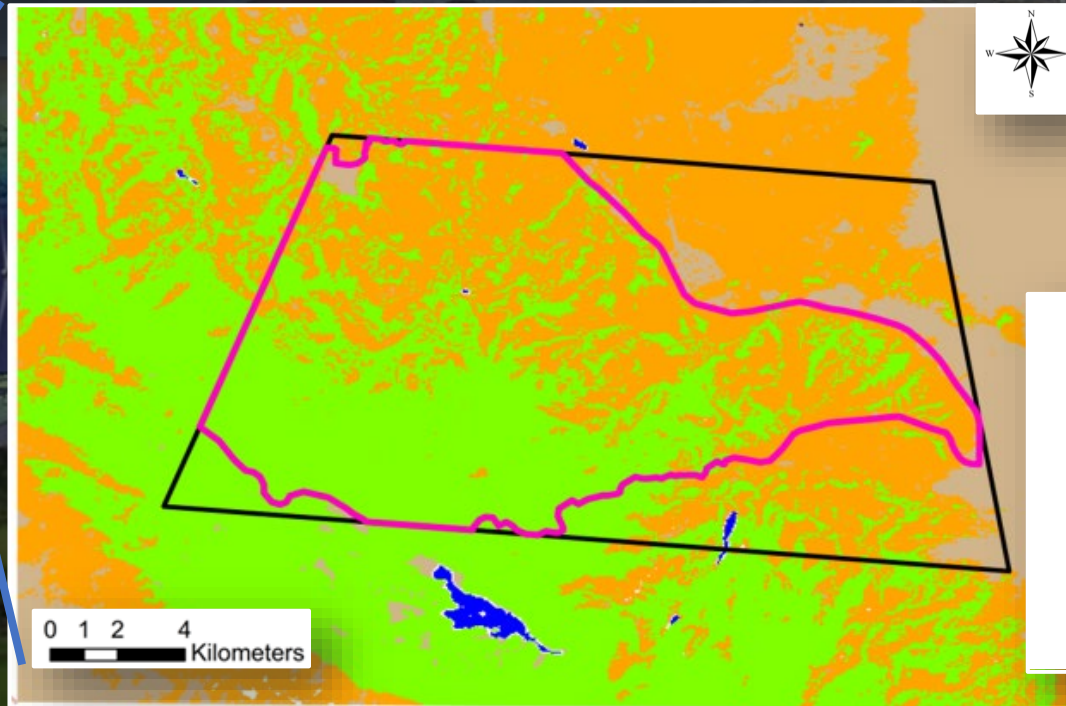
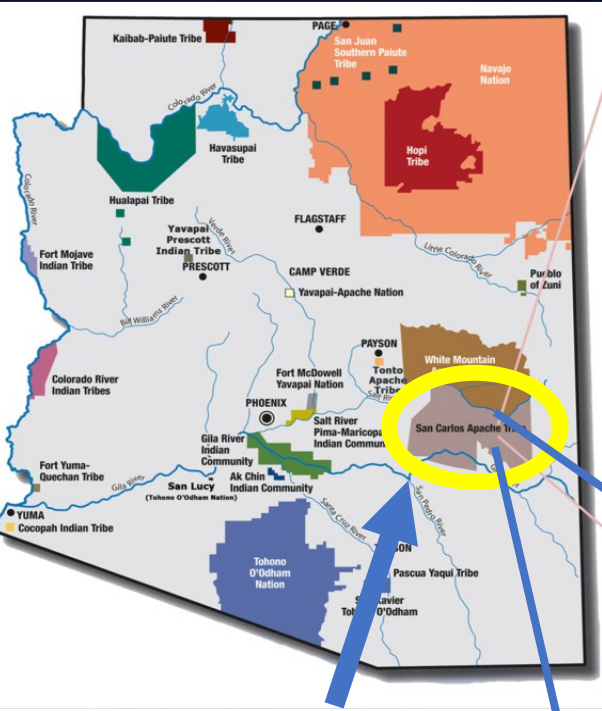
Some selected Titles

- Evaluation of Landsat-9 interoperability with Sentinel-2 and Landsat-8 over Europe and local comparison with field surveys
- Improving retrieval of leaf chlorophyll content from Sentinel-2 and Landsat-7/8 imagery by correcting for canopy structural effects
- Multidecadal grassland fractional cover time series retrieval for Germany from the Landsat and Sentinel-2 archives
- Multimodel ensemble estimation of Landsat-like global terrestrial latent heat flux using a generalized deep CNN-LSTM integration algorithm
- Assessing spatial variations in soil organic carbon and C:N ratio in Northeast China's black soil region: Insights from Landsat-9 satellite and crop growth information
- Landsat observations of total suspended solids concentrations in the Pearl River Estuary, China, over the past 36 years
- Vegetation regeneration dynamics of a natural mediterranean ecosystem following a wildfire exploiting the LANDSAT archive, google earth engine and geospatial analysis techniques
- Lake evaporation in arid zones: Leveraging Landsat 8's water temperature retrieval and key meteorological drivers
- Land use and land cover mapping using Landsat-8 and Sentinel-2 data in Al Qunfudhah coast, western Saudi Arabia: A comparative study
- Bridging the national data gap with Google Earth Engine and Landsat imagery by developing annual land cover for Afghanistan
- Effects of establishment fertilization on Landsat-assessed leaf area development of loblolly pine stands
- Urban heat island intensity in coastal cities of northern Colombia using Landsat data and WRF/UCM model
- Mapping vegetation height and identifying the northern forest limit across Canada using ICESat-2, Landsat time series and topographic data
- Mangrove monitoring and change analysis with landsat images: A case study in pearl river estuary (china)
- Mapping cropland abandonment and distinguishing from intentional afforestation with Landsat time series
- Landsat assessment of variable spectral recovery linked to post-fire forest structure in dry sub-boreal forests
- Carbon stock inversion study of a carbon peaking pilot urban combining machine learning and Landsat images
- Mapping and discrimination of the mineralization potential in granitoids from Banyo area (Adamawa, Cameroon), using Landsat 9 OLI, ASTER images and field observations

Landsat Data for Tribal Land Management

Landsat data are used to:

- Map vegetation, biomass and fire burn severity, monitor drought occurrences
- Evaluate drought impacts, relationship between vegetation characteristics and changing climate, identify future vulnerabilities
- Inform timely land management decisions.



Legend

- Study Area
- Creek Fire
- Water
- Barren
- Pinyon-Juniper-Oak woodland
- Ponderosa pine forest
- Grassland

San Carlos Apache Reservation:

- Covers 1.8 million acres
- Has diverse ecosystems and vegetation types that support a natural resource-based economy.

Nature Based Solutions – Arid Land Water Harvesting



NATURE-BASED SOLUTIONS RESOURCE GUIDE

COMPENDIUM OF FEDERAL EXAMPLES, GUIDANCE, RESOURCE DOCUMENTS, TOOLS, AND TECHNICAL ASSISTANCE

NOVEMBER 2022

Nature Based Solutions for Climate Adaptation & Climate Mitigation

- ✓ Increases Water Availability
- ✓ Holds Sediments in Place and Promotes Soil Formation/Productivity
- ✓ Stores C and N in soil-water-carbon sinks where plants grow
- ✓ Controls stormwater runoff and filters water
- ✓ Provide climate resiliency

