The USGS Land Remote Sensing Program

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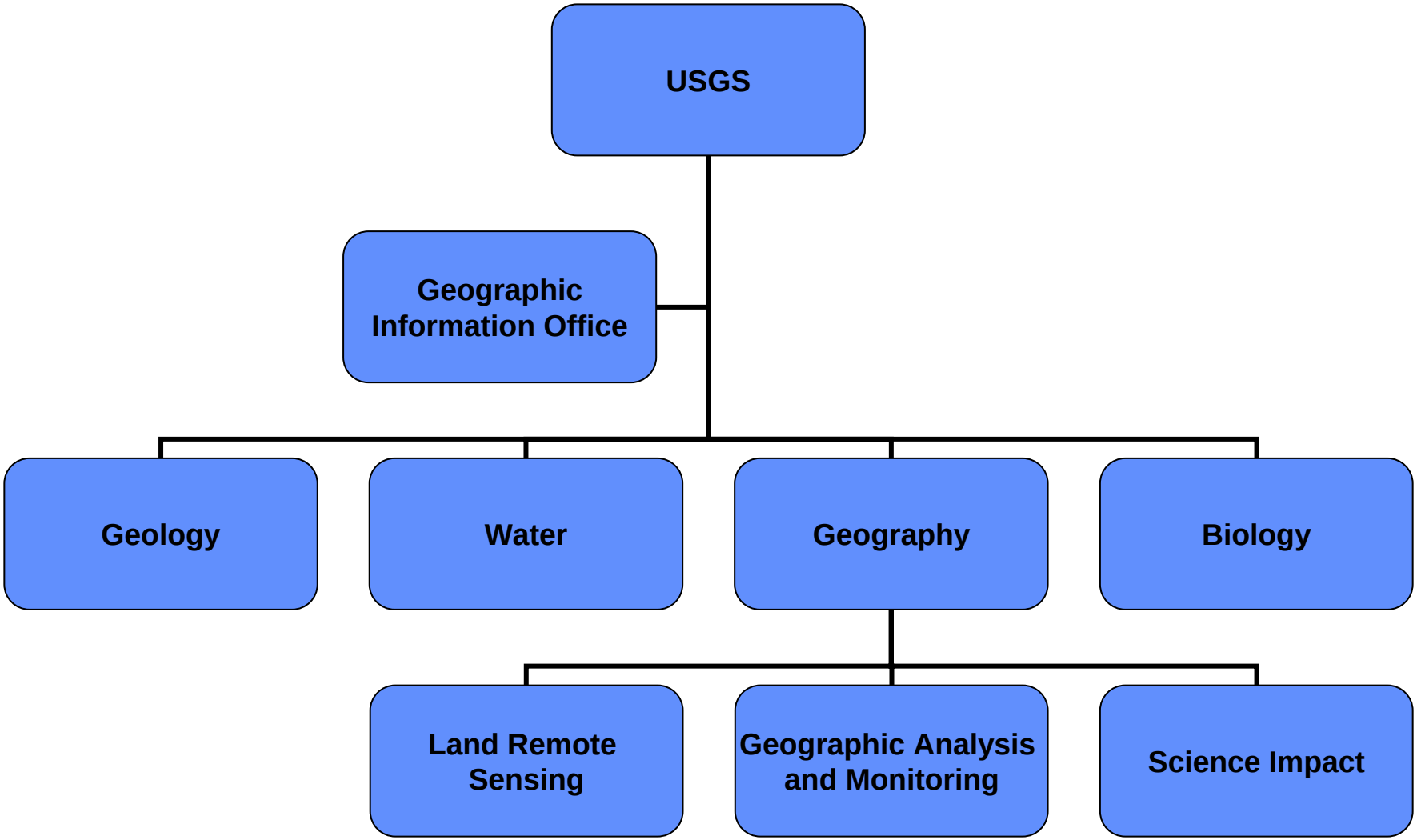
The USGS


USGS
Geographic Information Office
Geology
Water
Geography
Biology
Land Remote Sensing
Geographic Analysis and Monitoring
Science Impact

Mission

- **Provide and encourage the use of historical, current, and future remotely sensed data and derived scientific information.**
- **Provide research that promotes the observation and analysis of Earth processes at all scales using remote sensing to understand the human and environmental dynamics of land change**

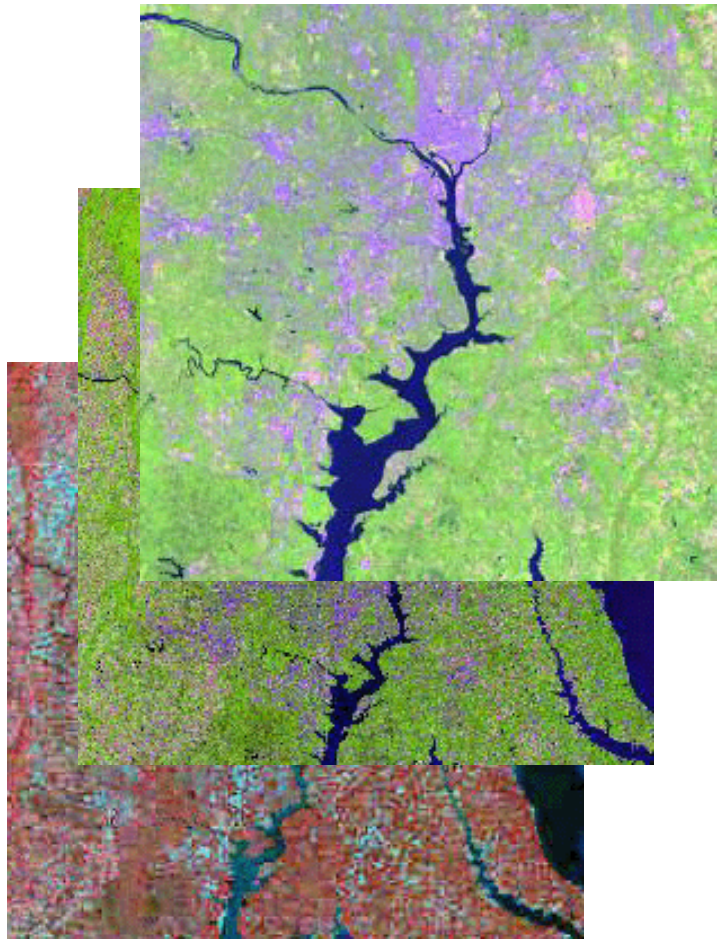
Program Components

- **Long-term Data Preservation and Access**
  - National Satellite Land Remote Sensing Data Archive (NSLRSDA)
  - Long-term Photographic Archive
- **Satellite Mission Operations**
  - Landsat 5 / Landsat 7/Landsat Data Continuity Mission
- **Landsat Data Gap Studies**
  - Access to Landsat like data in the near future
- **Remote Sensing Research and Data Utilization**
  - Applications of Remote Sensing that address Landscape Change and Societal Needs through New Remote Sensing Techniques, Data, and Information
- **Next Generation of Operational Land Imaging System**
  - Landsat Data Continuity Mission (LDCM)

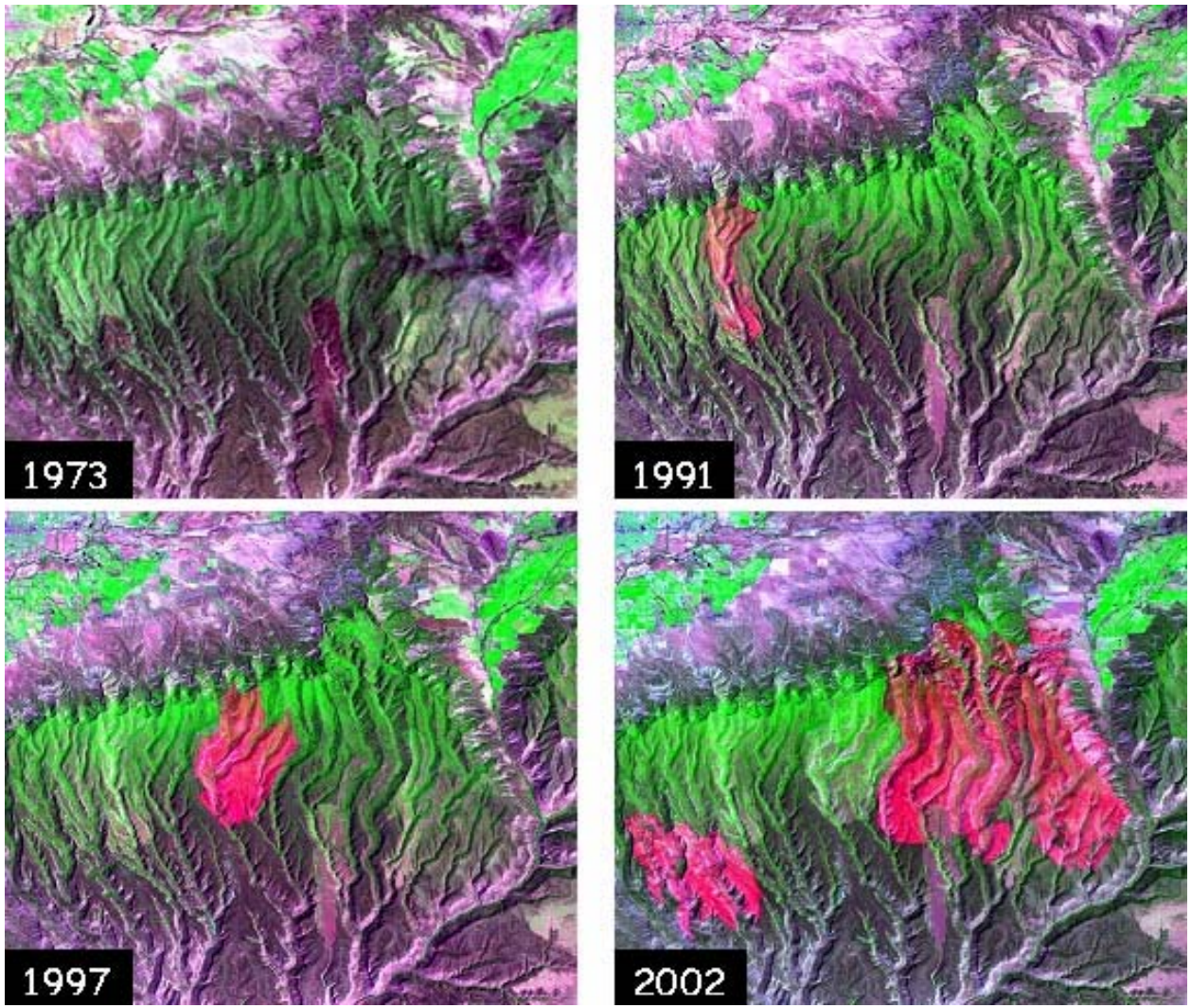
Long-term Data Preservation and Access

Data Archive – 34 Years and Counting (March 2006)

- **ETM+ sensor: Landsat 7**
  - **600,000+ scenes**
- **TM sensor: Landsat 4 & 5**
  - **642,000+ scenes**
- **MSS sensor: Landsat 1 through 5**
  - **641,000+ scenes**



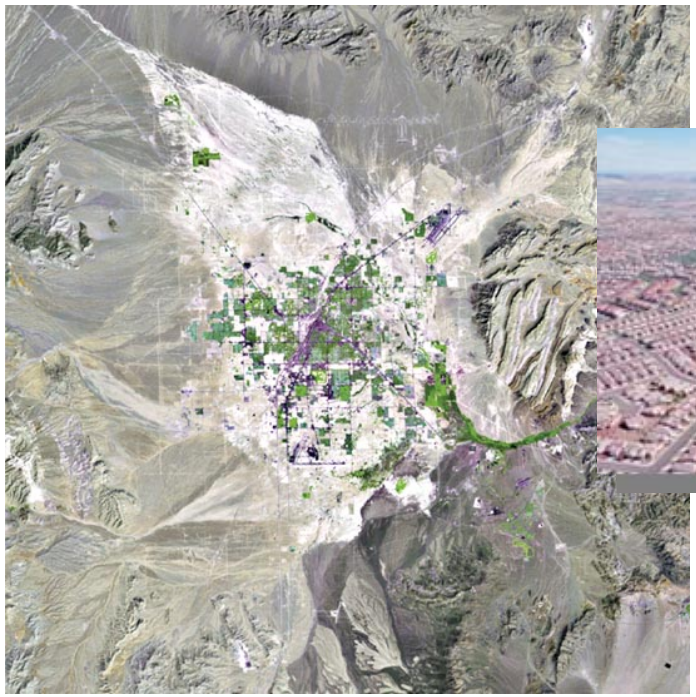
Archive Exploitation Example: Wildfire Warning, Analysis, and Monitoring

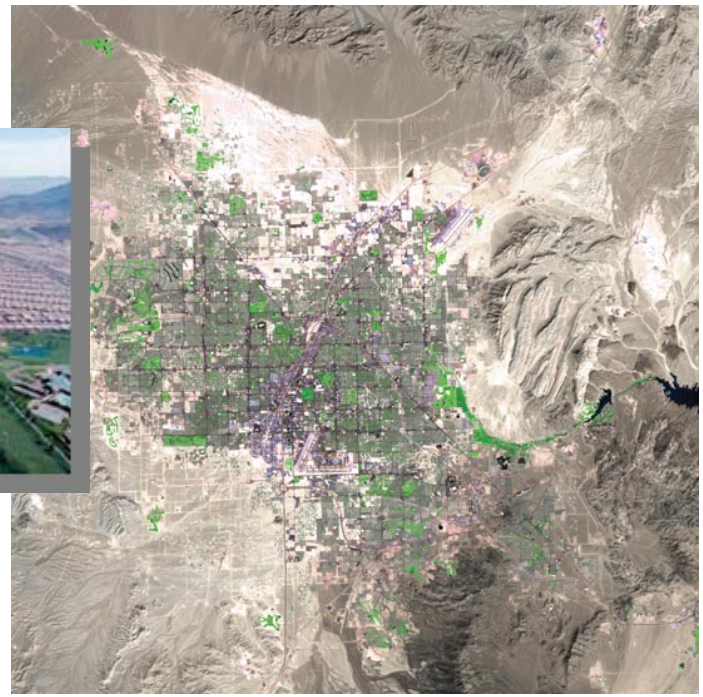


A history of fires over the last three decades

Mesa Verde National Park, Colorado

Archive Exploitation Example
Urban Growth: Las Vegas 1973 vs. 2000





This Landsat image shows Las Vegas in 1973 (population 358,400). Purple areas represent roads and other urban infrastructure.

By 2000, Las Vegas (population 1,563,280) had sprawled in almost all directions, especially in the Northeast and southeast.

Satellite Mission Operations – Landsat 5

- **Landsat 5 and its Thematic Mapper (TM) sensor have been on orbit for 22 years**
- **No onboard data recorder**
  - Data capture by the U.S. (Sioux Falls plus Alaska during fire season) and 9 International Cooperators with 12 ground stations
- **Beginning to Fail**
  - Solar array drive malfunctioned a second time Nov. 2005; operations changed to compensate for problem
    - Full U.S. and International Cooperators coverage resumed January 2006
  - Backup amplifier problem March 16, 2006
    - Fixed on March 30, 2006
- **Fuel to be depleted in 2010**
- **Satellite could fail anytime before 2010**

Satellite Mission Operations – Landsat 7

- **Landsat 7 Enhanced Thematic Mapper-Plus (ETM+) sensor have been on orbit for 7 years**
- **Satellite and sensor problems began in 2003**
  - ETM+ scan line corrector (SLC) failed May 2003
    - USGS developed filler products
  - 1 of 3 Landsat 7 gyros turned off May 2004; USGS developing 1-gyro flight capability (spacecraft maneuver capability now; not full science ops.)
- Full U.S. and global coverage continuing
- Gyro risk study projected probability of Landsat 7 failure in 2007
- Fuel to be depleted in 2010
- Satellite could fail anytime before 2010

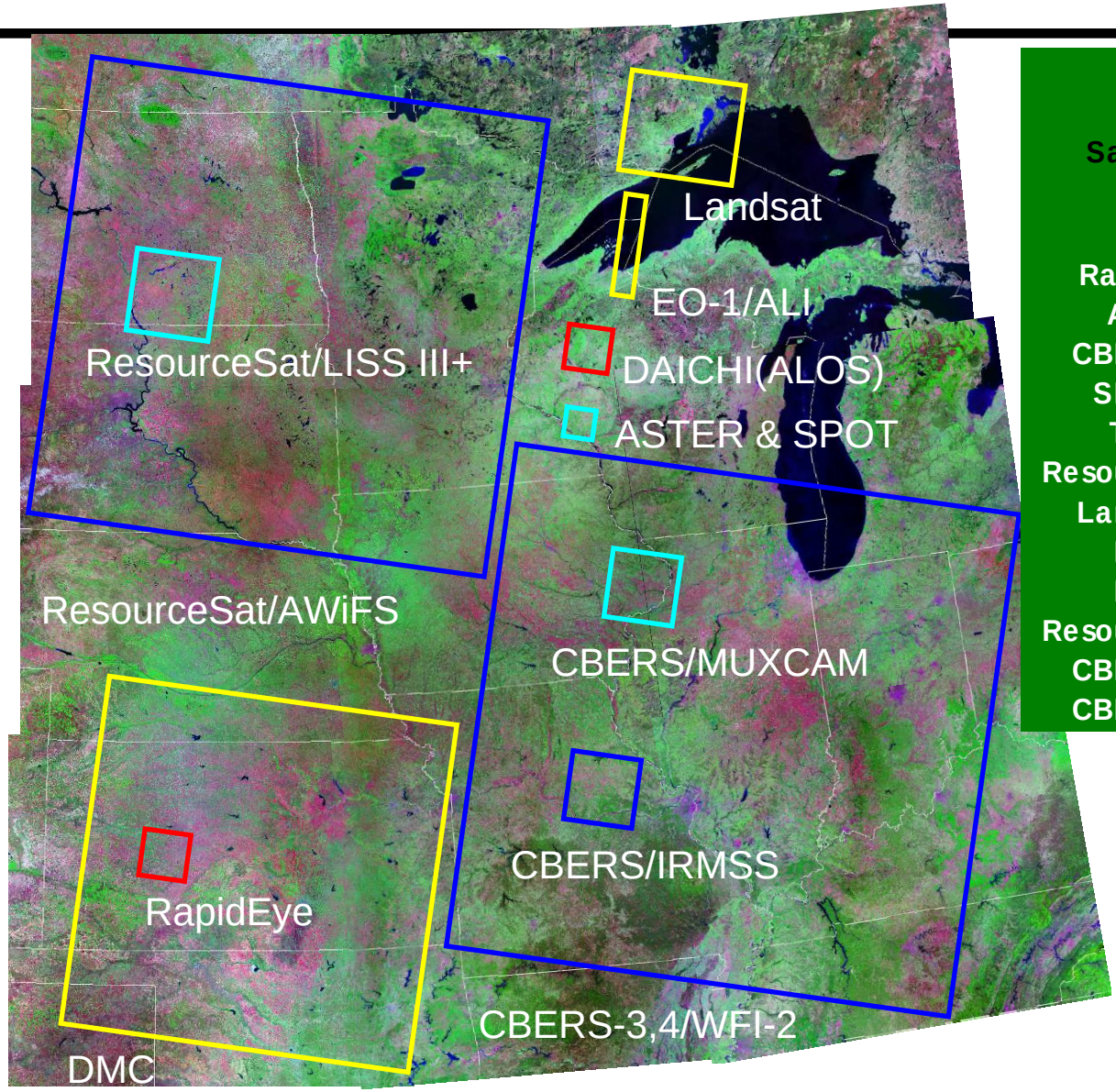
Landsat Data Gap Studies

- **No current system is capable of producing Landsat quality global coverage.**
- **Many operational uses of Landsat will likely be interrupted.**
- **LRS Program currently seeking viable alternatives.**

Potential Alternate Data Sources

- **Systems most comparable to Landsat are SPOT (French), IRS (Indian), CBERS-2 (Chinese/Brazilian), and ASTER (Japanese)**
  - Additional sources include ALOS (Japan), RapidEye (German - 2007)
- **Overall, spectral coverage is less than Landsat**
- **Costs vary compared to Landsat**
  - **SPOT is more expensive**
  - **ASTER & AWiFS are cheaper**
- **Landsat data may be shared; some commercial systems require additional licensing fee for open distribution**
- **Landsat data not directly comparable to High-Res or MODIS/VIIRS data**
  - **IKONOS, QuickBird, and OrbView 3 are high-res but local vs. global**
  - **MODIS/VIIRS almost daily global coverage at a coarse (250 to 1000m) spatial resolution – not fine enough for Landsat comparisons**

Alternate Data Source Options



Satellite	Sensor	Ground Sample Distance (m)
RapidEye	REIS	6.5
ALOS	AVNIR	10
CBERS-3,4	MUXCAM	20
SPOT 5	HRG	10/20
Terra	ASTER	15/30/90
ResourceSat-1	LISS III+	23.5
Landsat 7	ETM+	15/30/60
EO-1	ALI	30
DMC	MSDMC	32
ResourceSat-1	AWiFS*	56
CBERS-3,4	WFI-2	73
CBERS-3,4	IRMSS	40/80

Note: For purposes of scene size comparison only; not actual orbital paths or operational acquisitions. High-resolution scenes too small to illustrate here.

USGS

LRS Program Research and Applications

- **Understand and characterize new sensors**
  - New aerial and satellite technologies
- **Develop applications and understanding of remotely sensed data**
  - Extracting Impervious Surface Information from Multi & Hyperspectral Data
  - Defining Landscape Characteristics from Remote Sensing Data in Support of Human Health Investigations
  - Developing LIDAR and RADAR Remote Sensing Technologies
  - Multi-sensor applications for Landscape and Regional Quantification of Climate Change Impacts and Carbon Dynamics
  - Mapping Invasive Species with Hyperspectral Data

- **Fund scientists and technicians in 6 major centers and across USGS**

Reston VA	Sioux Falls, SD
Rolla, MO	Denver, CO
Menlo Park, CA	Anchorage, AK

Landsat Data Continuity Mission (LDCM)

- **In February 2006, NASA published a synopsis of its approach to procure and support a free-flyer spacecraft, instrument, and operational system**
  - The Landsat Data Continuity Mission will have a 5-year mission life with 10-year expendable provisions.
  - NASA plans to issue the solicitation with an optional requirement for the instrument to observe a portion of the thermal spectrum.
  - Following a prescribed on-orbit acceptance period, NASA will transfer ownership of the observatory and the associated contracts to the USGS, which will then operate the spacecraft and manage the data.
  - NASA will invite industry to comment on a draft request for proposals (RFP) this spring.
  - A final RFP is slated for release in the third quarter of CY 2006.

LDCM Guiding Principles

- **Understanding and responding to the needs of the research and applications communities**
- **Advancing the use of Landsat type data for monitoring the Earth's land surfaces**
- **Contributing to the mission and goals of the USGS, DOI, and the Nation's land imaging interests**
- **Integrating LDCM with past, present, and future remotely sensed for the purpose of observing and monitoring global environmental systems**

LDCM and the Future of Operational Land Imaging

- **Goal to transition the Landsat program from a series of independently planned missions to a sustained operational program**
  - Funded and managed by a U.S. Government operational agency or agencies, international consortium, and/or commercial partnership.

- **Supported by interagency leadership team**:
  NASA, USGS, DoD, USDA, NOAA

- **Formation of a team to develop a long-term plan to achieve technical, financial, and managerial stability for operational land imaging**

- **Final report September/October 2006**

Landsat Science Team

- **USGS Sponsored Team**
  - Purpose to conduct research on:
    - Data acquisition
    - Product access and format
    - Science opportunities for new- and past-generation Landsat data.
  - Team will offer informed advice and recommendations to the USGS and NASA on topics that will affect the overall success of the LDCM mission.

Science Team Expertise

- **Applications – with emphasis on those applications that have historically been reliant on Landsat data.**

- **Technical needs – especially those of large operational customers (e.g., global change studies, agricultural surveys, disaster assessment, etc.).**

- **Instrument functions – including long-term calibration and image geometry and radiometer performance.**

- **Data issues – including acquisition strategies, data access requirements and specifications, product characteristics, data management capabilities, data archiving.**

Science Team Responsibilities

- **Provide science-based feedback on critical design issues**
  - instrument and data systems
- **Contribute to the specification and design of the data acquisition strategy and data access systems**
- **Conduct experiments on science and applications elements of program**
- **Represent the breadth of user perspectives**
  - requirements on product formats and product generation issues
- **Provide insights on long-term issues**
  - gap-filling options, future missions
- **Consider interoperability of Landsat with other systems currently in orbit or planned for launch**

Science Team Composition

- **Landsat Science Team will consist of approximately 16 members**
  - Competed and funded seats
    - External scientists (8 research and development contracts)
  - Other competed seats – supported by home organization
    - Federal agency scientists (3-5)
    - International scientists (2-3)
  - LDCM Science Team Leadership
    - USGS (Tom Loveland, John Dwyer)
    - NASA (Jim Irons, Jeff Masek)

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