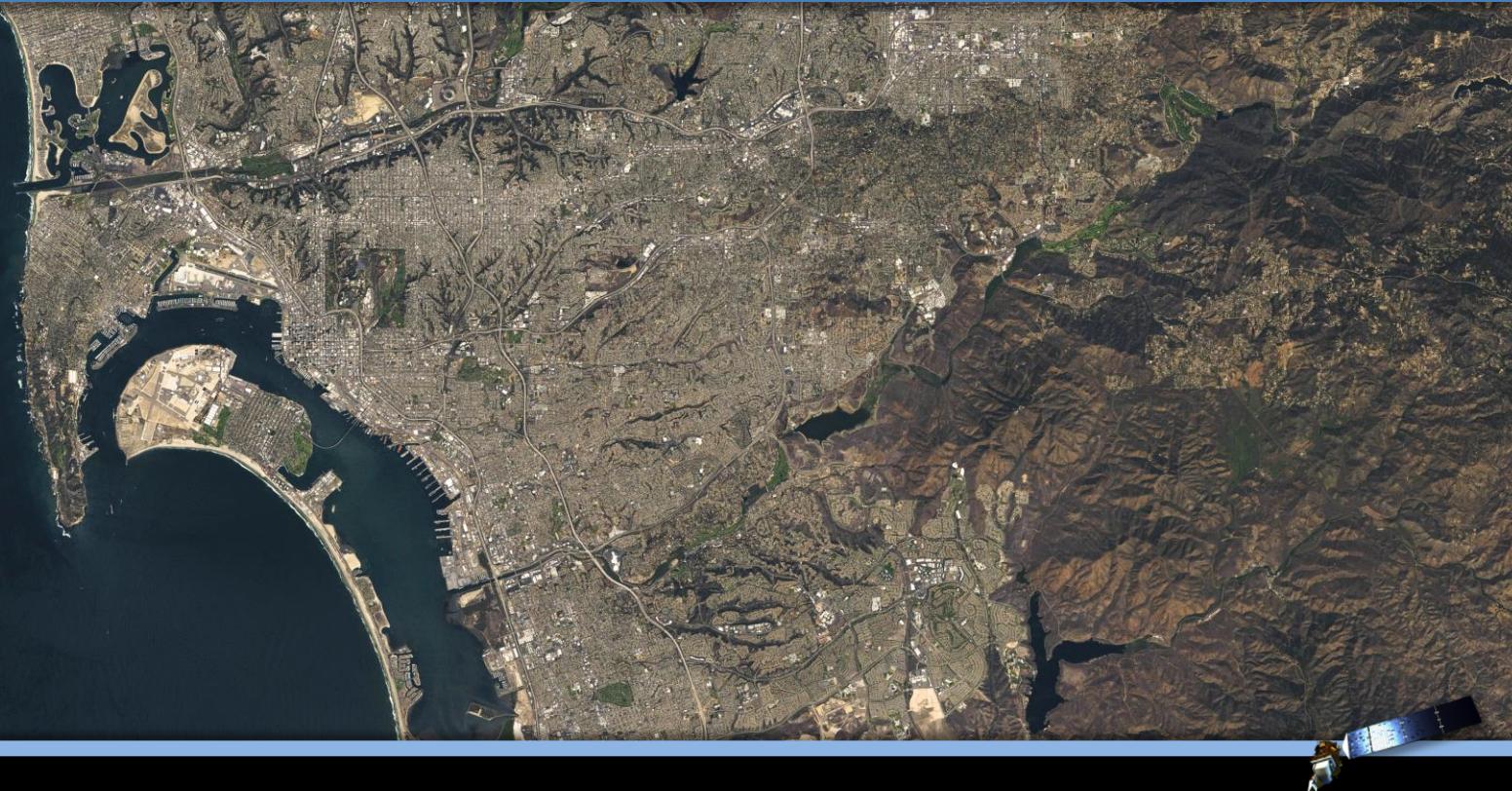


Landsat and Follow-On Missions



WSWC – CDWR Workshop on Hydroclimate Monitoring Systems and Measurement Needs, June 23-25, 2014 San Diego

Tim Newman, Program Coordinator
Land Remote Sensing Program
U.S. Geological Survey

*Landsat 8 – Operational Land Imager (OLI)
image taken April 7, 2014 of
San Diego, California
Bands 4,3,2-8 Pan Sharpened*

The Value of Landsat Data

- As the user community expanded from 1972 to 1985, the value of Landsat data steadily increased
- The first U.S. Government attempt to commercialize the program via NOAA in 1983 brought high prices (\$4400 per scene) and a decline in users
- Congress, still preferring a commercial approach, subsequently conceded that was not yet feasible, directing NASA in 1992 to build Landsat 7
- With a \$600 per-scene USGS price and no license restrictions following the 1999 launch of Landsat 7, the user community began expanding again
- When the USGS completed an automation project in late 2008 to preprocess and post standard Landsat products for free downloading via the Internet, the user community began explosive growth
 - Distribution went from approximately 20,000 menu-driven, customer-selected digital products/year to 2 million pre-processed image downloads in 2009; now 5 million/year
 - Approximately 50,000 users download Landsat data from the USGS Earth Resources Observation and Science (EROS) Center

The Value of Landsat Data, continued

- From an extensive 2012 user survey, USGS economists derived a conservative estimated value of \$1.79B to U.S. users who downloaded Landsat data in 2011
 - This and other studies indicate that within any single year, user benefits far exceed Landsat 8's total cost
- Landsats 7 and 8 provide 8-day imaging; the USGS has scheduled U.S. imaging every 8 days since combining Landsat 5 and 7 operations in 2001
 - Recent studies show that two-thirds of Landsat applications require 8-day imaging
 - Landsat users in agriculture, water resources management, and wildfire response take advantage of 8-day repeat imaging
- Only Landsat has the capability to collect thermal (heat signature) data simultaneously with optical imagery
 - Increasing numbers of state, county, and private irrigation-water managers are benefitting from the efficiency of monitoring water consumption utilizing this capability

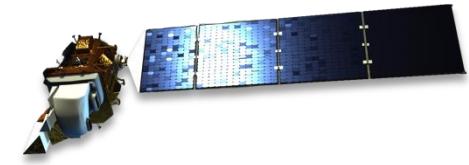
The Value of Landsat Thermal Data

- A thermal band was added to Landsat 3 but failed soon after 1978 launch
- A thermal band was included on Landsats 4 and 5, but due in part to high data prices from 1983 to 1999, interest was primarily shown by researchers; few operational uses were evident
- By 2001, expanded thermal interest was triggered by USGS data-price reductions, an improved thermal band, and 8-day Landsat 5/7 coverage
- The U.S. Government set out in 2000 to convert to a data buy around 2005 via a subsidized commercial satellite; a thermal band requirement was deleted by NASA as too expensive and by industry as unprofitable
- When the Administration changed its strategy and directed NASA in 2005 to build another Landsat, a thermal capability was not initially included
- Operational thermal users, primarily from western states, campaigned successfully for NASA to add a thermal sensor on Landsat 8

Operational Status

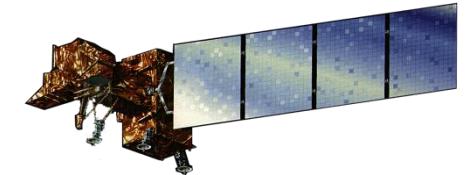
Landsat 8

- Collection increased from approximately 550 to 650 new scenes per day; supports 8-day revisit cycle
- Improvements: better signal-to-noise, new bands (coastal blue, cirrus, thermal)
 - Crisper images; less color saturation
 - Better resolution of snow and ice-covered regions
 - Detection of water-column constituents
 - Better cloud screening



Landsat 7

- Collecting over 400 new scenes per day; about 22% of pixels missing per scene (faulty scan-line corrector)
- L7 collection strategy modified to concentrate on continental coverage; L8 capturing islands & reefs
- Sufficient fuel for a few more years of operation; limited subsystem redundancy



Operational Status

(continued)

Landsat-based Information Products (<http://earthexplorer.usgs.gov/>)

- Standard orthorectified L1T calibrated radiance Landsat scenes
- LandsatLook (full-resolution JPEGs browse/print images)
- New TM/ETM+ surface reflectance Climate Data Record (CDR) products currently available on-demand for any WRS-2 path/row
- New TM/ETM+ surface temperature CDR products under development; will soon be available for evaluation on-demand for North America
- New OLI surface reflectance CDR in development and will be made available on-demand for any WRS-2 path/row
- New OLI surface temperature CDR in development and will be made available on-demand for North America
- Surface Water Extent, Burned Area Extent Essential Climate Variable (ECV) products available soon for evaluation for CONUS and Alaska
- Snow-covered area ECV due late next year for CONUS and Alaska

The Status of Sustainability

- NASA, with USGS, is conducting a Sustainable Land Imaging Architecture Study, with an implementation plan due this August to the Administration
- Congress, the Administration, NASA, and the Department of the Interior/USGS all agree on the importance of land-imaging continuity
 - A government-wide assessment of 132 Earth-observing satellite systems ranked Landsat as having the second-highest societal-benefit impact behind only the GPS system
 - The Senate is calling for a low-risk, near-term launch of a Landsat 8 rebuild, not to exceed \$650M, while non-concurring with foreign-partner or commercial alternatives
 - The Administration, while committed to a 25-year sustainable system, is stating the Senate solution is premature and that \$650M is not feasible for a Landsat 8 rebuild
- The USGS is concerned about the need for near-term data continuity
 - The Landsat 8 thermal sensor design life is exceeded in 2016
 - Landsat 7's fuel supply will expire by 2018; any key component could fail beforehand
 - 8-day coverage capability is lost with only one Landsat on orbit
- The Nation is remarkably close to solving a big problem for users of Landsat data
 - Although the cost cap appears to be in question, the bills will go into conference over the next few weeks and things may change. The outcome is not certain.

Back Up

Senate Language: June 5, 2014

"Landsat Data Continuity.—The Committee provides \$68,100,000, \$4,000,000 above the request, for a land imaging mission successor to Landsat 8. With Landsat 7 at risk for ending its mission life as early as 2017, the Committee is deeply troubled at the potential loss of 8-day continuous terrestrial coverage now provided through the Landsat satellite series. The Committee does not concur with various administration efforts to develop alternative “out of the box” approaches to this data collection—whether they are depending on commercial or international partners. Given the constraints in Federal funding and the absence of credible alternatives to a conventional land imaging mission that ensures Landsat data continuity, NASA should proceed with an acquisition in fiscal year 2015 for a mission to launch a follow on to Landsat 8 by not later than 2020 that does not exceed a cost cap of \$650,000,000, inclusive of all launch vehicle costs. Such a mission shall maximize the utilization of non-recurring engineering efforts from Landsat 8 to maintain a relatively low level of project risk. In addition, as a follow on to Landsat 8, program reserves shall be limited to not more than 10 percent for the duration of the mission’s development and all hardware contracts should be firm fixed price and reflect steep discounts over the price paid for comparable components for Landsat 8. The Committee notes that the notional land imaging fiscal year 2016 budget is now more than \$100,000,000 below what is needed for a 2020 launch. Hence, the Committee expects the 2016 budget to reflect resources necessary to meet that launch date.” <http://www.gpo.gov/fdsys/pkg/CRPT-113srpt181/pdf/CRPT-113srpt181.pdf>

Departments of Commerce, Justice, and Science, and Related Agencies Appropriations Bill, 2015, p. 109

Administration Response: June 17, 2014

“Future Science Missions. The Administration appreciates the Committee's support for science missions, but is concerned about prematurely specifying elements of future missions while the missions are in a very early state of development. In particular, the Administration believes the Committee's proposed approach to a follow-on Landsat mission is not feasible within the bill's proposed cost cap of \$650 million...”

http://www.whitehouse.gov/sites/default/files/omb/legislative/sap/113/saps4660s_20140617.pdf

Statement of Administration Policy (Senate) June 17, 2014

The Context for Land-Imaging Sustainability

- October 2010: Congress directs the White House Office of Science and Technology Policy (OSTP) to produce and routinely update a strategic plan for Earth observations
- February 2011: OSTP convenes a **National Earth Observations (NEO) Task Force**, drawn from 11 Federal departments and agencies
- 2012: NEO Task Force conducts an **assessment of 362 EO systems** (space, air, land, and sea platforms) with regard to their contributions within a framework of 13 societal benefit areas; **among 132 satellite systems, Landsat ranks second highest in impact, surpassed only by GPS**
- April 2013: OSTP releases the **National Strategy for Civil Earth Observations**, which describes assessment methodology and calls for updates every three years
- July 2014: OSTP to release the **National Plan for Civil Earth Observations FY2015**, which makes formal recommendations to support a broad spectrum of EO efforts, including NASA and USGS responsibilities to continue joint efforts to sustain moderate-resolution, multispectral, satellite-based Earth observations

Characterization of User Needs

- USGS 2013 National Land Imaging Requirements Pilot Project elicited 151 distinct, representative user applications where Landsat data are used routinely to produce consistent services or informational products. See: <http://pubs.usgs.gov/of/2014/1107/>
- Government and university application sources elicited include:
 - Bureau of Indian Affairs
 - Bureau of Land Management
 - Bureau of Reclamation
 - Fish and Wildlife Service
 - National Park Service
 - Office of Surface Mining
 - State Government (Ohio & Western States Evapotranspiration)
 - Universities (Idaho, Maryland)
 - U.S. Department of Agriculture (ARS, FAS, FS, FSA, NASS, NRCS, RMA)
 - USGS
 - NASA
- Six National EO Societal Benefit Areas were addressed:
 - (1) Agriculture & Forestry, (2) Climate, (3) Disasters, (4) Ecosystems, (5) Energy & Mineral Resources, and (6) Water Resources Note: Comparative importance of user applications was not assessed
- The need for thermal IR data was identified in 36% of all requirements

Sustained Land Imaging = Data Continuity

The USGS, glad to see the Administration's commitment to sustained land imaging, is open to whatever solutions ensure long-term data continuity.

“The term ‘**data continuity**’ means the continued acquisition and availability of unenhanced data which are, **from the point of view of the user** –

- (A) Sufficiently consistent (in terms of acquisition geometry, coverage characteristics, and spectral characteristics) with previous Landsat data to allow comparisons for global and regional change detection and characterization; and
- (B) compatible with such data and with methods used to receive and process such data.” Land Remote Sensing Policy Act of 1992 (PL 102-555)

For the USGS, a sustained Landsat-like **data stream** means more than continuous sensor data; it includes **long-term data archiving, backward-compatible data products, a global data acquisition strategy, an open data policy, rigorous data calibration, and a commitment to data continuity**.