USGS Management Update

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Satellite Operations
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 (Landsat 1-8, S-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 2019 Landsat 10 decision

Science, Research & Investigations
Conduct science, research and technology investigations to improve upon and develop new products and services

- Applied science & applications, including drought monitoring, global cropland estimates
- Remote sensing research and development, including unmanned airborne systems

Manage National Civil Applications activities

- Provide National Security Space system geospatial data supporting USGS applications
- Facilitate Federal civil agency use of these systems via Civil Applications Committee

Fundamental goal: Ensure public availability of a primary data record about the current state and historical condition of the Earth’s land surface
USGS National Land Imaging Budget

2018 Enacted Budget restored 2018 President’s Budget proposed reductions
• Satellite Operations funding
  • L7/8 Flight & Ground ops, L9 development, L-10 Requirements work, EROS Archive and new products
• Science Research & Investigations funding
  • Includes Education & Outreach Grant

2019 House & Senate Budget Marks* restore 2019 President’s Budget proposed reductions
• Satellite Operations funding matches 2018 Enacted Budget AND adds requested L9 increase
• Science Research & Investigations funding is level

*But this has not yet become law
Landsat Operations and Development Status

**Landsat 7 (1999- )**
- Collecting about 475 new scenes per day; latest fuel estimate projects operating into 2021.

**Landsat 8 (2013- )**
- Collecting up to 725 new scenes per day; together with Landsat 7 supports 8-day revisit.

**Landsat 9 (December 2020 launch)**
- Essentially a copy of Landsat 8, but with important improvements for accuracy and resiliency
- Upgrade to fully Class B (Thermal IR instrument was a Class C instrument on Landsat 8); 14-bit data

**Landsat 10 (~2025-2030 launch)**
- Technology and user needs studies underway to support an architecture study to commence later this year.
- Everything is on the table at this point (e.g., smallsats, hyperspectral, data buys, Public-Private Partnerships).
Landsat Data Policy Study for 2018

- Landsat Advisory Group (LAG) Task topic title: “Considerations of cost sharing models for Landsat data”

- DOI leadership is seeking to better understand economic and data policy considerations and impacts in relation to user needs, as well as the potential for public-private partnering (“P3”), with respect to various cost sharing models for Landsat data.

- The “fee recovery” issue has been looked into as recently as 2012 by the LAG—that paper can be found online at the NGAC website.

- This represents a good opportunity to inform current leadership on a number of Landsat data policy issues, in particular, the interplay with ESA’s adoption of a free and open policy for Sentinel.

- NLI’s position is to support an objective investigation by the LAG.

- Feedback and information: Email account (Landsatdatapolicy@usgs.gov) and FAQ section on EE website.
NLI Program Priorities for 2018-2019

- Inform Landsat 10 design and development via NASA-USGS Architecture Study Team
- Maintain operational continuity of Landsat 7 and Landsat 8
- Keep pace with NASA on Landsat 9 development
- Define and prepare for Global Analysis Ready Data (ARD)
- Obtain operational status and productivity from Land Change Monitoring, Assessment, and Projection (LCMAP)
- IT modernization for Landsat data leveraging commercial cloud
- Continue working toward Landsat/Sentinel-2 harmonization
- Investigate UAS and small satellite capabilities, Landsat synergies
- Release of new Landsat user survey, OSTP National Plan for Civil Earth Observations/Earth Observations Assessment (EOA) 2016 results synopsis
- Ensure future commercial data buys include civil agency requirements and favorable licenses
- Expand RCA scope to include all civil high and low resolution requirements
Sustainable Land Imaging (SLI)

- Collaboration between NASA and DOI/USGS that enables the development of a multi-decade, spaceborne system that will provide users worldwide with high-quality, global, land-imaging measurements compatible with the existing 45+ year record
  - Landsat 9 is the first SLI Mission
  - NASA and DOI/USGS to collaborate in developing program strategy and architecture, identifying user needs, and defining mission requirements
  - SLI Joint Steering Group – Chaired by NASA Associate Administrator for Science and Interior Assistant Secretary for Water & Science – will meet periodically to coordinate and integrate SLI efforts, and to enable overall program strategy generation and approval

- Under the SLI program, NASA and DOI will continue to work together to ensure sustained access to land remote-sensing observations for U.S. research and operational users
  - **Space systems**-- NASA will maintain responsibility for developing, launching and checking out space systems on-orbit before transferring to USGS for operations
  - **Ground systems**-- DOI/USGS will be responsible for developing and maintaining, to include operating the on-orbit spacecraft, and collecting, archiving, processing and distributing SLI systems data to users
Landsat 10 Planning under SLI

- Under SLI, USGS is working with NASA on early Landsat 10 planning activities, including requirements and technology development, to reduce cost and risk in future missions
  - USGS is partnering with Federal agencies and others to document the uses of and requirements for land imaging data
  - NASA is conducting instrument reduction studies, business model studies and other technology investigations to reduce cost and risk in next-generation Landsat missions
- USGS and NASA will continue requirements and technology activities and work together on a post-Landsat 9 Architecture Study in 2018-2019, leading to an initial decision as early as 2019 on the post-Landsat 9 system architecture, with launch in the mid-late 2020s
  - Everything is on the table at this point
  - Measurements must enable backward and forward assessments

Future Landsat systems need to ensure Earth Observation Continuity; USGS and NASA are open to new technologies, business approaches
USGS User Needs

• Mod-res land imaging needs from Federal civil subject matter experts representing >150 science and operational applications
• Major findings:
  – At a minimum, users need continuity of Landsat data and derived products with free and open data access
  – To better perform their work, users need weekly clear observations; 10m spatial resolution for VNIR/SWIR and 10-30m for thermal; additional/narrower spectral (VNIR/SWIR/TIR) bands
  – Ideally, users need contiguous 10nm-wide VNIR/SWIR bands and more (5-8) thermal bands
  – Observation frequency is the most limiting factor; then spatial resolution
• Federal needs are similar to non-Federal needs
• Needs are maintained in USGS databases that can be dynamically sorted, visualized, and compared to capabilities to support Architecture Study Team (AST) trade studies
Land Imaging AST Charge

- Define a global, Sustainable Land Imaging (SLI) system for a 20-year period starting in 2018
- Provide cost effective options for near-term capabilities, continuity risk mitigations, technology infusion
- Consider refined capabilities requested by the user communities
- Include new measurement approaches & potential international and private sector partnerships

AST Study Process

- Established study trade space via expert knowledge, intensive AST discussions, and RFI responses
- Explored alternatives via several design cycles

Key AST Finding → Landsat 8 rebuild for Landsat 9 had the lowest technical risk

- Consistent with Congressional and Landsat community desires
- Enables several years for SLI to prepare for efficient implementation of future technologies
- Direct data continuity with Landsat 8

Phase 1 of the first AST started with ~500 architectures

Next SLI AST will begin this year, building upon results of the first AST while factoring in new requirements & space capabilities, as well as private sector roles
2013-2014 Architecture Study Team (AST)

• The Landsat Science Team (LST) was consulted for its insights into past, current and desirable future capabilities
  – Statement on **Data Continuity**
  – Statement on **Sentinel-2**
  – Feedback on **near-term options** (TIR gap-filler or delayed full spectrum)
  – Feedback on **long-term options** (high revisit or hyperspectral)

• **LST overwhelmingly supported goal of more frequent, multispectral data sets**
  – Improved ability to **defeat cloud cover** and use “every clear pixel”
    • Critical for mapping of land cover, vegetation change in cloudy areas
  – **Intra-annual spectral changes** (e.g. phenology) seen as key for mapping vegetation type and condition
  – **More frequent revisit** advances hydrological and cryospheric applications, where conditions change daily to weekly
  – LST noted that hyperspectral data essential for specific applications (e.g. ecosystem physiology & chemistry, species-level compositional mapping, etc.), and provide potential for physically-based modeling of ecosystem function
SLI Architecture Study Tradespace

• Utilize exiting and future capabilities of the international and private sectors
  – ESA Sentinel-2 missions are expected to operate well into the 2030’s
  – India’s space agency has a long-running Earth observing program
  – Planet, Digital Globe and other commercial firms are continuing to improve their capabilities and products
    • The Joint Agency Commercial Imagery Evaluation (JACIE) collaboration continues to monitor and assess commercial offerings

• Improving Technology
  – More capability on smaller satellites to reduce the space segment costs
  – Develop improved “lossless” compression to reduce data volume, and store and deliver products
  – Improved product offerings and packaging to reduce product sizes
    • User-defined areas of interest, spectral subsets, information products
  – Utilization of commercial cloud provider resources to house, process and disseminate basic and higher-level products to users
What are the Major Steps in an EO mission?

- User Needs Assessment
- Architecture Study
- Mission Concept
- System Acquisition Strategy
- Contract Award
- Mission Requirements
- Mission/Instrument Design
- Mission/Instrument Build
- Instru. Characterization/Cal
- System Integration and Test
- Mission Launch
- Mission Operations
- Science Data collection
- Data Quality
- Archiving
- Product Production and Distribution
- Ground Sys. Requirements
- Ground Sys. Design
- Ground Sys. MOC Build
- Ground Sys. Science Sys Build

Mission Ops
Ground Station
Data Processing
NLI Program Guidance to LST 2018-2023

- **Contribute to AST assessment for L-10**
  - Trade space recommendations for science
  - Radiometric sensitivity analyses
  - Impacts of error propagation from lower to higher level products

- **Contribute to Landsat harmonization with other remote sensing data**
  - Landsat / Sentinel-2 spatial and spectral
  - Commercial smallsats and Unmanned Aerial Systems
    - Techniques to exploit Landsat quality with lower-radiometric quality/higher spatial and/or temporal resolution systems
  - Future sensor assessments
    - Spectra Processing, Band aggregation, Advanced Processing
NLI Program Guidance to LST 2018-2023

- **Advancing time-series/LCMAP R&D**
  - Time-series tools
  - Product generation with uncertainty propagation quantified
  - Extending to a data cube concept

- **Water Quality Assessment**
  - Optimize exploitation of L8/L9 signal-to-noise ratio and spectral bands for water application