Landsat Advisory Group (LAG) Status Report

NGAC Meeting

April 3, 2018

Frank Avila
LAG Chair

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Agenda

- LAG Mission
- Subcommittee Introduction
- Tasks Status Update
- Task #1 Final Report Presentation
- Task #2 Final Report Presentation
- Questions / Discussion

LAG Mission

Provide advice *to the Federal Government, through the Department of the Interior National Geospatial Advisory Committee,* ***on the requirements, objectives and actions of the Landsat Program*** *as they apply to continued delivery of societal benefits for the Nation and the global Earth observation community.*

LAG 2017 Membership

Name	Organization
Frank Avila (LAG Chair, NGAC Member)	National Geospatial-Intelligence Agency (NGA)
Roberta Lenczowski (LAG Vice-Chair, NGAC Member)	Roberta E. Lenczowski Consulting, LLC
Rebecca Moore (NGAC Member)	Google, Inc.
Kevin Pomfret (NGAC Member)	Centre for Spatial Law and Policy
Kass Green	Kass Green & Associates
Peter Becker	ESRI
Tony Willardson	Western States Water Council
Steven Brumby	Descartes Labs
Walter Scott	MAXAR Technologies/DigitalGlobe
Joanne Gabrynowicz	University of Mississippi

Federal Contact: Tim Newman and Peter Doucette (USGS)

Status Update

- Task #1 – Provide recommendations to possible future Global Land Data collection mission beyond Landsat 9
  - Team Lead – Kass Green
  - Status – Final paper submitted for NGAC acceptance

- Task #2 – Provide advice on the feasibility and utility of implementing temporal data cubes to support projection or “forecast” models of land change trends
  - Team Lead – Bobbi Lenczowski
  - Status – Final paper submitted for NGAC acceptance

LAG Task #3 – Fee recovery for Landsat data

- DOI leadership has requested that USGS consider possibilities for fee recovery for Landsat data.
  - Recognizing that this issue has been investigated in the past, DOI leadership is seeking to better understand the Landsat user community's needs in terms of "willingness-to-pay." (Guidance)
  - LRS is requesting that the LAG review the results from previous publication, the 2012 LAG paper "Statement on Landsat Data Use and Charges", and other relevant studies, to consider the plausibility of fee recovery today.
  - USGS has initiated a study to update results from 2011 study on "*The Users, Uses, and Value of Landsat and Other Moderate-Resolution Satellite Imagery in the United States*".

Status Update

LAG Task #3 – Fee recovery for Landsat data

- LAG held multiple discussion sessions to address this new task
  - Group continues to refine strawman draft paper
  - Explores various fee recovery options outlining pro/cons to Government and research/user/industry communities
  - Group will incorporate information derived from early results of USGS User Community Study – anticipated by August 2018
- Next Steps – assign a Team Lead
- Paper expected to be completed and ready for submission for NGAC approval prior to Fall 2018 meeting

Task #1 Report Presentation:

Recommendations for Possible Future U.S. Global Land Data Collection Missions Beyond Landsat 9

Lead - Kass Green

LAG Task #1 – Recommendations for Possible Future U.S. Global Land Data Collection Missions Beyond Landsat 9

- Tasked in August of 2017 to provide recommendations in regards to possible future U.S. Global Land data collection missions beyond Landsat 9, which is currently planned for a launch in late 2020. Specifically consider:
  1. Capabilities that are complementary to the expected capabilities of the commercial remote sensing industry, as well as the European Union's Copernicus Program, including discussion of utility and limitations for leveraging cubesat and smallsat technology,
  2. Technical feasibility and application value of enhanced collection capabilities while maintaining continuity with historic and current Landsat system capabilities and applications, and
  3. Opportunities for public-private partnerships (P3).

Findings

- 1.a. None of the current smallsat or cubesat satellite systems deployed to date have the technical capabilities required by the thousands of researchers, government agencies, NGOs, and commercial companies who rely on Landsat continuity for research and operational decision making. While the smallsats and cubesats may exceed Landsat capabilities in spatial resolution and/or revisit time, none of these satellites currently have sensors with the needed spectral bands, calibration stability, or swath area required by tens of thousands of U.S. Landsat users.
- 1b. Commercial systems to date have targeted a higher spatial/temporal resolution market niche which is not served by government systems with free and open data policies such as Landsat, Sentinel-2, GOES, or MODIS.

Findings con't.

- 1c. Unlike Sentinel and Landsat, none of the commercial providers offer imagery worldwide without use restrictions and at no cost, an important consideration for researchers and agencies relying on Landsat and Sentinel to support operational decisions.
- 1d. Landsat and the Copernicus Program's Sentinel-2 multispectral bands are very similar and can be used in combination with one another. However, only Landsat provides moderate resolution thermal imaging capabilities.

Findings con't.

- 2a. Possibilities for enhanced capabilities for future Landsat Missions while maintaining continuity include maintaining current Landsat capabilities at lower cost by leveraging emerging technologies, adopting the Copernicus acquisition model for cost savings, increasing temporal and spatial resolutions, and improving Landsat spectral resolution.
- 3a. Public-private partnerships are successful only when there is a non-government required product with sufficient demand to generate significant commercial revenue for the private partner, and the public partner agrees to not make that product freely available.

Recommendations

2a. The U.S. Government should aggressively investigate rapidly emerging and increasingly proven technologies which could greatly reduce the cost of Landsat missions. Included in this investigation should be consideration of smaller satellites with Landsat 8/9 Operational Land Imager (OLI)-like performance along with free flyer thermal missions to maintain continuity in Landsat thermal measurements. As a test, it is recommended that the U.S. Government consider placing a thermal sensor on a dedicated free flyer companion satellite to one of the existing Sentinel-2 systems. Additionally, it is recommended that a study be undertaken to determine if additional Clouds, Aerosols, Vapors, Ice, and Snow (CAVIS) bands or input from a suitable auxiliary lower resolution satellite, could be used to reduce costs associated with sensors for radiometric calibration.

Recommendations con't.

2b. Too many critical U.S. research and operational programs rely on U.S. leadership in moderate resolution earth observations for the U.S. to cede its leadership in moderate resolution earth observations to the European Union's Copernicus Program. Maintaining U.S. homeland, food, and environmental security are all dependent upon the Landsat program. However, the U.S. should continue to work closely with the European Union to better harmonize the Landsat and Sentinel data sets, obtain economies of scale where possible and share lessons learned. The Copernicus approach of building multiple satellite constellations at once and launching them over time should especially be investigated to reduce development and acquisition costs per satellite.

Recommendations con't.

2c. Regarding the capabilities of Landsat 10, it is recommended that:

- The Landsat 10 ground sample distance be set to 10 meters or larger, so as to increase compatibility with Sentinel sensors, ensure wider swath widths, increase coverage, and reduce overlap with commercial providers.
- The U.S. Government should investigate the benefits and costs of increasing Landsat spectral resolution.
- From the standpoint of continuity with previous Landsat missions for change monitoring applications, wide swath scanning sensors are probably preferable in that they offer greater synopticity (simultaneous collection of large areas).

Recommendations con't.

3a. The U.S. Government should conduct a market study to determine if sufficient demand exists to support exploration of the creation of a public-private partnership where the contractor provides two or more tiers of data - one meeting U.S. Government Landsat technical requirements for open and free distribution, and others that provide "superior" data which is sold to users, thereby creating a sufficient revenue stream to offset at least some of the costs of building and operating the system. If this model is pursued, the Government must ensure that there is an equitable balance of risk between the Government and its private sector partner.

Task #2 Report Presentation:

The Feasibility and Utility of Implementing Temporal Data Cubes to Support Projection or "Forecast" Models and Land Change Trends

Lead – Roberta "Bobbi" Lenczowski

LAG Task #2 – The Feasibility and Utility of Implementing Temporal Data Cubes to Support Projection or "Forecast" Models and Land Change Trends

- Requested to study the feasibility and utility of implementing temporal data cubes to support projection or 'forecast' models of land change trends
  - Follow-on to two previous LAG study papers published in 2013
  - Five questions posed

Two Previous LAG Study Papers

- "Product Improvement: Advise USGS on Potential Means of Modifying the Current Products to Make Them More Useful to Commercial Information Providers and Value-added Analysts"
  - Clearly define what USGS will produce and avoid competition with commercial work.
  - Refine geometric accuracy and radiometric measurements to enable better change detection.
  - Improve L1G product geometric accuracy and co-registration.
  - Define a standard surface reflectance product.
  - Consolidate scientific research and publish best practices for a range of products. Provide certification/validation facilities for products not produced by USGS.
  - Simplify access to the L1T product.
- "Cloud Computing: Potential New Approaches to Data Management and Distribution"
  - Support third-party cloud providers by providing bulk data download.
  - Co-locate data and on-demand processing for only the desired information.
  - Transmit the required processing model to the cloud so massive data could be handled by multiple CPUs.
  - Download subsets of L1T products.
  - Give attention to use of open software standards to avoid tying any services to proprietary software.
  - Streamline security.

Five Questions Posed

- In addition to Landsat, what other data sources (to include EO, SAR, and LIDAR) are optimally suited for leveraging (e.g., co-registered) to support data cube implementations for land change analysis and forecast modeling?
- What kinds of Landsat time-series products would have the broadest community use or most impactful contribution in specific areas?
- Which organizations with expertise in forecast modeling are best postured to evaluate and demonstrate the forecast potential from a Landsat-based temporal data cube?
- How far back in time into the Landsat archive should the staging of 'analysis ready data' be considered? E.g., early data collections such as multi-spectral scanner (MSS) data are less equipped (in terms of metadata) to support rigorous geometric and radiometric calibration compared to later collections.
- How could efficient synergy be realized among government and commercial roles for data cube development, and operations (processing, storage, distribution) to satisfy broad community needs?

Findings

- Finding 1: Internationally the utility of the data cube for organizing Landsat data over time and location has growing acknowledgement to support time series analysis
  - Colombia has found value in examining land change since 2000 and enabling understanding the trends for forest mapping and management.
  - The main objectives of the Swiss Data Cube (SDC) are to support the Swiss government for environmental monitoring.
  - The Vietnam Data Cube is intended to create broad applications for socioeconomic sustainable development goals for Vietnam as well as other countries in the region
- Finding 2: The recommendations from the aforementioned study papers can be aligned with this notional architecture of the Data Cube
  - Enhances the scientific value of the imagery
  - Provides additional value to the commercial and government organizations wishing to extract the maximum value from the imagery
  - Offer potential new approaches to data management and distribution

Findings (continued)

- Finding 3: Non-USGS processing of data using the open-source code and algorithms available from USGS could necessitate that USGS also release procedures documentation and some verification test datasets.
- Finding 4: The commercial sector is ready to provide data cube tailoring assistance, given its increasing experience with global geospatial data. It is also prepared to provision infrastructure to assist in the production of Analysis Ready Data (ARD).
- Finding 5: The data cube implementation involves a broad scope of standards issues.

Recommendations

- *Five recommendations with respect to the U.S. Landsat Analysis Ready Data (ARD) and its potential for being incorporated in a variety of datacubes, as a direct-use dataset in monitoring and assessing landscape change*
  - USGS should publish verification procedures that the methods and workflows have been replicated properly for any non-USGS processing. (Verification task itself not the responsibility of USGS.)
  - USGS EROS Center should release any error/difference study and analysis between the reflectance values of traditional scene pixels and the ARD unit pixels, which may have already been completed, to determine any radiometric changes resulting from preprocessing to create the ARD.
  - When improved processing approaches are ready, the reprocessing should apply to the entire data set in use and users should not be required themselves to apply compatibility adjustments to any ARD received prior to the change.
  - Prioritizing development work should be carefully scrutinized with consideration given to whether globally extending ARD may be more important than spending available time incorporating the MSS collection.
  - USGS should not undertake to scale the US ARD coverage effort globally by themselves, as the private sector is better prepared with needed tools, mature techniques, and, particularly scalable infrastructure.

Recommendations (continued)

- *Two recommendations about geospatial datacubes, as they become more globally employed to manage and exchange information for a variety of applications*
  - USGS representation, as a Strategic Member, to the Open Geospatial Consortium should advocate for and participate in more discussion about data cube standards within the OGC Technical Committee.
  - Preparing data cubes for specific uses should not be an objective of the government, which should be cautious about proceeding without private partnerships even with production of some generic forms of a data cube. The tailored data cubes should not be a federal government production responsibility.

Recommendations (continued)

- *Additional recommendations are made with reference to this report*
  - A subsequent request should be made to a future LAG Team to evaluate progress on the findings and recommendations of this paper and to update as needed.
  - USGS should begin to survey those, who request the ARD, on some routine basis over the next year, gathering information for a subsequent report.
    - To date there is limited experience obtaining and using ARD.
    - On-going information exchanges between the public and private sectors may provide more insight into defining the interdependencies to make datacubes the most effective way to advance use of imagery and expansion of GIS technology.

Questions?