NGAC Landsat Advisory Group
Initial Synopsis of NRC Report "Landsat and Beyond"

Initial NGAC Landsat Advisory Group Comments on NRC Report, "*Landsat and Beyond: Sustaining and Enhancing the Nation's Land Imaging Program*" (http://www.nap.edu/catalog.php?record_id=18420)

Preface: The following comments focus specifically on the findings and recommendations of the NRC Committee on Implementation of a Sustained Land Imaging Program that pertain to the current and future role of Landsat as part of a comprehensive national land imaging program.

Sponsors of the report: The Department of the Interior's (DOI's) U.S. Geological Survey (USGS)

Purpose of the Report: The tasks to the committee focused on a sustained land imaging program without specifically mentioning the Landsat program.

> Task 1—Identify and/or validate primary organizations and segments of society and their fundamental historical, present-day, near-future, and long-term data, information, and service requirements that need to be supported by a sustained land imaging program.
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> Task 2—Identify and recommend characteristics and critical program support areas expected of a sustained land imaging program including, but not limited to, the continuous operation and refinement of U.S. government-owned, spaceborne land imaging capabilities (e.g., passive, as in optical land imaging; active, as in LiDAR or synthetic aperture radar [SAR] measurements).
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> Task 3—Suggest critical baseline products and services derived from sustained land imaging capabilities, including higher-level information products such as climate data records (CDRs) and terrestrial essential climate variables (ECVs).
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> Task 4—Considering the requirements for an operational land imaging capability, provide recommendations to facilitate the transition of single-mission NASA research based land imaging technology or missions to sustained USGS land imaging program technology or missions, including the relationships between USGS, NASA, and NOAA in developing, maintaining and effectively utilizing land imaging capabilities.

Contributions of the report: The report contains a set of findings and recommendations that relate to the four tasks. Therefore, it provides an important summary of the need for a comprehensive national land imaging program and the role that Landsat contributes to such a program. It provides an excellent history of the Landsat program and a frank assessment of its strengths and weaknesses to support current and future user needs. It contains a comprehensive set of references to technical, budgetary and policy issues relating to the current and future status of Landsat. (The LAG September 18, 2012 Statement on Landsat Data Use and Charges is a primary reference.)

Major Conclusions:

> "The committee's primary recommendation is that the U.S. government should establish a Sustained and Enhanced Land Imaging Program with persistent funding to respond to current and future national needs.
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> "Although funding to begin the next mission would be promising, the necessary budget appropriation has not yet been enacted. No sustained program has been established to ensure

the future of land imaging, and it is clear that the continuation of the Landsat program is once again in jeopardy."

"Ensuring continuity of the ongoing data stream does not require continuing to fly the same sensor, nor does it require that all measurements be made from a single space platform."

Major Recommendations:

"The committee recommends key elements of a successful Sustained and Enhanced Land Imaging Program (SELIP) no matter where the federal government decides it should reside."

"The top priorities for the Sustained and Enhanced Land Imaging Program should be to assure that the core program provides for continuity of Landsat products and coverage on a secure and sustainable path."

"For the Sustained and Enhanced Land Imaging Program to be successful, the division of program responsibilities between the USGS and NASA should be designated such that the agency responsible for balancing science requirements with mission complexity and cost is also provided with the necessary budget. Both agencies should participate in an iterative process to design missions that meet the needs of research and operational communities, but final decisions should be made by the agency that has been given the budget."

Other Findings:

- The United States pioneered global, synoptic, frequent-repeat global imaging. Other nations are now developing systems whose capability rivals or exceeds U.S. systems. National needs require the United States to reassert leadership and maintain and expand capabilities.
- Space-based land imaging is essential to U.S. citizens as it is a critical resource for ensuring U.S. food, energy, health, environmental, and economic interests.
- The economic, intrinsic, and scientific benefits to the United States of Landsat imagery far exceed the investment in the system.
- To best serve the needs of the country, the land imaging program of the future requires an overarching national strategy and long-term commitment, including clearly defined program requirements, management responsibilities, and funding.
- The continuity of Landsat imagery has never been ensured through the development of a sustained government program. Instead, responsibility has been shifted from one organization to another over Landsat's 40-year history, resulting in persistent uncertainty for the future of this important asset.
- NASA has demonstrated that it is the civil agency with the technical capacity and the congressional support to design and build civilian space missions.
- The USGS-operated data management and distribution systems function effectively and efficiently.
- NOAA uses Landsat data to monitor Earth's coastal regions, but NOAA's primary use of satellite data focuses on the ocean and the atmosphere.
- Building a satellite sequence with new requirements and technologies for each individual instrument is an expensive way to acquire land imaging data and inhibits the addition of new capabilities.
- A sustained land imaging program will not be viable under the current mission development and management practices.

Recommendations

The committee's primary recommendation is that the U.S. government should establish a Sustained and Enhanced Land Imaging Program with persistent funding to respond to current and future national needs. Such a program would:

- Develop a plan for a comprehensive, integrated program that capitalizes on the strengths of USGS and NASA, maintains current capability and the existing archive, and enhances the program as technology enables new imaging capabilities and data products;
- Ensure acquisition of land imaging data continuously from orbital platforms, and periodically from airborne platforms, to respond to the needs of producers and consumers of derived data products along with users who analyze imagery;
- Establish partnerships with commercial firms and international land imaging programs to leverage enhanced capabilities;
- Coordinate land imaging data buys across the U.S. government; and
- Include a research and development component to improve data products based on core measurements and to develop new measurement methods and consider evolving requirements.

Important content pertaining to Landsat:

1. Clear statement that the USGS currently has a limited role in the development of any successive Landsat missions

> *"The results of this RFI have not been released to the public, but in the FY 2014 budget request, the intent to begin a sustained land imaging program in the USGS has been reversed, and budgetary responsibility for operating, building, and launching future Landsat satellites is once again to be assigned to NASA."*
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> *" In 2014, USGS will work with the National Aeronautics and Space Administration to analyze user requirements and develop a successor mission to Landsat 8, formerly known as the Landsat Data Continuity Mission. Funding to begin work on the successor mission is provided in the 2014 budget for NASA, which will be responsible for development of Landsat-class land imaging satellites going forward. The USGS will continue its operational role in managing the collection, archiving, and dissemination of Landsat data to users.27 "*

2. The NRC committee views Landsat as part of a comprehensive land imaging program that consists of an extensive array of other sensors and data. They specifically mention

- Airborne and spaceborne fine-resolution remote sensing data from public and commercial sources that can be used for detailed land use and land cover, urban infrastructure, transportation, hydrology, and disaster response;
- LiDAR data that can be used to extract precise digital surface and terrain models, building and vegetation height information, and vegetation canopy and internal structure information;
- Synthetic aperture radar (SAR) and interferometric SAR (InSAR) images at resolutions suitable for studies of deformation, elevations, and surface cover; and
- Hyperspectral data collection and information extraction capabilities for hydrology,ecosystem health and biodiversity, and soil science and mineralogy.

3. The NRC committee found that the major value of the medium resolution landsat data is the continuity of the record for monitoring change

> *"The value added of increasing the synergistic use of these data is sufficient to consider broadening the scope of the SELIP's data holding, while retaining the focus on Landsat-type measurements to continue the historical legacy"*

Specific examples of benefits to the United States made possible by analysis of Landsat data include the following:

Agricultural forecasting and management
Monitoring climate change impacts
Monitoring natural defenses to natural disasters
Wildfire risk management

4. The NRC committee provides a list of applications that cannot be supported by landsat – these include:

- Land use/land cover.
- Building and property infrastructure.
- Socioeconomic characteristics.
- Transportation and utility infrastructure.
- Hydrology.

5. The NRC committee states that there is limited commercial interest in Landsat 30 meter data.

> *"Between these scales, history and user surveys have shown that Landsat data at moderate resolutions (15 to 100 m, at 8- to 16-day frequency) have significant intrinsic value for a broad range of federal and non-federal scientific and operational uses, but low promise for commercialization."*
> *"While commercial products are mainly finer resolution than those provided by the Landsat system and are often not as comprehensive in coverage, they augment the operational capabilities available today and can enable focused studies that are impossible to undertake with Landsat-quality data."*

6. The NRC committee believes that there are commercial data sources that might be used to augment the Landsat data stream

> *"Data with fine spatial and in some cases spectral, resolution are available commercially. This would be a comparatively low-cost way to augment a U.S. national program and insure continuity and compatibility with the U.S. archive. In this approach, if properly integrated in the imaging program, temporal, spatial or spectral coverage can be increased over what a cost-constrained baseline U.S. system might provide."*

7. The NRC committee suggests that if the Landsat program is considered an operational system (rather than research) then the goal should be to continue the existing data stream with the lowest possible cost.

> *"Regardless of the approach selected, integration of the data from Landsat 9 and beyond with data from both commercial and international sources is necessary. Given*

> *these other factors, the committee does not recommend a specific course of action. The agencies and the Congress must decide what combination of options to implement."*

8. The NRC committee believes that there are several low cost alternatives to the deployment of a clone of Landsat 8. These include a block buy of specialized small satellites that capture the existing bands at 30 meters. It also includes a wider scan swath, employing a constellation of smaller satellites and flying as a secondary payload on another mission.

> *"Several of the Landsat satellites have been acquired in a very expensive way. Particularly for Landsat 7 and Landsat 8, each satellite included substantial new technology, was designed afresh, was acquired one at a time using cost-plus contracts, and was managed with a philosophy of over-engineering to minimize perceived risk, with the well-intended objective of improving the chances of mission success."*

9. The NRC committee notes that Landsat is a global asset that is used to support several programs such as Australia's National Carbon Accounting They note that while other nations are or will be in a position to provide data that will complement Landsat, none of them will provide a substitute for the fundamental data stream.