



Strengthening the Future of EROS

Contributing to the Understanding of a Changing Earth

**U.S. Department of the Interior
U.S. Geological Survey**

*USGS EROS
Strategic Plan
2016 to 2021*

Table of Contents

LETTER FROM THE EROS DIRECTOR.....	3
INTRODUCTION.....	4
MISSION AND VISION.....	4
FUTURE DIRECTIONS.....	4
1. Land Change Monitoring, Assessment, and Projection.....	4
2. Sustainable Land Imaging and Ground System Optimization.....	5
3. Center for Calibration and Validation.....	6
4. EROS Enterprise Architecture	7
5. Mundt Federal Center Consolidation	8
6. Recruit, Retain, and Train	8
EROS CORE CAPABILITIES AND GUIDING PRINCIPLES.....	9
Core Capabilities.....	9
Science and Applications.....	9
Technology	11
Data, Information, and Knowledge Management	11
Partnerships, Collaboration, and Communication	12
Administrative and Performance Management.....	12
Guiding Principles.....	12
Steward Leadership	12
Requirements Focused.....	12
Collection and Access to Data	12
Science Relevance	13
FEEDBACK	13

LETTER FROM THE EROS DIRECTOR

Our future is built on a strong foundation of data management, partnerships, science, technology, and people. Achieving our mission, while strengthening the future of EROS, is vital to our organization's performance and directly contributes to our Nation's ability to understand and respond to the changes in land use, land cover, and land condition at local, regional, and global scales. These changes, both natural and anthropogenic, pose ever-growing science and technology challenges that all of us must proactively address.

In the late 1980s and early 90s, EROS experienced a revolutionary shift in its science and applications priorities that transformed its science from a series of localized remote sensing and geospatial data applications to the current emphasis on large-area mapping and monitoring. The time is right for a second revolution that shapes the EROS science, research and applications program as a major contributor to the understanding of our changing Earth.

To that end, this 2016-2021 EROS Strategic Plan conveys a targeted and focused set of challenges and opportunities for moving EROS forward and further strengthening our mission of "*contributing to the understanding of a changing Earth.*" There is so much to be proud of and look forward to as we move together toward our vision of being:

1. The world's primary source and steward of remotely sensed land images of the Earth.
2. Authoritative providers of land change science data, information, and knowledge.
3. Leaders in understanding how changes in land use, cover, and condition affect people and nature.

EROS is a world-class Center, with a reputation that is rooted in the Center's long-standing record of science, service, and stewardship as a land remote sensing science and data center. Our foundation is strong, and our opportunities are many. This plan serves as a window to a bright future we will collectively achieve over the next 5 years.

Frank P. Kelly

Frank P. Kelly, Ph.D.
Director, Earth Resources Observation and Science (EROS) Center
Space Policy Advisor

Strengthening the Future of EROS – 2016 to 2021

INTRODUCTION

The Earth Resources Observation and Science (EROS) Center, a U.S. Geological Survey (USGS) Science Center, is the steward of Landsat satellite imagery and other land records, and the provider of land change science data, information, and knowledge to aid in the understanding of a changing Earth. EROS is responsive to the Department of the Interior’s goals for a scientific foundation for decision making and the USGS Climate and Land Use Change (CLU) science strategy. The 2016-2021 EROS Strategic Plan is a key mechanism for implementing the CLU Mission Area science strategy, and is consistent with the USGS geographic research focus on land change science and the USGS vision to provide science for a changing world.

MISSION AND VISION

The EROS mission “*contributing to the understanding of a changing Earth*” is accomplished through science and applications, systems development, information technology, and operations. EROS uses remotely sensed land data to monitor, assess, and project how changes in land use, land cover, and land condition affect people and nature.

The EROS vision is to be:

- The world’s primary source and steward of remotely sensed land images of the Earth;
- Authoritative providers of land change science data, information, and knowledge; and
- Leaders in understanding how changes in land use, cover, and condition affect people and nature.

Additionally, these three vision statements serve as the framework for the USGS EROS Center’s land change science and applications agenda.

FUTURE DIRECTIONS

As we look ahead, it is essential that we continually challenge our future directions in science, research, and applications; technology; products and services; and stewardship. By better understanding and bringing more focus to the following six key directions, strategic actions, and their intent, we create the opportunities for making our CLU Mission Area and EROS foundations even stronger as we move into the next decade.

1. Land Change Monitoring, Assessment, and Projection

In setting the stage for the future, it is clearly understood the core of the EROS science and applications agenda is land change science, as articulated in the Land Change Monitoring, Assessment, and Projection (LCMAP) vision:

An interdisciplinary science and applications program that generates and uses land change data and information products to explain how the patterns, processes, and consequences of changes in land use, land cover, and land condition, at multiple spatial and temporal scales, affect people and nature. LCMAP provides a capability to continuously track and characterize changes in land cover, use, and condition and translates this information into assessments of current and

historical processes of change in order to support evaluations and decisions relevant to environmental management and policy.

The strategic intent of LCMAP and the Center's science agenda, as detailed in the EROS Center Science Strategy, is that EROS will provide structured, operational, ongoing, and timely collection and delivery of accurate and relevant data, information, and knowledge on land use, cover, and condition to support a wide array of science questions. This is in direct response to our USGS Mission Area science strategy for climate and land use change research along with the broader global environmental priorities that span the USGS. Simply, the EROS science emphasis is understanding the patterns, processes, and consequences of changes in land use, land cover, and land condition that are associated with the interaction between human activities and natural systems. To that end, EROS will:

- Provide documentation and understanding of historical land change and contemporary land change as it occurs through public release of planned Landsat products (e.g., climate data records/essential climate variables such as surface reflectance, surface temperature, burned area, surface water extent, snow covered area, and biomass).
- Explain how past, present, and future land change affects society, natural systems, and the functioning of the planet at local to global scales.
- Alert relevant stakeholders to important or emerging land change events in their jurisdictions.
- Support others in the use of land change data, information, and science results.

Strategic Actions and Products

- Complete the assessment of a continuous change detection classification (CCDC) algorithm for detecting land change. – Quarter 1 Fiscal Year (FY) 2016
- Define and reach community consensus for a definition of analysis ready data (ARD). – Quarter 1 FY 2016
- Provide the CCDC algorithm for operational implementation. – Quarter 1 FY 2017
- Achieve initial operations capability for CCDC. – Quarter 2 FY 2017
- Achieve initial operations capability of LCMAP for the conterminous U.S. – Quarter 1 FY 2018
- Achieve operational release of LCMAP for the rest of the globe. – Quarter 1 FY 2020

2. Sustainable Land Imaging and Ground System Optimization

As part of the CLU Mission Area's monitoring strategy, this direction will address managing national land remote sensing assets and implementing, in conjunction with NASA, Landsat and other satellite missions. The direction is two-fold; first, the Sustainable Land Imaging (SLI) program (as established by the Administration in 2015), and EROS will provide stakeholders with necessary land imaging data operationally over the long term, and will ensure for the preservation and access to the data. The Nation's SLI program extends and builds on our land remote sensing records for at least another 20 years and includes: the initiation of Landsat 9 with a goal for a 2021 launch; a multi-year system innovation leading to mature and advanced land remote sensing measurement technologies; and an emphasis on strategic alignment with the European Union's Sentinel mission. As a result, SLI as an operational program will include missions, science, data, information, requirements analyses, access, distribution, policy, and technology components. Second, EROS will enhance and improve its ground system architecture, consistent with our Mission Area and Center-wide approach to effectively and efficiently prepare for the future, with particular emphasis on the SLI program. EROS will:

- Develop and implement the Earth Observation Requirements Evaluation System (EORES) to maintain and prioritize land remote sensing user requirements enabling data driven solutions analyses for decision makers.
- Develop the ground systems; operate the on-orbit spacecraft launched by the National Aeronautics and Space Administration (NASA); acquire auxiliary foreign or commercial data sets; and collect, archive, process and distribute the SLI system data to users.
- Investigate, and implement where beneficial, new technology and cost efficient approaches, as well as potential Federal, international, and private sector partnerships, such as the NASA's LP DAAC (Land Processes Distributed Active Archive Center) and others.

Strategic Actions and Products

- Initiate Landsat 9 ground systems definition and development activities. – Quarter 1 FY 2016
- Define Sustainable Land Imaging scope and governance. – Quarter 4 FY 2016
- Complete the elicitation of key requirements from 31 USGS Programs and 450+ subject matter experts. Provide the Earth Observations Assessment (EOA) 2016 repository and assessment via EORES and begin operations and maintenance phase. – Quarter 4 FY 2016
- Issue Landsat 9 Mission Operations Center (MOC) request for proposals. – Quarter 2 FY 2017
- Award MOC Contract. – Quarter 3 FY 2017
- Perform Data Processing and Archiving System (DPAS) Critical Design Review (CDR). – Quarter 4 FY 2017
- Perform additional EORES analyses and other Federal agencies' requirement elicitation. – Quarter 2 FY 2017
- Complete the EOA 2016 capabilities assessments in support of the USGS Land Remote Sensing Program and EROS. – Quarter 4 FY 2017
- Perform MOC CDR. – Quarter 2 FY 2018
- Perform Ground Network CDR. – Quarter 2 FY 2018
- Implement MOC. – Quarter 1 FY 2020
- Implement Ground Network Landsat 9 upgrades. – Quarter 1 FY 2020
- Implement DPAS Landsat 9 upgrades. – Quarter 2 FY 2020

3. Center for Calibration and Validation

Another focus within the science strategy of our Mission Area that deals with monitoring is the need to “develop calibrated and validated geophysical measurements and integrated data products with the accuracy and precision needed to map, measure, and monitor land changes attributed to climate change, other natural disturbances, and human activity; and identify and evaluate new remote sensing technologies to provide measurements needed to detect and monitor global change.” With that said, the key to any science and analysis system is well calibrated data products with defined accuracy and uncertainty system measurements available for each step in the processing chain, particularly as higher level products and models are developed to support scientific detection, monitoring, and projection. As the USGS Center responsible for providing synoptic Earth observations, it is clearly our priority to develop calibrated and validated geophysical measurements. As well, we are responsible for developing integrated data products with the accuracy and precision needed to map, measure, and monitor land changes attributed to climate change, other natural disturbances, and human activity. Our approach is to perform the calibration/validation function at the sensor data level to ensure a baseline input to product generation, and also to provide an ongoing calibration and validation check through the product generation phase. EROS is positioned within the global

community to be the expert to address calibration and validation effectiveness across a broad range of land remote sensing systems. With a strong workforce, we are focused on improving radiometric and geometric consistency across measurement systems, and troubleshooting issues associated with all phases of the Landsat satellite and other global land data records. This broad-based perspective permits intelligent prioritization and evaluation of potential new remotely sensed measurements, and identification and evaluation of new remote sensing technologies to provide measurements for detecting and monitoring global change. As the recognized Center for Calibration and Validation, EROS will:

- Provide a production capability for effective and efficient calibration and validation services to a broad customer base (from scientists to policy makers) ensuring the highest possible quality of cross-system data and information available for land change assessment and scenarios for projection models.
- Continue to grow EROS as a global center of excellence for calibration and validation baseline input and processes.

Strategic Actions and Products

- Define requirements for calibrating and validating higher-level, integrated data and information products using existing Landsat satellite and other global land data calibration processes and practices. – Quarter 3 FY 2016
- Define the operations concept for the Center for Calibration and Validation, with an end state and road map. – Quarter 4 FY2016
- Based on requirements, determine the ‘Gold Standard’ processes and practices to be continued, improved, or established for calibration, validation, and data quality information. – Quarter 1 FY 2017
- Develop and deliver an EROS capability to provide the best calibration, validation, data quality, information processes and practices for Earth observation data and information use across the National Satellite Land Remote Sensing Data Archive. – Quarter 1 FY 2018

4. EROS Enterprise Architecture

In 2010, the Office of Management and Budget (OMB) launched the Federal Data Center Consolidation Initiative (FDCCI); and in 2014, the President signed into law the Federal Information Technology Acquisition Reform Act (FITARA), to stem the growth of Federal data centers, shift IT investments to more efficient computing platforms, improve service delivery, and reduce costs. The EROS Enterprise Architecture (EEA) improvements will make great strides in that direction using both Government-based and commercial-based solutions. Its intent over the next 5 years is to shift the Center’s emphasis to centrally managed enterprise capabilities and services to meet EROS current and future processing requirements not strictly a part of EROS. Our primary goal is to align EROS resources to be more effective and efficient in support of the Center’s key directions, with particular emphasis on optimizing the effectiveness and efficiency of SLI and LCMAP. This shift enables managed, strategic planning of an architecture evolution throughout the Center. Fundamental to this evolution is the implementation of an Enterprise Business Model that serves as a guide for the management of resources across projects. Rather than procuring, installing, and managing their own equipment, projects will share resources for a capability and performance level as a service, while still retaining authority over all requirements. While the current collection of semi-independent project approaches is effective, these changes will enhance efficiency to better balance capabilities and capacities from project to project. An EEA approach provides many benefits, such as a Center-level

system of systems view for EROS to enable effective strategic planning and provide centralized security, and to optimize services from small to large projects. In implementing the EEA, EROS will:

- Maintain as-is architecture and user characterization documentation going forward.
- Transition to the target architecture in an evolutionary versus revolutionary way.
- Build upon interagency partnerships.
- Revisit the EEA and implementation plan on an annual basis and update as needed.

Strategic Actions and Products

- Establish the EEA infrastructure governance. – Quarter 1 FY 2016
- Develop and implement an EEA implementation plan. – Quarter 3 FY 2016
- Fully develop and implement a Center-wide business model. – Quarter 1 FY 2017
- Enable the science data systems through the EEA. – Quarter 4 FY 2018
- Enable the land satellites data system through the EEA. – Quarter 4 FY 2019
- Achieve full enterprise architecture implementation. – Quarter 3 FY 2021

5. Mundt Federal Center Consolidation

The Mundt Federal Center Consolidation effort is in direct response to the previously mentioned 2010 OMB FDCCI and the 2014 FITARA and their goals to develop and report on data center strategies that consolidate inefficient infrastructure, optimize existing facilities and increase investment in more efficient infrastructure such as interagency colocation, green technologies, and the cloud. EROS has long provided data center services to the global remote sensing community and will continue to develop both aspects of its mission, that is, science and data, in a collaborative Federal data center work environment. Over the next 5 years, EROS will:

- Assess the structure, components, interfaces and interactions of the existing EROS data center. Normalize the use of data center information management tools in concert with facilities infrastructure planning to fully understand the current EROS ‘system of systems.’
- Utilize the EROS Enterprise Architecture approach to integrate science mission processing needs and opportunities, with needs and opportunities from data center consolidation users and partners.
- Ensure the effectiveness of this capability with an eventual goal of highly efficient and reliable IT services across all aspects of the broad EROS mission.

Strategic Actions and Products

- Implement a plan to expand opportunities to co-locate EROS facilities with key partners, as well as sustain existing facilities through planned improvements. – Quarter 1 FY 2017
- Ensure EROS facilities portfolio is appropriately aligned to support a reliable, safe and secure work and living environment. – Quarter 1 FY 2017

6. Recruit, Retain, and Train

The Department of the Interior’s vision for a 21st Century workforce includes a highly skilled and engaged workforce that reflects diversity and ensures its Mission Area goals. EROS recognizes it is critical to create, sustain, and retain a viable workforce to support its current and future land remote sensing science and data center needs. Our reputation is built on our people; and our people are our future. A well-tuned workforce intersects all of the components of the EROS Strategic Plan and the

EROS Science Strategy. The sustainment and professional development of our workforce, along with establishing a collaborative and focused work culture, is essential to meeting our mission and vision. EROS will:

- Enhance the knowledge base and skills of the workforce.
- Address requirements needed to grow data science and team science expertise and practices.
- Continue to promote and expand policies, programs, and practices that lead to a diverse workforce at all levels of the organization.
- Provide a safe and secure infrastructure.
- Provide a work environment centered on meeting the challenges and opportunities of our mission while improving employee satisfaction.

Strategic Actions and Products

- Develop a workforce plan for the USGS organizations at EROS, specifically the initiation of a campaign to refresh our staffing profile with the education and skills needed to carry out our vision. – Quarter 1 FY 2017
- Enhance development and training programs to improve and expand leadership, management, and technical competencies of the entire workforce. – Quarter 1 FY 2017
- Implement new and enhanced methods and technologies for training delivery, such as simulations and on-demand training. – Quarter 1 FY 2017
- Improve recruitment strategies to ensure future workforce skills align with EROS vision. – Quarter 2 FY 2017

EROS CORE CAPABILITIES AND GUIDING PRINCIPLES

Our USGS EROS 2015-2025 Strategic Plan is not complete without addressing these Center-wide capabilities and guiding principles, which represent crosscutting requirements and relationships that support the Center as a whole.

Core Capabilities

There is a long-standing premise that EROS is built on, which is ‘data management is our bread and butter; partnerships are a way of life; science makes us relevant; technology keeps us competitive; and our people are our future.’ This foundation makes EROS strong and serves as a guide as we embrace opportunities to maintain, grow, and make these Center-wide capabilities even stronger in support to Interior, USGS, and EROS programs, projects, and future initiatives.

Science and Applications

At the highest level, the EROS science and applications program strives to be relevant, have an impact, exhibit national and international leadership, and to advance innovation. The EROS vision focuses on improving the understanding of the rates, causes, and consequences of land use and land cover change at the local, national, and global scale; and provides Landsat satellite and other global land data records, to everyone, anywhere, anytime, and at no charge. This level of understanding presents an overarching, long-term scientific, applications, and technical challenge to EROS that requires a significant effort to meet.

With LCMAP as the structure for organizing, producing, and delivering land change science products, its viability depends on a relevant science and applications agenda that includes topical science goals that are the basis for our specific projects and activities. The three science goals associated with our land change science priorities and LCMAP include:

1. Improving global land change monitoring through remote sensing research.
2. Understanding the temporal and geographic dimensions of land change.
3. Improving the understanding of the connections between climate and land change (e.g., land use, cover, and condition) and their combined impacts on human and natural systems.

These goals represent the topical scope of our science and applications priorities. Moving forward, science and applications projects will be organized and led through seven science focus areas. The following is a definition of each of the science focuses:

Remote Sensing Research and Development (R&D) for Land Change: Research addressing remote sensing data quality and consistency, algorithms and strategies for characterizing geo- and biophysical surface properties and dynamics including land change, and strategies for validation of remote sensing and environmental products.

Land Change Products – Land Cover: Planning, implementation, and production of the National Land Cover Database.

Land Change Products – Fire: Planning, implementation, and production of land data sets needed to characterize vegetation related to fire fuels and fuel conditions, and the analysis and monitoring of burn severity.

National and Regional Land Change Assessments: Research, analysis, and synthesis of data leading to the development of assessments of the rates, causes, and consequences of land change.

Vegetation, Water, and Climate Dynamics: Quantification and monitoring of the impacts of weather, climate, and land use on vegetation condition and water resources.

Coastal Zone Changes and Impacts: Regional to national assessments of the complex interactions between coastal communities and natural landscapes associated with climate change, sea-level rise, and human development.

Early Warning for Food Security: Research and analysis leading to operational early warning forecasts and assessments of acute food insecurity.

The seven science focus areas collectively contribute to the three science goals. The relationship between the science focus areas and the EROS Science Strategy goals are shown in table 1. All seven will ultimately play a role in meeting the broader EROS mission, *contributing to the understanding of a changing Earth*, and specifically to being *leaders in understanding how changes in land use, cover, and condition affect people and nature*.

Table 1. Relationship Between Science Focus Areas and EROS Science Goals.

Science Focus Areas	Science Goals		
	Improving global land change monitoring through remote sensing research.	Understanding temporal & geographic dimensions of land change.	Improving the understanding of connections between climate & land change & their combined impacts.
Remote Sensing R&D for Land Change	Primary		
Land Change Products – Land Cover		Primary	
Land Change Products – Fire		Primary	
National & Regional Land Change Assessments		Primary	Secondary
Vegetation, Water, & Climate Dynamics		Primary	Secondary
Coastal Zone Changes & Impacts			Primary
Early Warning for Food Security			Primary

The seven science focus areas also contribute to establishing the LCMAP foundation. The challenge ahead is for the science focus areas to work together to make LCMAP implementation successful.

Technology

The technology needed to support the EROS Center Science Strategy, and specifically LCMAP, is being explored, and will be even more so over the next 5 years. In addition to the software technology required, high performance computing (HPC) is increasingly seen as necessary to deal with the rates, volumes, and latency of the data and analysis required. EROS will be working with USGS, Interior, and other partners in these technologies.

Data, Information, and Knowledge Management

As mandated by public law, the USGS is to ensure the long-term preservation, continued population, and timely access to the Nation’s land remote sensing data holdings. As a result, EROS manages and preserves a variety of data collections acquired from a wide array of current and historical sources, and distributes them to a broad range of global and niche user communities in science, applications, and operations. Data sources range from active satellite missions that are operated by EROS and others; historical aerial and satellite sources; as well as information about elevation, land cover, and other aspects of the Earth’s land surfaces. Access to the data is via a number of web-enabled user interfaces tailored to the collaborators’ and users’ needs, from simple websites to fully featured data discovery tools.

This robust data management capability serves as a spring board, where by EROS will begin implementation of a user-focused information services capability as a consequence of our data services paradigm shift – moving from a provider of data to a provider of information services and solutions. The capability will provide the foundation for a more cohesive and aggressive strategy for communications, applications services, outreach, and other user and stakeholder support that draws upon shared responsibilities across the Center, including collaboration with a number of partners to more effectively meet National, Interior, USGS, and EROS strategic objectives.

Partnerships, Collaboration, and Communication

Our partnerships provide EROS a capacity to achieve what may not otherwise be possible. We recognize our mission success and strong foundation are built on partnerships created by individuals believing they can better achieve their goals by working together. There are a host of stakeholders, cooperators, and users for which EROS communicates, collaborates, and serves: including but not limited to other Federal agencies, educational institutions, state, county, and city governments, Native American institutions and tribes, foreign governments, and international (non-government), and others. Their needs are increasingly complex and continually growing. Communicating the value of the Center's data, information, and products, both internally and externally, is critical to our mission success. Connecting the Center's data, information, services, and knowledge to current and potential stakeholders through development of user friendly communication and education capabilities is key to ensuring the value of our data, products, and services are well known, understood, and applied in service to critical requirements. Engagement with users is needed at all levels, nationally and internationally, to better understand customer requirements and assistance needs. Our future directions and solution strategies depend on the unique knowledge and information exchanged through our ongoing communication and collaboration methods, such as public scientific outreach, presentations, and publications.

Administrative and Performance Management

EROS is on a Federal campus and is an USGS-owned facility. Our physical infrastructure and qualified Federal and contractor workforces require effective administrative and performance management measures, at both headquarters and in the field. These measures will be integrated into processes across the Center, incorporated into our strategic efforts, and used to inform our decisions. Effective management of the scientific and physical and human resources is imperative to delivering the right products and services at the right time.

Guiding Principles

These guiding principles are key precepts to the EROS organization and its broad base of professional, executive, and administrative employees. These principles are fundamental to EROS and its mission and vision.

Steward Leadership

- Branches, teams, and our contract partners first, foremost, and always put the USGS and EROS Center mission first.
- Stewards, ensuring long-term preservation of land remote sensing data and information holdings, dedicated to understanding a changing Earth.
- Responsible stewards of Government assets, including real estate, facilities, equipment, and observatories.
- Committed to the continuation of the Landsat record.

Requirements Focused

- Responsive to community requirements.
- Undertake projects and activities that are appropriate mission-relevant activities.

Collection and Access to Data

- Underscore the Sustainable Land Imaging archive as the centerpiece of EROS and the land change science program.
- Dedicated to timely access of the EROS archive holdings to all parties requesting data at no cost in the use of land change information and knowledge.

Science Relevance

- Emphasize the advancement of science, technology, and societal benefits of remote sensing products and services.
- As a USGS science center, ensure that stakeholder science needs and priorities are considered in all areas – operations, research, and administration.
- Adhere to science best practices, such as transparency, peer review, and communications.

FEEDBACK

Communication with our expanding constituent, customer, and user base is vital to achieving our mission and the success of our projects and activities. To communicate with us or for more information about EROS, contact our EROS Policy and Communications Office, at holm@usgs.gov or 605-594-6127.