EARTH SCIENCE
DIVISION

EARTH SCIENCE APPLICATIONS GUIDEBOOK

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Guidebook Overview

This Earth Science Applications Guidebook is divided into three sections, as described below.

UNDERSTAND EARTH SCIENCE AT NASA

Since the 1960s, NASA has studied the Earth, using the vantage point of space to understand our planet – and other planets. NASA Earth data empowers people to respond to real-world challenges: managing natural hazards, building the U.S. economy, ensuring national security, and strengthening communities in the U.S. and across the globe.

These missions also help us vet and improve technology, demonstrating their effectiveness and value for exploration beyond our own planet. Dive into these pages to understand NASA's strategy to accelerate and advance the impact of Earth science and information.

Topics include:

- Explore NASA's Earth Science to Action Strategy (ES2A)
- Understand user-centered science
- Learn about the value of Earth data and remote sensing

DEVELOP AN EARTH ACTION PROPOSAL

This section offers insights on solicitations issued by the NASA Earth Action element of the Earth Science Division (ESD). While specific Earth Action programs may offer support, most are funded through the Research in Opportunities in Space and Earth Sciences (ROSES) solicitation.

Earth Action proposals should be built on high-quality science, effective management, and the pursuit of societal impact. They should clearly and persuasively present:

- Transformative, innovative uses of science
- Engagement and collaboration with specific users
- Practical, sustained benefits for users and others
- Excellent leadership of skilled teams

The information here should be considered together with guidance in NASA's Grant and Cooperative Agreement Manual (GCAM).

Topics include:

- Is Earth Action right for your project?
- The role of users in proposals
- What goes into a strong proposal

MANAGE AN EARTH ACTION PROJECT

Given their emphasis on delivering societal impact, projects funded by Earth Action programs tend to be managed differently than a standard research grant. The management approach involves active planning to collaborate with users, build a team, monitor results, and communicate with external audiences. The team structure may vary as well, with partners as co-investigators (either funded or unfunded). When these elements are managed well, Earth Action projects are more likely to deliver usable, lasting solutions.

This section offers insights and best practices on these "non-science" dimensions of managing an Earth Action project.

Topics include:

- Get started with new funding
- Collaborate with users and partners
- Work through implementation challenges
- Evaluate and close a project

UNDERSTANDING EARTH SCIENCE AT NASA

Key Takeaways

Main Topics

- NASA's Earth Science to Action Strategy (ES2A)
- NASA's Earth Action (EA) element
- How Earth information is used for decision-making

- ES2A centers on making America safer, stronger, and more prosperous through missions, research, and applications that empower people to apply NASA Earth science to real-world challenges.
- The NASA Earth Action programs work with partners in federal, state, and local government, the private sector, nonprofits, communities, and academia on solutions often referred to as "applications."
- A successful Earth Action application uses NASA science and is "user-centered," meaning it is designed around the needs of a specific user to address a specific decision or decisions. When feasible, NASA Earth Action seeks to transition an application to a user's environment.
- Key Earth Action priorities are:
  - Scaling successful applications to more users
  - Building bridges between NASA research and practical uses of the science
  - Ensuring applications are driven by user needs.
- Earth Action applications provide data for decisions related to policy, legal, and regulatory frameworks; planning, management, and response; monitoring and tracking impact; and alert systems and other information for the public, among many others.
- Satellite-derived Earth observations (EO) provide data and analysis to manage a range of environmental, economic, and social challenges. They save money, protect human health and property, foster economic growth and national security, and promote transparency and collaboration in decision-making.

Section 1.1 Earth Science to Action (ES2A)

1.1.1 Earth Science to Action (ES2A) Strategy: 2024-2034

These are the key pillars of the Earth Science to Action (ES2A) strategy:

Vision

A thriving world, driven by trusted, actionable Earth science.

Mission

Compelled by our planet's rapid change, we innovate and collaborate to explore and understand the Earth system, make new discoveries, and enable solutions for the benefit of all.

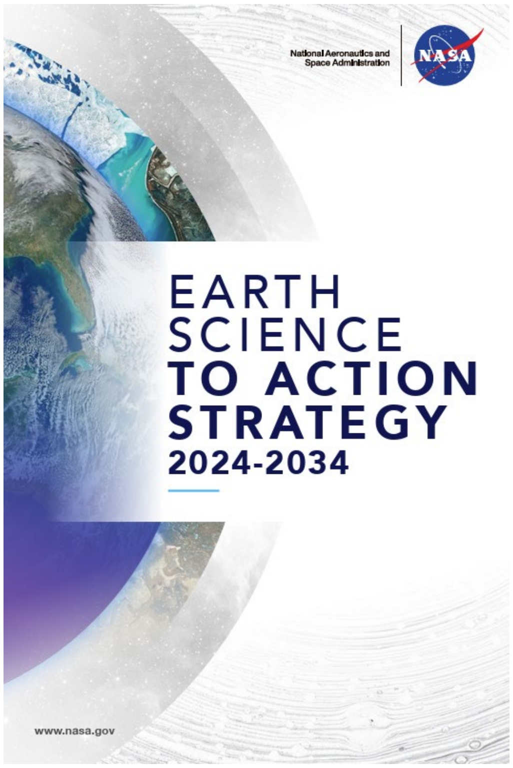
Goal

Within a decade, we will advance and integrate Earth science knowledge to empower humanity to create a more resilient world.

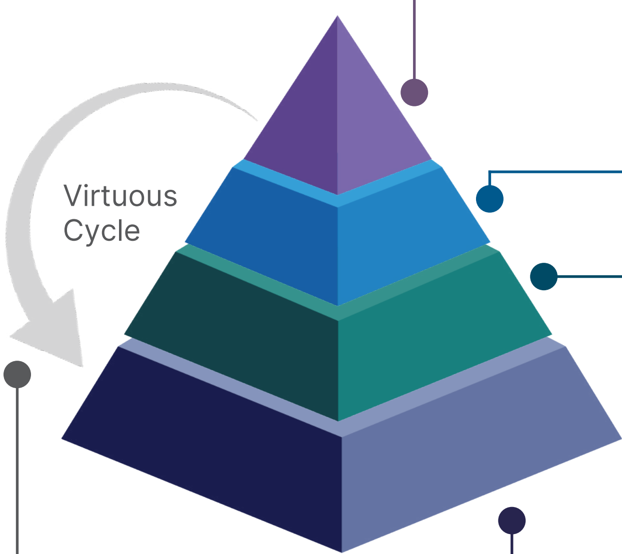
Objectives

Holistically observe, monitor, and understand the Earth system.

Deliver trusted information to drive Earth resilience activities.



1.1.2 The ES2A Pyramid



Public Understanding & Exchange

- Put more scientific understanding into public sphere
- Deliver applied science to users
- Participate in multi-way info exchange
- Use input to inform subsequent work

Solutions & Societal Value

- Offer models, scientific findings, and info through Open-Source Science principles
- Support climate services
- Provide science applications and tools to inform decisions

Earth System Science & Applied Research

- Grow scientific understanding of Earth's systems
- Develop predictive modeling for science applications and tools to mitigate, adapt, and respond to climate change

Foundational Knowledge, Technology, Missions & Data

- Technology innovation
- Earth observations missions
- Data collected from space, air and ground

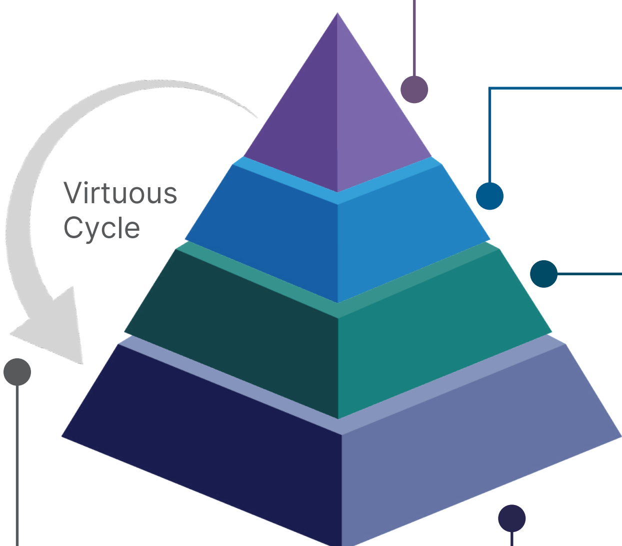
Virtuous Cycle

- User needs inform next iteration of future programs, missions, and initiatives

1.1.3 ES2A Example: GPM Mission

The Global Precipitation Measurement (GPM) mission, a satellite constellation supported by NASA and other U.S. and international agencies, is a good example of Earth Science to Action in practice.

The graphic below illustrates how GPM's next-generation observations of rain and snow contribute to better weather forecasting.



Public Understanding & Exchange

Users participate at all stages to share requirements, iterate on product development, communicate impacts, and affirm the value of NASA data.

Solutions & Societal Value

The National Weather Service, U.S. Drought Monitor, private companies, and others deliver more accurate forecasts and earlier alerts. People, businesses, and government agencies are empowered to make better decisions on weather-related risks to agriculture, health, and transportation.

Earth System Science & Applied Research

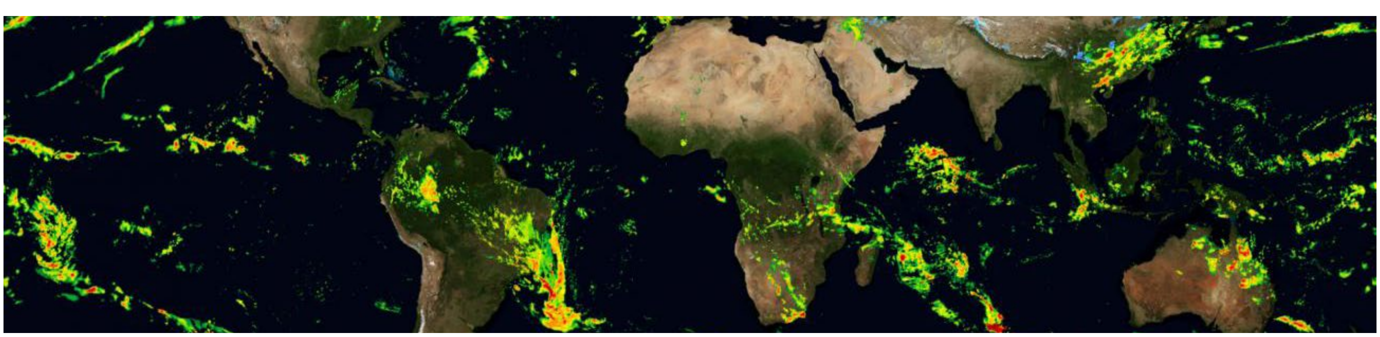
NASA's Short-term Prediction Research and Transition (SPoRT) project makes IMERG's real-time estimates more accessible through value-added data products, visualizations, and formats tailored to users' workflows.

Foundational Knowledge, Technology, Missions & Data

GPM observes Earth's precipitation, providing a global picture of rain and snow through an advanced algorithm: Integrated Multi-satellitE Retrievals for GPM (IMERG).

Virtuous Cycle

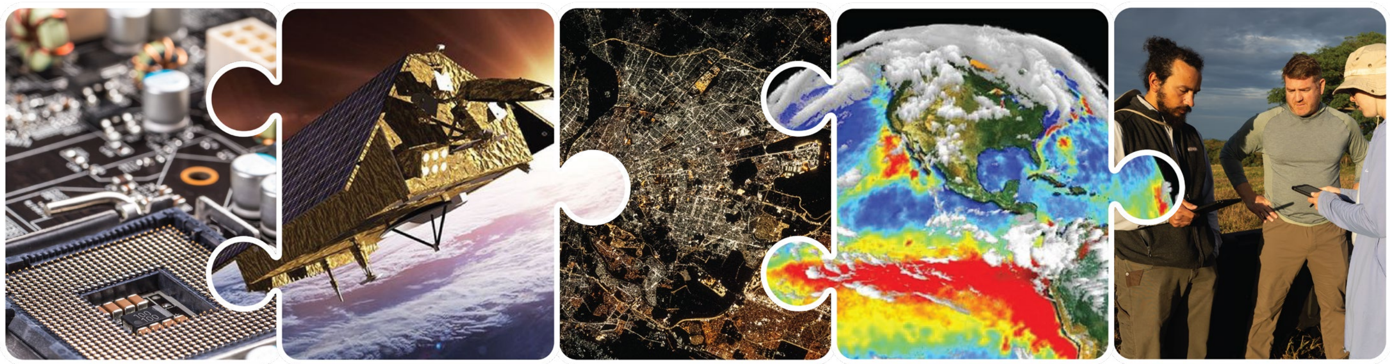
Regular interaction between users and NASA channels feedback to the science team, algorithm developers, and future mission planners about potential improvements and innovations.



1.1.4 Earth Science Division

NASA's Earth Science Division has five elements. Earth Action, the applied science element, leverages advances in Earth science research to help people put Earth data and tools to work.

Select a puzzle piece to visit the website for each element.

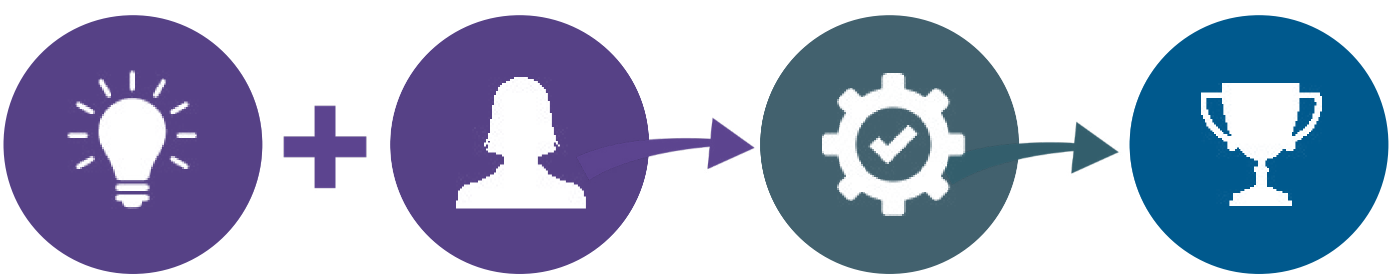


1.1.5 How Earth Action (EA) Works

NASA Earth Action provides technical support and funding to institutions and individuals in academia, government agencies, and the private sector, enabling them to collaborate with a user or users to create practical solutions based on NASA data.

These solutions – often called "applications" – take the form of datasets, models, tools, visualizations, research, and other products. They strengthen a user's ability to manage challenges and decisions related to disasters, water, food and agriculture, the environment, health, and more. Earth Action applications make Earth information actionable, accessible, and timely.

The Earth Science to Action Continuum



1.1.6 Leadership Perspective on EA

Thomas Wagner is Associate Director of the Earth Action program within NASA's Earth Science Division Science Mission Directorate. Here is his perspective on why Earth Action matters:

Thomas Wagner

One of the great things about NASA's program is that it's truly end to end. On a fundamental level, we develop new sensors that we can fly in space. Then we develop the missions to do them. We develop the data systems and do the basic research to get that data down and use it. And then we take applications that bring it home to anybody who wants to use that data, and that's anybody from the private sector through to individuals. Earth Action is all about helping people make practical decisions that affect their lives, their businesses, or anything that they really need to make a decision about.

We really exist in a golden era of satellite observations. We are making measurements from space that do amazing things, from measuring rainfall to looking at how the ground is deforming, to understanding the plankton that live in the ocean. But, Earth Observation data is hard to use. And on top of that, things are changing all the time, like modeling is becoming a more important tool.

What inspires me most about Earth Action is that I see that in the world we live in today, and with the amazing capabilities that have emerged in satellite observation, and the new capabilities with AI and machine learning, I think that we have a real chance to let people answer their own questions however they want, wherever they want, and we really want to be at the forefront of that.

1.1.7 Three EA Principles

To deliver impact in a world facing many complex challenges, Earth Action emphasizes three principles: Scaling, Building Bridges, and User-centered Science.

Scaling

Maximizes impact by building on existing research innovations and extending successful applications to new users.

Building bridges

Connects the knowledge generated by the NASA Earth Science Research Program to public and private sector organizations that can use that knowledge for societal benefit. This entails a virtuous cycle of research outcomes leading to practical applications that, in turn, identify new research needs.

User-centered science

Puts user needs at the center of application projects and engages them as full partners in application development and implementation.

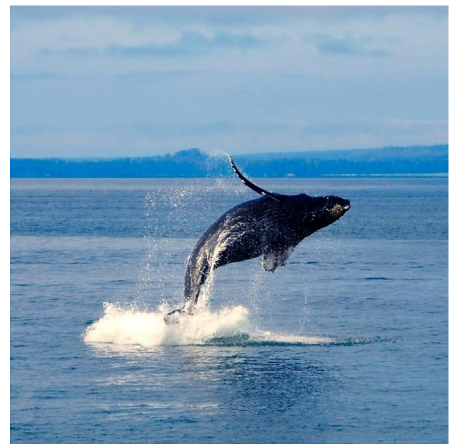
1.1.8 Explore Recent NASA Projects

These links lead to summaries of successful NASA Earth Action proposals funded through Research in Opportunities in Space and Earth Sciences (ROSES). They demonstrate how NASA Earth Action contributes to the Earth Science to Action strategy. They also illustrate key aspects of Earth Action projects; for example, 1) how NASA science addresses a user need and 2) how applications bridge scientific research and real-world solutions.

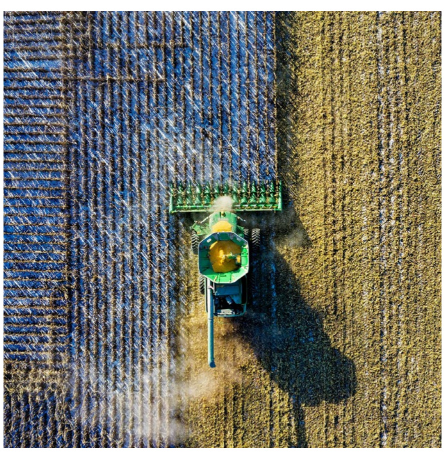
Select an image to visit the summaries of successful NASA Earth Action proposals.

Disasters

Wildland Fires



Ecological Conservation Impact Assessment



Agriculture

Water Resources

Health and Air Quality

Section 1.2 Explore User-centered Science

1.2.1 Defining User-centered Science

User-centered science is an approach in which the needs, decisions, and real-world context of a user drive the development of the solution.

NASA Earth Action and NASA-funded partners collaborate with a user or users on all stages of application design and implementation, first by identifying a specific need, and then using NASA and other data to devise a solution. With more than 50 years of experience building Earth science applications, NASA has learned this type of co-development leads to tangible, sustained results.

1.2.2 EA Users and Collaborators

NASA Earth Action works with partners from federal, state, and local government, the private sector, nonprofits, and communities. Alongside those directly funded by NASA, a range of other people and institutions may engage with an application, at varying levels of involvement.

A NASA-funded team is:

The lead scientist, called a principal investigator, and various others who receive NASA funding and are directly responsible for delivering the application.

A Partner is:

Often, "partner" is used generically for any audience involved in some way with an application project. But "Partner" – with a capital P – is used for institutions that have a formal, legal agreement with NASA.

Co-developer or collaborator

People and institutions that work actively with a NASA-funded team to create an application and seek to transition it to their own environment.

User or end user

People and institutions who work with NASA scientists and grantees on data, tools, research, and other applications.

- In the Earth Action context, "user" and "co-developer" are used interchangeably. "User" is the term referenced most frequently in this Guidebook.
- In other contexts, "user" may refer to those who consume data and tools but do not work actively with NASA.

Decision-makers

People or institutions with power to take action based on information and analysis provided by an application. In some circumstances, the decision-maker and user (or co-developer) may be the same.

Stakeholders

People or institutions with a vested interest in an application, especially its benefits. They may play a role in expanding its use and ensuring it is sustained.

EARTH DATA FOR LOUISIANA'S OYSTER INDUSTRY

The following example illustrates the roles and responsibilities of the various partners involved in an application.

NASA-funded application team: Researchers at the University of Louisiana at Lafayette develop an application to enhance real-time monitoring of water quality, algae blooms, and aquatic habitats.

Co-developers/Users: Coastal Protection and Restoration Authority, Louisiana Department of Wildlife and Fisheries, and Louisiana Department of Environmental Quality use water quality products to support their routine monitoring and habitat assessment.

Decision-maker: Louisiana Department of Health, which issues public health alerts when needed.

Stakeholders: Companies and conservancies that manage oyster beds know when harvesting must be suspended.

Partners: The Louisiana Harmful Algal Bloom Taskforce, a partnership of universities, government agencies, conservation groups, and others, supports communications, research, and monitoring.

1.2.3 Examples of Ways Partners Use Earth Observations (EO)

NASA Earth Action works with partners from federal, state, and local government, the private sector, nonprofits, and communities. Alongside those directly funded by NASA, a range of other people and institutions may engage with an application, at varying levels of involvement.

Municipalities

Miami-Dade County is trying to reduce deaths from extreme heat by using satellite data together with census and health data to pinpoint areas at greatest risk. The information is being used to train first responders, improve public heat advisories, and target tree planting locations.

States

North Dakota county officials are collaborating with NASA and the regional office of NOAA's National Weather Service to track satellite-derived data on snow water equivalent and soil moisture to improve forecasting and reduce risks to communities in the highly flood-prone Red River Basin.

Federal Government

The US Department of Agriculture relies heavily on NASA Earth observations to monitor drought, crops, and other agricultural conditions. A user-friendly tool called Crop-CASMA visualizes soil moisture and vegetation data to help farmers decide where and when to plant crops.

US State Department

Analysis from FEWS NET, the Famine Early Warning Systems Network, guides decisions on the U.S. government's humanitarian assistance program. FEWS NET forecasts food insecurity in 40 countries based on satellite data and analysis of commodity prices and livelihoods.

Citizen Scientists

Bird watchers across the United States team up with researchers at Cornell University's eBird project to share their sightings through a mobile application. Their observations are combined with NASA MODIS (Moderate Resolution Imaging Spectroradiometer) data to track avian populations throughout North America.

Private Sector

The consulting firm BGC Engineering created new models for data from the NISAR (NASA-ISRO Synthetic Aperture Radar) mission to help American pipeline, mining, energy, and transportation companies manage infrastructure risks. These models enable the companies to evaluate infrastructure resilience to geotechnical hazards (e.g., landslides, sinkholes and earthquakes) and hydrotechnical hazards (e.g., riverbank erosion and flooding).

Non-Governmental Organizations

Conservation International integrates satellite-derived water data in a freshwater health index tool that local authorities use for decisions on water management, including fresh water for human consumption, fishing, tourism, and other economic benefits.

Federally Recognized Tribes

The Chickasaw and Choctaw Nations in Oklahoma are working with NASA and others to adapt an existing tool to monitor drought severity and improve water management in their communities. First co-developed with the Navajo Nation, the tool provides data and visualization resources to strengthen Tribal decision-making and increase their resilience to droughts.

1.2.4 Program Manager Insights on Success

What makes for a successful Earth Action application? We asked NASA Earth Action team members for their perspectives.

When you say what defines success, maybe it's a change in policy that was informed from Earth observations. Maybe it was the improvement in some decision support tool. Maybe it was an improvement in management of forecast decisions, such that the partner can directly say, 'Thanks to working with NASA, thanks to utilizing Earth observations, our forecast decisions, our management decisions, our policy decisions are better today for it.' And this improves society, this benefits society. At the end of the day, success is defined with the partner saying, 'Our needs are answered, and society has benefited from it.'

John Haynes
NASA Earth Action's Program Manager for Health and Air Quality

You need to have this end user component so that we are actually working with an institution or institutions outside NASA that need these products to do their jobs, do their work better, so that we are helping them do a better job. So much so that there is long-term sustainability in those applications that we develop. By that, I mean there is a willingness on the part of the end users or partners to continue using the data or continue working with these operational tools or these decision support tools - that we funded at the outset - after our funding has elapsed.

Woody Turner
NASA Earth Science Division's Program Manager for Biological Diversity

There's a lot of different definitions of success when it comes to applications, and at the basic element of it, it's making sure that NASA observations are being used for practical decision-making, that users are involved in the development of solutions that are being developed for them, and that people can use and access NASA data.

Erin Urquhart
NASA Earth Action's Program Manager for Water Resources

Section 1.3 Learn about Earth Data and Remote Sensing

1.3.1 The Value of Earth Data & Remote Sensing

Satellite-derived Earth observations touch the lives of millions of people every day.

From water quality warnings to crop assessments, hurricane forecasts to wildfire response, remotely-sensed Earth data strengthens our ability to manage complex challenges- and much more can be done to expand their use.

This section explores the many ways Earth Action applications are helping governments, researchers, businesses, and community groups deliver on their missions.

1.3.2 How Earth Observations EO

NASA data are useful across sectors ranging from agriculture and disaster management to energy use and health to finance risk management and security. They provide evidence that empowers leaders in these sectors to make decisions to advance their work. Examples of decisions include:

- Policy, legal, and regulatory frameworks
- Planning, management, and response
- Monitoring and tracking impact
- Alert systems and other information for the public, among many others

Here are some examples of how EO supports decisions:

Pinpointing Agricultural Water Use

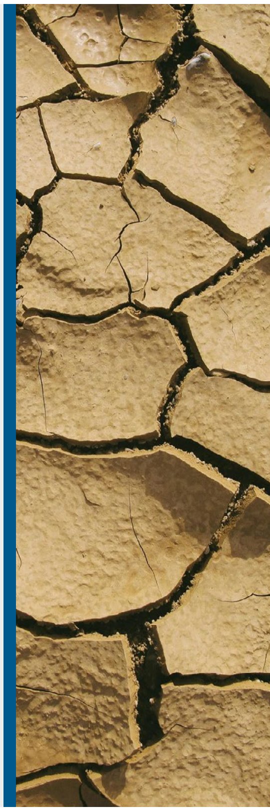
With more frequent droughts across the United States, water managers and users need resources to help balance supply and demand. The publicly available OpenET online platform uses satellite data to quantify evapotranspiration (ET), the process by which water moves from the land to the atmosphere.

OpenET can determine the amount of water consumed by crops and other vegetation through ET at the level of individual fields (30 m). This information supports data-driven irrigation management, incentive-based water conservation programs, sustainable groundwater management programs, and quantification of vegetation water stress and wildland fire risk.

OpenET data also support improvements in watershed-scale water budgets that anchor long-term planning to ensure reliable water supplies for communities, agriculture and wildlife. OpenET's transparency and accuracy help foster collaboration among stakeholders working to increase the long-term sustainability of our water supplies.

Application Data Sources: Landsat, Terra, Aqua, GOES, and other satellites

Visit OpenET's Youtube channel to learn more.



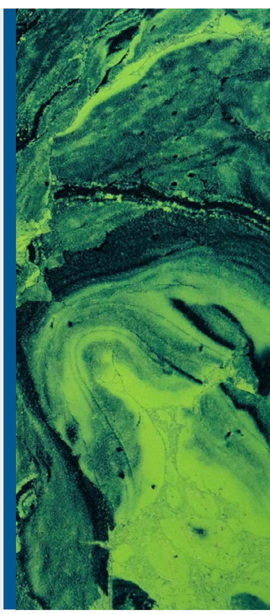
Early Warning on Dangerous Algae

The Cyanobacteria Assessment Network (CyAN) uses satellite data to prevent people, pets, and livestock from exposure to sickening bacterial blooms. Multiple states use CyAN to help monitor drinking water, recreational areas, and other sources, often detecting blooms sooner than they could with traditional observations. The data helps them decide where to focus sampling resources and when to issue alerts.

In one case, CyAN's detection of a bloom in a Utah recreational area - just before a busy holiday weekend – saved an estimated $370,000 in health costs. CyAN is managed by a multi-agency team led by the Environmental Protection Agency.

Application Data Sources: Sentinel-3, ground data

Visit the EPA's website to learn more.



Wildfire and Landslide Response

Remote sensing data was key to response efforts during the June 2025 Trout Fire and Seven Springs Fire in New Mexico. Through its Disasters Response Coordination System, NASA provided wildfire imagery, burn severity data, and landslide risk analyses to help state officials identify risks to life, property, and critical infrastructure as well as future threats of flooding in burned areas.

NASA's Landslide Hazard Assessment for Situational Awareness (LHASA), which leverages the latest machine learning techniques, provided "nowcasts" to identify when and where landslide risk was elevated, and which populations and infrastructure might be affected.

Application Data Sources: Landsat, Sentinel-1 SAR, Sentinel-2, Planet Labs, Global Precipitation Measurement (GPM), Soil Moisture Active Passive (SMAP), Suomi NPP VIIRS FIRMS, and ISS Crew Earth Observation (photography)

Visit this NASA article to learn more.

Measuring Solar Energy to Support National Defense

Saildrone, a California company, builds and operates wind- and solar-powered uncrewed craft that can stay at sea for up to a year. The company used NASA's Prediction of Worldwide Energy Resources (POWER) data to forecast solar energy and plan routes, payloads, and operating seasons.

Saildrones support U.S. national security by providing surveillance, reconnaissance, and intelligence at sea.They are also used to collect weather and ocean data, map the seafloor, and track wildlife. Energy forecasts developed using POWER data contributed to uninterrupted operations in challenging and unpredictable environments.

Application Data Sources: Data come from GPM IMERG, GMAO MERRA-2, GEOS-IT and a variety of energy flux products, which are modeled into tailored, analysis ready datasets.

Visit the POWER website to learn more.

1.3.3 More Examples of EO and Decision-making

Learn more by visiting these videos and story maps.

- How NASA Data Stabilizes Global Markets
- Helping Communities Protect Drinking Water
- Mapping Animal Movement Story Map from Duke University

Visit the Earth Information Center to learn more.

1.3.4 Learn About EO

Earth observations leverage the unique vantage point of space to deliver information on the planet's complex systems. Those observations are remotely sensed by instruments mounted on satellites, spacecraft, and aircraft. A wide range of organizations including space, weather, and other government science agencies and commercial entities manage instruments that provide Earth observations.

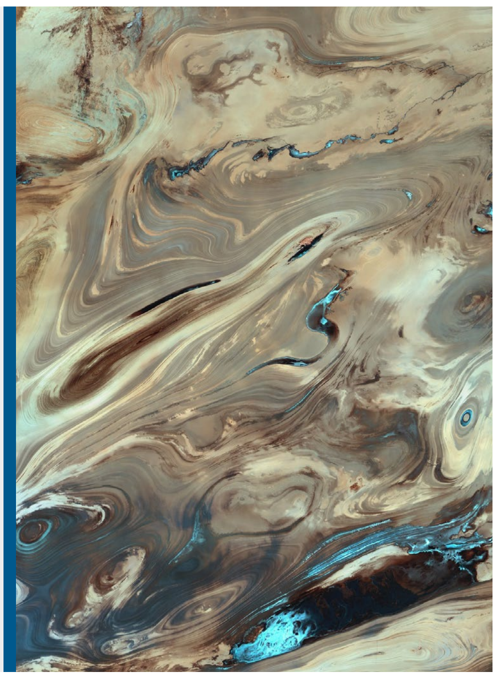
"The aggressive pursuit of understanding Earth as a system—and the effective application of that knowledge for society's benefit—will increasingly distinguish those nations that achieve and sustain prosperity and security from those that do not."
- National Research Council, 2005

Learn more about remote sensing

- NASA Earthdata
- NASA Applied Remote Sensing Training (ARSET) Program courses

Places to find Earth data

- NASA Earthdata
- Earthdata Search
- NASA Worldview
- JAXA Observation/Result Research Database
- ISRO Bhuvan Geoportal
- ESA Copernicus Space Data Ecosystem
- ESA Earth Online
- CEOS Data and Tools



1.3.5 Satellite Mission Partnerships

NASA's Earth Science Division coordinates independent and joint satellite missions for long-term global observations of the land surface, biosphere, solid Earth, atmosphere, and oceans.

These include partnerships with space agencies from other nations, which promote scientific progress and enhance peaceful relationships.

Here are some examples of international partnerships:

Landsat

Run jointly with the U.S. Geological Survey, the Landsat program comprises nine satellite missions dating back to 1972. The latest, Landsat 9, was launched in September 2021.

Sensors such as the Operational Land Imager and Thermal Infrared Sensor provide moderate resolution imagery on land use and land change across areas as varied as forests, coral reefs, cities, and disaster zones.

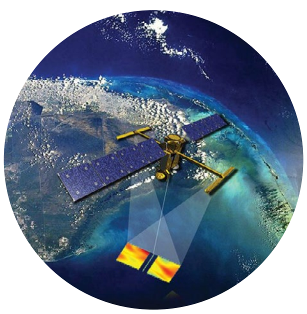
Visit the Landsat page to learn more.

NISAR

Launched in July 2025 with the Indian Space Research Organisation, the NISAR (NASA-ISRO Synthetic Aperture Radar) satellite mission will track subtle changes in Earth's surface caused by natural processes and human activity.

By detecting movements as small as a few millimeters, NISAR will help scientists improve forecasts for earthquakes, landslides, and volcanic eruptions. NISAR's frequent, global coverage will enable rapid disaster assessment and more effective response and recovery.

Visit the NISAR page to learn more.



SWOT

The SWOT (Surface Water and Ocean Topography) mission is the first satellite to conduct a global survey of Earth's surface water, including oceans, lakes, and rivers. By capturing detailed measurements of water levels and surface topography, SWOT will improve understanding of how water moves through and shapes our planet.

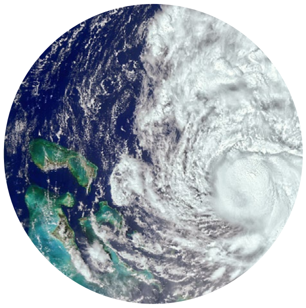
This data is essential for monitoring climate change, managing freshwater resources, and studying ocean circulation. SWOT is a collaboration between NASA and France's Centre National d'Études Spatiales (CNES), with additional support from the Canadian and UK space agencies.

Visit the SWOT page to learn more.

Sentinel-6 Michael Freilich

This joint U.S.-European mission will support a decades-long effort to measure global ocean height from space, which is vital to understanding melting glaciers, rising ocean temperatures, and sea level rise. A secondary objective is to measure temperature and humidity in the troposphere. The first satellite launched in 2020; a second launched in November 2025. NASA is working with the European Space Agency, European Organisation for the Exploitation of Meteorological Satellites, and National Oceanic and Atmospheric Administration. The European Commission and France's CNES are also providing support.

Visit the Mission page to learn more



PACE

Launched in 2024, the Plankton, Aerosol, Cloud, Ocean Ecosystem (PACE) mission is designed to monitor ocean health, air quality, and climate. Its advanced sensors collect detailed data on phytoplankton diversity, atmospheric aerosols, and cloud properties. PACE's observations help scientists, environmental agencies, and resource managers understand climate change, track harmful algal blooms, and help improve weather and air quality forecasts.

PACE is supported by NASA with contributions from a consortium led by the Netherlands Institute for Space Research (SRON) and Airbus Defence and Space Netherlands as well as the National Oceanic and Atmospheric Administration (NOAA) and University of Maryland.

Visit the PACE page to learn more.

1.3.6 Collaboration and Open Data

Since the transformative moment in 2008 when the U.S. Geological Survey made Landsat data available to the public at no cost, collaboration and data-sharing have delivered huge benefits.

Today, all U.S. government agencies, along with many international agencies and some private companies, make their data free and open. NASA's Science Mission Directorate mandates that all scientific information produced with NASA funding be made publicly available without cost or restriction, as allowed by law.

Here are some benefits of collaboration and open data:

Data democracy

Open data, automated models, and freely available online training are empowering more people to engage with Earth data and applications, whether or not they are scientists.

Cooperation across disciplines

Cross-disciplinary and interdisciplinary cooperation is helping experts come together to address complex problems related to water scarcity, food insecurity, and air pollution, among others.

Standard data formats

While standardization is still a major challenge, increasing collaboration on data collection and analysis is making it possible to compare data and model outputs across oceans, landscapes, and airspace.

1.3.7 Advantages and Disadvantages of Satellite Data

Earth observations are expanding scientific knowledge exponentially. Innovations in remote sensing, such as CubeSats and hyperspectral imaging, artificial intelligence and machine learning, and advanced computational capability are just a few of the new technologies driving change. These capabilities, together with the increasing number of individuals and institutions able to use them, suggest that the future potential of Earth data likely goes beyond what we can currently imagine.

But satellite data are not perfect, nor are they 100 percent certain. Like all data, they come with limitations. Generally, remotely-sensed data adds greatest value when combined with in situ observations, other ground data, and spatial information. These additional sources support calibration and validation of sensors, algorithms, and models. That helps reduce uncertainty and assure data quality.

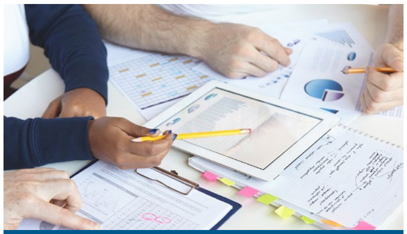
Advantages	Disadvantages
Data are available and comparable over large areas.	Because of the nature of orbits, satellite measurements are typically available once or twice per day. Ground sensors may monitor continuously.
Satellites typically revisit places with a known and consistent frequency, which may be helpful in areas that otherwise rely on manual recording of ground observations.	Most satellite sensors cannot see through clouds. (Microwave remote sensing, such as synthetic aperture radar, is an exception.)
Satellites provide information on remote and understudied locations.	Satellite imagery often depends on the detection of color.
Free, accessible imagery and datasets allow for low-cost monitoring and analysis.	Atmospheric phenomena may distort measurements.
Decades of archived data enable long-term analysis of change over time.	Satellites only have historical observations for the years in which they were in orbit.
Space asset providers are increasingly committed to maintaining the continuity of datasets and products.	Satellite sensors may fail and are not easily replaced.
Improved data delivery and processing allow for more near-real time observations.	Non-technical specialists may not find satellite-derived products easy to use.
Satellites offer a wide variety of data at various resolutions.	
The trend toward automated processing and analysis-ready data products increases accessibility of satellite information.	

DEVELOP AN EARTH ACTION PROPOSAL

Key Takeaways

Is Earth Action Right for Your Proposal?

- Earth Action projects involve collaboration with a specific user or users and aim to transition the application to the users' environment.
- Before submitting a proposal, ensure that your science, methods, and approach align with Earth Action's mission of delivering user-centered, solutions-driven outcomes.
- Earth Action projects can be visualized as a pathway moving forward on three concurrent tracks centered on people, science, and management.
- Earth Action proposals ask for a description of the project's maturity using a 9-step index: the Application Readiness Levels (ARLs).



Main Topics

- Developing a proposal for NASA Earth Action funding
- Guidance on unique aspects of Earth Action projects
- Strategies to meet and engage users
- Tips specific to Earth Action proposals

Engaging Users

- Relationships with users are the cornerstone of Earth Action proposals: trust, transparency, and shared goals are essential.
- Successful applications grow out of genuine collaboration with users at the proposal stage, anchored in close listening and co-design.
- Proposals should demonstrate an appropriate use of existing science and clear understanding of how the proposed application will address the user's needs.
- The proposal must describe the application's technical feasibility and how it will fit within user workflows so that it can be adopted and transitioned into the users' environment.

What Goes into a Strong Proposal

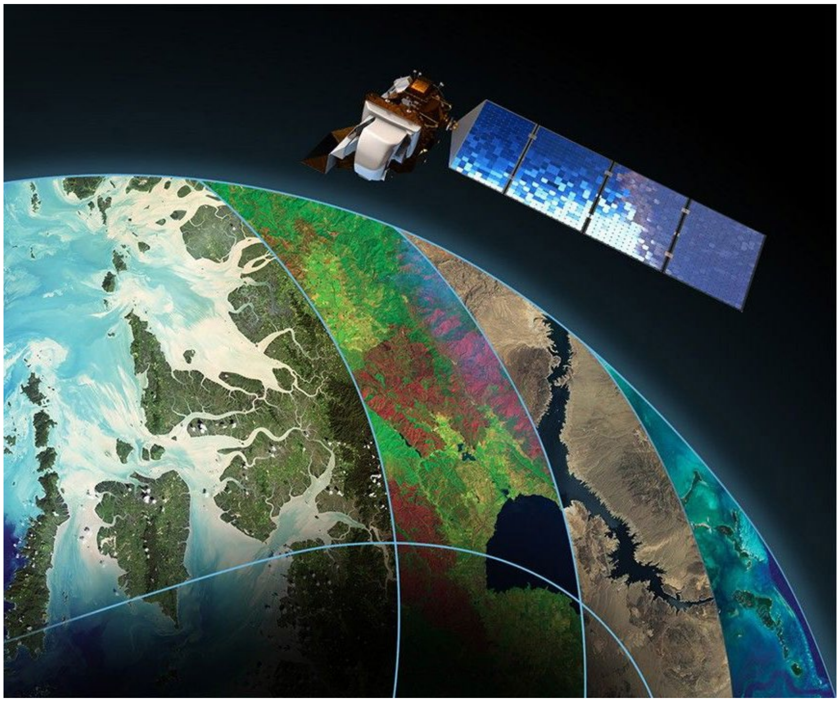
- A strong proposal describes sustained collaboration with a specific user or users to help address a specific decision or challenge they face.
- Reviewers look for a compelling rationale for the application, a concrete explanation of how the science will address a specific challenge, a credible sustainability plan, and likelihood of impact.
- NASA Earth Action defines impact by the extent of application use, positive benefits for users and others, and practical actions to improve users' decisions. Proposals should clearly explain the anticipated impact and how it will be measured.
- Teams should be multidisciplinary, adaptable, and skilled in technical and non-technical skills, such as communications and user engagement.

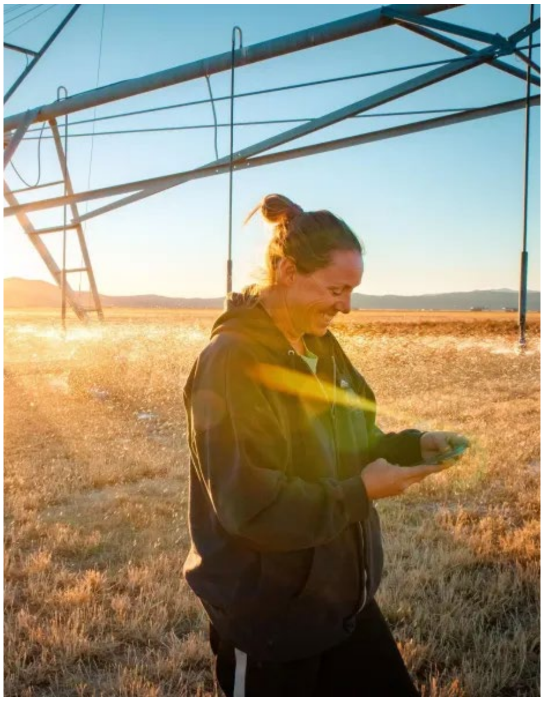
Section 2.1 Is Earth Action Right for Your Project?

2.1.1 What Makes Earth Action Unique

Earth Action connects existing science to needs of a specific user or users, empowering them to make data-driven decisions.

All proposers should start their funding search by confirming: Is NASA Earth Action the right place to seek funding? Ensuring that your goals align with Earth Action is the first step in building a successful proposal.





Doug Morton
Earth System Scientist at Goddard Space Flight Center

Here is Doug Morton's perspective on Earth Action proposal readiness:

"One of the most important elements to be successful in a proposal is to be able to easily articulate why now, why this approach, and who is going to use it. If you can capture those ideas in just two sentences, then you're ready to write an Earth Action proposal."

2.1.2 From Earth Science Research to EA

Applied science projects evolve out of fundamental Earth science research and connect that science to user needs.

	EARTH SCIENCE RESEARCH	EARTH ACTION
GOAL	Expand knowledge + understanding of the Earth system	Use remotely sensed Earth data to solve specific, practical problems
SCIENCE AIM	Answer a scientific question	Apply NASA science and data for a practical use
NATURE	Observational, analytical, computational	Collaborative, driven by user needs
RESULTS	New insights, methods, measurements	New tools, products, processes, services – often run in user environment

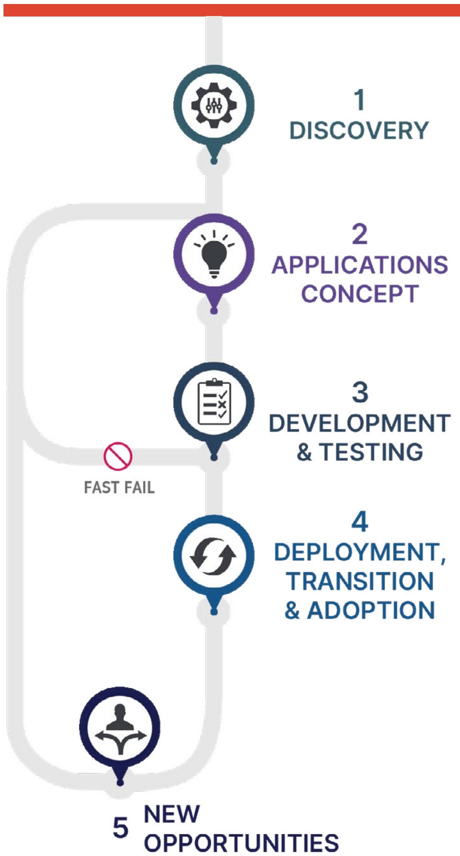
2.1.3 Research in Action – Flood Risk Example

This graphic illustrates how NASA Earth Action goals are met through an application project. This NASA-funded effort, led by Avantika Gori, Assistant Professor of Civil and Environmental Engineering at Rice University, is helping Texas decision-makers manage and prepare for hurricane-related flood risks to transportation infrastructure.

	EARTH ACTION GOALS	FLOOD RISK APPLICATION
GOAL	Use remotely sensed Earth data to solve specific, practical problems	Help local responders avoid flood damage to transportation and other infrastructure
SCIENCE AIM	Apply NASA science and data for a practical use	Use NASA soil moisture data* to improve flood models and strengthen hazard and risk projections
NATURE	Collaborative, driven by user needs	Co-development with a regional organization that supports local governments
RESULTS	New tools, products, processes, services – often run in user environment	Accessible, actionable maps identifying transportation and other infrastructure at risk of damage

* These data include: Integrated Multi-satellitE Retrievals for the Global Precipitation Model (IMERG), Soil Moisture Active Passive (SMAP) microwave data, and high-resolution optical imagery.

2.1.4 EA Applications Pathway



Fast fail

Application not viable. Review discovery findings and application concept.

In general, Earth Action projects can be visualized as a pathway moving forward on three concurrent tracks. These center on people, science, and management.

Every project will unfold differently – especially in terms of the time required to develop a functional application – but there are some common steps.

PEOPLE

Step 1: Discovery

- Build relationships
- Understand user needs
- Engage others in your concept
- Be open to skepticism

Step 2: Applications concept

- Iterate with users
- Listen to feedback
- Affirm their commitment
- Agree on a collaboration approach

Step 3: Development and testing

- Collaborate with users
- Prioritize their needs
- Communicate about data opportunities and limitations

Step 4: Deployment, transition, and adoption

- Build user capacity
- Provide ongoing support

Step 5: New opportunities

- Stay in touch with users
- Improve the application
- Work with new users to replicate and scale

SCIENCE

Step 1: Discovery

- Listen and understand user needs
- Assess how your work can fill those needs

Step 2: Applications concept

- Formalize the concept
- Consider requirements to sustain the application
- Modify and adapt

Step 3: Development and testing

- Create a prototype or demonstration
- Iterate and reiterate
- Ensure users will use and be able to sustain the application
- Automate outputs when possible

Step 4: Deployment, transition, and adoption

- Ensure the application runs smoothly in user environments
- Troubleshoot and refine

Step 5: New opportunities

- Publish new papers
- Pursue related research questions
- Identify new applications

MANAGEMENT

Step 1: Discovery

- Define objectives
- Identify opportunities (e.g., funding, partnerships)

Step 2: Applications concept

- Develop a project plan or proposal
- Choose a project management approach
- Build a team with diverse skills

Step 3: Development and testing

- Motivate the team
- Plan for training, support on data management, and sustainable infrastructure
- Communicate progress with others

Step 4: Deployment, transition, and adoption

- Support users during adoption
- Invest additional human/financial resources as needed to get over implementation hurdles
- Evaluate impact
- Communicate stories and share results

Step 5: New opportunities

- Apply and share lessons learned

2.1.5 Key Elements of EA Proposals

While each Earth Action solicitation is unique, they typically require three elements not included in other NASA proposals:

- Users' active engagement throughout the application lifecycle
- Clarity on how the science will strengthen a user's decision-making
- A concept for sustaining and/or transitioning the application to the user's environment

In some solicitations, specific plans are required. Others ask for a detailed discussion of the elements. Note that these requirements are in addition to standard NASA proposal elements, such as a scientific/technical/management section and open data plan, among others. Most ROSES solicitations provide a checklist to help you understand the structure and required elements of a proposal.

Here are two excerpts from recent NASA Earth Action solicitations:

Ecological Conservation, 2024

3-page End User Description Form covering:

- Roles and responsibilities of users
- Detailed schedule for engagement with users
- How users will integrate project products in decision-making
- How user will measure success
- User authority and capacity to use the project products
- User hosting and management of the project products during and after the project

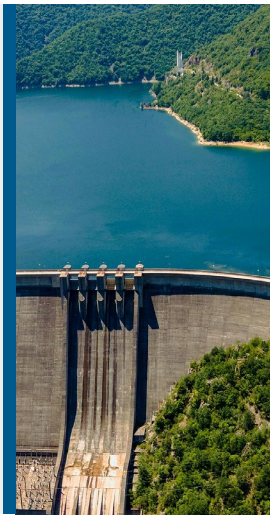
Review the complete solicitation.

Water Resources, 2025

Requires detailed narrative on:

- User engagement and needs assessment through the project lifecycle
- Solution development and testing based on co-development
- Implementation and evaluation emphasizing user adoption and sustainability
- Includes early stage (Type 1) for ARLs 2-4 and advanced stage (Type 2) for ARLs 5-8/9. Type 2 requires a formal plan to transition the application to the user.

Review the complete solicitation.



2.1.6 More EA Solicitation Examples

Select the images to review more examples of Earth Action solicitations.

Water Quality 2025

Disaster Risk Reduction, Recovery, and Resilience, 2024

Health and Air Quality 2024

2.1.7 Application Readiness Levels (ARLs)

NASA Earth Action proposals ask for a description of the maturity of the project using a 9-step index: Application Readiness Levels (ARLs). Adapted from NASA's Technology Readiness Levels, the ARLs measure and track an application's progress.

All Earth Action proposals are expected to have exceeded Step 1: Basic Research. After that, solicitations typically specify that projects should be at one of two stages of development:

Early Stage

Projects to develop new applications that:

- Start with a well-proven algorithm
- Test feasibility and proof-of-concept, or create an early prototype
- Begin at ARL 2 or 3, and aim to advance at least one ARL per year

Advanced Stage

More mature projects aiming for deployment in a user's environment and sustained use by decision-makers, starting at ARL 5 or higher based on whether the project has:

- Defined the application with end users (ARL 2)
- Conducted feasibility and proof-of-concept work (ARL 3)
- Co-developed and tested a working prototype (ARL 4)
- Aims to reach ARL 8-9 by the end of the project
- Includes a plan to transition the application into sustained decision-making

2.1.8 ARLs and the Applications Pathway

ARL 1	Basic research	DISCOVERY, CONCEPT, AND FEASIBILITY
ARL 2	Invention: Application concept	
ARL 3	Viability established: Proof of application concept	
ARL 4	Prototype/plan: Initial integration and verification	DEVELOPMENT, TESTING, AND VALIDATION
ARL 5	Potential determined: Validation in relevant environment	
ARL 6	Potential demonstrated: Demonstration in relevant environment	
ARL 7	Functionally demonstrated: Application prototype in partner's decision-making	DEPLOYMENT, TRANSITION, AND ADOPTION
ARL 8	Functionally proven: Application completed and qualified	
ARL 9	Sustained use: Approved, operational deployment, and use in decision-making	

2.1.9 Why Get Involved in Earth Action

We asked two NASA scientists about why they value their work on Earth Action applications.

It's exciting to see folks whose eyes just light up seeing a new way of looking at something that they can't really monitor very well now. And how real that is for them. In the algorithm development space, you often feel a couple steps removed from people actually using the products and you hear feedback at conferences and things, but this felt much more immediate. So that was exciting.

I've made the case many, many times that remote sensing helps to monitor poorly observed parts of the world because I know that in theory, but hearing them actually talk about what that means for them in practice, how expensive it is to get to some of these places, how little information they have across a lot of parts of Alaska on important hydrologic targets really shed a lot of light on that for me. It was very meaningful just seeing an idea go from the beginning to actually being used in a small but important application for them.

Michael Durand
Professor,
Ohio State University

I think by doing applied work you ultimately will improve your research because I think sometimes we're in our little niche and we're so focused on, if I can just improve this part or if I can just change this or I just develop a model to do this. But unfortunately, sometimes you get all the way to the stakeholder and that thing actually isn't really moving the needle, right? So if you want to be a researcher who does really high impact research, ultimately the impact, a measure of the impact is also: is it benefiting society? And if you're not doing any applied work, it's kind of hard to understand, like, draw that line: is this really niche thing that I'm focusing on, what actually is the impact of this thing beyond my immediate field?

Avantika Gori
Assistant Professor,
Rice University

2.1.10 If an Earth Action Project is Not for You

Aside from leading a project, Earth Action offers many other ways to get involved. Find out what's happening through newsletters, social media, and EO community events. And consider these types of engagement:

Short-term

- Share data or model output with an application team
- Advise a 10-week EarthRISE Developers Academy project
- Provide expertise to the Earth Action Disaster Response Coordination System during an activation
- Take an Applied Remote Sensing Training (ARSET)

Medium-term

- Be a co-investigator (funded or unfunded) or collaborator on an application project
- Become an Early Adopter on a new mission
- Join a community of practice. For example, the Earth Action Health & Air Quality Applied Science Team has regular community meetings, communicated through their newsletter.

To learn more, visit the For Researchers section of the NASA Earth Science website as well as Earth Action website program pages. You can also reach out to Earth Action contacts provided on this NASA program officers list.

Section 2.2 Is Earth Action Right for Your Project?

2.2.1 The Role of Users in Proposals

Earth Action's emphasis on user-centered applications is at the heart of its funded solicitations.

Earth Action proposers must demonstrate:

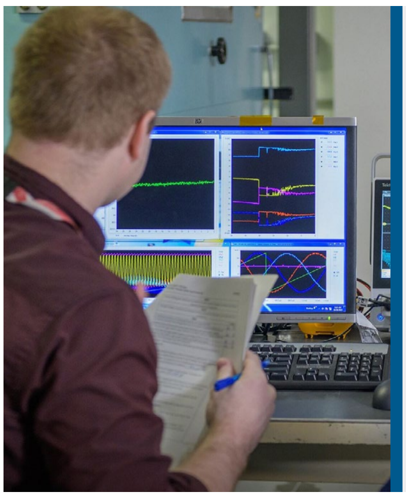
- A clear concept of how NASA science will help a specific user or users make better decisions
- Detailed understanding of the user's needs, reflecting the real challenges and actual workflows of their decision-making processes
- A vision for how the collaboration will work, outlining practical steps for co-development and sustained engagement
- Definitions of success and value, fully shared by the user

This level of detail cannot be captured in one meeting with a potential user or an exchange of emails – it requires an investment in relationships and trust-building.

2.2.2 From Systems Engineering to Design Thinking

For decades, systems engineering has been the standard NASA method for designing and managing missions and applications. Today, NASA Earth Action enhances this approach by engaging users in collaborative processes such as design thinking and co-development.

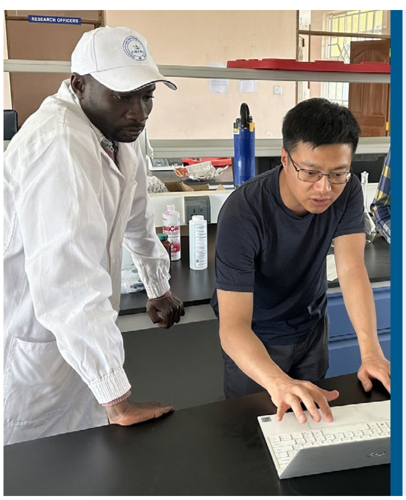
The blend of user-centered approaches with the rigor of traditional engineering makes for a stronger Earth Action proposal.



SYSTEMS ENGINEERING

Systems Design | Product Realization | Technical Management

- Requirements driven
- Technical requirements documented early
- Application designed to meet specifications
- User engagement at critical points
- Testing, verification, and validation to refine design
- Progress to next phase determined at key decision points
- Phases are usually anticipated

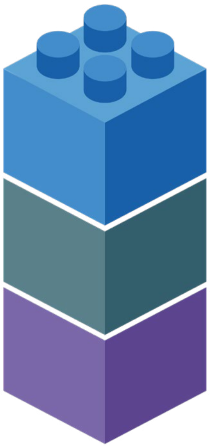


DESIGN THINKING

Empathize | Define | Ideate | Prototype | Test

- Human-centered, co-creative
- Deep exploration of users and their challenges
- Goals defined together with users
- Solutions shaped and reshaped iteratively with users
- Prototyping and testing to learn, adapt, and improve
- Activities and outcomes evolve
- Phases tend to be dynamic; may occur concurrently or repeat

2.2.3 Three Building Blocks for Proposals



3 **Fit the science to the problem**

2 **Listen closely to uncover the real, specific challenges**

1 **Relationships with users are the starting point**

1 Relationships with users are the starting point

Proposers are expected to collaborate with users to develop a proposal. That process is much easier when a proposer has relationships before the process starts. Ideally, scientists spend time getting to know potential users and their community long before a solicitation is announced. Even if the connections start at the time of the proposal, meaningful collaboration on the proposal and throughout the application lifecycle is essential.

Scientists' perspectives on relationships with users as the starting point:

I realized this is very hard for the early career researchers because they just got started. They are in the process of building the network. But I think based on my experience, my suggestions would be: don't wait until you have a fully formed project idea - just to start small, even just to participate in a project focusing on application or have some conversations with end users with state agencies, federal agencies to see: what are their needs? What is their challenge? These types of conversations can help early career researchers even form a project idea. This is how I started.

Bingqing Liu
Assistant Professor,
University of Louisiana at Lafayette

I think there has to be some prior background or relationship already established rather than this being an afterthought. I mean, I see that a lot and sometimes when I review proposals, it's like, okay, the expertise is there. The ideas are good. But there hasn't been enough time or effort spent in building those bridges and relationships with the end users and you just kind of grab someone and show it in your proposal so that you could show you have an end user in place. So I would highly recommend that the PIs, young PIs, spend some time building their relationships and their profiles with these end user agencies.

Faisal Hossain
Professor, University of Washington Department of Civil and Environmental Engineering

2 Listen closely to uncover the real, specific challenges

Dialogue and exchange with users will determine the specific ways the application can strengthen their decisions. This means:

- Close understanding of their goals - and the obstacles to those goals
- Detailed perspective on their workflows; for example: how and what data they use already, and what human and technical resources they have to integrate a new application
- Clear communication of data limitations and what is required by the user with respect to data formats, latency, and other parameters

Scientists' perspectives on listening closely to uncover the real, specific challenges:

When you have an idea for how your science could be useful to external users, and you want to collaborate with them, or they approach you with a need, you really need to iterate with them to bring your science to a point that it's useful to them.

You have to understand their skills and how they could use the NASA science, and you need to understand the format that the data would be and the art of the possible. So it's not a fast process. You need to start working well in advance or find somebody who already has a relationship with end users relevant to your science.

Stephanie Schollaert-Uz
Applied Sciences Manager, Goddard Space Flight Center

If I sit down with people and I ask them to tell me what's important to them, then what's really important to us as a team is to be able to turn around what they've shared and show back to them 1) that we've understood what they've said and 2) that we can integrate what they've shared into our project objectives - and try to reflect that back immediately.

When you're early in the project, part of the growth of trust is when people tell you what's important to them. You need to then re-present to them what you are learning and hearing and say, am I getting this right? So give them lots of chances to understand and provide that input and then show that you genuinely understood by addressing the points that they brought up.

Scott Davidoff
Human-centered designer, Space Science Institute

3 Fit the science to the problem

Established applied scientists often caution new application developers against being "a hammer in search of a nail." In other words, collaboration should not be driven by a scientist's desire to promote a dataset or model, but by the need to address a user's problem. In some cases, the solution will be a tested, conventional approach – not the latest, cutting edge technology.

This is especially important when the goal is to transition an application to a user's environment: ultimately, users must be able to maintain the data and related infrastructure, as well as the required human and financial resources, into the future.

Scientists' perspectives on fitting the science to the problem:

A real critical element of success is when we can enable and empower other people. And I think that sometimes that means less is more. Sometimes, we have to be able to develop at the level that [end users] can consume and use the information and then that enables them to learn and grow, as opposed to trying to push all the information, or the latest information into a situation where they don't or can't use it – even though it may be the best information and best model available.

If it is not usable by the end user, it is not going to have the impact that it could have.

Jim Nelson
Brigham Young University, Professor of Civil and Environmental Engineering

You can target the most fancy, fantastic tools, but their utility will be limited if the user doesn't know how to properly use them, or have access to proper training and support. We strive to develop straightforward and easily adoptable tools so users can really lean on that technology for their decision-making needs.

As a PI, a key to ensuring successful adoption of applications is to carefully understand exactly what the user needs and capabilities are. What is their level of understanding? What is their state of the art? The fun part is trying to efficiently match those needs and capabilities.

John Bolten
Chief of Hydrological Sciences Laboratory at Goddard Space Flight Center

2.2.4 Engaging Users in a Proposal

The foundation for an Earth Action proposal is a relationship between project team and user based on trust, transparency, and a shared sense of potential value.

There are five potential tasks related to engaging users and developing a proposal:

- Know the territory
- Reach out and listen
- Frame the challenge together
- Co-design the solution
- Formalize the proposal

It is most relevant to new collaborations at the Discovery phase. (This is described in the previous section on the Applications Pathway, corresponding to ARLs 1 and 2.) Yet, these also represent good practices for proposal processes at later stage ARLs.

The following pages describe each task.

2.2.5 Task 1: Know the Territory

If you have never collaborated with users, you will need to invest time learning about them.

Start by exploring and learning. Familiarize yourself with the organizations whose missions align with your area of interest and expertise. Consider federal, state, and local agencies, as well as the private sector, non-profits, and community groups. Note their mandates, current use of Earth information, and current partnerships. To tackle this review systematically, consider approaches such as a landscape scan, gap analysis, or situational analysis.

Once you have a good sense of the landscape, start connecting with users. The best way to do that is to go to them: find the venues where they spend their time, read what they read, and get to know their professional community.

Here are some entry points for finding users:

Who do you know?

Before reaching out, learn about existing relationships. Find out if your colleagues are already in touch or if you have contacts in common. Tapping into established connections is a great way to jumpstart a relationship. Otherwise, you run the risk of duplicating efforts or competing with them. Remember, too, that your colleagues may have worked hard to forge these relationships; respect that investment and coordinate openly with them.

Do background research

Take time for due diligence. That means reviewing what's already out there – reports, evaluations, case studies, journal articles, mainstream media, and other relevant studies. Immerse yourself in the available evidence and lessons learned so that you can build on what already exists. That contextual information will help you present a compelling argument in your proposal.

Read what your users read

Be sure to go beyond your own resources: read the trade or sector media that your potential users consume. That will introduce new ideas and help you see the issues from their perspective. It also may offer entry points for your conversations.

Go to the meetings your users attend

Unless your users are Earth scientists, they are not likely to go to American Geophysical Union or American Meteorological Society meetings. Instead, go to conferences or workshops specific to their field and learn firsthand about their challenges.

Tap NASA resources

Develop contacts with Earth Action Program Managers at NASA Headquarters and applied scientists at NASA centers. They may connect you to potential user groups or have other useful guidance.

Leverage ongoing collaborations

For your first Earth Action project, consider teaming up with researchers already working on a relevant application. That's an excellent way to get to know users and learn from others' experience.

Volunteer for review panels

Joining a panel to review proposals will not put you in direct contact with users, but you will learn about leading topics in your areas of interest and meet others working in your field.

Organize a listening tour

Targeted conversations or interviews with people in the user community can provide a sense of their interests and needs and open a door to a more substantial relationship.

Checklist: Important Things to Understand

As you engage users, work toward a clear understanding of these topics:

- ☑ **Actors and relationships**
  Who is involved, their roles, responsibilities, connections, and potential partners
- ☑ **Current activities and resources**
  Existing initiatives, capacities, and available skills, tools, or funding
- ☑ **Needs, gaps, and barriers**
  Where current efforts fall short, what users still require, and constraints or risks to address
- ☑ **Opportunities and trends**
  Emerging practices, innovations, or policy windows that could necessitate and/or motivate collaboration

2.2.6 Task 2: Reach Out and Listen

Engaging with users on their priorities and decision contexts is one of the most exciting and interesting points of the proposal process. It's where innovation and science come together to shine light on a potential solution. Getting the details right at this stage puts the collaboration on a strong footing.

It's important to keep in mind that many users manage multiple responsibilities with limited staff and budgets; they may not be able to move at your speed. Being realistic about their commitments and constraints early on will contribute to smooth collaboration later.

Another priority is asking the right questions.

How to Ask Questions

The traditional starting point for conversations with users might seem to be: "What do you need?" But application developers have learned that experiential questions catalyze dialogue on pain points, bottlenecks, and other real-life context.

This sort of exchange also creates space for setting expectations on the potential benefits and limitations of Earth science information. In general, successful applications scientists are practiced at the communications style of "Listen. Ask. Repeat."

Here are some examples of exploratory questions:

- Tell me about a day at your job. What do you spend your time on?
- What work problems keep you up at night?
- What would you like your organization to be better at?
- Tell me about a problem you haven't solved.
- What would you like to be able to do that you can't do now?
- What's a decision or action you'd like to be more certain about?
- What information don't you have now that you wish you had?
- If you had a magic wand to make something better with your work, how would you use it?

Build Rapport with Potential Users

Here are examples of good practices in connecting with potential users.

User: Please don't bombard me with information – let's just talk.
Scientist: Got it. I'll listen carefully and ask questions.

User: It seems like you only see risks and problems.
Scientist: Right. I'll highlight opportunities and solutions too.

User: It feels like you are pushing your ideas without first understanding my needs.
Scientist: Fair point. Let's co-develop ideas from the start.

User: Your science is valuable, but so is our experience.
Scientist: Absolutely. I'll respect and elevate your knowledge.

User: I don't understand or have an interest in technical jargon.
Scientist: Then I'll describe the work in clear, plain language.

User: I don't think we have the time and resources for such a big project.
Scientist: We'll start small and build toward long-term goals together.

2.2.7 Task 3: Frame the Challenge Together

A NASA Earth Action proposal must clearly describe user needs, the application of science to address them, and the resulting impact on users' decisions or work flows. This concept starts with a collaborative process to frame the challenge.

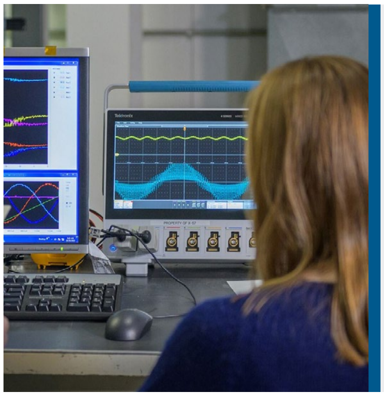
Assessment of user needs is key to understanding the challenge. At the proposal phase, the level of assessment will vary depending on factors including the depth of existing knowledge and user relationships and available human and financial resources. Often, time and resources will be tight, requiring proposers to devise a light, targeted process that still delivers the content for a compelling proposal. Here are some ways to assess user needs:

Confirm Technical Details

The early stages of getting to know a user may yield rich exchanges on broad concepts. Eventually, the discussions must delve into the detail of the application concept. These questions may help get to those specifications.

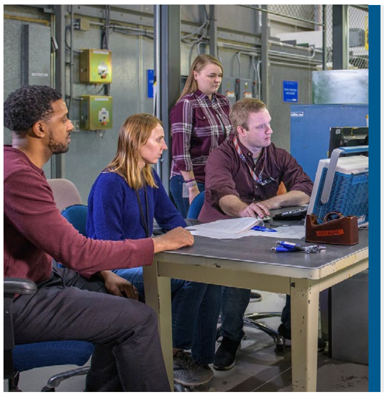
Decisions

- What decision(s) do the user organizations make?
- What kinds of analysis support those decisions?
- What types of actions do they take based on the decisions?
- What is the quality of their current decisions and actions, and what quality do they desire?
- What capacity do they have (or need) to sustain improved decision-making?



Information and models

- How frequently do they need information products to support their decisions and actions?
- How timely must those products be?
- What system of units do they use and prefer?
- What data formats do they prefer? Which can they use?
- If they are using models, what grid spacings do their models use?
- What additional capacity might they need to continue using the information products and sustaining the application?



User community

- What audiences do the users serve (that is, who are their users, clients, customers, and partners)?
- How do they support those audiences?
- How might this application help them do that better?
- How can the applications team play a supportive role in bringing the application to those audiences?
- What are the users' trusted sources of information (websites, portals, trade journals, other publications)?

Needs Assessment Tools

A structured approach to assessing needs may be helpful at the proposal stage; other times it will be more feasible and constructive after a proposal is funded. In either case, some level of exploration is required to understand both the needs and networks. This includes the people, agencies, and communities potential users serve. This familiarity will build certainty about the ways they can apply the application to their processes and workflows.

You may also learn about important audiences you hadn't considered. For example, does the agency communicate externally to the public and the media – and would they expect to share information about the application publicly? Exploring these connections together is a way to strengthen relationships and build trust.

Here are examples of structured approaches to assess user needs:

Stakeholder Mapping/Network Analysis	A visualized representation of users and their connections, with some prioritization of relationships. Can be undertaken informally with a small group or in a larger workshop setting. Why > Offers perspective on relevant institutions and policies for decision-making, and which relationships are most important and/or influential.
Key Informant Interviews & Focus Groups	One-on-one or group conversations guided by a structured set of questions. Why > Useful for in-depth, qualitative insights into user needs, perceptions, and motivations. Helpful for exploring complex issues and building trust.

Surveys & Questionnaires	Structured feedback from users on a set of questions (following the requirements of the United States Paperwork Reduction Act). Why > Effective in getting input from a large group quickly, comparing responses across user types, or quantifying trends.
Journey Mapping	An exercise with users to map the steps of their processes; helpful in identifying pain points, decision moments, and opportunities for support. Why > Valuable in illustrating the full user experience and uncovering bottlenecks or unmet needs across a workflow. Particularly helpful for end-to-end process improvement.
Personas & User Profiles	An exercise to develop representative profiles of people that capture their roles, their challenges, and how they might use Earth information. Why > Helpful for synthesizing needs into representations of potential user groups. Best when an application will be used by multiple groups for different types of decisions; for example, public and private sectors, or federal and state government.
Co-Design Workshops	Collaborative sessions where users help shape solutions, ensuring relevance and buy-in. Why > Ideal for engaging users in testing and refining initial ideas. Also fosters buy-in and relationship-building.

Assessment Example: the Satellite Needs Working Group

The Satellite Needs Working Group (SNWG) connects U.S government satellite data providers – NASA, NOAA, and USGS – with more than 25 federal agencies, helping them identify ways to use satellite data to improve their work. In support of SNWG, NASA leads the assessment of needs and the implementation of solutions to meet those needs.

NASA takes a holistic approach to identifying needs, co-designing solutions, and co-developing with the agencies to make the solution work in their environment. To leverage efficiencies across agencies and ensure the likelihood of success, NASA undertakes a multi-phase user needs assessment process.

The Phases of the Process

Survey of agencies
Every 2 years to highlight gaps, overlaps, and priorities for collaboration

Solutions
High-impact projects selected for funding and implementation

Discovery interviews
Cross agencies teams representing NASA, NOAA, and USGS interview potential users to define their needs explicitly

Solution development
Interview teams co-design a potential solution, together with agency users

Assessment report
A report recommends potential solutions and details available data, tools, trainings, and other resources. The reports are sent to the agencies as a response to their surveys

2.2.8 Task 4: Co-design a Solution

Once needs have been determined, the next task is to co-designing the application concept with users.

Co-design goes beyond consultation. It centers on active and systematic iteration between the scientist(s) and users. Not every detail will be ironed out, but it is critical to have reasonable certainty on the expected impact of the application and how users will sustain it into the future. Proposal reviewers look for this clarity.

Co-design evolves into co-development: once a proposal is funded, users and partners will work together to build, test, and refine the proposed solution into a practical, sustainable, and effective application.

Here are some topics and considerations when Co-designing with users:

Products and Outputs

- Define expected output(s) (datasets, models, dashboards, visualizations, decision-support tools)
- Specify delivery methods and accessibility
- Describe documentation practices
- Outline data risks and limitations

Data

- Identify required inputs from NASA and other sources
- Outline data management and update processes, including metadata and documentation
- Identify formats and interoperability
- Note collection and validation methods
- Clarify open data policies or sharing agreements

Roles and Responsibilities

- Clarify contributions of all partners (expertise, staff time, resources)
- Define responsibilities for technical work and engagement
- Anticipate required approvals in the users' environment
- Specify expected commitments

Sustainability

- Ensure future feasibility and viability of application outputs
- Identify hardware and software needs
- Assess required human and financial resources
- Define tasks to ensure sustainability

Training and Capacity

- Assess current competencies and gaps
- Identify target audience for skills-building
- Anticipate training methods and users' language needs
- Meet users' immediate and long-term needs for skill-building

Co-design Tips

Here are a few tips from Earth Action scientists on co-design at the proposal phase.

One of the potential pitfalls is – because we're all scientists at the end of the day – is we try to sneak in more science into an Earth Action proposal than what they are hoping to fund, which is that engagement and demonstrated use over the course of just a couple of years that it can be ingested, utilized and form the basis of decision-making in someone else's environment.

Doug Morton
Earth System Scientist at
Goddard Space Flight Center

Very often, we really want something to work and we jump right in on the assumption it will work – before taking a hard look at where the science is, where the data products are, what we know about their accuracy and what formats and data services are available to deliver that. And so I think that being patient with that process and investing the time up front can save a lot of time down the road.

Forrest Melton
Project Scientist for OpenET
and Earth Action Associate
Program Manager Agriculture

As you're crafting your ideas, you just need to focus more on the theoretical rigor, the scientific aspect of it. Like, does it stand the test of science? Does it make sense? Is there really a need? How much of an effort or a jump will this be for the end user to really adopt this? If that means that they have to invest a lot of training in their staff, changing their software, changing the way they do business - then it's going to take a long time, and it's probably not going to go anywhere. You have to adapt to their boundary conditions more than them adapting to our boundary conditions at the science level.

Faisal Hossain
Professor, University of Washington Department of Civil and Environmental Engineering

2.2.9 Task 5: Formalize the Proposal

The last task is to collaborate in drafting the proposal. Each solicitation will have specific requirements: be sure to read it carefully and adhere to the requirements.

A central element is a description of the application's intended impact. Visit Section 2.3.4 to learn how NASA Earth Action defines impact. Other possible requirements might be a user engagement plan and a transition and sustainability plan.

While not required, it's also good practice at this stage to identify and be transparent about the expected benefits of collaboration for all partners (beyond the application itself). For example, co-authored publications may be something of interest to all partners.

User Engagement Plan

Earth Action proposals require a detailed description of how users will collaborate on the application. This may be requested in the proposal narrative, as a specific plan, or in an End User Description Form, depending on the solicitation.

These documents should describe how the NASA-funded applications team and users will interact and collaborate throughout the life of the project, covering the following points:

- A timeline for engagement that aligns with project goals and user activities
- The methods that will be used to engage with users, including communication tools (workshops, virtual or face-to-face meetings, conference calls, etc.)
- Identification of risks, challenges and barriers that might exist or occur during the project when engaging with users
- **Note: the budget should include resources for user engagement activities, such as workshops**

See Section 2.1.7 for examples of these plans.

Transition and Sustainability Plan

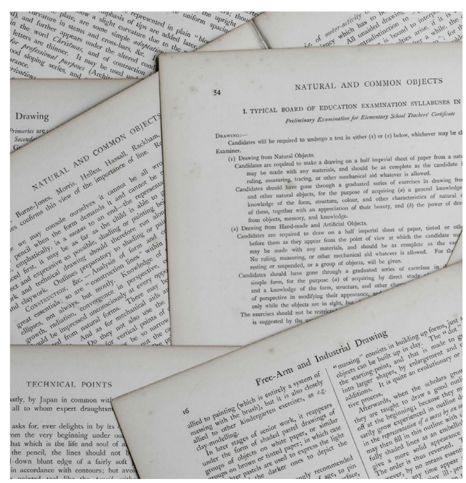
Earth Action proposals, especially those seeking to achieve higher ARLs, may be required to submit a transition and sustainability plan. This information should be part of the narrative or in a dedicated section, per the solicitation requirement. Normally, the plan should not exceed one page. Key elements include:

- A path for moving the application into the users' environment during the project period
- Description of the users' ability to sustain the application in the future, including required human and financial resources and institutional requirements
- Anticipated capacity building to foster users' adoption, including documentation, training, and other support
- Anticipation of barriers to adoption and a process for overcoming them

Section 2.3 What Goes into a Strong Proposal?

2.3.1 Insights on Strong Proposals

The prior sections highlighted the building blocks of an Earth Action application and insights on engaging users in proposals. This section provides detail on other aspects of Earth Action proposals, including budgeting and staffing.



Dr. Max Bernstein
Science Mission Directorate, Lead for Research

"Don't just write a proposal that can be understood, write a proposal that cannot be misunderstood."

2.3.2 Building an EA Team

The NASA Grant And Cooperative Agreement Manual (GCAM) is a must-read during the proposal process and throughout the life of a project. It describes roles and requirements for key personnel and how to represent them in a proposal. They may include a Principal investigator (PI), Co-principal investigators (CoPI), Co-investigators (Co-I), collaborators, postdoctoral associates, graduate and/or undergraduate students, other professionals and consultants. In most cases, a user should be listed as a Co-PI, Co-I, or collaborator on the project team. In some cases, users may be funded through the grant.

Each solicitation provides clear guidance on where and how to describe these personnel.

While it may not be necessary or feasible to include the full team, proposers should describe the blend of skills, disciplines, and personalities that will make the project successful.

Characteristics of a Successful EA Team

Varied Skills and Backgrounds

Team members with varied skills and life experiences bring their unique perspectives to the development of applications. Those perspectives contribute to more useful, accessible, and effective applications.

For example, a principal investigator may not enjoy or excel at user engagement. In that case, it's ideal to include a team member who has those skills.

Multiple Disciplines

Earth Action applications that expand the use of Earth observations to sectors such as health, insurance, and transportation may benefit from expertise beyond remote sensing. With a multidisciplinary team, an application can integrate additional data sets and yield richer analysis.

Along with natural and social science experience, skills may be required in technologies such as machine learning, cloud computing, statistics, data visualization, and user interface/user experience.

Personal Investment

Team members who are passionate and committed to the vision of the application will be key players in multiplying its impact.

Good Communicators

Whether led by the principal investigator or another team member with relevant expertise, effective communications are a must. Ideally, all team members should have the ability to translate science to plain language and promote the value of the application.

Language skills may be needed to broaden the community invested in the application.

Advice on Building a Team

We are trying to work with things that are already developed and demonstrated and are ready to be used in a context where the majority of your team effort is going to be on transitioning that to another environment and training and supporting those operational users to use information. It's often not exactly the same team that you need to develop that work. This could mean working with more IT and programming support to generate, develop and maintain an API, as opposed to the concepts that went into analyzing the satellite remote sensing information or modeling outputs and that led to the scientific investigation that demonstrates the value of that product. The last mile might be a different set of skills.

Doug Morton
Earth System Scientist at Goddard Space Flight Center

There are definitely skills within design - or broadly within the social sciences - that some scientists can do...One of the questions that scientists who are looking to do applied research would need to think about is do they either want to learn how to do these skills or bring on a specialist who has the capabilities... the skills are learnable, but I think it's a shortcut in order to be more effective at bringing on people who have the capabilities.

Scott Davidoff
Human-centered designer, Space Science Institute

It is critical to incorporate collaborators from diverse disciplines into your team - and especially early career scientists - because they bring in a lot of energy, fresh ideas, and the desire to push things forward.

Enrique Montes
Associate Scientist, University of Miami Cooperative Institute for Marine and Atmospheric Studies

2.3.3 Budgeting for an EA Project

Earth Action proposals use the same budget framework as other Science Mission Directorate projects. But unlike research budgets, which generally center on personnel labor, publication costs, and travel, Earth Action budgets must also reflect the proposal's commitment to engagement, transition, and sustained use of results. The solicitation will outline specific budgeting requirements.

Here are potential Earth Action-specific budget line items:

Roles and Responsibilities

Consultation workshops, travel for partner meetings and conferences, and other collaboration activities over the lifecycle of the application

Capacity Development

Training, materials, and other user skill-building activities, including both staff time and workshop/event costs

Transition

Staff time for scaling prototypes, developing decision-support tools, integrating with partner systems, sustaining services

Evaluation/Metrics

Staff time for a systematic approach to monitoring impact

2.3.4 Evaluating Impact

Earth Action proposals should be clear and persuasive in describing the project's anticipated impact. In most cases, a solicitation will ask for a detailed description or a plan for how the team will evaluate that impact.

At the proposal stage, proposers and users should come to consensus on questions such as: how do we define impact? What difference will the application make for users and other partners? How can we measure that?

There are many milestones along the path to delivering impact. Sharing knowledge and expanding awareness of how to use Earth observations are two examples. But NASA Earth Action looks for projects that will deliver impact in three primary ways.

Here are some of the definitions of impact:

Use

Extent of application use by the users and/or the public

Example: Information from a tool measuring drought severity is included in the Navajo Nation's monthly bulletin, which is sent to 80 tribal authority, state, and other decision-makers.

Action

Real world activities and changes to the implementation of users' decisions

Example: Authorities decide when to enact temporary speed restrictions in affected shipping lanes based on information from an application that predicts movement of breeding whales.

Benefit

Positive results for users, their partners, or their environment as a result of having employed EO information in use and action

Example: Models that improve tornado forecasts enable local leaders to warn the public about oncoming storms earlier than in the past, resulting in dramatic declines in mortality in affected areas.

For more proposal tips, review this video, made to support the 2024 ROSES A.60 Ecological Forecasting solicitation.

Thanks to Keith Gaddis, NASA Earth Action program manager for Biological Diversity and Ecological Forecasting, for sharing these insights.

2.3.5 Evaluating Impact: NASA Lifelines Example

The NASA Lifelines project seeks to reduce disaster risk and strengthen resilience at community level by expanding the ability of humanitarian agencies to integrate Earth data into their planning and response actions.

The project monitors impact using a theory of change, a structured framework that maps out how and why a set of actions will lead to a set of desired outcomes. The framework has multiple tiers that show how program activities will deliver results that lead to high-level impact over time.

IF these program objectives are supported:	• Fostering use of Earth observations in humanitarian decision-making • Increasing Earth science-humanitarian community partnerships and interdisciplinary approaches • Identifying new research questions on how Earth science can strengthen humanitarian action • Building a global, multidisciplinary community adopting these approaches • Increasing investment in the use of Earth science for humanitarian action
THEN changes in humanitarian response to disasters and resilience-building will be:	• More reliable • Better coordinated across boundaries • Faster • More flexible • Better able to meet humanitarian principles • More tailored to affected people
And the high-level impact will be:	• More effective • More efficient • Targeted humanitarian action

Visit the NASA Lifelines page to learn more.

2.3.6 Tips on Earth Action Proposals

Proposal characteristics

- Compelling rationale for the application that will excite the reviewers. Start with people!
- Simple, readable, and understandable
- Conveys the problem, why it must be addressed, and how NASA Earth data will support its solution
- Maps out collaboration with a specific user or users
- Uses accessible, powerful images and figures to reinforce key messages
- Describes the project in detail with credible anticipated outcomes
- Provides definitions of success and evaluation plans
- Addresses sustainability, especially on data management and user skills/capacity
- Identifies a community of interested partners
- Presents the team, especially the principal investigator, in a way that inspires confidence
- Includes a complete, right-sized budget

A strong abstract quickly and persuasively explains:

- The challenge you are trying to address
- Your solution and its expected impact
- What is unique about your solution and why it will be effective
- Why YOU are the person to lead the project
- Why YOUR TEAM is right for the project
- Why NOW is the time for this project

Pro Tips

- Read the entire solicitation very carefully.
- Review the evaluation criteria carefully.
- Write your proposal with the reviewers in mind.
- Let your passion shine through the proposal.
- Strive for simplicity and readability, not complexity.
- Highlight the key message for each section in a way that breaks up the text, e.g., with a box, bold text, different font, or other visual cue.
- Describe the impact of past work, not just the who, what, when, and how.
- Use the proposal process to demonstrate leadership and team collaboration.
- Balance the reviewers' interest in specificity with assurances of flexibility and responsiveness to user needs.
- Ask people outside your discipline to give feedback.
- Interact and engage funders as much as their process allows, but don't overwhelm them.
- Be prepared for specialized requirements, such plans on communications, user engagement, and monitoring and evaluation.

2.3.7 NASA Proposal Resources

NASA Earth Action issues calls for papers, crowdsourcing, funding, and solicitation opportunities for both researchers and citizen scientists. Most are funded through Research Opportunities in Space and Earth Science (ROSES). Activities may use remote sensing data from a variety of sources, but NASA data must be integrated in the technical approach.

ROSES and other solicitations can be found on the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES).

Dual-Anonymous Peer Review

Some ROSES proposals will undergo dual-anonymous peer review (DAPR). This approach to reviewing proposals aims to reduce bias and ensure fairness. In this process, both proposers and reviewers remain anonymous to each other until all evaluations are complete.

Proposals are divided into two parts: an anonymized scientific document and a separate Expertise and Resources (E&R) document. Reviewers assess the anonymized proposal on its scientific and technical merit; only after initial scoring are the E&R documents reviewed to confirm that the team has the capability and resources to carry out the work. Visit the DAPR page to learn more.

Need help?

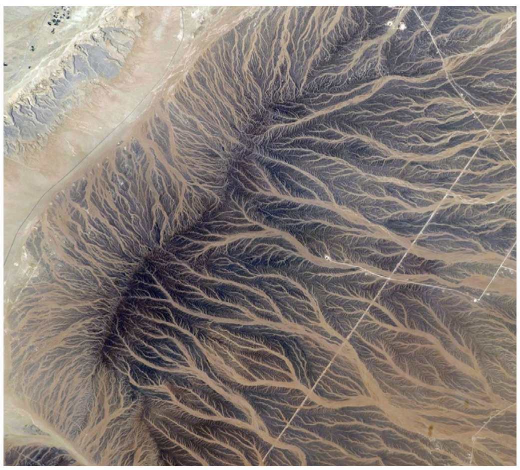
NASA Earth Action scientists are a great resource in providing guidance on developing a proposal, within the usual constraints of federal contracting requirements.

Each solicitation includes a NASA headquarters contact who is available to respond to queries.

Pro Tips

- Establish relationships with NASA team members outside of a solicitation call.
- Be sure to read the solicitation carefully before reaching out to the solicitation contact.
- Don’t wait until the last days of the submission process to ask for help.

2.3.8 More NASA Proposal Resources



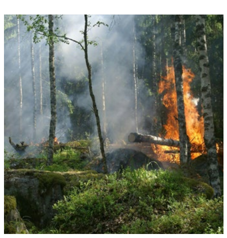
- NSPIRES
- NSPIRES help page
- Science Mission Directorate researchers page
- Science Mission Directorate solicitations page
- Science Mission Directorate library and links page
- Information on Dual-Anonymous Peer Review
- Planning list for Science Mission Directorate solicitations
- NASA Grant and Cooperative Agreement Manual
- NASA Grants Policy and Compliance page
- Grants.gov

2.3.9 Explore Recent NASA Projects

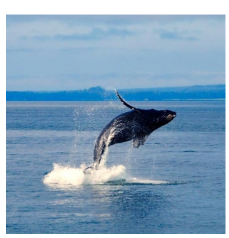
These links lead to summaries of successful NASA Earth Action proposals funded through Research in Opportunities in Space and Earth Sciences (ROSES). They demonstrate how NASA Earth Action contributes to the Earth Science to Action strategy. They also illustrate key aspects of Earth Action projects; for example, how 1) NASA science addresses a user need and 2) how applications bridge scientific research and real-world solutions.

Select an image to visit the summaries of successful NASA Earth Action proposals.

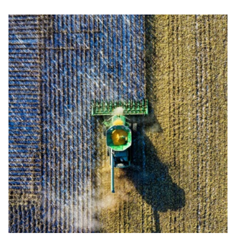
Disasters



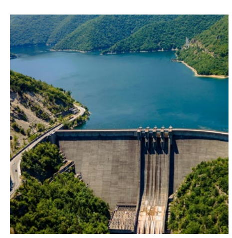
Wildland Fires



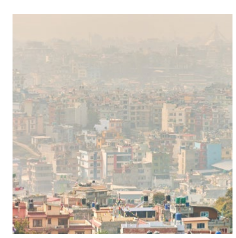
Ecological Conservation Impact Assessment



Agriculture



Water Resources



Health and Air Quality

MANAGE AN EARTH ACTION PROJECT

Key Takeaways

Get Started with New Funding

- Set the foundation early: Earth Action projects require proactive, user-focused planning from the start.
- Plan for sustainability from Day One to ensure a solid basis for transitioning the application to the user.
- Develop a deliberate approach to project management.
- Build a multidisciplinary team with members who are adaptable, skilled at communications, and invested in the project.
- Communicate and build awareness, using clear, plain-language materials and storytelling, to build a community that will support and sustain the application.
- Develop a monitoring and evaluation framework with metrics to show progress and impact.

Main Topics

- Managing a NASA Earth Action project
- Considerations for getting started
- Co-developing applications with users
- Anticipating hurdles
- Managing the close of the project

Collaborate and Share with Users and the Community

- Co-development with users is essential. Iteration is expected. Applications are most successful when designed with, not for, users.
- Methods such as human-centered design, structured decision-making, and scenario planning can be valuable co-development tools.
- Well-planned capacity building is a critical success factor for transition and adoption.

Work Through Implementation Challenges

- Expect hurdles and be prepared to adapt.
- Barriers may include institutional constraints, changing leadership, shifting priorities, staff turnover, conflicting data environments, underperforming models, or funding delays.
- Success requires flexibility, transparency, and persistence.
- Solve problems collaboratively to strengthen both the application and user trust.

Evaluate and Close a Project

- Close-out should be deliberate and thoughtful, based on collaborative planning with users for transition as well as user-friendly documentation, clarity on post-project support, and joint reflection on results.
- Final project reports and other communications efforts are very valuable in promoting your work and helping others – especially NASA program managers – understand how your results align, scale, or support other work happening across the NASA community.

Section 3.1 Get Started with New Funding

3.1.1 Getting Started

The early stages of a new Earth Action project involve big decisions that can set the stage for success later. Alongside the scientific and technical considerations, the early work planning might include:

- Setting up a management structure that addresses reporting and financial responsibilities
- Finalizing and preparing the team
- Formalizing agreements with users
- Identifying additional stakeholders to involve
- Mapping out a communications plan
- Determining ways to measure impact
- Planning for longer term sustainability and transition

Pro Tip: Refer to the NASA Grant and Cooperative Agreement Manual (GCAM) throughout the duration of the grant.

3.1.2 Planning for Sustainability

For many Earth Action projects, the goal is to help users take over management and future use of the application. To achieve this, project teams have to start planning for transition and sustainability from the very beginning of the project.

Some NASA solicitations will have required a transition and sustainability plan as part of the proposal – it can serve as a starting point for detailed planning. If no plan was required, one should be developed with users early on in the collaboration. These plans should be living documents, revised and expanded as the collaboration grows and the capacity needs become clear.

Most considerations for sustainability tie directly to the users' environment. They include:

1. Enabling institutional authorities or policies related to the users' decision-making
2. Data management systems and policies
3. Data, software, and computational infrastructure
4. Long-term budget requirements
5. User skills and technical capacity

Early on, a project team must have a sense of two things: 1) technical requirements to support users' adoption of the application in their environment and 2) institutional and human resources to sustain it into the future.

3.1.3 Project Management

An effective Earth Action project manager takes a deliberate approach to organizing tasks, engaging team members and users, and driving toward project outcomes.

The most suitable approach depends on the particularities of the project and the people who will work on it – the project manager will have to determine which approach will work best. In practice, project managers often blend approaches, leveraging the respective advantages of each. Earth Action projects often lean toward an iterative style, enabling the team to adapt as users' needs evolve or shift.

This section explores key management topics:

- **Project Management Approaches**
- **The Project Manager**
- **Project Manager Styles**
- **Scientist Perspectives**

3.1.4 Project Management Approaches

Building on the discussion of systems engineering and design thinking in Section 2.2.2, this graphic provides perspective on a few basic management approaches.

MORE CONTROLLED ⟷ MORE DYNAMIC

PLAN DRIVEN

Traditional

Building on the discussion of systems engineering and design thinking in Section 2.2.2, this graphic provides perspective on a few basic management approaches.

Waterfall

After significant planning, tasks are managed sequentially in phases.

Critical path

This step-by-step methodology sets priorities for interdependent tasks. Activities are deemed critical or non-critical based on which can be achieved fastest with the biggest return for the project.

ITERATIVE

Agile

With comparatively less upfront planning, this approach focuses on short cycles of activity known as sprints. These are intended to deliver immediate results and point the way to next steps.

Scrum

A form of agile management, this approach features quick development cycles and very close team collaboration (sometimes with daily meetings) to maintain energy and enable quick pivots.

Adaptive

Project goals remain constant but the pathway to the goals evolves based on new information and changes in context.

3.1.5 The Project Manager

Capable project managers advance a project across application readiness levels, managing concurrent streams of science and people. Some managers organize the work around the tasks. Others organize around the team. Typically, the principal investigator serves as the project manager, especially on smaller applications projects.

Qualities of an effective NASA Earth Action application project manager:

- Solutions-oriented
- Consistent
- Clear-sighted
- Scientifically credible
- Open-minded, adaptable
- Clear communicator
- Decisive
- Persistent
- Team builder

Project Manager Styles

What project manager style will catalyze results? Depending on the context, a combination of styles may work best.

Affiliative

Managers embed themselves as a peer on the team, leading from the front.

Coaching

Managers work through team members to achieve the project goals, prioritizing support and mentoring.

Authoritative

Managers set goals and strategies and then allow team members to work independently to fulfill them.

Directive

Managers set goals and strategy and direct team members to fulfill them.

Democratic

Managers foster collaborative action, allowing all staff members to contribute to the decision-making.

Pacesetting

Managers emphasize results and deadlines, holding employees accountable for delivering on them.

3.1.6 Perspectives on Project Management

We are light and agile. We recognized early on that we had to have a vision and we had to have pragmatic ways of doing things. At the same time, we tried to strike that right balance between putting in so many rules and procedures and layers of people that it just slows you down. You want to be clear about how you're structured, how you're managed, and how you make decisions, but you want to make sure you're not spending all your time in management. To be relevant in applied sciences, you have to have some flexibility in how you structure your activities.

Inbal Becker-Reshef
Program Director, NASA Harvest, University of Maryland, Department of Geographical Sciences

My project management style is team-oriented. On a flood early warning project I led, we broke the team into four tracks, with each track lead responsible for day-to-day operations and ensuring that deliverables were met. I found that was a really good model because I wasn't micromanaging the team. They were able to go and do what they needed to do and bring me in when they needed me.

Maggi Glasscoe
Research Affiliate, Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder

I think that my management style might be more around my way of thinking, which is going towards the bottlenecks and the juicy problems and solving those first, and then having everything else sort of fall in line. That's probably more in line with the agile approach, but you know, you can find yourself in a pickle if you don't also have a Gantt chart and have deliverables and make sure that you've got that approach too.

Charles Huyck
Executive Vice President, ImageCat

3.1.7 The Value of Communications

If an Earth Action application were a living thing, communications would be its circulatory system. The flow of information – from the project team, to external audiences, and back to the project team – creates a feedback loop and empowers all involved. It helps build a community invested in the application and likely to support it into the future.

A NASA project grant will detail requirements for internal communications, such as periodic reports, ad hoc updates and information requests, and requests to participate in team meetings or other activities. These are extremely important and valuable to the NASA program team.

The grant may or may not have requirements for external communications. Even when not required, an external communications plan can raise awareness and engage a larger community of stakeholders. It will also help NASA program managers see opportunities to promote your work within Earth Action and across platforms such as the Earth Information Center.

A principal investigator may not be best suited to leading the project's communications - and that's okay. What's important is that communications are a project priority.

Review of each component of a communications plan will help an applications team think strategically about who to reach, what they want to achieve, and how to share information in ways that will contribute to the success of an application.

The Audience: Identify who you need to reach

The application team, users, their stakeholders other decision-makers, NASA program managers and other funders, the general public

Your Goals: Clarify the purpose of the communications

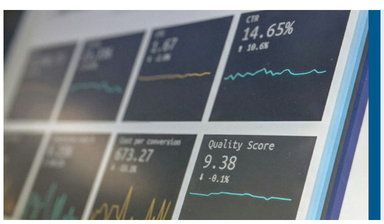
Informing project decisions, building trust, encouraging collaboration, fostering buy-in and use, demonstrating value

Content and Messages: Decide what information needs to be shared

Technical findings, progress updates, lessons learned, real-world stories that show impact

Methods: Choose the channels to reach each audience

Meetings, newsletters, workshops, social media, journal articles, trade publications, media outreach



Monitoring: Identify ways to assess progress

Targets or metrics to indicate whether you are meeting your communications goals

3.1.8 Two Elements of Effective Communications

Project Manager Styles

Plain language communications are critical to engaging non-specialists in an applications project. Some scientists fear that simplified, non-technical communications erode the integrity of their research. In fact, clarity amplifies its impact. It helps decision-makers, partners, experts in other fields, and the public engage with the information confidently.

Importantly, this principle of accessibility applies to text as well as graphics, maps, and other visualizations.

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Importantly, this principle of accessibility applies to text as well as graphics, maps, and other visualizations.

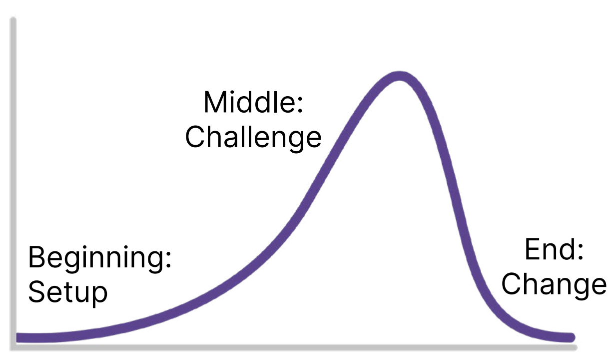
- Define abbreviations and avoid technical language
- Keep it simple, clear, and concise
- Use real-life examples to connect the science to everyday life
- Provide persuasive, simple statistics and other facts to illustrate your point
- Use both words and images to reinforce key messages
- Put the most important information up front
- Restate important information briefly at the end

Embracing Storytelling

Alongside every algorithm, data set, or dashboard is a compelling story about why that information is needed and how it can help. These stories are a great tool for expanding audiences, fostering their engagement in your work, and driving home its value. They don’t replace data or evidence - they complement them.

Traditional Story Arc

- **Beginning: Setup**
  Introduce the situation: who is involved and what’s at stake?
- **Middle: Challenge**
  Build tension: what problem or conflict needs to be solved?
- **End: Change**
  Show how an Earth Action application delivers a positive benefit.



The Story: Restoring Tribal Fishing Stocks with Satellite Data

Beginning: Setup
For generations, Oregon's Columbia River tribes have relied on salmon as a source of food, culture, and identity.

Middle: Challenge
Rising river temperatures threaten the fish. A lack of ground data makes it hard to see where the water is too warm.

End: Change
Using satellite data and machine learning, University of Washington researchers and tribal partners now have access to data and tools to track temperature and take action as needed, such as seeking the release of cooler water upstream.

View a storymap on the project.

3.1.9 Monitoring and Evaluating Impact

Performance monitoring and evaluation are valuable tools for managing an Earth Action application project.

Performance monitoring → Improved project management

- Assesses project progress and the need for modifications
- Highlights opportunities for innovation and new directions
- Provides information for communications with partners and funders
- Sets a baseline against which impact can be measured

Monitoring tracks progress, typically relying on a set of indicators determined at the start of the project.

Evaluation takes a more encompassing look at whether the project is delivering a higher-level benefit.

Understanding Outputs, Outcomes, and Impact

Performance monitoring plans often use a framework that defines metrics and anticipates outputs, outcomes, and impact.

What are metrics?

These specific, measurable indicators gauge progress, assess results, and capture lessons learned. They may be quantitative (e.g., datasets produced, users trained) or qualitative (e.g., evidence of improved decision-making). Project reporting should track progress against these metrics. Pro tip: Choose metrics for the quality of the information they offer, rather than for big numbers that have little value.

What are outputs, outcomes, and impacts?

Outputs

The products, services, and capacities the project/team builds and delivers

Example:
Maps produced, datasets developed, tools and models built, trainings held

Outcomes

The changes in user activities, decisions, and performance that result from the project's outputs

Example:
Improved decision-making as users apply and act on Earth science information (e.g., more effective distribution of food assistance, resources saved through targeted mosquito control)

Impact

Higher-level social, economic, or environmental change that emerges from the combination of outputs and outcomes

Example:
Lives saved by disaster warnings, fewer food-insecure people, fewer cases of malaria

Metrics for Measuring Change

How to make performance monitoring manageable:

- **Right-size:** Match the level of effort to the project's scale and resources.
- **Jump right in:** Start monitoring early, even at a low level of effort, to establish a baseline
- **Align with users:** Link the project's metrics with those users employ in their decision-making, if appropriate
- **Align with funders:** Ensure metrics feed into the project funder's monitoring and evaluation frameworks

Performance metrics can help identify gaps, strengthen user engagement, and capture evidence of broader outcomes and impacts. NASA Earth Action recommends that project teams develop metrics with users.

Sample questions the project team and users might address:

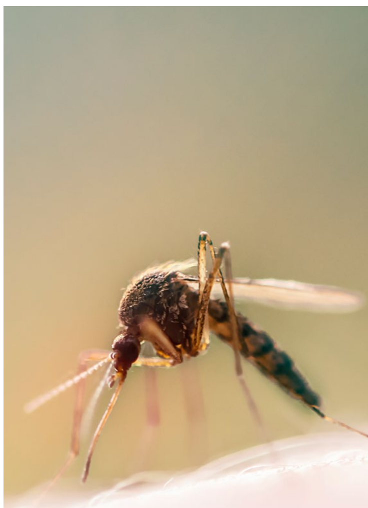
- How are decisions currently being made?
- What do the team and user most want to change in that decision-making process, capability, and impact through the project and use of NASA data?
- How can one measure that change? Where is the decision-making capability along the scale of this metric?

Sample outcome metrics from a NASA Ecological Conservation Program document:

- Changes in policies/decision based on project outputs
- Time saved on workflow as a result of the solution
- Reduction of legal challenges
- Environmental impact (e.g., amount of land conserved)
- Cost or resource effectiveness
- Ecosystem service benefits (qualitative or quantitative)

Leveraging Partner Metrics

In some cases, metrics that users have in their workflows might be adapted to serve an application project's monitoring and evaluation needs.

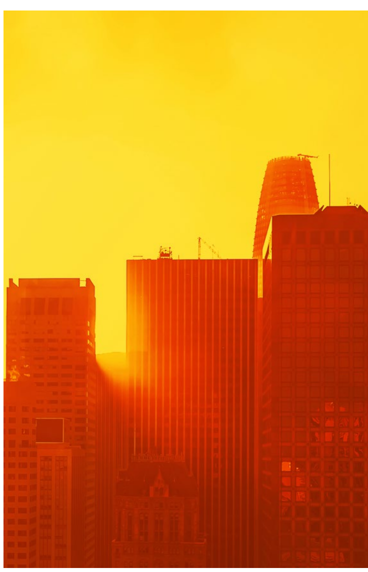


Disease Early Warning

Health officials in Kenya issue alerts on potential malaria outbreaks when a series of metrics reach certain thresholds related to analysis of soil moisture and temperature, human population density, and weekly surveillance data.

Possible project metrics:

- Outcomes: Changes in the frequency of alerts, the timing of alerts and, how many more people are alerted
- Impact: Improved health care system readiness for outbreaks, decreases in malaria cases (attributable to the alerts)



Disaster Management

State and federal partners use remote sensing information to determine the severity of an extreme heat emergency and make decisions about how, where, when, and to whom they might provide assistance.

Possible project metrics:

- Outcomes: Number of people who receive assistance, speed of delivery of assistance, types of assistance
- Impact: Whether assistance reduces illness and deaths from the heat; whether those most affected by and most vulnerable to the heat shock (especially older adults, outdoor workers, and people with chronic illnesses) receive assistance

Energy Conservation

Drawing on remotely-sensed weather and climate data, the University of Michigan uses metrics on energy consumption to identify the need for upgrades to lighting, cooling, and other systems in campus buildings.

Possible project metrics:

- Outcomes: Number of upgrades driven by data
- Impact: Amount of money saved on reduced energy consumption, reduced emissions related to energy consumption

Section 3.2 Collaborate with Users and Partners

3.2.1 Collaborating with Users and Partners

In the early 2000s, the National Research Council used the term “valley of death” to describe the gap between research success and real-world use of science. In the world of Earth science, this “valley” was represented by applications that were developed without clear users or certainty about how users would or could integrate the application into their decision-making. Many of those applications were not put to use.

Earth Action seeks to bridge the valley by funding applications that support a specific user in using NASA data to address a specific need. Collaboration and co-development approaches are intended to assure application impact and the effective use of human, financial, and technical resources.

3.2.2 User Confidence in EO Data

A major factor shaping collaboration with application stakeholders is their familiarity with remote sensing; newcomers almost always need time to understand and appreciate the value of the data. For more than a decade, Tracey Holloway, lead of NASA's Health and Air Quality Applied Science Team (HAQAST), has seen this firsthand.

HAQAST supports a nationwide network of over 1,000 people and 14 research teams working on health and air quality topics including wildfire smoke, diesel emissions, and breast cancer. Dr. Holloway has outlined how HAQAST stakeholders – ranging from government health officials to advocacy groups, researchers, and businesses – progressively engage with remote-sensing information.

- Awareness of the data
- Realization that the data can inform their work
- Willingness to try using the data
- Confidence in searching for better data to answer their questions
- Integration of the data in their decision-making processes
- User adoption, adaptation, and maintenance of the data and related products
- Future development of the data products

Thanks to Tracey Holloway, team leader of the NASA Health and Air Quality Applied Sciences Team for sharing her ideas.

3.2.3 Co-Development of Applications

Co-development is a term used frequently to characterize Earth Action engagement with application stakeholders. This collaboration approach brings scientists and partners' respective skills and experience to the application, from planning, designing, implementing, and testing through to its implementation.

The idea is that scientists create with – not for – the users.

Co-creation and co-design are terms closely related to co-development. Although the terms are sometimes used interchangeably, their meanings are slightly different.

- Co-production: joint ownership, governance, and delivery of solutions
- Co-creation: jointly generating ideas
- Co-design: jointly designing solutions

All are participatory processes typically involving researchers, end users, and other stakeholders in shaping solutions.

3.2.4 Scientist Perspectives

A few NASA Earth Action scientists shared their views on co-development with users.

So the co-production process is really a process of building trust, and we can start with a small thing and continuously build a product together with the users - rather than delivering a full resolution product to the agencies and asking them to use it. We need this co-development process to help.

Bingqing Liu
Assistant Professor,
University of Louisiana
at Lafayette

You go to the user, saying we have our datasets, our products, and we believe they may be useful to you. You share your ideas, like putting up a dartboard and asking the users to toss the darts. And invariably, you will hear, 'Thank you very much, but you got this all wrong.' But that's where the co-development is - let's work together to fix it.

Ashutosh Limaye
NASA Earth Action Program
Manager for Agriculture

I feel like everything I've done has eventually, one way or the other, morphed into a co-development process. In different cases, I've come in from different directions, but at some stage, not always at the very beginning, there's always some point where there's intensive co-development to actually build the application into something that is useful.

Michael Wimberly
Professor of Geology and Environmental Sustainability, University of Oklahoma

Be honest about the need for flexibility, and the fact that everyone has to be prepared for things to change and evolve. While it may seem a weakness to some, collaboration that embraces the idea of flexibility is a strength.

Benjamin Zaitchik
Professor of Earth and Planetary Sciences, Johns Hopkins University

3.2.5 Co-development Example 1

Co-development Example 1: Human-centered Design for Hydrological Monitoring

Application: Move a set of prototype hydrological tools based on evapotranspiration (ET) and evaporative stress data from NASA to the New Mexico Office of the State Engineer (NMOSE) and build a publicly available dashboard. The project was anchored in a multifaceted human-centered design (HCD) approach, which put user needs and experiences at the core of solution development.

Application uses:

- Drought response and mobilization
- Forest and wildfire monitoring
- Agriculture and water management

Application team: Led by Joshua Fisher, Chapman University

Stage: 3-year project, started at ARL 7 and achieved ARL 9

1 **Year 1 - Design**

Hosted repeated consultations with NMOSE water-rights managers, hydrologists, and legal staff, and then extended to other state and federal agencies such as forestry and agriculture. Together, they refined anticipated data needs, including resolution, format, and latency, and the look of the dashboard and user experience with it.

2 **Year 2 - Sustainability**

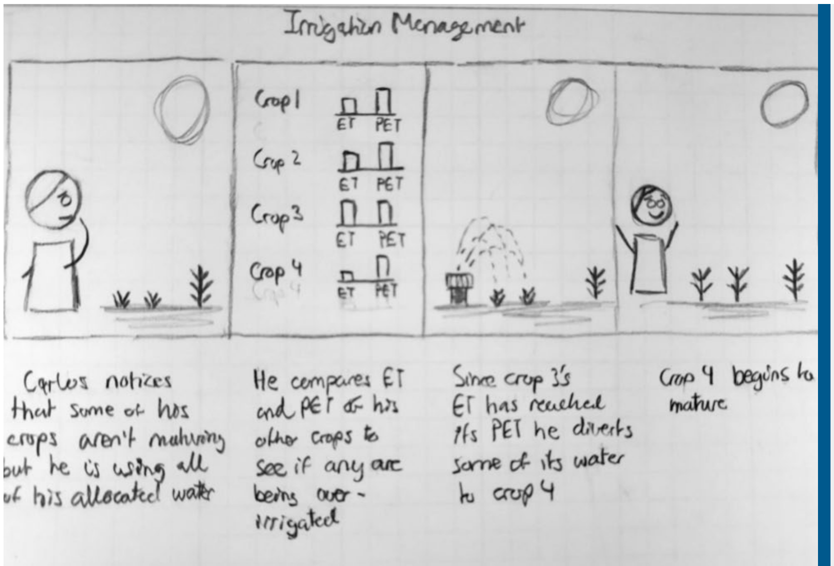
Heavy emphasis on operability and transition and multifaceted capacity development activities, with workshops, social media-style video demos, step-by-step guides, and an online discussion board.

3 **Year 3 - Impact Assessment**

Users co-developed a structured approach to monitoring change and provided regular feedback on its implementation.

Lessons from the Consultations

- Original observations from the prototype tools weren't relevant to all potential users
- New, critical needs were identified:
  - A historical record of ET, which didn't exist at the time
  - More data layers, e.g., distinguishing between crop water use and precipitation
  - Traceability features, showing who generated each report and when – important for court challenges
- Testing and iteration with participants improved design, training, and impact assessment methods
- The variety of training methods attracted more participants and users



HCD consultation method: "Needs-validation storyboarding"

In design sessions with users, the team shared 20 cartoon vignettes, each with before and after scenes showing a fictional character facing a familiar challenge and how the application might help.

Instead of asking directly "how can the application help you," the storyboards allowed users to react honestly, identify relevant capabilities, and brainstorm other possibilities.

How I latch on to human centered design is that quote that's often attributed to Henry Ford right when he was designing the car. He said, 'If I had asked people what they wanted, they would have said faster horses - because they didn't know what could exist.' And you see that a lot in applied sciences and water resources. What do you want? Well, we're used to this, I guess more of it.

And so sure, I could ask people, how do you make decisions? Like I could send out a survey and they would send me some answers. But what I've learned is that the answers that I would get are not the real answers. And so the design, the design methods that Scott employs, is able to look under the hood. I can only see the top of the hood. I know there's a hood there, but his industry is designed to look under the hood and really figure out what somebody says to me in a survey is not actually how they make decisions. And that was mind-blowing to me.

Joshua Fisher
Associate Professor, Chapman University, on working with HCD expert Scott Davidoff on the NMOSE application

3.2.6 Co-Development Example 2

Co-development Example 2: Structured Decision-making for Improved Flood Management

Application: Improve an existing satellite-based application to measure water levels in Alaska's rivers and glacial lakes by integrating data from the Surface Water and Ocean Topography (SWOT) mission.

Application uses: Improved flood monitoring and management in areas lacking ground monitoring data, especially for glacial lakes, which can unexpectedly burst, causing massive flooding.

Application team: Led by Michael Durand, Ohio State University with Co-investigator Merritt Harlan, USGS

Stage: 3-year project, started at ARL 7 and achieved ARL 9, resulting in a new, official USGS data product

How Structured Decision-making Guided the Project

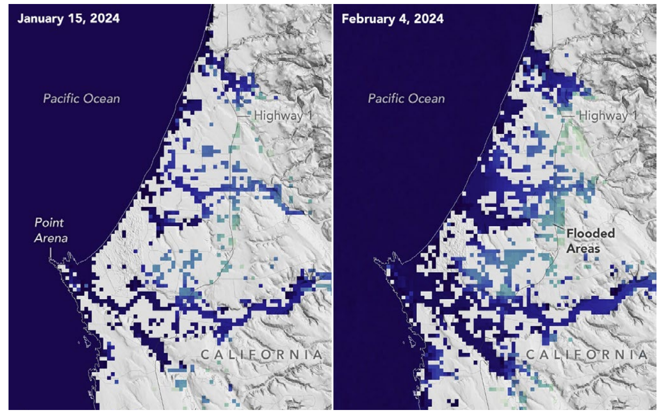
Structured decision-making approach:

- A step-by-step process commonly used to define the decision context, clarify objectives, identify potential solutions, analyze opportunities and trade-offs, address uncertainty, and decide.
- Collaboration started with a multiple day, in-person meeting, followed by periodic in-person meetings and regular monthly meetings.

Key method: Scenario planning

The team's decision-making process was based on the use of scenarios. During a structured brainstorming session, collaborators from the state Department of Transportation, USGS, the NOAA River Forecast Center, and others considered a dozen different application concepts, ultimately pursuing four of them.

Lessons



During proposal development, the application team was focused on river discharge. But the users repeatedly said that monitoring glacial lakes was a priority.

The team wasn't certain the data would support that but mentioned it in the proposal because it was important to the users. In the end, glacial lake monitoring became the focus of the application.

Part 1: Hear what users are telling you.

At first we were like, oh, that'll never work. And they kept bringing it up. And so we thought, okay, let's really go back to the lower level data products, and we were talking to some of the engineers at JPL about what SWOT data could do.

And then we thought, okay, maybe there's something here. And then we just started pursuing it a little bit at a time and it built into an exciting idea.

Michael Durand
Professor, Ohio State Univeristy

At the start of the process, SWOT had not yet been launched and its uses were untested. The scenario approach was very useful: users were able to think openly and creatively about a wide range of challenges that could be met with remote sensing data.

Part 2: Keep iterating with users.

We knew that SWOT was new and we weren't sure exactly all of the possible things that we might be able to do with it. So we created like almost, I think a dozen different applications, as we brainstormed...like we might do this, we might do that, we might do that. I just might do that. We only pursued three or four of them, but with each new additional one, we were trying to pull more information from their minds and their experience and their expertise.

I think it demonstrated, hey, we're trying to listen to you and hear from you and get as many of your ideas. And then we built from there. We didn't just drop them there. We did build from there and in the next meetings or two, we would revisit them and try to see how those pieces could come together and what the prospects might be and have them reflect on them a month or two months after the original brainstorm.

We were centering this idea that it was a new satellite. We were going to learn about it together as a team throughout the course of the project.

3.2.7 Developing Capacity

A fundamental aspect of managing an Earth Action application is helping users develop the capacity to engage with the data even after the collaboration ends. Some level of skills building will likely be required. That might include training, peer-to-peer support, internships, user guides, etc. The depth and breadth will vary depending on objectives and the users' existing level of capacity. When transition and adoption of the application is an objective, extensive capacity development may be required.

- Co-develop a plan and individual interventions with users
- Use multiple methods, such as: in-person and online workshops, self-paced training, peer-to-peer and on-the-job training, short videos, etc.
- Establish offline, asynchronous platforms to promote interaction and exchange
- Test materials with users and revise based on their feedback
- Target various audiences and tailor the learning objectives to their needs, for example: a core group engaged on technical aspects, senior leaders on decision-making and policy implications, additional stakeholders who can support use of the application
- Localize and adapt the content to the users' experience
- Adjust the level of technical detail to the audience
- Build skills progressively over time
- Use students or interns to provide one-on-one assistance during in-person training
- Plan strategies to institutionalize the learning
- Provide coaching and follow-up support
- Evaluate and improve

The Importance of Documentation

Detailed, high-quality documentation is important in sustaining users' ability to use, maintain, and even develop applications into the future. It can also reduce errors, foster user adoption, and ensure that the knowledge will endure, even with staff turnover and funding changes.

Examples of this documentation include:

- User guides
- Training materials
- Descriptions of workflows
- Metadata specifications
- Case studies
- Communication products
- Plain language materials for non-technical audiences

GitHub, an open source platform for storing, sharing, and collaborating on code and other digital projects, is frequently used as a repository for documentation.

3.2.8 Collaboration Success Factors

NASA researchers shared tips for strong collaboration on an Earth Action application project.

Build partners' understanding and confidence in the science

Becky Chaplin-Kramer, Lead Scientist, Natural Capital Projection, co-appointed at Stanford University and University of Minnesota

"A lot of time, at the outset, the [research] question is limited by the decision-makers' imagination or understanding of what is possible. By bringing new science and novel innovations along the way, decision-makers sometimes have their eyes opened up. They begin thinking about new and different possibilities and different questions that better serve their needs."

Find a champion

Will McCarty, NASA Weather Program Manager

"You have to get that one stakeholder who's really willing to make the investment to learn how to use the data properly. That relationship will then allow for back and forth exchanges that are important - because mistakes may be made. Ultimately, that helps create the opportunity for the people around them to learn, propagating the satellite data or tool through the rest of the enterprise."

Build a network

Faisal Hossain, Professor, University of Washington Department of Civil and Environmental Engineering

"It doesn't happen overnight, but you need deep, personal relationships, with individuals, but also across agencies."

Set expectations and be transparent

Inbal Becker-Reshef, Program Director, NASA Harvest, University of Maryland, Department of Geographical Sciences

"Do not oversell your capability or the science itself - this is going to hurt the project eventually. Whether it's the models or mapping or anything else - make sure you are honest about what you know and what you don't know. And communicate very clearly about uncertainty."

Be flexible and adaptable

Helen Bailey, Research Professor, University of Maryland Center for Environmental Science

"Keeping partners engaged and communicating throughout the project is important because their priorities might change over the course of a few years. And making sure you are able to adapt is really helpful."

Make your work usable and accessible

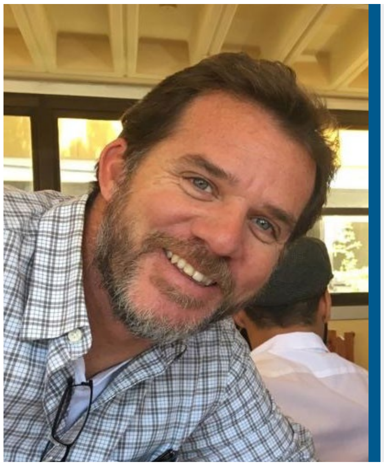
Tracey Holloway, Scientist and Professor at University of Wisconsin-Madison and Lead of NASA's Health and Air Quality Applied Science Team

"For many of our stakeholders, their jobs do not include keeping up-to-date on satellite technology. We are trying to convince them it is worth their time to learn about this data and engage with this data. We have to make it easy for them."

Work across disciplines

Shanna McClain, NASA Earth Sciences Division Disasters Program Manager

"For early career scientists wanting to get involved in Earth Action, it's very important to understand that academia can often put you on a very specific path... But what ends up making some of the strongest Earth scientists – especially those working in the Earth Action sphere – are those who are not only strong in physical sciences, but are also very strong in social sciences."



Go the extra mile

Enrique Montes, Associate Scientist, University of Miami Cooperative Institute for Marine and Atmospheric Studies at NOAA's Atlantic Oceanographic and Meteorological Laboratory

"Engaging with collaborative networks often entails many hours of hard work – you may need to stay up for an international call that's happening at 2 a.m. – but it's worth it. When you invest that extra mile of effort to help your community do these things more effectively, you build exciting collaborations and do projects you never imagined doing."

Section 3.3 Work Through Implementation Challenges

3.3.1 Working Through Implementation Challenges

Budget shortfalls. Staff turnover. New management priorities. Under-performing models. The list of potential application hurdles goes on. Even with the best planning and management, application projects might encounter a few setbacks along the way.

This section draws on the experiences of NASA Earth Action scientists and researchers to provide an overview of common challenges.

3.3.2 Common Application Hurdles

Institutional Barriers

Bureaucracy

Slow or multilayered decision-making processes may inhibit progress. The team may have to invest time unexpectedly to get over the hurdles.

Cost-sharing

A funder's requirements may be a stumbling block for some users.

Conflicting data environments

Some institutions may restrict the use of certain platforms or datasets, or artificial intelligence.

Funding delays

Resources do not always come through on schedule.

Publish or perish

In an academic environment, pressure to publish or secure new funding may compete for time with other implementation priorities.

Project lifecycles

The project may ultimately require more time than the typical 2-3 year funding cycles.

Partnership Pitfalls

Changing circumstances

User priorities may shift as leadership and staff change. Project buy-in may decline.

Weak collaboration

Neglected relationships, inconsistent project management, and poor communication can undermine successful outcomes.

Partner burnout

Users juggling many responsibilities and relationships may lose enthusiasm or have trouble keeping project commitments.

Partner expectations

Users may be disappointed if the application takes longer or doesn't deliver the results they expected.

Sustainability

Human capacity

Frequent staff turnover - and the need to train new staff - can strain project team resources.

Data management

Users may have difficulty in 1) finding financial resources for data infrastructure, such as cloud computing costs, and 2) building and maintaining the team's analytical and data management skills.

3.3.3 When Things Don't Go As Planned: Examples

Dive into these examples of real-life challenges in developing and delivering applications.

Scenario 1: Concerns Over Uncertainty

The Application

Historically, a government agency made decisions on land use permits based on statistical analysis of field data. That analysis assessed the state of the land using a range of indicators, such as percentage of bare ground or prevalence of invasive species. Building on an existing tool, the NASA scientists integrated satellite data with the field data, enabling assessment of far larger areas than could ever be covered by humans on the ground. With the additional information, the agency can produce indicator-based maps covering hundreds of thousands of acres.

The Challenge

Remote sensing does not lend itself to traditional parametric statistics, so different types of statistical analysis are required. Also, remote sensing data is most always communicated with error metrics, something not typically reported with ground data. The agency team overseeing the permit process, who are not remote sensing experts, are feeling uncertain about whether the upgraded tool is strengthening the evidence for the decision or adding uncertainty that could create a pathway for legal challenges. They are asking for clear, accessible statistics for the decision documents.

How the NASA Scientists Responded

They worked with the agency to understand the uncertainty.They committed time to guiding the manager and others on his team through the statistics and the uncertainty issues.

They developed a statistically-valid framework based on the remote sensing data. They also promoted their approach among the broader land management community through articles in publications they read regularly, such as society journals about rangelands.

Scenario 2: Unexpected Results

The Application

A global apparel company that sources natural fibers wants to understand the impact of their operations on the health of grasslands and native animal populations. Using remote sensing and ecosystem modeling, scientists set out to analyze whether improved animal herding and sustainability practices are leading to a positive change in rangeland conditions.Their aim is to provide data for indicators requested by the project partners, who also have some data from their own ground monitoring.

The Challenge

The area where the materials are sourced has vast areas of bare ground. Despite using various vegetation indices (e.g., NDVI, SATVI, and others) and sourcing data from two different sensors (Landsat and MODIS), the bare ground was so homogenous that the data lacked specificity. The analysis showed trends but did not provide detailed data for the indicators.

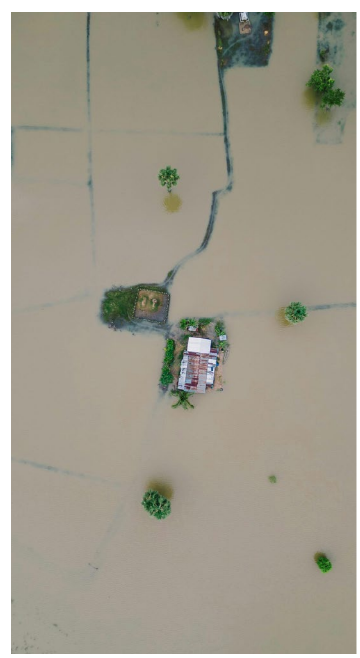
How the NASA Scientists Responded

They found new questions that the data could address.They helped the project partners understand the assumptions and reliability of the analysis, and why it was still useful. They also identified ways to answer different but valuable questions for assessing their sustainability efforts.

They also took a new approach to the ecosystem modeling based on phenological types and climate data. That helped them align remote sensing data and climate trends with ground data in specific areas of the grasslands where the signal was clearer.

Scenario 3: When the Data Fails

The Application



A parametric insurance company uses innovative modeling to help smallholder farmers recover after disasters such as excessive rainfall and floods. Unlike conventional insurance, which usually relies on loss inspections to determine compensation, the company has an automated platform that processes satellite rainfall data and other information using pre-determined thresholds to trigger payouts. The system's strength lies in its speed – devastated farmers receive cash within days of a major weather event.

The Challenge

At one point, the company's system began flagging extreme rainfall readings – more than 900 millimeters in a single day – across multiple sites. The calculation platform generated the payout reports. After realizing the readings were unrealistically high, analysts became concerned and contacted the NASA team leading the Global Precipitation Measurement (GPM) mission team. They confirmed that the GPM Core Observatory had a short-term calibration problem that resulted in unrealistic estimates across several regions. Soon after, NASA released a statement confirming the data failure.

How the NASA Scientists Responded

The analysts used a backup data source to replace the high values and communicated openly about the situation. The analysts reran the calculations using estimates from NOAA's Climate Prediction Center Unified Rain Gauge Analysis and adjusted the payouts as necessary. With NASA's public confirmation in hand, they communicated with partners and insured clients.

To minimize future problems, they built an automated quality-control system to flag questionable readings before payouts were triggered and identified more backup data sources. They also established clear communication protocols that became part of the company's standard operations, strengthening technical reliability and stakeholder trust.

Section 3.4 Evaluate and Close a Project

3.4.1 Evaluating and Closing a Project

The last stage of an Earth Action project should be as deliberate as the first, with active project management and close collaboration with users to wrap up activities well.

Some key close-out tasks may include:

- Financial reports and a final program report, which may involve a formal evaluation.
- External communications to share results and lessons, and acknowledge the contributions of users and other partners. The Earth Information Center may be a place to promote results.
- Discussion of opportunities to replicate and scale the project or pursue new research questions and applications may also be appropriate.

Some applications require more time than the typical ROSES 2- or 3-year funding cycle. In those cases, the project may end, but work on the application may continue.

As you're capturing the impact of your project, consider how that impact might fit within the broader NASA Earth Action landscape. The Earth Action team - and especially your Program Manager - would love to hear how your results align, scale, or support other work happening across the NASA community.

Talk to your Program Manager and peers and ask how this work relates across the landscape.

Natasha Sadoff
NASA Earth Action Program Manager for Satellite Needs, EarthRISE, and ARSET

3.4.2 Transition

Most NASA Earth Action projects aim to transition applications to users, building their capacity to adopt and sustain its capabilities over the life of the collaboration.

For projects at lower ARLs, complete transition and adoption may not be feasible (or even anticipated). On more advanced projects, achievement of ARL 9 – deployment and use in decision-making – may be the ultimate goal.

In either case, some level of transition will take place at the end of the project. Here are some good practices for a successful transition:

Transparency and Early Communication
Set expectations about the closure in advance

Shared Decision-Making
Work together to clarify transition roles and responsibilities

User-Friendly Documentation
Provide detailed, practical, accessible documentation related to application tools, datasets, and methods

Continued Relationships
Discuss and clearly define the level of ongoing cooperation and support once the project ends

Reflection, Learning, and Sharing
Formally and jointly reflect on what was learned and share lessons with others

Acknowledgment and Recognition
Ensure all reports, journal articles, presentations, and communications recognize the contributions of all partners

3.4.3 Capturing Impact

The final report for a NASA Earth Action grant should assess whether the project met its objectives, document lessons learned, and make recommendations for future work.

Beyond this basic requirement, project teams sometimes conduct deeper, formal evaluations to understand the value and impact of their work. These evaluations can use a range of qualitative, quantitative, and mixed methods to understand the societal benefit of an application.

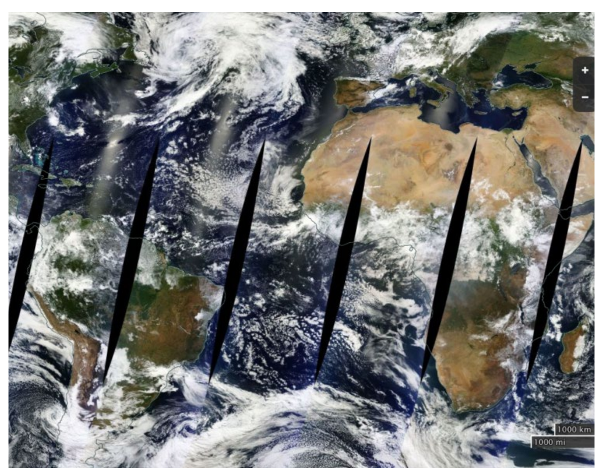
Here are examples of evaluation approaches used on NASA Earth Action projects:

Self-assessment: The HAQAST Example

NASA's Health and Air Quality Applied Sciences Team (HAQAST) concluded its 2016-2020 project cycle with a case-based self-evaluation. The evaluation used quantitative and qualitative outcomes from individual projects, focused teams, and partnership experiences to demonstrate that coordinated research and user engagement produced results far beyond what individual teams could achieve.

The assessment used seven areas of "success" as the framework, providing detailed evidence points under each:

- Growing the air-quality and public-health user community
- Improving satellite-derived surface $PM_{2.5}$ for health applications
- Characterizing global background ozone affecting the U.S.
- Advancing global health challenges with NASA data
- Evaluating community-scale health impacts
- Quantifying uncertain emissions sources
- Improving tools for real-time and retrospective fire analysis



Rather than a formal metrics-based assessment, the evaluation emphasized collective outcomes and lessons learned – showing how HAQAST's collaborative model translated NASA Earth science into actionable information and measurable public benefit.

Impact Assessment Examples

Does the use of EO data save money or provide other benefits, such as saving lives and averting infrastructure damage or medical costs?

An impact assessment compares what happened after an intervention to what would have happened without it, using that information to estimate the benefits. To arrive at a monetary value, evaluators may consider market pricing, costs avoided, replacement costs or contingent valuation (that is, how much someone might pay for that value).

Rather than a formal metrics-based assessment, the evaluation emphasized collective outcomes and lessons learned – showing how HAQAST's collaborative model translated NASA Earth science into actionable information and measurable public benefit.

Landsat value in 2023: $25.6 billion

This evaluation, conducted previously in 2017 and 2019, calculates a value for the imagery used and downloaded by government, commercial, and non-profit entities. In reality, the data is free and open, provided at no cost. It supports a vast array of activities ranging from water management and wildfire restoration to insurance underwriting and mineral exploration.

Costs averted by improved flood forecasting

A 2025 study looked retrospectively at 2011 flooding of the Sheyenne River in Valley City, North Dakota, determining that use of satellite-informed forecasting capabilities available today would translate to flood protection decisions made five days earlier and a reduction in mitigation costs of about $1.7 million.

Emissions reduced by better wildfire management

In Chiang Rai, Thailand, a mobile app called Smoke Watch helped reduce agricultural burning and air pollution, leading to an estimated $3,000 in economic savings per square kilometer due to avoided carbon emissions.

DOWNLOADS AND RESOURCES

Thank you for visiting the NASA Earth Sciences Application Guidebook.

This guidebook was produced and is maintained by the NASA Applied Remote Sensing Training (ARSET) program. Share your feedback via ARSET's contact form.

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Available Downloads from this Guidebook

- Summary of Section Takeaways
- Earth Action Applications Pathway
- Summary of Five Tasks for Engaging Users in a Proposal
- All Links and Additional Resources in this Guidebook