JAXA Workshop

Applications and Socio-Economic Benefits of Earth Observations

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NASA Earth Science

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Topics Covered

NASA Earth Science

Earth Science Applications

Socio-Economic Assessments:
- VALUABLES
- CONVEI

Perspectives & Lessons

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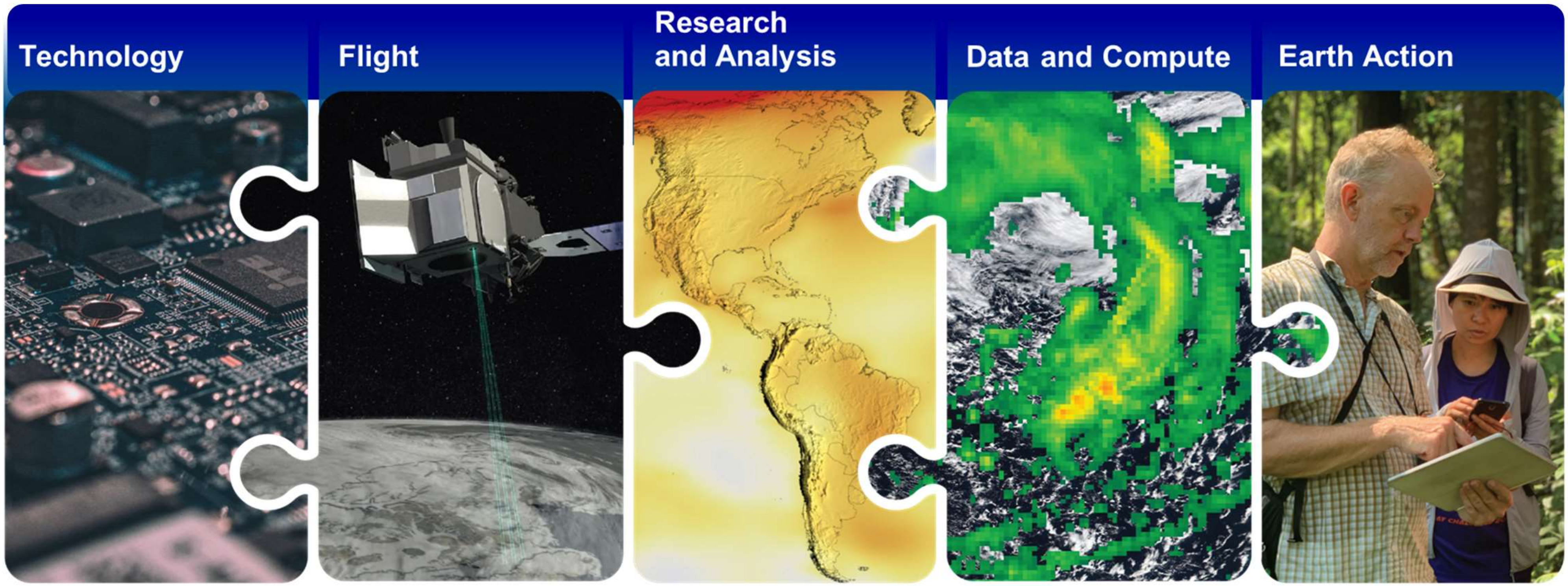


Earth Science To Action

Earth Science | NASA

2024-2034 Strategic Plan for Earth Science

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

Objectives

Holistically observe, monitor and understand the Earth system

Deliver trusted information to drive Earth resilience activities

https://science.nasa.gov/earth-science/earth-science-to-action/

Applications

Earth Science Applications ≡
Uses of Earth science data and information products to inform decisions and guide actions of organizations for management, policy, and business decisions

Connections to Partners & Users

Bring their unique feedback back into the Earth Science community to inform research, missions, data products, etc.

Create multipliers and induce demand for Earth Science data and information products

Partnership and User-centric
Applying the most appropriate science

Types of Applications

Earth Science information provides evidence for different types of decisions and actions:

Planning, management, resource allocation, and response

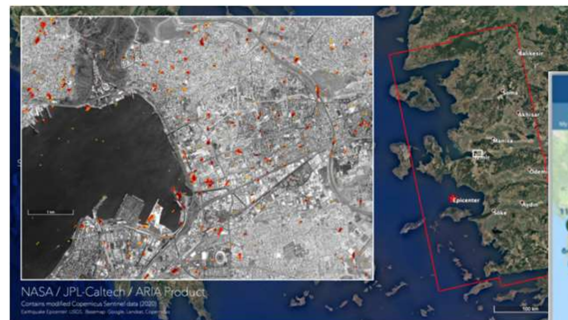
Ex: Damage proxy maps after disasters to target deployment of supplies

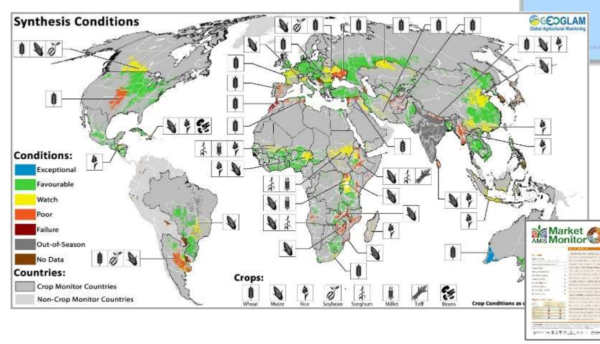
Monitoring and tracking impact

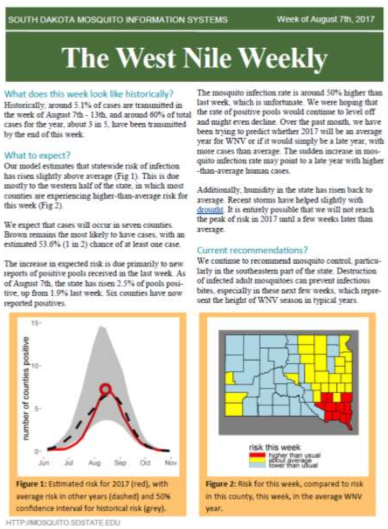
Ex: Monitoring crop conditions and examining impact of droughts

Alert systems and forecasts

Ex: Early warnings of environmental conditions, such as harmful algae blooms in lakes






SOUTH DAKOTA MOSQUITO INFORMATION SYSTEMS — Week of August 7th, 2017

The West Nile Weekly

What does this week look like historically?
Historically, around 5.1% of cases are transmitted in the week of August 7th - 13th, and around 60% of total cases for the year, about 3 in 5, have been transmitted by the end of this week.

What to expect?
Our model estimates that statewide risk of infection has risen slightly above average (Fig 1). This is due mostly to the western half of the state, in which most counties are experiencing higher-than-average risk for this week (Fig 2).

We expect that cases will occur in seven counties. Brown remains the most likely to have cases, with an estimated 53.6% (1 in 2) chance of at least one case.

The increase in expected risk is due primarily to new reports of positive pools received in the last week. As of August 7th, the state has risen 2.5% of pools positive, up from 1.9% last week. Six counties have now reported positives.

The mosquito infection rate is around 50% higher than last week, which is unfortunate. We were hoping that the rate of positive pools would continue to level off and might even decline. Over the past month, we have been trying to predict whether 2017 will be an average year for WNV or if it would simply be a late year, with more cases than average. The sudden increase in mosquito infection rate may point to a late year with higher-than-average human cases.

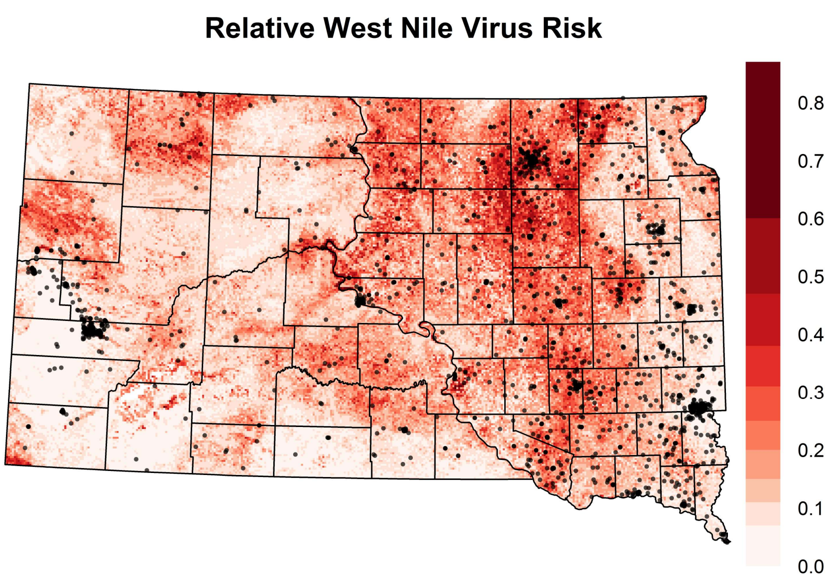
Additionally, humidity in the state has risen back to average. Recent storms have helped slightly with drought. It is entirely possible that we will not reach the peak of risk in 2017 until a few weeks later than average.

Current recommendations?
We continue to recommend mosquito control, particularly in the southeastern part of the state. Destruction of infected adult mosquitoes can prevent infectious bites, especially in these next few weeks, which represent the height of WNV season in typical years.

Figure 1: Estimated risk for 2017 (red), with average risk in other years (dashed) and 50% confidence interval for historical risk (grey).

Figure 2: Risk for this week, compared to risk in this county, this week, in the average WNV year.

HTTP://MOSQUITO.SDSTATE.EDU

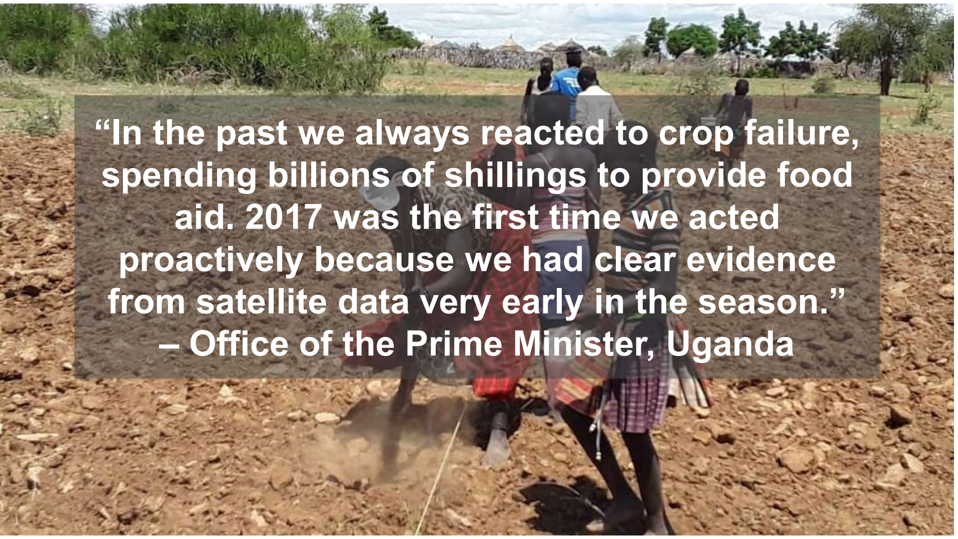


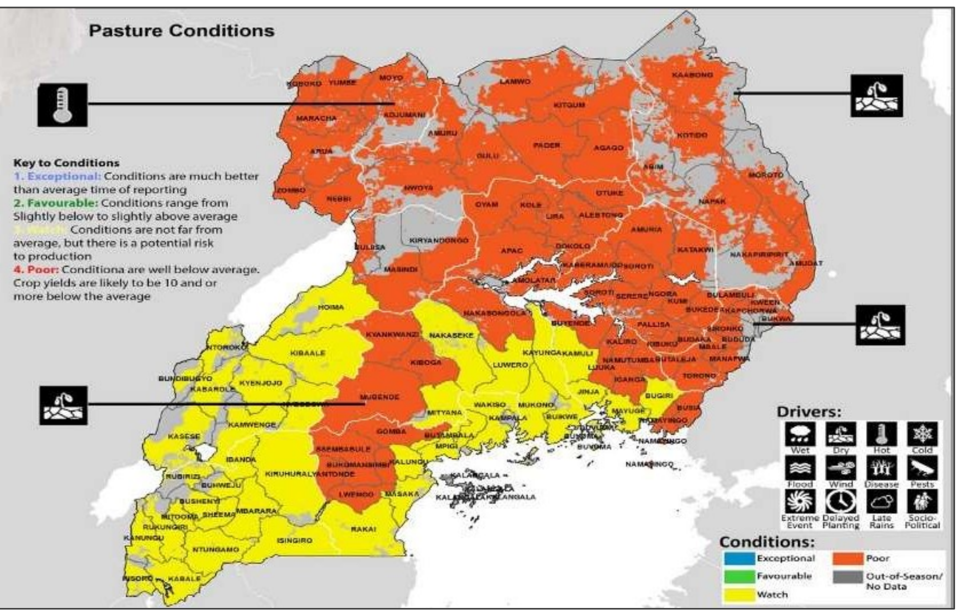
SOUTH DAKOTA DEPARTMENT OF HEALTH

Early-Warning System for West Nile Virus Disease in South Dakota

South Dakota has the highest per-capita incidence of mosquito-borne West Nile Virus. The SD Department of Health worked with a NASA-sponsored team to apply Earth science data and models for risks maps

WNV forecasting and risk mapping tools improve the effectiveness of mosquito surveillance and control in the main transmission season by helping to target limited resources more effectively – the impact is fewer visits to the hospital and lost days of work/school





Early Warning from Satellite Data Strengthens Food Security in Uganda

Poor conditions in satellite and field data trigger the Uganda Disaster Risk Financing (DRF) fund, and the combined information supports proactive response to food insecurity from drought and crop failure. The Crop Monitor published by GEOGLAM uses NASA Terra/Aqua MODIS satellite data to monitor crop and vegetation conditions.

2017: DRF funds (USD 4.11M) paid to 31K households for ~150,000 people. Ugandan gov't saved USD 2.6 million.

2018: DRF funds (USD 2.6M) paid to 23K households when NDVI fell under threshold in 3 districts.

Earth Science Applications

Socioeconomic Impact Assessments

- VALUABLES
- CONVEI

VALUABLES
CONSORTIUM

Valuation of Applications Benefits Linked with Earth Science
2017-2023

Advance and exercise methods in the valuation of the applied benefits of Earth observations

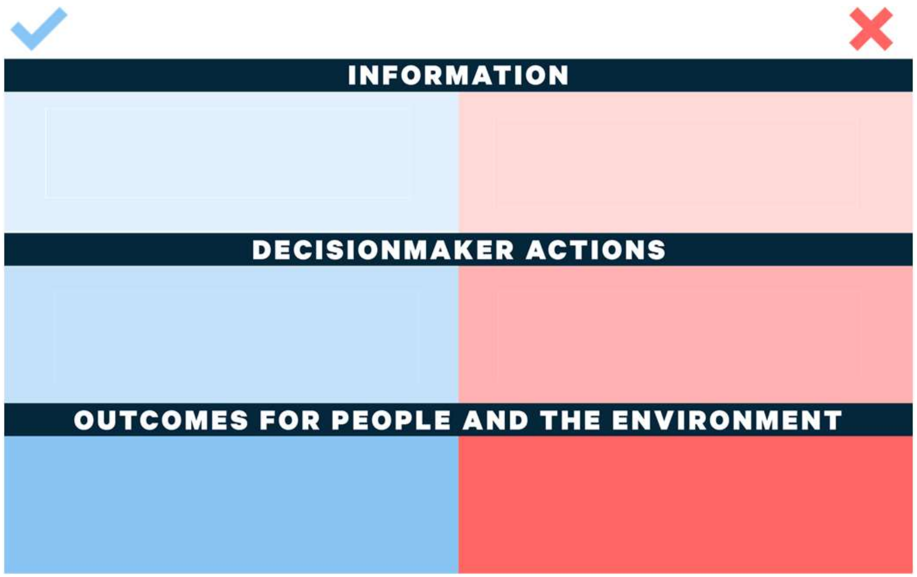
Support opportunities for Earth science and economic communities to engage

Create tools to broaden awareness of terms and methods in socio-economic analyses

RESOURCES *for the* FUTURE

www.rff.org/valuables/

VALUABLES
Impact Assessment Framework



The difference in socio-economically meaningful outcomes between the two states represents the value of the information

Explainer Series at:
https://www.rff.org/valuables/tools-resources/

Sample of Impact Assessments of EO

Protection of endangered species
Value of EO to reduce ship strikes of Blue Whales and reduced compliance costs

Informing post-wildfire response
Value of Landsat data to design cost-effective mitigation and recovery plans.

Enforcement of air quality standards

Detection of harmful algal blooms

Improving predictability of corn and soybean prices

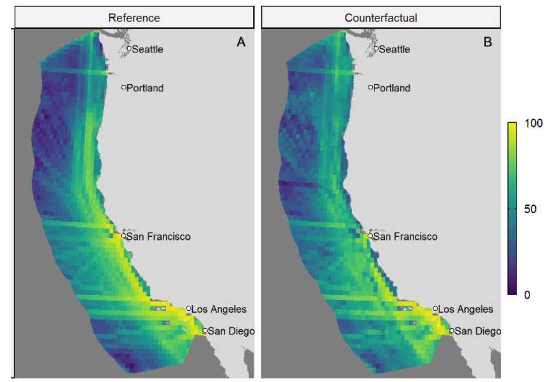
Improving drought & river flow forecasts

Impact: Whale Strikes

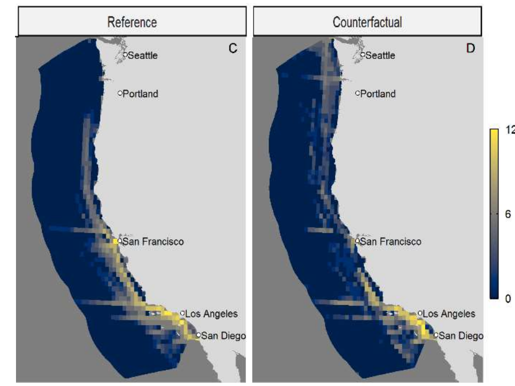
VALUABLES CONSORTIUM

Endangered Blue Whales share same locations as commercial shipping vessels at times of the year. The WhaleWatch tool uses Earth science data to identify whale hot spots for ship captains to avoid or to reduce speed.

What's the value of incorporating satellite data into a tool to help commercial ships avoid whale strikes off the U.S. Pacific Coast?



Expected fatal strikes
(percent chance of occurring)



Regulatory intervention
(by number of months per year)

✓	✗
INFORMATION	
Predictions of blue whale distribution for each **month** by 25 km^2 area based on **remote sensing** of tagged blue whales distribution and environmental covarieties. These are of **low relative uncertainty.**	Predictions of blue whale distribution for each **season** by 25 km^2 area based on **in situ** sightings of blue whales and direct measurements of environmental covarieties. These are of **low relative uncertainty.**
DECISIONMAKER ACTIONS	
Scientists estimate fatal ship strikes of blue whales for each period and area to support rulemaking. Managers implement regulations to slow ships in **fewer** areas at greatest risk of fatal ship strikes during **a few critical months**.	Scientists estimate fatal ship strikes of blue whales for each period and area to support rulemaking. Managers implement regulations to slow ships in **more** areas at greatest risk of fatal ship strikes during **the full critical season**.
OUTCOMES FOR PEOPLE AND THE ENVIRONMENT	
Compliance with conservation policy at lower estimated fatal ship strikes, conserving blue whales in the Eastern North Pacific at lower cost to vessel operators.	**Compliance with conservation policy at higher estimated fatal ship strikes**, conserving blue whales in the Eastern North Pacific at higher cost to vessel operators.

RFF Working Paper: https://tinyurl.com/2485hbcj

Impact: Whale Strikes

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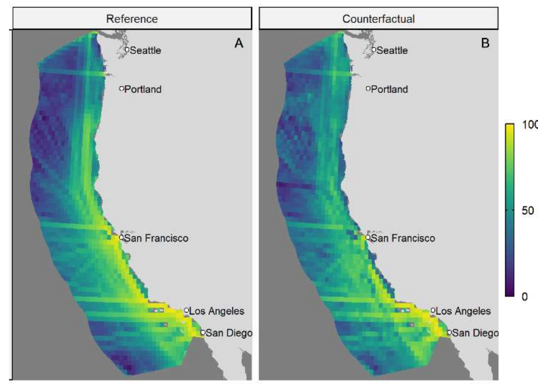
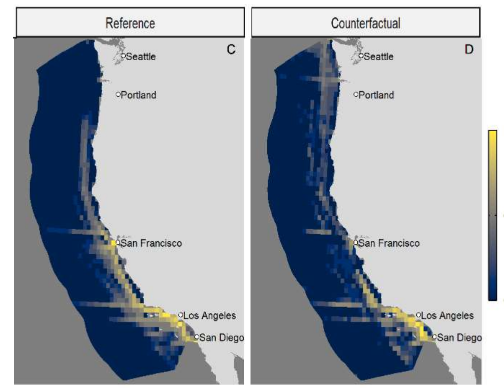
What's the value of incorporating satellite data into a tool to help commercial ships avoid whale strikes off the U.S. Pacific Coast?

The commercial shipping industry could save $21-332 million annually and reduce fatal ship strikes with endangered blue whales (to 4 per year)

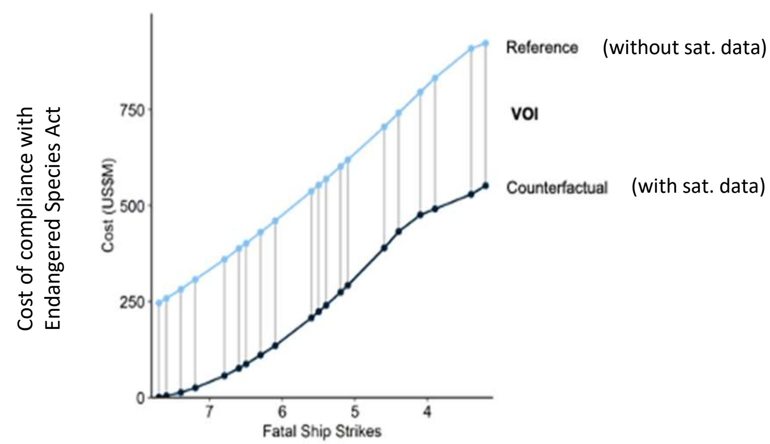
RFF Working Paper: https://tinyurl.com/2485hbcj



Expected fatal strikes
(percent chance of occurring)



Regulatory intervention
(by number of months per year)



Cost of attaining various levels of target fatal strikes in the reference (ISDI) and counterfactual (RSDI) cases.

CONVEI

Collaborative Network for Valuing Earth Information

Improve understanding of the value of Earth science information to society:

Advance assessment methods and the knowledge base

Enhance the capacity of a diverse and inclusive community of Earth scientists and social scientists to conduct such assessments

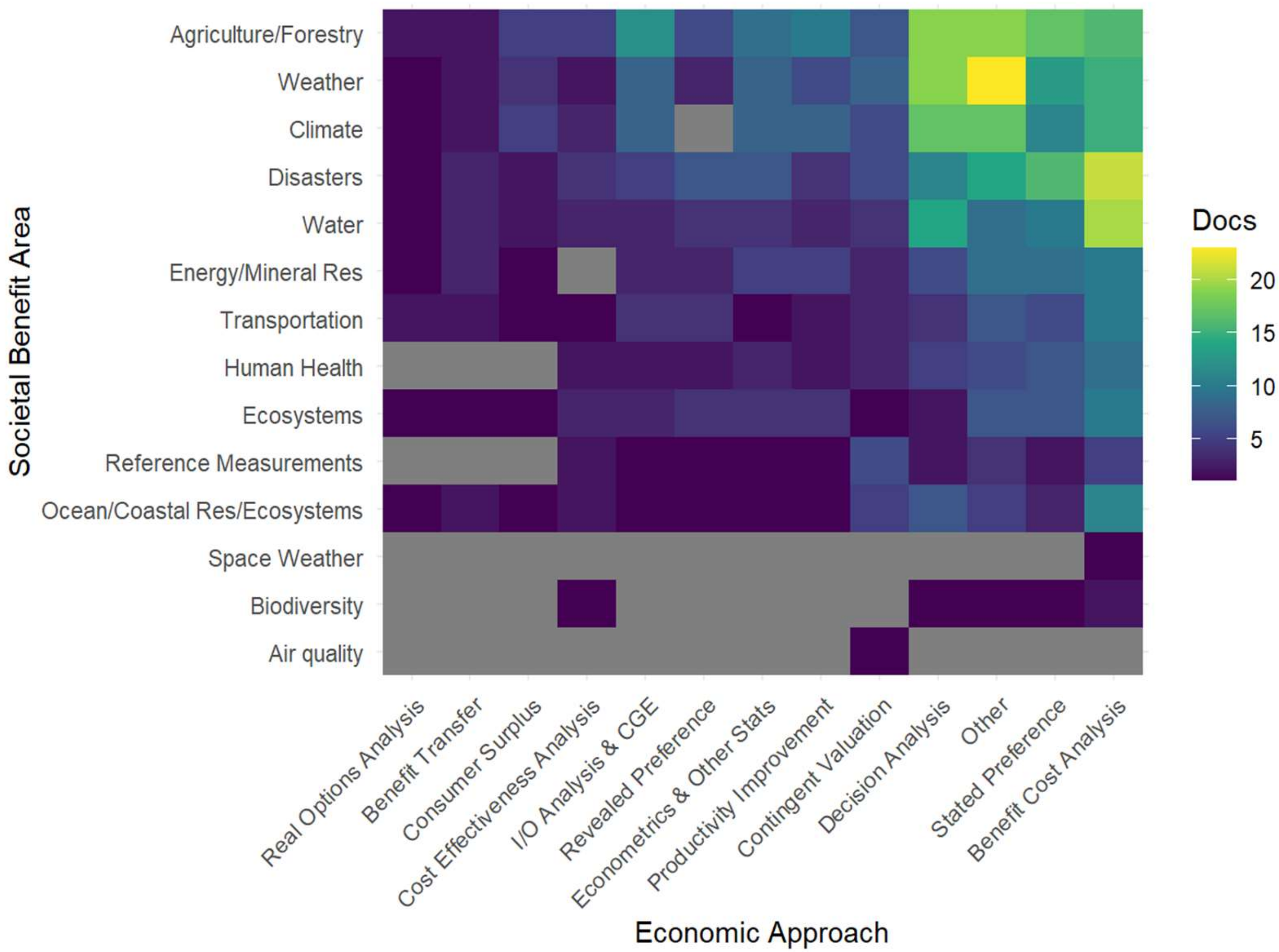
WWF

https://www.worldwildlife.org/projects/convei-collaborative-network-for-valuing-earth-information

CONVEI

HDgov

Applying a ***diverse set of methods***



CONVEI

OBJECTIVES

Build Knowledge Base: Socioeconomic assessments

Advance socioeconomic assessment methods as related to Earth science information (ESI) in decision-support and operational contexts

Develop case studies of socioeconomic assessments of the societal benefits of ESI in diverse contexts

Characterize the complexities in the valuation process that arise from converting inputs from multiple Earth observation (EO) systems into actionable information and use in decisions

Expand Community and capacity

Build community: interdisciplinary, multi-sector, diverse, and inclusive, addressing socio-economic assessments of ESI

Enhance the capacity for socioeconomic assessment concepts, methods, and techniques

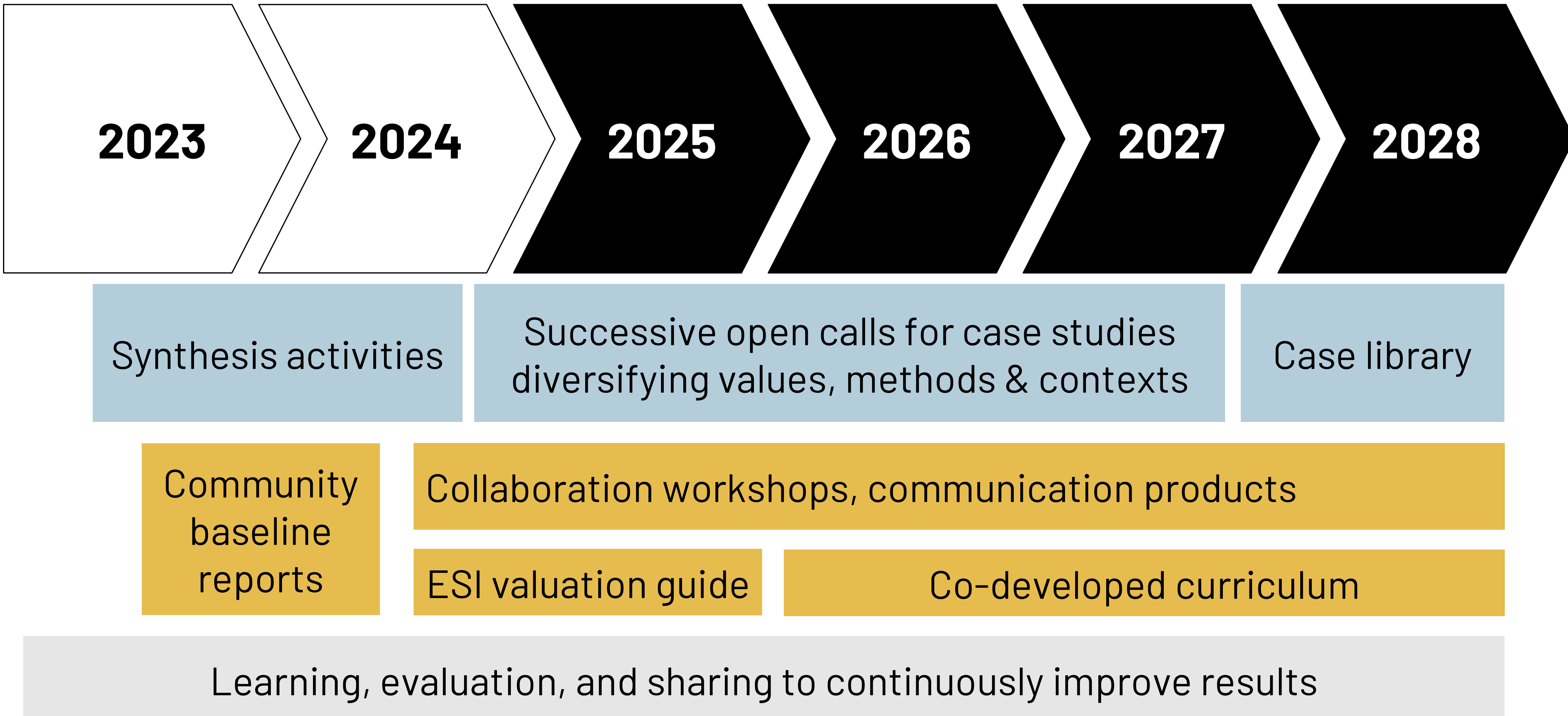
Strengthen collaborations between Earth scientists, economists, other social scientists, and Indigenous knowledge holders

Communicate the socioeconomic value and benefits of ESI in decision-support and operational contexts

Diverse values of ESI are easily measured and understood by a large, inclusive community

The ESI produced better meet society's needs, and challenges are more quickly solved

ACTIVITIES & TIMELINE



Perspectives and Lessons Learned

ON-LINE RESOURCE

NASA Science

An online resource with practical tips and guidance on how to develop applications with impact

Platform with interactive, multimedia content

Lessons and practical tips from decades of work in engaging with organizations to apply Earth science in their planning, decision processes, and actions

https://appliedsciences.nasa.gov/guidebook/

VIEW GUIDEBOOK

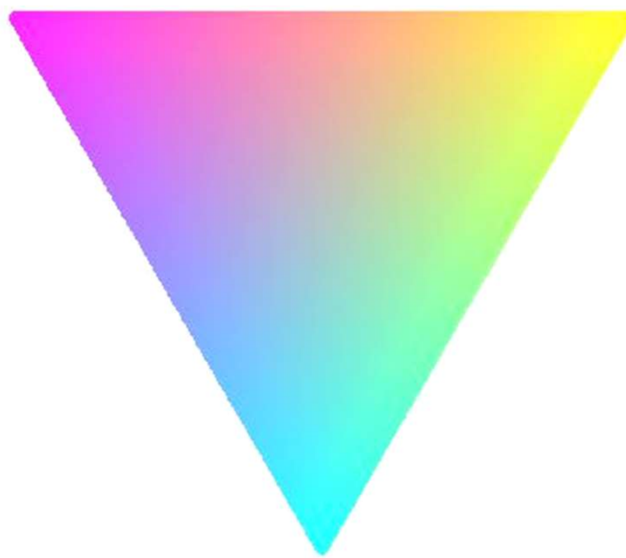
Key features:

- *Success factors & characteristics of successful projects*
- *Types of "users" and "decisions" plus concrete examples*
- *Practical advice and nuts & bolts guidance*
- *Cases illustrating typical pathways*

Programmatic Considerations in Developing a Community to Apply Earth Observations for Socio-Economic Benefits

Creating Tools

Develop or integrate Earth science in tools with well-positioned, trusted partners in their community. Enable broad use of information products



Creating Spaces

Support opportunities for Earth science experts and users to connect and exchange ideas in identifying challenges, crafting solutions, or surfacing research questions and data needs

Creating Capacity

Support development of knowledge, skills, and abilities around Earth science and other topics for greater uptake, application, and impact

Major Lessons

NASA Science

1. Applications is interactive, hands-on, and relational much more than transactional

2. Apply the most appropriate science and not necessarily the latest or cutting-edge results

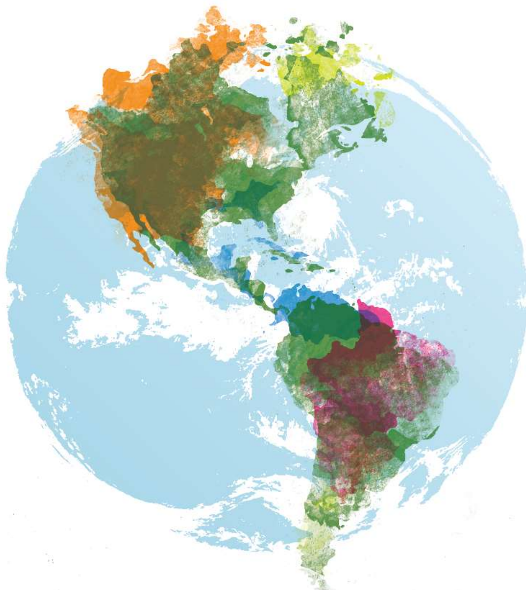
3. Experience, insight, and technical expertise exist in user communities – authentically appreciate that and engage them early and often

4. Identify the metrics the user organization employs to assess the quality of their decisions. Establish a clear baselines to determine value of EO

5. Don't ask "What Do You Need?" Ask more leading questions for an exploratory conversation with users

6. Go to where the managers and users meet and convene. Attend *their* meetings and engage in *their* associations to learn their language, concerns, and issues

7. Ensure reward structures incentivize and recognize applications work and valuation of socio-economic benefits



EARTH.
SCIENCE.
ACTION.

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Earth Science Applications

Backup Materials, Resources, and References

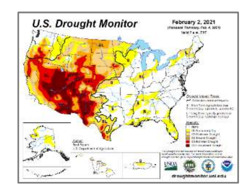
TERMINOLOGY

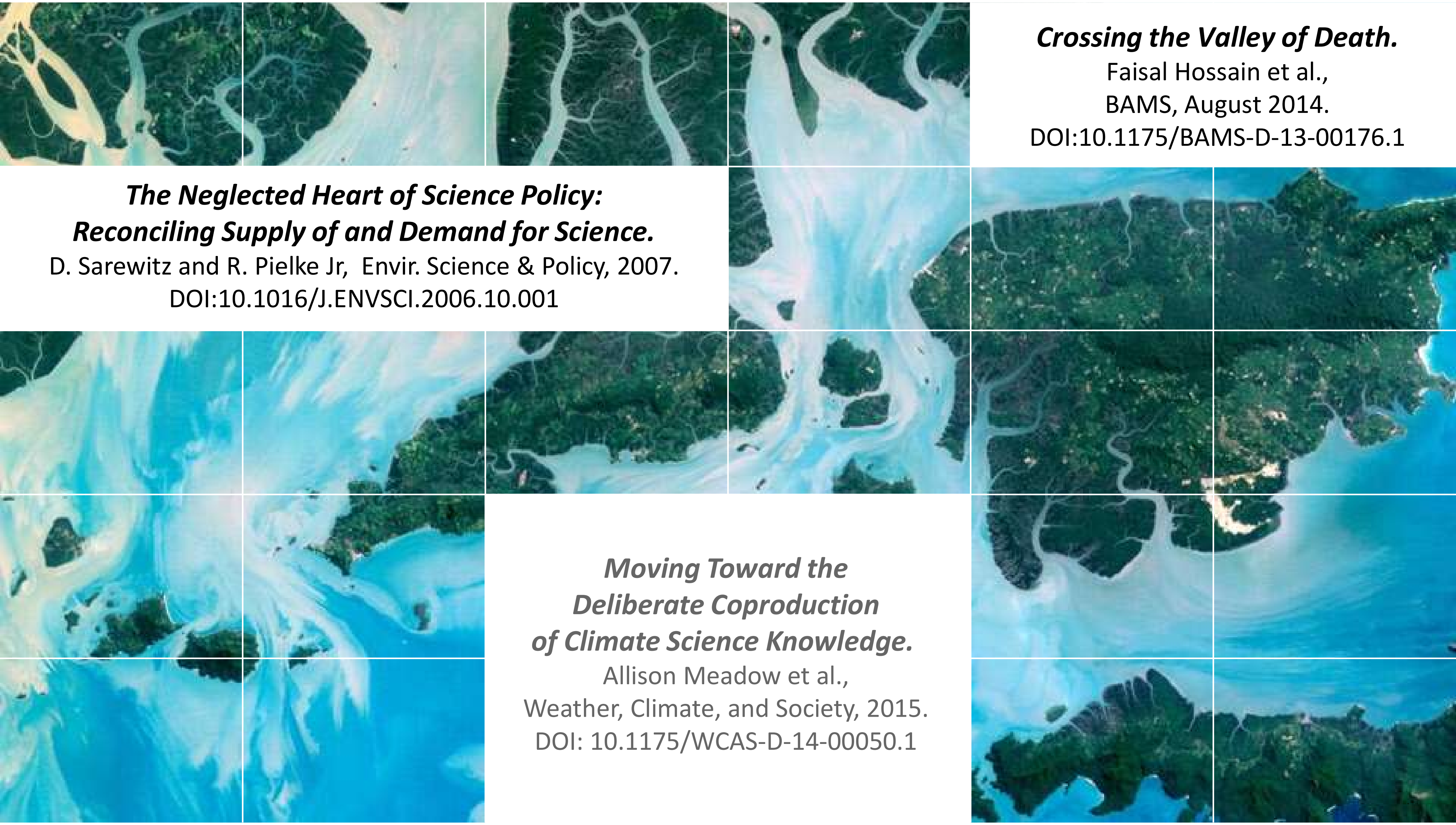
NASA Earth Science has defined science to include research, applied research, and applications with the emphasis based on the specific activity. Suggested differentiation …

Research: Fundamental learning to explain phenomena and understand processes in the natural world → *What role does soil moisture play in the water cycle?*

Applied Research: Development of scientific knowledge directed to particular result and codification of knowledge in models and tools for predictive capabilities → *Development of groundwater and soil moisture drought indicator variables derived via GRACE-FO and other observations*

Applications: Uses of data and information products to inform decisions and guide actions of organizations for policy, business, and management activities
aka, decision-support applications → *Integration of GRACE-FO based indicators into the information flow and decision process for weekly production of the U.S. Drought Monitor*

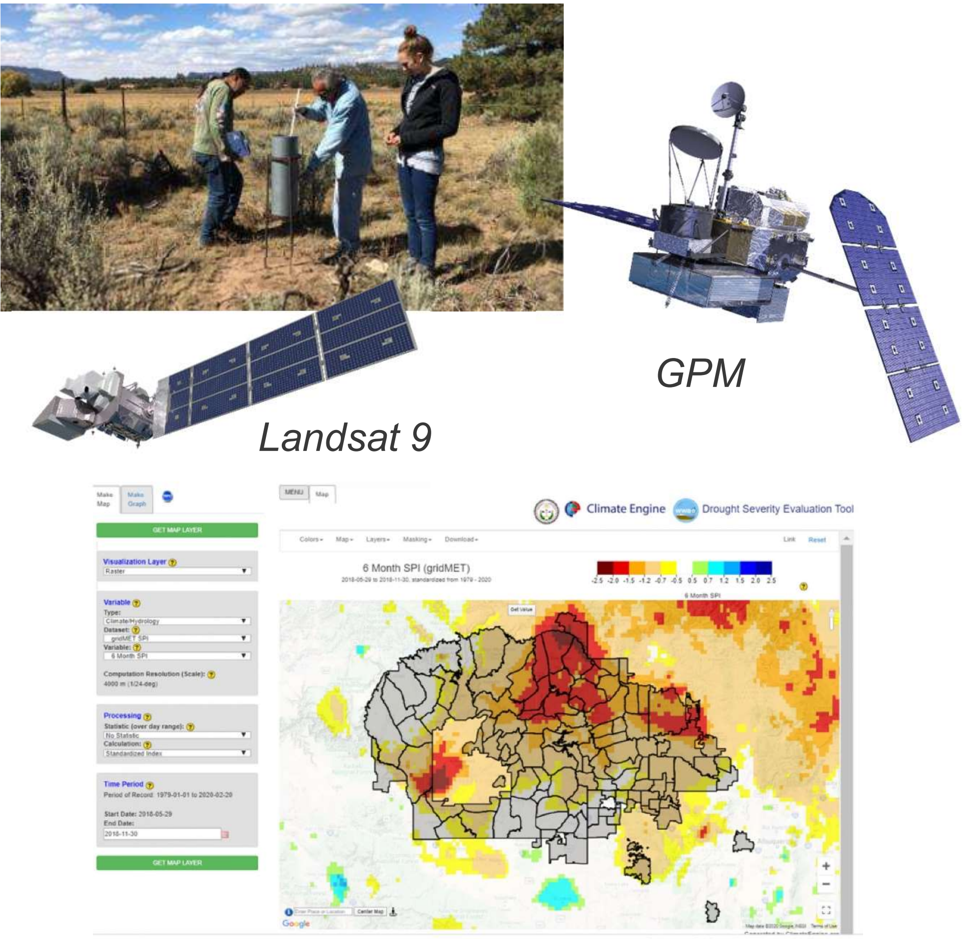




Crossing the Valley of Death.
Faisal Hossain et al.,
BAMS, August 2014.
DOI:10.1175/BAMS-D-13-00176.1

The Neglected Heart of Science Policy: Reconciling Supply of and Demand for Science.
D. Sarewitz and R. Pielke Jr, Envir. Science & Policy, 2007.
DOI:10.1016/J.ENVSCI.2006.10.001

Moving Toward the Deliberate Coproduction of Climate Science Knowledge.
Allison Meadow et al.,
Weather, Climate, and Society, 2015.
DOI: 10.1175/WCAS-D-14-00050.1



Outlook across the Navajo Nation:
Warmer colors representing drought conditions.

Navajo Nation Enhancing their Water Management

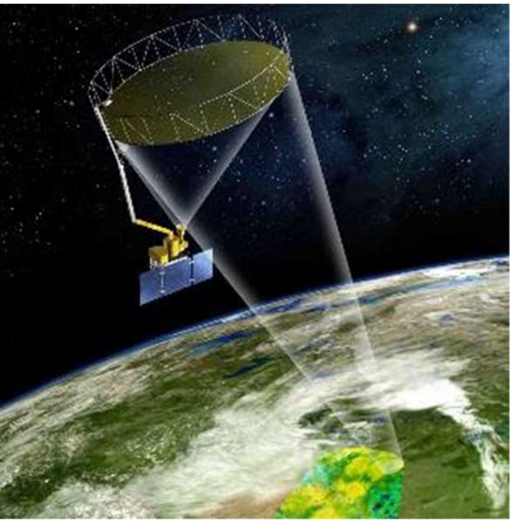
The Navajo Nation augments their sparse and limited ground-based measurements with Earth science data and drought monitoring tools

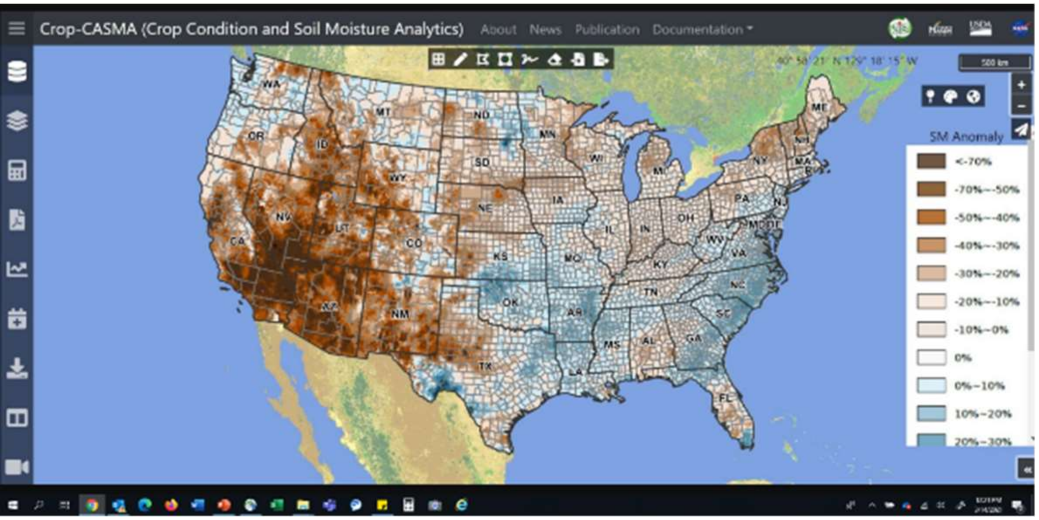
Drought Severity Evaluation Tool is operational at Navajo Dept. of Water Resources

The Navajo Nation uses the tool in allocating water resources and drought relief funds across their 110 chapters in more efficient and equitable ways

Data & Info:

GPM *CHIRPS* *Landsat* *Rain Gauges* *Models*

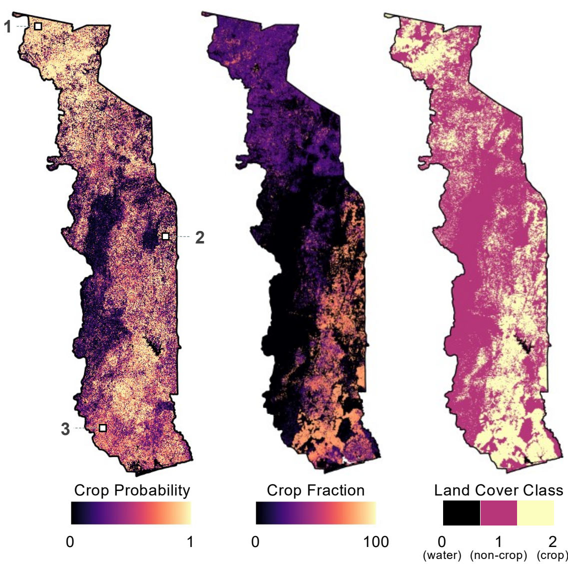




Soil Moisture Data in Hands of Farmers

Farmers looking for help on where their fields need water and where they can conserve have a new tool, using data from NASA's SMAP satellite. USDA's Crop Condition and Soil Moisture Analytics tool helps people grasp the impact of extreme events like flooding and drought and identify conditions that might prevent planning.

Example Use: USDA's weekly Crop Progress Reports, which give information to help make plans for when to plant crops, track crop health and growing progress, and forecast agricultural yields.



10-m cropland maps of Togo


Covid-19: Lomé launches agricultural response plan to help farmers cope amidst the pandemic

AGRICULTURE Friday, 01 May 2020 12:01

Enabling Rapid Response for Food Aid during Covid-19 Pandemic

In alignment with daily curfews to contain the spread of Covid-19, Togo instituted a 100% digital G2P cash transfer scheme to supplement the livelihoods of agrarian rural communities and hundreds of thousands of informal workers.

Togo worked with the NASA Harvest Consortium for 10-m maps of the nature and distribution of agricultural land. Together with poverty data, the maps supported the design of social protection policies like a loan program to farmers for the purchase of inputs and the renting of machinery.

Impact: Water Quality

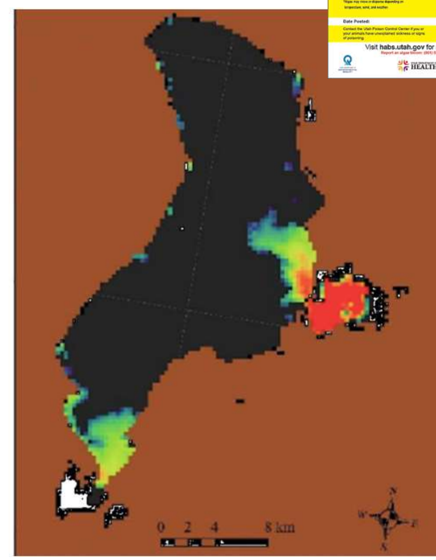
Earth science data, such as chlorophyll-a, help detect algal blooms often before they are visible with the naked eye. The insights allow pro-active and preventative actions to reduce human and animal exposure and improve health.

What was the value of using satellite data to detect a harmful algal bloom and manage recreational advisories in Utah Lake in 2017?

~$370,000 in socioeconomic benefits associated with improved human health outcomes per stated assumptions

Utah Lake, Utah

Landsat 8
June 20, 2017
Algal bloom shows as darker water



Copernicus Sentinel-3
June 21, 2017
Red, orange, yellow show higher concentrations of cyanobacteria

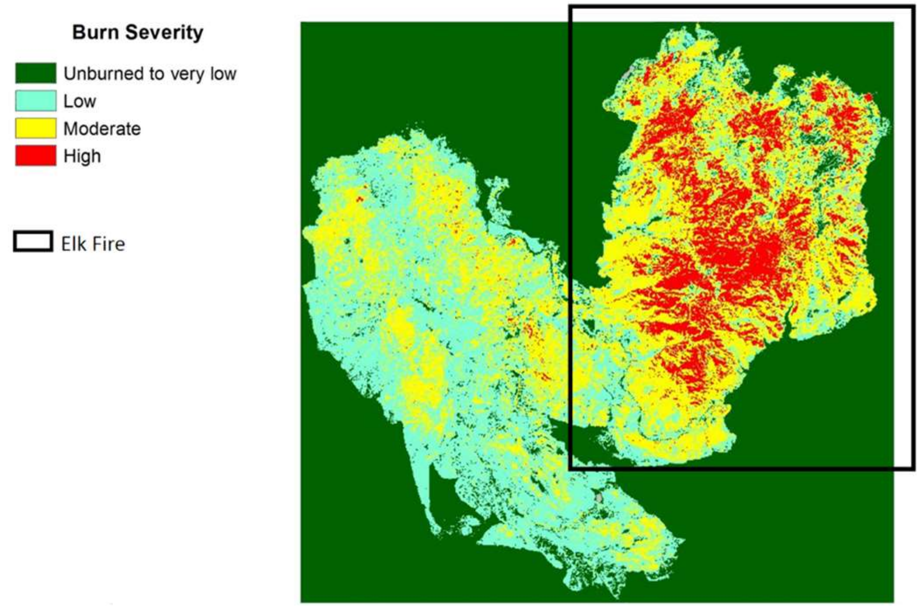
Stroming et al., *GeoHealth* 2020 DOI

Impact Analysis: Wildfires

Within two-weeks of a wildfire, Federal agencies need to determine where to target remediation efforts to shore-up soils, vegetation, etc. A project worked to apply Earth observations to this process.

What were the savings from using Landsat imagery to prioritize post-wildfire response activities?

Impact analysis: Landsat saves Federal agencies up to $7.7 million each year in post-wildfire response costs



Burned Area Reflectance Classification (BARC) map based on Landsat imagery for the 2013 Elk Complex Fire, Boise National Forest, Idaho

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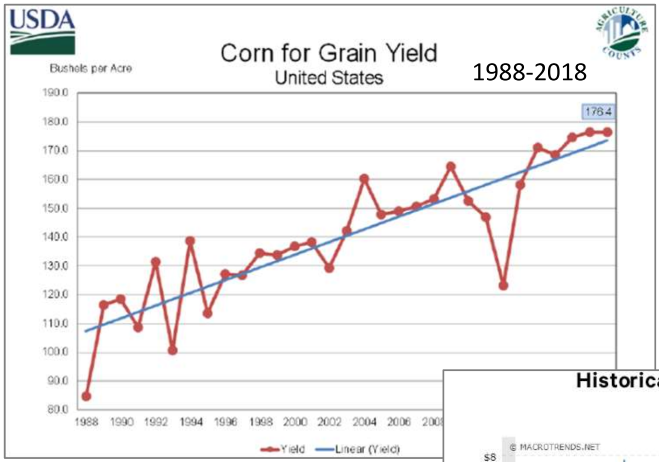
Publication: "Monetising the savings of remotely sensed data and information in Burn Area Emergency Response (BAER) wildfire assessment" (Bernknopf et al., *International Journal of Wildland Fire* 2020 https://doi.org/10.1071/WF19209)

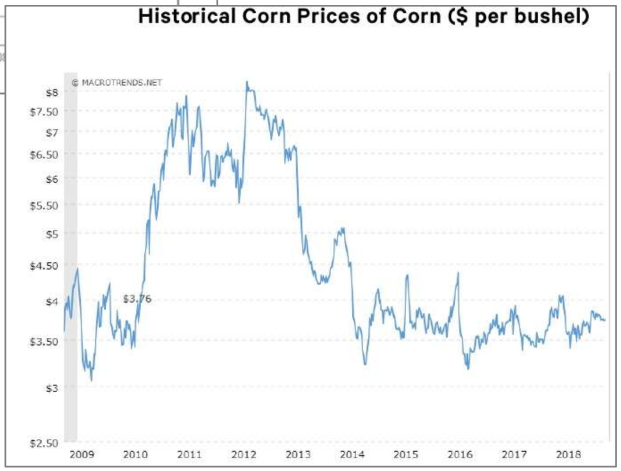
Impact Analysis: Agriculture

Soil moisture is a variable in managing agricultural production and predicting crop yields.[1] This study used market-based methods to quantify the value of SMAP data, as weather uncertainties are reflected in agricultural risks in market trading.

What is the value of a 30% reduction in weather-related uncertainty in corn and soybean futures markets?

Impact analysis:
$0.9 billion for U.S. corn and
$0.5 billion for U.S. soybeans annually





Publication: [1] "Market-based methods for monetizing uncertainty reduction" (Cooke and Golub, *Environment Systems and Decisions* 2019 https://doi.org/10.1007/s10669-019-09748-w)