

*The SMAP mission is in the first tier recommended by the 2007 National Research Council (NRC) Earth Science Decadal Survey*

Incorporating applications into mission plans is not optional, but rather

- 1) Mandated from Congress with the NASA authorization act,
- 2) Recommended as a requirement from the National Research Council.
- 3) Critical component of the SMAP Applied Sciences activities AND
- 4) Quickly become a measure for mission's success



# What is an Application?

**Applications** are defined as innovative uses of mission data products in decision-making activities for societal benefit.

**Applications research** will provide fundamental knowledge of how mission data products can be scaled and integrated into users' policy, business and management activities to improve decision-making efforts.

**User Community** includes

- individuals or groups
- public or private sectors
- national or international organizations
- local to global scales of decision making



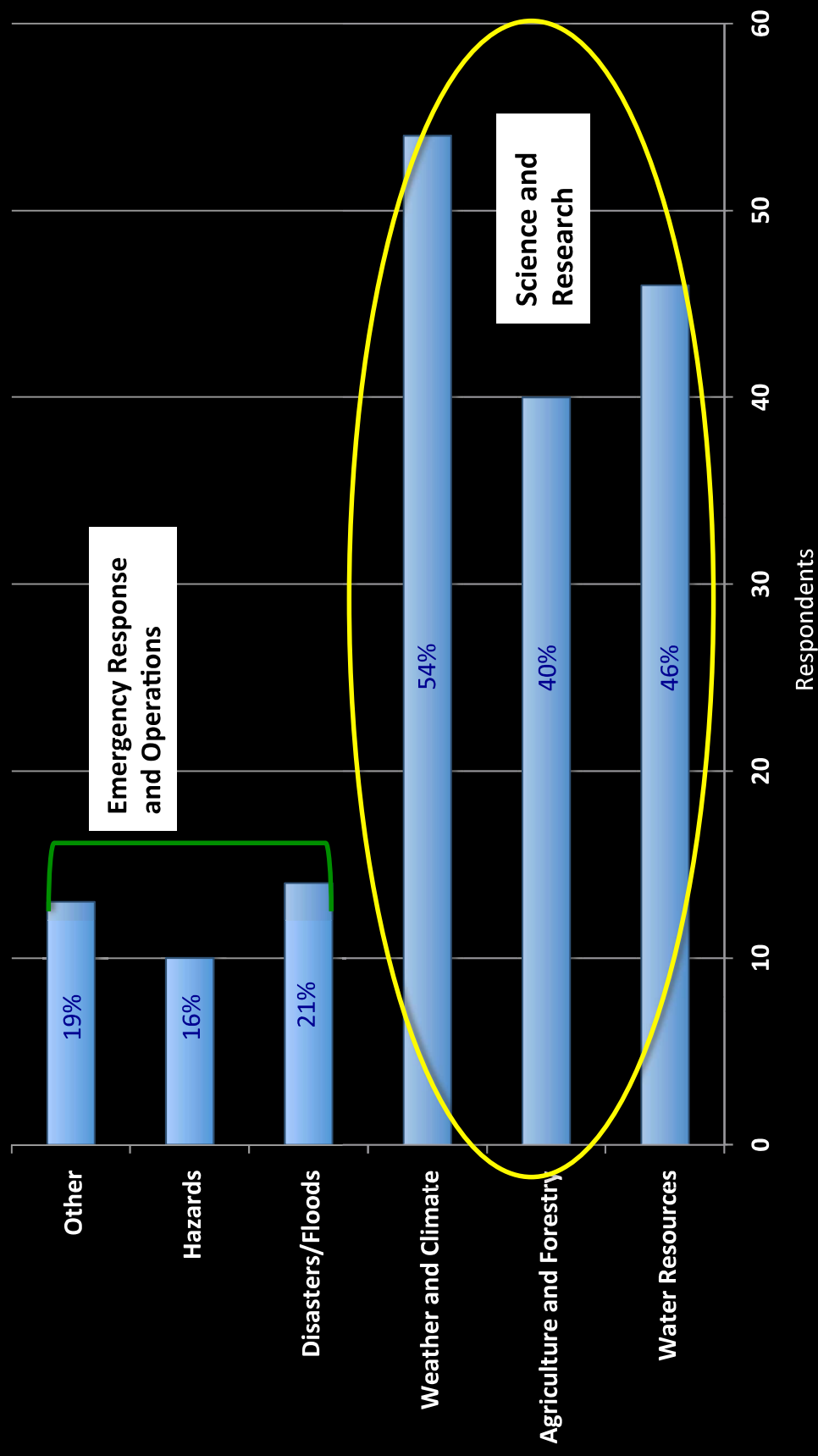
# Assessing the SMAP community- SMAP Survey conducted in 2012

Results revealed that the SMAP user community had:

- Gap between research and policy applications
- High perceived value of soil moisture
- Uncertainty as to how ground observations will scale to remotely sensed data
- Where to access SMAP-like data

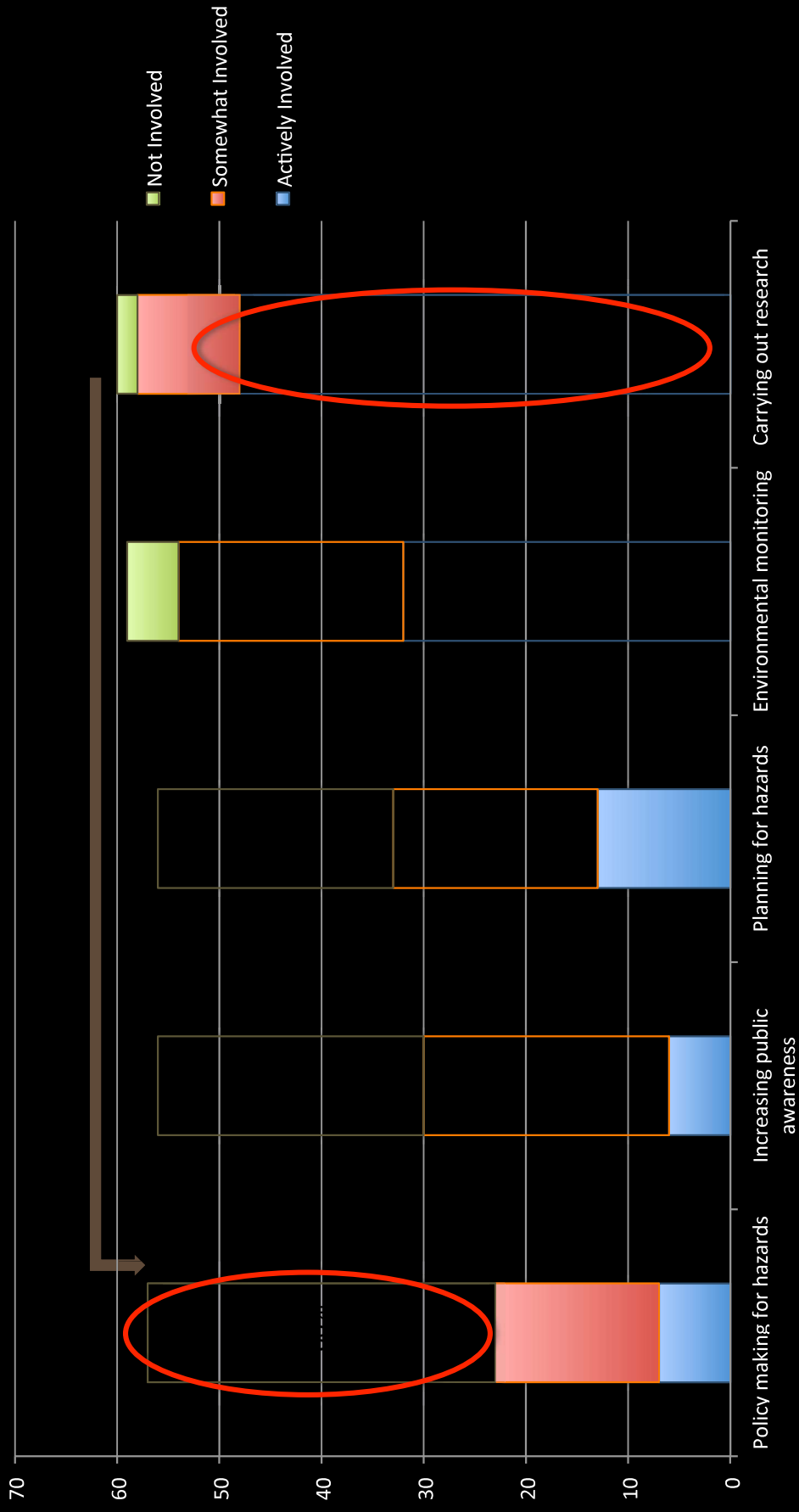
# Applications will focus on bridging gaps

- Results show most users associated with SMAP are research/science users.
- Operational users were under-represented. *Our goal is to address this gap*



# Move science into action

- A clear need to facilitate the movement of research into policy.







# Early Adopters

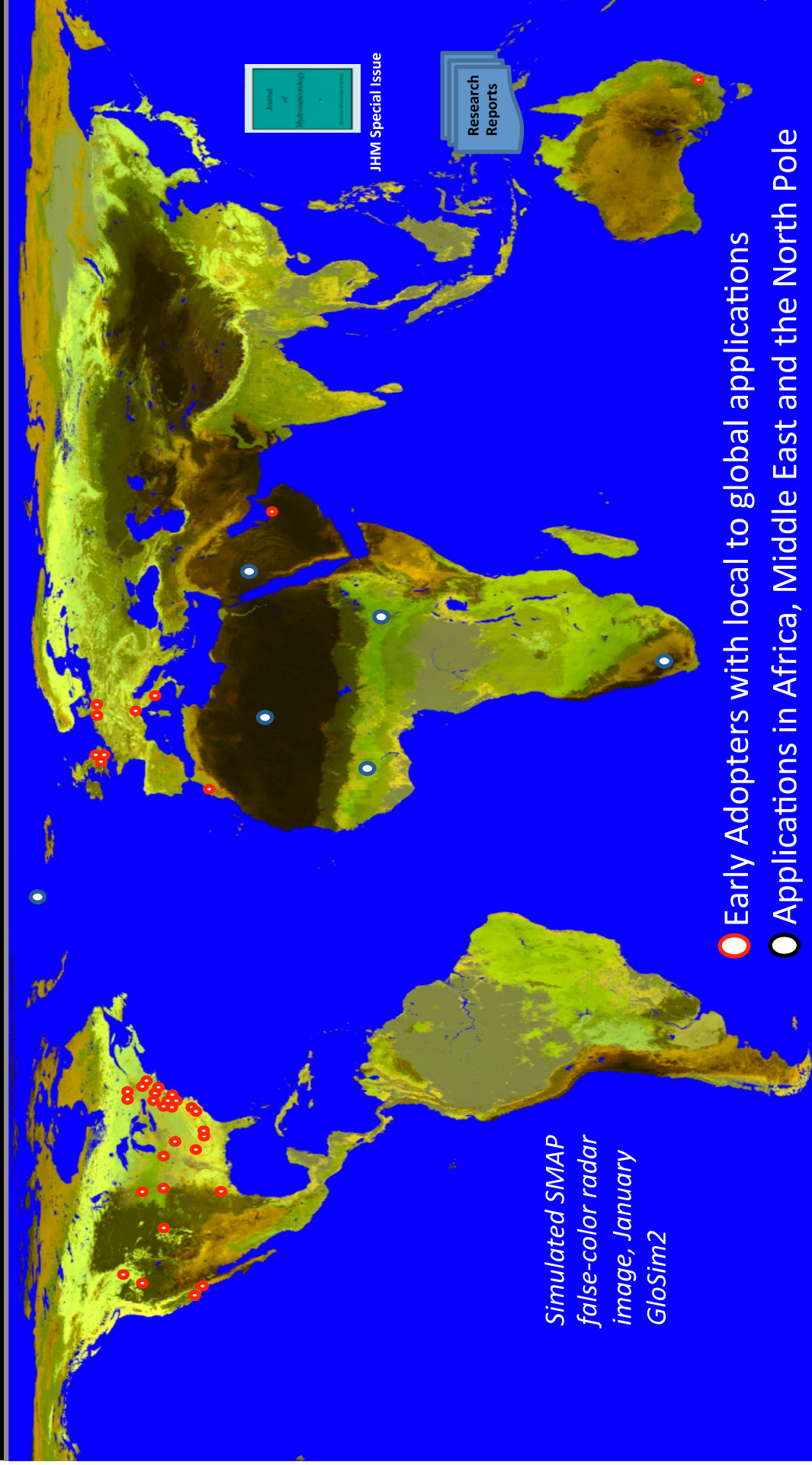
- The Early Adopters are a subset of the mission user community.
- The EA Program is a volunteered effort that links the EA to the SMAP ST to trade ideas, guidance and feedback in an effort to understand the applications of SMAP data





*Simulated SMAP  
false-color radar  
image, January  
GloSim2*

- Early Adopters with local to global applications
- Applications in Africa, Middle East and the North Pole



JHM Special Issue



Research Reports



**SMAP Early Adopters are Spanning Agriculture, Weather, Emergency Response, Human Health, and Military Readiness**



# SMAP Early Adopter Program

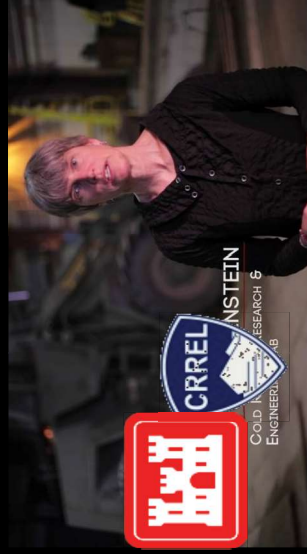
- Short-term Prediction Research and Transition (SPORT)
- Early Adopters working to assimilate SMAP observations into real-time, high-resolution land surface model output to support National Weather Service users
- Bradley Zavodsky (NASA/MSFC), Jonathan Case (ENSCO, Inc.), Dr. Clay Blankenship (USRA)



- NASA National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center (DAAC)
- Siri Jodha Khalsa, Amanda Leon, Karla LeFevre, Shannon Leslie, and Mike Laxer,



# Who are the Early Adopters?



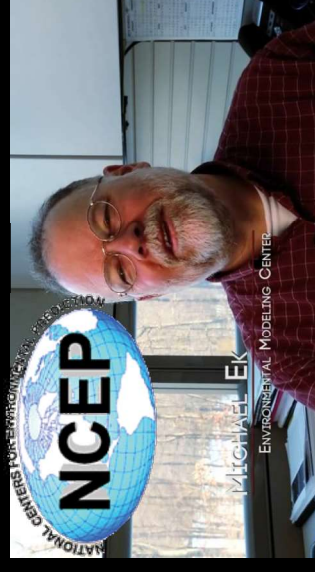
US Army: “When you are talking about soil moisture, you are talking about mobility or you are talking about water security.”

National Drought Mitigation Center: “As we get these data at a higher resolution, covering the entire country, we are going to do our jobs better.”



NOAA: “There is a number of conditions of the surface that we need to know. And soil moisture is probably one of the most important.”

NASS: “Potentially, this could be a really big cost saving measure for our organization.”



*video at [smap.jpl.nasa.gov](http://smap.jpl.nasa.gov), publications at [journals.ametsoc.org/page/smap](http://journals.ametsoc.org/page/smap)*

# Who are the Early Adopters?



Columbia University: “[SMAP] will protect not only the lives, but the livelihoods, of rural populations that are vulnerable to the impacts of drought and floods.”



AER: “SMAP is going to have a capability to resolve more details in flood events at a more timely manner. This is important for disaster management...”



CUNY: “We are looking at the quality and amount of water that is available to the City of New York.”

video at [smap.jpl.nasa.gov](https://smap.jpl.nasa.gov) , publications at [journals.ametsoc.org/page/smap](https://journals.ametsoc.org/page/smap)

# Early Adopters Post Launch

SMAP Mission Applications Themes	
Weather and Forecasting (5 EAs)	Agricultural Productivity (11 EAs)
Droughts (9 EAs)	Human Health (5 EAs)
Floods (7 EAs)	National Security/Mobility (3 EAs)
Carbon (1 EA)	
SMAP Mission Applications Themes-Expanded by EAs	
National Security-Sea Ice (5 EAs)	Decision Support/Communication Tools (6 EAs)

- Total of **52 Early Adopters** for SMAP Mission
- Research and collaboration between the SMAP ST and each EA organization will continue with each EA to provide clear metrics and an analysis of the value of soil moisture or freeze/thaw data in their application.
  - EA case study per EA category
- Early Adopters given the opportunity to apply for access to pre-beta-release products for their research through a formal request to the SMAP Applications Team

# SMAP Application Samples



# Flooding

# Global application of soil moisture for flooding

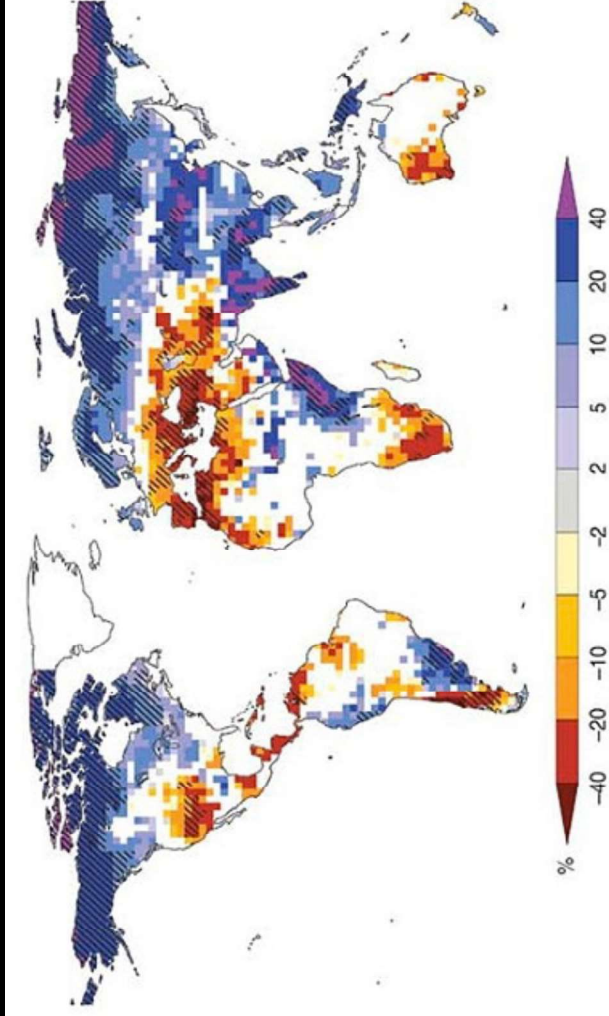
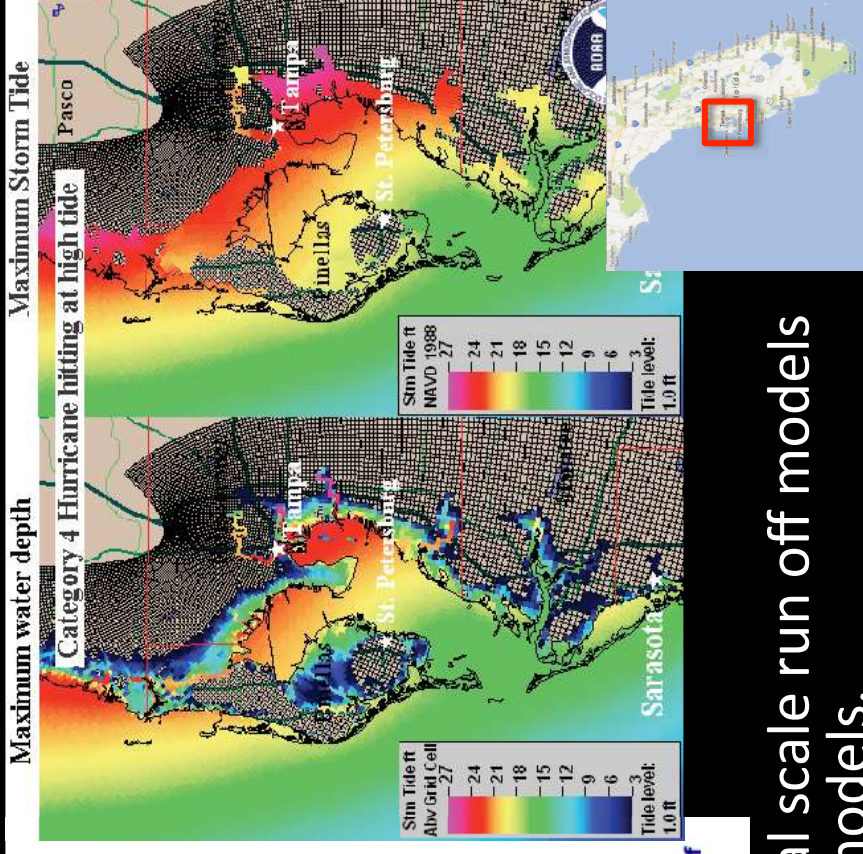


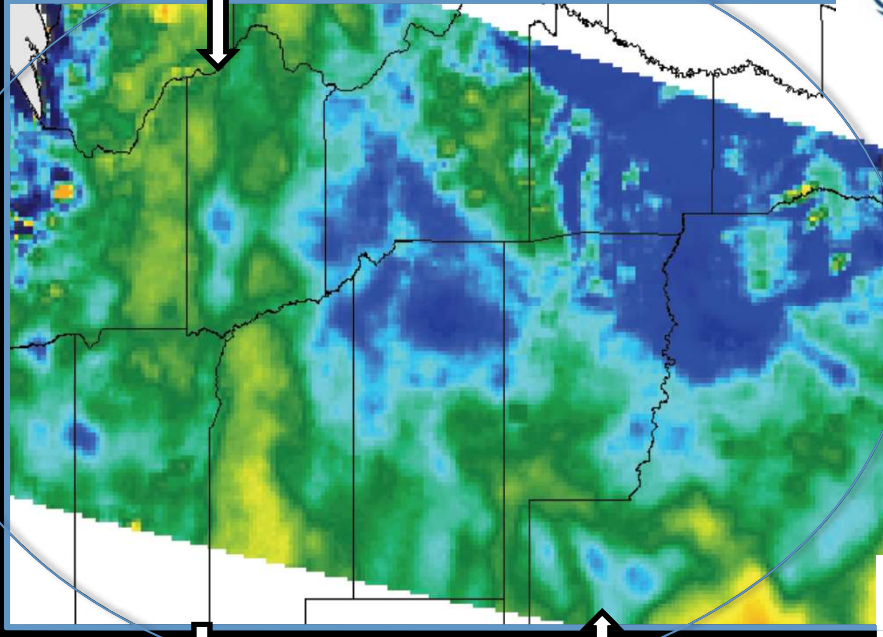
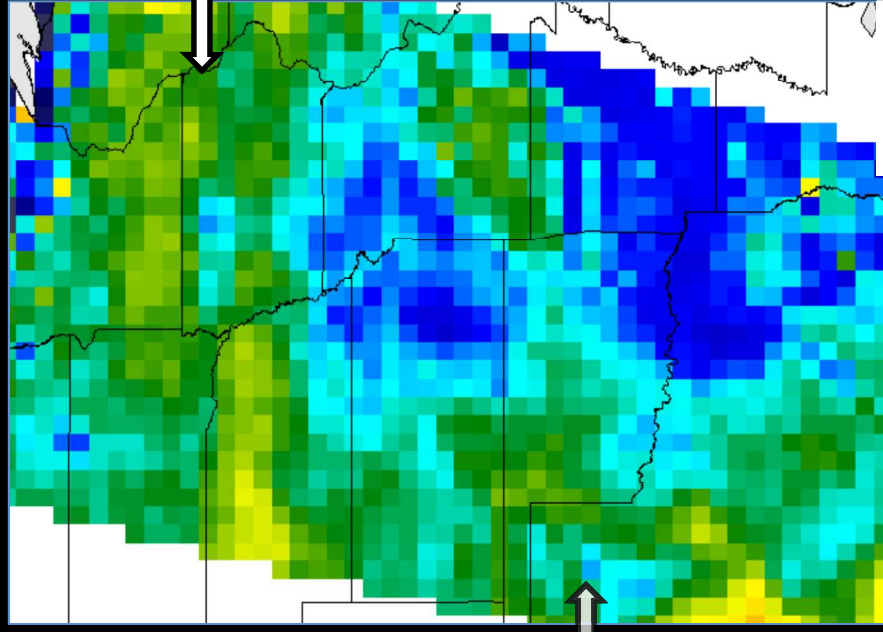
Figure 10.18 Runoff model projections of large-scale relative changes in annual runoff for the period 2090-2099 relative to 1980-1999. Courtesy IPCC



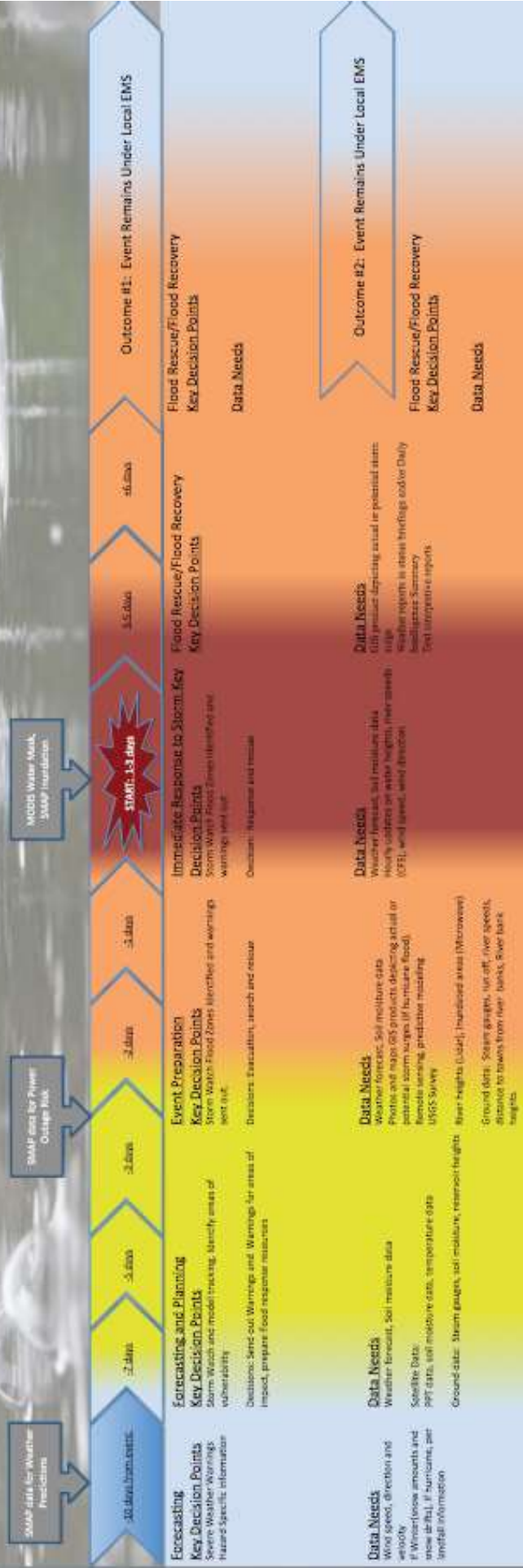
- Evaluate global scale run off models with climate models.
- Evaluate scenarios at the global scale using soil moisture data.
- Evaluate the scale of data needed for decision making.



# Improve how we communicate to practitioners



# U.S. Flood Planning and Response Decision/Data Time Line



**UNCERTAINTY** (Red section) | **ACCURACY** (Green section) | **Accuracy Needs?** (Green section)



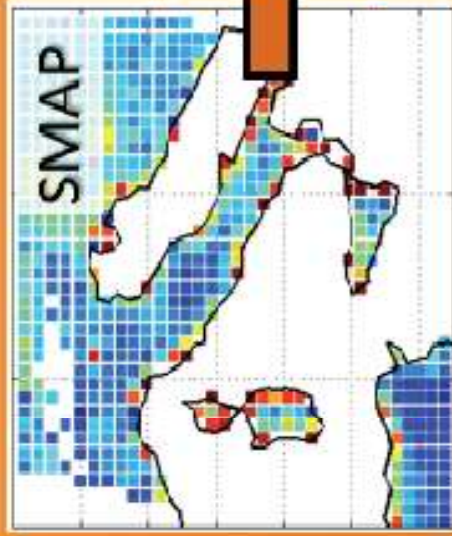
# Flood Mitigation in Central Italy



Research Institute for Geo-Hydrological Protection, Luca Brocca

## NATIONAL SCALE FLOOD WARNING SYSTEM

3



Integration of SMAP soil moisture and ground-based precipitation observations for flood (and landslide) alert issuing at national scale.

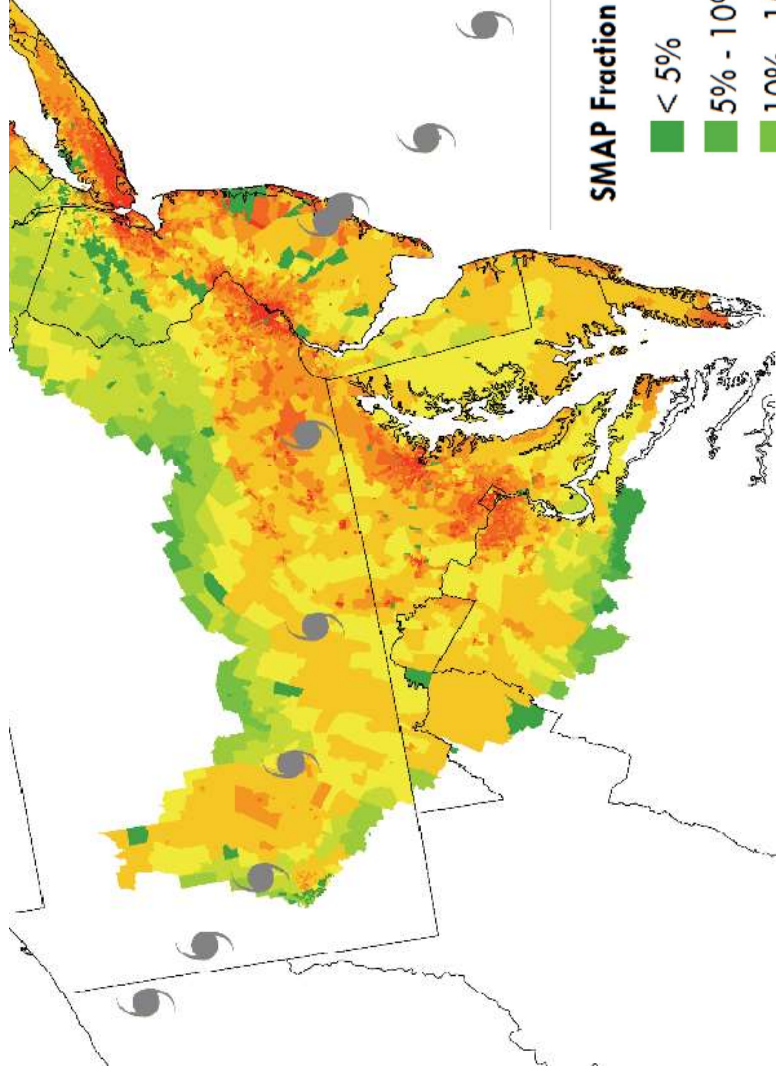


# Hurricane Power Outage Prediction



**Texas A&M University**, Brent McRobert, Steven Quiring

Prediction of Power Outages for Sandy Wind Field  
With modeled soil moisture: 15,989,091 people affected  
With SMAP soil moisture: 16,327,051 people affected



*Outage predictions are sensitive to soil moisture.*

*Using SMAP data has a significant impact on predictions of people affected by outages.*

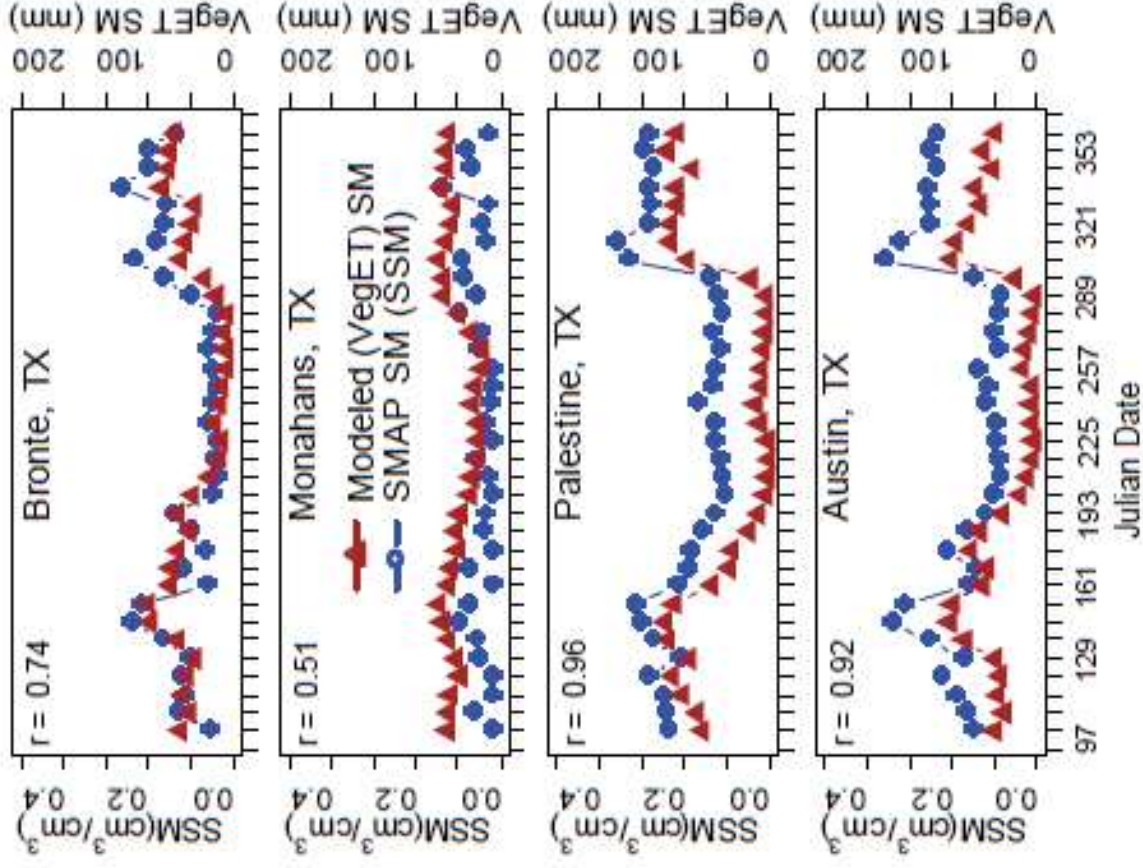
Drought



# Drought Monitoring



**U.S. Geological Survey**, Manohar Velpuri, Jeff Morisette



USGS conducts drought monitoring in areas dominated by grasslands and shrublands.

SMAP showed a reliable and expected response of capturing seasonal soil moisture dynamics in relation to precipitation, land surface temperature, and evapotranspiration.



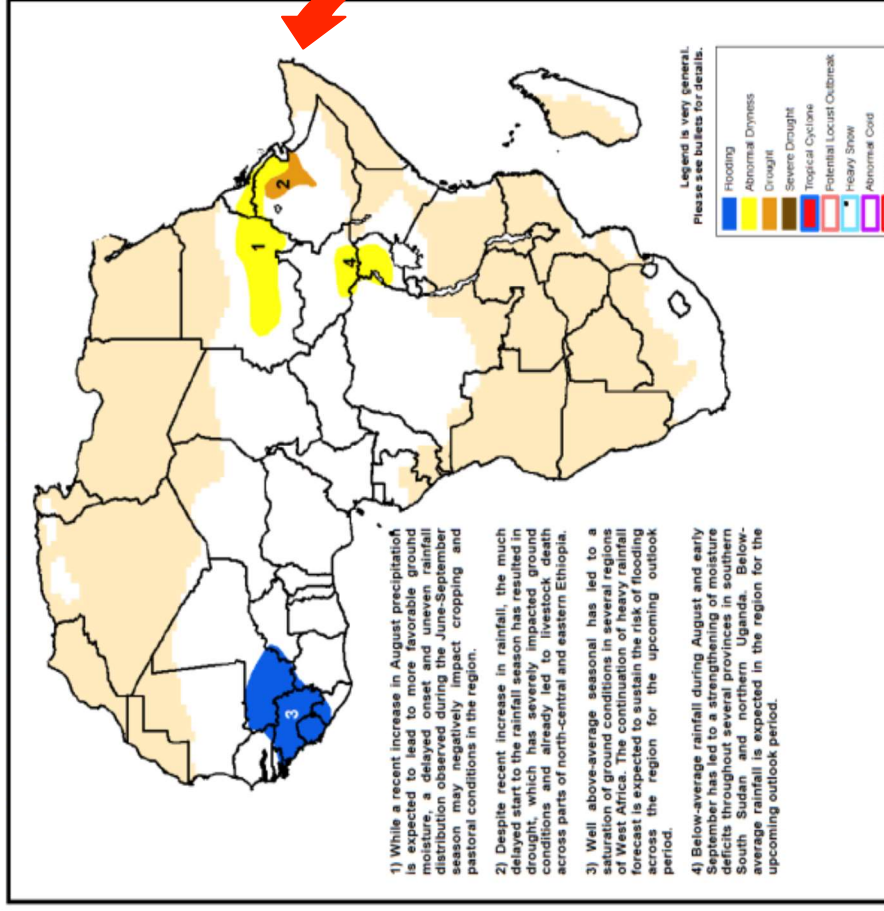


# Famine Early Warning System (FEWS) in Africa



**USGS & UC Santa Barbara**, Chris Funk, Amy McNally and James Verdin

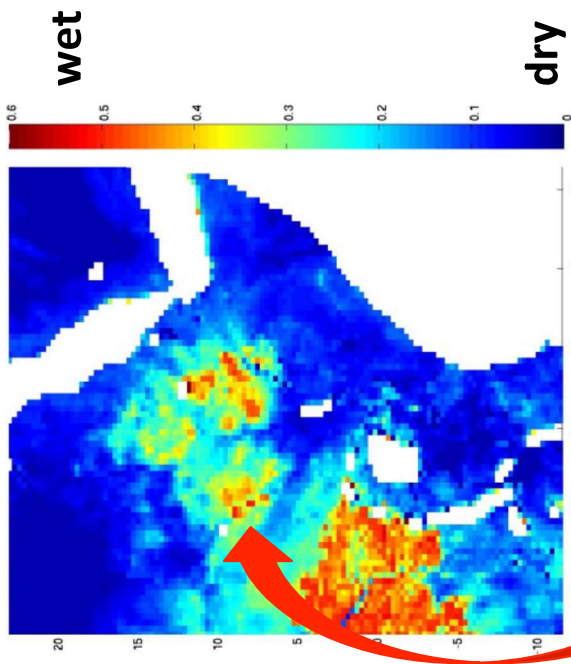
## Climate Prediction Center's Africa Hazards Outlook Sept. 24-30 2015



**FEWS reports drought in Ethiopia but higher than average September rain.**

**SMAP images will be introduced to FEWS analysts for better famine prediction**

**Sept. flooding in East Africa is captured by SMAP L-3 regional images (Sept 10-18).**



**SMAP sees moderately-to-very wet soil.**

# Improving Forest Fire Risk Maps

Barcelona Expert Center, ICM/CSIC, UPC, *Maria Piles*

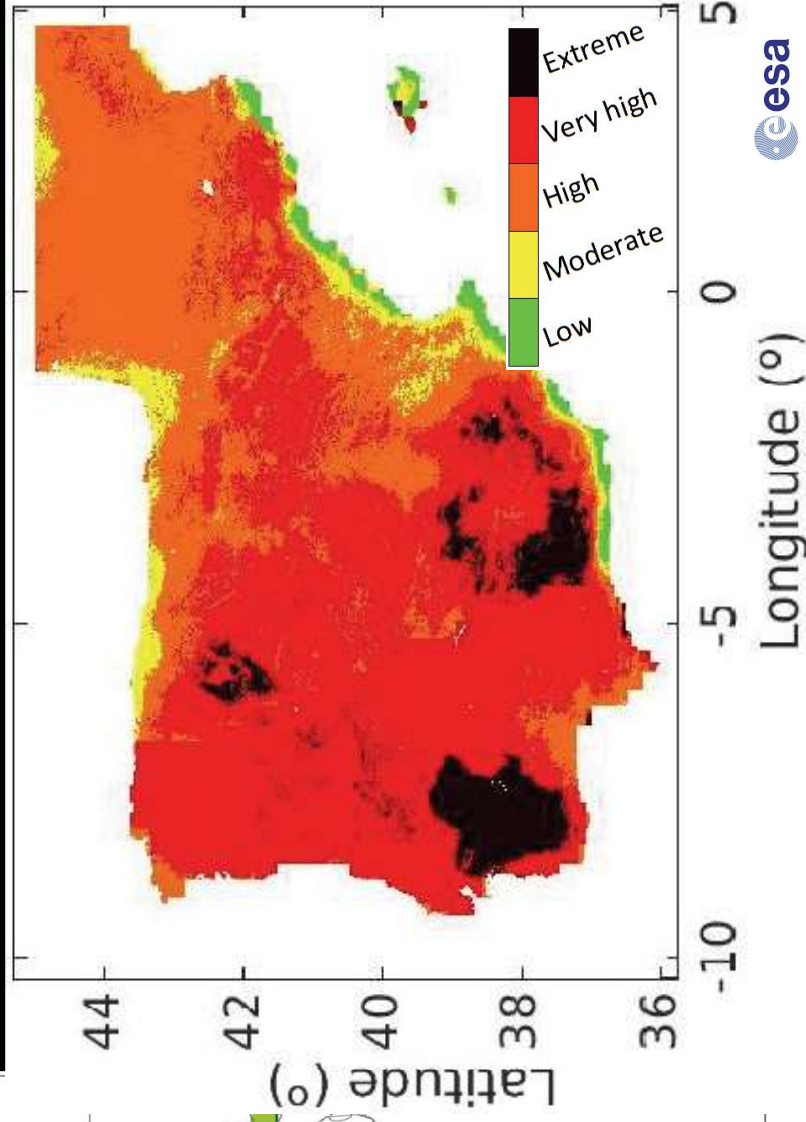
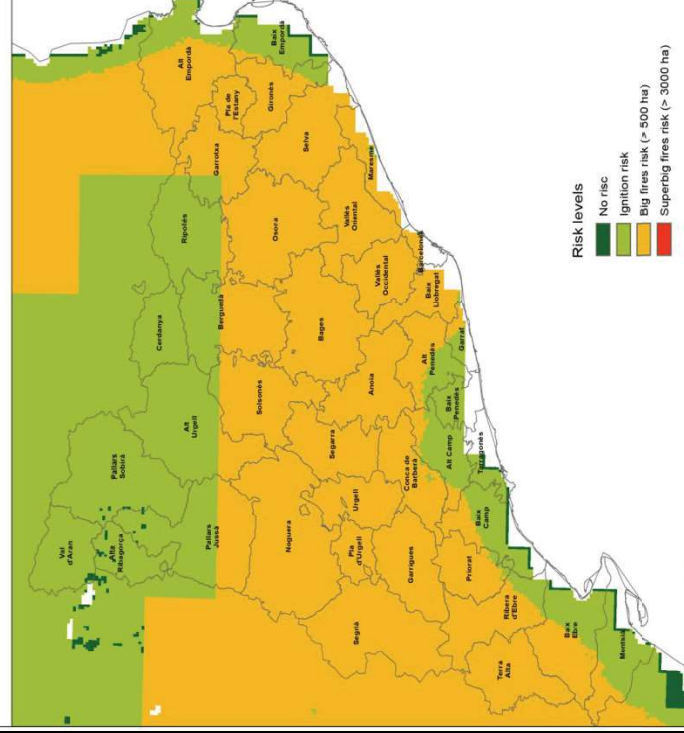
*The Barcelona Expert Center provides free access to fire risk maps.*

Map showing 5 fire risk categories based on modeling and SMAP soil moisture product.

## FIRE RISK MAP USING SOIL MOISTURE DATA

24/06/15

Fire risk map using soil moisture data from downscaling images at 1 km resolution of SMOS.  
Source: SMOS Barcelona Expert Centre



# Decision Support Tools



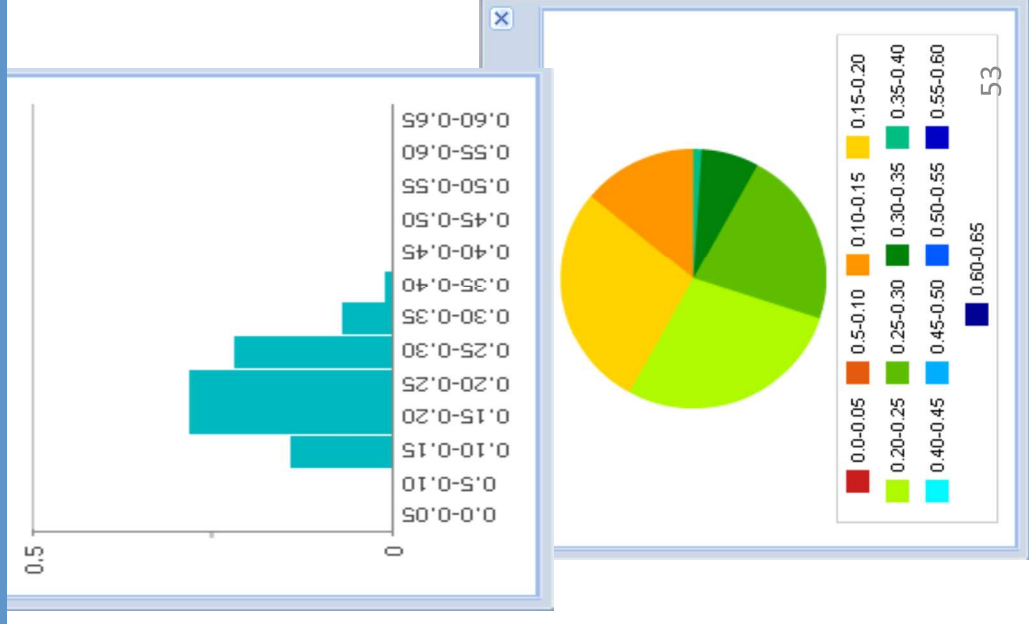
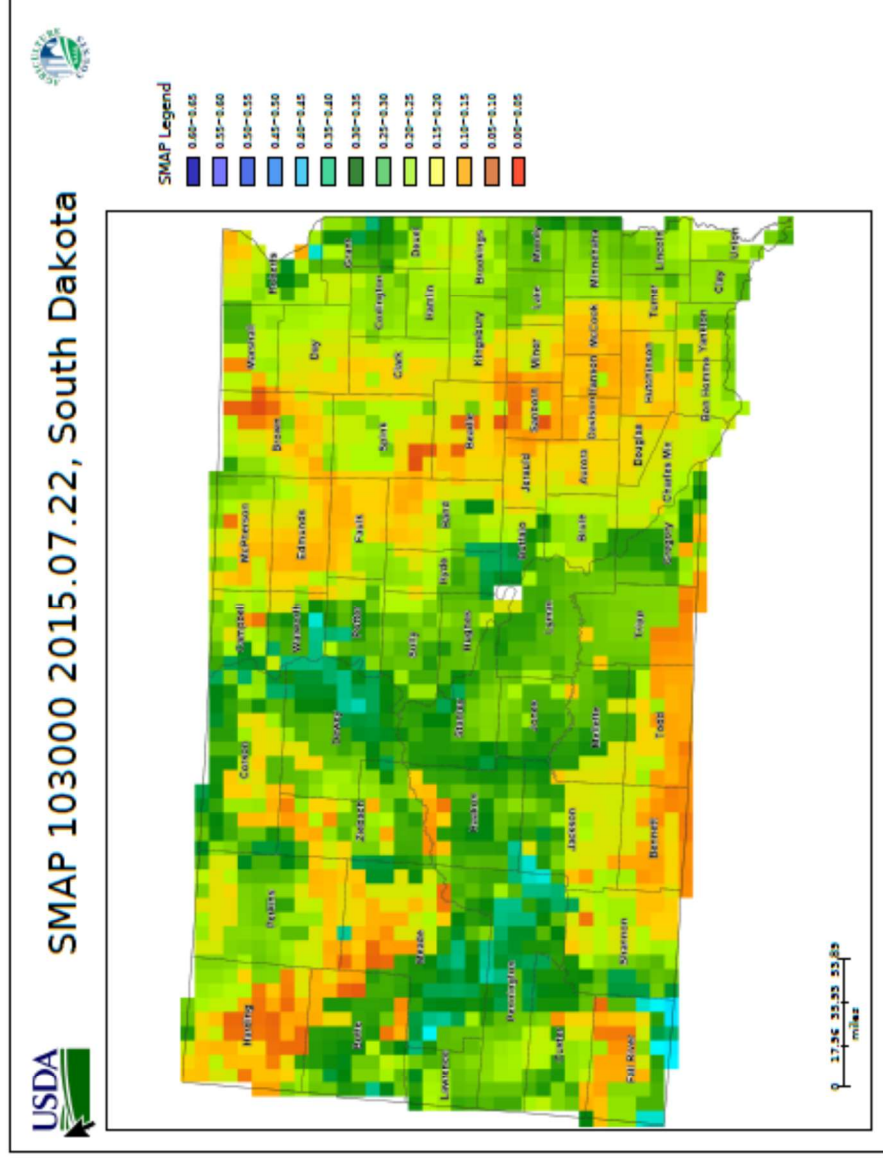
# USDA Crop Condition Report



**USDA National Agricultural Statistics Service**, Zhengwei Yang, Rick Mueller

*USDA NASS VegScope visualization, analytics  
and dissemination tool*

**Soil Moisture Statistics for South Dakota  
2015.07.22**





# Military Vehicle Mobility

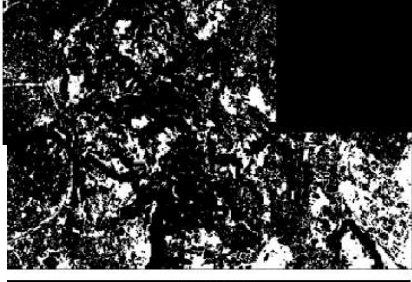
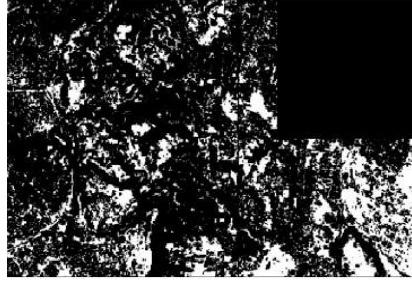


**Lockheed Martin**, Derek Ward

Mobility Map **without using** SMAP data,  
Assuming soil 30% saturation



Mobility Map **using** SMAP data,  
With a continuum of soil moisture information



HumVee

ATV

Transport  
Truck

Light  
Truck

*White denotes areas identified as GO mobility for 4 vehicle types.*

*With SMAP, we are better able to predict mobility of vehicles in **Central Indonesia**.*

*NATO Reference Mobility Model is the basis for the calculations.*



# Google Earth Engine Analysis Platform



**Google Technology Company,** Tyler Erickson, Rebecca Moore

The screenshot displays the Google Earth Engine web interface. At the top, the browser address bar shows the URL `https://code.earthengine.google.com`. The main interface is divided into several panels:

- Scripts Panel:** Shows a list of scripts under the 'sample\_reprojected\_to\_4326' project. The selected script is 'sample\_reprojected\_to\_4326', which contains the following code:

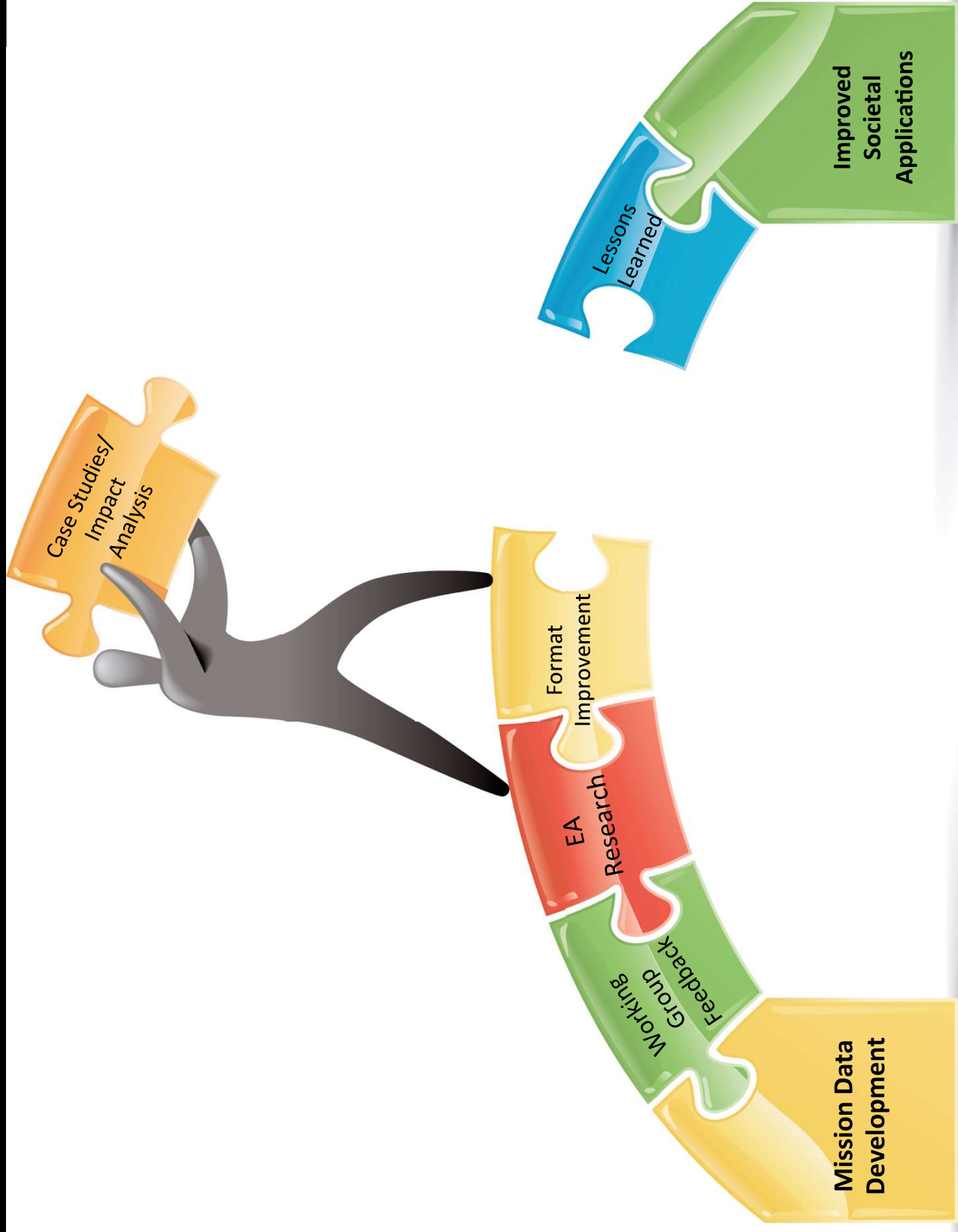
```
Imports (1 entry)
var sample_I3: Image users/tylere/SMAP/test2016-07-13...

1 Map.addLayer(
2   sample_I3,
3   {min:0, max:0.5, palette:'red,yellow,green,blue'},
4   'sample_I3'
5 );
```
- Inspector Panel:** Shows the execution results for the selected script, including a point coordinate and pixel values:

```
> Point (-4.75, 9.62) at 20km/px
-> Pixels
  > sample_I3: Image (1 band)
    b1: 0.22196854650974274
  > objects
```
- Map Panel:** Displays a global map with a color-coded overlay representing soil moisture data. The map shows high moisture (red/orange) in the Amazon basin and low moisture (blue) in the Sahara and parts of the Arctic.
- Layers Panel:** Shows the current map layers, including 'Map' and 'Satellite'.

*Screenshot of a SMAP L3 Soil Moisture data product within the Earth Engine platform*

# Applications Bridge Science & Societal Application through EAs



# What's Happening Now?

## Case Studies

- Case Study: an “example project” that can demonstrate both science and societal impact.
- We ask: *How are SMAP science products used in decision support systems and how does the new data stream affect the system performance?*  
1 case study per category of SMAP Mission Applications by 2018.
  - (Weather, drought, flood, agriculture, health and national security)
- *Currently working on understanding the societal impacts of EAs involved in weather, agriculture, flood and drought.*



# Early Adopter Feedback

- Improved Data Services for DAACs
- Tutorials and SMAP hands-on learning
- Improved formats and context for broadening user community
- Inform and guide future mission on Applications Program
- Inform new decadal survey missions (EA Program already moving forward at NASA)
- Joint mission products and opportunities
- Commercial users for SMAP data
- Lessons Learned Document for NASA HQ
- Data Impact for societal applications-a need for **Case Studies**

# Application Strategies and Events

- Workshops and meetings
- Translate science for targeted applications
- Networking and identifying synergistic opportunities before and after launch.
- Thematic Focus sessions are hosted by our end users at their facility to highlight their uses and needs.
- Conduct data tutorials to educate on mission applications and have hands on opportunities to work with the data.
- The Early Adopter Program

***Common theme: Building Relationships, leverage capabilities and address challenges as early as possible.***

# Team Effort to engage SMAP end users



SMAP Applications Started back in  
2009

Peggy O'Neill, Vanessa Escobar,  
NASA GSFC

Simon Yueh, Seungbum Kim, Erika  
Podest, Narendra Das, Steven  
Chan, Eni Njoku, NASA JPL

Amanda Leon, NASA NSIDC DAAC

Susan Moran, Wade Crow and Tom  
Jackson, USDA