Earth Observations Assessment

Disasters

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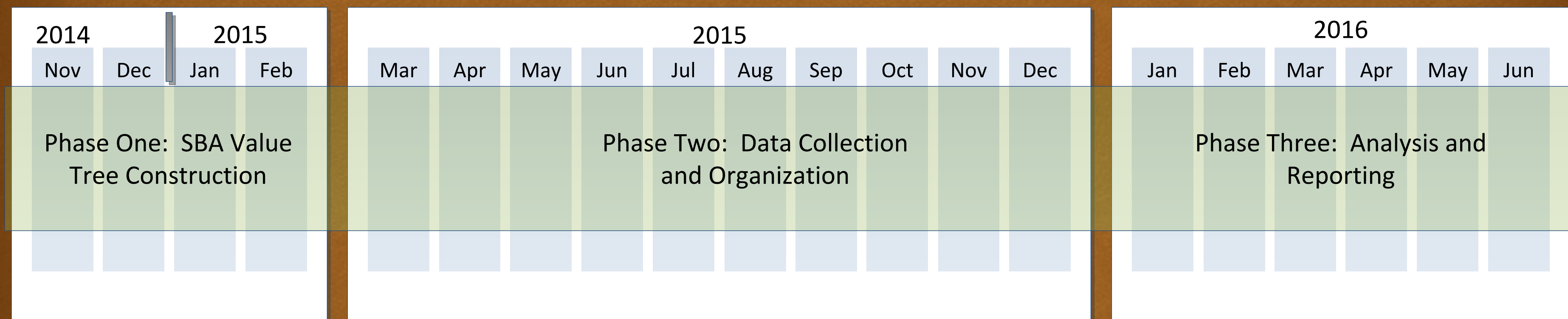
Background:

NASA Authorization Act of 2010 provided congressional instruction to develop a triennially updated strategic plan. National Strategy for Civil Earth Observations (2013) established a triennial assessment. First Earth Observation Assessment (EOA 2012) was input to the National Plan for Civil Earth Observations (2014).

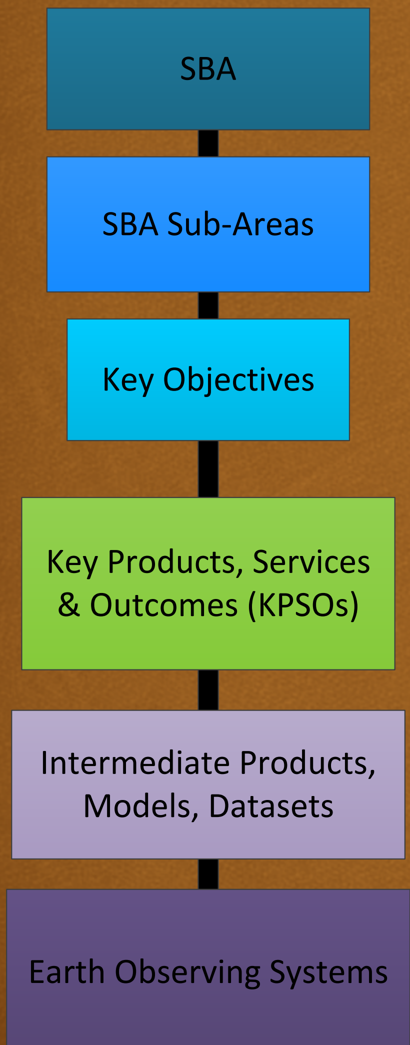
EOA 2016: Produced an assessment of the portfolio of Earth observing systems that support Federal agencies in the framework of SBA. EOA 2016 provided greater detail regarding the uses of Earth observing data in the delivery societal benefit, seeking added insight on research priorities and future needs in addition to existing systems.

EOA 2016 Schedule

- Assessment conducted in three broad phases



SBA Value Tree Model



Societal Benefit Area (SBA)

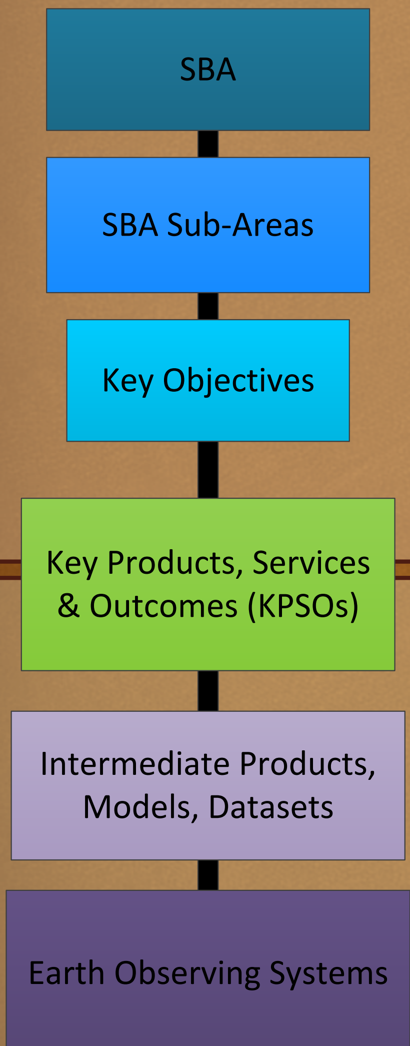
SBA Sub-Areas

Key Objectives: Activities supported by Earth observing systems, data, and products.

Key Product, Service or Outcome (KPSO): Required to make progress toward a Key Objective, produced by Federal Agencies.

Intermediate Products, Models, Datasets: The data and information needed to produce KPSOs.

SBA Value Tree Model (cont'd)



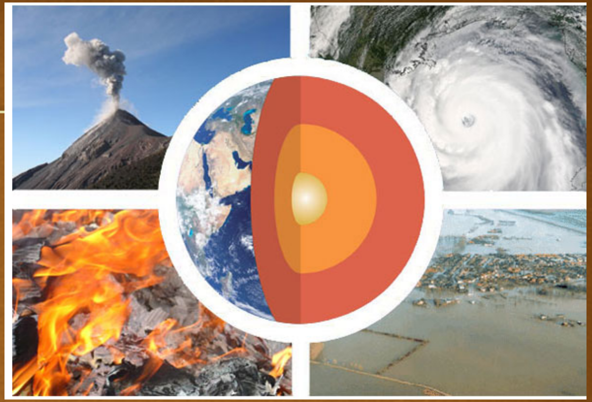
The Top of the Value Tree: Defined by the SBA Teams

- SBA Teams defined the value tree through KPSOs
- SBA Teams identified KPSOs and guided Assessment Team engagement and the collection of supporting data

The Bottom of the Value Tree: Data collected from Agencies by the Assessment Team

- The Assessment Team engaged subject matter experts identified by the SBA Teams
- The teams identified and evaluated the Earth observation data used to produce the KPSOs

Overall Scope of Disasters SBA



Background: Earth observations support fundamental understanding of hazards that support more accurate and timely alerting, better hazard and risk assessments, and disaster mitigation, response, and recovery actions

What Hazards? Earthquakes, landslides and land subsidence, droughts, coastal inundation, heat waves, tsunamis, tornados, severe weather and storms, tropical storms, floods, wildfires, volcanic eruptions, and space weather hazards such as radiation and geomagnetic storms.

Team Scope: The team considered how Earth observations benefit disaster-related events. They also considered what items may be covered by other teams and the time period of disaster-related procedures

Overall Scope

- Addressing secondary hazards or compound disasters (i.e. 2011 Tohoku earthquake and tsunami, Fukushima Daiichi Nuclear Power Plant)

- Addressing hazards with long time-horizon (e.g. drought)

- Addressing changing hazard profiles due to climate change impacts? Adaptation measures?

Overlaps/Challenges

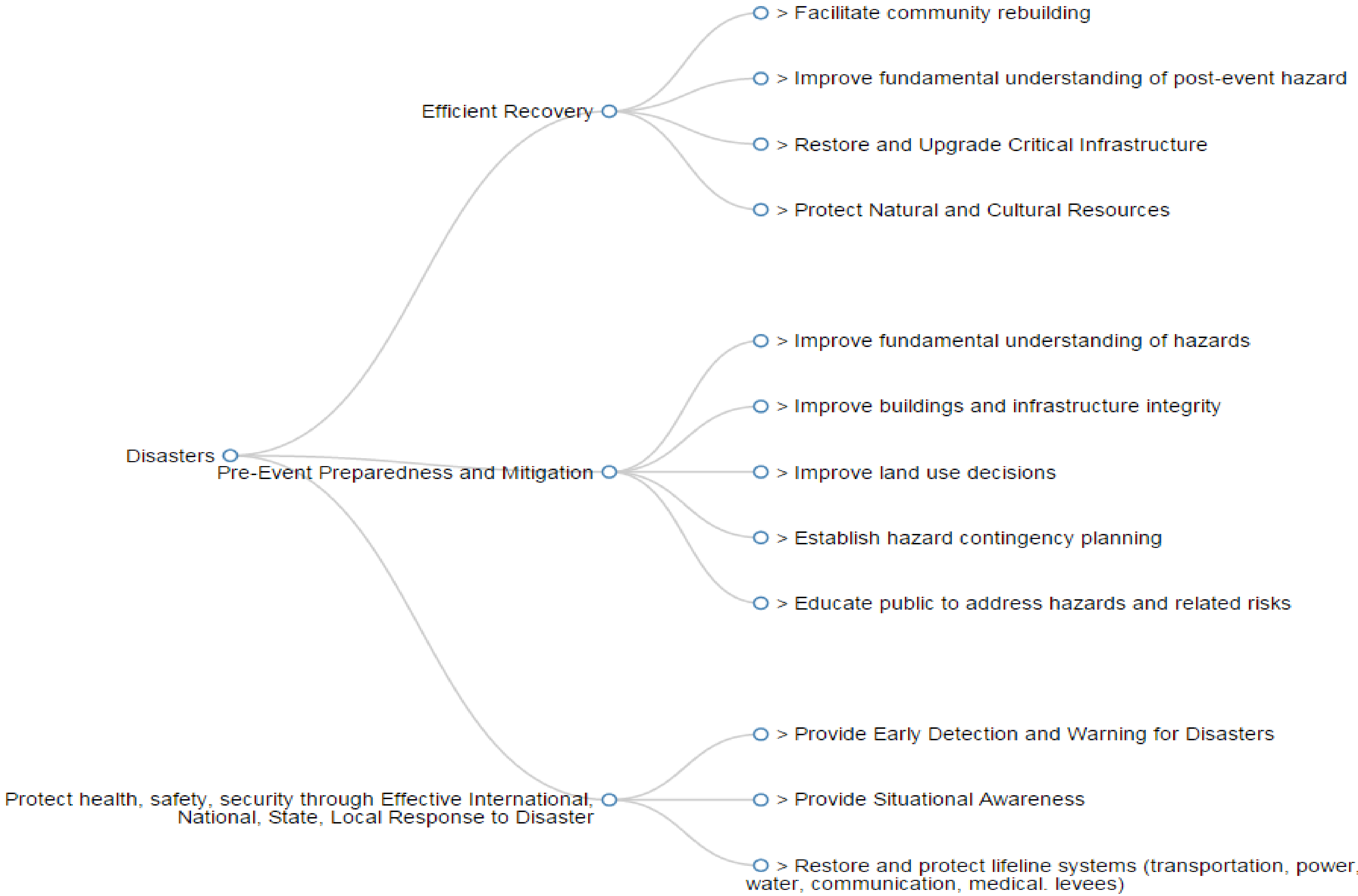
- Did not include subject matter discussed in other SBAs like Space Weather, Weather and Climate

- Included weather and hydro-related events associated with high frequency

- Ongoing impacts of natural disasters can play out over days, weeks, or even months, and vary greatly depending on the type of disaster or specifics of the particular event.

- We estimated weights based on a sense of average needs, but one should expect great variability on an event-by-event basis.

Disasters SBA Value Tree



Key Objectives by Sub Area

Table D-1. Key Objectives by Sub-area

Sub-area	Key Objectives
Pre-event preparedness and mitigation **50%**	• Improve fundamental understanding of hazards • Improve land use decisions • Improve buildings and infrastructure integrity • Establish hazard contingency planning • Educate public to address hazards and related risks
Effective disaster response **35%**	• Provide early detection, advisories, and warning for disaster • Provide situational awareness • Restore and protect lifeline systems (transportation, power, water, communication, medical, levees)
Efficient recovery **15%**	• Improve fundamental understanding of post-event hazard • Restore and upgrade critical infrastructure • Facilitate community rebuilding • Restore and protect ecosystems and cultural resources

Numerous Key Product, Service or Outcomes (KPSOs) defined and grouped as follows:

- Hazard Assessments
- Database and catalogs
- Public communication and technical assistance
- Planning, preparation, and risk assessment
- Citizen science
- Forecasts, advisories, warnings, and situational awareness
- Loss estimates
- Codes and standards

Example from EOA 2016 Overall Results (across all SBAs), 3000 SMEs

Key
- 99th percentile
- 95th Percentile and Above
- 90th Percentile and Above
- 75th Percentile and Above
- 50th Percentile and Above
- Below 50th Percentile
- Blank Cells Indicate Input Does Not Contribute to Area

	Earth Observation Inputs	Overall	Agriculture and Forestry	Biodiversity	Climate	Disasters	Ecosystems	Energy and Mineral Resources	Human Health	Ocean and Coastal Ecosystems and Resources	Reference Measurements	Space Weather	Transportation	Water Resources	Weather
1	Global Positioning System (GPS)	4.28%	2.66%	1.90%	1.45%	3.92%	4.34%	2.57%	0.99%	7.08%	18.11%	7.57%	2.47%	0.87%	2.28%
2	Landsat Optical	3.67%	12.38%	2.62%	3.36%	1.76%	13.76%	1.04%	2.96%	1.80%	1.10%		0.69%	5.69%	0.21%
3	National Elevation Dataset (NED)	2.88%	6.83%	1.59%	2.15%	1.32%	8.59%	2.54%	2.07%	1.17%	1.69%	< 0.01%	1.36%	6.27%	1.58%
4	Next Generation Weather Radar (NEXRAD)	2.75%	0.55%	0.02%	0.83%	1.81%	0.39%	2.04%	4.71%	0.47%	0.06%		6.64%	6.30%	11.63%
5	USGS Streamgages	2.70%	0.97%	0.04%	0.56%	0.35%	3.18%	1.61%	1.01%	1.16%	0.63%		2.64%	19.74%	3.76%
6	Geostationary Operational Environmental Satellite (GOES) Imager	2.67%	1.09%	0.13%	2.07%	4.84%	0.36%	1.74%	3.87%	0.47%	0.08%		7.05%	1.38%	11.11%
7	National Water Level Observation Network (NWLON)	2.50%	0.11%	0.37%	0.84%	1.41%	0.32%	0.55%	0.85%	2.83%	11.60%	0.01%	8.55%	3.19%	2.11%
8	Commercial Airborne Lidar	2.33%	2.03%	0.95%	1.40%	3.80%	6.71%	1.24%	0.51%	2.43%	5.62%		2.96%	2.52%	0.08%
9	National Agricultural Imagery Program (NAIP)	2.20%	9.32%	1.21%	1.49%	0.53%	7.53%	3.73%	1.55%	0.45%	0.23%		0.48%	1.37%	0.27%
10	Global Climate Observing System (GCOS) Surface Network (GSN)	1.34%	1.25%	0.16%	8.31%	0.38%	0.50%	0.25%	2.77%	0.08%	0.05%		0.79%	1.94%	1.16%
11	NWS Cooperative Observer Program (COOP)	1.33%	3.17%	0.07%	3.18%	0.62%	1.03%	0.22%	2.77%	0.12%	0.03%		0.66%	3.52%	1.90%
12	NWS Radiosonde Observations (RAOBS)	1.33%	0.28%	0.02%	1.58%	0.67%	0.38%	0.58%	3.13%	0.14%	0.08%		3.25%	1.72%	5.24%
13	Airborne High-Resolution Imagery	1.24%	2.40%	0.85%	0.59%	1.03%	4.07%	1.19%	0.63%	2.93%	0.30%	< 0.01%	1.23%	0.63%	0.20%
14	NOAA Ships	1.23%	0.24%	0.88%	1.25%	0.45%	0.07%	0.50%	1.45%	8.53%	0.65%	0.03%	1.68%	0.43%	0.21%

Example from EOA 2016 Disaster SBA

Table D-2. Disasters (Field Work/Field Campaigns and Literature/Reports Separated)

Key:
- 99th percentile
- 95th Percentile and Above
- 90th Percentile and Above
- 75th Percentile and Above
- 50th Percentile and Above
- Below 50th Percentile
- Blank Cells Indicate Input Does Not Contribute to Area

Key	Earth Observation Inputs	SBA: Disasters	Sub-area: Pre-Event Preparedness and Mitigation	Sub-area: Effective Disaster Response	Sub-area: Efficient Recovery
1	Public Observer Networks/Citizen Reporting/Crowd Sourcing	7.75%	2.26%	13.67%	11.26%
2	WeatherReady Nation Information	7.09%	14.56%		
3	Geostationary Operational Environmental Satellite (GOES) Imager	4.84%	1.12%	10.59%	3.12%
4	USGS NEIC Earthquake Catalogs	4.41%	6.82%	0.56%	5.84%
5	Global Positioning System (GPS)	3.92%	3.63%	2.87%	7.35%
6	Commercial Airborne Lidar	3.80%	7.01%	0.56%	1.20%
7	Advanced National Seismic System (ANSS)	3.08%	1.83%	3.24%	6.72%
8	California Integrated Seismic Network (CISN)	3.07%	5.36%	0.07%	2.86%
9	USGS Earthquake Catalogs	2.71%	5.21%	0.14%	0.81%
10	Deep-Ocean Assessment and Reporting of Tsunamis (DART) Real-Time Monitoring System	2.67%	1.44%	5.30%	0.32%
11	General Building Stock (GBS) Inventory	2.05%	0.75%	2.17%	5.95%
12	Paleoseismic Field Observations	1.98%	3.04%	0.10%	3.06%
13	NASA Unmanned Aircraft Systems (UAS) Synthetic Aperture Radar (SAR) Data	1.94%	1.86%		6.83%
14	Next Generation Weather Radar (NEXRAD)	1.81%	0.22%	4.33%	0.94%
15	Landsat Optical	1.76%	3.14%	0.12%	1.27%

Full results for internal use on OMB-MAX (https://max.omb.gov, login required)

Disaster Team write-up described below (Note: not included in published EOA, but we assume it will go forwarded for National Plan?)

Current Observation Portfolio “not bad but still many gaps”

- **Overall:** We have many observation systems that are satellite-, air-, ground-, and marine-based that contribute to objectives of Disasters SBA

- Satellite (USGS/NASA Landsat, NOAA GOES, NOAA POES, NASA MODIS), Ground (USGS ANSS, GPS, GNSS, LiDAR), Marine (Rain Gauge Networks, Tsunami DART), and Air (LiDAR, UAVSAR)

Highest Priorities for Future

Sustaining the ability to prepare for and mitigate hazards

Continuing to provide high-profile forecasts, advisories, warnings, and situational awareness products needed to meet societal demands when a disaster is unfolding

But, we need to overcome huge gaps….

Example Geohazard Gaps

Complete the building of the ground-based USGS monitoring systems for earthquakes (ANSS) and volcanoes (NVEWS).

Currently, many volcanoes have insufficient monitoring systems (for example, seismometers and continuous GPS), and others have obsolete equipment.

Need for improved imaging of land surface change and deformation (SAR/InSAR) and a precise national topographic data set (LiDAR).

Example Geohazard Gaps (Cont)

Need high-resolution precise national digital elevation data set for nearly every disaster type. The USGS 3D Elevation Program (3DEP) is a patchwork of airborne LiDAR surveys across the contiguous US and Hawaii, with lower-resolution IfSAR elevation data for Alaska.

Real-time data from broad ocean areas is another data gap

Better oceanic and coastal bathymetry data are needed to model tsunamis, and identify submarine volcanoes and faults.

Insufficient density and current distribution of real-time GNSS sites

Example Weather Related Gaps

Large observation data gaps for weather exist in the upper atmosphere and above the surface in the planetary boundary layer (PBL).

Radiosondes are not covering measurements of temperature, humidity and wind on a consistent and broad basis, and the lack of PBL information often hurts forecasts especially for severe weather and fire weather support.

We already see how increased observations of upper air data can improve forecasting of tropical storms, blizzards and any weather event that impacts all sub areas of disasters.

Example Weather Related Gaps (Cont)

Need to expand river flood-forecasting capabilities from the 4,000 river forecast locations. Substantial improvements in the network are needed to develop a robust flood monitoring and documentation process that extends the streamgauge network (USGS)

Extreme lack of ground moisture observations for monitoring fire potential and forecasting floods. Soil moisture is a key parameter for understanding, modeling, and forecasting many hydrology and ecosystem related disasters

Example Weather Related Gaps (Cont)

Lack of complete understanding of impacts of atmospheric rivers on flooding over major continents

Significant Earth-observing data gaps in the ability to measure the snow water equivalent in the snow pack, which limits reliable forecasts of flooding associated with rain-on-snow events

There is a significant gap in the ability to track the spatial extent and timing of floodwaters as they advance, crest, and then begin to recede in the days to months following a flooding or coastal inundation event.

Recommendations (GeoHaz)

Innovations to develop cost effective observing systems are a priority. One example would be cost-effective means for obtaining high-rate, real-time observing data from broad ocean areas.

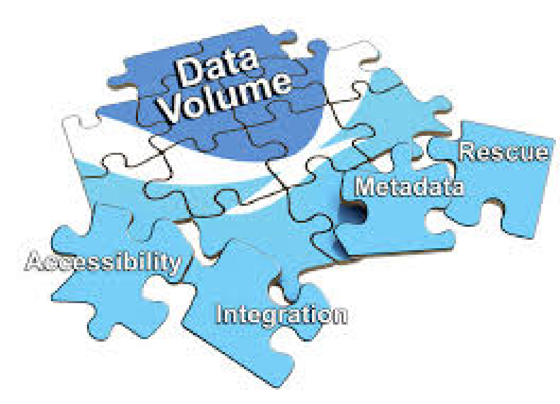
Real-time offshore geophysical monitoring is another priority, with particular focus on subduction zones.

Satellite approaches are being developed to aid in detecting, measuring, and tracking land surface deformation in heavily vegetated regions, such as those found on many volcanoes and in areas typically with numerous landslides.

Recommendations (Weather)

Concentration should be on increasing measurements of weather variables above the surface of Earth with new technology that allows automated characterization of the atmosphere (such as with LiDAR and new devices to replace radiosondes)

Use of mobile networks and flood-measurement campaigns by field personnel and new technologies based on surface radars and use of optical and infrared cameras could boost the efficiency and area extent of flood-data observations (now covered by gauges). Need to improve satellite microwave measurements



Data Management!

Open access to digital data sets from Earth-observing systems is essential to realizing their full societal benefit

Expand the sharing of U.S. Government-purchased data supporting hazard science and disaster response among all agencies

Reducing data latency, and increasing real-time streaming of data, are essential components of providing timely fundamental information used in the decision-making process as disasters unfold

Need to attract top-notch software engineers and engineers