Using Satellite Data for Disaster Management – Community Inputs

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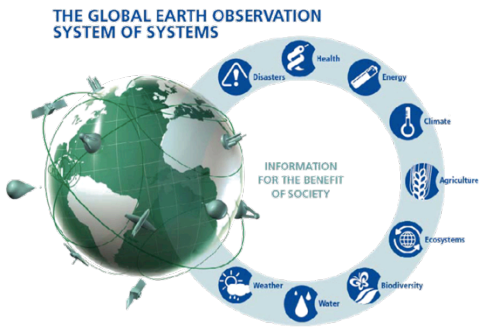
Session Goals

1. Explore the challenges and strategies for using satellite data in disasters management and risk reduction
2. Seek community feedback to help identify best practices, gaps in service, and recommendations for the use of satellite data for disasters management; Collect and discuss the user requirements for using satellite data in operational systems
3. Discuss the role of Space Policy in considering the needs of the environmental data and applied research user community in the mission design process

Overview

- Introduction / Problem statement
- Practitioner perspectives: Case Studies
- GEOSS Architecture – A functional view
- Recommendations

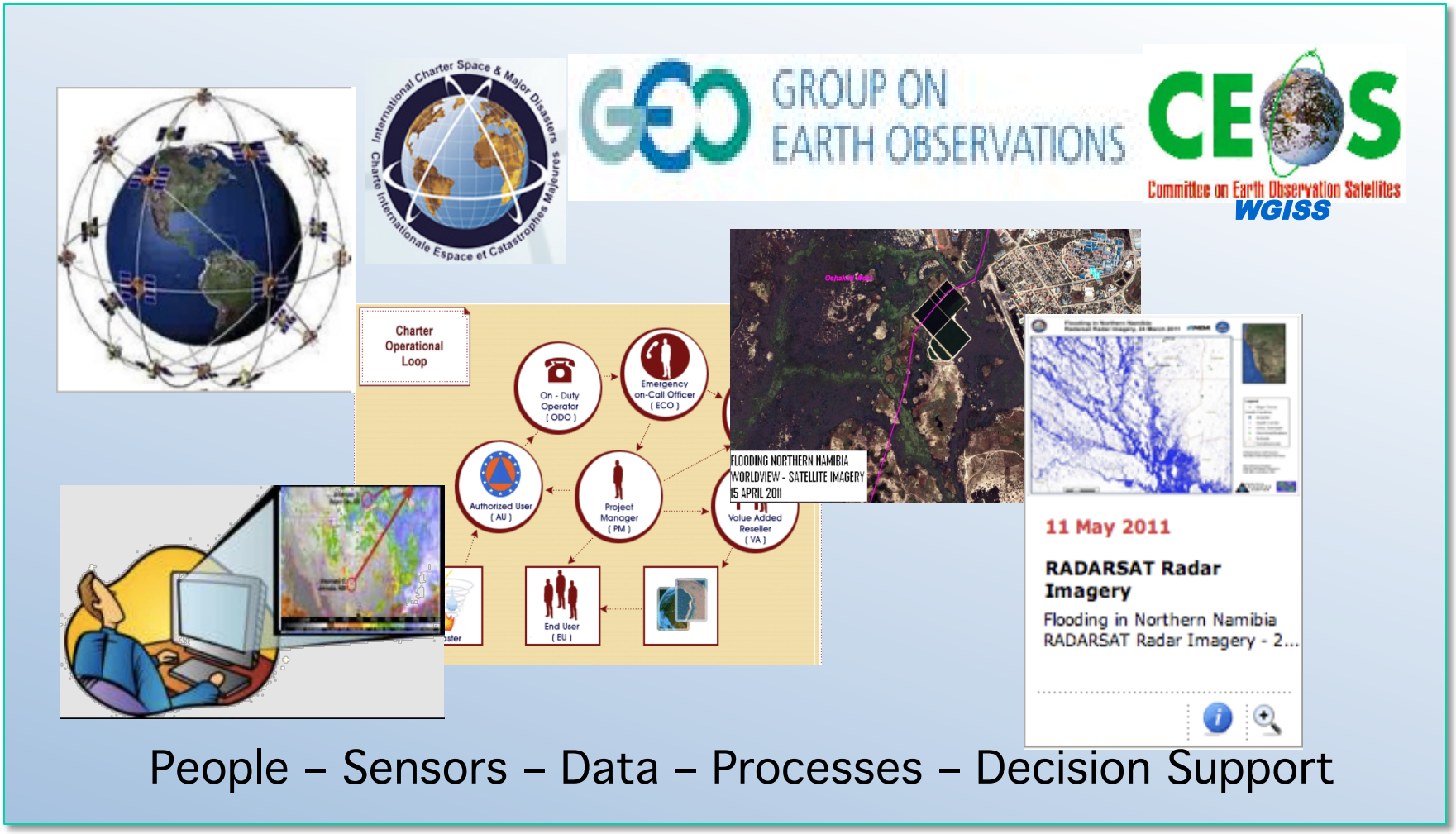


CEOS
Working Group on Information Systems and Services

ESIP
The Federation of Earth Science Information Partners
Fostering connections to make data matter

GEO GROUP ON EARTH OBSERVATIONS

Introduction



GEOSS Architecture for Use of Satellites in Disaster and Risk Management

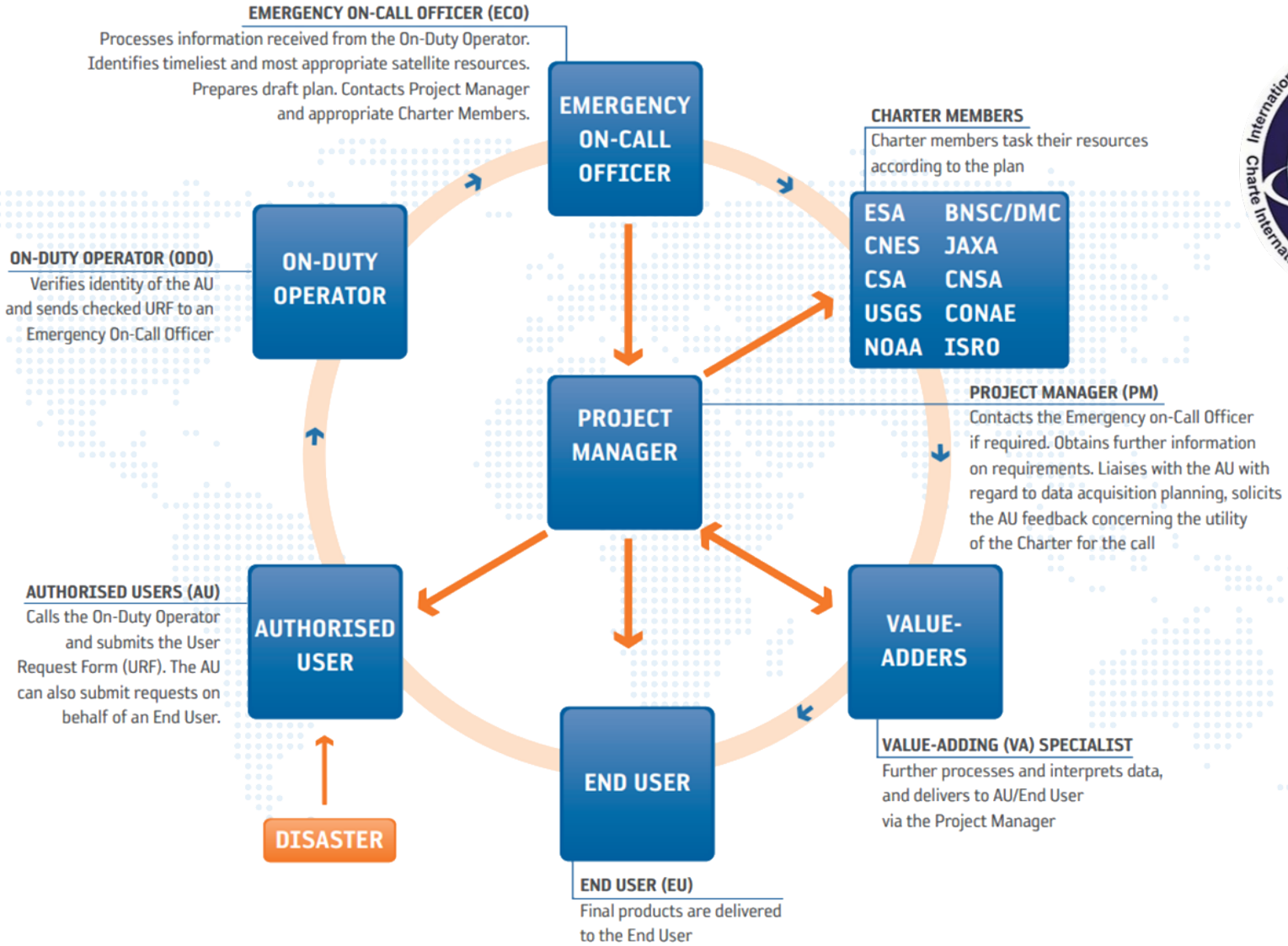
Experience-based analysis

- Data Brokers
  - International Charter – Space and Major Disasters
- Disaster response case studies
  - China: Sichuan / Wenchuan earthquake 2008
  - Japan: Tōhoku / Sendai earthquake & tsunami 2011
- Technology pilots
  - Namibia Flood Sensor Web Pilot

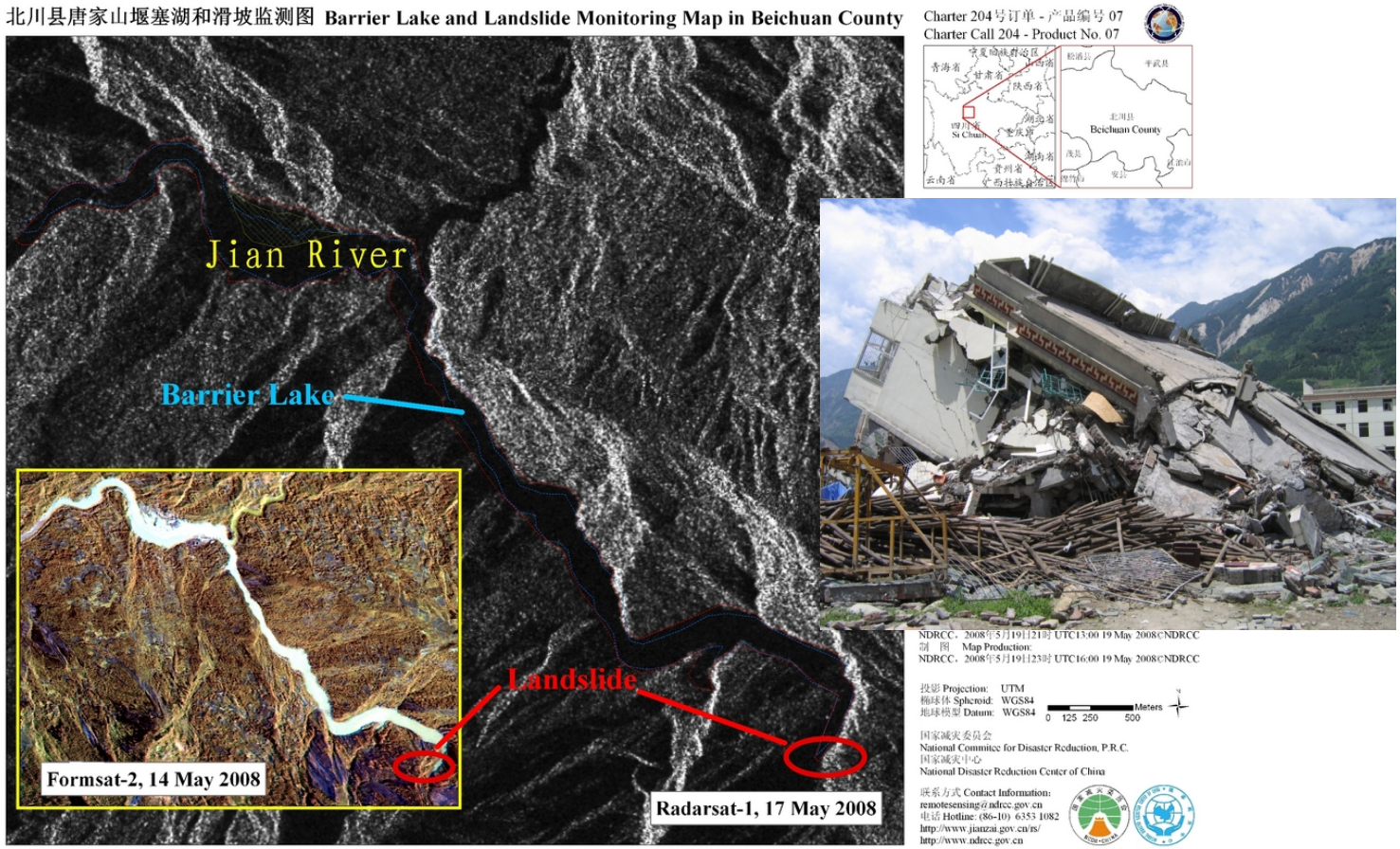
Case study questionnaire

1. Overview: Summarize the disaster event in a few sentences
2. Indicate which organizations or individuals participated in
   - Responding to the disaster
   - Forecasting the disaster, or identifying high-risk times or places
   - Reducing the risk or impact of the disaster
3. How did these organizations or individuals interact or collaborate with each other?
4. Who was involved in supplying satellite information to these activities?
5. What satellite information was used *(or needed)* to support these activities?
6. What processing was performed on the data before users obtained it?
7. How could the information support to these activities been streamlined? Or, how could these activities have taken better advantage of available information?

Data Broker: International Charter - Space and Major Disasters



China: Wenchuan / Sichuan earthquake



- Monday, May 12, 2008, 14:28:01 CST (06:28 UTC)
- 7.9 ~ 8.0 magnitude
- Death toll estimate: 69,170

Wenchuan / Sichuan earthquake: Needs Identified

- Increase value of earth observations in rapid response
  - Higher resolution Satellite and Aerial imagery
  - Higher frequency revisit rates over disaster-struck areas
  - Improved image geometric and radiometric quality
- Improved processing / interpretation capabilities
- Back up ground control after major earthquakes
- *A network* of earth observation systems
  - To unify space, air, ground-based observations
  - Support high spatial, spectral, temporal resolution
- More international cooperation in geospatial technology and participation in CEOS, GEOSS

Li, 2009 on "EO for Earthquake Disaster Monitoring & Assessment" *Photogrammetric Engineering & Remote Sensing*

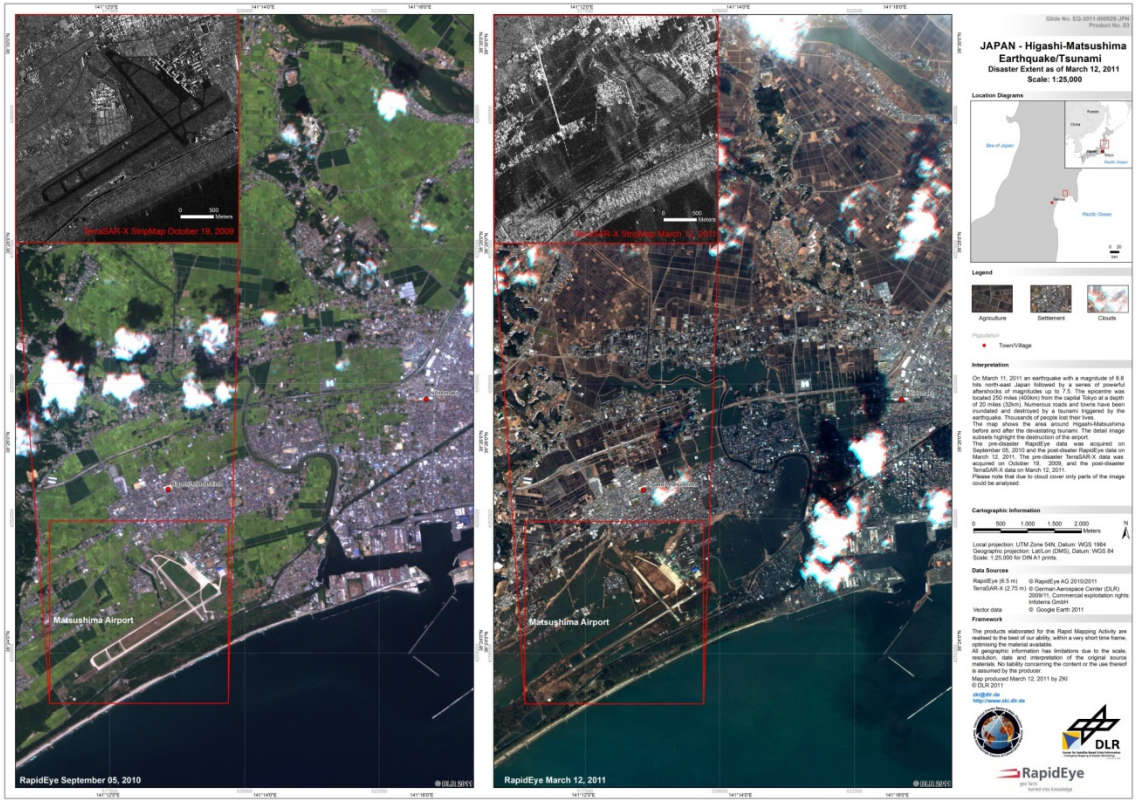
Great East Japan Earthquake of 2011

Friday, March 11, 2011

14:46 local time

9.0 magnitude quake

11.8 m tsunami wave



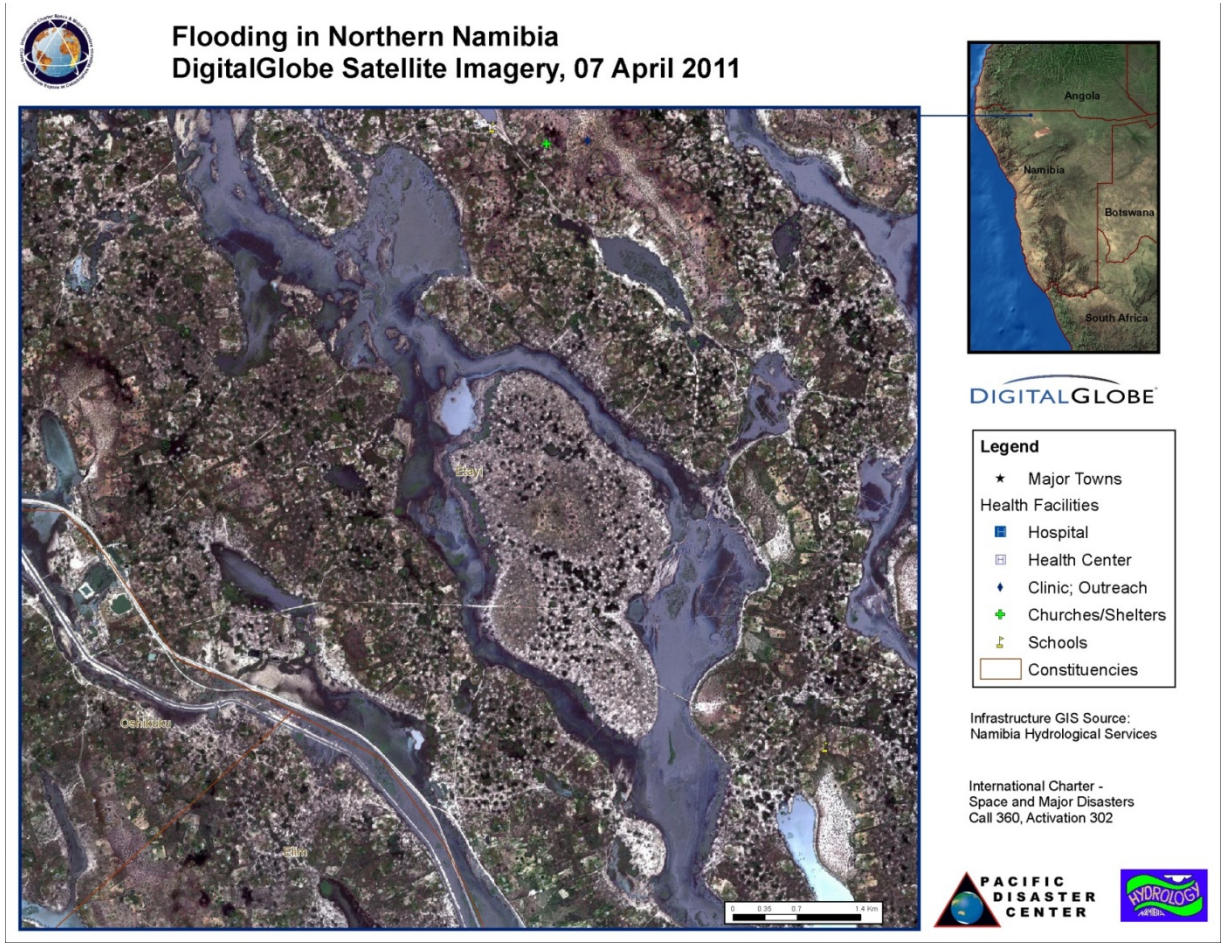
- 15,783 lives lost; over 4,000 missing; nearly 6,000 injured
- Over 100,000 homes destroyed; nearly 800,000 damaged
- Meltdown at Fukushima Dai-ichi Nuclear Power Station

Japan Earthquake: Lessons Learned

- Special needs regarding immediate impacts
  - Restore communication and services to affected areas
  - Keep the media informed
- Build *regional bases*, i.e., remote sensing centers of expertise across Japan
  - Data handling and interpretation
  - Timely delivery
  - Share workload with experts external to JAXA
- Implications for remote sensing assets
  - Accelerate preparations for successor satellites
  - Promote research into new sensors

JAXA, 2012 “Response to the Great East Japan Earthquake: assistance using earth observation satellites and communication satellites”

Namibia Sensor Web Flood Pilot



- Northern Namibia, March 25-April 10, 2011
- Highest known flood in the country's history

Namibia Flood Pilot: Challenges

- Technical challenges
  - Specialized analysis & modeling for regional characteristics
  - Last mile delivery of data products
- Coordination Challenges
  - Automate tasking request interface for data and services from collaborators
  - Obtain data, not just pictures from suppliers
  - Expand data release licenses

Cross-case comparisons

	Namibia	China	Japan
Information used	Rainfall estimates (from sat. data & 3 hydro models validated w/ TRMM); MODIS; Landsat; EO-1 and RADARSAT (via tasking)	Airborne imagery provided necessary high resolution	Daichi ALOS; many others
Information processing	Preprocessing (geolocation, calibration); Atmospheric correction; Interpretation ("water mask" and other flood features)	Georectification, contrast stretch, joining image scenes, image interpretation, and extracting graphics and digital elevation models. Also 3D simulation & visualization	inSAR; false-color composites; damage analysis; rendering as digital or hardcopy images
Recom-mendations	More localized interpretation algorithms; obtaining quantitative data from Int'l Charter; tasking arrangements with JAXA, SPOT, et al.	Higher-resolution, higher-frequency satellite observations. Alternatives to ground control for geolocation. Int'l cooperation	Capacity building in regional offices; sharing workloads; communications infrastructure; wider awareness

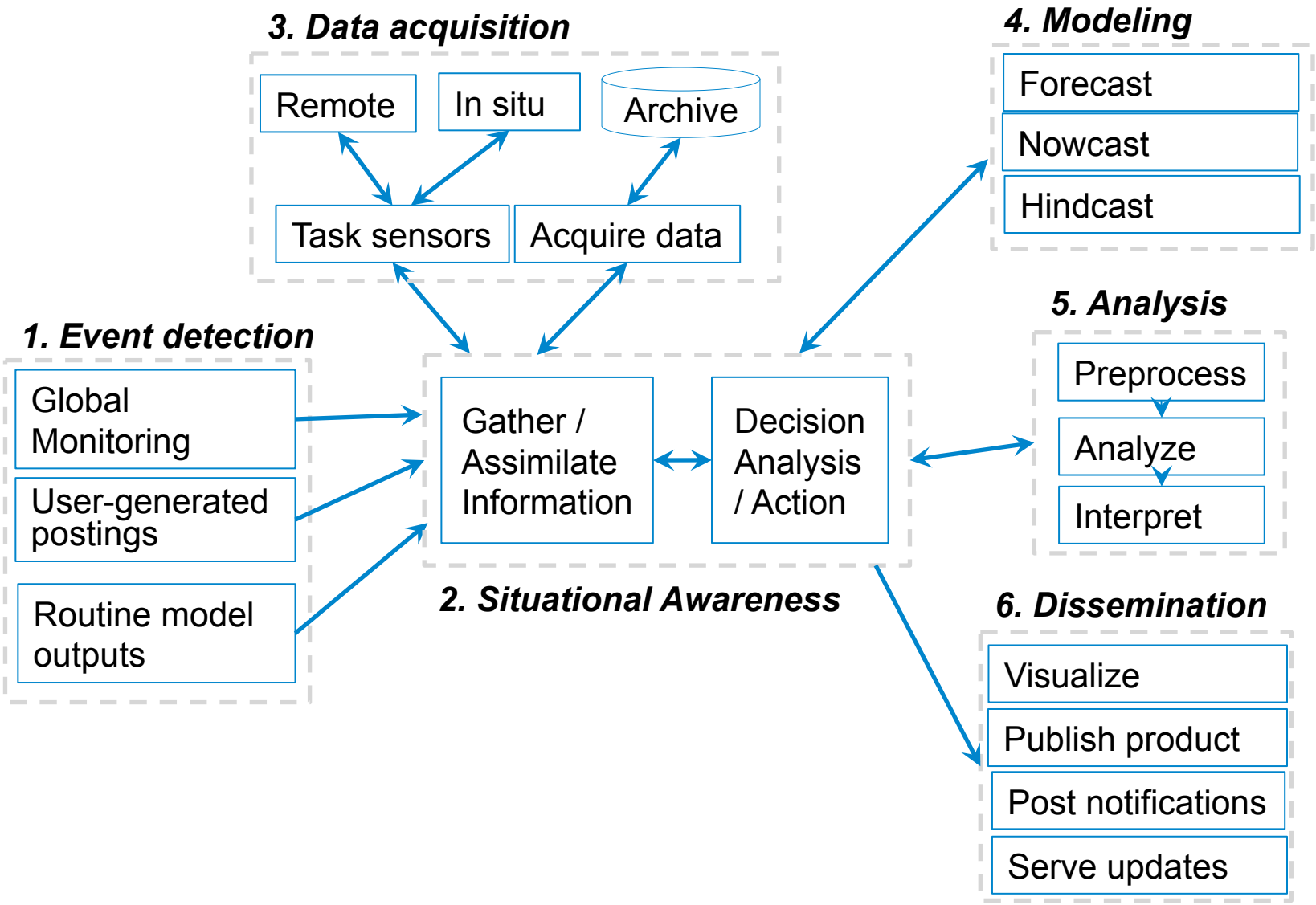
Preliminary findings

- Different users need very different data
  - PDFs and JPEGs vs.
  - Quantitative data grids
- Metadata describing fitness for use is crucial
  - Operational decisions require knowing data quality
  - Can't just filter out all imperfect data
- Collaboration, not just dissemination, is key
  - Providers, co-analysts, & end users not always disjoint sets
- Need frequent, high-resolution satellite observations
- Traditional IT challenges apply:
  - Discovery, semantics, provenance
  - Uncertainty in processing, modeling, and forecasts
  - Security

Architecture Implications: Phases of DRM Capability

- System initiation *vs.* operations for disaster types and lifecycle phase
- Initiation: identify and develop …
  - Inputs for event detection, event triggers
  - Indicators for situational awareness (*e.g.*, flood extent)
  - Modeling elements (*e.g.,* regional flood model)
  - Workflows and data flows (for processing and delivery)
  - Automation opportunities (*e.g.,* subscriptions, custom products)
- Operations phase: monitor and respond …
  - Monitor data streams, detect events & trigger workflows
  - Track key indicators
  - Task sensors; acquire data
  - Run models (hindcast, nowcast, forecast)
  - Analyze and disseminate products

Functions involved in Satellite Data Support to Disaster Management

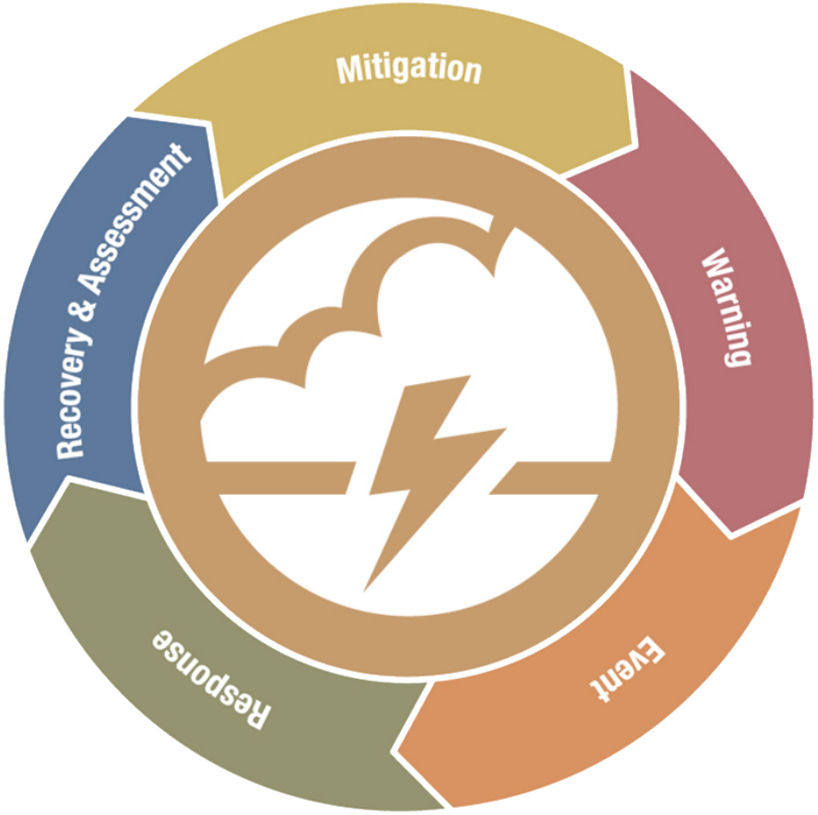


Challenges

- Some data have restrictions (who; when): this prevents
  - Use by entire end user communities
  - Continued access to products for ongoing recovery and research
- Major effort involved in getting just the right data
  - When drawing on multiple data sources, many datasets may be available; most are complex; and not all are equally useful
    - Based on space, time, sensor characteristics, quality, and other factors
  - End users often under pressure in a crisis situation. Need to work with users and suppliers in advance of the crisis.
  - Need tools to help end users get (only) the information they need; to match products to audiences; and to facilitate rapid use of products.
- Degraded or inadequate network infrastructure
- Outdated or inadequate basemaps (*e.g.,* DEMs)

Preliminary Recommendations

- Need to expand coordination / brokering mechanisms, like the Charter, to all phases of the disaster lifecycle
- Must allow broader data access / data sharing
- Need a services infrastructure to streamline access
  - Near-real-time services
  - On-demand, user-customizable products
- Need open, well-defined, interoperable interfaces



What are the Space Policy Implications?