NASA JPL Disaster Response and Response to 2015 M7.8 Nepal Earthquake

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- Introduction to Nepal Response
- How the Response Team Functioned
- Timeline and Core Products
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- Who Used the Products and How
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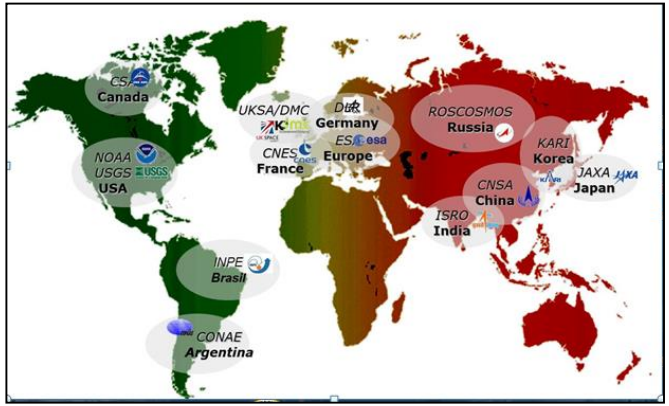
- Lessons Learned

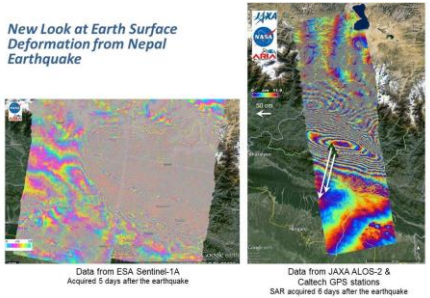
Coordination and Collaboration

The Disasters Program is exploring innovative partnerships for providing

- **Scientific and technical expertise**
- **Data and products, and**
- **Decision support**

to assist shared emergency-response stakeholders.





Rapid Assessment and Tiers of Disaster Response

Assessment: 30-50 events per year
Tier 1: 10-30 events per year
Tier 2: 3-10 events per year
Tier 3: 0-3 events per year

Assessment

Rapid Hazard Assessment Expected

- Centers and program experts to contribute within scope of daily activity
- Guidance to elevate to Tier response, direct to research or no action
- Days

E.g.: media report

Tier 1

Response and Recovery Short Term and Best Effort

- Centers and programs respond as available with only minor impact to existing/on-going activities
- Detailed assessment and products scaled to modest response
- Weeks to Month(s)

E.g..: Napa Earthquake (2014), Chile Earthquake (2015), Oklahoma tornadoes, yearly floods

Tier 2

Significant Contributions Over Extended Period

- Contributions are considerable given continual assessment of size and scale of impact
- Personnel relevant to disaster type (s) expected, tasked, and assigned to support
- Data and products adapted into recovery
- Weeks to Month(s)

E.g.: Nepal Earthquake (2015), Deep Horizon (2010), Eyjafjallajökull Eruption (2015)

Tier 3

Disaster is of major national importance

- All relevant personnel expected to review activities for level of support to the disaster and/or be on-call
- Assets and personnel may specifically assigned and tasked for lengthy time period (Months into recovery).

E.g.: Hurricane Katrina (2005), September 11, 2001 attacks

Current and Future Plans

- Developing playbooks for different disaster types
  - Definition of entry/exit strategies
  - Key response products
  - End-user contacts
- Improve communication and response infrastructure
  - Disaster response website
  - Coordination tools
    - Centralized information hub, file sharing etc.
- Strengthen inter-agency and end-user relationships
  - Meetings/exercises

Introduction: Response to 2015 Nepal Earthquake

- M7.8 Nepal quake created a humanitarian crisis
  - 8,800+ fatalities / 22,000+ injured
  - 602,000+ destroyed homes
  - 284,000+ damaged homes
- NASA and partners assessment
  - Actionable data from space resources and scientific capabilities
  - Focused on providing products for **humanitarian response and situational awareness**
    - Science can come later

(Photo: AP)

(Photo: AP)

How the Team Functioned

Initial JPL coordination telecon → NASA Coordination → Sub-Groups

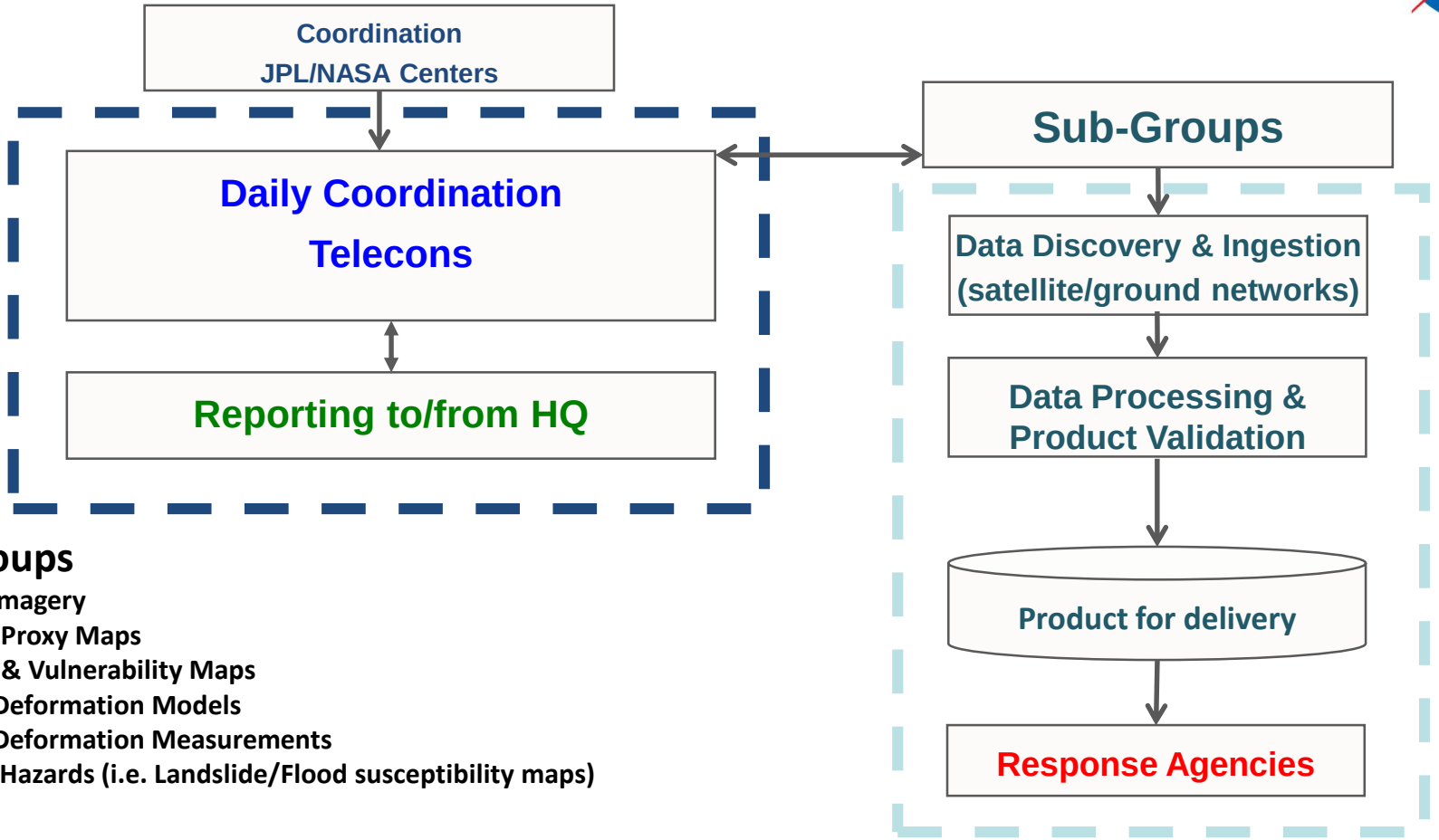
Coordination (within hour of event)

- Organizing and leading daily telecons (e-mail lists)
- Coordinating with other space agencies to provide satellite data
- Maintaining a calendar of events and products
- Managing e-mail traffic
- Coordinating product distribution

Sub-Group Creation

- Focused response effort on products
  - Observations from satellites
  - Maps of surface change
  - Models of the earthquake

How the Team Functioned



Sub-Groups

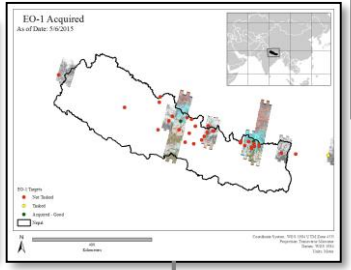
- Optical Imagery
- Damage Proxy Maps
- Damage & Vulnerability Maps
- Surface Deformation Models
- Surface Deformation Measurements
- Induced Hazards (i.e. Landslide/Flood susceptibility maps)
- Media

Timeline & Core Products

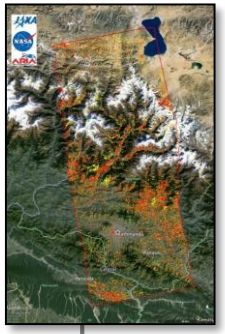
Products include:
Surface deformation maps (interferograms)
Optical imagery
Damage Proxy Maps
Damage & Vulnerability Maps
Surface Deformation Models
Surface Deformation Measurements
Induced Hazards (i.e. Landslide/Flood susceptibility maps)

M7.8 Earthquake & 1st coordination call

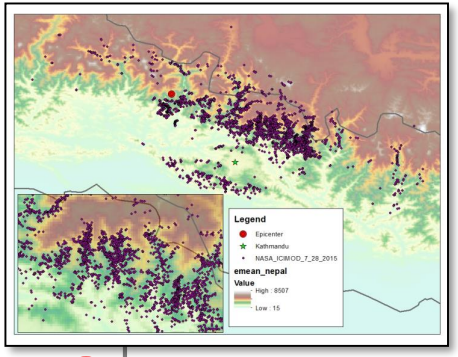
CSK Damage Proxy Map (DPM)
- Delivered to NGA, OFDA/USAID
- Publicly released

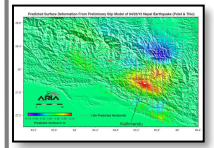


ALOS-2 DPM
- Delivered to NGA, OFDA, DigitalGlobe, Esri
- Publicly released



Landslide mapping + Susceptibility Maps SERVIR/ICIMOD





Initial quake models
Interferograms
tilt maps

GPS Surface Deformation
- Delivered to USGS
- Publicly released

First Radar Surface Deformation – S1A publicly released

Sub-Groups formed
& First optical images

Optical Imagery: Landsat, ASTER, EO-1 Tasking

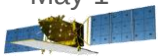
Landslide Identifications

M7.3 Aftershock

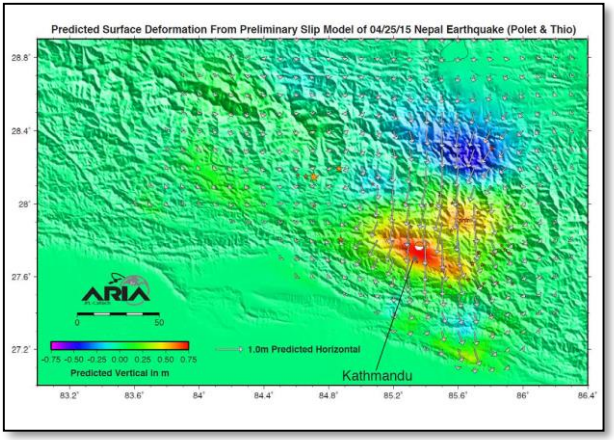
Last telecon

Day 0 April 25 | Day 1 April 26 | Day 3 April 28 | Day 4 April 29 | Day 7 May 1 | Day 9 May 4 | Day 10 May 5 | Day 17 May 12 | July

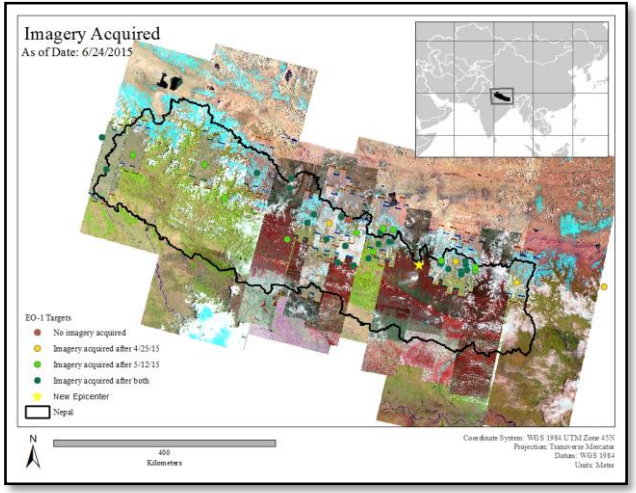
COSMO-SkyMed images Nepal



ALOS-2 images Nepal



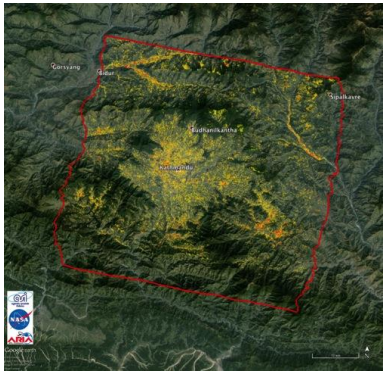
Initial quake models
Interferograms
tilt maps



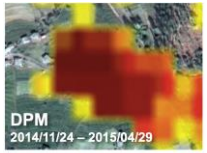
Optical Imagery:
Landsat,
ASTER, EO-1
Tasking

Landslide mapping +
Susceptibility Maps
NASA-ICIMOD Landslide
Database: Volunteer Effort
(4,311 mapped landslides)

Damage Assessment from Radar

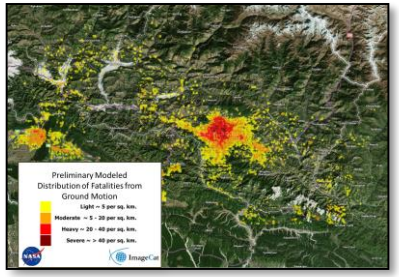


Jet Propulsion Laboratory
California Institute of Technology

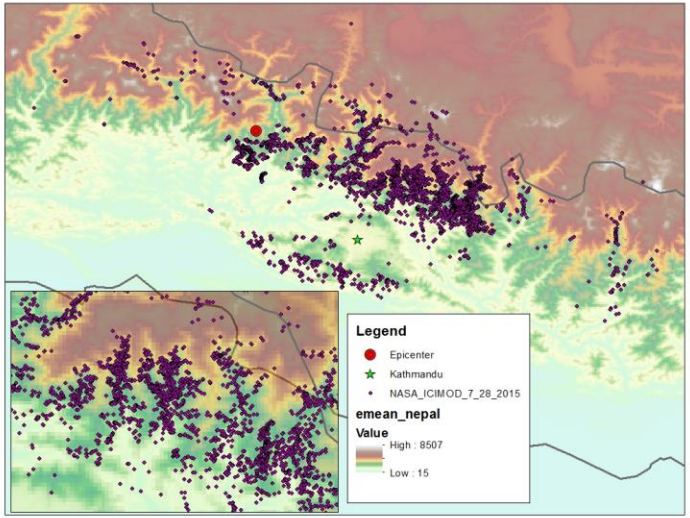


- Highlighted areas of potential damage (25 mi x 31 mi, or 40 km x 50 km footprint) from ASI COSMO-SkyMed Synthetic Aperture Radar (SAR) data.
- Validated with NGA optical analysis of collapsed buildings in more remote regions.
- Delivered to NGA, GEER, OFDA, ICIMOD for their damage assessment efforts in support of humanitarian response

CSK Damage Proxy Map
(DPM)



Damage Vulnerability Map



Interfaces Used & Delivery Mechanism

Interfaces

- NASA HQ
- ASI → COSMO-SkyMed
- JAXA → ALOS-2
- USGS→NGA
- SERVIR→ICIMOD
- In country sources via Jeff Kargel/U. Arizona

Delivery Mechanisms

- USGS, SERVIR/ICIMOD and NASA media interfaces (articles)
- Sub-Group derived products stored in local servers
- Products emailed to key users
- Then released through links on NASA Marshall website

Who Used the Products and How?

Users	Examples of how they are used
World Bank	Damage assessment for economic loss
NGA	Determine priority areas for analysis
USGS	Search for land damage and surface rupture in their fieldwork
OFDA/USAID	Damage assessment for response on the ground
ICIMOD	Search for land damage, landslides, and river blockage
GEER	Guidance for geotechnical engineer reconnaissance fieldwork
DigitalGlobe	Determine priority areas for high-resolution image acquisition
UNICEF	Exposure and damage assessment for response on the ground
ESRI	Post on their interface for sharing

What Worked

- Rapid infusion and coordination of Agency/Inter-Agency effort
- Telecons and cloud-based collaboration tools
- People were generally very responsive and eager to participate
  - Volunteerism and Commitment
- Product generation
- Self assessment

Lessons Learned

- Establishing relationships and protocols with response organizations prior to an event is key
  - Engage with end-users to identify which products are useful
- Assemble a roster and playbooks for different disaster types
- Need more than 1 coordinator established at the beginning
- Establish guidelines for telecons and product posting
- Automation for situational awareness and product generation is high priority
  - “I am only as useful as the quality of my sleep.” – Sang-Ho Yun (JPL)
- Need to define entry and exit strategies