GIS Support for the Indian Ocean Tsunami Disaster

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ABSTRACT

Tsunami Response Efforts: GIS and Remote Sensing Utility and Applications

The December 26, 2004 earthquake off the coast of Indonesia resulted in a humanitarian crisis the likes of which has not been seen in over a century. Accurate early damage estimates were made complicated by the tsunami's broad spread – politically and geographically – as well as the narrow footprint of the coastal damage. This also made it difficult to plan the appropriate level of international response, despite the unprecedented offerings of assistance. Scientific and technical agencies that collect, process, and utilize remote sensing and GIS assets mobilized their resources quickly in an effort to provide support to the immediate post-disaster response efforts. Still, a judicious assessment of these efforts reveals serious gaps in the ability of remotely sensed data and GIS mapping tools to contribute effectively to immediate field-based relief needs. This paper will provide a critical examination of, primarily, USG remote sensing and GIS response efforts to the tsunami disaster.

USGS Response to Dec. 26 Tsunami

- USGS' Global Seismic Network (GSN) flashed seismic data minutes after quake to NOAA's Pacific Tsunami Warning Center (PTWC) and other GSN members.

- USGS' National Earthquake Information Center (NEIC) issued first alert of an 8.5 earthquake in the Indian Ocean.

- E-mails/Pager notifications to 25,000+ recipients, incl. those in affected countries.

- EROS Data Center on 12/27 began acquiring LandSat, ASTER, ALI, and Hyperion imagery [*NASA EOS: Terra, SRTM*]. Provided support under the International Charter: Space and Major Disasters (India and Sri Lanka activated the Charter).

- 12/28 began puchasing/licensing/posting of commercial, public domain, and USG GIS/RS data and derived products on public domain ftp site and USGS web site.

- NEIC by 12/29 produced "Shake Maps" (showing location/intensity of shaking) and PAGER maps (estimating numbers affected by strong ground shaking).

- Preparation of draft science plan for reconstruction and development.

USGS
science for a changing world

The National Map

Asian Tsunami Disaster Response

Home   Background   Imagery   Documents   Interactive Viewers   Related Links

The National Map Hazards Data Distribution System (HDDS)/Asian Tsunami

The The U.S. Geological Survey is playing a vital role through its National Center for Earth Resources Observation and Science (EROS) in relief efforts to nations impacted by the Asian tsunami disaster of December 26, 2004. EROS maintains the world's largest collection of civilian remotely sensed data of the Earth's land surface. Within hours after the disaster occurred, EROS began providing relief organizations worldwide with pre- and post-tsunami satellite images, as well as image-derived products that incorporate information on population density, elevation, and other relevant topics. These images and image-derived products are being used by relief organizations to make practical, well-informed decisions as to where relief efforts are most urgently needed and how best to carry out those efforts.

Download Data

Click to go to Interactive Viewer

June 12, 2001

Click to go to the HDDS Interactive Viewer

December 29, 2004

NOAA Tsunami Response

Immediate Assistance:

- Within minutes following an alarm signaling a strong earthquake, NOAA's Pacific Tsunami Warning Center in Hawaii issued a bulletin to Pacific governments indicating a magnitude 8.0 earthquake (later upgraded to 9.0) had occurred off the west coast of Northern Sumatra, Indonesia.

- Lead agency for International Charter: Space and Major Disasters, to coordinate for dissemination remotely sensed info and derived products.

Current Assistance:

- Providing updated weather information to support recovery efforts.
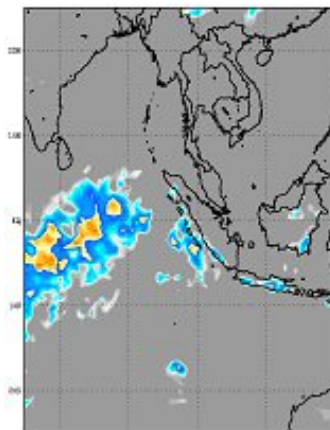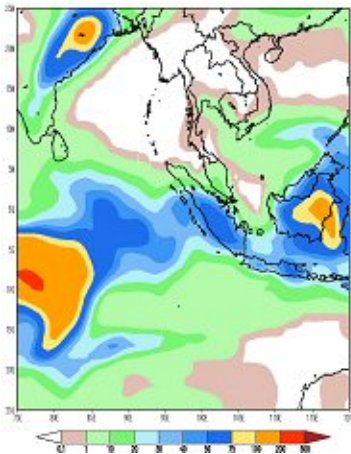
National Geospatial-Intelligence Agency (NGA) Tsunami Disaster Support

- Image City Maps produced
- SRTM 1 Elevation Data with void fill produced
- Controlled Imagery Base produced
- VMAP 1 and DFAD0 provided
- CADRG Raster Maps provided and produced
- Aeronautical information updates
- Over 100 GB of Commercial Imagery purchased (CSIL; PDC)

http:osis.nga.mil/IS/tsunami/index.cfm

Damage Assessment Maps and Shapefiles

PACIFIC DISASTER CENTER
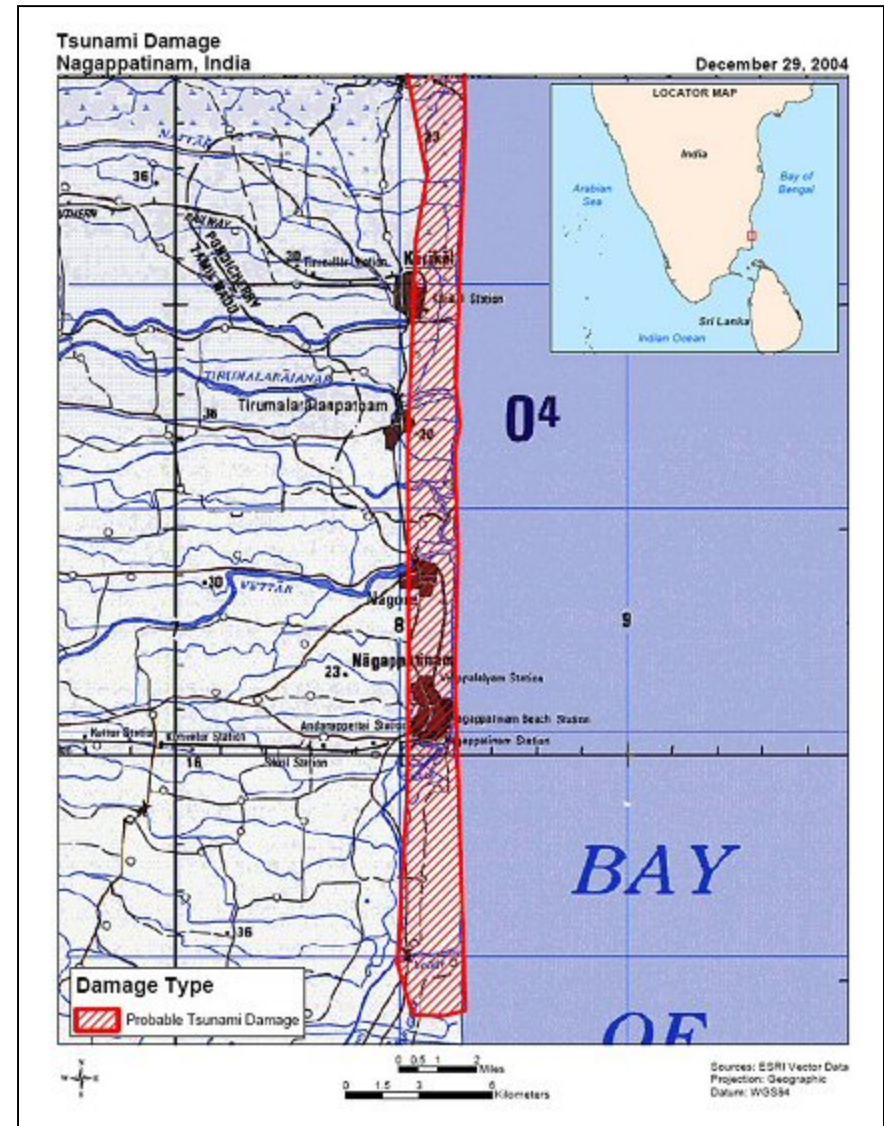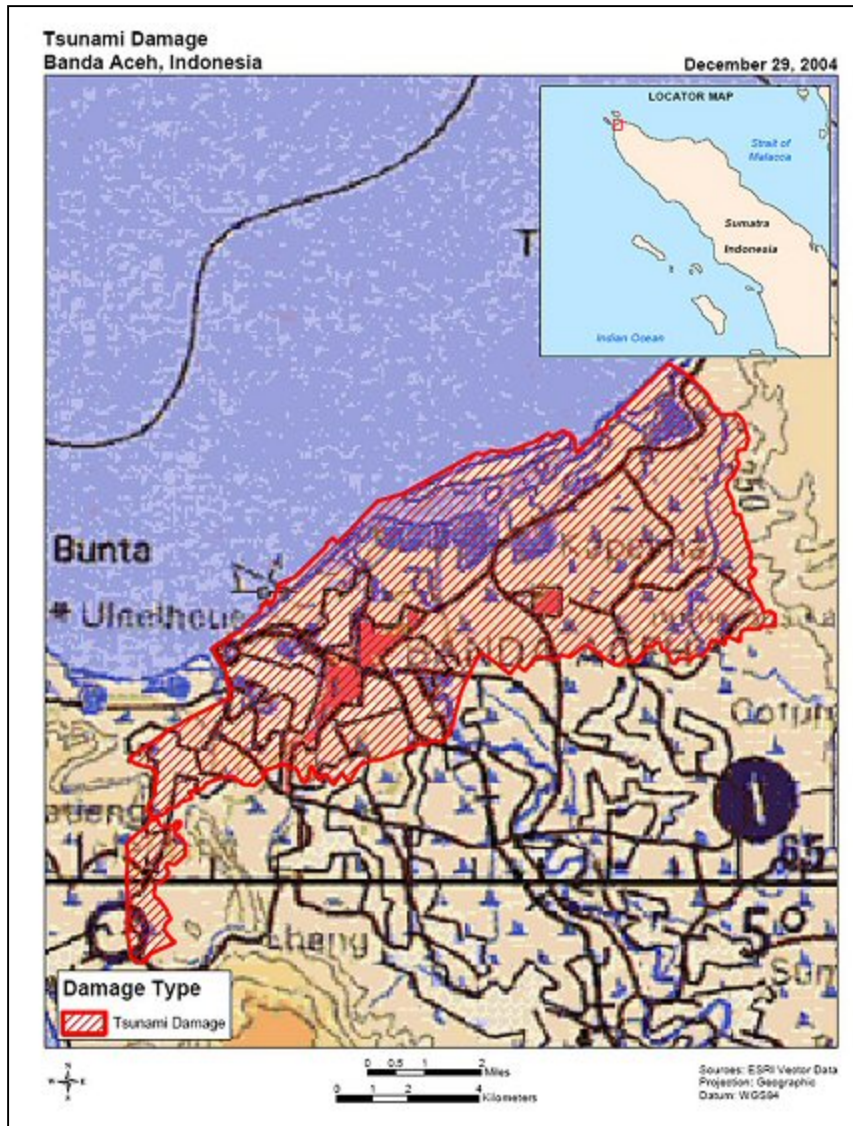
- **Geospatial Data Processing and Distribution –**
  - Obtained and processed high-resolution satellite imagery from NGA; coordinating processing with USGS EDC, Mercy Corps and other organizations.
  - Launched ArcIMS-based "*Indian Ocean Tsunami Geospatial Information Service*" and the corresponding Internet-based *Map Viewer*. (http://www.pdc.org/tsunami). ESRI provided consultative services to support high-volume/high-availability site requirements.
  - Providing on-line access to the GIS data via the Internet map service, the viewer, and the ftp site at Maui High Performance Computing Center (MHPCC)
    - Non-mil. org with direct SkyMedia/CSIL access
    - Supporting USG Inter-Agencies and the international communities of interest
- **In-country GIS Data Collection & Usage -**
  - Used to characterize conditions in the disaster zone for USPACOM Joint Task Force (JTF).
  - Illustrated the before/after effects and computed geographical extent of damage.
  - Portrayed high population densities for Humanitarian Assistance target areas.
  - Used in identification of damaged areas to target P-3 flyovers (to acquire higher resolution imagery of downed bridges, roads, etc. for determining main supply routes, hospital locations, helicopter landing zones, refuge camps.)
  - Supported data collection efforts in Thailand and Indonesia
- **Earthquake Notification Solution**
  - Short term e-mail notification solution to Southeast Asian disaster managers for possible large aftershocks and earthquakes in the Indian Ocean

PACIFIC
DISASTER
CENTER

Managing Partner:
EAST-WEST
CENTER

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PDC Mission Statement

The Pacific Disaster Center's mission is to provide applied information research and analysis support for the development of more effective policies, institutions, programs, and information products for the disaster management and humanitarian assistance communities of the Asia Pacific region and beyond.

Fostering Disaster-Resistant Communities

Partnerships
East-West Center
Program Office

PDC Accomplishments
2003 Highlights

Last update 2005-01-19 07:00 (HST)

5.7
6.3
6.5
5.2
5.2
5.0
KULAP
11S
5.2

(c) Pacific Disaster Center / East West Center
Shaded Relief: (c) WorldSat International Inc., 2001 - www.worldsat.ca - All Rights Reserved.

PDC NEWS | 📰 News archives

❗ **Latest Information on the Great Sumatra Earthquake and Tsunami**
PDC is collecting information resources for the public on this disaster. Click here for key overview resources, PDC news and updates, and other information products including preliminary damage maps for India, Thailand, Indonesia, Sri Lanka, and Somalia..........
more

Public Messages   last 24hr

- **PHFO HST Jan 19 06:45 GMT Jan 19 16:45**
  AUTOMATED WIND AND PRECIPITATION DATA FOR SELECTED HAWAII STATIONS - KNOTS
- **PHFO HST Jan 19 06:46 GMT Jan 19 16:46**
  HIGH SEAS FORECAST - N. PACIFIC
- **PHFO HST Jan 19 06:31 GMT Jan 19 16:31**
  AUTOMATED WIND AND PRECIPITATION DATA FOR SELECTED HAWAII STATIONS - KNOTS
- **PHFO HST Jan 19 05:58 GMT Jan 19 15:58**

SEARCH

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Perspectives

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WEATHER
Local Hourly Weather:
▸ Hawaiian Islands
  Yesterday in Hawaii

INFORMATION

· Hawaii Astronomical Tides

· Hawaii Civil Defense

· Hawaii Emergency Phone Numbers

· Honolulu Traffic Cam

· Maui County Hotline

· Warning Bulletins

· International News Links

· Homeland Security

🌐 Internet

Office of U.S. Foreign Disaster Assistance

FUNDING:

Humanitarian Information Center (HIC) in Sumatra, and UN OCHA/Field Information Support Unit (oversees HICs & chairs Geographic Information Support Team -- UN agencies, donors, others).

Cooperative Agreement with University of Georgia's Institute of Technology Outreach Services (ITOS) to maintain GIST Data Repository and provide processing, collection, and other services.

Seconded a staff member to HIC in Sumatra.

Agreement with USGS/EROS Data Center to obtain, process, analyze imagery.

PARTNERSHIPS:

Strategic input for data coordination effort within the humanitarian community via the GIST.

Work with NGA to obtain/distribute 1:50,000 scanned Indonesian maps for NW Sumatra.

Arranged with partners to provide vector base data, some created by extracting features off of large-scale Indonesian maps.

Distributed LandSat and VMAP1 data provided by USGS/EDC.

Arranged for and distributed two sets of damage area polygons and maps for the region, one developed by USGS/EDC using change detection techniques on LandSat data.

Arranged for and received IKONOS, QuickBird, and OrbView imagery from NGA. Worked with USGS/EDC to provide distribution in appropriate formats.

HIU Common Operating Picture:

- **Health,**
- **IDP Locations,**
- **USG Assistance**
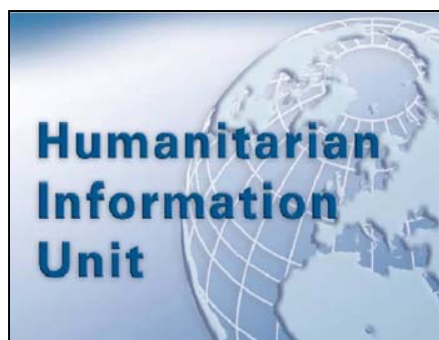
Aceh GIS Database/CI Applications
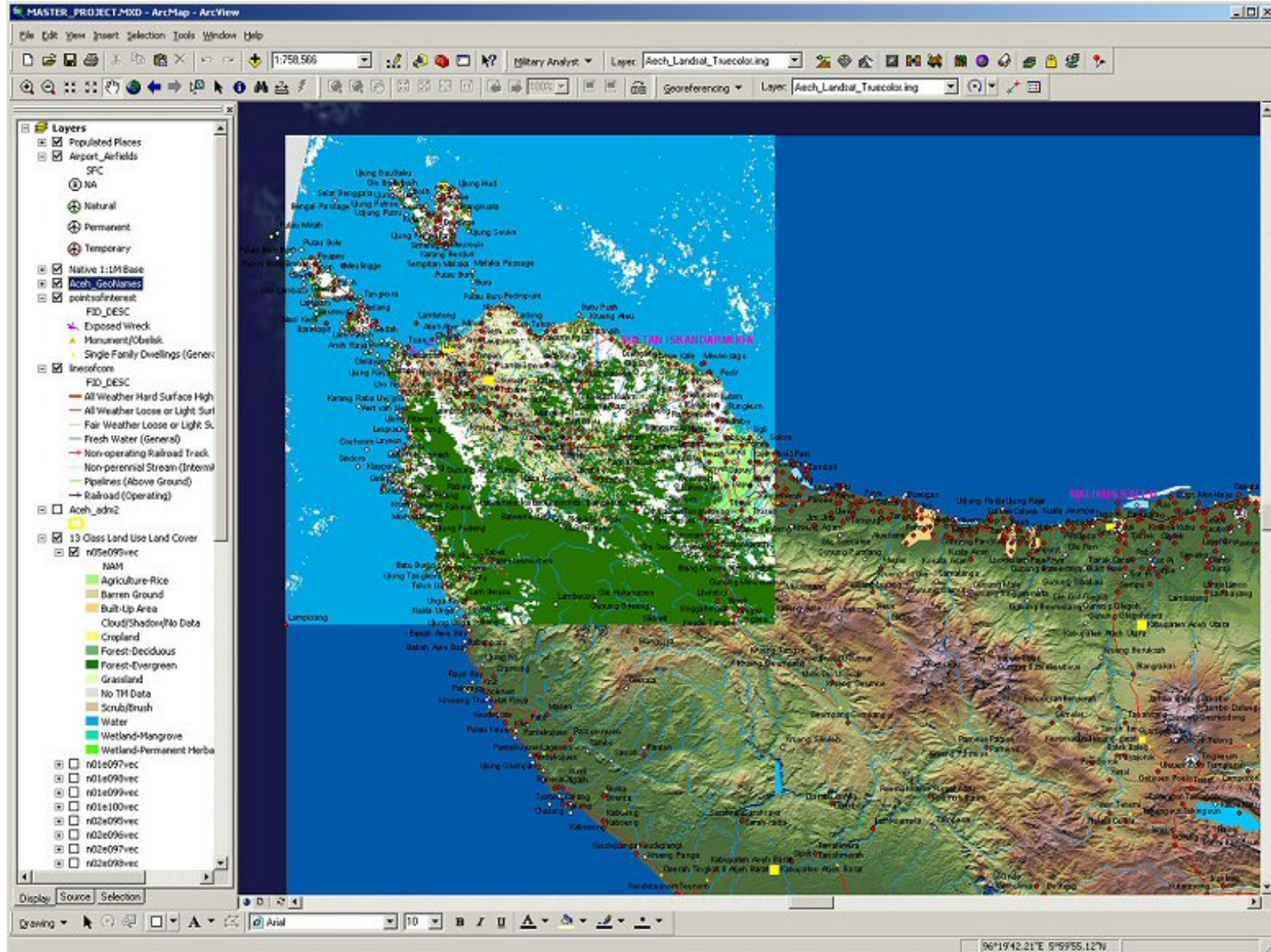
State INR/GGI
Aceh Coastal Atlas

Aceh, Indonesia
Coastal Area Atlas
Index to Sheets

Andaman Sea

Strait
of
Malacca

Banda Aceh
Sabang
Pulau Weh
Kota Sabang
Kota Banda Aceh
Kabupaten Aceh Besar
Janthoe
Sigli
Bireun
Kota Lhokseumawe
Lhokseumawe

Kabupaten Pidie
Kabupaten Bireun
Kabupaten Aceh Utara
Kabupaten Aceh Timur

Kabupaten Aceh Jaya

Calang
Takengon
Kota Langsa
Langsa
Karang Baru

Kabupaten Aceh Barat
Kabupaten Aceh Tengah
A C E H
Kabupaten Aceh Tamiang

Meulaboh
Kabupaten Nagan Raya
Suka Makmué
Kabupaten Gayo Lues
Blangkejeren

Kabupaten Aceh Barat Daya
Blangpidie

SUMATERA UTARA

INDIAN OCEAN

Kabupaten Aceh Selatan
Kutacane
Kabupaten Aceh Tenggara

Tapaktuan

Kabupaten Simeulue
Pulau Simelue
Sinabang

KEPULAUAN BANTAK

Kabupaten Aceh Singkil
Singkil

Pulau Lasia
Pulau Babi

INR
Bureau of Intelligence and Research
U.S. Department of State

Scale of map sheets
1 : 535,000

Specific efforts were required to compile *good* data.

Repaired holes in SRTM level 1.

Determined the best 2nd Order Administrative boundaries from more than 10 different sources.

Added attributes to the geonames layer to distinguish administrative capitals.

NGA GEOINT Support at the Department of State, INR/GGI

- **Damage Assessment Maps and Shapefiles**
  - INR/HIU, DoS Tsunami Task Force, USAID/OFDA

- **Aceh GIS Database**
  - INR/HIU, INR/GIU, USAID/OFDA, UN/OCHA - HIC

- **Mission Specific Transportation Data**
  - INR/HIU, INR/GIU, USAID/OFDA, INR/HIU,

- **GA support to the INR/GIU Atlas Project**
  - USAID/OFDA, INR/HIU, DoS Tsunami Task Force,
  - United Nations

Tsunami Humanitarian Information Sharing (THIS) Interagency Working Group

Information about GIS services and availability of imagery was was disseminated through formal Dept. of State diplomatic channels (cable) to USG embassies around the world.

eRoom Collaborative Space
https://bceroom.state.gov/eroom

Groove Collaborative Space for the Field
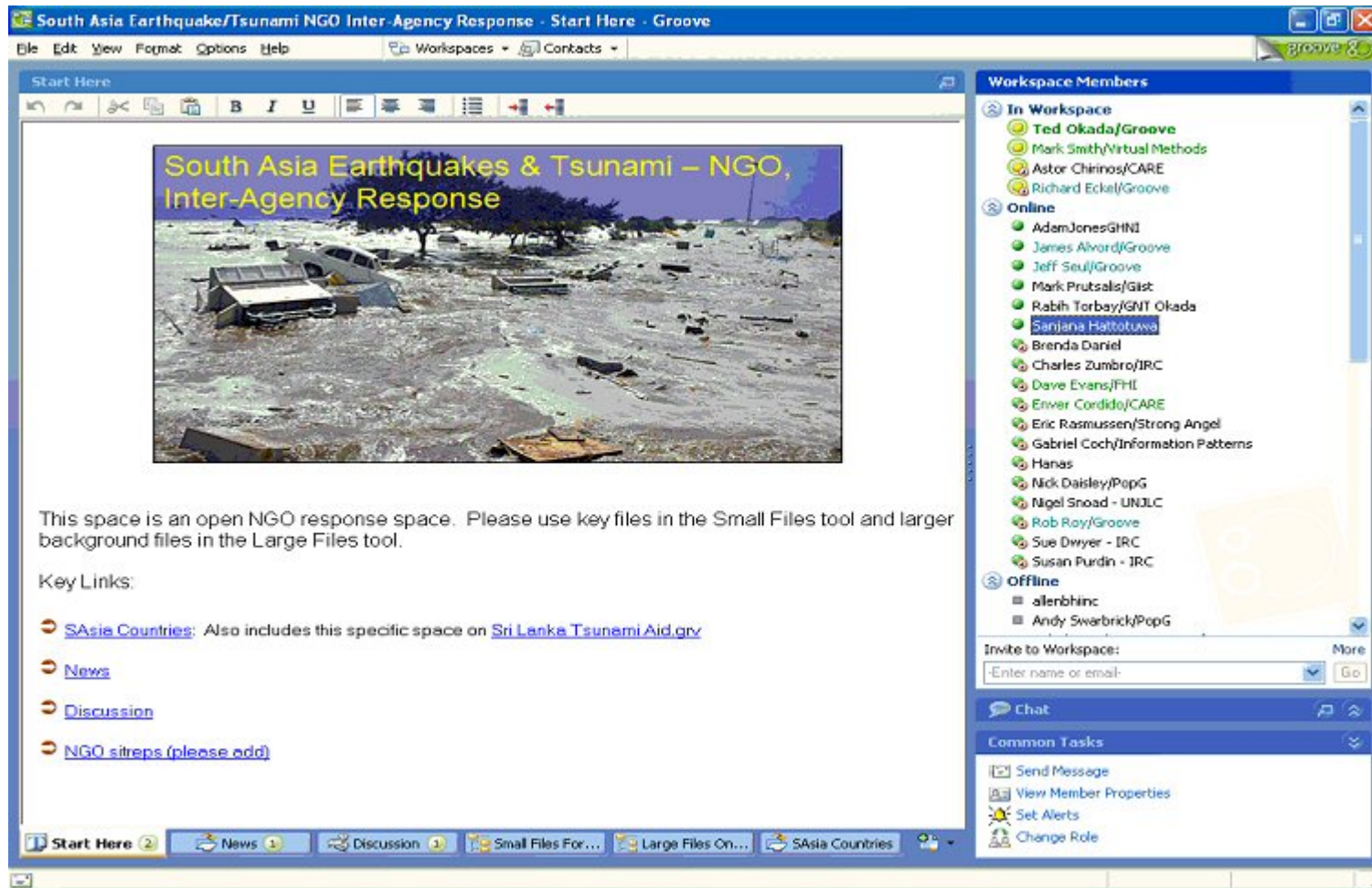
Groove is ideally suited for collaboration and information sharing in austere environments. It is not web-based, is based on peer-to-peer connectivity, and users can access Groove "spaces" on their laptops without internet connectivity.

HIU Website
http://hiu.state.gov

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Address   http://www.geodata.gov/gos   Go

geodata.gov
U.S. Maps & Data

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state & local geographic data

Make a Map

Launch:
The National Map
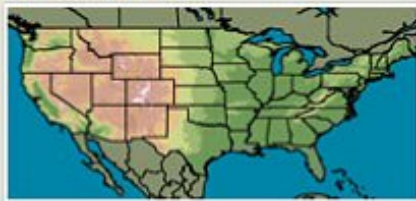
Search for Data

Search all the data in this site

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How to find the maps & data you need
and how to publish your data here.
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Find out about the latest geographic
data sharing and acquisition initiatives.

Information Center

Geodata.gov is part of the Geospatial One-Stop E-Gov initiative providing
access to geospatial data and information. For help use the Quick Start Guide.

To find geospatial data that meets your specific criteria:
   Select "Search all data in this site", in left column,
   -- OR --
For quick access to featured geospatial resources by subject:
   Click on one of the Categories or Sub-Categories below.
   Click '+' sign to see sub-categories.

Indian Ocean Disaster

Data Categories

→   **Administrative and Political Boundaries**

→ + **Agriculture and Farming**

→   **Atmosphere and Climatic**

→ + **Biology and Ecology**

→   **Business and Economic**

→   **Business and Economic**

→   **Cadastral**

→ + **Cultural, Society, and Demographic**

→ + **Elevation and Derived Products**

→ + **Environment and Conservation**

Internet

Indian Ocean Disaster

Open category:
---Indian Ocean Disaster

→ **What is new?**

→ **Live Data and Maps**

→ **Imagery**

→ **In Country Resources**

▢ **Downloadable Maps**

→ **Tools**

→ **Emergency Resources**

→ **Other Resources**

→ **News**

→ **About this Category**

→ **Help**

Introduction

This page provides links to web sites, resources, and maps relevant to the recent earthquake, tsunami, and disaster recovery efforts in the Indian Ocean region. Users worldwide are encouraged to post Live Data and Maps, Downloadable Data, Resources, and Maps related to the Indian Ocean Disaster on geodata.gov.

Go to main channel: Natural Disaster Events

Base Maps

1:50K Image Maps on Demand for Indian Ocean Area

Content Summary: These PDF map files present EarthSat NaturalVue 15m resolution satellite imagery, overlayed with populated place names from the NGA VMap Level 0 data set and airports from the NGA DAFIF data set. PDF maps cover coastal areas of the Indian Ocean region impacted by the Tsunami.

Content Purpose: Over 200 1:50K Image Maps on Demand are available for download in PDF format for the following regions: Sri Lanka; Thailand, Malacca Strait; Sumatra South, Indian Ocean; India, Bay of Bengal; Northeast India; and Sumatra, Andaman Sea.

Publisher: ESRI

Content Type: Static map image

(VIEW DETAILS)   (GO TO WEBSITE ❯)

NOAA Tsunami FTP website

(GO TO WEBSITE ❯)

World Historical Earthquake Locations

Content Summary: An earthquake is the motion or trembling of the ground produced by sudden displacement of rock in the Earth's crust. This data layer represents significant historical earthquake locations around the world. Each point contains information such as the date and magnitude of the earthquake. This data was compiled

Done   ● Internet

The real story:
Role of commercial imagery, vendors, private concerns

German Aerospace Center:
Center for Satellite-Based Crisis Information

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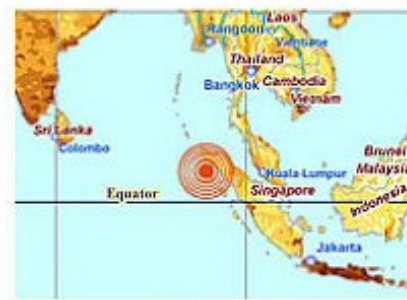## News & Publications

Indian Ocean Disaster

On December 26, 2004, a 9.0 earthquake in the Indian Ocean caused a series of forceful tsunamis to bring death and disaster to many countries that flank its shores.

This page offers a collection of links to map and data resources relevant to the recent earthquake, tsunami, and disaster recovery efforts in the Indian Ocean region.
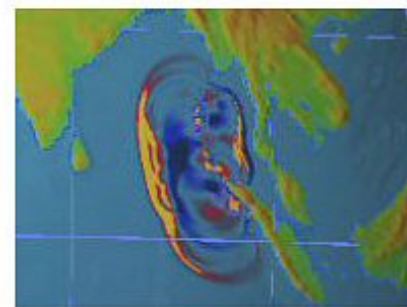

This map shows the population density of the area affected by the tsunami. ⇢ View animation.

⇢ Indian Ocean Disaster Data and Resources are available on Geodata.gov

You'll find

- Live Data and Maps
- Imagery
- Other Data Resources
- Downloadable Maps
- Tools
- Emergency Resources
- Other Resources
- News

Tsunami simulation courtesy of NOAA.
⇢ View animations 1, 2.

Internet

Planned NOAA Tsunami Assistance

- On January 14, 2005, the U.S. announced plans to expand the U.S. tsunami detection and warning capabilities as a contribution of the Global Earth Observation System of Systems, or GEOSS—the international effort to develop a comprehensive, sustained and integrated Earth observation system.

- NOAA will expand the deployment of its Deep-ocean Assessment and Reporting of Tsunamis (DART) buoy system to include the Indian Ocean, and work to enhance the dissemination of future tsunami warnings to potentially effected countries.
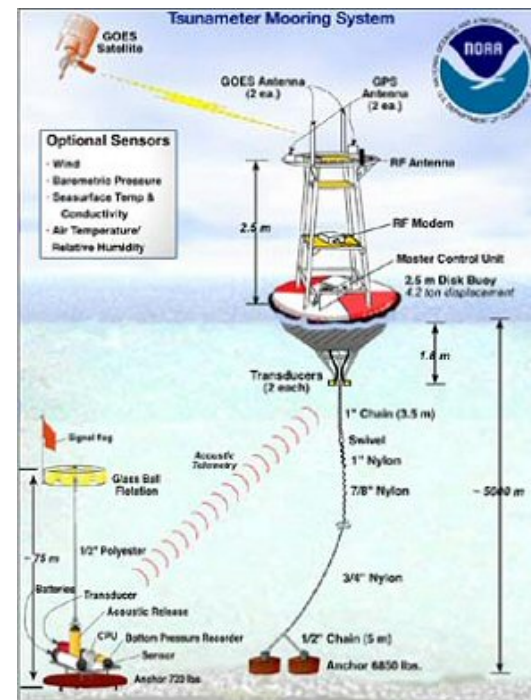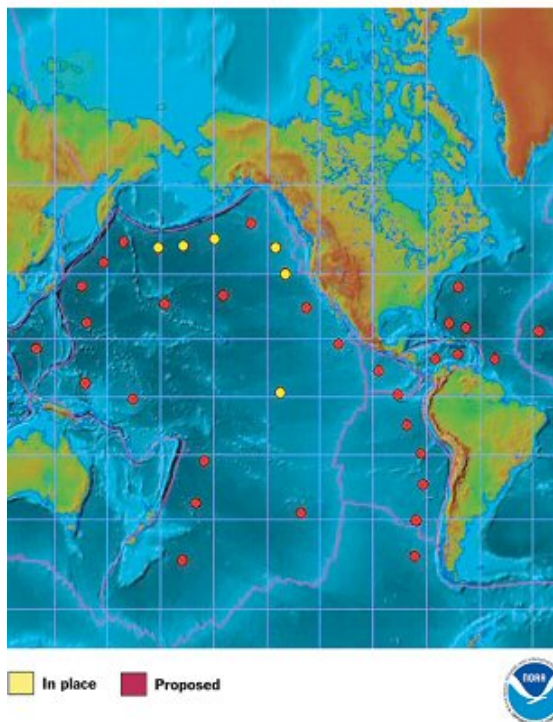
Lessons Learned – working with geospatial data

- Nothing simple, automated, or clean about compiling the best data available. Phone calls, research, and tedious tweaking of data.

- Oftentimes, data with better attributes is better than more-detailed data with little or no attributes.

- Available data doesn't mean you end up with a good cartographic product. Much of the data needs to be edited, orthorectified, etc. (e.g. -different shorelines).

- Sources were compiled from the United Nations, Global Forest Watch, NGA, State Department Map Annex, Dartmouth Flood Observatory, World Bank, and NASA.

- Some of the best data came non-government sources (e.g. Global Forest Watch, Dartmouth).

- Networking with colleagues across different agencies, commercial vendors, businesses, and NGOs are necessary in the compilation of good datasets.

Lessons Learned – applying geospatial information

- Extent of Disaster/Footprint

- Populations at Risk

- Field-driven requirements

- GIS vs. IM and IT

- Appropriate Technology

- Relief vs. Rehabilitation