Estimating Exposure



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Pacific Disaster Center

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APEC
Asia-Pacific Economic Cooperation

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Presentation Overview

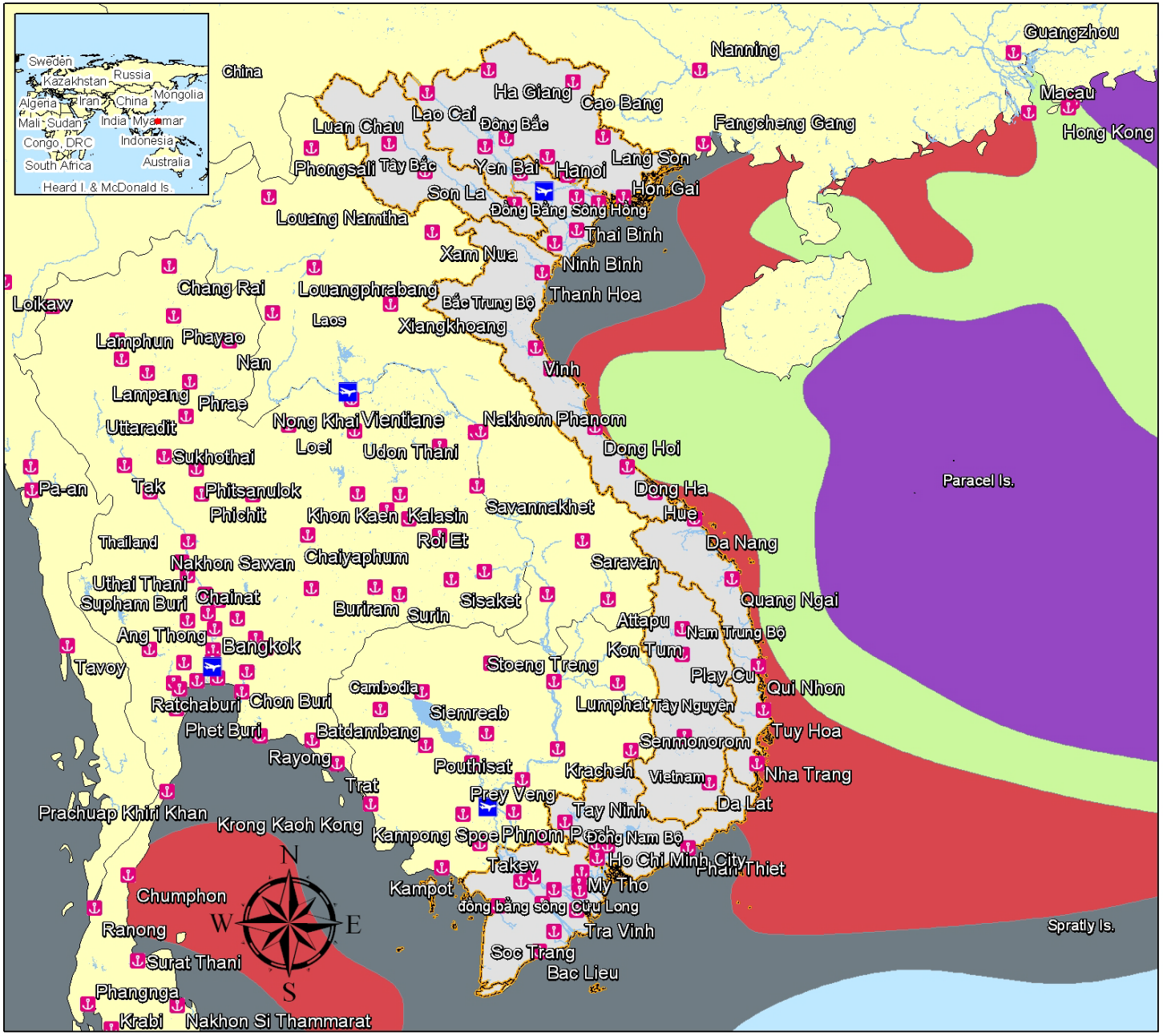
1. Mapping Hazard Events
   – Current, historical, hazard zones, modelling
2. Mapping Assets
   – Types, characteristics, exposure
3. Data Collection
   – Direct, indirect, challenges, metadata
4. Case Study #1
5. Case Study #2

Importance of Maps

- **Maps Are Important Tools for:**
  - Recording and storing information
  - Discovering and analyzing spatial patterns and relationships
  - Conveying information that is difficult to express verbally or as text
  - Expressing patterns or trends over time
  - Navigating by sea, air and land
  - Assisting in decision making

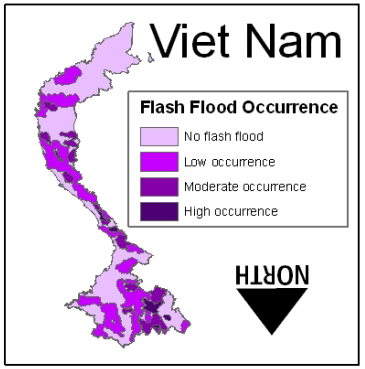
Mapping Considerations

- Considerations When Creating Maps:
  - Purpose (message, audience, etc.)
  - Selection
  - Scale
  - Projection
  - Classification
  - Symbology
  - Visual Clarity
  - Data Availability and Quality
  - Ethics



Storm Intensity Zone

- Populated Place
- Capital City
- Countrary Boundairy
- Viet Nam



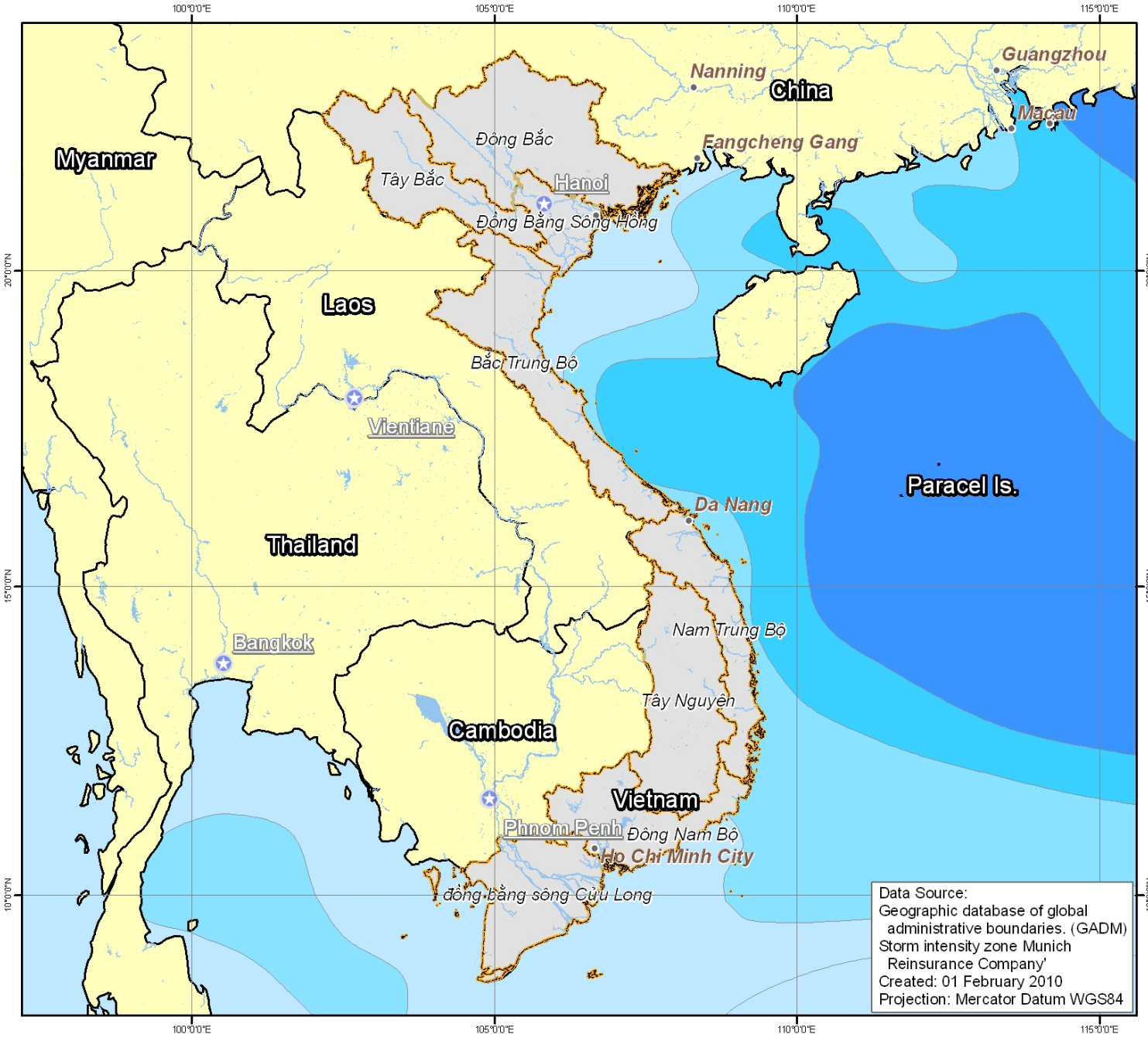
Storm Intensity Zone

- 118 - 153
- 154 - 177
- 178 - 208
- 209 - 249
- 250 +

Scale Bar

0 250 500

Viet Nam Tropical Storm Intensity Zone



Legend

- Capital City
- Major City
- World Country Boundaries
- Viet Nam Province
- Major Waterbody

Storm Intensity Probability

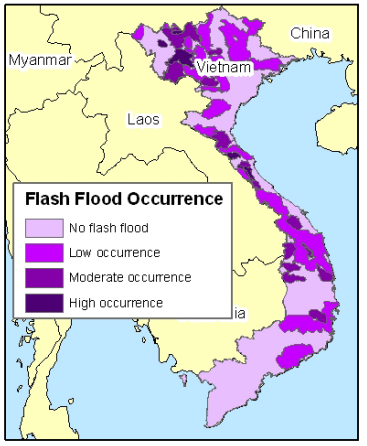
Wind speeds with a 10% chance of occuring within 10 years

- 118 - 153 km/h
- 154 - 177 km/h
- 178 - 208 km/h
- 209 - 249 km/h
- 250 + km/h

N W E S

0 50 100 200 Miles

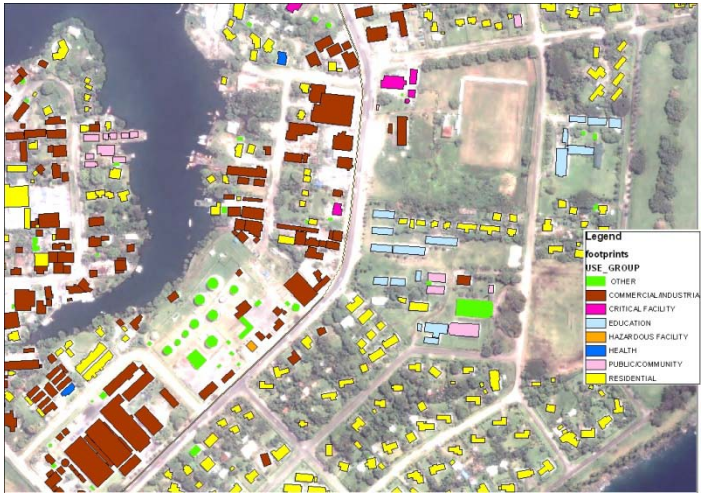
0 50 100 200 300 Kilometers

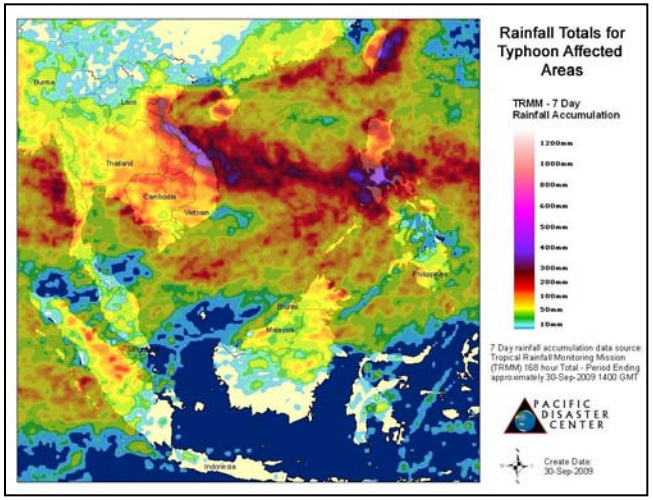


How Does Mapping Support DM?

Maps help users understand the location, distribution and relationships of:

- Hazards and their characteristics
- Assets (resources) and their characteristics
- Overlap of hazards and assets (Exposure)





Why is Hazard Mapping needed …

Text based Products are Inadequate for Decision Makers

- Lack Situational Awareness
- Warnings are Hard to Digest
- Information is Scattered
- Risks are not Understood
- Dissemination is Limited

Time is *LIFE*

- Information you can't easily understand and act upon isn't particularly useful

Sample Advisories

Hurricane

HURRICANE DAVID FORECAST/ADVISORY NUMBER 15
NATIONAL WEATHER SERVICE MIAMI FL EP0402
0000Z WED AUG 29 1979

Tsunami

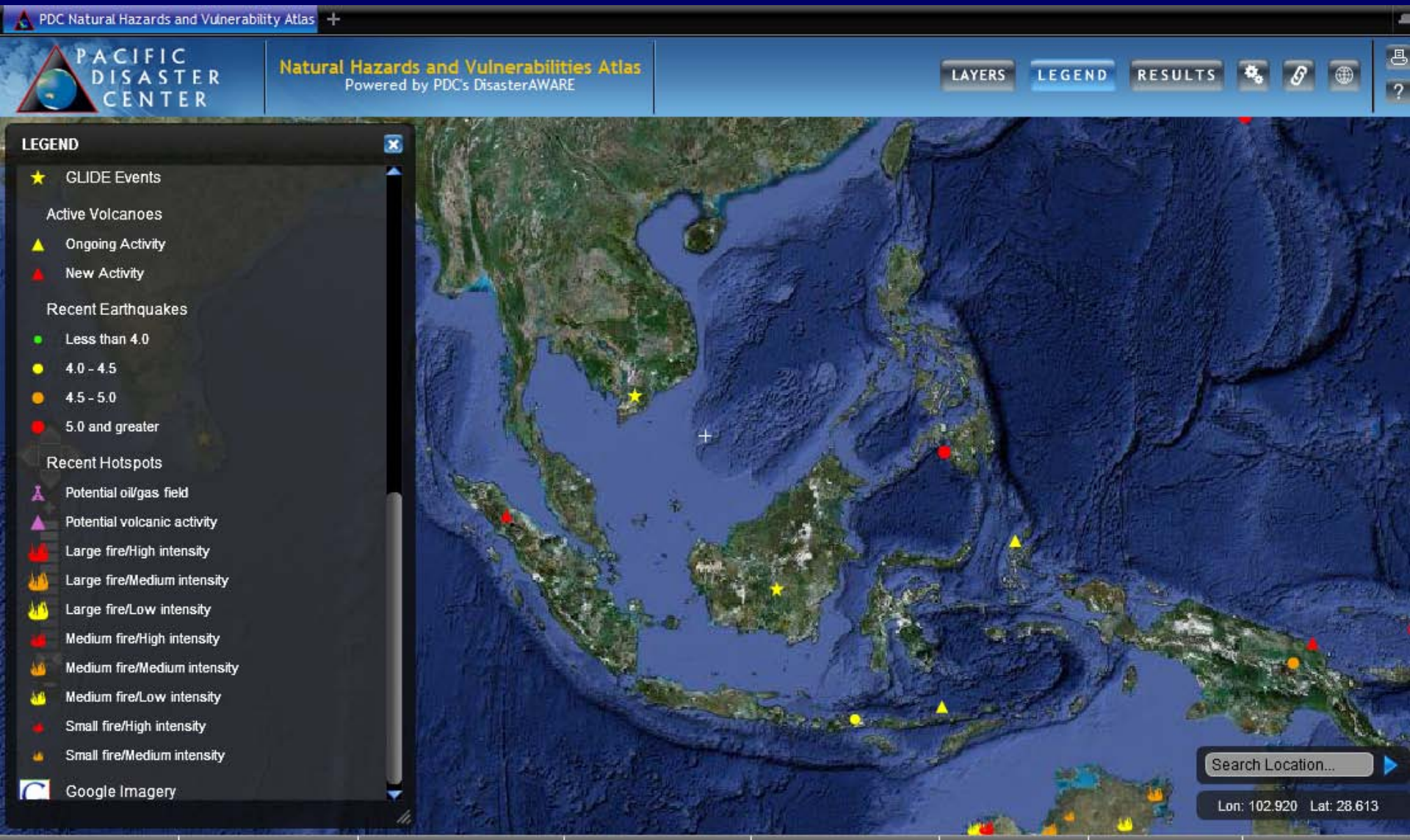
```
Starting time: HST 11/14/2005 11:39
Starting time: UTC 11/14/2005 21:39
Location: longitude 144.8 EAST  latitude 38.2 NORTH
Magnitude: 7.3

Arrival Time is in HST
```

EQ

MAG	UTC DATE-TIME y/m/d h:m:s	LAT deg	LON deg	DEPTH km	Region
5.9	2006/04/29 04:06:13	-11.313	118.534	30.0	SOUTH OF SUMBAV
5.1	2006/04/28 18:01:28	41.766	80.669	31.8	SOUTHERN XINJIAI
5.2	2006/04/28 09:05:26	23.978	121.655	8.2	TAIWAN
5.3	2006/04/27 19:13:10	-16.050	-173.789	75.2	TONGA
5.1	2006/04/27 16:35:23	-25.337	-105.586	10.0	EASTER ISLAND RE
5.2	2006/04/27 14:48:25	-6.174	147.711	87.8	EASTERN NEW GUI
5.3	2006/04/27 04:18:28	0.321	30.026	10.0	LAKE EDWARD REG
5.3	2006/04/26 16:38:54	4.499	95.944	74.5	NORTHERN SUMATI

Combine and Visualize Multiple Datasets



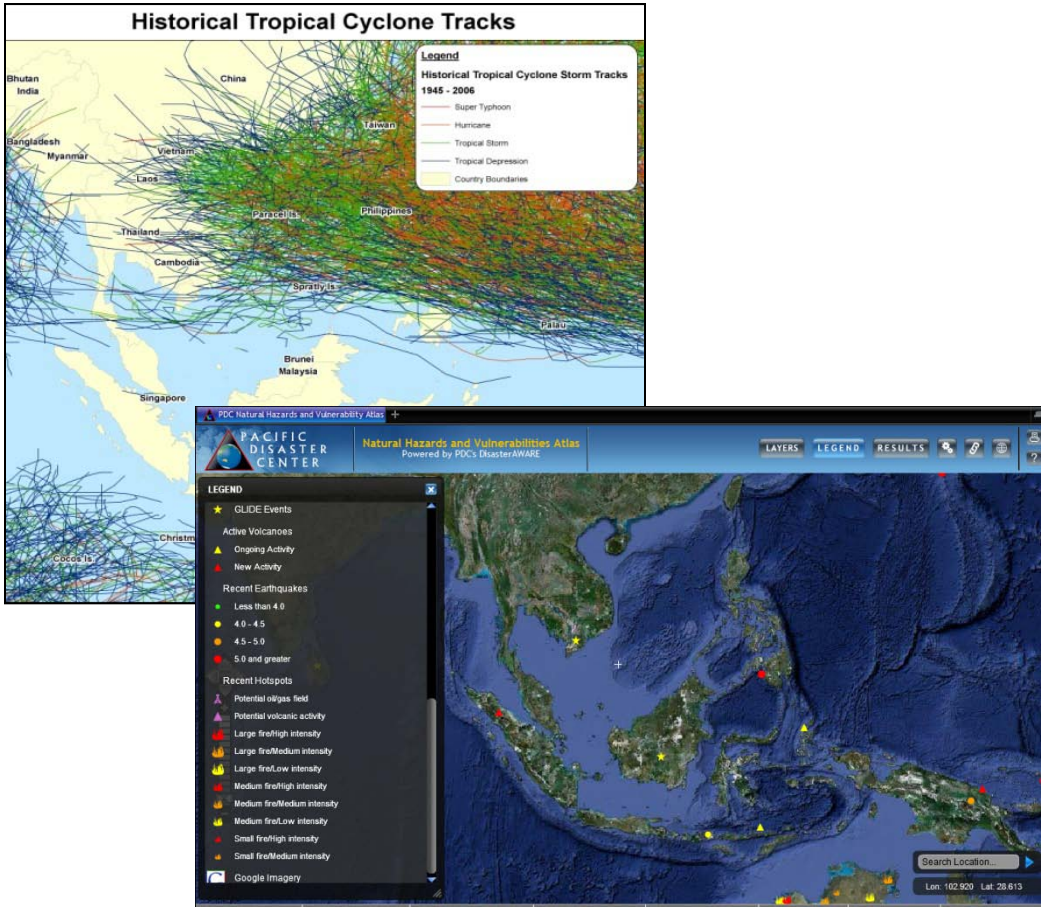
Hazard Mapping Equips Disaster Managers

- **Mapping hazard information allows disaster managers to answer questions such as:**
  - Where are current hazards and what is their extent?
  - Where have hazards occurred in the past and with what frequency and intensity?
  - What hazards are most likely to occur?
  - Where are various hazards most likely to occur?
  - Where are there high likelihoods of several types of hazards?
  - Where is an impending hazard likely to impact?

Mapping Hazard Events

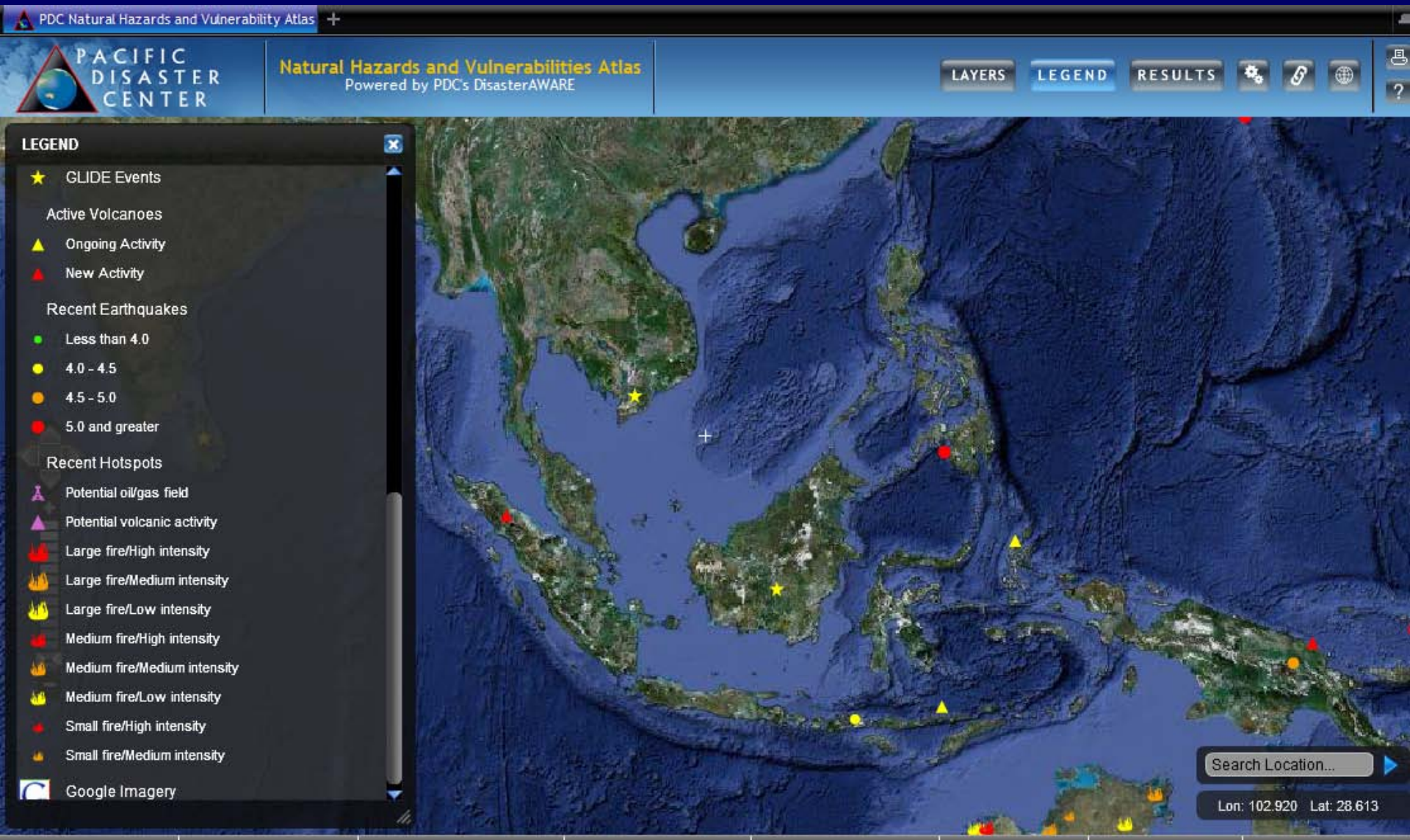
- Real Time Hazards
- Historical Hazards
- Hazard Zones
- Scenario Modeling

Mapping Hazard Events



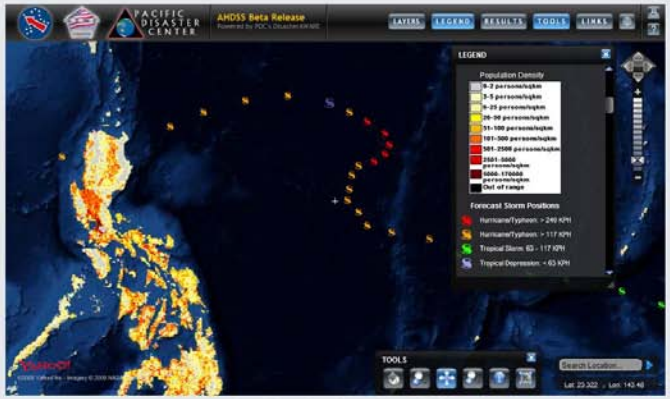
We can display information about hazards by mapping discrete hazard events (current or historical) as points, lines or areas

Mapping Current Hazard Events

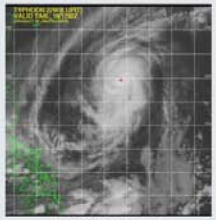


Mapping Current Hazard Events

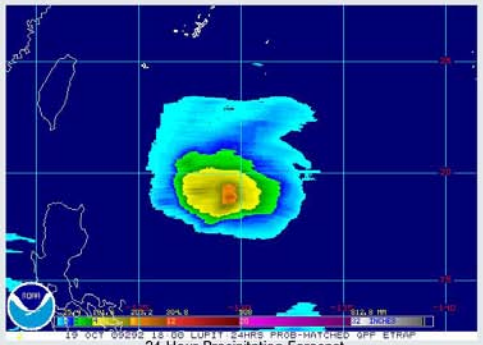
Tropical Storm Lupit
Situation Update Advisory #24 Oct
19, 2009 18:00 Zulu

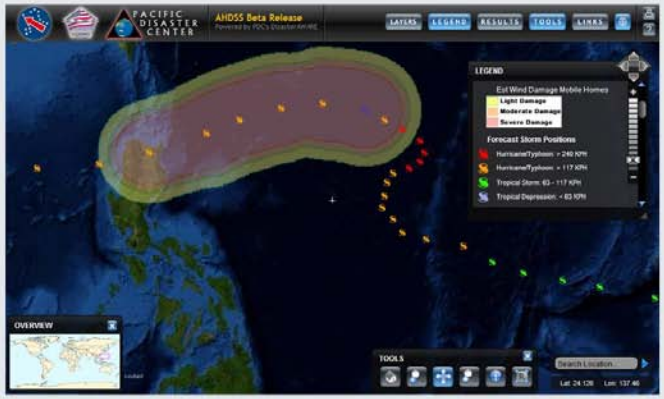


Population Density in Storm Path

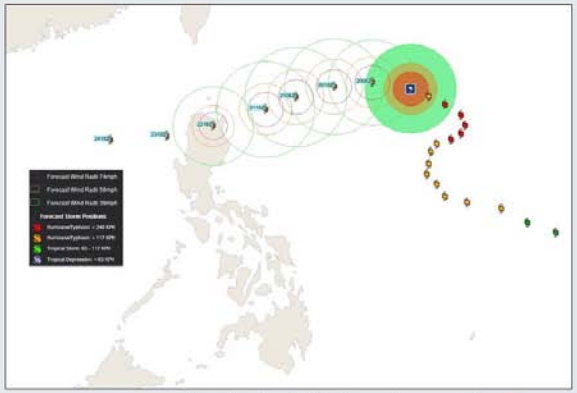

IR Satellite Image


JTWC Forecast


24-Hour Precipitation Forecast



CATS Model Estimated Damage to Mobile Homes (poorly constructed, single walled structures)


Storm Track and Winds Forecast

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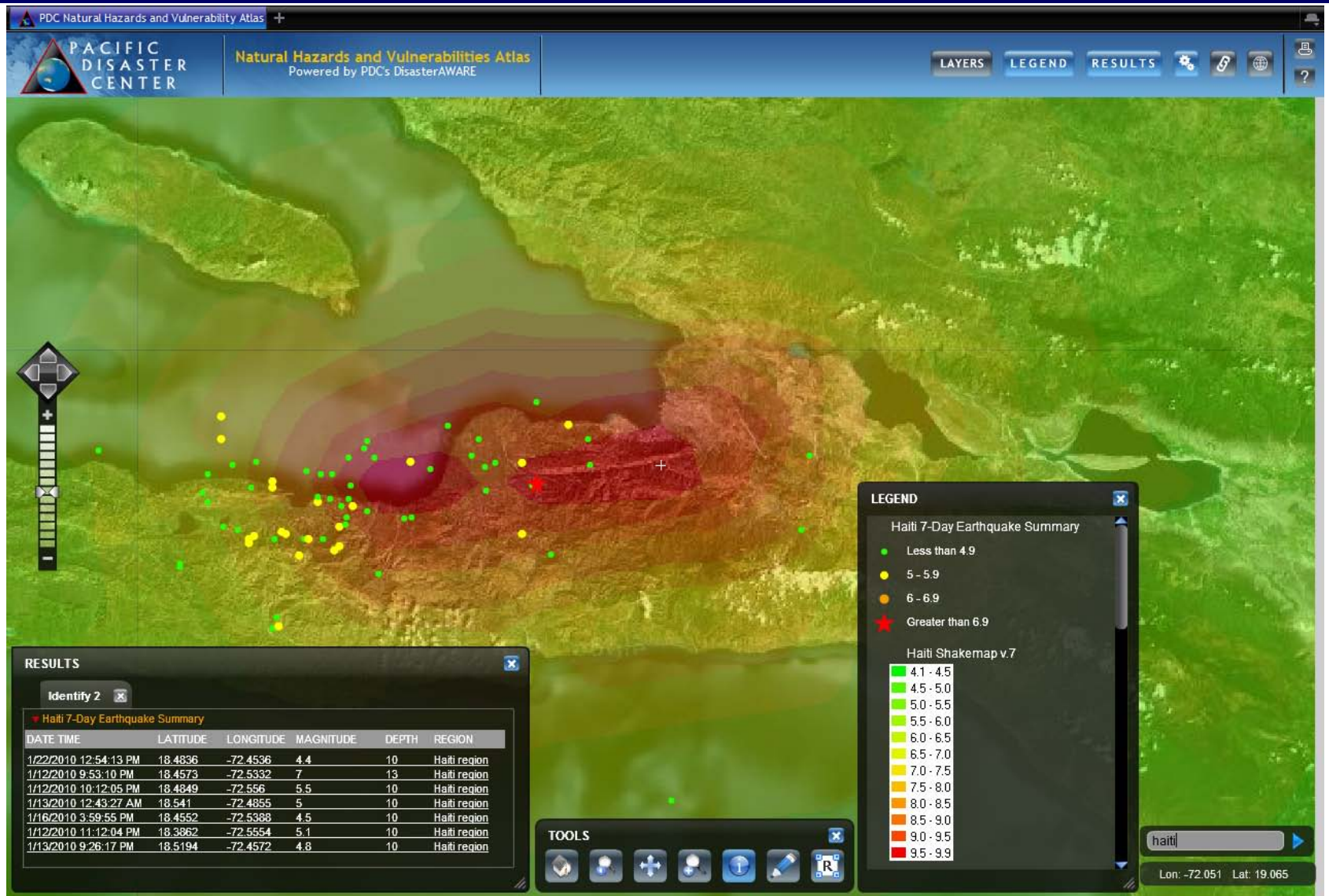
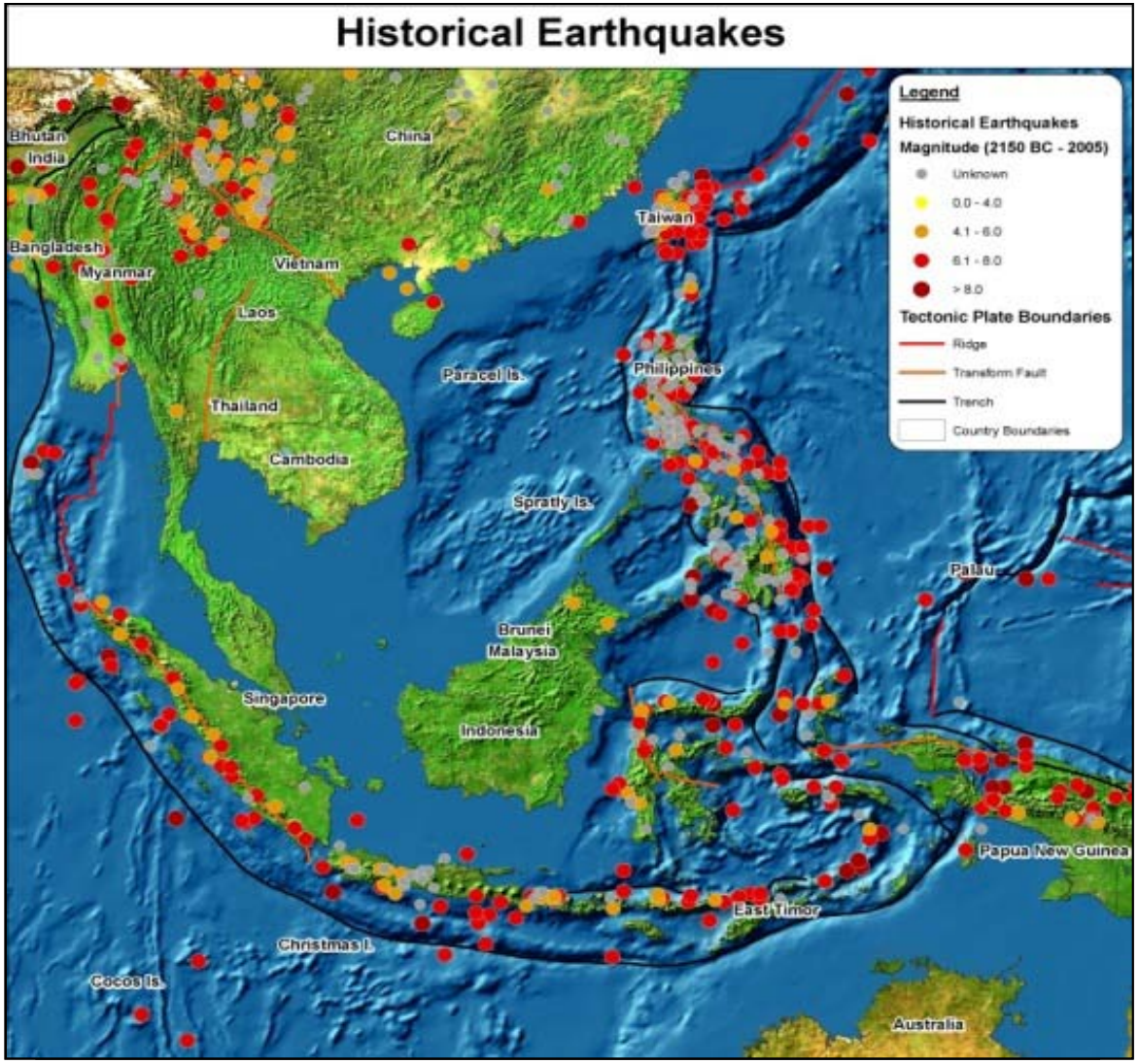
Tropical Storm Situation Update showing path and intensity of the storm and population at risk.

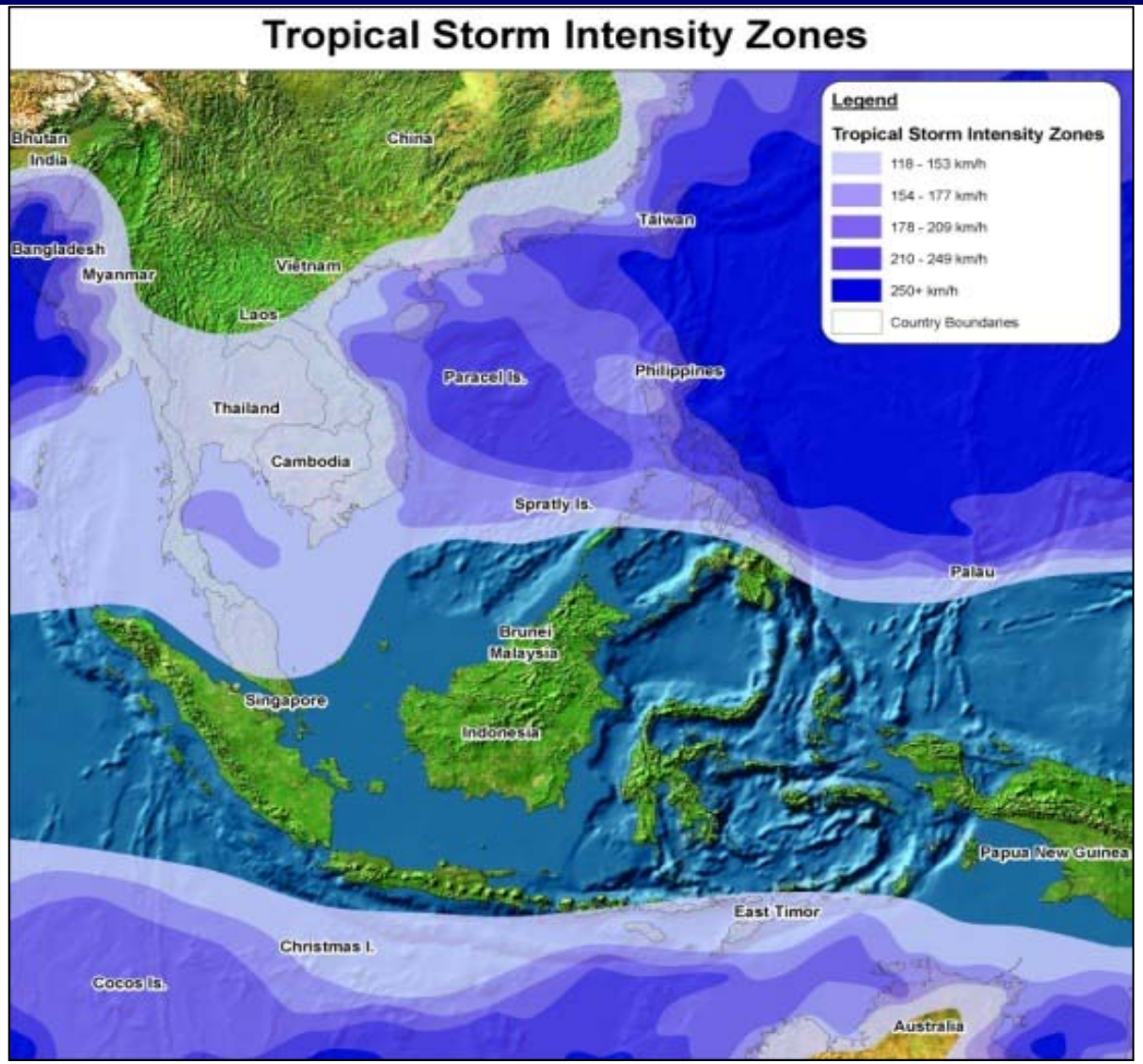
Mapping Current Hazard Events



Mapping Historical Hazard Events

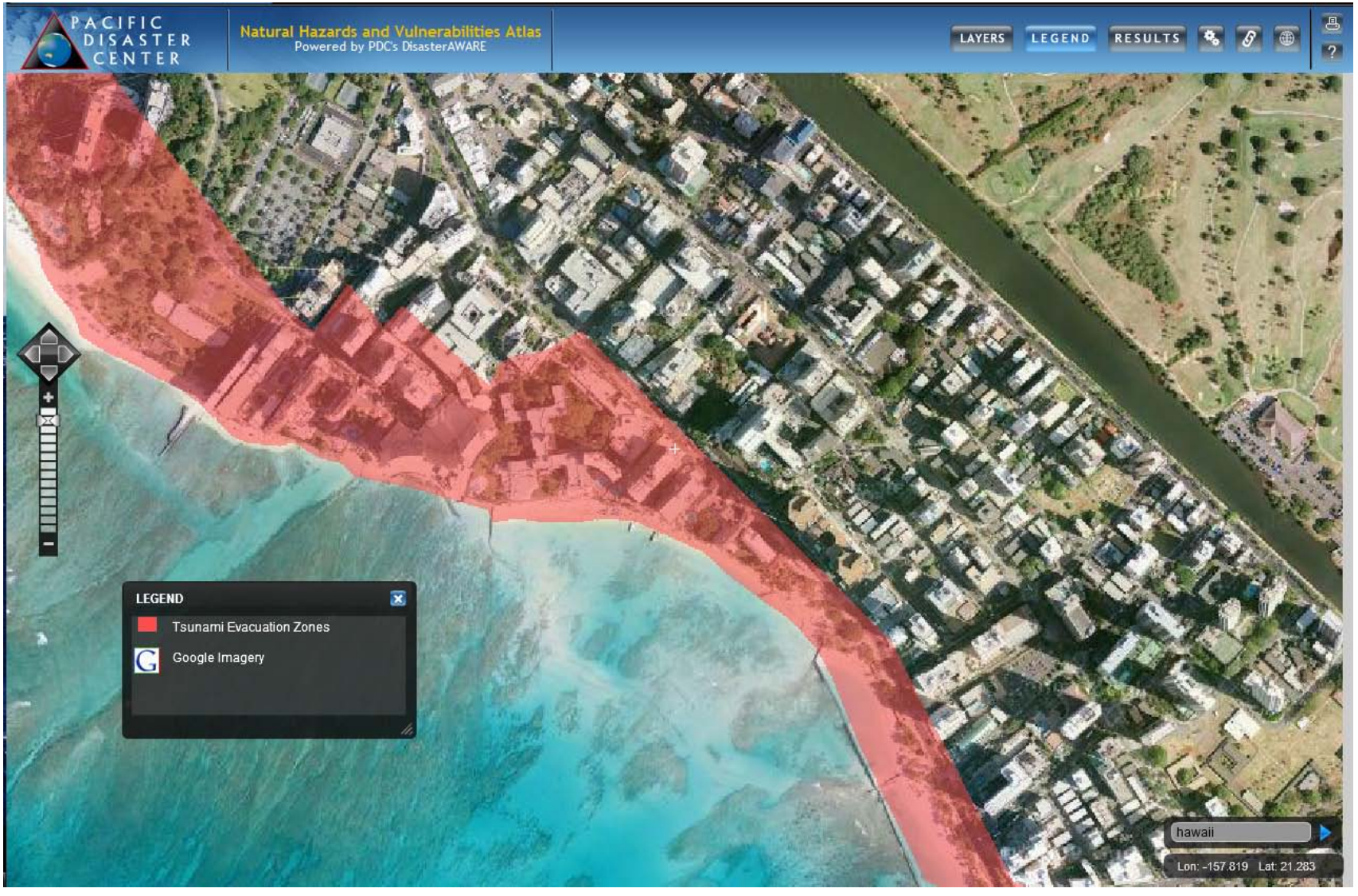


Hazard Zones

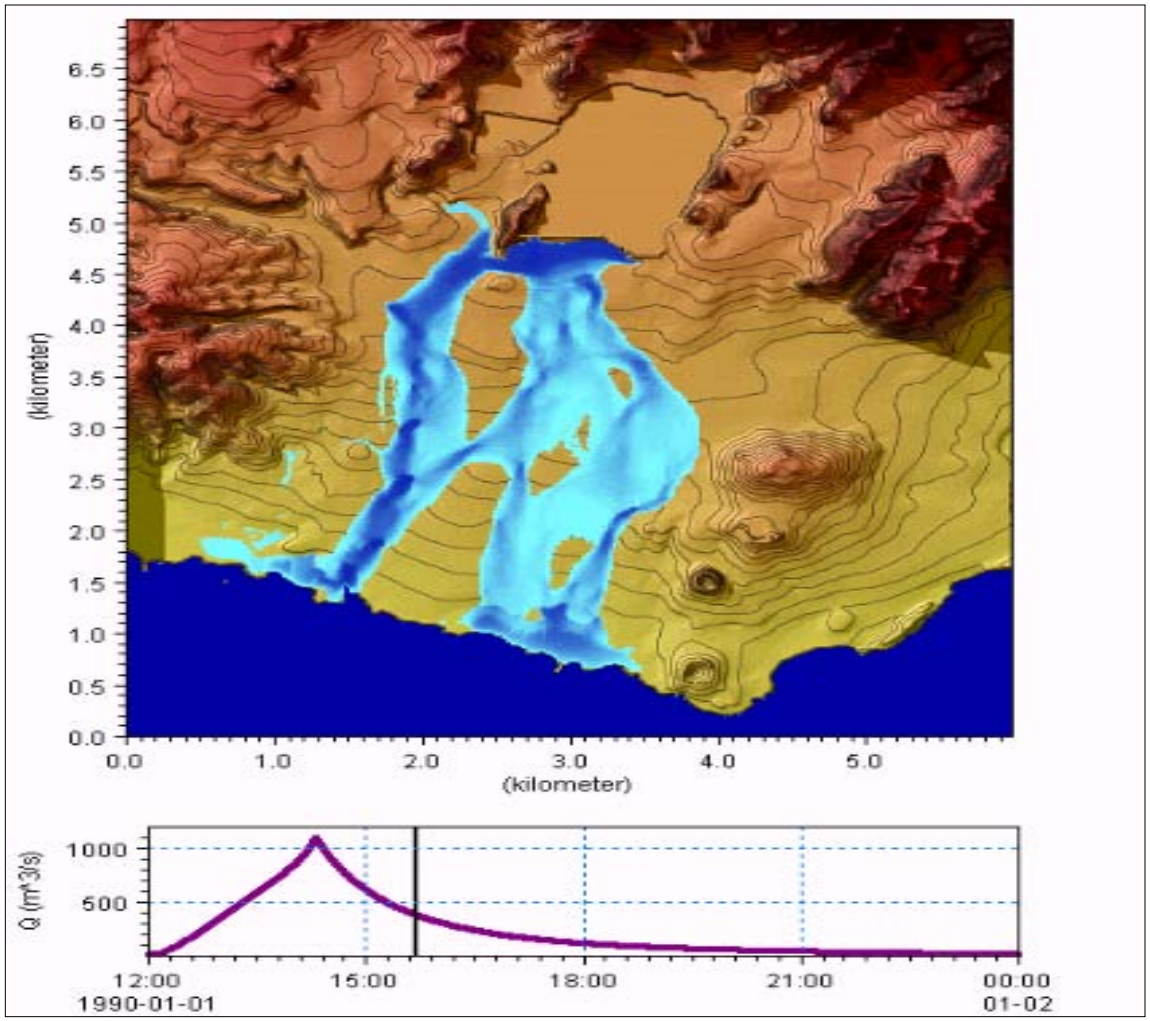


We can display information about hazards by deriving probabilities of occurrence for certain hazard types from historical data and mapping the variation across space.

Hazard Zones



Hazard Modeling



We can display information about hazards by mapping the outputs of models used to predict the behavior and characteristics of a real event or mock scenario.

Hazard Related Data Examples

- Past, present and future events
- Magnitude or intensity
- Timing and duration
- Associated losses and impacts
- Tropical cyclones
- Floods
- Landslides
- Drought
- Salt water intrusion
- Wildfire
- Climate variability

Mapping Assets

- What are assets?
- Why is mapping assets important?
- What information about assets is necessary to collect?

Mapping Assets

- **Mapping Assets and Resources**
  - Socio-cultural, economic, or environmental objects and systems that could be impacted by a hazard event.
  - May influence events themselves.
  - People, buildings, transportation networks, cities, cropland, markets, forests, power plants, and many others.

Mapping Assets

What is important to your community?

Asset Data Examples

- Energy Infrastructure
- Health Infrastructure
- Communications Infrastructure
- Transportation Infrastructure
- Governance Infrastructure
- Security Infrastructure
- Education Infrastructure
- Other Critical Facilities or Infrastructure
- Water Supply
- Food Supply
- Population and Demographics
- Economics
- Environment

Mapping Assets

- **Mapping asset and resource information allows disaster managers to answer questions such as:**
  - Where are there gaps in critical infrastructure?
  - What assets and resources are located farthest away from critical services?
- Assets Plus Hazard Equals Exposure
  - Where are there high concentrations of assets and resources likely to be exposed to a hazard event?

Mapping Asset Characteristics

Mapping the Characteristics of Assets

- Need more than “Is the point a building or a bridge?”
- Structural vs. non-structural assets
- Quantity and quality
- Construction type & materials
- Condition, capacity or capability of assets and resources

Mapping Structural Asset Characteristics

Feature Characteristics
Name, Address, Location
Function
Owner/Operator
Number of employees, patients, students, guests etc.
Contact information
First-floor flood elevations (if a building)
Hazardous materials (HazMat) present?
Constructions materials
Age of feature
Estimated value of contents
Estimated replacement cost
Storage capacity (if HazMat)

Business Characteristics
Business name
Location
Business type
Business revenue
Number of employees
Capacity
Seasonal capacity
First-floor flood elevations
Estimated replacement cost
Estimated value of contents

Base/Reference Data Examples

- Administrative and Political Boundaries
- Hydrography
  - Rivers/Streams
  - Lakes
  - Wetlands
- Oceans
- Land Use/Cover
- Topography
- Bathymetry
- Geology
- Aerial Photography and Space Derived Imagery (Raster)
- Other Boundaries
  - Public lands
  - Parks
  - Land parcels
  - Tax/Census
- Public Places
- Place/Feature Names

- Collecting Data
  - Indirect Collection
  - Direct Collection
  - Metadata

Indirect Data Collection

Indirect Collection

- Data was collected by another organization
- Free and for fee
- Unlikely to be able to get all the data you want
- Normally the best place to start
  - Why collect data that someone else already has?
- Utilize networks and data sharing portals
- Usually global or regional, local data is sometimes difficult to find in a useable format
- Types include downloadable, offline or services

Indirect Data Collection Sources

The following is a list of some regional data sources:

The Global Hazards Information Network (GHIN): http://www.pdc.org/ghin

United Nations Environmental Programme (UNEP), Project of Risk Evaluation, Vulnerability, Information & Early Warning (PreView): http://www.grid.unep.ch/activities/earlywarning/preview

Socioeconomic Data and Applications Center: http://sedac.ciesin.columbia.edu

GeoNetwork: http://www.fao.org/geonetwork/srv/en/main.home

Global Land Cover Facility (GLCF): http://glcf.umiacs.umd.edu/index.shtml

EM-DAT: The International Disaster Database: http://www.emdat.be

ReliefWeb: http://www.reliefweb.int

Open Street Map: http://wiki.openstreetmap.org/wiki/Main_Page or http://downloads.cloudmade.com or http://download.geofabrik.de/osm

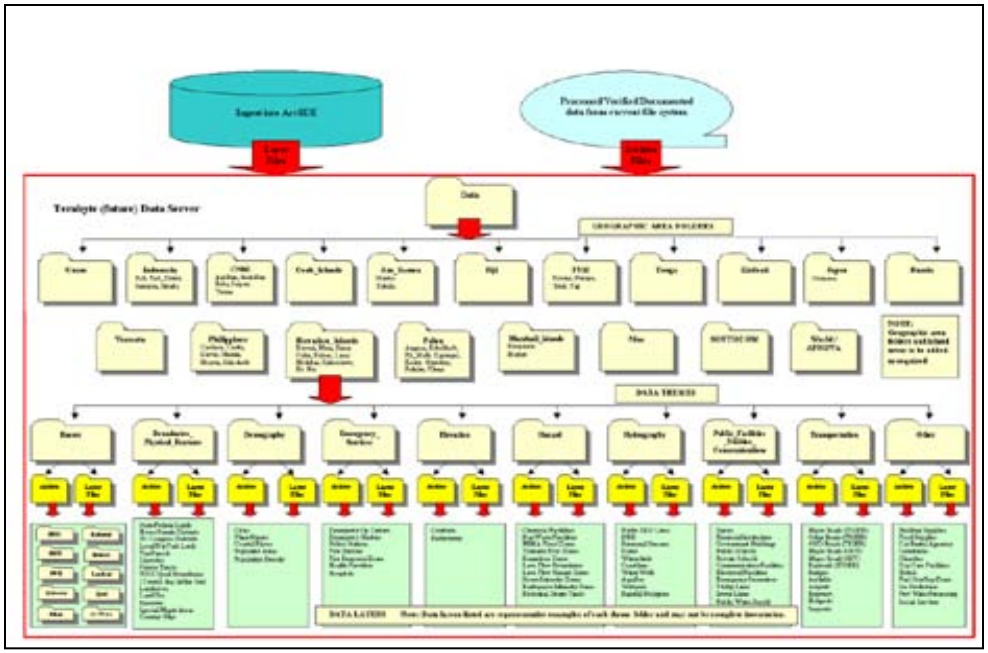
Direct Data Collection

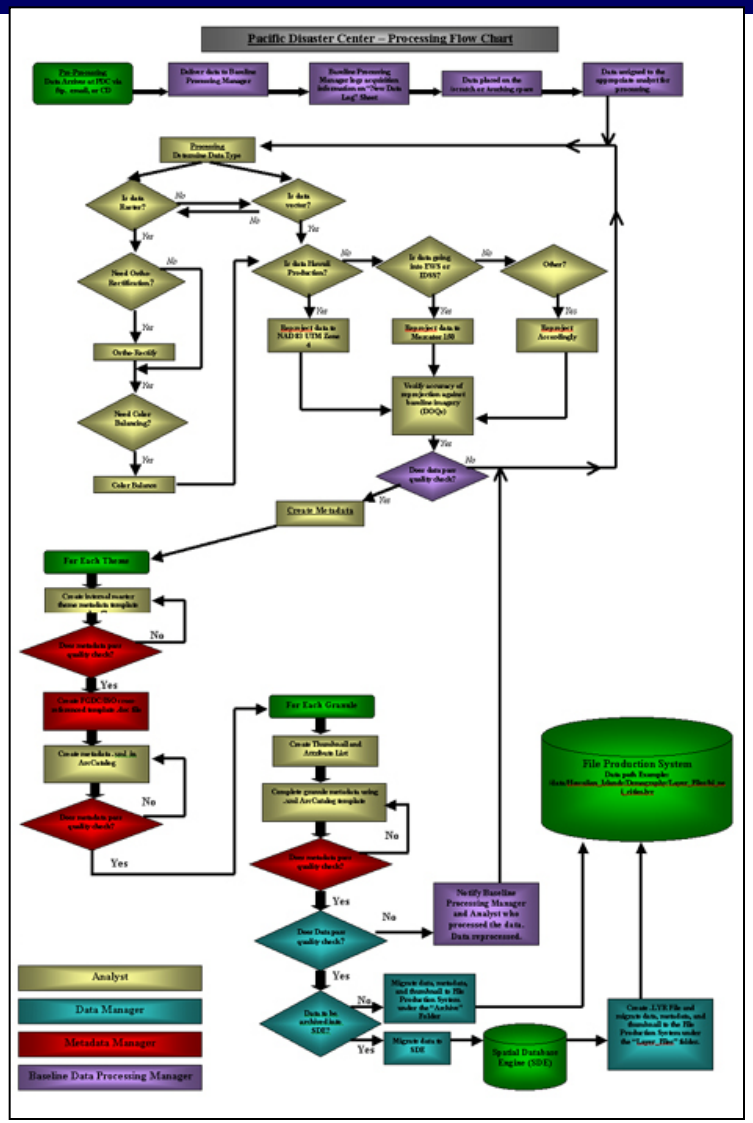
Direct Collection – 3 methods

1. Manually record desired information on location on a hard copy map. Associated attribute information will need to be documented elsewhere with an ID to link the location and attribute data. Paper maps can be brought into a GIS environment and digitized.
2. Collect the desired location and attribute data during a field survey using GPS. This information can then be integrated into a GIS.
3. Aerial and satellite images provide spatial information and, when processed, can be included in a GIS. Assets can be “heads up digitized” from these images.

Geospatial Data Management

Geospatial data is should undergo strict processing and documentation procedures





Metadata

Data About Data

A metadata record is a file of information, usually presented as an XML document, which captures the basic characteristics of a data or information resource. It represents the *who, what, when, where, why* and how of the resource.

- Data Source
- Contact Information
- Dates (various)
- Attribute descriptions
- Accuracy and Scale
- Summary of dataset
- Use and Access Constraints
- Spatial Reference
- Processing history
- Keywords

Metadata

PACIFIC DISASTER CENTER
Fostering Disaster-Resilient Communities

Global Hazards Information Network (GHIN)
Powered by Pacific Disaster Center

SEARCH | BROWSE | PARTNERS | PDC Geospatial Information Service

1 Type place name & press Find:
FIND
or draw search area:

2 Choose content type:
Downloadable Data
Choose content theme:
Category: FGDC PRiMO
<FGDC Content Themes>
Optional Keyword (e.g. river):
hazard

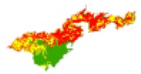
3 START SEARCH
Search NSDI Clearinghouse

Currently displaying records 1 - 12
Pages: 1

Content Found by Search

Downloadable Data

Publisher: Pacific Disaster Center
Content Title: Tutuila landslide hazard zones
Coverage Area: American Samoa
Map Scale: 1:24,000
View Details



Publisher: Pacific Disaster Center
Content Title: Hawaii Hazardous Dams
Coverage Area: Hawaii
Map Scale: 1:unknown
View Details

Publisher: Pacific Disaster Center
Content Title: Hawaii Emergency Operations Centers
Coverage Area: Hawaii
Map Scale: 1:24,000
View Details

Publisher: Pacific Disaster Center
Content Title: Hawaii Dams
Coverage Area: Hawaii
Map Scale: 1:unknown
View Details

Considerations

- Data Is the Biggest Challenge
  - Lack of centralized catalog & consistent search tools
  - Limited metadata / data documentation inhibits understanding
  - Access to actual data is sometimes restricted or unavailable
- The more accurate/current data you have, the better your product
- Data must be current enough, detailed enough, and accurate enough to fit your needs
- Data collection and processing take time and money
  - Must balance mapping and assessment needs with available human and financial resources

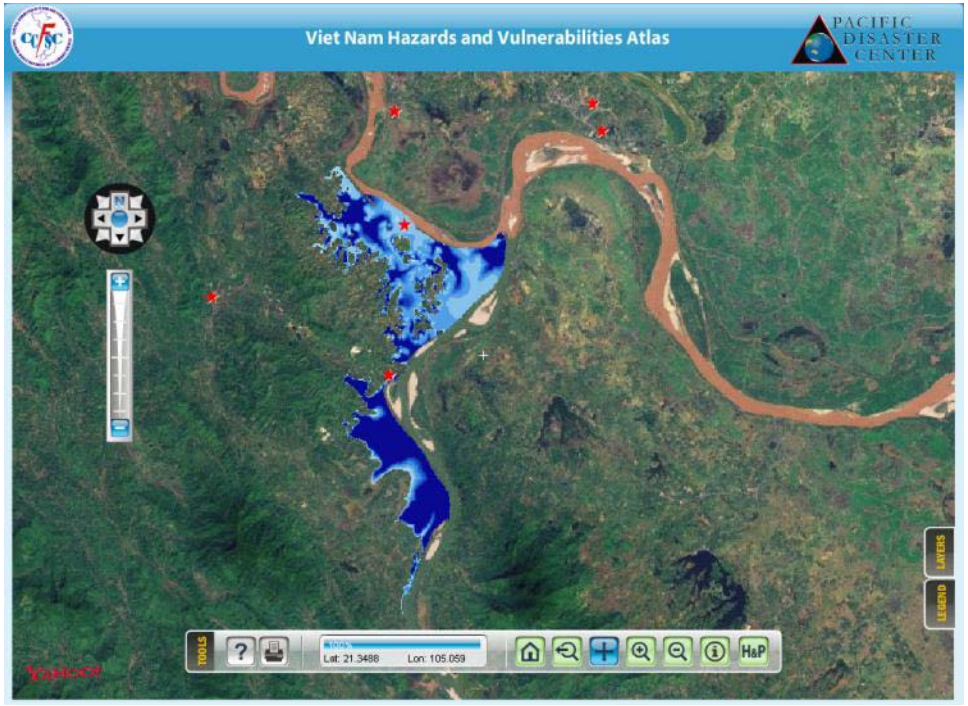
Case Study #1

Phu Tho Province Flood Inundation

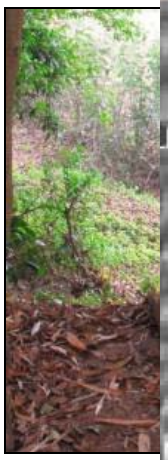
Phu Tho Province Flood Inundation

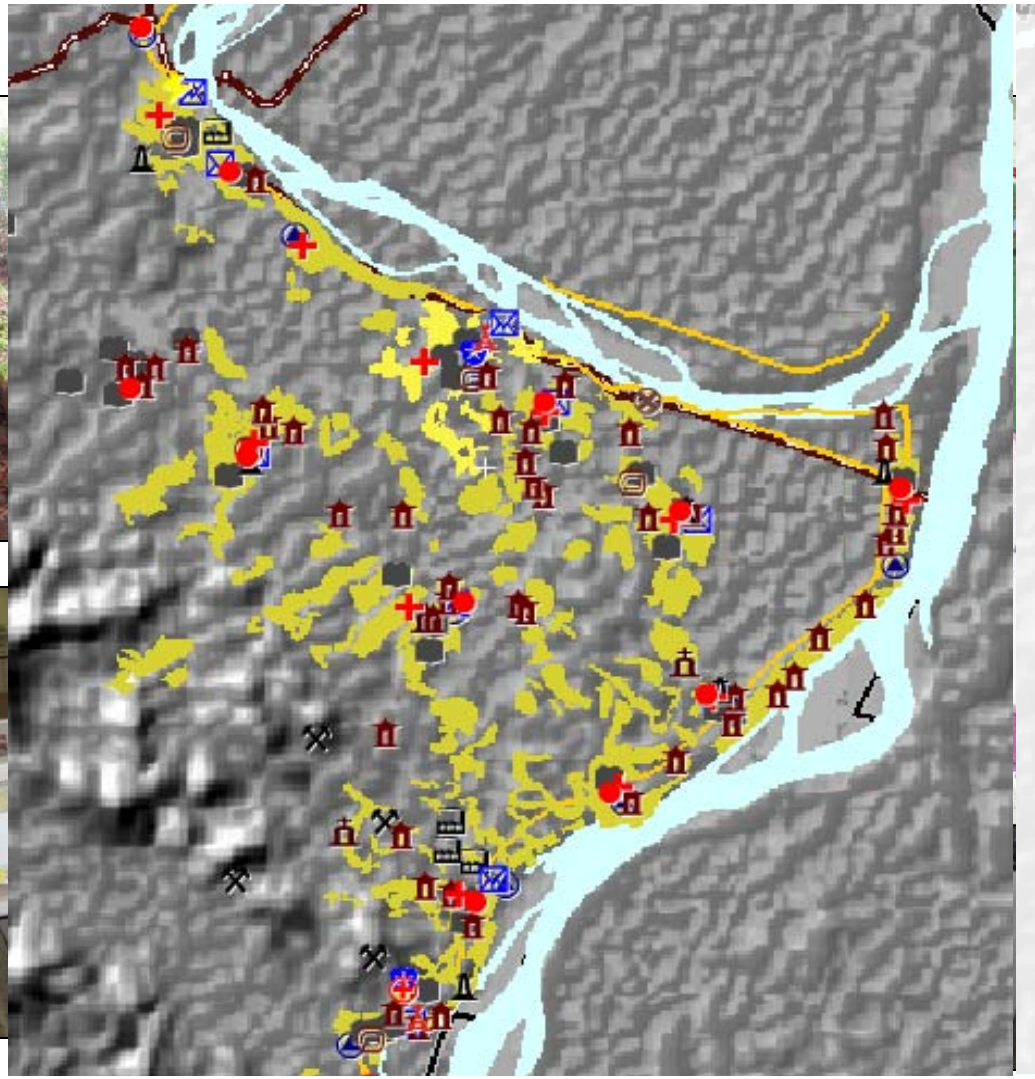
Purpose: To better understand potential inundation areas and resulting impacts of flooding

- **Scenario:** hypothetical breaching of dykes along Black & Red rivers
- Reduce impacts to lives and assets
- Allow Disaster Management officials to refine mitigation options and evaluate preparedness plans, including warning systems and evacuation procedures
- Modeled using the DHI MIKE 21 Flood model

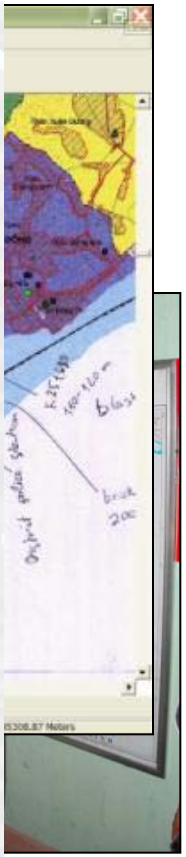


Key Infrastructure Data Collection

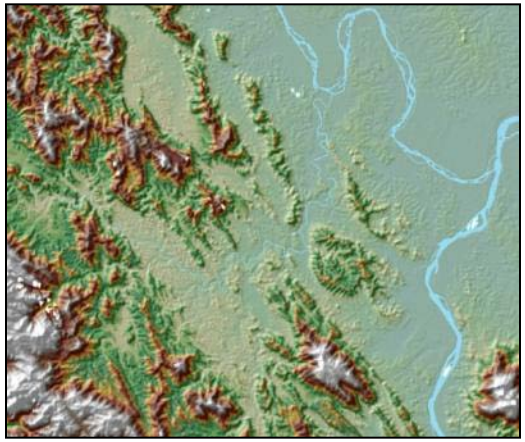




- Banks
- Factories
- Markets
- Mines
- Government Facilities
- Post Offices
- Schools
- Stadiums
- Churches
- Pagodas
- Statues
- Tourism
- Clinics
- Commune Offices with Police
- District Police Station
- Hospitals

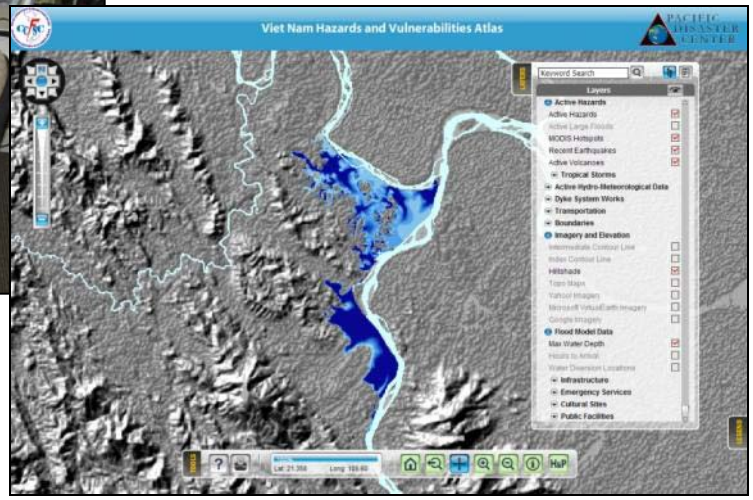


Run Flood Model



Elevation Data: 20-Meter created by PDC

Modeling Analyst



Graphical Output

Dyke #1	**Model Assumptions**
River:	Black River
Dyke **Height:**	5 meters
Rate Discharge:	300 cubic meters/second
Estimated Breach Size:	80 meters

Model Input Parameters

Flood Exposure Assessment

PACIFIC DISASTER CENTER

Viet Nam Dyke Breach Assessment Report

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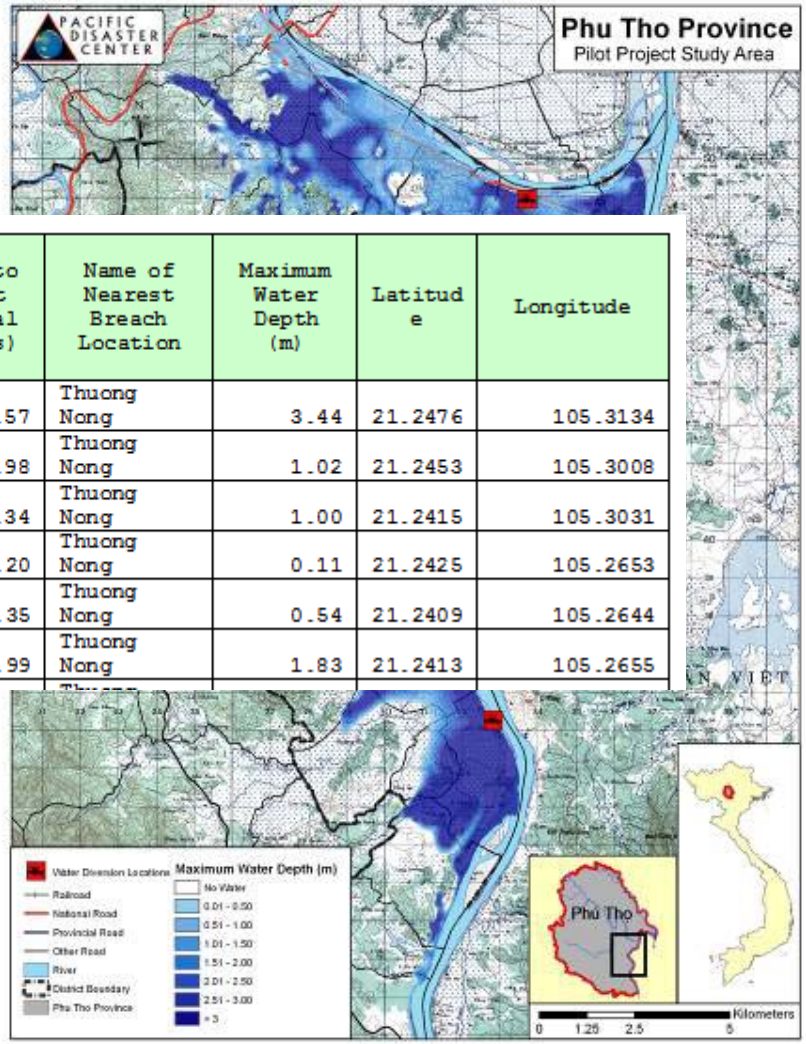
Dyke #3	Model Assumptions
River:	Black River
Height:	5 meters
Rate Discharge:	550 cubic meters/second
Estimated Breach Size:	137 meters

Dyke #4	Model Assumptions
River:	Red River
Height:	5 meters
Rate Discharge:	300 cubic meters/second
Estimated Breach Size:	56.5 meters

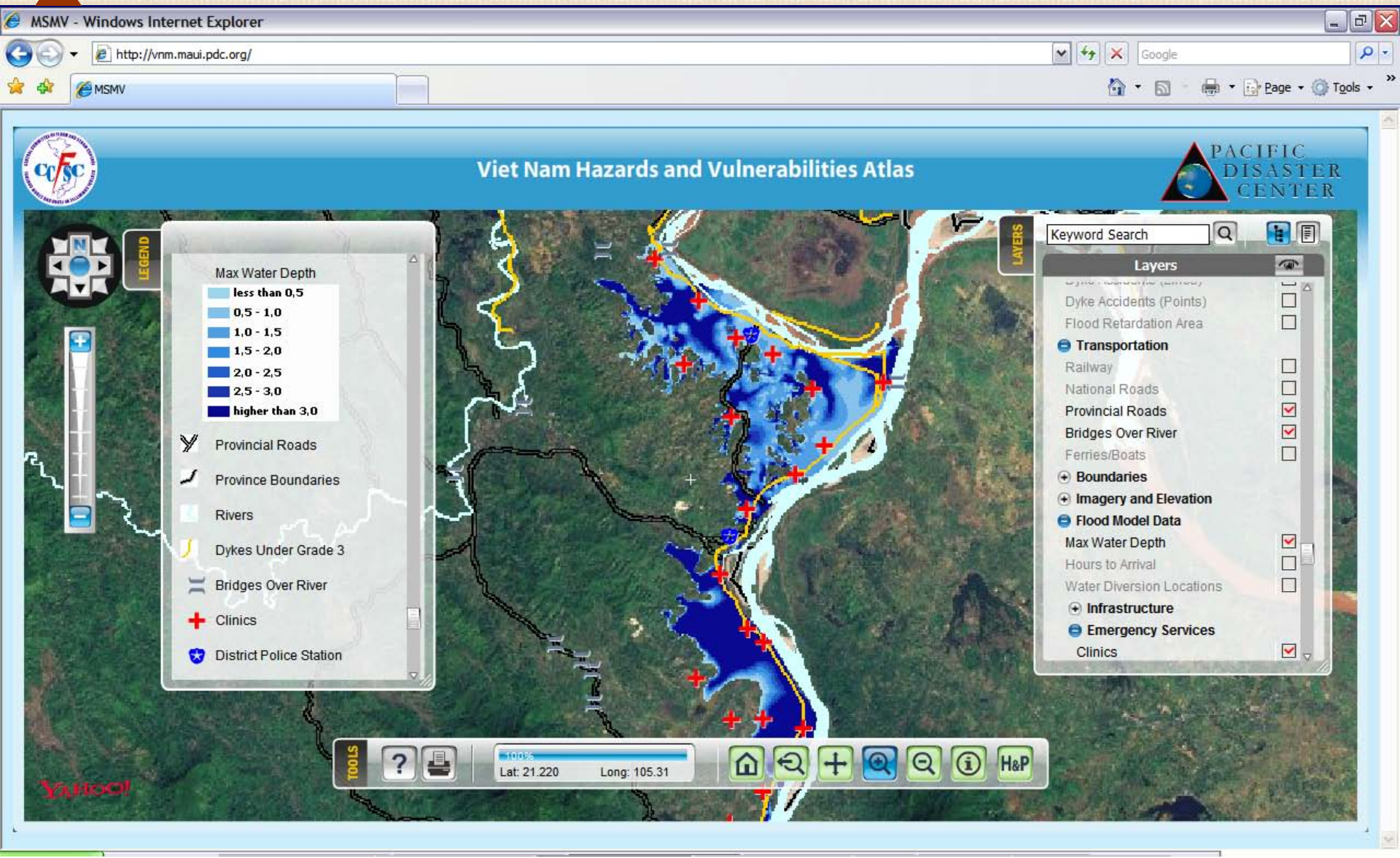
Hypothetical Scenario Vietnam Dyke Breach Scenario 11/3/2007

1

Infrastructure Type	Commune	Distance to Nearest Breach Location (km)*	Time to First Arrival (hours)	Name of Nearest Breach Location	Maximum Water Depth (m)	Latitude	Longitude
Pumping Station	X. DÊu D¬ng	0.87	2.57	Thuong Nong	3.44	21.2476	105.3134
School	X. DÊu D¬ng	2.11	8.98	Thuong Nong	1.02	21.2453	105.3008
School	X. DÊu D¬ng	1.90	8.34	Thuong Nong	1.00	21.2415	105.3031
Clinic	X. DÞ NÊu	5.79	46.20	Thuong Nong	0.11	21.2425	105.2653
Commune Office with Police	X. DÞ NÊu	5.89	42.35	Thuong Nong	0.54	21.2409	105.2644
Post Office	X. DÞ NÊu	5.78	42.99	Thuong Nong	1.83	21.2413	105.2655



Internet Map Viewer



Real-Time Hydro/Met Data

STT	TỒN TRÓM	MÌ TRÓM	TĂNG
STATION #	NAME OF STATION	CODE OF STATION	TOTAL RAINFALL IN ONE DAY
1	TRUNG Ì KIỒU	54001	2
2	LÝ TỐN ỐÉ	54002	1
2	SỐNG ỐÌ	56964	0.2
3	MÊNG TÌ (TV)	74100	5
3	SỐNG ỐÌ	56977	0
4	NEM GÌÌNG	74102	3

SỐNG	TỒN TRÓM	MÌ TRÓM	NGÌY	GIỀ	MÙC NÍC
NAME OF RIVER	NAME OF STATION	CODE OF STATION	DATE	TIME	WATER LEVER
ỐÌ	TRUNG Ì KÌU	54001	17/07/2007	13	72791
ỐÌ	MÊNG Ì (TV)	74100	19/07/2007	16	28232
ỐÌ	MÊNG Ì (TV)	74100	19/07/2007	19	28235
NEM NA	NEM GÌÌNG	74102	17/07/2007	16	20661
NEM NA	NEM GÌÌNG	74102	17/07/2007	19	20656
NEM NA	NEM GÌÌNG	74102	17/07/2007	22	20653
NEM NA	NEM GÌÌNG	74102	18/07/2007	1	20651
NEM PỐ	NEM PỐ	74103	18/07/2007	1	22539
NEM PỐ	NEM PỐ	74103	18/07/2007	7	22535

Case Study #2

Pacific Exposure Database

Pacific Hazards

- **Pacific Island nations are at risk from multiple natural hazards**
  - Volcanic eruption
  - Earthquake
  - Tsunami
  - Landslide
  - Cyclone
  - etc

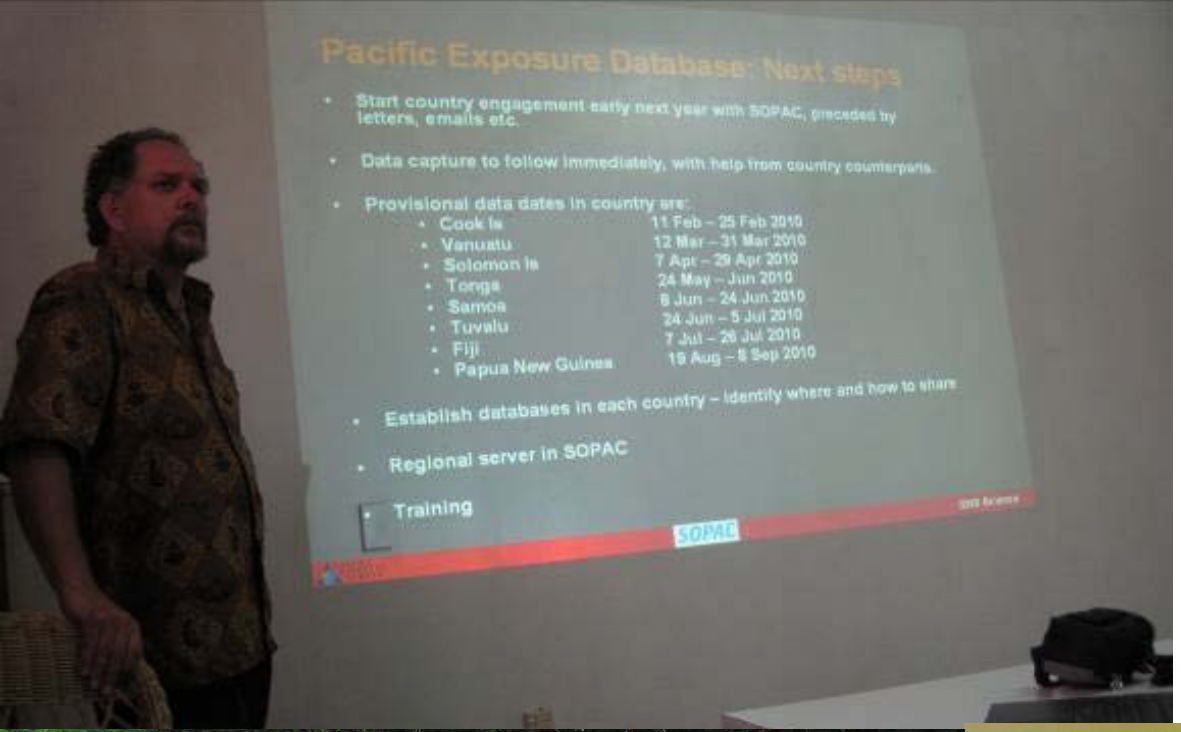
Exposure Data is Limited

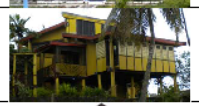
However….

- Little information on buildings, lifelines, critical assets and infrastructure
- Little information on exposure
- Makes modelling risk difficult
- Can’t estimate damage if we don’t know what is present

Pacific Exposure Database Process

- Perform indirect data collection for basedata
- ‘Heads-up Digitize’ buildings and footprints from imagery
- Develop data model for attribute information
- Training of local counterparts
  - Project
  - GPS units & data model
  - Building classification
- Direct data collection in field using GPS
- Data processing and QA/QC process to verify data
- Delivery to clients



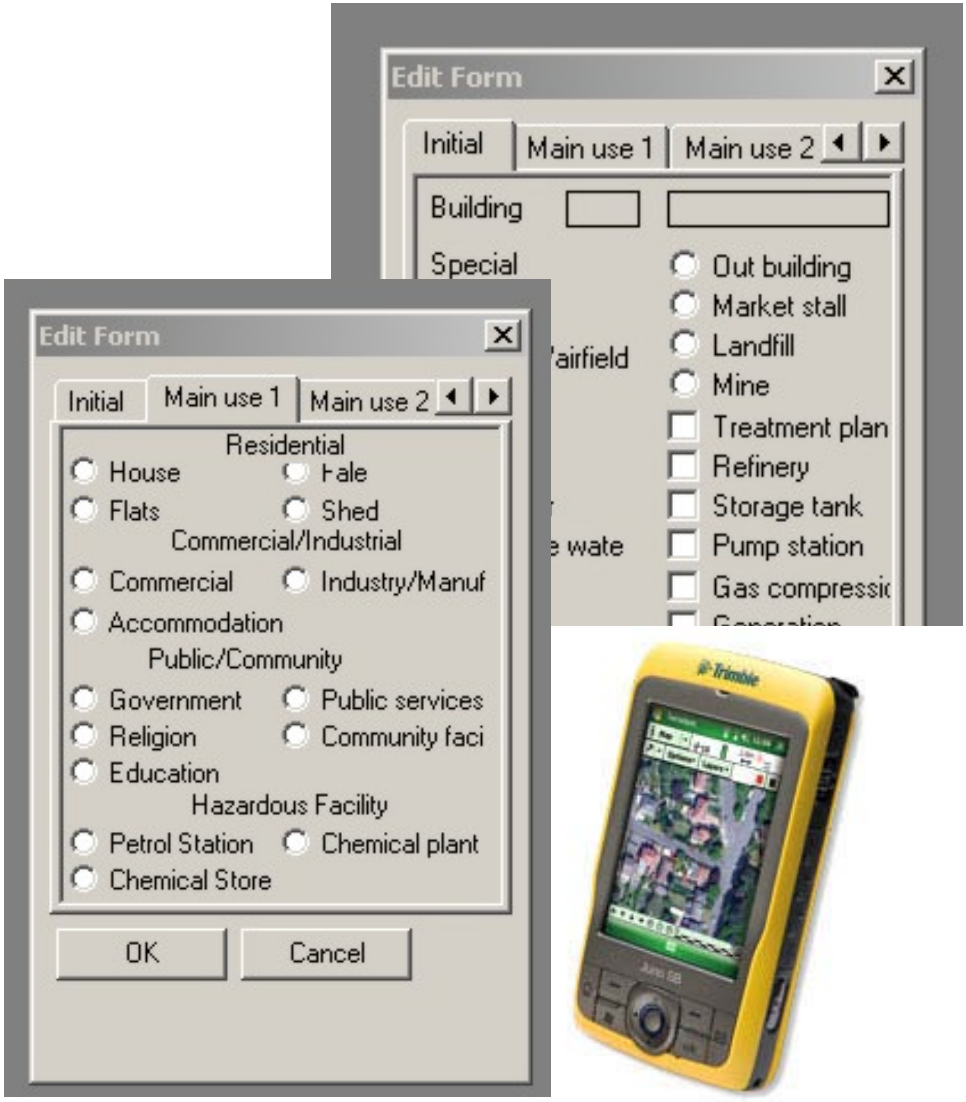
Term	Description	Example
Concrete Slab	Concrete slab sits on ground and building walls sit on slab	
Wooden/Concrete Pile	Timber or concrete post less than 1m tall that supports the floor	
Wooden Pole	Timber pole greater than 1m tall that support the floor (typically timber). Normally poles are less than 3m tall.	
Reinforced Concrete Columns	Concrete column more than 1m tall supports the floor, typically concrete. Normally columns are 3m tall.	
Steel Column	Steel column supports the floor, typical in multi-storey commercial buildings.	

Foundation Bracing
This refers to material that is used to brace (or support) the building foundation. Often the foundation bracing is not visible from the outside.

Term	Description	Example
Timber Wall	Timber wall built between timber piles or poles or concrete columns	
Concrete Wall	Concrete wall built between concrete columns	

Field Data Collection

- Collect information via handheld computer /GPS
- Utilize pre-prepared menus, hand held devices, satellite imagery and other digital maps and local counterparts
- Photo of each building
- Raw data to stay in country, final data will be provided when processing is complete



Field Data Collection

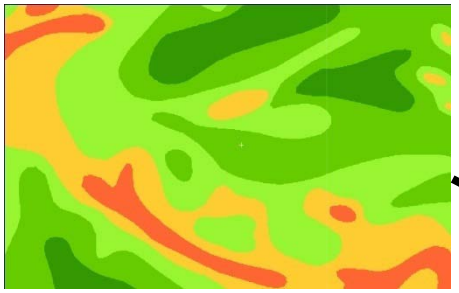
Buildings

- Focused on the construction type of buildings
- Key attributes which can be used to characterize building “fragility” include:
  - use
  - age
  - structural type
  - construction materials
  - roof configuration
  - number of stories
  - area
  - floor level

Use of Pacific Exposure Database

- Asset database will be overlaid with hazard model outputs to create an exposure database

Hazard



Assets

Exposure

25 - Households

1 - Government Building

2 – Schools

4 – Businesses

1 – Airport

2 – Communications

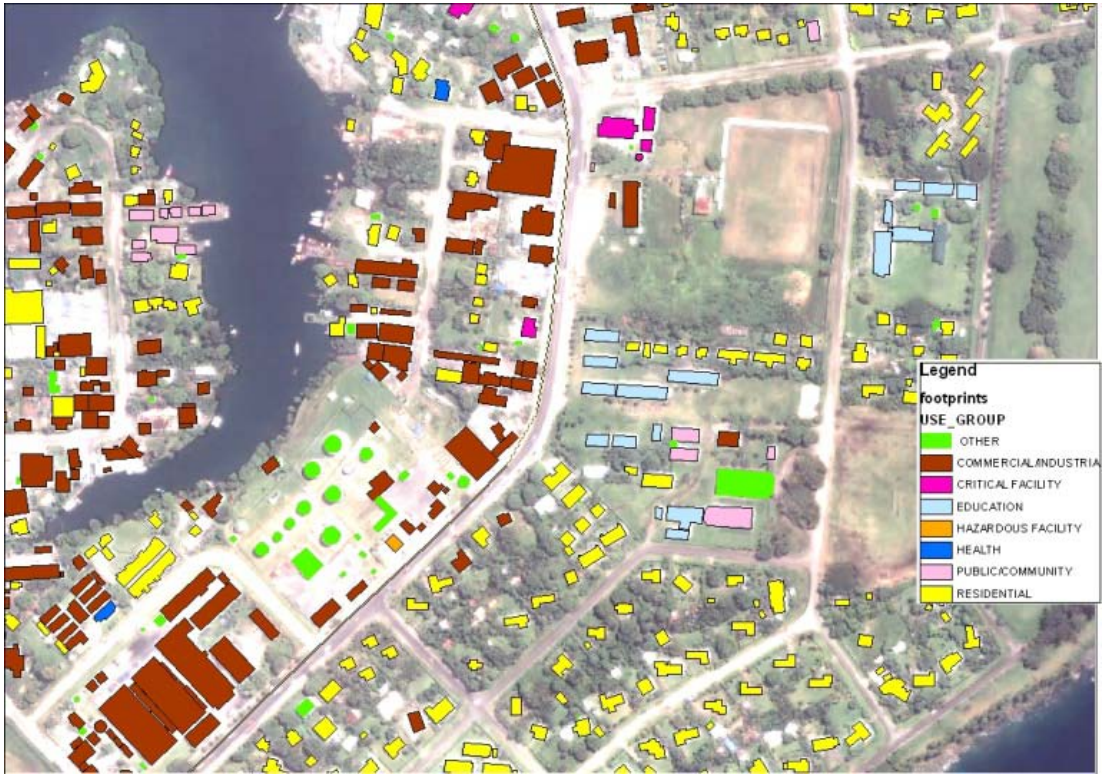
1 – Police Station

1 – Fire Station

Use of Pacific Exposure Database Cont.

Other Uses

- Land use planning
- Linked to other databases



Pacific Exposure Database QA/QC Tool

SOPAC

← IMAGE Photo 1 of 3 →

Fields denoted with an asterisk (*) are required.

ROOF	
Roof Pitch 1 *	MODERATE
Roof Pitch 2	
Roof Pitch 3	
Roof Shape 1 *	GABLE
Roof Shape 2	
Roof Shape 3	
Roof Shape 4	
Roof Material 1 *	METAL SHEET
Roof Material 2	
Roof Material 3	
Parapet *	False
Cantilever *	False

WALL	
Building Frame 1 *	TIMBER FRAME
Building Frame 2	LOAD BEARING WALL
Building Frame 3	
Building Frame 4	
Wall Material 1 *	TIMBER BOARD
Wall Material 2	CONCRETE
Wall Material 3	
Wall Material 4	
Wall Material 5	
Wall Openings *	<75% OF WALL IS WINDOW
Shutters 1 *	EXTERIOR GRILL
Shutters 2	
Shutters 3	

FOUNDATION	
Foundation 1 *	CONCRETE COLUMN
Foundation 2	SLAB
Foundation 3	
Foundation 4	
Bracing 1 *	NONE
Bracing 2	
Bracing 3	
Bracing 4	

FLOOR	
Occupied Levels *	2
Unoccupied Levels *	0
Occupied Units	1
Plan Shape *	REGULAR
Floor Area (m^2)	[illegible]
Min Floor Level (m)	0.0-0.1 M
Max Floor Level (m)	0.0-0.1 M
Site Slope *	FLAT

USE	
Use Group *	COMMERCIAL/INDUSTRIAL
Main Use *	COMMERCIAL
Sub Use 1	
Sub Use 2	
Sub Use 3	

DEFECTS	
Defects 1	
Defects 2	
Defects 3	
Defects 4	
AGE (YEARS)	8

COLLECTION COMMENTS

Bottle Shop

245 of 256 characters left

EDIT COMMENTS

256 of 256 characters left

SOURCE	
Machine Name	[illegible]
User Name	[illegible]
Visit Date (Local)	Mar-22-2010

BUILDING ID SB-AX 000001

← BACK NEXT →

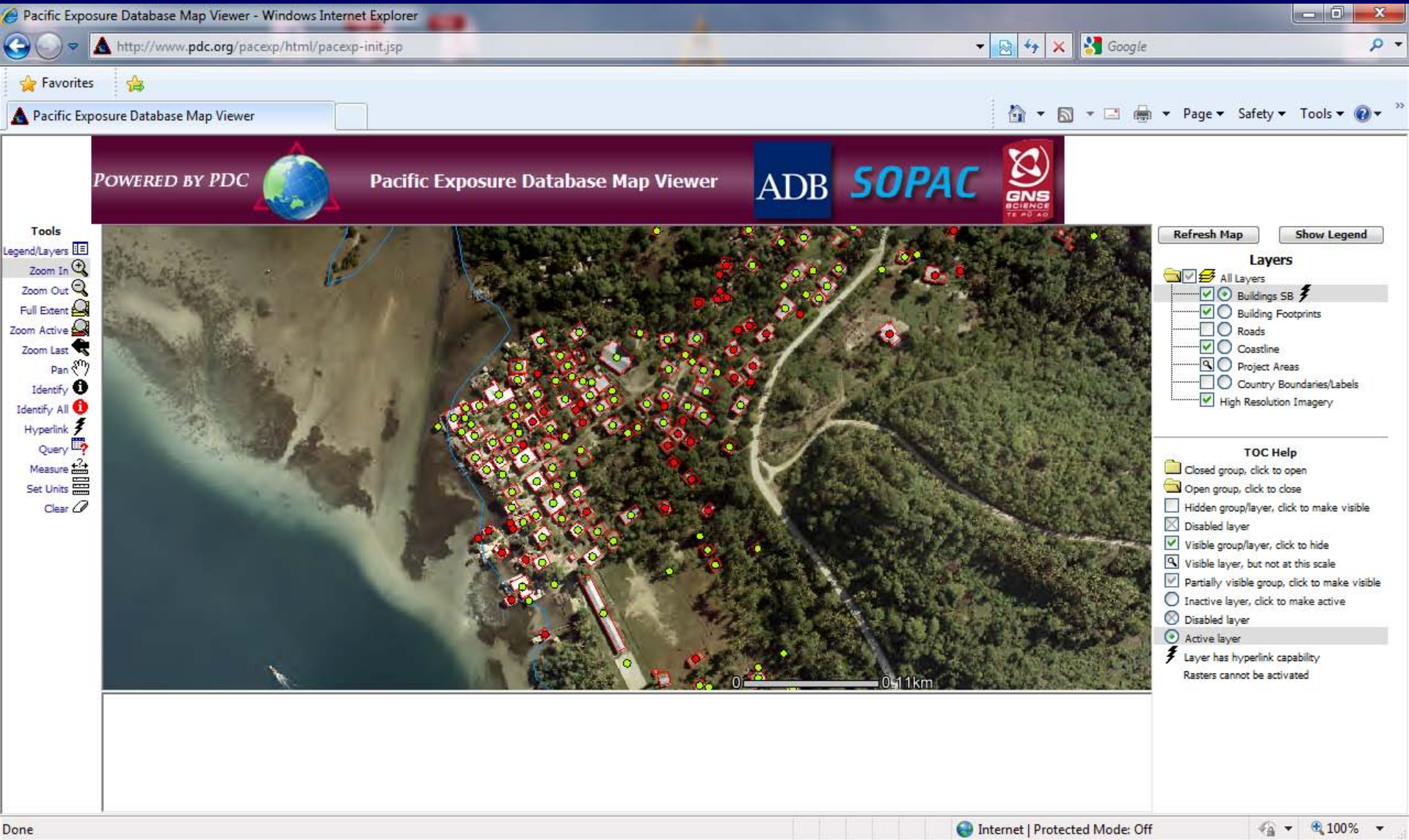
RECORD 1 of 12228

Save Reset

Link for this building: http://[illegible]

powered by Pacific Disaster Center

Pacific Exposure Database Map Viewer



MAHALO!!

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PDC Homepage: http://www.pdc.org

Hazards Atlas: http://www.pdc.org/atlas

GHIN: http://www.pdc.org/ghin

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Estimating Exposure

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  - Todd Bosse, Pacific Disaster Center

- **Published Source Materials**
  - Pacific Disaster Center. 2010. Course materials developed for the Ministry of Agriculture and Rural Development (MARD) Natural Disaster Risk Management Project: Education and Training Program. Hanoi, Vietnam, March-May 2010.
  - Pacific Disaster Center. 2009. All Hazards Decision Support System developed for the JTF-HD SMEE Program. Presented in various locations in the U.S. Pacific Command AOR, 2007-2009.
  - Pacific Disaster Center. 2007. Course materials developed for the Best Practices in Disaster Management and Vietnam Atlas Training Workshop. Hanoi, Vietnam, 08 November 2007.
  - GNS Science, New Zealand, and Pacific Disaster Center. 2010. Presentation. Pacific Exposure Database conducted in eight South Pacific Island Nations, February–October 2010.

Data and Mapping Resources Worksheets

APEC Workshop on Hazard Mapping and Risk and Vulnerability Assessment

October 19-21, 2010
Grand Formosa Regent Taipei
Chinese Taipei

Base Data Type	Source 1	Source 2	Source 3
Admin and Political Boundaries			
	Data Description:	Data Description:	Data Description:
Hydrography			
	Data Description:	Data Description:	Data Description:
Land Use/Land Cover			
	Data Description:	Data Description:	Data Description:
Topography			
	Data Description:	Data Description:	Data Description:

Bathymetry			
	Data Description:	Data Description:	Data Description:
Geology			
	Data Description:	Data Description:	Data Description:
Aerial Photography/Space Derived Imagery			
	Data Description:	Data Description:	Data Description:

Hazard Type	Source 1	Source 2	Source 3
Tropical Cyclone			
	Data Description:	Data Description:	Data Description:
Flooding			
	Data Description:	Data Description:	Data Description:
Earthquake			
	Data Description:	Data Description:	Data Description:
Landslides			
	Data Description:	Data Description:	Data Description:
Other Hazards			
	Data Description:	Data Description:	Data Description:

Asset/Resource Type	Source 1	Source 2	Source 3
Energy Infrastructure			
	Data Description:	Data Description:	Data Description:
Health Infrastructure			
	Data Description:	Data Description:	Data Description:
Communications Infrastructure			
	Data Description:	Data Description:	Data Description:
Transportation Infrastructure			
	Data Description:	Data Description:	Data Description:
Governance Infrastructure			
	Data Description:	Data Description:	Data Description:
Security Infrastructure			

	Data Description:	Data Description:	Data Description:
Education Infrastructure			
	Data Description:	Data Description:	Data Description:
Water Supply			
	Data Description:	Data Description:	Data Description:
Food Supply			
	Data Description:	Data Description:	Data Description:
Population and Demographics			
	Data Description:	Data Description:	Data Description:
Economics			
	Data Description:	Data Description:	Data Description:
Environment			

	Data Description:	Data Description:	Data Description:
Other Elements of Interest			
	Data Description:	Data Description:	Data Description: