GeoTechnologies for Hazard Mapping & Risk and Vulnerability Assessment



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GeoTechnologies for HM & RVA

- Module Objective
  - Introduce Key GT's for HM & RVA
  - Define and characterize GT's and their key components
  - Illustrate their application for HM & RVA

GeoTechnologies for HM & RVA

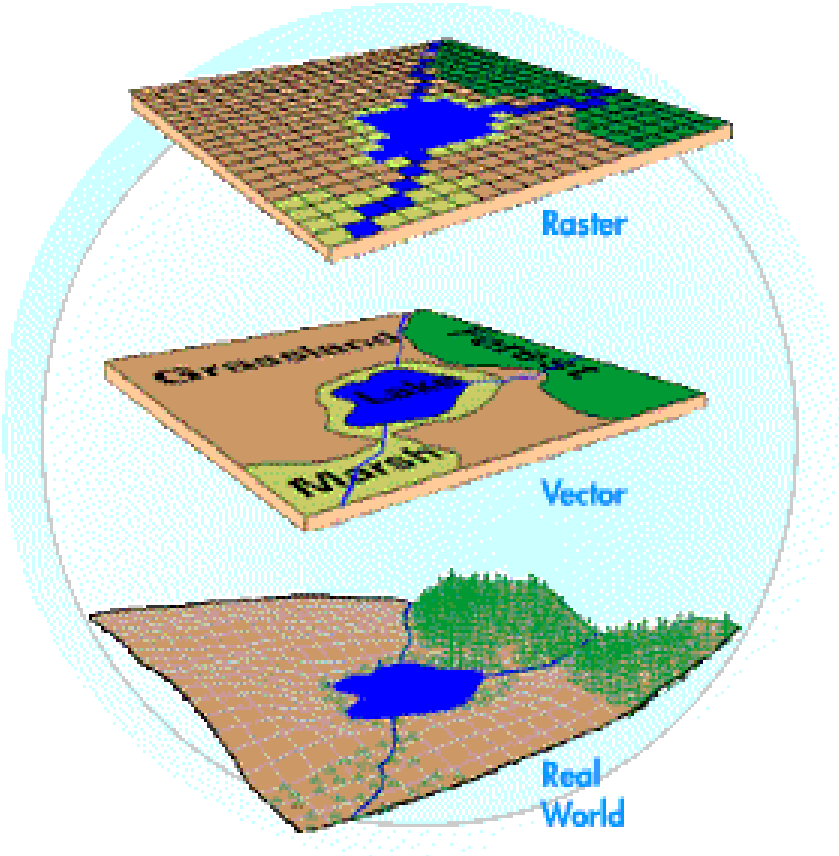
- Key GTs for HM/RVA
  - Geographic Information Systems (GIS)
  - Global Positioning Systems (GPS)
  - Remote Sensing (RS)
  - Modeling and Simulation (M&S)

Geographic Information Systems

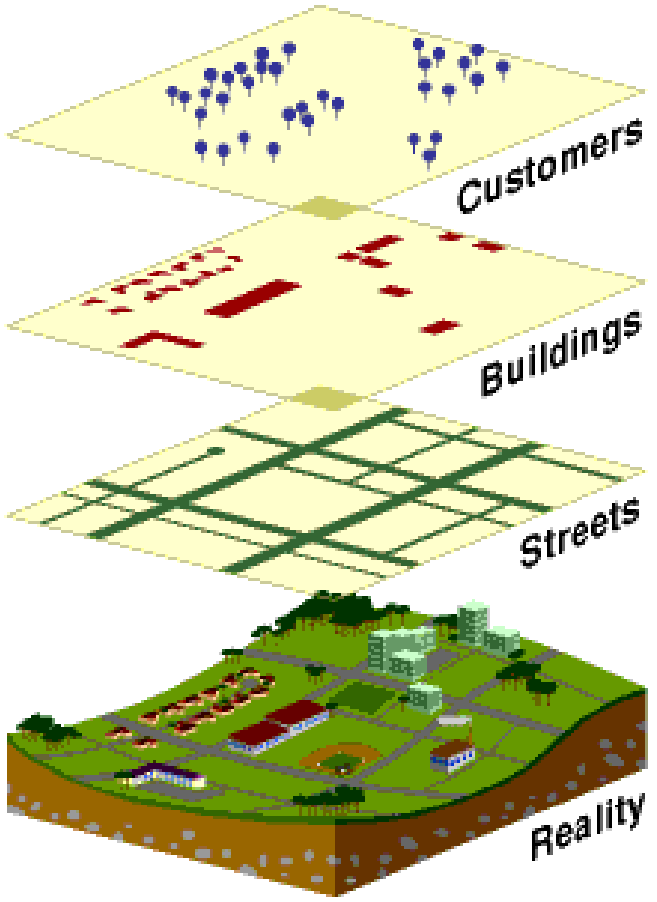
- What is GIS?
  - A GIS integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced (geospatial) information.
  - GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.

Source: GIS.com

Geographic Information Systems



Abstracting “real world features” via various data models

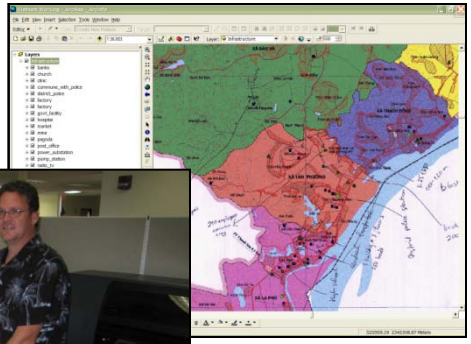


Each “layer” represents a different theme or set of features

Key GIS Components

- **Hardware** capturing and storing data, performing analyses, publishing maps, etc.
  - Computers, scanners, digitizing tables, printers, plotters, GPS, etc.
- **Data** that describe features of interest
  - Hazard zones, infrastructure, populated places, natural resources, etc.
- **People** with skills to operate GIS tools, assess data, and communicate results

Data Collection & Preparation

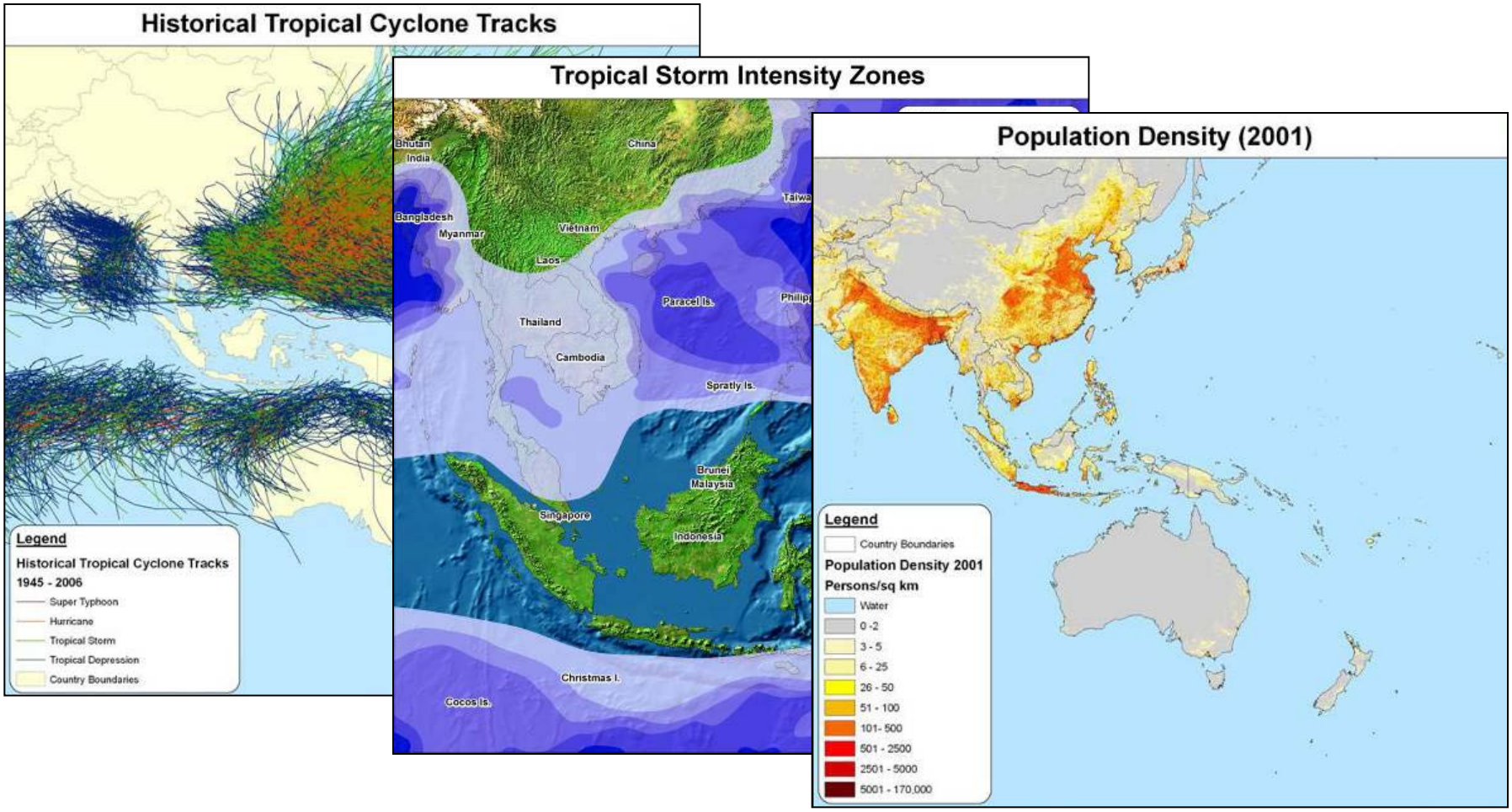


Geographic Information Systems

- How does GIS support HM & RVA?
  - Map patterns of past hazards and hazard zones
  - Locate and characterize assets
  - Assess the geospatial relationship between hazards and assets and their characteristics
  - Map and communicate risks

GeoTechnologies for HM & RVA

Global / Regional (Hazards / People)

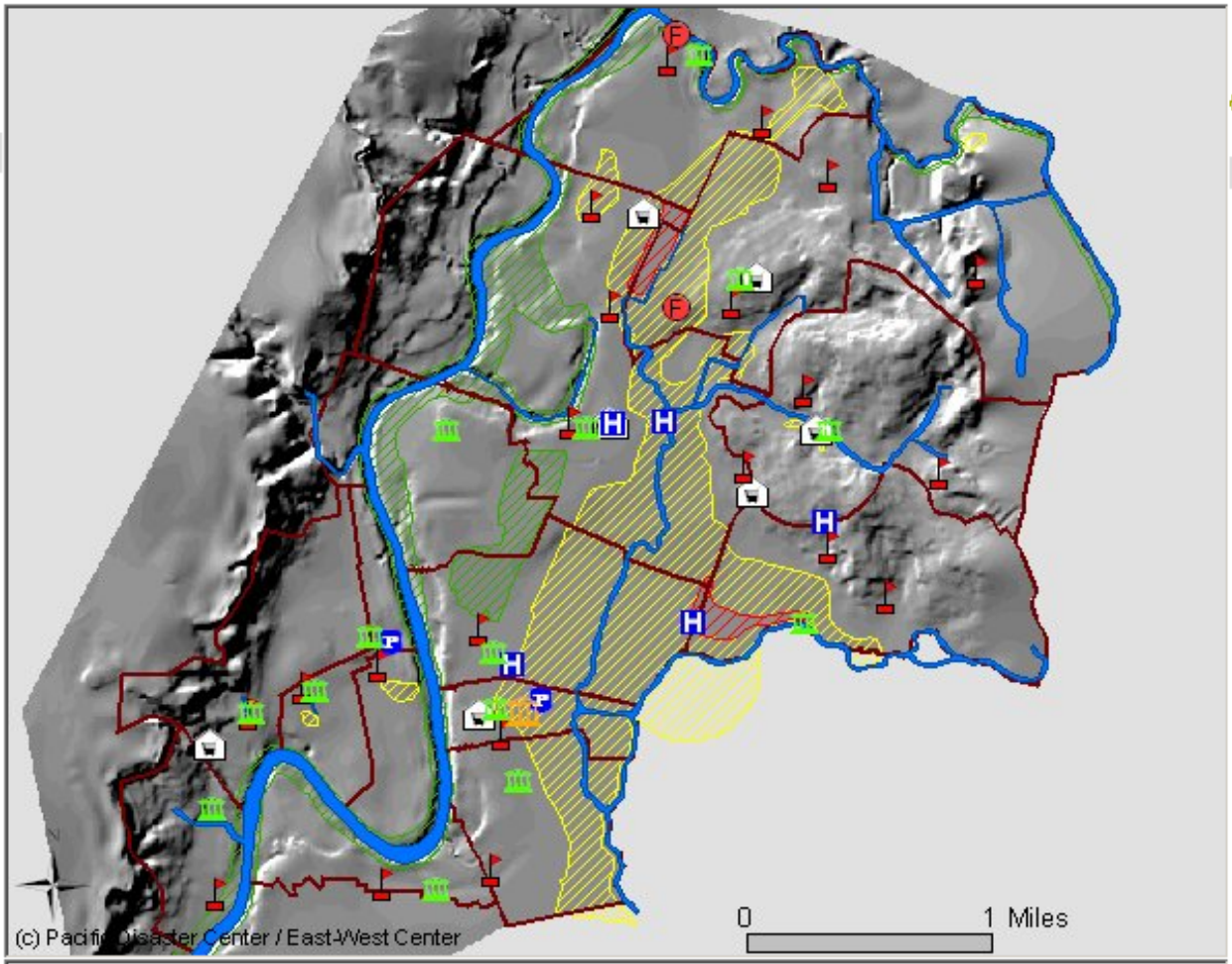


Marikina City map viewer - Microsoft Internet Explorer

Marikina City
The River City

Flood Prone Areas & Critical Facility Locations

Tools
Help
Legend/Layers
Zoom In
Zoom Out
Full Extent
Zoom Active
Zoom Last
Pan
Identify
Identify All
Query
Measure
Buffer
Select Box
Clear



Refresh Map

Layers
All Layers
Facilities
City Hall
Barangay Hall
Public Safety Center
Fire Station
Hospital
Elementary School
Market
Building Footprints
Transportation
Utilities
Boundaries
Hazards
Earthquake
Flood
Flood Prone Areas
Flooded Areas
Elevation and Imagery
2m Contours
DEM
Shaded Relief
Marikina IKONOS
Air Photos
QuickBird_XS
QuickBird_Pan

TOC Help
Closed group, click to open

Done
Local intranet

Global Positioning Systems

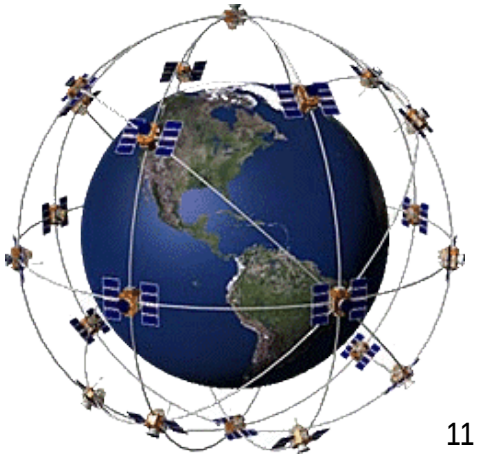
- What is GPS?
  - GPS is a radio navigation system that allows land, sea, and airborne users to determine their exact location*, velocity, and time 24 hours a day, in all weather conditions, anywhere in the world.
  - 24 GPS satellites (21 active, 3 spare) are in orbit at 10,600 miles above the earth, spaced so that from any point on earth, four satellites will be above the horizon. Each satellite contains a computer, an atomic clock, and a radio.

* Accuracy ranges from centimeters to meters, depending on equipment, conditions, etc.

Source: GIS2GPS.com

Key GPS Components

- Space and Control Segments
  - Satellites and their ground stations
- User Segment
  - Devices to receive GPS signals
  - Store/display coordinates in navigation, mapping or other applications

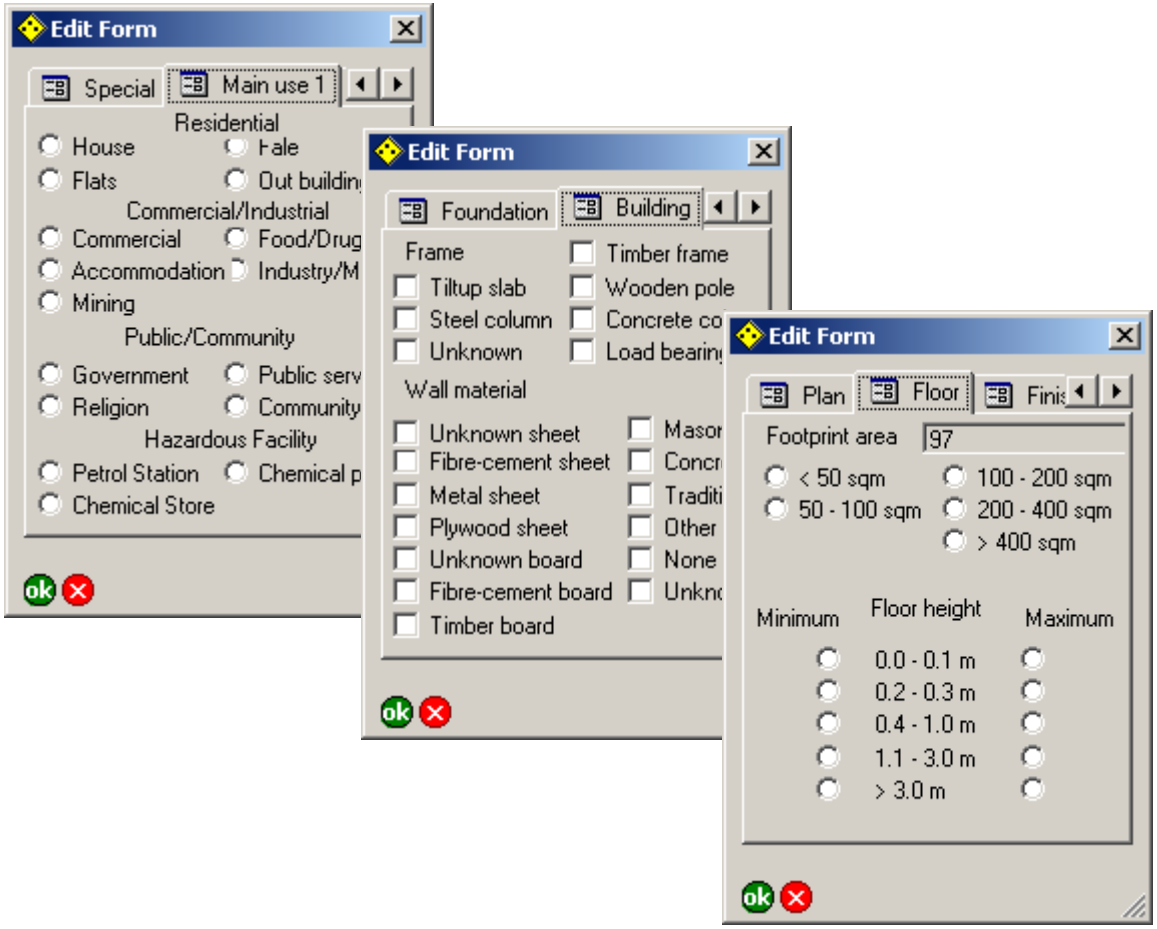


Global Positioning Systems

- How does GPS support HM & RVA?
  - Capture precise and detailed information on locations of hazards, hazard zones, and assets
  - Geo-tag photographs of infrastructure (or damage after a disaster)
  - Assist with navigating (locating) to a feature of interest to further study it

Source: NOAA

GPS for Field Data Collection



Remote Sensing

- What is Remote Sensing?
  - RS is a technique used to collect data about the earth without taking a physical sample. A sensor is used to measure the energy reflected from the features of interest. This information can be displayed as a digital image or as a photograph. Sensors can be mounted on a satellite orbiting the earth, or on a plane or other airborne structure.

Source: NOAA

Key Components of RS (1 of 2)

Example of an Active Sensor

- Sensors
  - Passive sensors record radiation reflected from the earth's surface. The source of this radiation must come from outside the sensor; in most cases, this is solar energy. Examples include satellite imagery and air photos. Typically require clear sky, daylight conditions.
  - Active sensors require the energy source to come from *within* the sensor. Examples include RADAR and LIDAR. Can penetrate clouds and be operated in all weather.

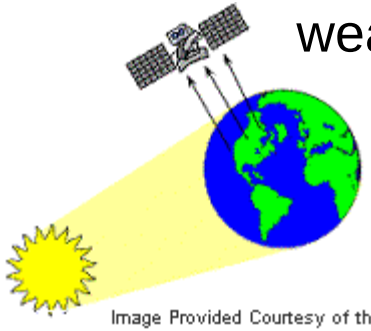


Image Provided Courtesy of the Canada Centre for Remote Sensing

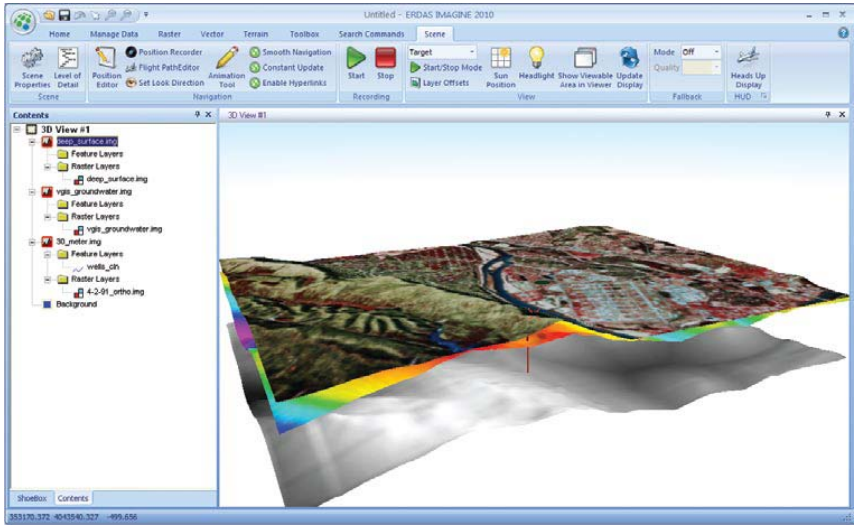
Passive Sensor

Active Sensor

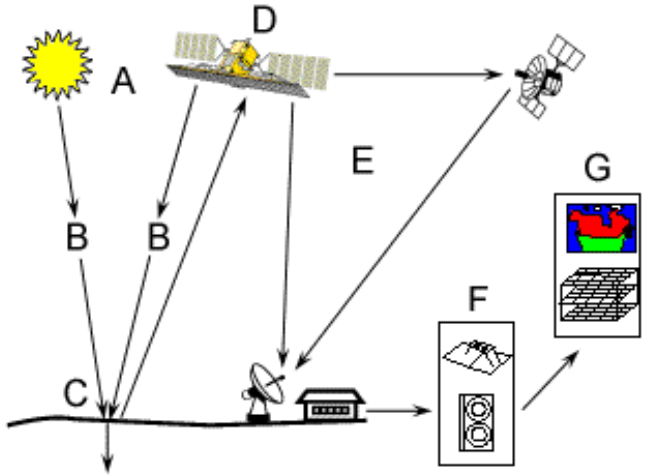
Image Provided Courtesy of the Canada Centre for Remote Sensing

Key Components of RS (2 of 2)

- Ground Stations (“F”)
  - Receive, record, distribute and archive RS imagery (RSI)



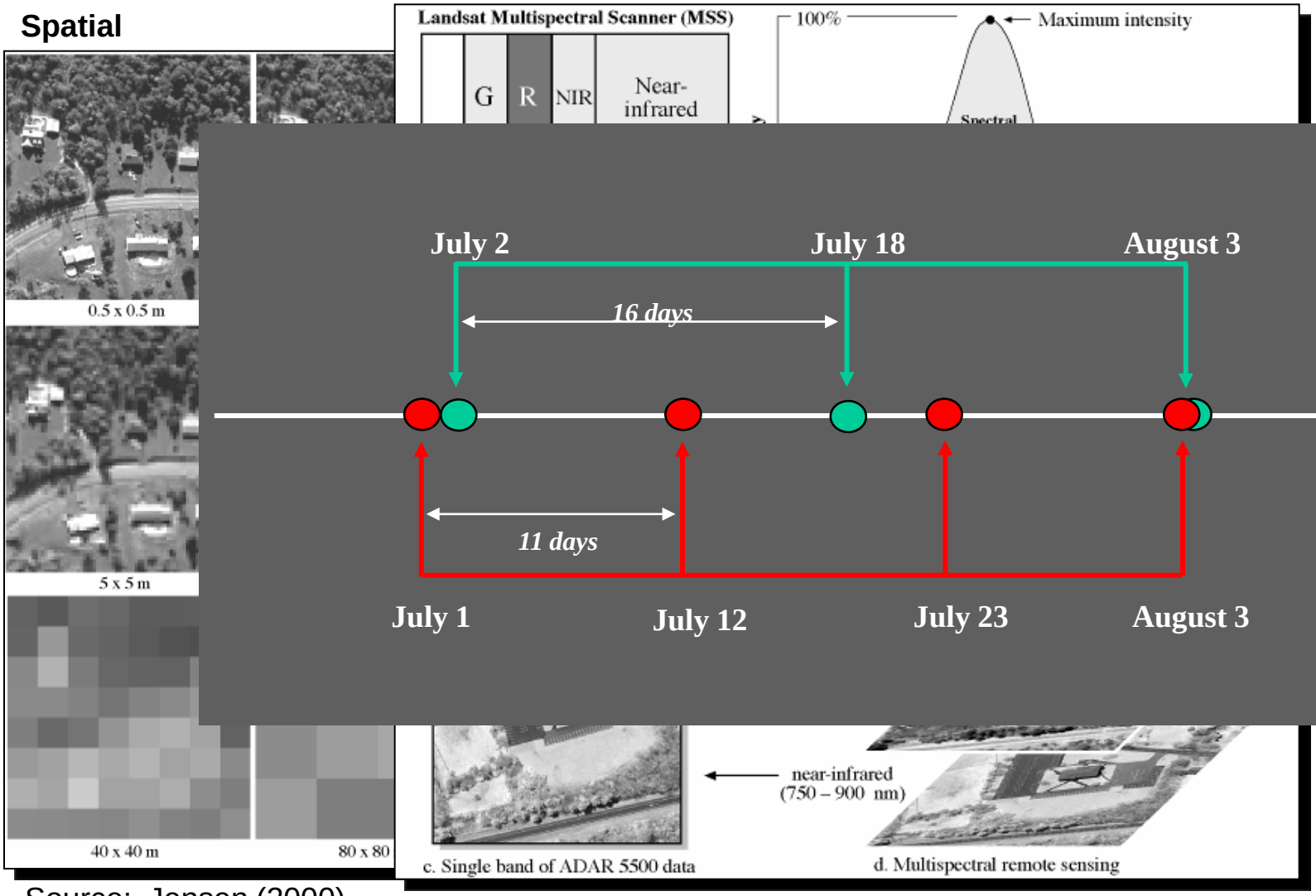
ERDAS Imagine Software



Courtesy of Canadian Centre for Remote Sensing

- Exploitation and Analysis Systems (“G”)
  - Hardware and software to process RSI, extract feature information, create maps, export to GIS

RSI Resolutions / Scales



Source: Jensen (2000)

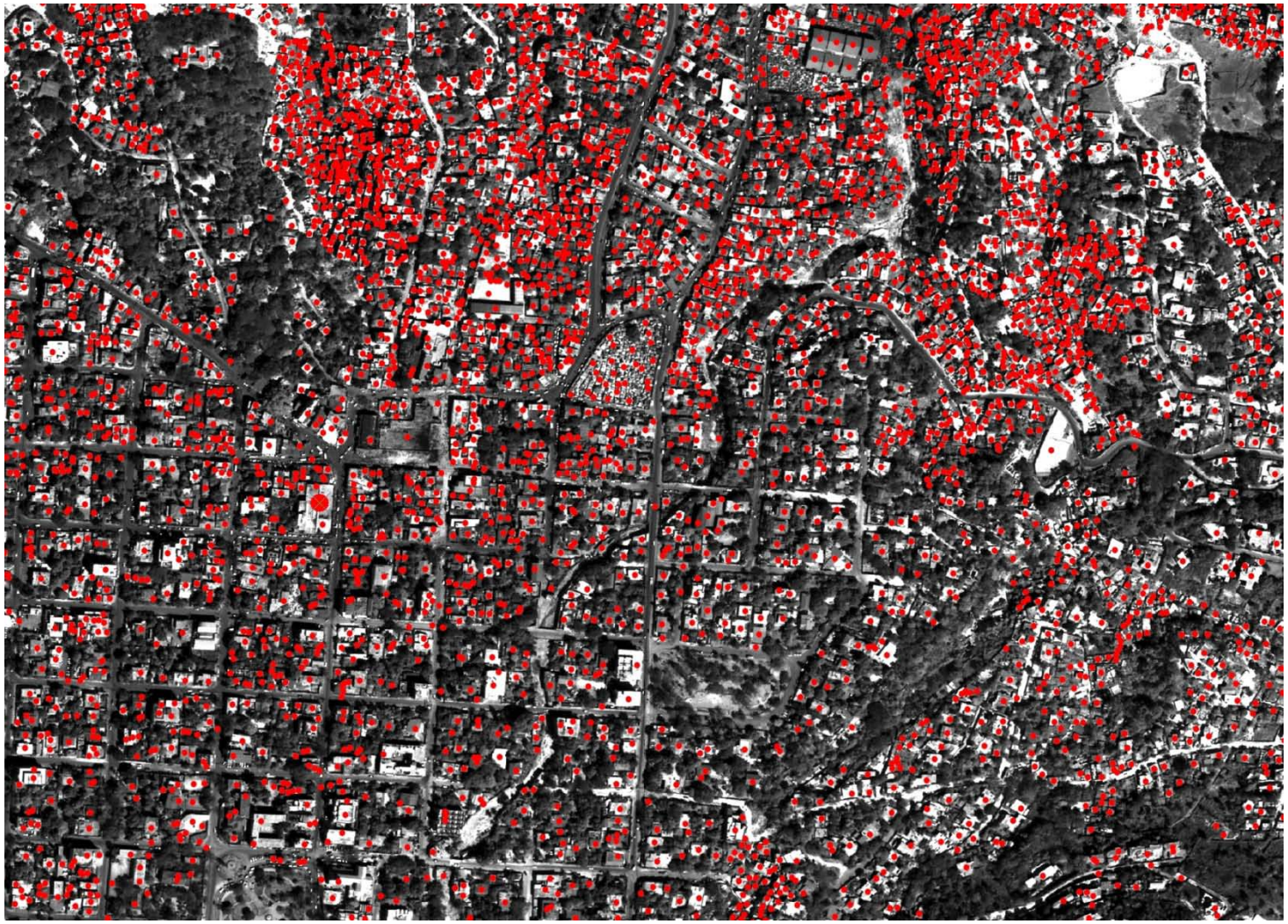
Remote Sensing

- How does RS support HM & RVA?
  - Mapping hazard events and hazard zones
    - Flood plains, fault lines, etc.
  - Mapping features of interest
    - Land cover, natural and environmental resources
    - Infrastructure
      - Buildings, Roads, Bridges, Ports, Power/Water/Communications Networks
      - Urban/residential areas

Feature Extraction - Transportation

Manual extraction of roads and bridges from high-resolution imagery

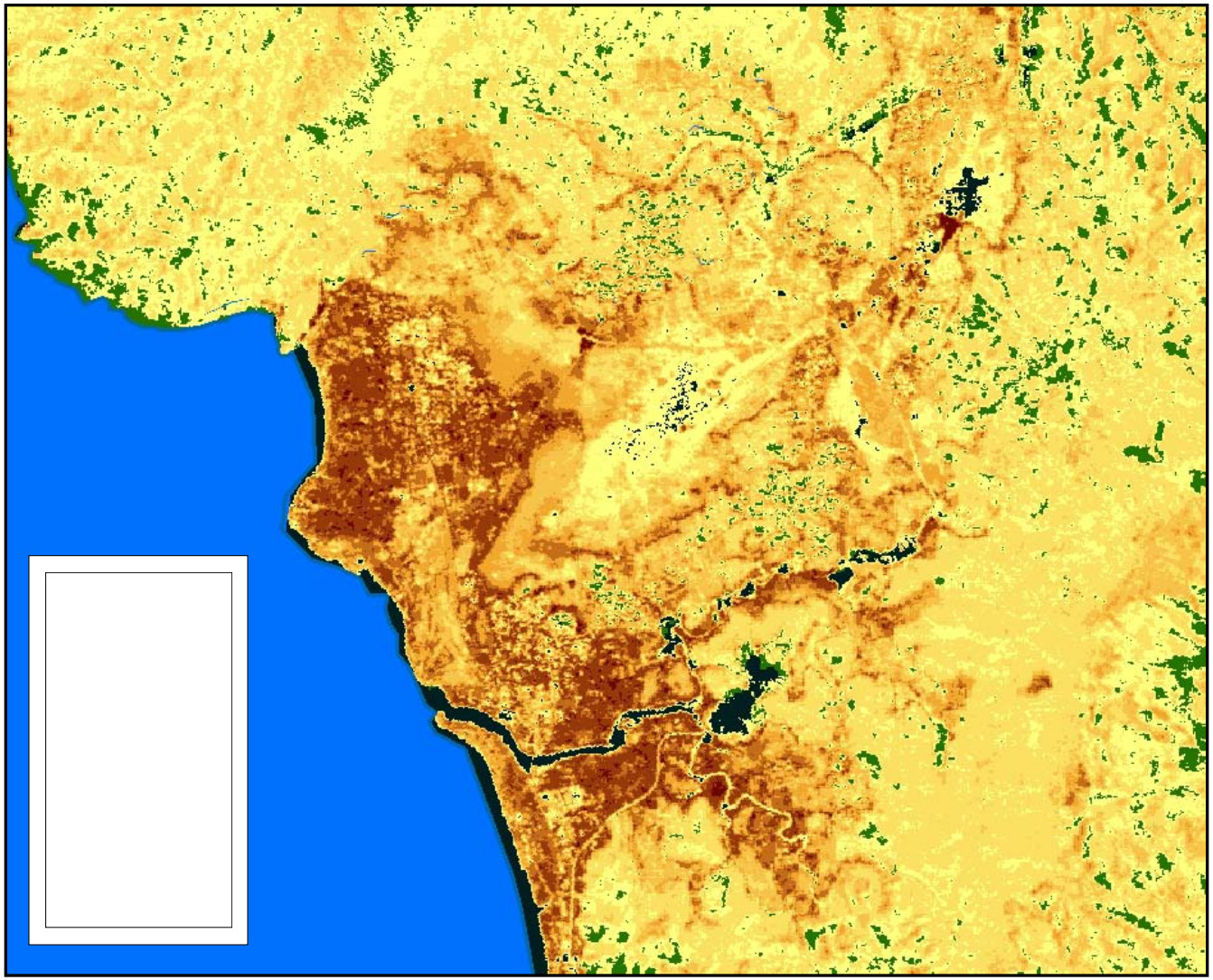
Feature Extraction - Buildings



Mapping buildings and other structures using high-resolution imagery

(Approx. 4000 are included in this area.)

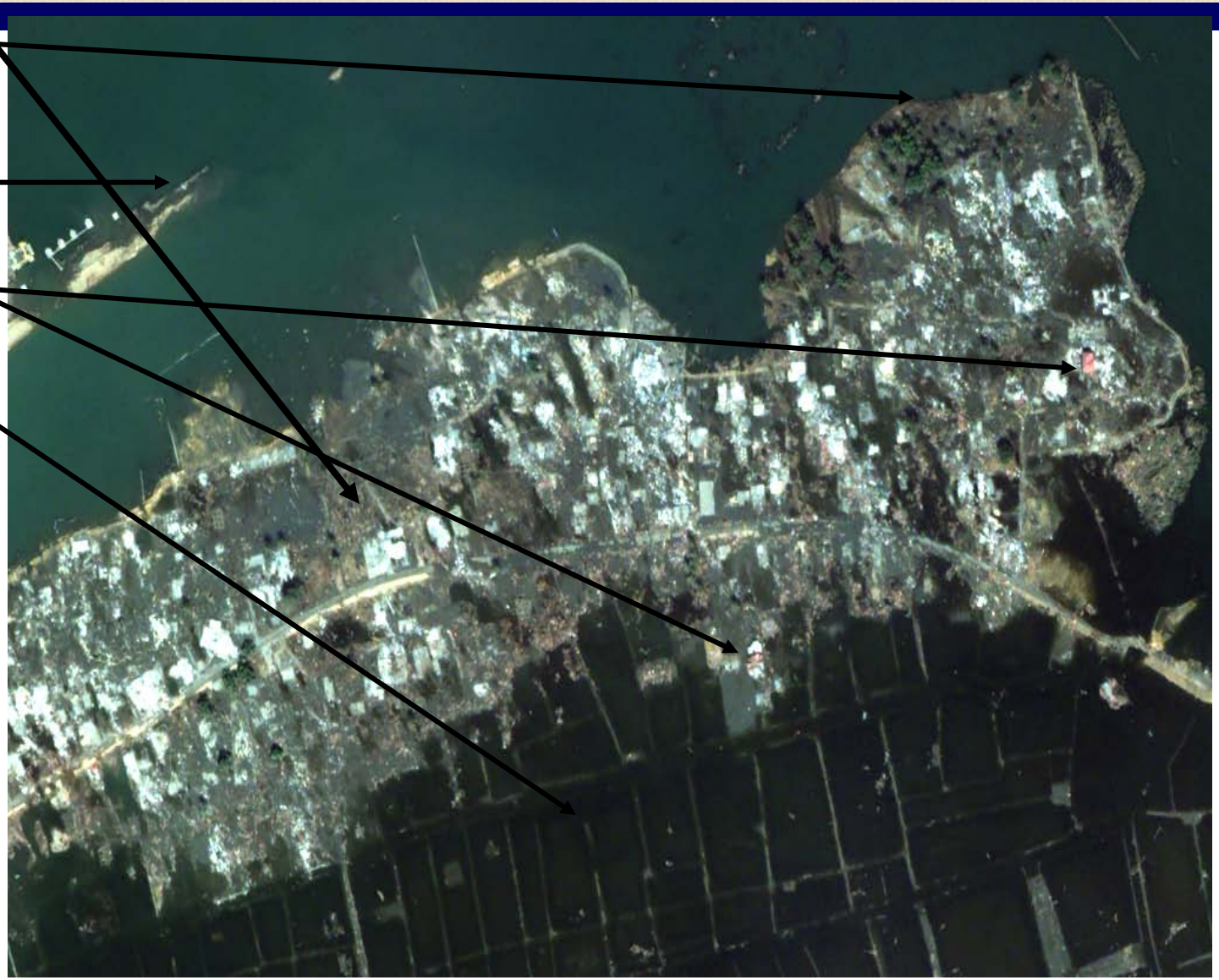
Change Detection / Monitoring



Mapping changes in vegetation (NDVI) using moderate-resolution imagery

Banda Aceh, Indonesia: Pre-event
June 29, 2005 – QuickBird (Pan-sharpened)

Banda Aceh, Indonesia: Post-event Dec 28, 2004 – QuickBird (Pan-sharpened)



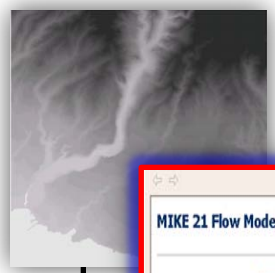
Key Components of M&S

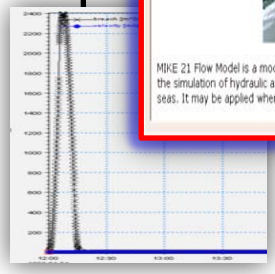
- **Computer model**, a numerical or statistical model designed to simulate different hazards and hazard scenarios.
- **Computer platform**, hardware on which the model runs can range from desktop computers to super computers.
- **Model validation** ensures that the model works properly and that the model output is credible.

Model Flow

Inputs

DEM

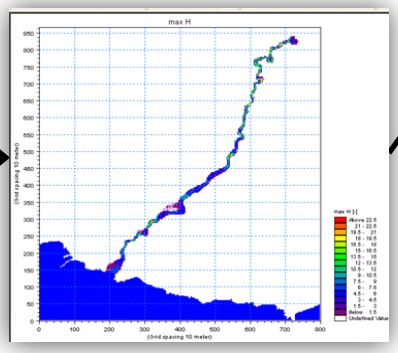




Hydrograph

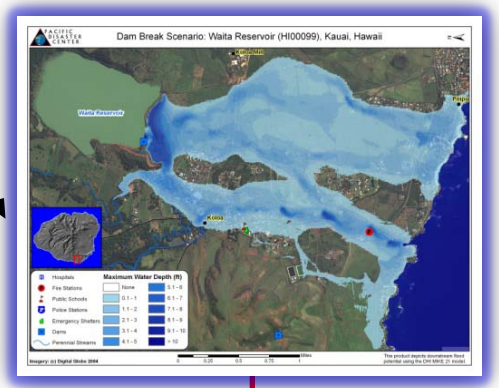
Model

Representative Output



Application

GIS Mapping/Animations



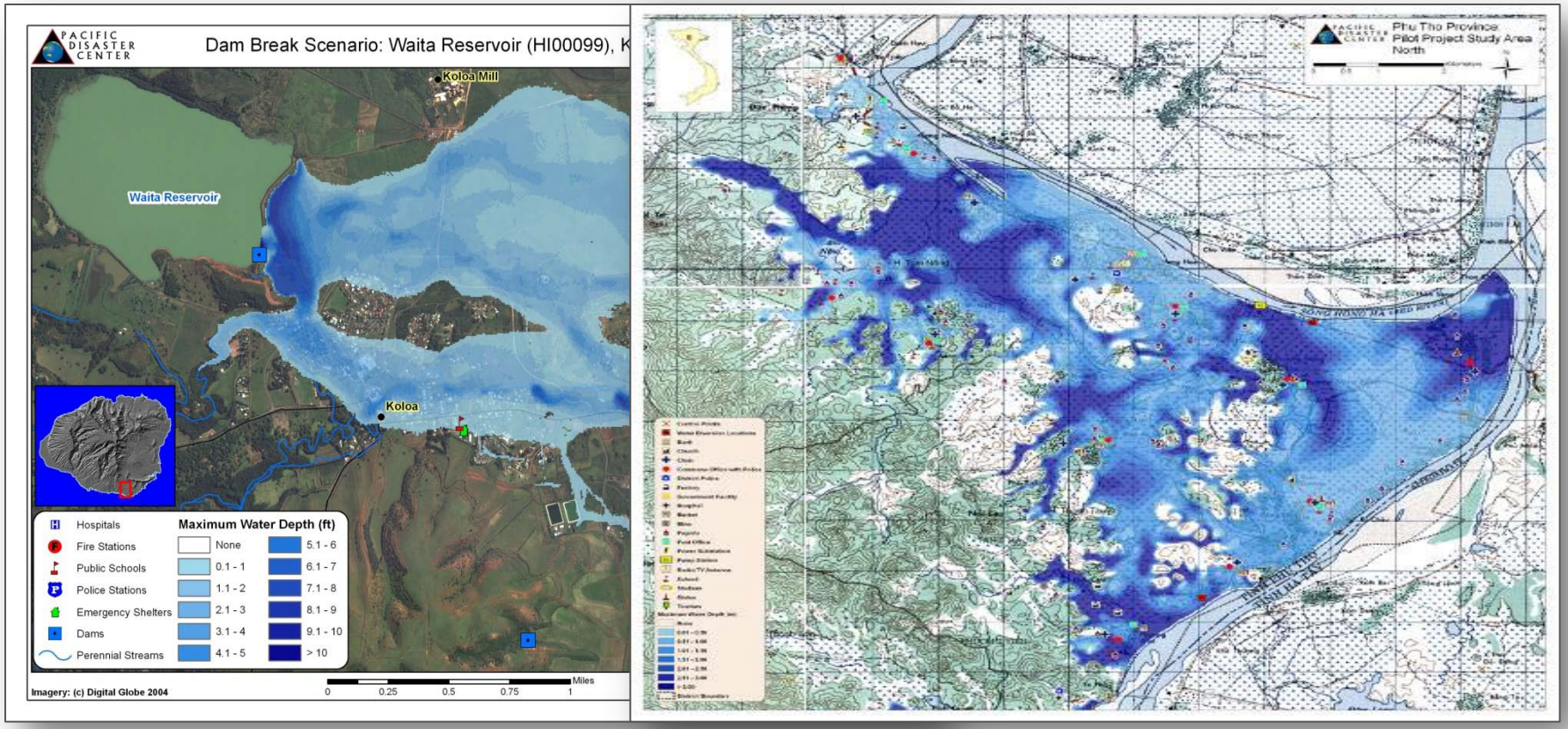
GIS Viewer

Modeling and Simulation

- How does M&S support HM & RVA?
  - – simulate different hazards (e.g., floods, landslides, earthquakes) under different conditions before they happen.
  - – predict future values or outcomes from on-going situation hazard events. For example, predicting water levels over the next 12 hours based on current water levels.

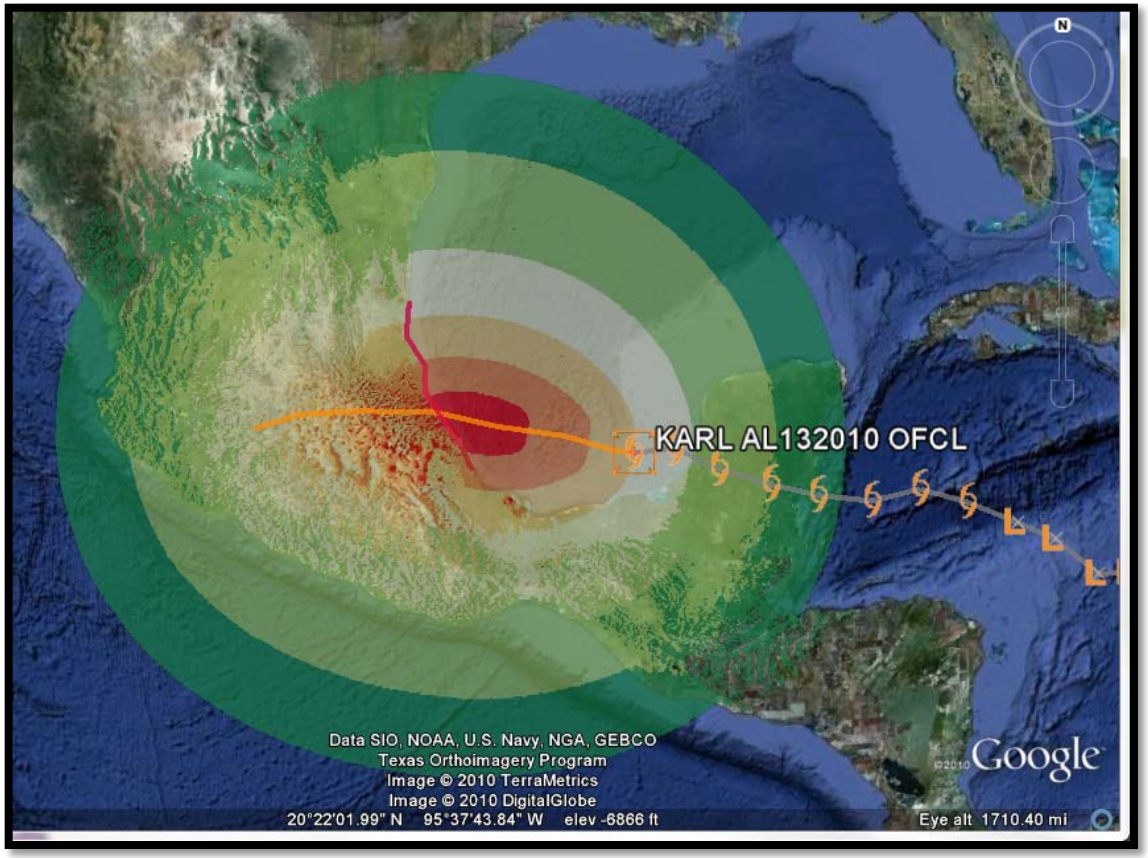
Hydrological

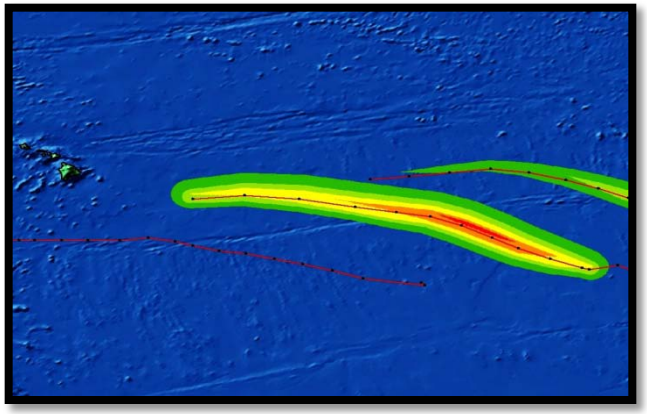
The MIKE hydrological model depicts flood inundation that could result from Rainfall, Dam or Levee Failure, and Storm Surge.

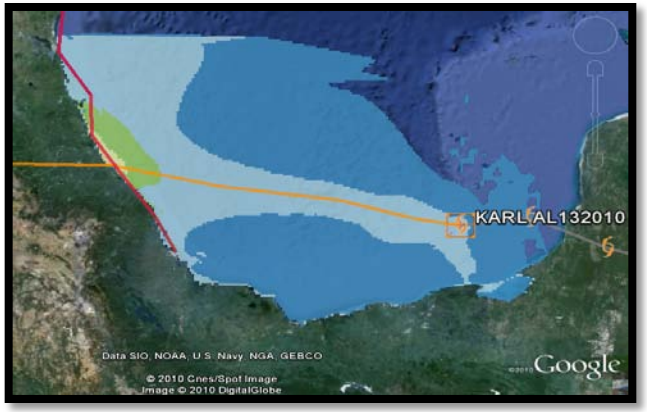


Tropical Cyclones

The TAOS tropical cyclone model depicts potential Winds, Storm Surge, Rainfall, and Wave Heights from Tropical Cyclones.





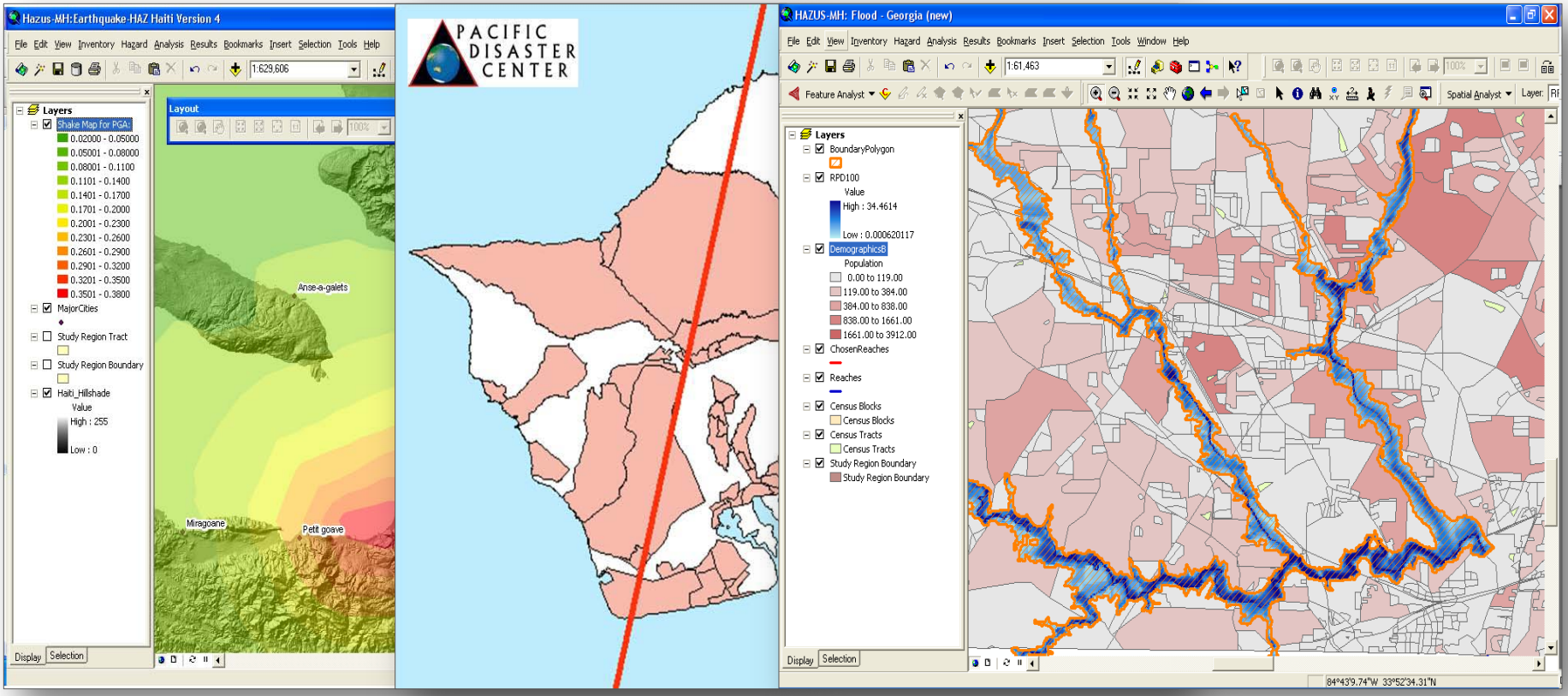


Tsunamis

The MOST tsunami model simulates the flood inundation that could occur from an earthquake-generated tsunami.

Loss Estimation

The HAZUS-MH (Multi Hazard) model depicts the physical damage and loss that could result from Earthquakes, Hurricanes Winds, and Flooding.



Summary

- GT's support HM & RVA through …
  - Collection and processing geospatial data for hazards and assets of interest
  - Analyzing spatial relationship between hazards and at-risk assets
  - Preparing maps and reports to define and communicate risks
  - Allowing assessment of various hazard mitigation scenarios

Acknowledgements

GeoTechnologies for Hazard Mapping and RVA

- **Contributing Authors**
  - Stanley Goosby, Pacific Disaster Center
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  - Michael Chatman, Pacific Disaster Center

- **Published Source Materials**
  - Esri GIS.com – Guide to Geographic Information Systems website (Accessed September 2010): http://www.gis.com/
  - The GIS 2 GPS Portal – Resources for Educators and Students website (Accessed September 2010): http://gis2gps.com/
  - National Oceanic and Atmospheric Administration website (Accessed September 2010): http://www.noaa.gov/
  - Natural Resources Canada website (Accessed September 2010): http://ccrs.nrcan.gc.ca/index_e.php
  - Jensen, John R. *Remote Sensing of the Environment: An Earth Resource Perspective*, Prentice Hall, 2000 (2007).