Humanitarian Assistance and Disaster Relief (HADR)

Remote sensing, GIS & Server Technology for Planning, Response & Mitigation

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HUMANITARIAN ASSISTANCE, DISASTER RELIEF

“Disaster relief is the response to reduce human suffering associated with natural disasters that cause the disruption of normal transportation and commerce and destroy infrastructure.”

(excerpt from U.S Southern Command’s HADR mission statement)
Humanitarian Assistance and Disaster Relief Overview

HADR planning for domestic and international agencies is based on 4 areas:

- **Warning / Evacuation**
- **Saving People**
- **Providing Immediate Assistance**
- **Assessing Damage**
- **Ongoing Damage**
- **Restoration of Infrastructural Services**
- **Reconstruction (Resettlement/Relocation)**
- **Economic and Social Recovery**
- **Ongoing Development Activities**

**Risk Assessment**
**Mitigation / Prevention**
**Preparedness**

**PRE DISASTER PREPARATION**
**RESPONSE & RECOVERY**
**PREVENTION & MITIGATION (POST DISASTER)**
**REHABILITATION RECONSTRUCTION (POST DISASTER)**
Disasters are dynamic and can leave lives, property, and infrastructure at risk to secondary percussions.

2008 Great Sichuan Earthquake that measured 8.0Mw on May 12, 2008 in Sichuan province, killing 69,195 people with 18,392 missing.
Critical first responders and incident managers need to understand and incident within a geographical context.

Equally important is updating and sharing critical information as a disaster unfolds.
Risk Mitigation: Individual

- **Is a key to National Preparedness**
- **Conduct an assessment of possible risks. Example in Earthquake prone areas:**
  - Make structural changes such as the installation of a *Gas Meter Earthquake Valve*
  - *Seismic retrofits* of property
  - Securing of items inside a building to enhance household seismic safety
- **All good ideas but has minimal impact on a larger scale**
**Risk Mitigation: Government**

- **Flooding**
  - Construct levees/dikes
  - Restriction of building in flood plains

[inset: Flood emergency Preparedness maps]

[inset: Sacramento River Levee]

[inset: Flood emergency Preparedness maps]
**Risk Mitigation: Government**

- **Land Slides/ Mudslides**
  - Conduct terrain slope analysis and identify areas of deforestation and re-seed

- **Earthquakes**
  - Identify fault lines and possible secondary hazards
    
  Eg. Dams, bridges (i.e. Auburn Dam, American River, Auburn, CA)
Pre-Disaster Preparation

Identification and mapping of areas that are susceptible to:

- **Wildfires**
  - Drought conditions

- **Floods**
  - River valley, flood plains, wetlands & marshes

- **Landslides**
  - Deforestation, forest burn areas

- **Earthquake hazards**
  - Bridges, highway overpass, dams, etc
What is the most efficient and effective way to transport supplies out from the airport to the affected regions in the event of an earthquake?
Pre-Disaster Preparation

**Identification and mapping areas that are suitable for:**

- Staging areas for first responders
- Helicopter Landing Zone (HLZ) for personnel evacuation and supply distribution
- Construction of relief and refugee camps

- Computer models can identify “at-risk” areas for a specific hazard
- Combining those results with near real-time information updates; GIS mapping tools can provide decision makers with vital information about populations, infrastructure, and critical facilities in the “at-risk” areas
The RESPONSE phase of an emergency may commence with Search and Rescue but in all cases, the focus will quickly turn to fulfilling the basic humanitarian needs of the affected population.
Response

- The Response can take the shape of a shelter-in-place or an evacuation
  - A shelter-in-place scenario requires determining the most appropriate location to stand up a camp and reassessing the ability to supply it during the relief efforts
  - In an evacuation scenario, the condition of the roads, highways, bridges must all be determined in order to safely evacuate the affected population
“The **RECOVERY** phase starts after the immediate threat to human life has subsided... the **REBUILDING**.”

Although geospatial analysis tools and techniques can still be used to monitor that phase such as monitoring the progress of the rebuilding, it is not as critical to the overall recovery effort as they were in the **Risk Mitigation, Pre Disaster Preparation and Response phase**.
Challenges: Human Challenges

- **Unpredictability** of the environment
- Added stress of *1st hand exposure to trauma & devastation*
- **Cooperation & collaboration** across multiple jurisdictions and levels of governments
- Lack of critical resources
Challenges: Technical Challenges

- To quickly assess the damage
- To instantly find all necessary background geospatial data
- Working with high volumes of remote sensing & mapping information in various data formats
- To collaborate and share information with other agencies and public officials
- To directly aid first responders
Tools and Techniques for HADR Mission Support
Image Classification

Categorize all pixels in a digital image into one of several land cover classes or “themes”. This categorized data may then be used to produce thematic maps of the land cover present in an image.
Image Registration

The process of transforming different sets of data into ONE coordinate system
Change Detection

Involves the use of multi-temporal sets to discriminate areas of land cover change between dates of imaging.
Terrain Analysis

Involves the collection, analysis, evaluation, and interpretation of geographic information on the natural and manmade features of the terrain.
LIDAR Analysis

Involves the analysis, evaluation, and the interpretation of LIDAR point cloud data

inset: A 3D view of raw, unprocessed LIDAR clearly shows levees, a bridge and trees
RADAR Analysis

Involves the analysis, evaluation, and the interpretation of RADAR imagery such as flood mapping, ice monitoring, terrain extraction and oil spill detection.
GIS Analysis

Enables the capture, query, analysis, editing and presentation of spatial information
3D Analysis and Visualization

Enables the exploration and evaluation of multi-sensor data in a virtual environment
Data Fusion

Process of merging data from multiple sources to optimize the data content OR create “Value-added” data
Data Catalog

Data Catalog is a collection of information about data sets, files or database, also describing the physical location of where the data is located.
Mobile / Web Services

Providing access to information and allowing for first responders to operate in a disconnected mode.
Intergraph Solutions for HADR Missions
Image Classification & Registration

**ERDAS IMAGINE**
- Supervised Classification
- Unsupervised Classification
- Image Segmentation (IMAGINE Objective)

**ERDAS IMAGINE**
- Manual Registration
- Semi-automated Registration (IMAGINE Autosync)
Image Classification & Registration
Change Detection

**ERDAS IMAGINE**
- Image Differencing
- **IMAGINE DeltaCue**
  - Broad Area Change; Site Monitoring Change; Filtering Change
- SAR Coherence Change

![Change Detection using 2.4 m Quickbird False-Color Imagery of Baghdad, Iraq](image)

Red circles highlight new construction
Blue circles highlight bomb damage

Time 1
5 July 2002

Time 2
15 July 2004

Change Detected
Yellow indicates brightness increase
Cyan indicates brightness decrease

inset: SAR Coherence Change Detection results
Terrain Analysis

**ERDAS IMAGINE**
- Slope
- Aspect
- Shaded Relief
- Contours
- Level Slice
LIDAR Analysis

**ERDAS IMAGINE**
- Display LIDAR as:
  - Elevation, Intensity
  - Returns, RGD Encoded
  - Classification
- 2D Profiles
- Editing
- Mensuration
- DEM Creation

Inset: Point Cloud Creation from Stereo pairs
RADAR Analysis

ERDAS IMAGINE
- Real-time Flood Mapping
- Oil Spill Detection
- Level Slice
- DEM Creation
- Raster to Vector

Inset: Flood Mapping with Level Slice tool on top, Shapefile overlay created from top Raster result

Inset: Oil Spill detection using Region Grow tool
3D Analysis & Visualization

**ERDAS IMAGINE**
- IMAGINE Virtual GIS
  - Water layers
  - Mist layers
  - 3D Models
  - Fly-through
  - Vector overlays
GIS Analysis

Geomedia
- Efficiently capture & edit vector feature data
- Visualize data to exact style specifications
- Display is quickly updated during pan & zoom
- Exporting to common formats with other organizations & departments
- Perform adhoc, what-if, complex, analysis across data sources
- Analysis & queries are dynamically updated as queries are edited or when data is modified
ERDAS IMAGINE - Spatial Modeller

- Combine GIS and image processing functions in the same spatial mode
- Combine raster, vector, and attribute data in a single model
- Use Geomedia vector and grid operators
- Enhance and build models with Python scripting
- Apply a model to a new data or a different geographical area at the push of a button
ERDAS APOLLO
- A comprehensive data management, analysis, and delivery system
- It enables an organization to organize and deliver massive volumes of both file-based and web-enabled data (including imagery, feature data, terrain, and virtually any digital object in the enterprise)
- It delivers geospatial data faster and with less hardware than competing server-based products
- An out-of-the-box service-oriented architecture (SOA) which can be easily customized and extended
Data Catalog & Distribution
Mobile / Web Services

**Geospatial Portal**
- Support for a variety of devices
- Display, zoom and switch between predefined maps
- Show feature attributes
- Center the map based on device localization capabilities (Eg. GPS, A-GPS)
Example Geospatial Workflow

- **Classification**
- **Registration**
- **LiDAR**
- **Radar Analysis**
- **Apollo Server**
- **GIS Analysis**
- **GeoPDF**
- **Terrain Analysis**
- **Mobile**
## Application of Geospatial Tools and Techniques

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“We, INTERGRAPH SG&I understand the challenges that Geospatial Analysts are faced with during times of crisis and we have the solutions to help you overcome these technical challenges”

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Questions