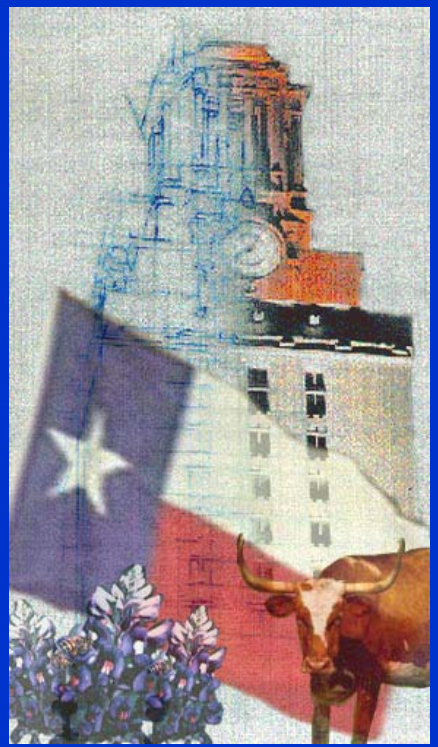
Using Satellite Images in Post-Earthquake Geotechnical Reconnaissance



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GEER Advisory Panel Meeting
7 January 2004

Post-Earthquake Response

- Earthquake response hampered by inadequate information
  - Which areas are most damaged?
- Earthquake reconnaissance time wasted "looking" for damage, maps, etc.
- Optical satellite images can provide critical information to plan reconnaissance and to study damage

High-Resolution Optical Satellites

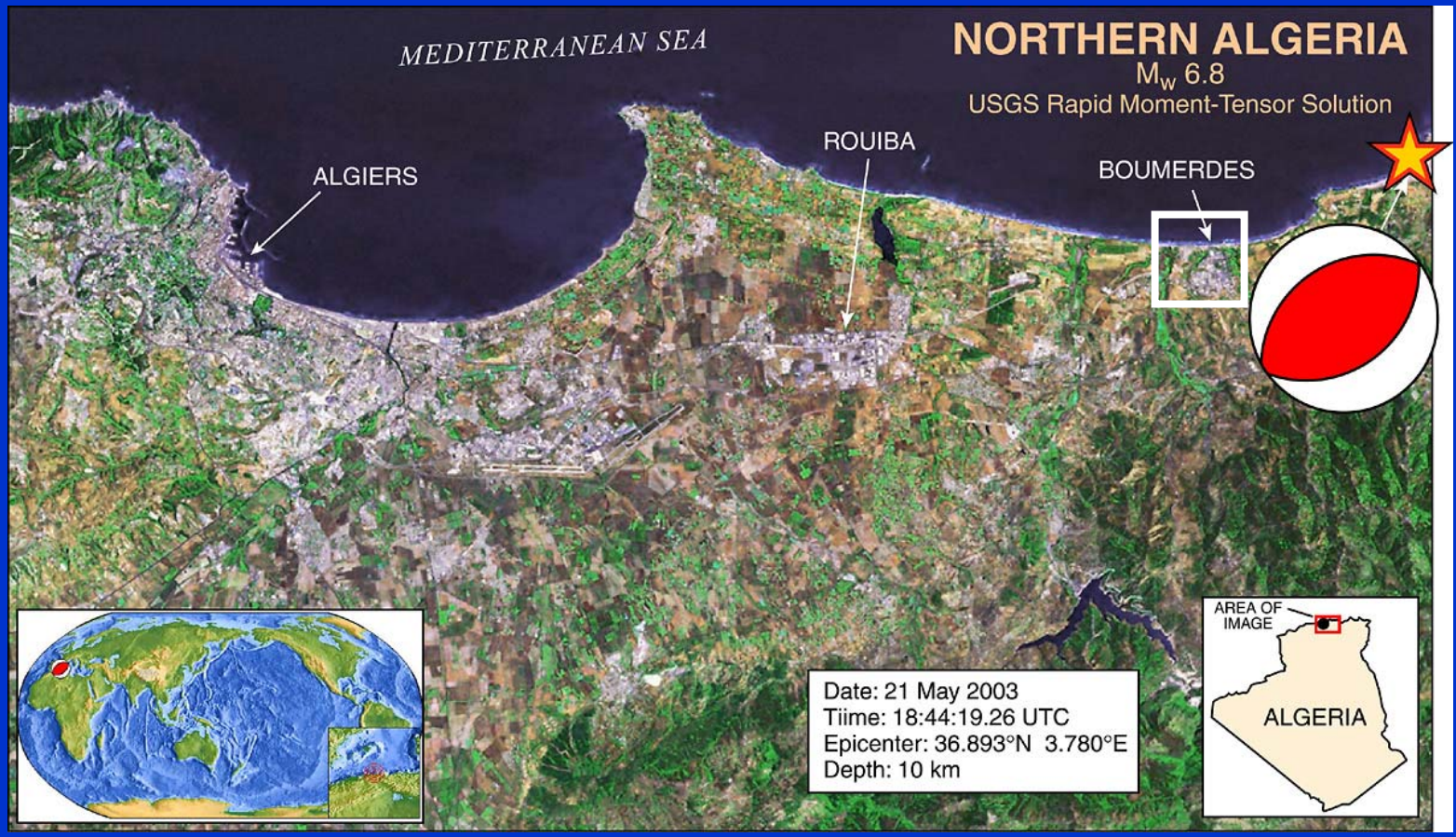
- Two commercial satellites
  - Quickbird (www.digitalglobe.com)
  - IKONOS (www.spaceimaging.com)
- Quickbird
  - 60 cm resolution panchromatic (B&W)
  - 2.4 m resolution multispectral (color)
- IKONOS
  - 100 cm resolution panchromatic (B&W)
  - 4 m resolution multispectral (color)

Optical Satellite Digital Data

- Panchromatic (black and white)
  - 450-900 nm band
- Multispectral (4 bands)
  - Blue 450-520 nm, Green 520-600 nm, Red 630-690 nm, Near Infrared 760-900 nm
- Pan-sharpened image
  - Fuse panchromatic and multispectral to obtain a high resolution color image

Northern Algeria Earthquake

- 21 May 2003, 7:44 pm, M_w 6.8



from neic.usgs.gov

Satellite Images

- 3 Quickbird images of Boumerdes
  - 22 April 2002, 11° OFF NADIR
  - 23 May 2003, 24° OFF NADIR
  - 18 June 2003, 8° OFF NADIR
- All images from DigitalGlobe archive
  - 25 km^2 minimum order size
  - ~\$30/km^2 for standard pan/ms data
  - 2 to 3 day delivery
  - Tasking requires 64 km^2 minimum size

Boumerdes 23 May 2003

SW Boumerdes – April 02

Buildings, roads, and cars readily visible

SW Boumerdes – May 03

- Pancaked buildings easily identified

SW Boumerdes – June 03

- Five pancaked buildings removed
- Other buildings removed

Damage Detection

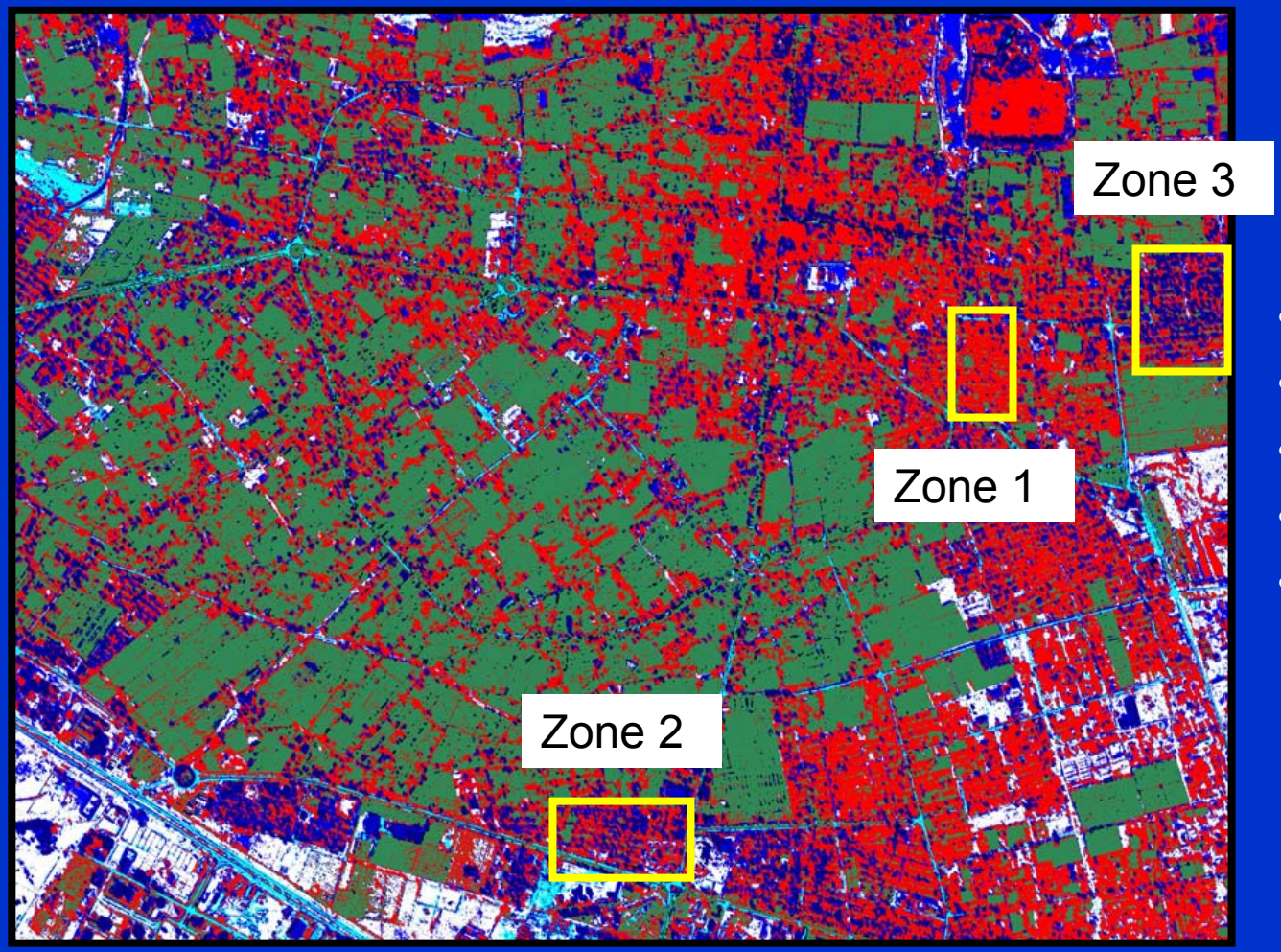
- Visual inspection of images can provide valuable damage information
- Evaluating large areas require semi-automated methods
- Methods available
  - Change detection (requires pre- and post-earthquake images)
  - Thematic classification (requires only post-earthquake image)

2003 Bam, Iran Earthquake

- 26 December 2003, M_w 6.6
- Quickbird images
  - Pre-event: 30 September 2003
  - Post-event: 4 January 2004
- EERI earthquake reconnaissance team took post-event image to field on laptop computers

Damage Identification

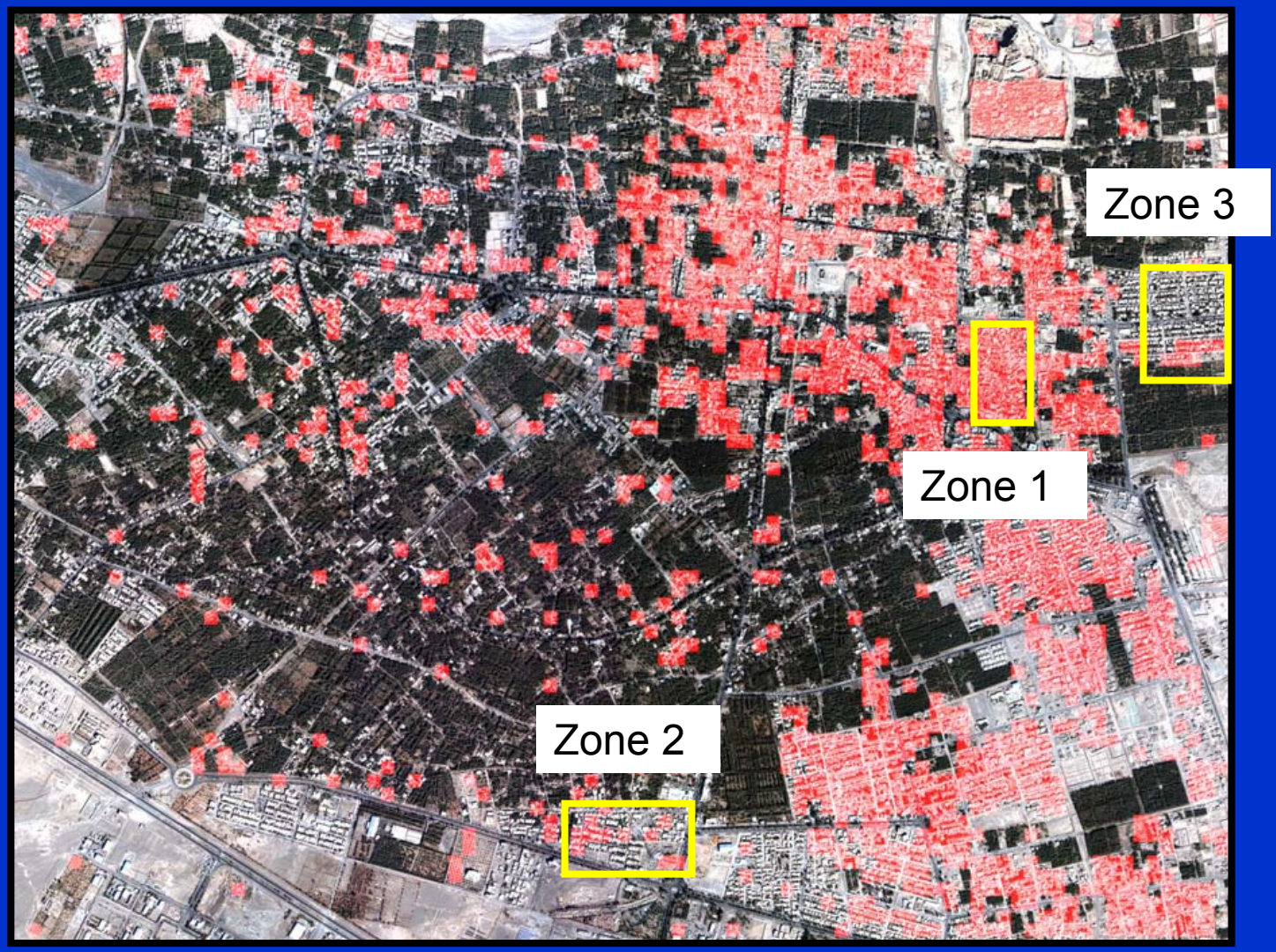
Maximum-likelihood classification



- Red – damage
- Green – vegetation
- Blue – buildings
- White – open areas
- Cyan – roads

Heavily Damaged Areas

Identify windows with >50% pixels classified as damage



Zone 1

Zone 2

Zone 3

Closing Thoughts

- Earthquake damage is readily visible in high-resolution satellite images
- Thematic classification can accurately identify fully collapsed buildings
- Acquisition timing
  - Requires clear conditions
  - Revisit time varies from ~ 5-10 days
- Trained reconnaissance team
  - Bam team did not really use images