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Aplicaciones Sísmicas de Percepción Remota y GIS en Puerto Rico

"3era Reunión Nacional de Percepción Remota y Sistemas de Información Geográfica de Puerto Rico"

14 de junio de 2005 - Mayagüez, PR

Por: **Christa von Hillebrandt-Andrade**
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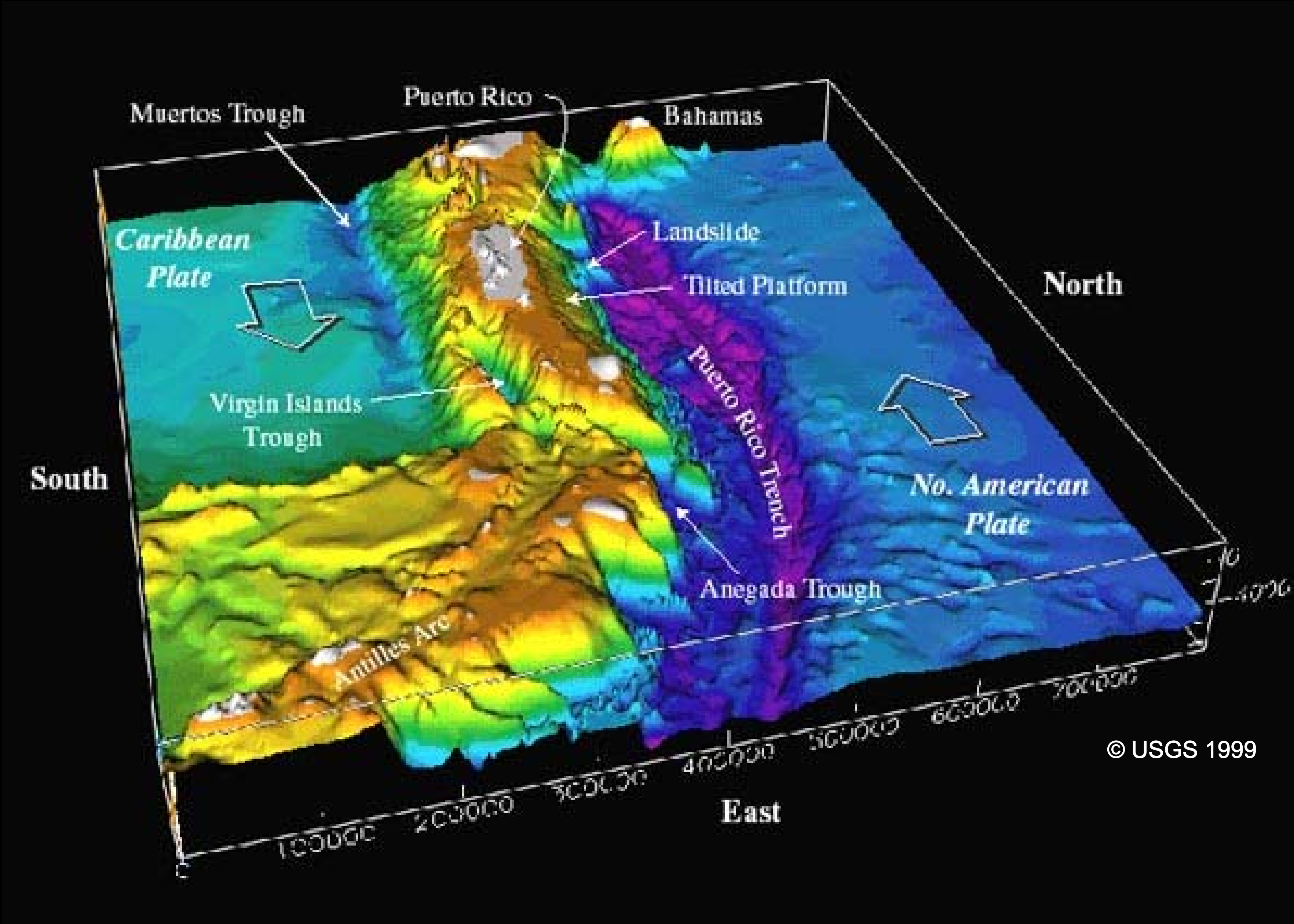
Auxiliar de Investigación & Analista Principal de Datos

Introducción

- Debido al aumento dramático en resolución y accesibilidad, los datos de sensores remotos están jugando un papel cada vez más significativo en la identificación de fallas potencialmente activas, la presentación de las amenazas, vigilancia sísmica, predicción y recuperación después de un desastre.
- Exploraremos el rol que estos recursos han tomado en el mundo y pueden tomar en Puerto Rico.


Puerto Rico
Muertos Trough
Bahamas
Caribbean Plate
Landslide
Tilted Platform
North
Puerto Rico Trench
Virgin Islands Trough
South
No. American Plate
Anegada Trough
Antilles Arc
East
© USGS 1999

Identificación de Fallas

Imagen SLAR de Puerto Rico

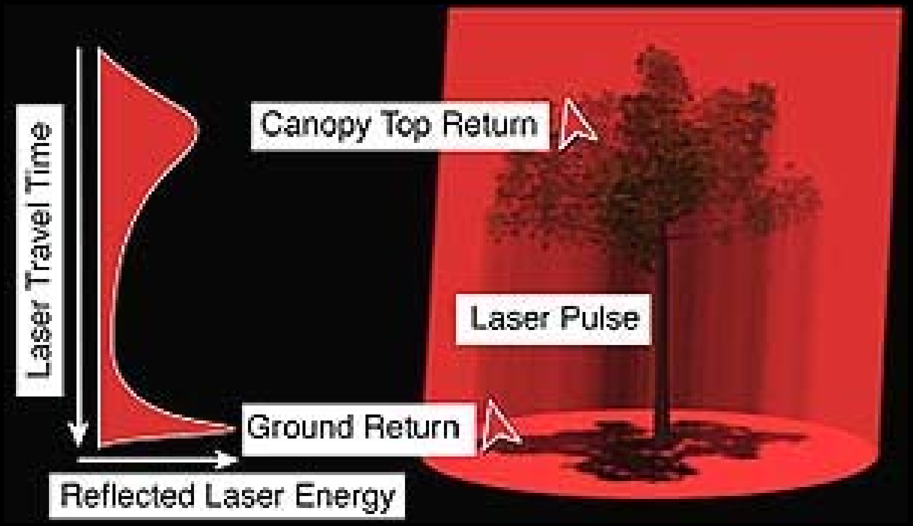
Figure 3. DEM of western Puerto Rico, showing several major faults, including Cerro Goden fault (CGF), Punta Algarrobo/Mayaguez fault (PA/M), Punta Guanajibo/Punta Arenas fault (PG/PA), and South Lajas fault (SLF). Mayaguez is the largest city in western Puerto Rico. A detailed figure ofthe region around Anasco and hte Cerro Goden fault appears in Figure 4. Modified from Mann et al., in press)


1936 aerial photograph
N
1 km
scarp
TRENCH SITE
scarp

LIDAR

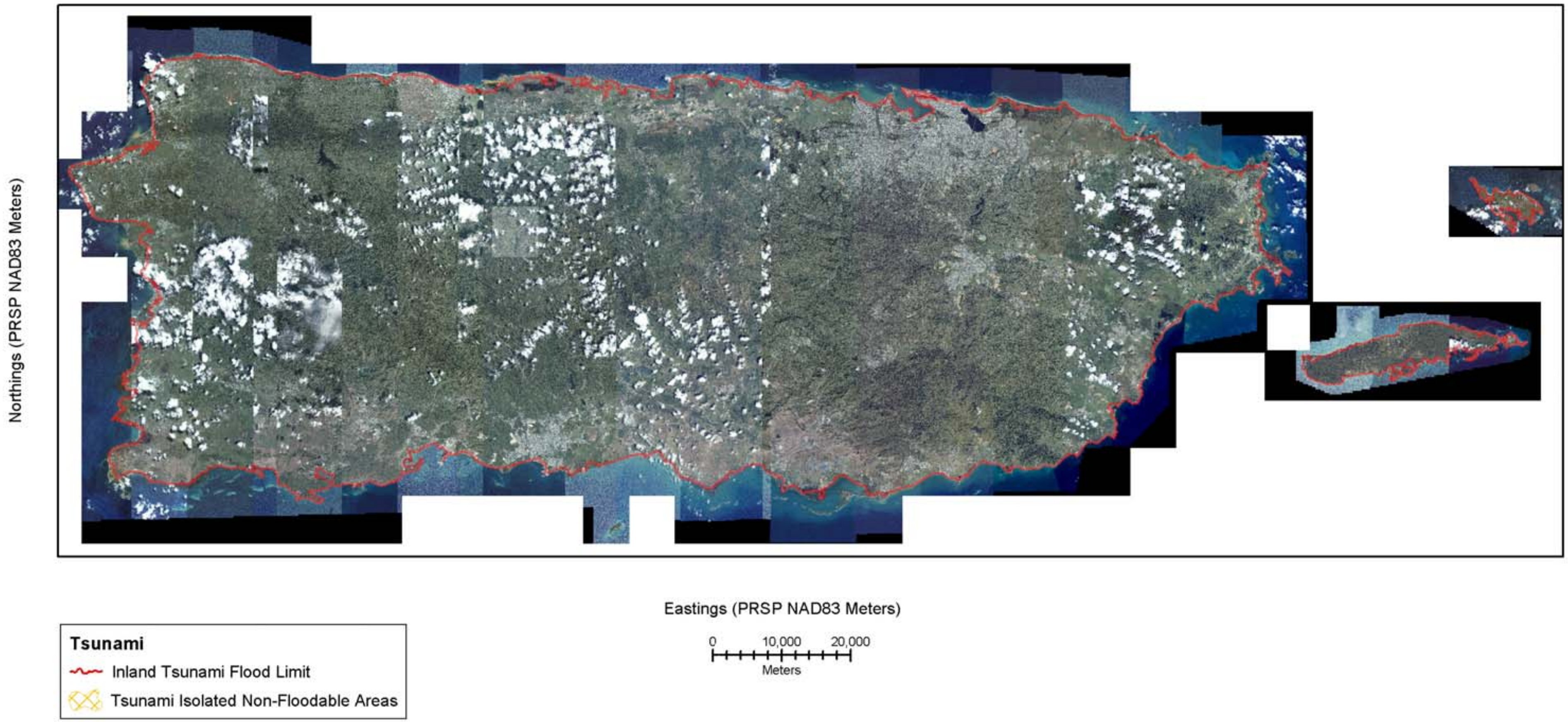
- Usado exitosamente para detectar fallas activas en Seattle Puget Lowland, Washington, Narrow Cape en la Isla de Kodiak, Alaska, Zona Sísmica Nuevo Madrid, y la Falla Norte de Anatolia en Turquía cerca a Istanbul donde la vegetación estaba limitand la efectividad de otras técnicas.

- De acuerdo con el Dr. David Harding, de NASA: "LIDAR es la mejor técnica que tenemos en este momento para areas cubierta por vegetación".

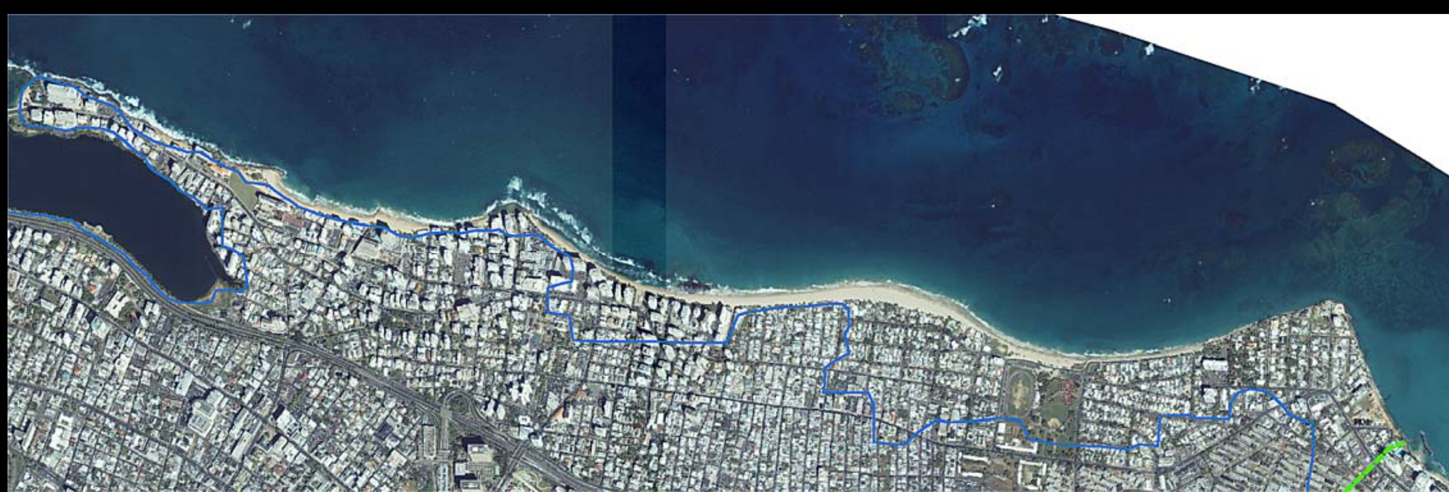


Presentación del Peligro

PUERTO RICO TSUNAMI FLOOD MAP



Mapa Topográfico vs IKONOS, Condado – Punta Las Marias

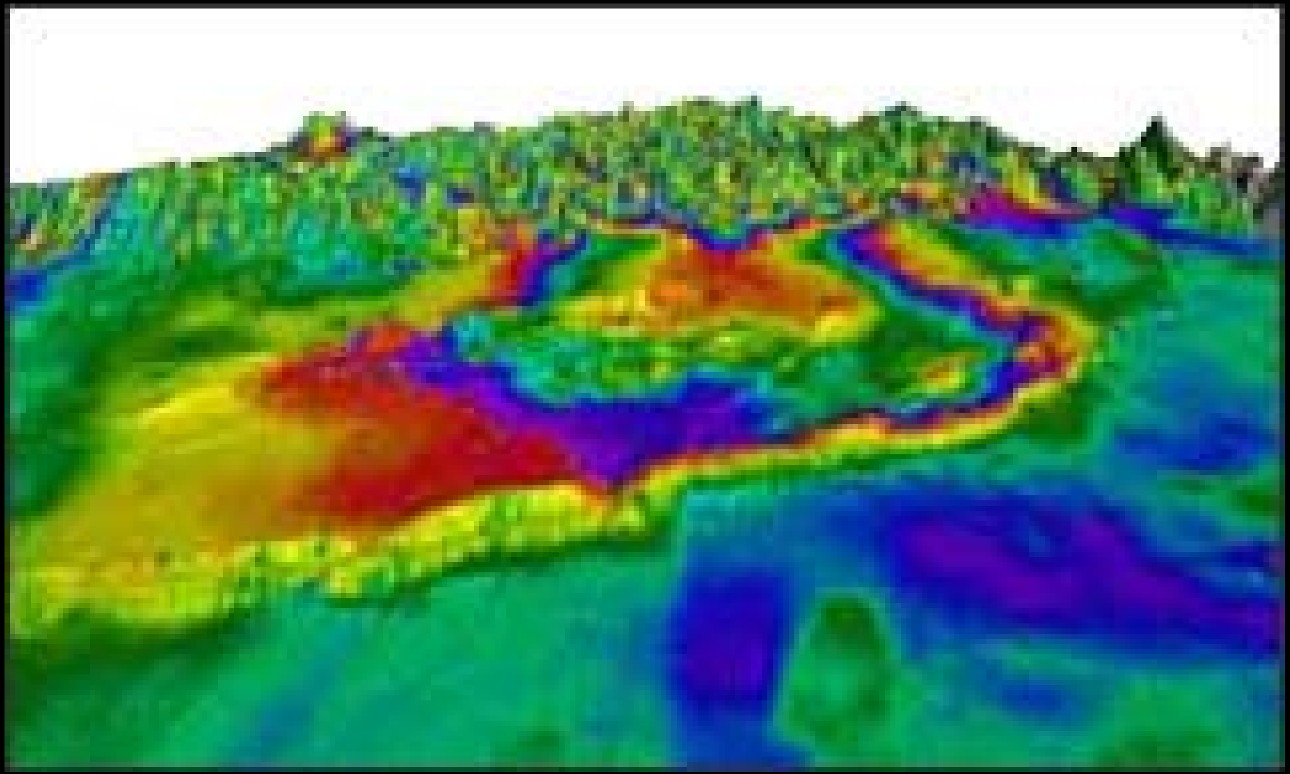


Mapa Topográfico vs IKONOS, Mayagüez

http://poseidon.uprm.edu

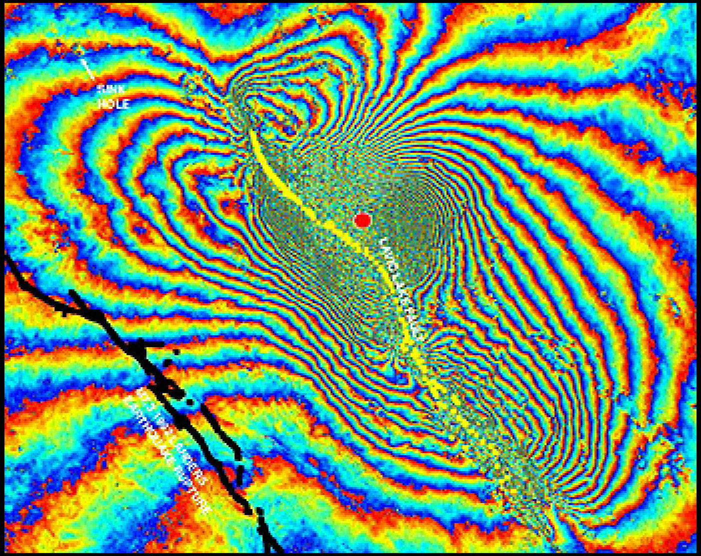

HAZUS® MH
EARTHQUAKE • WIND • FLOOD
FEMA's Software Program for Estimating Potential Losses from Disasters
FEMA

Vigilancia/Predicción

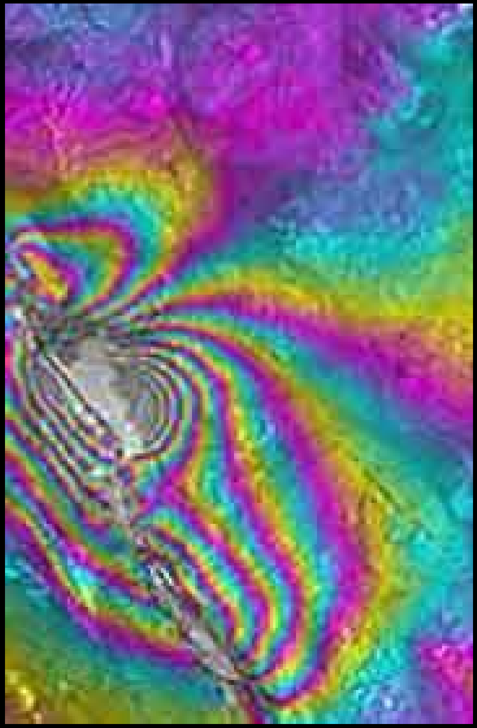


En Irán, se ha usado InSAR (Inferometric Synthetic Aperture Radar) para monitorear movimiento a lo largo de fallas para las cuales no hay datos sísmicos. Científicos de COMET (Centre for the Observation and Modelling of Earthquakes and Tectonics) han demostado que InSAR puede ser usado para medir pequeñas tasas de esfuerzo acumulado entre terremotos. En esta imagen cada ciclo de azul a rojo representa 2.8 cm de movimiento.

- InSAR se considera como una posible herramienta para la predicción de terremotos. A mano derecha se ve el desplazamiento a lo largo de la Falla Lava Lake determinado del analisis de datos del satélite ERS-1. Poco después ocurrió el terremoto de Hecto Mines de 7.1 el 16 de Octubre de 1999.



Nicholas M. Short, Sr. **Geophysical Remote Sensing: Crustal Dynamics; Seismology**
http://rst.gsfc.nasa.gov/Intro/Part2_1c



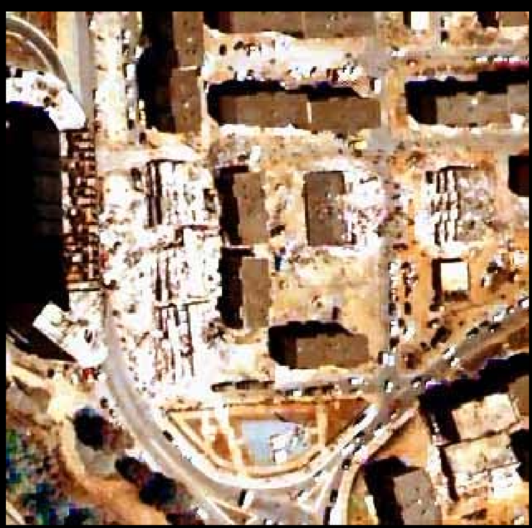
A la derecha, imagen InSAR demuestra el desplazamiento vertical del terreno debido al Terremoto de Hector Mine. Los datos fueron recopilados por el satélite ERS-2 de la Agencia Espacial Europea el 15 de Septiembre y el 20 de Octubre de 1999.

National Geographic News, July 20, 2004
http://news.nationalgeographic.com/news/2004/07/0720_040720_earthquake.html

Recuperación

Antes (4/22/02)

Después (5/23/03)



Imágenes de Quickbird (Digital Globe) de la ciudad de Boumerdes, Algeria

Terremoto de Algeria, Mayo 21, 2003, M 6.8 (USGS, 2003)

Terremoto Bam,Iran
Dec. 26, 2004, M 6.6

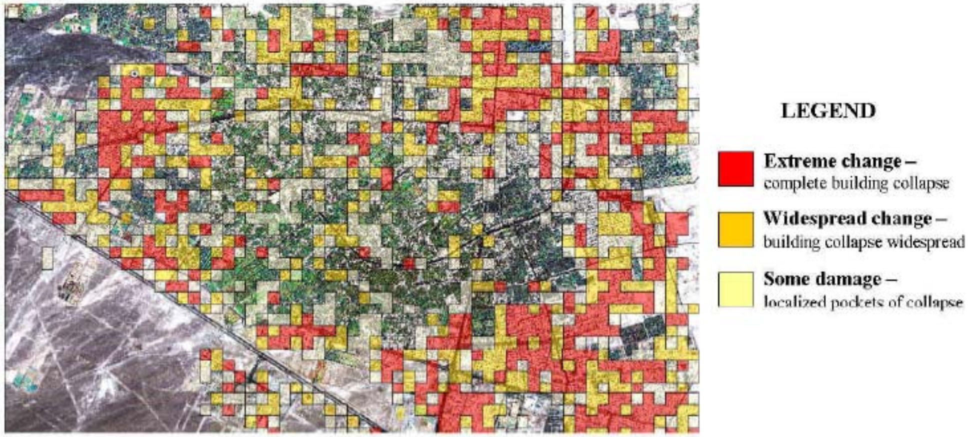


Figure 5 Preliminary VIEWS damage assessment for Bam, obtained using texture-based change detection. Red and orange areas correspond with pronounced changes between the 'before' and 'after' scenes, which are primarily associated with collapsed buildings. To aid visualization, results are overlaid with QuickBird coverage from 30th September 2003. Imagery courtesy of DigitalGlobe, www.digitalglobe.com.

The Bam (Iran) Earthquake of December 26, 2003: Preliminary Reconnaissance Using Remotely Sensed Data and the VIEWS (Visualizing the Impacts of Earthquakes with Satellite Images) System

Prepared by:

Beverley J. Adams, Charles K. Huyck, Michael Mio, Sungbin Cho, Shubharoop Ghosh, Hung Chi Chung and Ronald T. Eguchi, ImageCat, Inc. (www.imagecatinc.com)

Bijan Houshmand, UCLA

Masanobu Shinozuka and Babak Mansouri, UCI. (http://shino8.eng.uci.edu/)

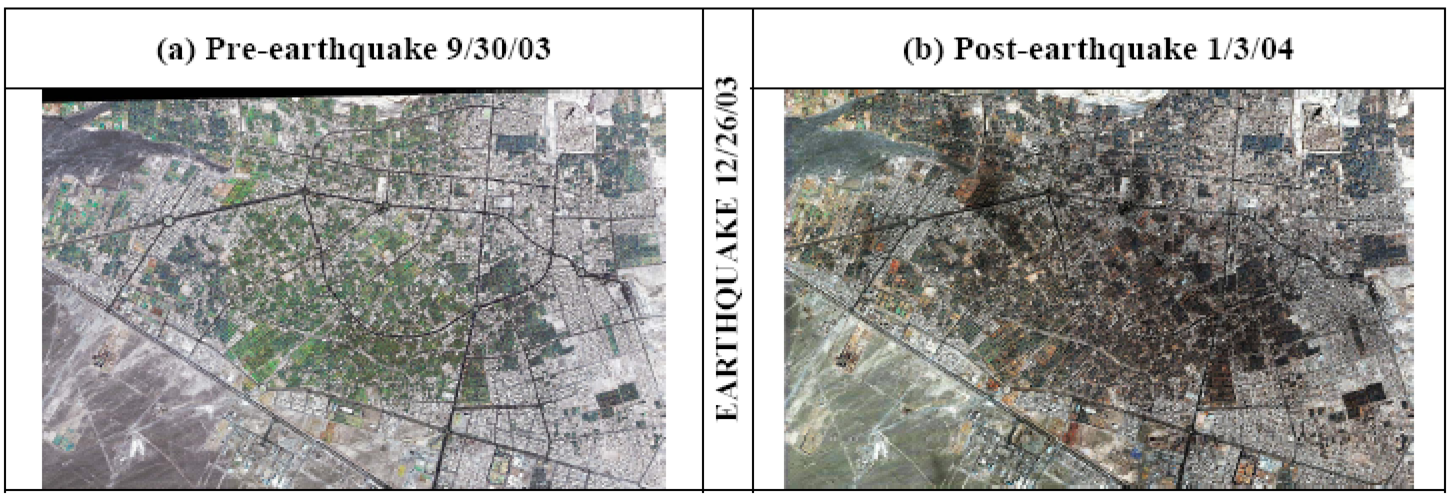


Figure 4 Pan-sharpened QuickBird satellite coverage of Bam, acquired: (a) in September 2003 'before' the earthquake; and (b) in January 2004 'after' the earthquake. In addition to differences between the scenes due to urban damage, the greenness of vegetation has changed because of seasonal effects and sensor look angle variation. Imagery courtesy of DigitalGlobe, www.digitalglobe.com.

Tsunami Océano Indico, 26 de Diciembre de 2004

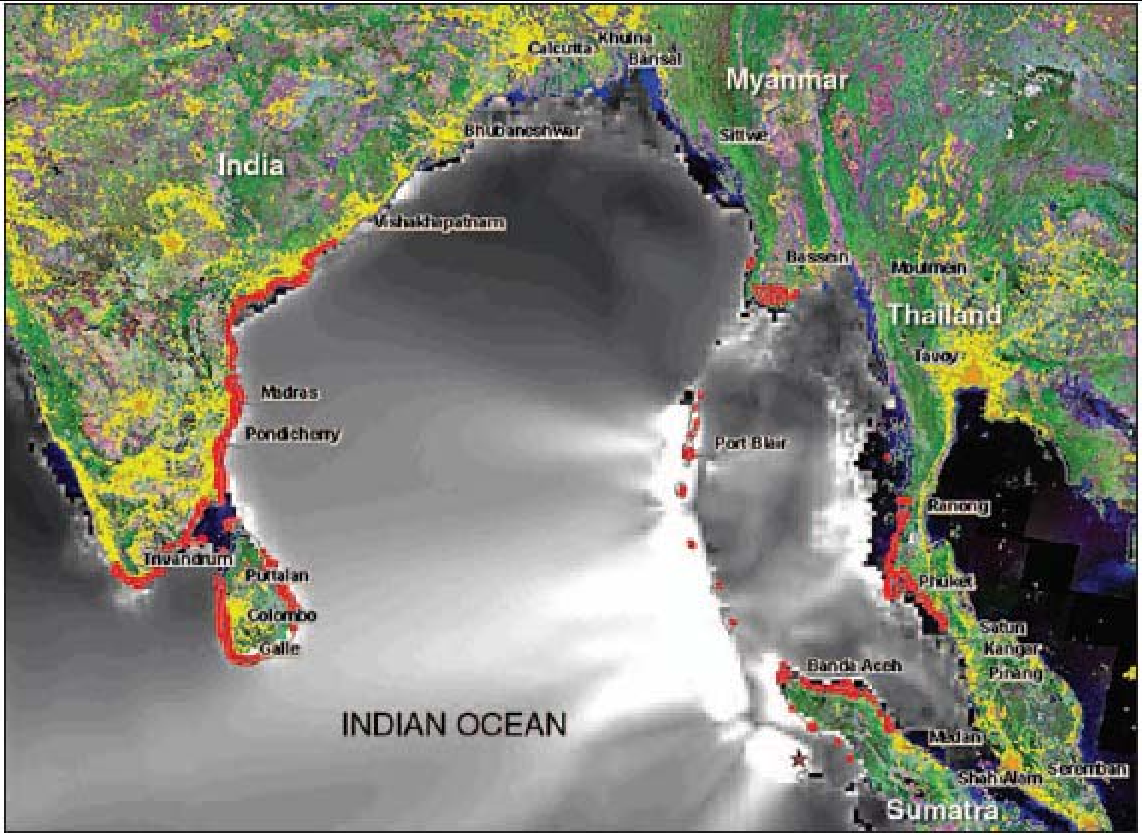


Figure 1. Assessment of potential devastation to coastal populations from the Indian Ocean tsunamis, using satellite imagery. Population data from NOAA's DMSP sensor is shown in yellow and orange. Areas marked in red are zones of potential damage.

MCEER

A Summary of Reconnaissance Efforts of the Multidisciplinary Center for Earthquake Engineering Research

MCEER RESPONSE

Post-Tsunami Urban Damage Survey in Thailand Using the VIEWS® Reconnaissance System

Shubharoop Ghosh, Beverley J. Adams, Charles K. Huyck, Michael Mio, Ronald T. Eguchi, Fumio Yamazaki and Masashi Matsuoka

ImageCat, Inc., Chiba University and the Earthquake Disaster Mitigation Research Center, National Research Institute for Earth Science and Disaster Prevention

Kalutara, Sri Lanka
Dec. 26, 2004 Tsunami

Natural Color, High Resolution

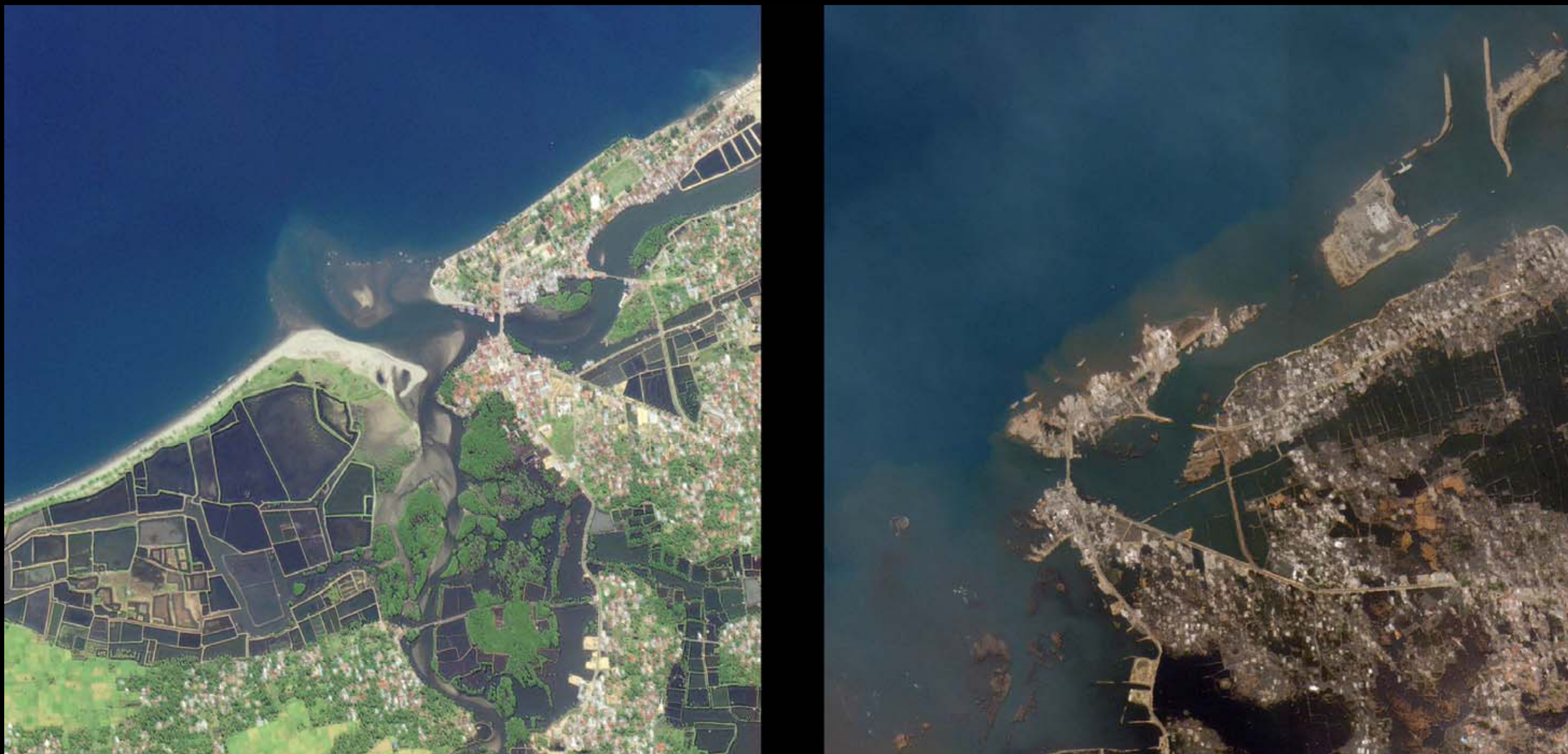
Quick Bird Satellite Image

Digital Globe

antes

durante

Indonesia
IKONOS de Space Imaging



January 10, 2003 Aceh, Sumatra, Indonesia December 29, 2004

Sistema de Reconocimiento VIEWS® eg. Thailand

QUICKBIRD image, courtesy Digital Globe, 1/5/05

IKONOS Image, courtesy GISTDA 12/29/04

VIEWS is ImageCat's notebook-based data collection and visualization system, originally developed for field reconnaissance after earthquakes. It integrates satellite imagery with real-time Global Positioning System (GPS) readings and map layers and operates in conjunction with a digital camera and digital video recorder. It can be deployed either from a moving vehicle or on foot during a walking tour.

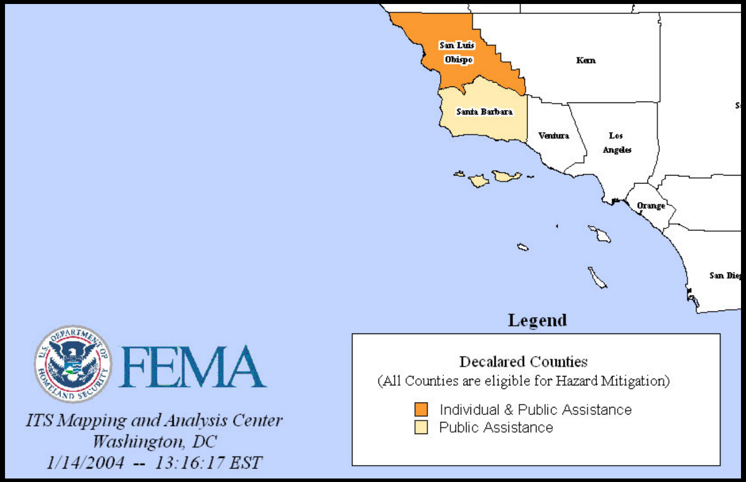
Table 1. "Before" and "After" satellite imagery for Thailand.

Satellite Imagery	Date	Time Frame	Area covered	Sources
15m Landsat	8-Apr 2003	Before	Phang Nga, Phi Phi, Phuket	*GISTDA**
60cm Quickbird	23-Mar 2002	Before	Phuket	*DigitalGlobe,USA*
60cm Quickbird	2-Jan 2005	After	Phuket	*DigitalGlobe,USA*
1m IKONOS	29-Dec 2004	After	Phang Nga	*GISTDA*
1m IKONOS	29-Dec 2004	After	Phuket	*GISTDA*
5m IRS	28-Dec 2004	After	Southern Thailand	*GISTDA*

* *Geo Informatics and Space Technology Development Agency*

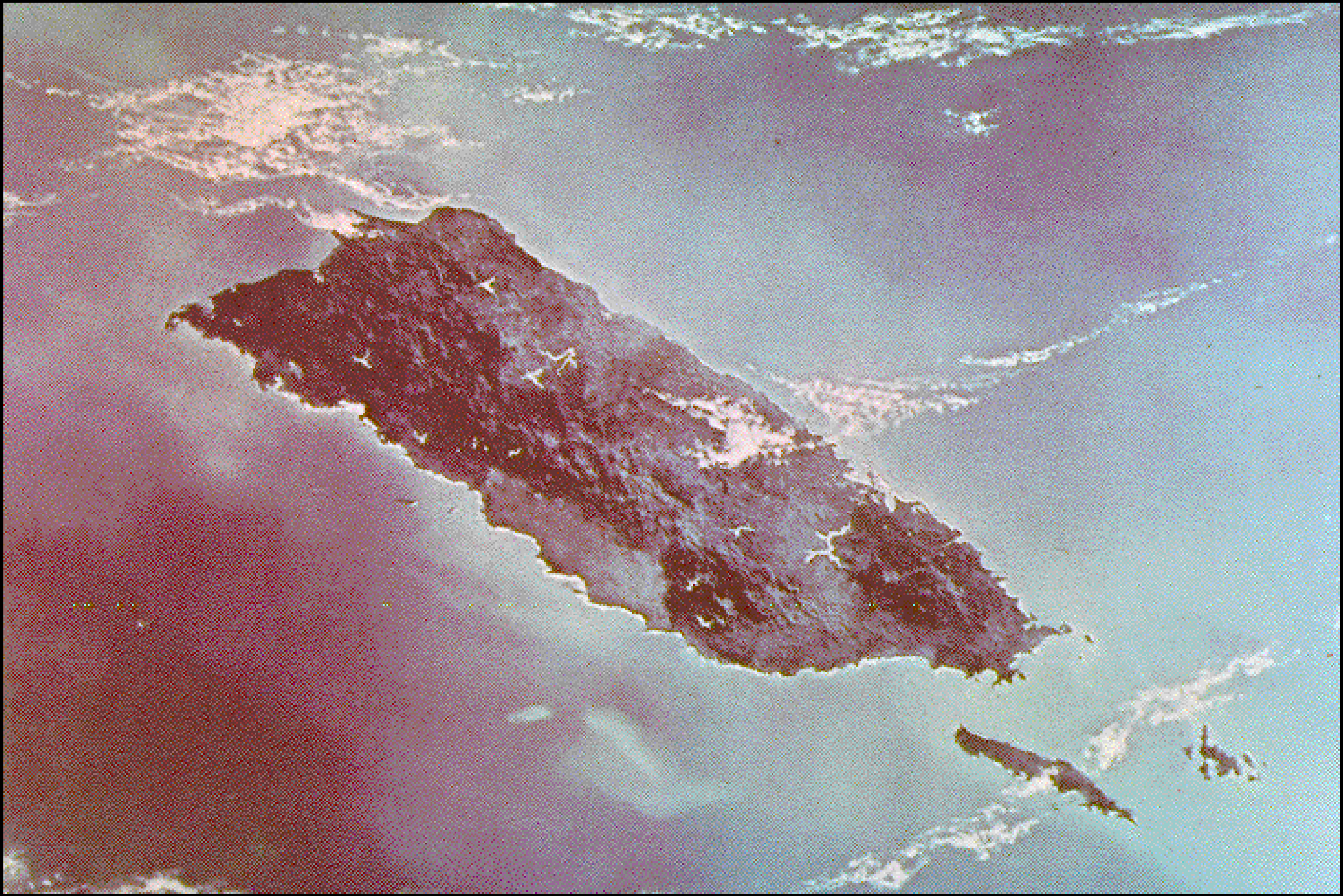
FEMA Mapping and Analysis Center

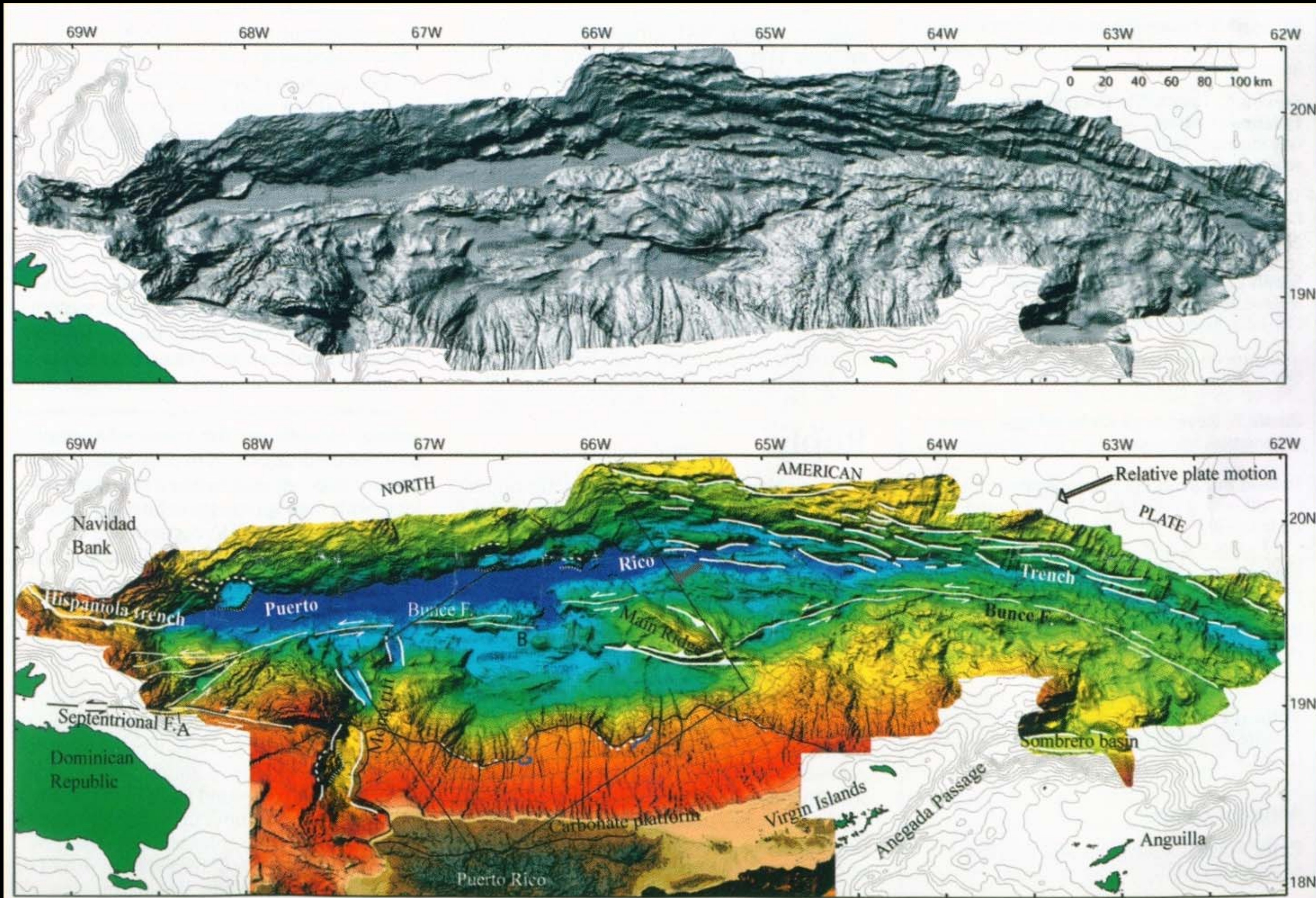
- FEMA has the Mapping and Analysis Center MAC (MAC) which is managed by an Information Technology Services Directorate (ITSD) Enterprise GIS Team (E-GIS Team) located in the Information Technology Services Directorate, Systems Engineering and Development Division, GIS and Data Solutions Branch
- During disaster response, the (MAC) may receive remote sensing data that indicates areas affected by the disaster, as derived from various imagery products. Typical examples include flooded, saturated, and/or damaged areas. You will find maps that use this type of data on many of our map pages.
- The MAC is permitted to share this remote sensing data with the public. The primary purpose for making this data available is so that various businesses with vested interests, such as insurance agencies, may apply it to their particular needs.
- Please note that GIS software is required to use this data.
- Our standard format for sharing this data is MapInfo Interchange Format (MIF). MIF data consists of two files, one with a .mif extension and one with a .mid extension. MIF data can be directly imported into MapInfo or converted into other GIS formats using translators readily available from other GIS software vendors.



Retos para Puerto Rico

Fallas sísmicas alrededor y en Puerto Rico





From Uri ten Brink, EOS, 2005

Conclusiones

- Existe una gran oportunidad para aprovechar las tecnologías de sensores remotos y GIS para identificar y representar fuentes de amenaza sísmica.
- En caso de un terremoto grande, estas tecnologías estarán jugando un rol importante y necesitamos tener ya un plan de respuesta.