

## Activities in Support of the Hurricane Mitch Reconstruction Program

U.S. Geological Survey

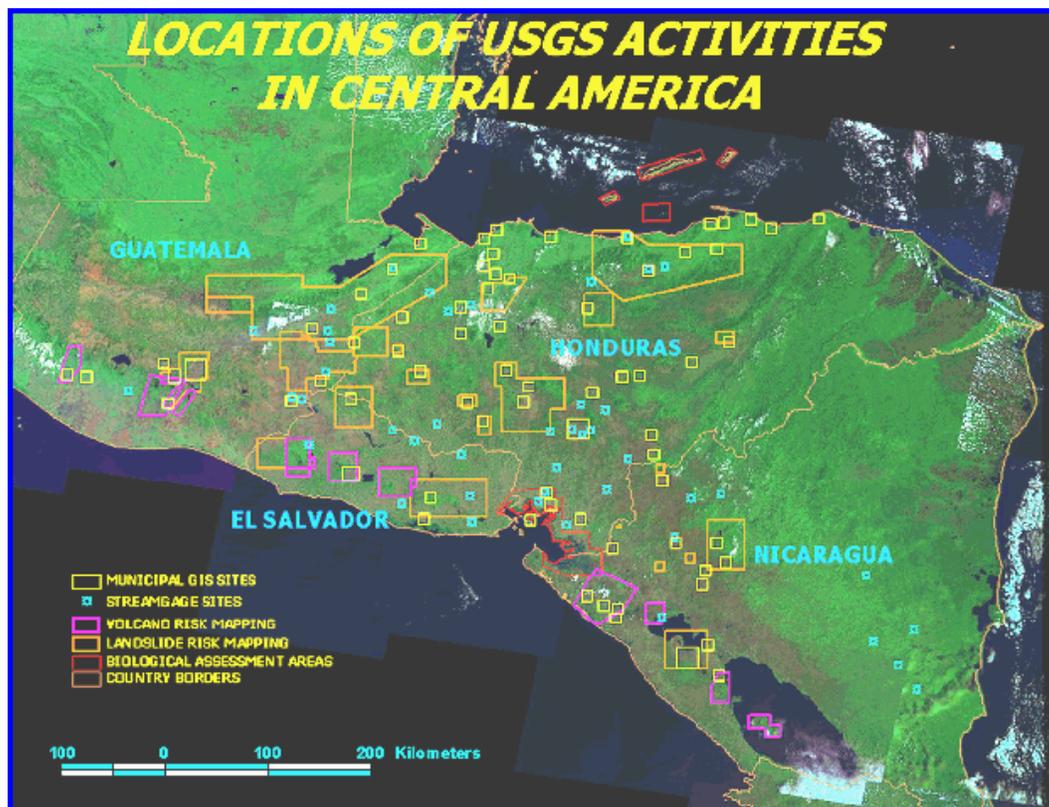
Executive Summary

March 2002

**Overview:** As part of the U.S. Government's program to assist Central America in the recovery from Hurricane Mitch, the USGS conducted a **\$14.15 million** program of activities in Honduras, Nicaragua, El Salvador, and Guatemala. This effort was designed to strengthen the affected countries' ability at both national and local levels to mitigate, prepare for, and respond to future natural disasters by:

- Facilitating access to basic data and information such as maps and aerial photography
- Conducting flood and landslide risk assessments
- Installing national stream-flow monitoring systems
- Conducting coastal assessments of biological resources
- Developing an internet data clearinghouse in each country
- Providing geographic information system (GIS) hardware and software, and other equipment for disaster mitigation, preparedness, response, and urban management, and
- Strengthening the capacity of counterpart agencies by formal training courses and by including their specialists in project activities.

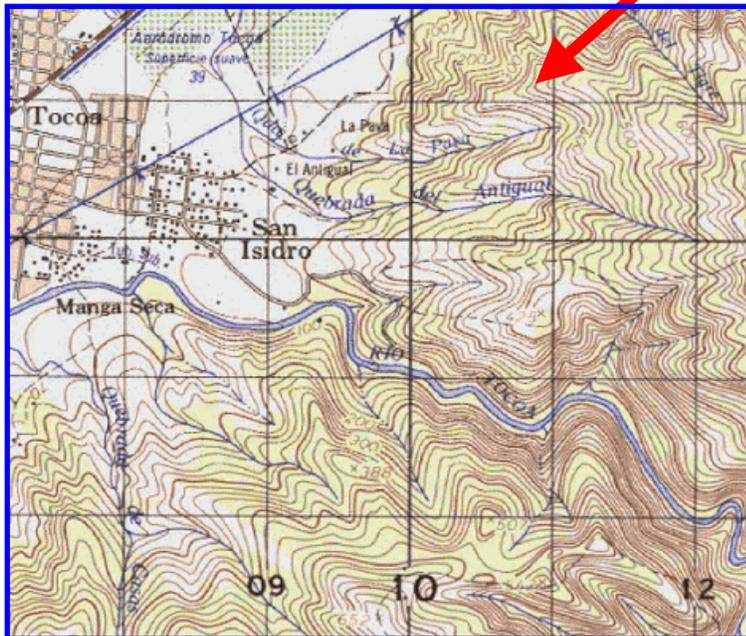
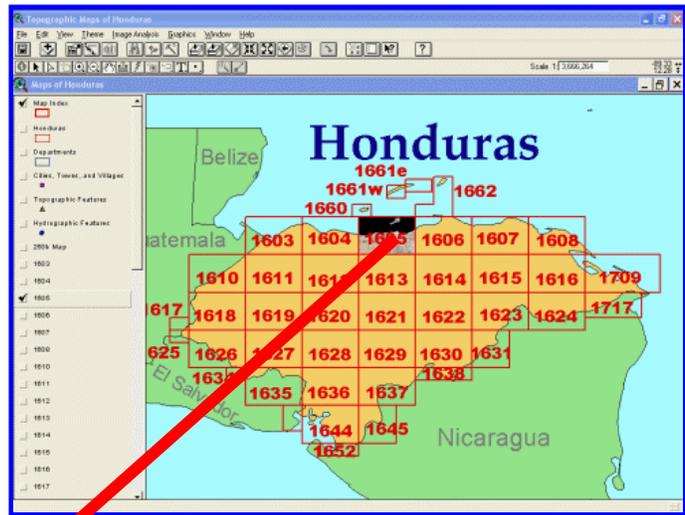
More detailed information is available on the USGS's Hurricane Mitch Program website at <http://mitchnts1.cr.usgs.gov/index.html>



## Digital Topographic Maps

One of the most important basic tools needed to support reconstruction and hazard mitigation activities are accurate topographic base maps showing topographic contours, locations of rivers and streams, roads, and layouts of cities, towns, and villages.

Although paper topographic maps at scales of 1:250,000 and 1:50,000 have been available in the Mitch-affected countries for some time, these maps were not available in digital form at the time Mitch occurred in 1998. Digital maps allow much more rapid and accurate measurements of distances and surface areas, and provide the base upon which to add additional information in the development of geographic information system (GIS) products.



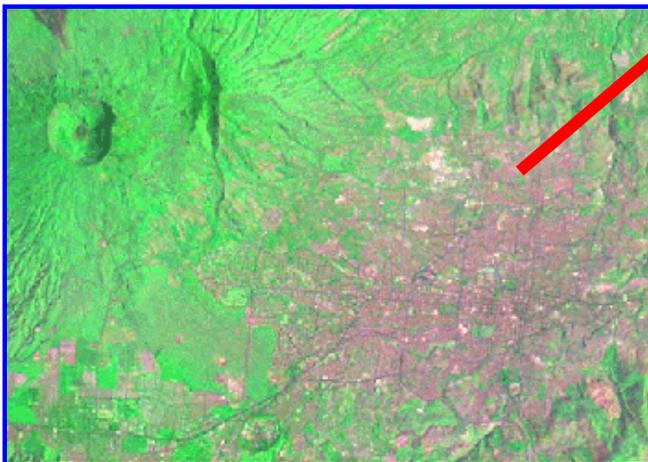
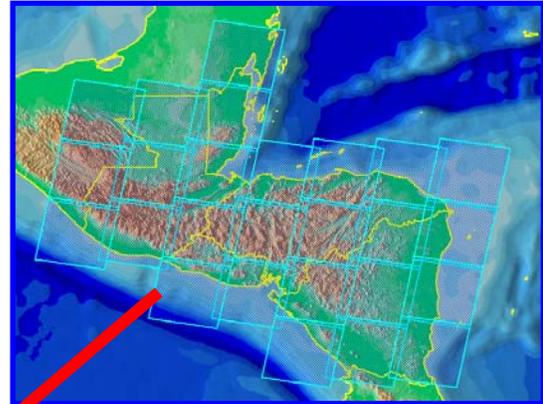
The USGS, working through the U.S. National Imagery and Mapping Agency (NIMA), compiled and packaged digital maps for Honduras, El Salvador, Guatemala, and Nicaragua at scales of 1:250,000 and 1:50,000. Approximately 900 individual map sheets were mozaicked and indexed. The maps were digitally compressed and packaged on a single CD-ROM for each country, together with software to view the maps, make measurements, and print copies of selected areas.

These products will be used as the basis for a national disaster-preparedness GIS for each country, and are also serving a host of other applications. For example, the El Salvador USAID Mission is using these maps to quickly evaluate potential housing sites in their earthquake reconstruction program.

## Satellite Imagery and Aerial Photography

Although topographic maps are essential for providing a geographic frame of reference, the information they contain is only as current as their dates of publication. The best alternative to doing extensive observations on the ground is acquiring imagery of priority areas from satellites or aircraft.

**Landsat satellite imagery** provides 15-30 meter resolution and the ability to detect subtle differences in vegetation and land cover. The USGS provided complete Landsat satellite imagery coverage for Guatemala, Belize, Honduras, El Salvador, and Nicaragua, both in digital form on CD-ROM, and as large format prints. Products were provided to U.S. and Central American



agencies participating in USAID-funded Hurricane Mitch relief activities, and are also available to the public and private sector on a cost-of-reproduction basis. This imagery is being used for a wide variety of applications, including land-use and land-cover analysis and assessment of agricultural areas.

**Aerial photography** – USGS has acquired over 28,000 frames of black & white, color, and color infrared aerial photography at scales ranging from 1:40,000 to 1:5,000. This photography is an important tool for fine-scale analysis and mapping of landslides and flood inundation patterns, and also provided the base for municipal information systems being developed in Central American towns. All photography has been catalogued, indexed, and archived at USGS's EROS Data Center and is available to the public for the cost of reproduction. Copies of negatives for each country have been provided to the national mapping agencies in each country.



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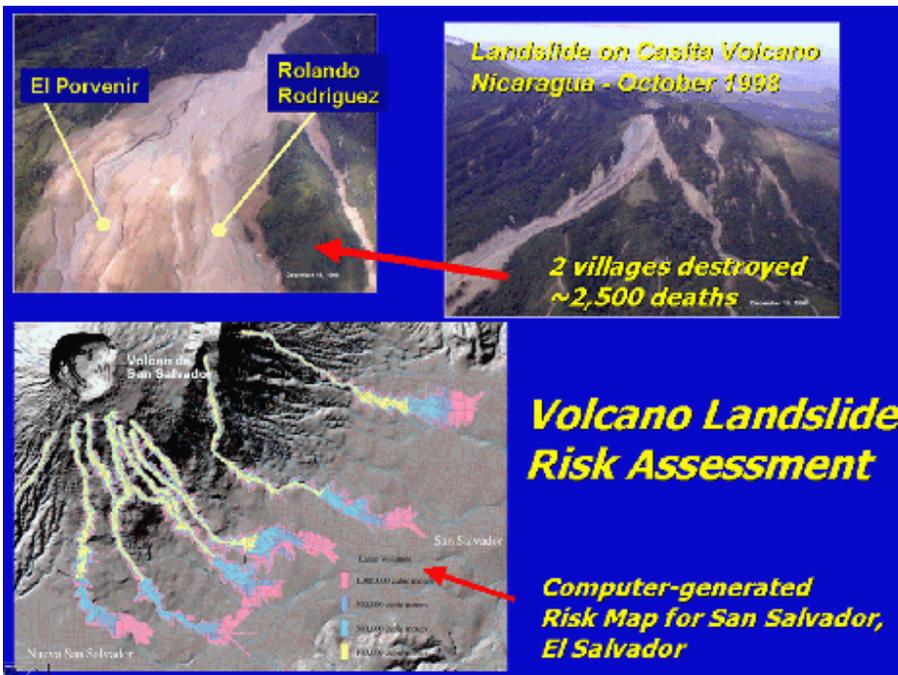
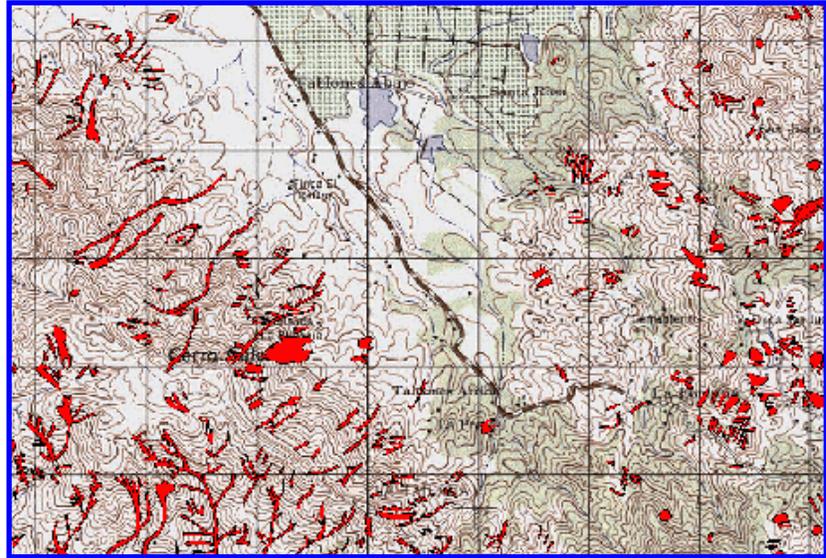
## Landslide and Volcano Hazard Assessments

Substantial loss of life and property occurred during Hurricane Mitch due to catastrophic ground failures (landslides, debris flows, mud flows, or subsidence). The El Berrinche landslide dammed the Choluteca River in Tegucigalpa and caused a serious public-health problem. Other ground failures were associated with volcanoes, the most dramatic example being the mudflow on Volcan Casita, where 2500 people were killed.

USGS evaluated and mapped ground failures in general in all four Mitch-affected countries. The risk of debris flows was also assessed on the slopes of volcanoes near population centers in Guatemala, El Salvador, and Nicaragua (Honduras has no active volcanoes).

This effort included four elements:

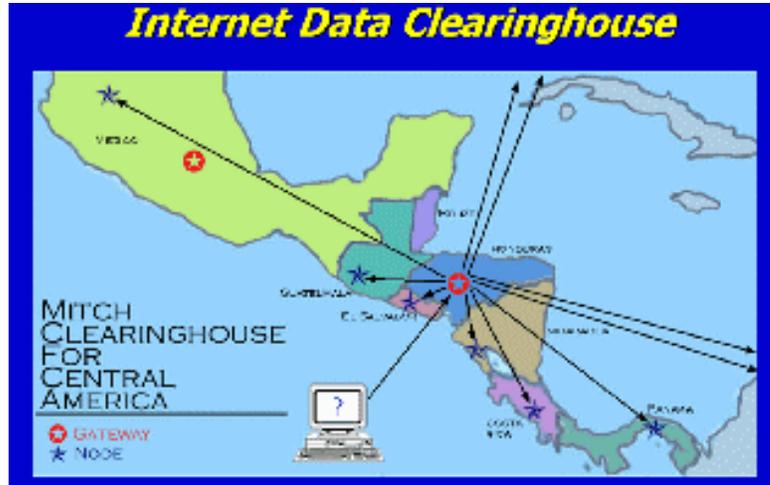
- 1) Production of landslide inventory maps of high priority areas,
- 2) Productions of landslide susceptibility maps for selected, high-risk areas,
- 3) Computer modeling of debris flow run-out paths for selected volcanoes, and
- 4) Consultation and training on landslide assessment technologies with counterpart agencies.



The maps and training provided by USGS are being used by counterpart agencies in Central America to guide decisions on new road and housing construction and to develop ongoing efforts to assess risk in critical areas.

## Internet Data Clearinghouse

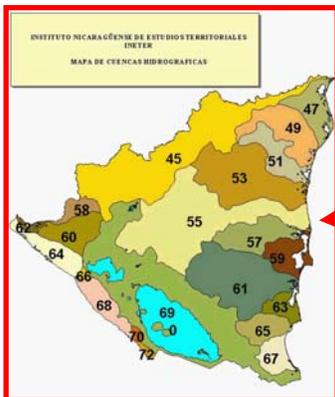
The reconstruction and planning activities conducted in Central America have generated a tremendous amount of data and information. The ability to search for and locate these data sets, their ready accessibility to local governmental agencies and various aid agencies, and the distribution of these data and information are critical elements of both reconstruction efforts and longer term planning. To facilitate the management of and access to relevant data, USGS worked with counterpart agencies in each of the Mitch-affected countries to design and install a regional network of Internet data servers. The project involved the following components:



- Training of counterpart agency specialists in Clearinghouse and metadata production.
- Installation of data servers (nodes) in each country
- Staging of key USGS data products with information on access to other data products.
- Development of a plan for continued national and regional cooperation to promote access to and use of geographic data for disaster assessments and mitigation.

Clearinghouse nodes are accessible through the USGS Hurricane Mitch website at:

<http://mitchnts1.cr.usgs.gov/index.html>



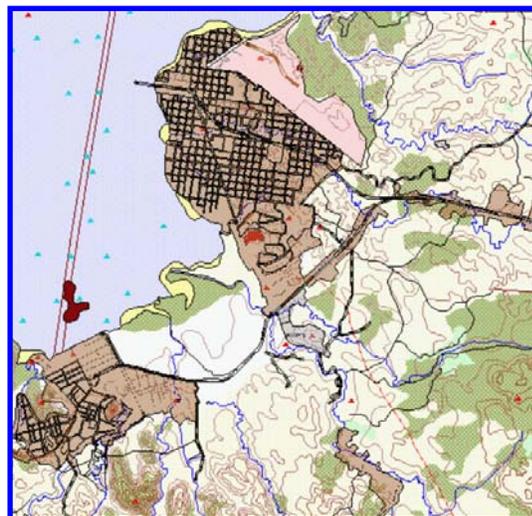
### Mapas digitales OnLine

Los siguientes mapas pueden ser consultados por medio de un Sistema de Información Geográfico (S. pesar de no ofrecer todas las herramientas de un SIG tradicional el usuario podrá hacer operaciones b combinar diferentes coberturas (mapas), realizar zooms o chequear información asociada en bases de Algu nos de los mapas también pueden ser bajados (download) a su computador, en caso de que se d realizar operaciones mas complejas

Título del Dato ( Click título, ver Metadato )	Fuente	Fecha	Formato Archivo
<i>Mapas de Referencias</i>			
<a href="#">Mapa de Isoyetas durante el huracan Mitch</a>	INETER	1992-1996	JPG
<a href="#">Mapa de Isoyetas durante la afectación del huracan Mitch</a>	INETER	1998	JPG
<a href="#">Mapa de Trayectoria ciclónica que ha afectado a Nicaragua</a>	INETER	1998	JPG
<a href="#">Mapa de la Red Meteorológica Nacional de Nicaragua</a>	INETER	1998	JPG
<a href="#">Mapa de Cuencas Hidrográficas de Nicaragua, escala 1:750,000</a>	INETER	1996 - 1997	JPG
<a href="#">Mapa de la Red de Estaciones Hidrométricas de Nicaragua, escala 1:750,000</a>	INETER	1999	JPG
<a href="#">Mapa de drenaje de suelos</a>	MAG-FOR	1995-1999	JPG
<a href="#">Mapa de los períodos caniculares</a>	MAG-FOR	1996-1999	JPG

## Geographic Information Systems

A geographic information system, or GIS, allows multiple layers of information to be combined and analyzed in a uniform geographic context. GIS technologies have broad applicability to the assessment and mitigation of natural hazards, disaster preparedness, environmental protection, and urban management and development. Prior to Hurricane Mitch, GIS was not widely used in Central America – principally because of the cost of GIS software and the lack of understanding of the benefits of these technologies.

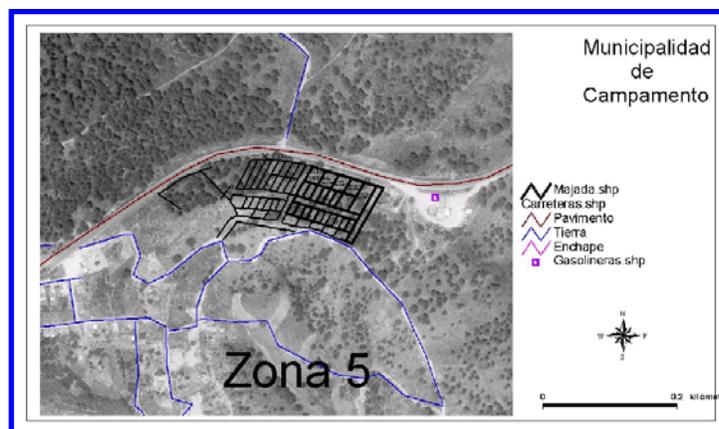


USGS provided GIS computer hardware, software, and training to more than 20 Central American disaster-response and other counterpart agencies in Honduras, Nicaragua, El Salvador, and Guatemala. These agencies will use these systems to evaluate hazard assessment and environmental data and develop better disaster response and mitigation plans.

USGS also provided similar GIS systems and training to municipal staff in over 60 towns throughout the four countries. These systems will allow municipal authorities to develop hazard mitigation and response plans, provide them with a tool to develop databases for development of simple cadastral systems, and assist in a variety of urban development decisions.



Environmental Systems Research Institute, Inc (ESRI), the world's largest manufacturer of GIS software, assisted USGS's program considerably. ESRI made its GIS software available at the university discount prices, which allowed software to be provided to a much larger number of users than would have otherwise been possible.



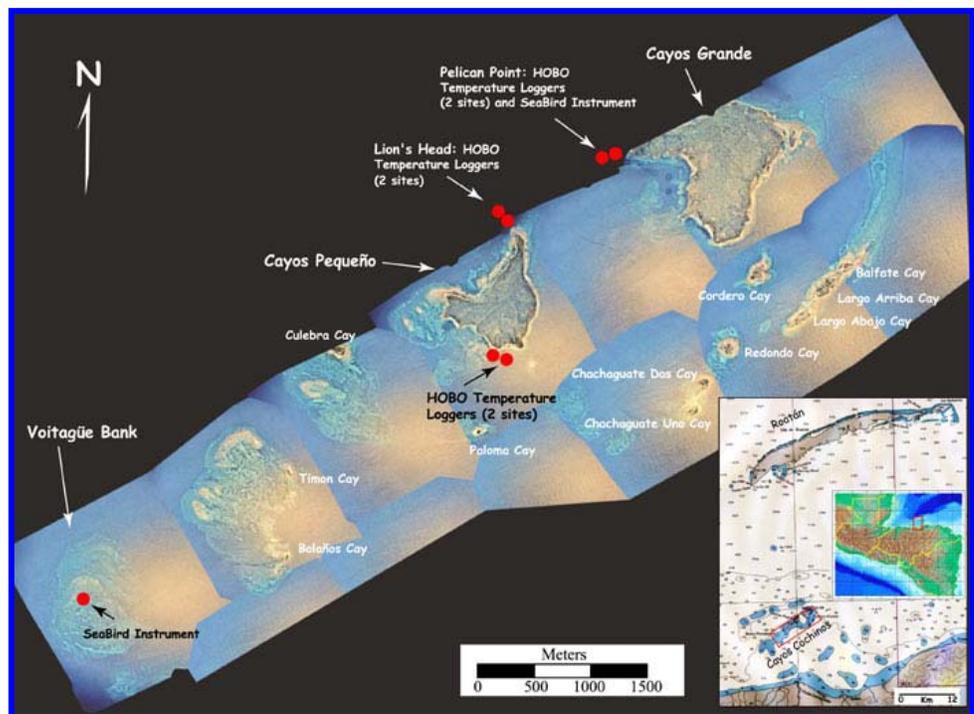
## Biological Assessments of Coastal Resources

The Pacific coast of Central America supports substantial shrimp and fishing industries, both of which were threatened by the massive flooding and sediment released into coastal areas. Coastal mangrove areas, which provide critical breeding grounds for shrimp and many species of fish, were also at risk. In many areas flood waters destroyed existing aquaculture pond levees, and changed courses of natural distributaries entering the Gulf



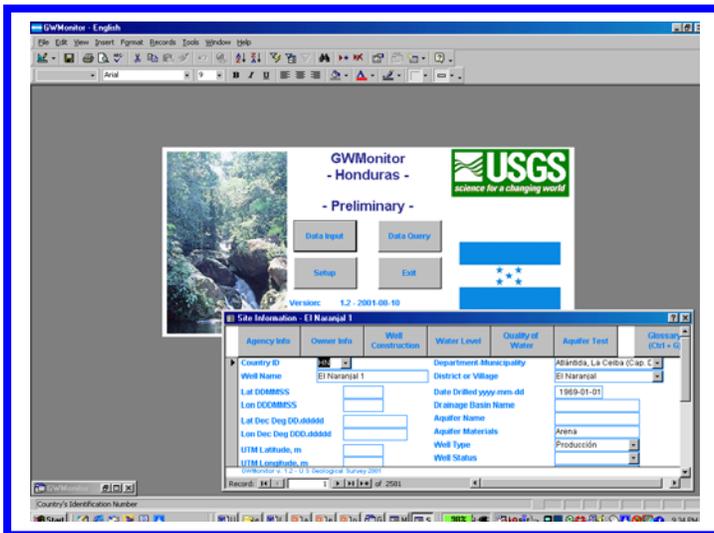
USGS biologists conducted extensive mapping and studies of critical ecosystems along both coasts, working closely with national and local agencies and with local shrimp industry groups. These investigations have provided important benchmark data on the health of these areas and have assisted Central American agencies in making more informed decisions on the use of their coastal resources.

**Coral reefs** on the Atlantic coast of Central America, which provide millions of dollars of tourist revenue to the region each year, were also threatened by the influx of sediment-laden waters during the storm. USGS scientists worked closely with Honduran coral reef resource managers, providing them with information in order to more effectively manage their reef resources. Activities included the development of monitoring programs, training, and technology transfer to enable Hondurans scientists to continue utilizing new technologies after the project has ended.



## Groundwater Resources Assessment

Honduras has relied on ground water for many of its domestic, agricultural and industrial water supply needs. As the nation's population grows, the need to monitor and manage ground-water resources is becoming a critical issue. The historical use of surface water as a means of transport and disposal of untreated wastes from agricultural, municipal, industrial and domestic sources has rendered most surface water in the country unfit for human consumption. This places a greater importance on the assessment, monitoring and development of ground water as a feasible water source. Water level and water-quality data are needed in order to monitor changes in ground-water conditions, to identify current trends and predict future trends, and to support management decisions necessary to maintain the quality and quantity of water needed.



A computer database was developed using Microsoft™ Access and was populated with all available ground-water data. The data base was distributed, with training, to designated counterpart personnel as well as to representatives from other agencies and municipalities, to NGO's associated with ground-water resources, and to private individuals interested in ground-water monitoring. The CD's containing the data base also contain a complete data-base

operating manual, a Microsoft™ Excel spreadsheet containing all available ground water data for users without Microsoft™ Access, several forms usable to guide collection of field data, and a list of contact information for all persons involved in Honduras ground-water resources.

USAID and USGS provided DIAT/SANAA with computers, office equipment, field equipment, GPS units, and software. Training and support also were provided.

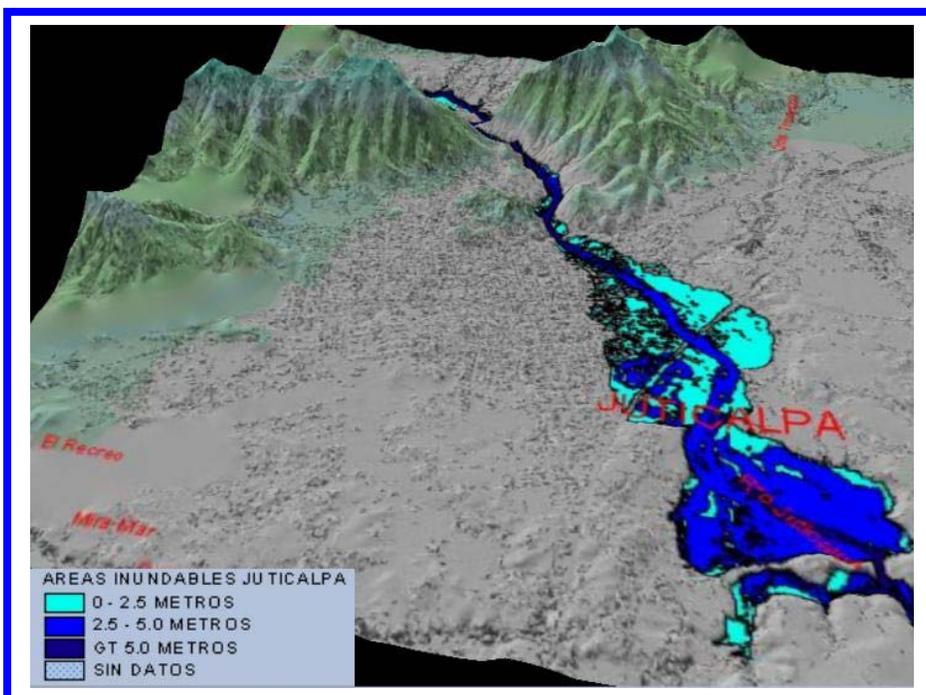
At the end of USGS involvement in this program, each designated Honduran counterpart was capable of operating his or her part of the ongoing program with minimal oversight. Other interested individuals and groups within Honduras are now able to understand and support efforts to develop ground water as a sustainable resource.



## Flood Hazard Mapping

Severe flooding from Hurricane Mitch caused large-scale damage and destruction to housing and infrastructure in Honduras. As the country worked to rebuild what was lost, it needed reliable maps of high-flood-hazard areas for municipal planning, infrastructure design, and overall mitigation of future disasters. A systematic method for defining these areas that can be applied throughout the country was needed. This project has created flood-hazard maps by developing and applying a method of estimating the 50-year flood or the flood, which has a statistical probability of being equaled or exceeded 2 times in 100 years on average. The aerial and depth of inundation for the 50-year flood has been mapped at fifteen selected locations in Honduras where Mitch flooding caused significant damage. This new tool can be utilized for urban, infrastructure, and land-use planning.

Flood-hazard maps for individual municipalities were developed by (1) estimating the 50-year flood discharge for each major river in the selected municipality, (2) constructing a hydraulic model of the river reaches within the municipality based on cross sections from topographic information, and (3) plotting water-level profiles, simulated with the hydraulic model, and area-and depth-of-inundation maps over topographic maps.



The USGS intended to provide tools to assist planners in the rebuilding of Honduras for both the short-term and long-term. In the short term, flood-hazard maps would be created for those municipalities with an urgent need for flood-hazard maps. It would be too time consuming and too expensive to provide flood-hazard maps to all

the municipalities in need within the time and money constraints of the project. In the long term, the methodology documented in the reports could be used to develop flood-hazard maps throughout Honduras. In order to perpetuate the program, the final objective, technology transfer, was achieved with hands-on training of Honduran engineers and planners with the software used to create the flood-hazard maps along with in-country seminars or meetings to advertise the project and the flood-hazard maps.

## Streamflow Monitoring Network and Hydrologic Databases

Flooding that resulted from Hurricane Mitch rainfall devastated infrastructure and communities throughout Central America. Many of the destroyed areas received little to no warning of the impending flood waves that swept down from upper watershed drainages. It was very evident that a new system was required to adequately warn population during future floods to mitigate damages and save lives. To address this



need, the USGS worked closely with counterpart agencies (and with other USG agencies such as NOAA) to identify critical areas where near real-time stream flow data were needed. The USGS and counterpart agencies installed or retrofitted 38 streamflow monitoring systems in the countries of Honduras, Nicaragua, El Salvador, and Guatemala. Seven of these gages were part of a transnational watershed management effort in the Río Lempa basin.

Each stream gage has been equipped with satellite telemetry equipment used for near-real time transmission of hydrologic data, and immediate dissemination of the data via the Internet. Other aspects of this program include development of a centralized hydrologic database for storage and analysis of hydrologic data collected; Intensive training and capacity-building within counterpart agencies to provide them with skills to independently collect, store, and analyze hydrologic data for use in flood forecasting and water-resources management; and Implementation of nation wide (and region wide) quality-control standards for hydrologic data collection, storage, and analysis.

During the passing of Tropical Storm Michelle in October 2001, real-time data from the streamgages in northern Honduras (Ulúa and Aguan River basins) were monitored closely by Honduran emergency management agencies, by SERNA/DGRH, and by the USGS. Early warning provided by streamflow and rainfall stations across northern Honduras allowed for the successful evacuation of at-risk residents and the mitigation of flood-related damages in affected areas. Humberto Calderon, Deputy Director of CEVS, provided the following excerpt after passage of Tropical Storm Michelle;

*“At critical times before, during and after peak discharges which caused extensive flooding in the city of La Lima, the access to real time data from the telemetric stations was very valuable and allowed the authorities such as CEVS, COPECO and Municipality to alert the people located in areas of risk. Also CEVS was able to better coordinate emergency works and repairs of levees, and time these works in relation to the fluctuations of the river water-level and discharge.”*

**Gross Funds Expended During the Life of the USGS Hurricane Mitch Reconstruction Program**

Program Component	Gross Funds Expended
<b>Digital Topographic Maps</b>	\$567,000
<b>Satellite Imagery and Aerial Photography</b>	\$1,511,000
<b>Landslide and Volcano Hazard Assessments</b>	\$1,744,000
<b>Internet Data Clearinghouse</b>	\$1,234,000
<b>Geographic Information Systems</b>	\$1,179,000
<b>Biological Assessments of Coastal Resources</b>	\$1,594,000
<b>Groundwater Resources Assessment</b>	\$340,000
<b>Flood Hazard Mapping</b>	\$942,000
<b>Streamflow Monitoring Network and Hydrologic Databases</b>	\$2,326,000
<b>In-country and HQ management, and staff support<sup>1</sup></b>	\$2,713,000
<b>Total</b>	<b>\$14,150,000</b>

<sup>1</sup>Full funding for 2 in-country program managers, as well as required support and administrative assistance required from staff at USGS headquarters in Reston.