U.S. DEPARTMENT OF COMMERCE

HURRICANE RECONSTRUCTION PROGRAM

CENTRAL AMERICA AND THE DOMINICAN REPUBLIC

FINAL REPORT

MAY 2002

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LIST OF IMPORTANT ACRONYMS AND ABBREVIATIONS

ADIOS – Automated Data Inquiry of Oil Spills
ANDA – National Water Authority (Nicaragua)
CAMEO – Computer Aided Management of Emergency Operations
CEL – Comisión Ejecutiva Hidroeléctrica del Río Lempa
CENDEPESCA – Centro Nacional de Desarrollo de la Pesca (El Salvador)
COEN – Emergency Management (El Salvador)
COF – Climate Outlook Forum
CONRED – Emergency Management (Guatemala)
CO-OPS - Center for Operational Oceanographic Products and Services (DOC/NOAA)
COPECO – Comision Permanente de Contingencias (Emergency Management, Honduras)
CORS - Continuously Operating Reference Station
CPH – Centro de Pronosticos Hidrologia
CPM – Centro de Pronosticos Meteorologia
CRRH - Comite Regional de Recursos Hidraulicos (Regional Committee for Water Resources)
DCP - Data Collection Platform
DOC – Department of Commerce
DOC/NOAA - Department of Commerce, National Oceanic and Atmospheric Administration
DPAS - Data Processing and Analysis Subsystem
DRGS - Digital Readout Ground Station
ENP - Empresa Nacional Portuaria
ESI – Environmental Sensitivity Index
ESPINSA – Especialidades Industriales, S.A. (Private Specialists in Water Treatment, El Salvador)
FUSADES – Fundacion Salvadorena Para Desarrollo E Economico Social (El Salvador)
GOES - Geostationary Operational Environmental Satellite
GPS - Global Positioning System
HARN - High Accuracy Reference Network
HUD – Housing and Urban Development
IGN - Instituto Geografico Nacional (all countries)
IMN – Instituto Meteorologia Nacional (Costa Rica)
INDRHI – Insituto Nacional de Recursos Hidráulicos (Dominican Republic)
INETER - Instituto Nicaraguense de Estudios Territoriales (Nicaragua)
INSIVUMEH - Instituto Nacional de Sismologia, Vulcanologia, Meteorologia e Hidrologia (Guatemala)
ITA – International Trade Administration
LABCODAT - CRRH Data Quality Control Laboratory
LAN – Local Area Network
MAGFOR – Ministry of Agriculture (Nicaragua)
MARENA – Ministry of the Environment (Nicaragua)
MARN - Ministry of the Environment (El Salvador)
MSL - Mean Sea Level
NESDIS – National Environmental Satellite, Data and Information Service
NIST – National Institute of Standards and Technology
NGO – Non-Government Organization
NGS - National Geodetic Survey
NMHS – National Meteorological and Hydrologic Service
NOS - National Ocean Service
NWS - National Weather Service
NWSRFS – National Weather Service River Forecast System
OAS - Organization of American States
OGP – Office of Global Programs
ONAMET – National Meteorological Agency (Dominican Republic)
PASA - Participating Agency Service Agreement
PROARCA/COSTAS - Programa Ambiental Regional para Centro América, Coastal Resources
PC - Personal Computer
QA/QC - Quality Assurance/Quality Control
RONMAC - Red de Observacion del Nivel del Mar para America Central (Water Level Observation Network for Central America)
SERNA – Secretaria de Recursos Naturales y Ambiente (Honduras)
SMN – Servicio Meteorologia Nacional (Honduras)
SNAT – Sistema Nacional Alerta Temprana (Dominican Republic)
SNET – Servicio Nacional Estudios Territorales (El Salvador)
UCA – University of Central America (Nicaragua)
USAID - U.S. Agency for International Development
USGS – U.S. Geological Survey
VHF - Very High Frequency
WAN – Wide Area Network
WLON - Water Level Observation Network
WX - Marine VHF Weather Channel

HURRICANE RECONSTRUCTION PROGRAM

CENTRAL AMERICA AND THE DOMINICAN REPUBLIC

EXECUTIVE SUMMARY

BACKGROUND

Hurricane Mitch was the most deadly and economically devastating hurricane to impact the Western Hemisphere in the last two centuries. Mitch struck Central America with such intensity that the damage left in its wake was not known for nearly a week. Its effects were felt by nearly three million people who were left homeless, lost their lives or were otherwise impacted by the storm. The damage estimate in Central America was $US5 billion. The number of deaths was estimated at over 11,000. The hardest hit countries were Honduras, Nicaragua, Guatemala, and El Salvador. As it moved through the mountainous regions of Honduras, Mitch dropped rainfall at the rate of 12 to 24 inches per day in parts of Honduras and Nicaragua. The total rainfall for this storm is estimated at 75 inches in some locations. Triggered by cataclysmic rainfall, mudslides and floods were widespread. Entire villages in Honduras, Nicaragua, Guatemala, and El Salvador were devastated.

Hurricane Georges caused widespread damage throughout the Caribbean. The Dominican Republic was one of the harder hit islands. The hurricane struck the island with brutal rage for 16 long hours on September 22, 1998. Heavy rains and furious winds, which reached up to 130 mph, covered nearly 70 percent of the country. The heavy rains, particularly in the western part of the country, produced mudslides and prolonged flooding. Hurricane Georges killed over 200 persons and left a path of destruction critically affecting the lives of over half the population and setting back the country's human and natural resources as well as the physical infrastructure base.

Following the devastation caused by Hurricanes Mitch and Georges, the U.S. Department of Commerce was one of 13 U.S. Government Agencies funded by the U.S. Agency for International Development (USAID) to help the countries of Honduras, Nicaragua, Guatemala, El Salvador, and the Dominican Republic rebuild their economies and improve their abilities to respond to hurricanes and other natural disasters. The Department's Hurricane Reconstruction Program was comprised of activities developed by three of its bureaus: the National Oceanic and Atmospheric Administration (NOAA), the National Institute of Standards and Technology (NIST), and the International Trade Administration (ITA). USAID allocated $US17.1M to the Department for the program.

Consistent with its environmental and economic mandates, the Department's goal in assisting with the reconstruction of these impacted countries was to support their ability to make decisions that minimize their exposure to future disasters and promote sustainable uses of natural resources.

The Department's objectives during project implementation were to provide key infrastructure elements; develop much needed hydrometeorological forecasting and early warning systems; help promote more sustainable, resilient uses of coastal resources; help build local and regional capacity for coastal hazards and mitigation; develop guidance for improving the construction of houses and assessing construction of critical facilities; and encourage disaster-resilient economic revitalization.

Department activities emphasized training and capacity building to promote maintainability and sustainability of the systems and programs that were implemented.

The Department's Program included various activities in six prime Problem Areas: (1) Base Infrastructure Reconstruction; (2) Forecast and Early Warning Systems; (3) Disaster Preparedness and Response; (4) Sustainable, Resilient Coastal Communities; (5) Economic Revitalization; and (6) Transnational Watershed Management. Within each area, different objectives were identified that provided the basis for identifying the activities to be implemented. These objectives are outlined below:

Base Infrastructure Reconstruction

- Provide a foundation for ongoing reconstruction efforts
- Reconstruct and improve weather and hydrologic forecasting and early warning networks
- Promote safe and efficient air and marine transportation
- Provide for a geo-spatial data and water level reference network
- Ensure that capacity exists to maintain and expand new base infrastructure

Forecast and Early Warning Systems

- Strengthen and develop basic national tropical storm and flood early warning capabilities
- Improve national and regional disaster preparedness and response infrastructures for forecasting, managing, and mitigating weather-related extreme events
- Build from basic capabilities to develop more sophisticated national and regional water resources management and early warning tools
- Provide climate forecast information that can be provided to national, regional, and international users

Disaster Preparedness and Response

- Improve national and regional disaster preparedness and response infrastructures for forecasting, managing, and mitigating weather-related extreme events
- Build local capacity for preventing and responding to hazardous materials spills
- Develop and transfer a framework for developing contingency plans for releases of hazardous materials during severe storms

Sustainable, Resilient Coastal Communities

- Develop an improved understanding of the Gulf of Fonseca natural processes in support of more sustainable uses of the Gulf by industry and artisans and for subsistence

- Work within existing programs (e.g., PROARCA/Costa) to transfer information and tools for sustainable aquaculture, building practices, and other coastal management approaches that promote resilience and sustainability

- Strengthen technical guidance for the construction of housing more resistant to natural hazards and assess the disaster resistance of critical facilities

Economic Revitalization

- Promote the development of trade and trade infrastructure that is disaster resilient

- Increase the transparency of government contracting in Central America and facilitate the continued adoption of open market economic rules

- Increase the availability of information in the United States about business opportunities in Central America that would accelerate reconstruction

- Expand the presence and use of the Department's U.S. and Foreign Commercial Service officers to help companies interested in working in the region

Transnational Watershed Management

- Provide tools for the sound management of water resources in the Río Lempa watershed

All activities were coordinated with USAID, other U.S. Government Agencies, counterpart agencies within each affected country, international non-governmental agencies, the private sector and other donors.

The Department's program is summarized in the following section.

PROGRAM ACTIVITIES OVERVIEW

The Department performed many and varied activities under the Hurricane Reconstruction Program. Activities were accomplished either for a specific country or regionally, covering all countries. The bulk of the activities were accomplished in the four Central America countries impacted by Hurricane Mitch but some activities had both a country and a regional component. Any regional activities were conducted in one or more of the Mitch-affected countries. In order to optimize the Department's implementation of some regional activities and to take advantage of existing resources in the entire Central America region, some regional activities were based in Costa Rica. The following table summarizes the Department's key activities for each of the areas and shows where each activity was based.

Department of Commerce Key Activities Summary

Area/Activity	Honduras	Nicaragua	Guatemala	El Salvador	Dominican Republic	Central America Regional	Comments
Base Infrastructure Reconstruction							
Improve Geodetic Networks	☑	☑	☑	☑		☑	
Improve Hydrometeorological Networks	☑	☑	☑	☑			
Improve Tide Stations	☑	☑	☑	☑		☑	Data downlink in Costa Rica
Develop Satellite Capabilities						☑	Receive site in Costa Rica
Implement Training Programs	☑	☑	☑	☑		☑	
Forecast and Early Warning Systems							
Improve Flood Warning Network	☑	☑	☑	☑			
Establish Flood Forecast Systems	☑	☑	☑	☑			See also Transnational Watershed Management
Develop Strategic Plans	☑	☑	☑	☑			
Implement Training Programs.	☑	☑	☑	☑		☑	
Develop a Regional Climate Prediction System						☑	

Department of Commerce Key Activities Summary

Area/Activity	Honduras	Nicaragua	Guatemala	El Salvador	Dominican Republic	Central America Regional	Comments
Disaster Preparedness and Response							
Strengthen Forecast, Warning, Preparedness & Response Institutions	☑	☑	☑	☑	☑	☑	Emphasis on training and capacity building
Improve Hazard Materials Spill Prevention and Response	☑	☑	☑	☑		☑	
Develop Reservoir Management Strategies					☑		
Develop an Approach for a Regional Hydrometeorological Center						☑	
Sustainable, Resilient Coastal Communities							
Support for Sustainable Uses of Gulf of Fonseca Resources	☑	☑		☑		☑	
Local Capacity Building and Support Network	☑	☑				☑	
Strengthen Guidance for Construction of Disaster-Resistant Housing					☑		

Department of Commerce Key Activities Summary

Area/Activity	Honduras	Nicaragua	Guatemala	El Salvador	Dominican Republic	Central America Regional	Comments
Assess the Disaster-Resistance of Critical Facilities					☑		
Economic Revitalization Support Trade Development and Commerce and Trade and Investment Forums						☑	
Transnational Watershed Management Implement a Hydrologic Forecast Capability for the Río Lempa Watershed						☑	Watershed located in portions of El Salvador, Honduras, and Guatemala – Forecast Capability Installed in El Salvador

ACTIVITIES

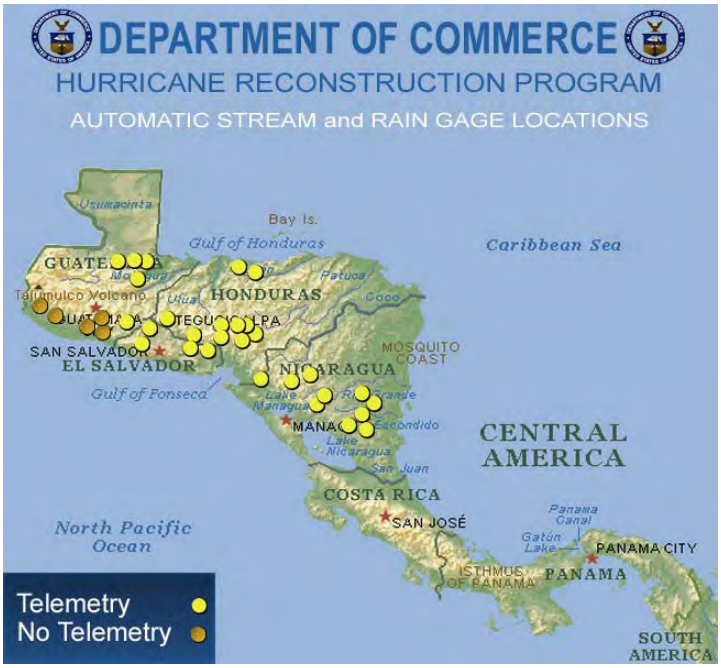
More detail on the Department's activities is provided in the body of the report. Provided below are examples of some of the activities performed by the Department's bureaus.

National Oceanic and Atmospheric Administration (NOAA)

NOAA's National Weather Service (NWS) focused on strengthening the hydrologic and meteorological agencies in Central America and the Dominican Republic by helping improve their capabilities in the areas of hydrologic forecasting (floods and droughts) and early warning systems. To accomplish this, the NWS installed monitoring equipment, improved communications systems, implemented hydrologic forecasting centers, and provided training in areas such as operational hydrology and meteorology, hydrologic modeling, monitoring system installation and maintenance, and maintenance program development.

As shown in the following maps, a total of 16 automatic weather stations, 31 automatic rain gage stations, and 3 automatic stream gage stations were installed throughout the region. These stations provide data for weather and hydrologic forecasting as well as climatological assessments.

Automatic Weather Stations



Automatic Rain and Stream Gages

In addition, the NWS also installed flood forecasting and warning systems throughout the region. Different types of systems were installed to provide the capability to forecast flows in the major rivers for flooding or drought conditions or quickly warn communities of flash floods. The river basins with systems installed are shaded on the following map.

Hydrologic Forecasting and Flood Warning Applications

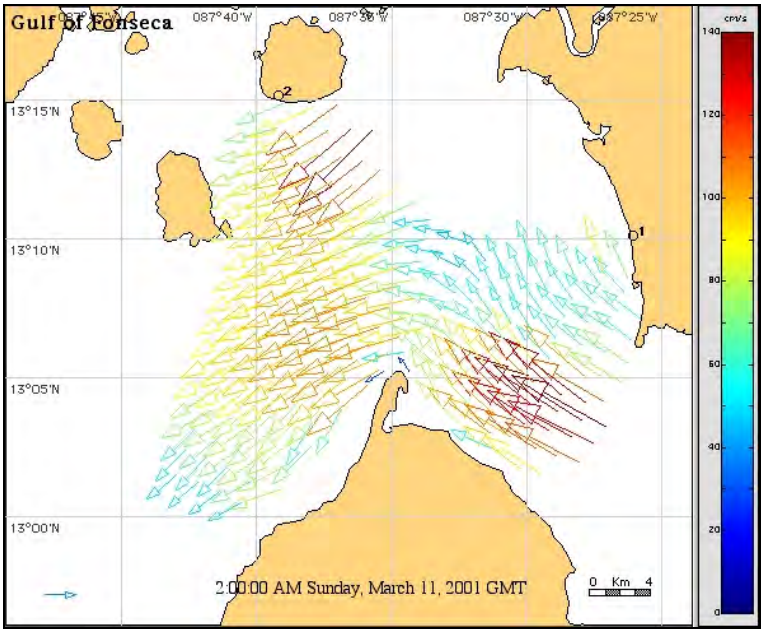
One of the hydrologic forecasting applications was installation of the National Weather Service River Forecast System for the Río Lempa River Basin. This transnational basin includes the countries of El Salvador, Guatemala, and Honduras. The NWS installed rain gages, implemented a river forecast center and installed data communications systems. The forecast system is an integral part of the management of the water resources in the basin. The forecast center issues daily river forecasts that are used by the hydroelectric utility to manage their four reservoirs along the Río Lempa.

NOAA's National Ocean Service (NOS) accomplished a variety of activities under the Program. NOS activities focused on promoting sustainable, resilient coastal communities, including addressing sustainable uses of coastal ecosystems and appropriate land use decision making; improving the water level observation and geodetic networks; and hazardous materials spill prevention and response - including development of Environmental Sensitivity Index maps.

Tide gages were installed as part of the reconstruction of the water level observation network throughout the region. This network (Red de Observación del Nivel del Mar para America Central – RONMAC) supports the development of the geodetic control network for the region as well as provides crucial water level and meteorological data for port operations. Gages were installed in the locations shown in the following map.

Tide Gage (RONMAC) Network

Many NOS activities were centered on supporting sustainable uses of the Gulf of Fonseca resources. The Gulf is a very important estuary in the region and is bordered by Nicaragua, El Salvador and Honduras. NOS' work involved developing a better understanding of the natural processes in the Gulf to support more sustainable uses by industry and for subsistence. To accomplish this, an initial monitoring program for contaminants in water, sediment, fish and crabs was developed. Upon completion, the initial program was then transferred to local representatives in industry and/or NGOs. In addition a survey was accomplished to identify major circulation patterns in the Gulf. A sample output from the circulation survey and a map showing representative crab and sediment sampling locations are shown in the following.



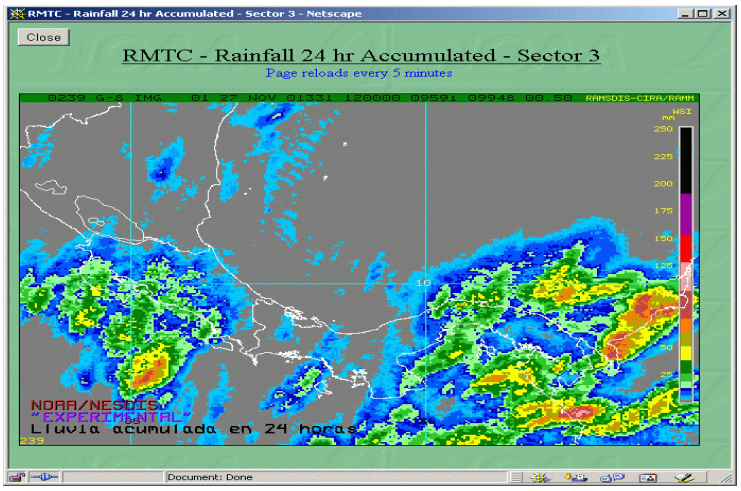
Gulf of Fonseca Circulation Survey Analysis

Crab and Sediment Sampling Locations

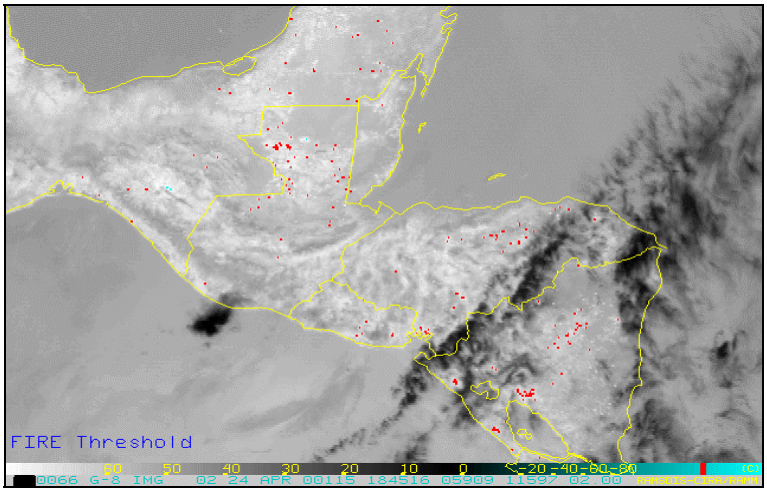
NOS also developed and implemented a project to reconstruct and improve geodetic networks in Nicaragua, Honduras, Guatemala, and El Salvador. Components of the program included installation of continuously operating reference systems with dual frequency global positioning system (GPS) receivers installed in each country - 24-hour continuous tracking capability and 1-2 cm accuracy, analysis and processing of a high accuracy GPS-reference network, and training on these systems.

As part of the hazardous materials spill prevention and response activities, NOS accomplished a series of workshops on responding to hazardous materials spills and on contingency planning to improve the local capacity in these areas. Environmental Sensitivity Index maps for critical coastlines such as the Gulf of Fonseca and the north coast of Honduras were also prepared. The ESIs provide key information to those responsible for hazardous material spill prevention and response by delineating critical environmental areas.

The National Environmental Satellite, Data and Information Service (NESDIS) of NOAA installed a regionally based satellite data receive system in Costa Rica. The data received from the NOAA GOES satellite is transmitted via the Internet to workstations installed in each country (NOAA also separately funded installation of workstations in Panama and Belize – no Hurricane Reconstruction Program funds were used). Through these workstations, meteorologists can view satellite cloud imagery at 1-kilometer resolution, see regional rainfall estimates, track volcanic ash plumes, and view potential forest fire hotspots –using special algorithms developed for Central America. The workstations allow the user a great deal of flexibility in viewing the satellite data.

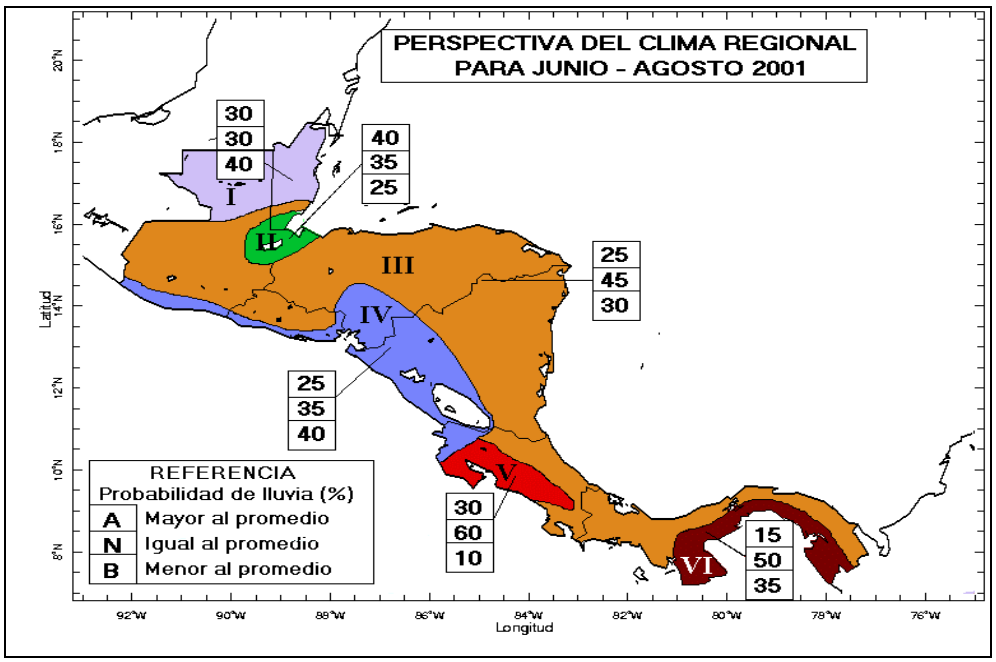


Satellite-Based Rainfall Estimates



Satellite-Based Fire Detection

NOAA's Office of Global Programs (OGP) developed a regional program to reduce the negative disruption often associated with climate variability and extreme events through the implementation of a climate information and applications system. One activity involved the organization of 'climate fora' to enable all countries to come together (physically or virtually) to develop a composite seasonal climate outlook for the region. Another activity was to provide capabilities within the region to perform model simulations and forecasts of regional climate. Climate forecast output from this modeling could then be used in local decision-making for different societal sectors throughout the region. These modeling results are then integrated into the climate forum process and seasonal outlooks are prepared – the June through August 2001 outlook is shown below.



Seasonal Outlook - Output From Climate Forum

National Institute of Standards and Technology

The Department's National Institute of Standards and Technology (NIST) worked exclusively in the Dominican Republic. NIST's focus was in the areas of building codes and construction practices that address buildings that are at-risk to severe winds and other natural hazards. To accomplish this, NIST performed two activities – assessing and strengthening the technical basis for guidance to assist the informal sector and small contractors in constructing housing that will be more resistant to natural hazards; and assist with the assessment of the disaster resistance of selected facilities that serve a critical function in the event of a natural disaster (e.g., hospitals and fire stations). These activities were accomplished through onsite assessments and workshops. A great deal of training was provided to the Dominican counterparts. NIST also worked closely with the Department of Housing and Urban Development on these activities.

Fire Station Assessed for Disaster Resistance - Dominican Republic

International Trade Administration

To help U.S. companies participate in internationally-funded reconstruction projects and other trade and investment opportunities in Central America, the International Trade Administration focused its efforts on four areas: (1) providing information on reconstruction efforts and possible projects, (2) facilitating U.S. company contacts with host countries' executing agencies, multilateral development banks, and potential business partners, (3) raising awareness in Central America of U.S. companies' skills and expertise, and (4) facilitating bilateral industry cooperation to make the region more resilient to natural disasters. They also hosted a delegation of 10 Honduran nursery managers as part of the Honduran Reforestation Initiative. This was aimed at helping Honduras on a variety of reforestation issues.

Hondurans Viewing a Reforestation Site in Alabama

FUNDING

The Department's budgets for each Problem Area were as follows.

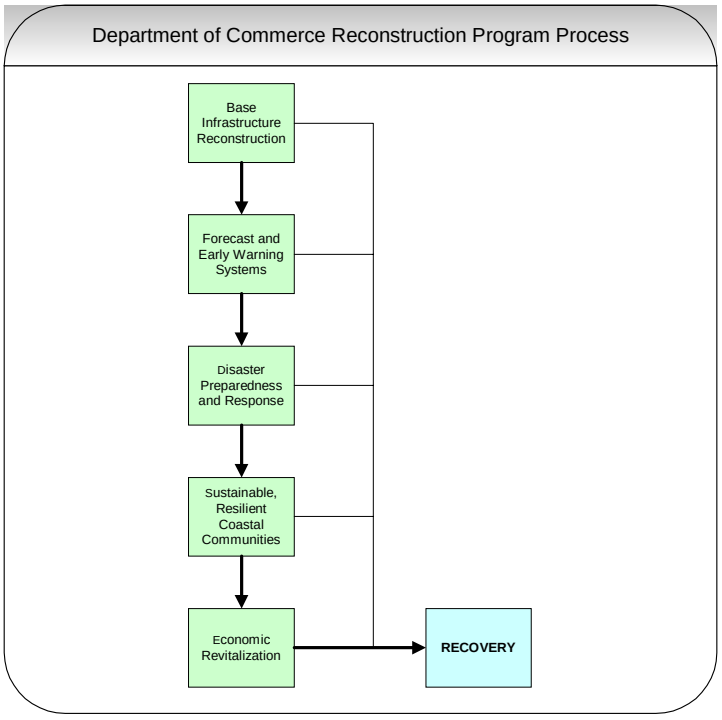
U.S. Department of Commerce Problem Area Budgets

Problem Area	Honduras	Nicaragua	Guatemala	El Salvador	Dominican Republic	Regional
Base Infrastructure Reconstruction	$1,808,000	$1,789,000	$938,000	$974,000	$0	$1,293,000
Forecast and Early Warning Systems	$1,615,000	$1,580,000	$665,000	$365,000	$0	$300,000
Disaster Preparedness and Response	$318,000	$344,000	$318,000	$161,500	$100,000	$532,000
Sustainable, Resilient Coastal Communities	$584,000	$613,000	$0	$178,500	$525,000	$799,000
Economic Revitalization	$0	$0	$0	$0	$0	$200,000
Transnational Watershed Management	$0	$0	$0	$0	$0	$1,100,000
Total Country Budget	$4,325,000	$4,326,000	$1,921,000	$1,679,000	$625,000	$4,224,000
Total Project Budget	$17,100,000					

The Department also executed an agreement with the USAID Mission in Nicaragua for the Nicaragua Small Shrimp Producer Assistance Program. The budget for activities under this agreement totaled $1,280,000. Direct contributions to the program by the Department included organizing and sponsoring a workshop in March 1999 in Tegucigalpa, Honduras to bring the region's hydrology and meteorology agencies together to discuss needs for improving their capabilities for early warnings and disaster response. This workshop provided some preliminary information needed to develop the Department's implementation plan. The Department also contributed RAMSDIS satellite workstations to Belize and Panama. These additional workstations allowed all seven Central America countries to share in the satellite data from the ingest system installed in Costa Rica. Both contributions came through the NOAA/National Weather Service.

KEY ACCOMPLISHMENTS

The Department's Problem Areas as defined earlier were developed and organized in a logical progression for the Central America reconstruction program as noted below.



The intent of the DOC program was to concentrate on reconstructing base infrastructure, developing forecast and early warning system capabilities, promote disaster preparedness (through mostly capacity building), then promote sustainable communities (the DOC effort focused on coastal communities – an area of expertise for one of its bureaus, the National Oceanic and Atmospheric Administration), and then support economic revitalization. Due to the short amount of time available to complete the program, the Department worked in all these areas simultaneously but none-the-less contributed to the overall recovery of the region.

Many of DOC's activities were designed specifically to mitigate impacts of future extreme natural events (e.g., floods and droughts) and man-influenced disasters (e.g., oil spills caused by a natural event). Some examples are as follows:

- Installation of prototype flood warning and forecast systems
- Installation of satellite imagery, satellite-based rainfall estimates, and satellite-based forest fire detection capabilities
- Installation of automated weather stations, rain gages, tide gages, and stream gages
- Implementation of a regional climate prediction system
- Assistance with the development of hazardous spill contingency plans
- Development of Environmental Sensitivity Index maps
- Assistance with identification of essential facilities that are at risk of damage or failure in an earthquake or hurricane

Proper use and maintenance of these systems will allow Department counterparts in the region to better forecast and manage disasters. In addition, implementation of many Department activities created the necessity for closer cooperation among the various agencies in each country – coordination that, in previous disasters, had not occurred especially during Hurricanes Mitch or Georges. For example, the hydrometeorological services now have more timely and precise data to provide the emergency management agencies and so these emergency management agencies now are beginning to rely more on the hydrometeorological agencies. The Department believes that with the improved tools and the more coordinated activities, that the region's early warning, disaster preparedness and response capabilities for potential natural disasters are greatly improved. It is anticipated that what will be evident is an incremental improvement. In addition, some of the Department's programs directly benefit the United States – an example includes access to additional, higher quality meteorological data from the upper air system and weather station and rain gage networks to support tropical weather analyses and forecast models.

Examples of successful applications of the Department's programs include – the regional climate prediction system used to develop long-term outlooks for rainfall in the region. The primary mechanism for developing these outlooks is a region-wide forum where a consensus outlook for rainfall and its departure from 'normal' is compiled. The regional forum in the spring of 2001 provided an outlook of a higher probability of below normal rainfall along the Pacific Coast for the following three months. This was disseminated to all users such as the agriculture sector. The outlook proved accurate, as the 2001 rainy season was a much below normal in that area – a drought in some regions. These fora have now become institutionalized in the region and are occurring regularly without DOC support. Another example is the use of the new satellite RAMSDIS workstations during Hurricane Michelle in October 2002. The hurricane caused widespread destruction primarily along the north coast of Honduras. At one point, it appeared to the general public and emergency managers in Honduras that Michelle was on a similar track as Hurricane Mitch causing great concern. However, the meteorological service in Honduras (Servicio Meteorologia Nacional, SMN) used the satellite imagery and satellite-based rainfall estimates to show that the hurricane was moving away from Honduras and to show where the heaviest rainfall had occurred. This greatly assisted emergency managers in relief and recovery efforts.

OTHER CONSIDERATIONS

The Department designed its programs with a great amount of consideration for the level of sophistication for the programs and equipment to be implemented and installed in the region. Of primary consideration was a selection of 'appropriate technology' – technology that was consistent with the capabilities within each country and that could be sustained if the counterparts also aggressively worked to sustain the equipment and programs that were installed. Discussions were held with counterparts prior to implementation to better determine what was needed, where it was needed, and what realistically could be sustained. For example, installations of automatic weather stations in each country were prioritized – with those most critical for providing key observations for weather forecasting considered first (including replacement of equipment lost or damaged during the hurricanes) and with the number of stations to be installed based how many could be expected to be maintained with available or minimal increases in resources. In addition, design and implementation of flood warning systems took into account the needs of at-risk communities and their capabilities and desires to operate and support these systems. In selecting the equipment that was to be installed, the Department decided to improve on the level of sophistication of equipment that was being replaced or supplemented in each country. The rationale for this decision was based on the need to improve the capabilities and operations of the counterparts rather than have them remain at status

quo. The idea was that by providing sustainable, appropriate technology and improving their capabilities, the counterparts could then provide more and better services that would make them more valuable within their government (and obtain more support and resources), attract stakeholders, and encourage investment from other donors – especially if they could show their ability to sustain the equipment and programs installed during the Hurricane Reconstruction Program. For some activities, this approach is beginning to show results. For example, the counterpart agency in El Salvador is now providing a major stakeholder (hydroelectric utility) with hydrologic forecasts using the forecast system implemented by the Department as part of the Río Lempa watershed management activity.

In general, the Department's counterparts are still struggling with allocating the proper resources to address the sustainability issues. Most of the counterpart agencies in the region are still under-funded in the areas of disaster mitigation and disaster management. There are too few professionals; there is a lack of visibility within the government and with the public (in some cases the only visibility is negative); and there is no support for items like vehicles, gasoline, or per diem to allow maintenance of field monitoring networks. During implementation, the Department did what it could to correct these issues – improve visibility, improve inter-agency coordination, initiate planning activities, and improve support within the government. The Department also supported applications for counterpart funding to help with sustainability of the programs. However, the Hurricane Reconstruction Program was too short to properly address all these issues during implementation. Consequently, the Department has decided to continue to help support programs such as hydrometeorological data collection in the region. To do this, a web site is being maintained that can be used to access and display the real-time data – this should help counterparts maintain data access as well as provide data (and a need for data) to stakeholders and other users. The Department expects to continue to support this web site well into the future – see www.nws.noaa.gov/oh/hads/

At this time, additional funding is most likely still required to support sustaining the programs and equipment installed by the Department and to protect the investment made by USAID. Special emphasis should be on training and equipment maintenance. More than 15% of the DOC budget went specifically to formal training and capacity building activities with additional resources to informal training and information exchange, more time and resources should have gone to training of counterparts – however the limited time to implement the project impacted on the ability to provide more needed training. In addition, follow-on activities to assess implementation of the technical guidance, systems and programs provided by the DOC to ensure the proper implementation, provide feedback as to their usefulness in mitigating disasters specifically in political and social environments such as Central America, and to ensure sustainability would be valuable and maybe should be built into future projects. A relatively small amount of financial support for sustaining and maintaining systems and programs and for planning (e.g., maintenance plans, strategic plans) can be useful in leveraging the large amount of funds invested during the Hurricane Reconstruction Program. Support for many programs can be accomplished on a regional level (e.g., field monitoring network maintenance) more efficiently than on a country-by-country level.

The Department feels that if initial funding was provided to allow more due diligence and ground-truthing at the beginning of the program – shortly after the hurricanes, that perhaps stronger and/or more focused programs could have been designed and implemented. The USAID missions were extremely helpful in helping the Department's bureaus in determining needs throughout the region but with the large post-hurricane workloads imposed on the missions, their available time to support these initial efforts was limited. Therefore funding to the USG agencies to determine critical needs and then develop more comprehensive proposals may have helped with program development.

COUNTRY ACTIVITIES

HONDURAS, NICARAGUA, GUATEMALA, EL SALVADOR, DOMINICAN REPUBLIC

INTRODUCTION

The following sections describe the Department of Commerce activities in more detail for each country. In the Central America region, the level of activities generally followed the level of destruction from Hurricane Mitch – the most activities occurred in Honduras with the least in El Salvador. The Department also had several regional programs in Central America that contributed to all or several countries. These regional programs focused on the Gulf of Fonseca (Honduras, Nicaragua, and El Salvador), the Río Lempa transnational watershed (Honduras, Guatemala, and El Salvador), or the entire region (activities based in Costa Rica). It is important to note that activities performed as part of these regional programs are discussed in the appropriate regional section, not in the country section. Activities in the Dominican Republic were limited but addressed important areas of concern for the government of the Republic following the passage of Hurricane Georges.

An additional program, not funded through the Hurricane Reconstruction Program Interagency Agreement with USAID, was done in Nicaragua. The results of this program – Nicaragua Small Shrimp Producer Assistance Program, are presented in this report in the Gulf of Fonseca regional program section.

COUNTRY ACTIVITIES

The activities for each country are summarized in the following sections. For many activities more detail is provided separate, individual reports compiled during the course of the Program.

HONDURAS

The following table summarizes the Department of Commerce activities in Honduras.

HONDURAS ACTIVITIES

Base Infrastructure Reconstruction

- Reconstruction and improvement of the geodetic network
- Installation of an automatic weather station on Swan Island
- Installation of an upper air measurement system in Tegucigalpa
- Installation of eight automatic rain gages for flood forecast and warning systems – San Lucas, Santa Lucia, San Marco de Colon, El Zuzular, Ocote Bonito, Nueva Armenia, La Union, La Habana
- Installation of a Wide Area Network connecting SMN, SERNA, COPECO for data and information sharing
- Installation of a tide gage at Puerto Cortes
- Installation of satellite workstations under the DOC Regional Program
- Installation of rain gages and an automatic weather station under the DOC Río Lempa Watershed Program

Forecast and Early Warning Systems

- Installation of a flood forecast and warning system for the Río Choluteca
- Installation of a flood forecast and warning system for the Río Aguan (upper)
- Installation of a high resolution flood inundation mapping and display system for the city of Tegucigalpa
- Development of Strategic Plans for hydrometeorological services
- Development of a climate prediction system under the DOC Regional Program

Disaster Preparedness and Response

- Implementation of training programs for forecast, warning, preparedness, and response institutions
- Implementation of programs to increase capacity for local response authorities to prevent, plan for, and respond to spills of oil or other hazardous chemicals

Sustainable, Resilient Coastal Communities

- Development of activities under the DOC Gulf of Fonseca Program

Economic Revitalization

- Support to the Honduran Reforestation Initiative under the DOC Economic Revitalization Regional Program
- Development of activities under the DOC Economic Revitalization Regional Program

BASE INFRASTRUCTURE RECONSTRUCTION

The Department's objectives for this problem area were to accomplish the following:

- Provide a foundation for ongoing reconstruction efforts
- Reconstruct and improve weather forecast and early warning networks
- Promote safe and efficient air and marine transportation
- Provide for a geo-spatial data and water level reference framework
- Ensure that capacity exists to maintain and expand new base infrastructure

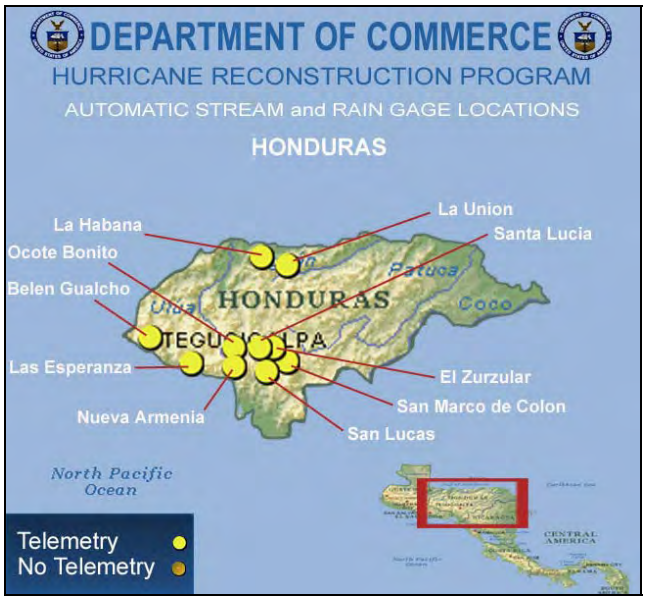
To accomplish these objectives, monitoring equipment was installed at various locations throughout the country and programs were developed to appropriately use the data collected by this equipment for a variety of purposes. The Department's goal was to install the most appropriate technology based on local capacities and resources to ensure the highest probability of sustaining the systems.

The hydrometeorological monitoring network was improved and expanded to support and strengthen the weather forecasting and early warning capabilities of the country. An **automatic weather station** was installed on Swan Island, located out in the Caribbean Sea. This station, which measures wind speed and direction, air temperature, humidity, rainfall, solar radiation, and atmospheric pressure on a 10-meter tower, will provide critical meteorological data useful for weather forecasting and for monitoring tropical storms and hurricanes. The data are transmitted via the GOES Satellite Data Collection System (DCS) back to a Digital Readout Ground Station (DRGS) located at SMN in Tegucigalpa (the GOES DCS is operated by the National Oceanic and Atmospheric Administration – National Environmental Satellite, Data and Information Service, NOAA/NESDIS).

Another useful tool for weather forecasting and for providing crucial data for forecasting tropical storms and hurricanes was installed in Tegucigalpa – an **upper air measurement system**. This system consists of meteorological balloons and instrument packages that measure temperature, humidity, and atmospheric pressure. The balloons are tracked to an altitude of 30,000 feet or more by a global positioning system to obtain estimates of wind speed and direction. The Department provided a ground station and expendables for 100 balloon releases.

Upper Air System Balloon and Instrument Package

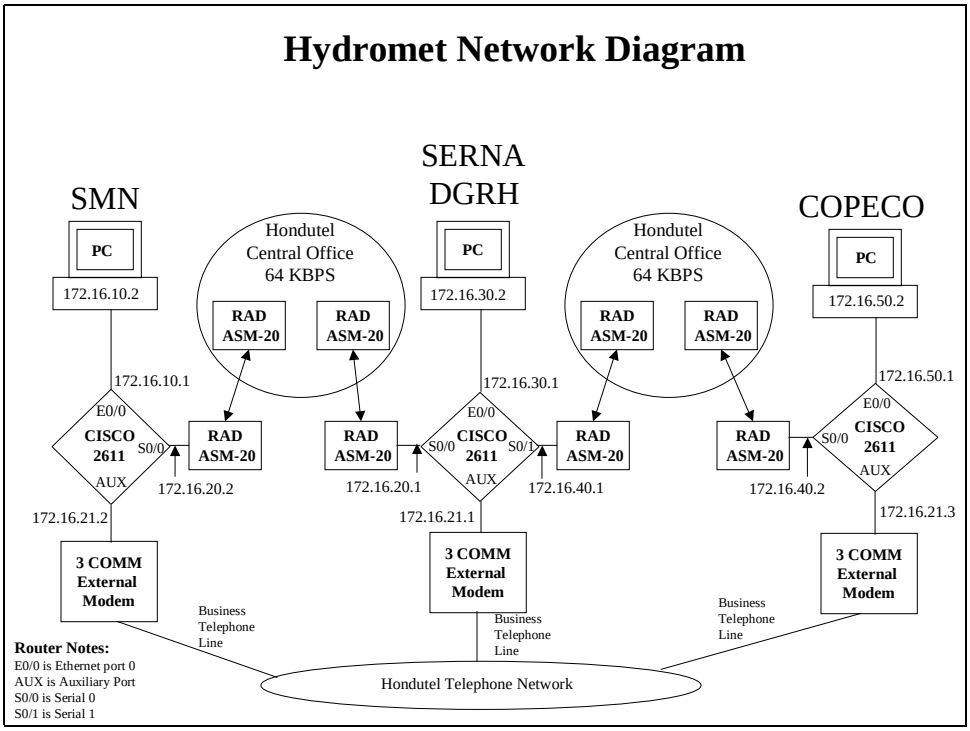
In support of the flood forecast and warning systems, the Department installed a network of **automatic rain gages** in the Río Choluteca and Río Aguan basins. These rain gages collect the data and transmit it via the GOES Satellite Data Collection System (DCS) back to the DRGS at SMN in Tegucigalpa. The data are then used as input to the hydrologic models used in the flood forecast and warning system.



Automatic Rain Gage Locations - Honduras

Automatic Rain Gage at Zuzular

In order to share data and information regarding potential floods, tropical storms, and hurricanes, the Department installed a **Wide Area Network** (WAN) to connect all three agencies. The WAN is especially critical for transmission of data from the monitoring networks (received at SMN through the DRGS) to SERNA and COPECO (where the flood warning and forecast systems are located). The WAN is operated by HONDUTEL.



Hydrometeorological Wide Area Network

The **tide gage** installed at Puerto Cortes is part of the Water Level Observation Network for Central America (RONMAC) installed by the Department as part of the Hurricane Reconstruction Program. The primary purpose of RONMAC is to provide support for the development and improvement of the geodetic framework of Central America. However, information and data derived from RONMAC will also be used in decision-making by a variety of national and regional agencies responsible for coastal resource management. Coastal management agencies will use these data to assist with monitoring the water quality, impact of sea level rise as a result of global climate change, and preparing coastal zone management plans. Regulatory agencies will use the data for permitting and enforcement and to determine marine boundaries for jurisdiction and managing offshore minerals resources. Emergency management agencies will use the data to prepare storm evacuation maps, to assist with early coastal hazard warnings for hurricanes and tsunamis, and coastal sea level predictions associated with climate change. Data from the RONMAC supports the design, development and construction of harbor facilities to enhance maritime commerce, production of accurate nautical charts, and improvement of marine nowcasts and forecasts. RONMAC stations will also have the capability of providing real-time water level and meteorological data to large vessels (oil tankers, containers, and cruise) and port officials to improve safe navigation and docking operations.

The Puerto Cortes station consists of an air acoustic water level sensor, a backup pressure water level sensor, a protective well, meteorological sensors, a data collection platform (DCP), GOES satellite radio transmitter, a voice modem, VHF radio, and a permanent bench mark network composed of a

minimum of five bench marks. GOES telemetry is the primary mode of data retrieval for RONMAC, telephone retrieval is optional. In addition to the sea level monitoring, it is important to understand coastal processes from the standpoint of "air-sea interaction". To accomplish this, other physical attributes were designed into the system. The additional sensors included the following: sea surface temperature, air temperature, barometric pressure, rainfall, solar radiation, wind speed and direction, and relative humidity.

Honduras Tide Gage Location

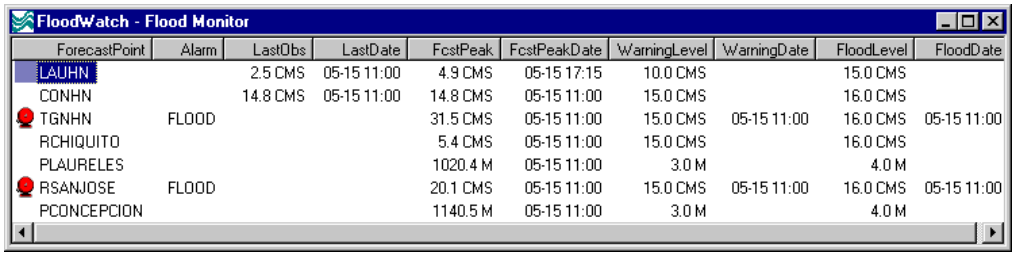
Puerto Cortes Tide Gage Station

The Department reconstructed and improved **geodetic networks** in Honduras. Components included: continuously operating reference systems (CORS) installed in Tegucigalpa and San Lorenzo, with dual frequency global positioning system (GPS) receivers, 24 hour continuous tracking capability, and 1-2 cm accuracy, analysis and processing of a high accuracy GPS reference network; training in station installation and GPS data processing, and links to international GPS networks. Improvements in local and regional geodetic information and infrastructure will support economic development, the effective management of property and natural resources, and improve preparation for and response to future natural disasters.

Also see the DOC Río Lempa Watershed and Regional Programs sections for additional Base Infrastructure Reconstruction activities.

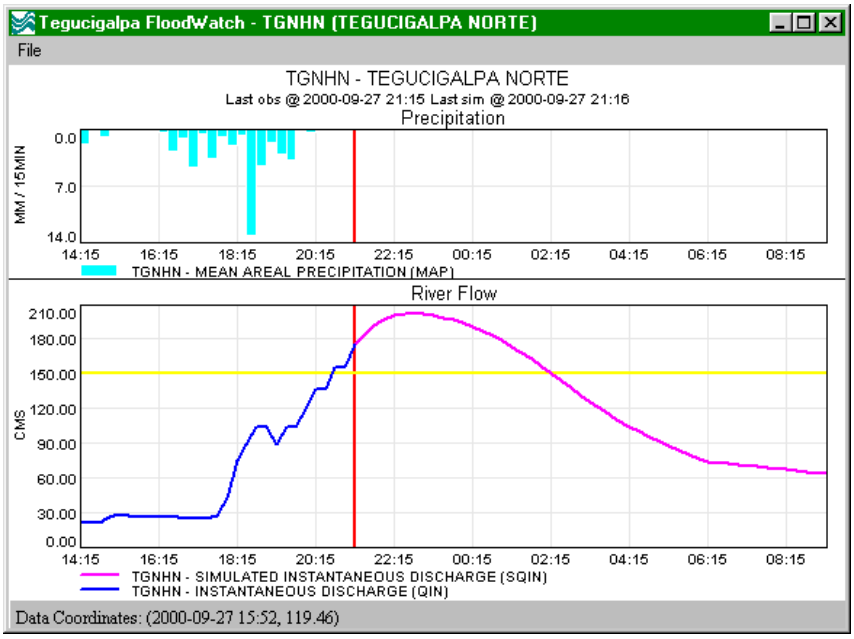
FORECAST AND EARLY WARNING SYSTEMS

The Department installed **flood forecast and early warning systems** in two key river basins in Honduras – the Río Choluteca and Río Aguan. These systems are comprised of an automatic rain and stream gage monitoring network and hydrologic models calibrated for both basins. The modeling system used in both basins, FloodWatch, simulates the hydrologic response of the basins as a function of input rainfall, observed streamflow, reservoir information, and other data. Streamflow forecasts are generated at points along the river called forecast points. The system is designed to allow operator interaction or to be run in a more automated mode. The operator can also input quantitative rainfall forecast information to further enhance the hydrologic forecasts. The Department worked closely with the U.S. Geological Survey (USGS) who installed the streamgages needed for the systems. The FloodWatch system is installed at both SERNA and COPECO in order to ensure redundancy, sustainability, and to satisfy the operational needs of both agencies. Data needed by the systems are available on the WAN installed by the Department connecting SMN, SERNA and COPECO. Displays are available in tabular or graphical form.



ForecastPoint	Alarm	LastObs	LastDate	FcstPeak	FcstPeakDate	WarningLevel	WarningDate	FloodLevel	FloodDate
LAUHN		2.5 CMS	05-15 11:00	4.9 CMS	05-15 17:15	10.0 CMS		15.0 CMS	
CONHN		14.8 CMS	05-15 11:00	14.8 CMS	05-15 11:00	15.0 CMS		16.0 CMS	
TGNHN	FLOOD			31.5 CMS	05-15 11:00	15.0 CMS	05-15 11:00	16.0 CMS	05-15 11:00
RCHIQUITO				5.4 CMS	05-15 11:00	15.0 CMS		16.0 CMS	
PLAURELES				1020.4 M	05-15 11:00	3.0 M		4.0 M	
RSANJOSE	FLOOD			20.1 CMS	05-15 11:00	15.0 CMS	05-15 11:00	16.0 CMS	05-15 11:00
PCONCEPCION				1140.5 M	05-15 11:00	3.0 M		4.0 M	

Tabular Flood Monitor Showing Flood Status at Forecast Points



Graphical Display for a Particular Forecast Point

For the Río Choluteca system, river forecast points are located at Apaciliagua, Ojo de Agua, Paso la Ceiba, Sagastume, Presa las Laureles, and Presa Concepcion – all corresponding to streamgages installed by the USGS. For the Río Aguan, river forecast points are located at Sabana Larga,

Olanchito, and Río Mame. Key communities include Tegucigalpa and Choluteca for the Río Choluteca system and Olanchito for the Río Aguan.

Flood Warning and Forecast Systems - Honduras

As part of the flood warning system for the Río Choluteca, the Department added a unique capability to **display actual and forecast inundated areas** for the city of Tegucigalpa. Using the outputs from the FloodWatch forecast system and detailed Digital Elevation Model (DEM) and ortho-photo data obtained from the USGS, the Department developed a real-time system named FloodMap to display areas potentially inundated during flooding conditions. This capability is installed at both SERNA and COPECO and is a useful tool for emergency managers. A sample FloodMap display (for a simulated Hurricane Mitch type event) is shown below.

FloodMap Output for Tegucigalpa (Simulated Flood)

An additional activity under this problem area was the **development of strategic plans** for the operations of the hydrometeorological services and consequent improvement of forecast and early warning capabilities. This activity was deemed important since, in general, these services are poorly funded and do not have high esteem within each government. The purpose of the plans was to provide guidance and direction for strengthening the services, a process begun during the Department's Hurricane Reconstruction Project. During the course of developing the plans, the directors of each service were interviewed regarding current operations, mandates, and vision for strengthening the services. Based on these interviews, a simple, inexpensive strategy was developed to assist with continued or further strengthening. The theme was the same for each country as all faced the same problems and issues – funding and poor visibility. The plans, which were transmitted to each USAID mission, focused on the following key themes – implement a technical advisory committee comprised of members from other government agencies, academia, and industry to help develop future strategies for advancing the agency (to improve credibility within the government); promote better coordination with other key institutions in the government; promote higher visibility with the media through press releases, interviews, regularly scheduled programs, Internet web pages; develop a risk assessment capability for preventing, reducing and managing risks for extreme natural phenomena (e.g., develop risk atlases); improve information and data processing capabilities; and continue developing sound approaches to system maintenance and upgrading monitoring networks.

Also see the DOC Regional Programs section for additional Forecast and Early Warning System activities.

DISASTER PREPAREDNESS AND RESPONSE

Many of the DOC activities under the Disaster Preparedness and Response Problem Area involved the implementation of various **training programs and workshops** for the forecast, warning, preparedness, and response agencies. The emphasis of the activities was **capacity building** to better prevent, plan for or respond to disasters or to ensure sustainability of the tools and programs installed and instituted by the Department. Some of these programs involved operations and maintenance of monitoring equipment installed by the Department and others on the collection, analysis, and application of various data and information needed by these agencies to fulfill their missions. Training in this problem area also supplemented various training activities performed in each of the other problem areas. Training activities in Honduras included those shown on the following table.

TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
Flood Forecasting Workshop	October – December 1999	United States	SMN, SERNA
Satellite Meteorology		Costa Rica	SMN
Satellite Digital Ground Station (DDRGS) Operation and Maintenance	July – September 2000	Honduras	SMN, SERNA
Operation and Maintenance of Automatic Rainfall Stations		Honduras	SMN, SERNA
Operation and Maintenance of PCBASE2 software for DDRGS		Honduras	SMN, SERNA
Operation of FloodWatch Software		Honduras	SMN, SERNA
Operation and Maintenance of PCBASE2 software for DDRGS	October – December 2000	Honduras	SMN, SERNA
Operation of FloodWatch Software		Honduras	SMN, SERNA
Operation of Wide Area Network, Including Routers		Honduras	SMN, SERNA, COPECO
Operation and Maintenance of Automatic Rainfall Stations		Honduras	SMN, SERNA
Contaminant Monitoring in Various Media and Chemical Analysis Techniques		Honduras	SERNA/CESCCO

TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
Flood Forecasting Workshop and Hydrologic Forecasting and Analysis Course	October – December 2000	United States	SMN, SERNA
Geodetic Surveys	January – March 2001	Honduras	IGN
Operation of FloodWatch Software – output analysis, identification of erroneous results, data error corrections		Honduras	SERNA
Operation and Maintenance of PCBASE2 software for DDRGS		Honduras	SMN, SERNA
Sampling Techniques for Sediment, Fish, and Crabs		Honduras	SERNA/CESCCO
Extension Agents to Promote Sustainable Uses of the Gulf of Fonseca Resources		Honduras	Zamorano Panamerican Agricultural School
Climate Variability and Extreme Events for Central America		Costa Rica	SMN
Tide Gage Regional Technical Training Workshop	April – June 2001	Guatemala	IGN, Empresa Nacional Portuaria, Navy
Operation of FloodWatch Software, Concepts of Flood Forecasting, Operations of Hydrologic Forecast Center		Honduras	SERNA

TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
RAMSDIS Satellite Workstation Operation, Use of Environmental Data in Meteorological Applications – fire detection, volcanic ash detection, forecasting	April – June 2001	Costa Rica	SMN
Flood Forecast System Operations, Hydrologic Forecast Center Operations	July – September 2001	Honduras	SERNA
RAMSDIS Satellite Workstation Installation and On-Site Training for Operations		Honduras	SMN
Tide Gage Regional Technical Training Workshop	October – December 2001	Costa Rica	IGN, Empresa Nacional Portuaria, Navy
Operation of FloodWatch Software for the Ríos Aguan and Choluteca, Operations of the Flood Inundation Software for Tegucigalpa		Honduras	SERNA, COPECO
Spill Response and Contingency Planning Workshops		Honduras	Empresa Nacional Portuaria, Navy, COPECO
RAMSDIS Satellite Workstation Operation, Use of Environmental Data in Meteorological Applications		Costa Rica	SMN
Hydrometeorological Monitoring System Maintenance Planning and Logistics Workshop		United States	SERNA

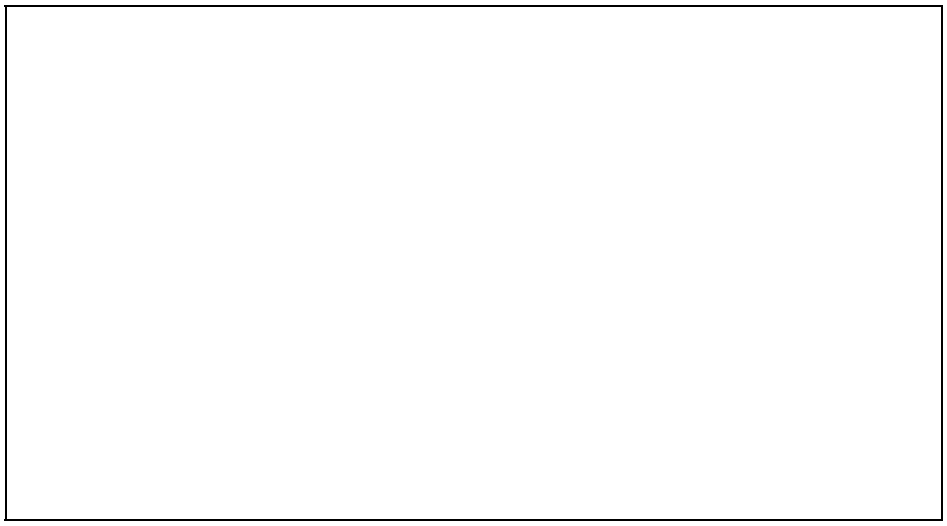
TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
Operational Meteorology and Hydrology Post Graduate Course	15 Months (2000-2001)	University of Costa Rica	SMN (1 Student)*
Hydrometeorological and Sea Level Monitoring System Installation, Operation and Maintenance Training (done during installation of equipment)	Entire Program	Honduras	SMN, SERNA, IGN, Empresa Nacional Portuaria, Navy

* Thesis title – Análisis de los Eventos El Niño y Niña en la Cuenca del Embalse El Cajón Entre 1972 y 1998.

In addition to the training activities discussed above, the Department also accomplished **spill preparedness and response** activities in Honduras. These activities provided local response authorities with increased capacity to prevent, plan for, and respond to spills of oil or other hazardous chemicals. This was accomplished through a series of activities, culminating in training and workshops.

Products included **Environmental Sensitivity Indexes** (ESI) for Honduras in the Gulf of Fonseca up to the extent of tidal influence and the Caribbean coast. All mapping products are hardcopy atlases and digital data files. Mapping products were developed with significant local expertise input and review. A total of 19 ESI maps were developed for Honduras. The ESI maps show coastal habitat types and important biological and human-use resources. Six major categories of biological resources are included in the atlases: marine mammals, terrestrial mammals, birds, reptiles/amphibians, fish and invertebrates. Human-use resources include protected areas, aquaculture sites, subsistence and commercial fishing areas, archaeological and historical sites, water intakes, boat ramps, recreational beaches, ports and marinas. Interviews were conducted with regional experts for each category of biological and human-use resource.

The intertidal coastal habitats of Golfo de Fonseca were mapped during overflights and ground surveys conducted in February 2000. During this work, an experienced coastal geologist delineated the intertidal shoreline habitats directly onto 1:50,000-scale topographic maps. Prior to the overflights, high resolution, black and white vertical aerial photographs obtained in December 1998 under the USGS Open Skies Program were examined to produce an initial classification. The photographs were particularly important in updating the location and extent of recent aquaculture sites, as well as delineating changes resulting from Hurricane Mitch.



Environmental Sensitivity Index Map - San Lorenzo, Honduras

Additional guidance documents and a simple trajectory model for the Gulf of Fonseca were also completed. Scenarios were developed and shortfalls identified for **spill contingency plans** in Honduras and other participating countries. Contingency plans, to be completed by the Hondurans, identify resources at risk, response priorities, scenarios, and organizational structures for the region and/or for each country. Standard training tools used by NOAA were modified and translated into

Spanish for use in the final one-week workshop in San Pedro Sula, Honduras. An additional training aid, the Trajectory Analysis Handbook, was developed as part of this effort. The following tools and guidance documents were used during the workshop and distributed to all participants:

1. Aerial Observations of Oil. This guidebook contains pictures of various types of oil spilled at sea and includes definitions and standard terminology used to define oil's appearance on the water.

2. Shoreline Assessment Job Aid. Habitat identification and a methodology for identifying, quantifying and recording shoreline oil impact are provided in this field guide. The habitat depictions correlate to those in the Environmental Sensitivity Index work.

3. Coastal Characteristics. Response technologies for habitats identified on ESI and in the Shoreline Assessment Job Aid are evaluated and discussed in this guidebook.

4. Trajectory Analysis Handbook. The physical processes relevant to determining the movement of oil are summarized and presented in this field guide.

5. Computer Aided Management of Emergency Operations (CAMEO). The CAMEO program was translated into Spanish as part of a separate EPA-sponsored effort, but proved quite appropriate for use in this effort. This tool provides access to response information for 6,090 chemicals, including physical property information and over 60,000 synonyms to assist in chemical identification.

6. Automated Data Inquiry of Oil Spills (ADIOS). The ADIOS program was the only tool used as part of the workshop that was not available in Spanish. Because of the extensive nature of the program, it was not initially considered as part of this technology transfer activity. However, during preparatory activities for the training and contingency planning workshops, it was identified as a useful tool by local agencies - even if it only existed in English. This model has a database of approximately 1,000 oil and oil products. By providing local environmental information (such as air and sea temperature, wind speed, wave heights, and salinity), weathering processes of specific oils can be identified (such as evaporation, dispersion, dissolution, etc.) and relevant property changes over time can be calculated (e.g., viscosity, water content).

SUSTAINABLE, RESILIENT COASTAL COMMUNITIES

See Gulf of Fonseca activities section.

ECONOMIC REVITALIZATION

See Regional activities section.

NICARAGUA

The following table summarizes the Department of Commerce activities in Nicaragua.

NICARAGUA ACTIVITIES

Base Infrastructure Reconstruction

- Reconstruction and improvement of the geodetic network
- Installation of five automatic weather stations – Granada, Esteli, Fátima, Chinandega, Boaco
- Installation of eight rain gages and two stream gages for a flood and river forecast system and a flood warning system – Cinco Pinos, Las Praderas, Guabo, Villa Sandino, Wapi, El Arenal, San Isidro, Teuestepe, Las Banderas (streamgage/rain gage), Piedra Fina (streamgage/rain gage)
- Installation of tide gages at Corinto and Puerto Cabezas
- Installation of satellite workstations under the DOC Regional Program

Forecast and Early Warning Systems

- Installation of a river and flood forecast system for the Río Escondido
- Installation of a warning system (ALERT) for the Río Malacatoya
- Installation of a Local Area Network connecting hydrology and meteorology sections for data and information sharing
- Development of a Hydrologic Forecast Center
- Development of Strategic Plans for hydrometeorological services
- Development of a climate prediction system under the DOC Regional Program

Disaster Preparedness and Response

- Implementation of training programs for forecast, warning, preparedness, and response institutions
- Implementation of programs to increase capacity for local response authorities to prevent, plan for, and respond to spills of oil or other hazardous chemicals

Sustainable, Resilient Coastal Communities

- Development of activities under the DOC Gulf of Fonseca Program

Economic Revitalization

- Development of activities under the DOC Economic Revitalization Regional Program

BASE INFRASTRUCTURE RECONSTRUCTION

The Department's objectives for this problem area were to accomplish the following:

- Provide a foundation for ongoing reconstruction efforts
- Reconstruct and improve weather forecast and early warning networks
- Promote safe and efficient air and marine transportation
- Provide for a geo-spatial data and water level reference framework
- Ensure that capacity exists to maintain and expand new base infrastructure

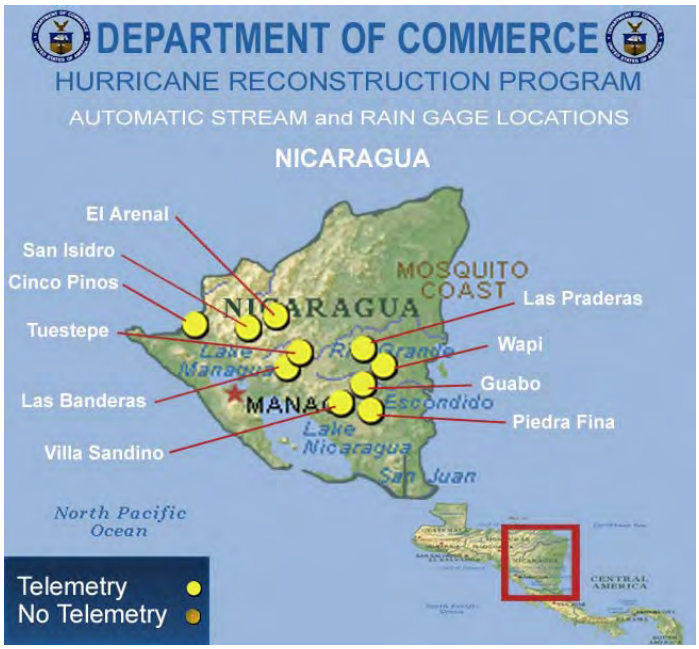
To accomplish these objectives, monitoring equipment was installed at various locations throughout the country and programs were developed to appropriately use the data collected by this equipment for a variety of purposes. The Department's goal was to install the most appropriate technology based on local capacities and resources to ensure the highest probability of sustaining the systems.

The hydrometeorological monitoring network was improved and expanded to support and strengthen the weather forecasting and early warning capabilities of the country. **Automatic weather stations** were installed at Granada, Esteli, Fátima, Chinandega, and Boaco. These stations, which measure wind speed and direction, air temperature, humidity, rainfall, solar radiation, and atmospheric pressure on a 10-meter tower, will provide critical meteorological data useful for weather forecasting, for flood early warnings, and for monitoring tropical storms and hurricanes. The data are transmitted via the GOES Satellite Data Collection System (DCS) (the GOES DCS is operated by the National Oceanic and Atmospheric Administration – National Environmental Satellite, Data and Information Service, NOAA/NESDIS). INETER accesses the transmitted data from the NOAA/NESDIS computers via telephone modem or the Internet.

Automatic Weather Stations – Nicaragua

Automatic Weather Station - Granada

In support of the flood forecast and warning systems, the Department installed a network of **automatic stream and rain gages** in the Río Escondido and Río Malacatoya basins. An additional gage was installed at Cinco Pinos for flood warnings and climatological purposes. These rain gages collect the data and transmit it via the GOES Satellite Data Collection System (DCS) where it is collected at INETER as with the automatic weather stations. The rainfall and streamflow data from the Río Escondido and Río Malacatoya basins are then used as input to the hydrologic models used in the river and flood forecast system for the Río Escondido basin and the flood warning system for the Río Malacatoya.



Automatic Stream and Rain Gage Locations – Nicaragua

The key counterpart for the hydrometeorological program was the hydrologic and meteorological sections at INETER.

The **tide gages** installed at Corinto and Puerto Cabezas are part of the Water Level Observation Network for Central America (RONMAC) installed by the Department as part of the Hurricane Reconstruction Program. The primary purpose of RONMAC is to provide support for the development and improvement of the geodetic framework of Central America. However, information and data derived from RONMAC will also be used in decision-making by a variety of national and regional agencies responsible for coastal resource management. Coastal management agencies will use these data to assist with monitoring the water quality, impact of sea level rise as a result of global climate change, and preparing coastal zone management plans. Regulatory agencies will use the data for permitting and enforcement and to determine marine boundaries for jurisdiction and managing offshore minerals resources. Emergency management agencies will use the data to prepare storm evacuation maps, to assist with early coastal hazard warnings for hurricanes and tsunamis, and coastal sea level predictions associated with climate change. Data from the RONMAC supports the design, development and construction of harbor facilities to enhance maritime commerce, production of accurate nautical charts, and improvement of marine nowcasts and forecasts. RONMAC stations will also have the capability of providing real-time water level and meteorological data to large vessels (oil tankers, containers, and cruise) and port officials to improve safe navigation and docking operations.

The two stations consist of an air acoustic water level sensor, a backup pressure water level sensor, a protective well, meteorological sensors, a data collection platform (DCP), GOES satellite radio transmitter, a voice modem, VHF radio, and a permanent bench mark network composed of a minimum of five bench marks. GOES telemetry is the primary mode of data retrieval for RONMAC, telephone retrieval is optional. In addition to the sea level monitoring, it is important to understand coastal processes from the standpoint of "air-sea interaction". To accomplish this, other physical attributes were designed into the system. The additional sensors included the following: sea surface temperature, air temperature, barometric pressure, rainfall, solar radiation, wind speed and direction, and relative humidity.

INETER was the Department's counterpart agency in Nicaragua for the tide gage installations.

Nicaragua Tide Gage Locations

The **Corinto station** is shown on the left and the **Puerto Cabezas** station is shown on the right.

The Department reconstructed and improved **geodetic networks** in Nicaragua. Components included: continuously operating reference systems installed in Managua, Esteli, Corinto, and Puerto

Cabezas, with dual frequency global positioning system (GPS) receivers, 24 hour continuous tracking capability, and 1-2 cm accuracy, analysis and processing of a high accuracy GPS reference network; training in station installation and GPS data processing, and links to international GPS networks. Improvements in local and regional geodetic information and infrastructure will support economic development, the effective management of property and natural resources, and improve preparation for and response to future natural disasters.

Also see the DOC Regional Programs sections for additional Base Infrastructure Reconstruction activities.

FORECAST AND EARLY WARNING SYSTEMS

The Department installed two types of **forecast and early warning systems** in Nicaragua – a river and flood forecast system for the Río Escondido basin and a flood warning system (ALERT) for the Río Malacatoya.

Flood Forecast and Warning Systems - Nicaragua

The Department implemented the **NWS River Forecast System (NWSRFS)** for the Rio Escondido basin in Nicaragua. The NWSRFS is the system used throughout the United States to forecast flows and water levels for all major rivers in the country. The NWSRFS provides INETER with the capability to make forecasts of water levels on the Río Escondido several days in advance. The system will provide a forecast as a function of input rainfall (actual and forecast), observed streamflow (from automatic streamgages), and other data. Forecasts are provided at key locations along the river where automatic streamgages have been installed. In addition to the rain and stream gages installed by the Department and discussed in the previous section, the Department worked closely with the U.S. Geologic Survey (USGS) for the installation of additional streamgages. The USGS installed streamgages (forecast points) at Valentin, Rama, Bueyes, and Salto Grande. The key community for forecasting on the Río Escondido is Rama. As part of the implementation of the flood forecast system, NWSRFS was ported to Windows 2000 PCs. This will allow INETER to maintain the system at a lesser cost since the model executes on regular PCs rather than more complex – and costly – UNIX workstations. The system requires operator interaction to develop forecasts.

An example forecast product, generated by INETER using the NWSRFS, is shown on the following page.

)STICO DE NIVELES DE LA CUENCA DE RÍO ESCONDIDO, MALACATOYA Y LAGO XOLOTLÁN

Fecha : 28/09/01 **Precipitación Media Total: 10 mm (Escondido) y 15mm (Malacatoya)**
Pronosticador: Ing. Jairo Ibarra.

PRONÓSTICO DIARIO A PARTIR DE 6: AM

Del 29/09/01 **Al 30/09/01** *Nota*

Estaciones	Nivel de Alarma (mt)	Nivel Observado 28/09/01	Niveles Pronosticados (mts) DÍA 29/09/01	DÍA 30/09/01	COMENTARIOS
Salto Grande	6.0	No dato	3.00	2.80	
Mulle De Los Buelles	8.0	1.25	1.30	1.20	
Valentin	8.0	1.00	1.30	0.90	
Piedra Fina	8.0	1.30	1.70	1.30	
Rama	6.5	0.60	0.65	0.55	
Malacatoya	4.00	1.20	1.10	1.00	
Lago xolotlán					

LOS PRONÓSTICOS EMITIDOS SON SOLAMENTE PARA LAS CUENCAS DEL RÍO ESCONDIDO, MALACATOYA Y EL LAGO DE MANAGUA (XOLOTLAN), LAS CUALES SON MONITOREADAS POR EL INETER.

Leyenda:

Observaciones: El presente pronóstico está basado en la estimación de la precipitación para las próximas 24 horas, realizadas por Meteorología.
Distribuidas de la siguiente manera: 10 mm acumuladas a las 18 hrs, para Río escondido y 15mm acumuladas a las 24 hrs, para Malacatoya. Contadas apartir de las cero horas en Nicaragua.

The Department installed a **community-based flood warning system (ALERT)** on the Río Malacatoya. This system is not as sophisticated as the Río Escondido river and flood forecast system. The system includes an automatic rain gage at Teustepe and an automatic streamgage/rain gage at Las Banderas. A computer base station is located at a rice processing plant in Malacatoya (the rice plant was selected since it is a 24-hour a day, seven day a week operation). Alarms go off at the base station once certain rainfall amount thresholds are exceeded at the up-river gage locations. A base station was also installed at INETER in Managua. The streamgage is also monitored as it is located downstream of a small dam. Data are transmitted from the gages to the base stations via line-of-site radio.

ALERT System Inauguration - Malacatoya

ALERT Base Station - Malacatoya Rice Plant

In order to share data and information between the physically separate hydrology and meteorology sections, a **Local Area Network** (LAN) was installed by the Department connecting the two groups. The LAN is critical for disseminating the data transmitted via the GOES Satellite Data Collection System (DCS) and received via modem at the Hydrologic Forecast Center at INETER. The Department worked with INETER in the installation of the forecast center.

Inauguration
Of the
Hydrologic Forecast Center

An additional activity under this problem area was the **development of strategic plans** for the operations of the hydrometeorological services and consequent improvement of forecast and early warning capabilities. This activity was deemed important since, in general, these services are poorly funded and do not have high esteem within each government. The purpose of the plans was to provide guidance and direction for strengthening the services, a process begun during the Department's Hurricane Reconstruction Project. During the course of developing the plans, the directors of each service were interviewed regarding current operations, mandates, and vision for strengthening the services. Based on these interviews, a simple, inexpensive strategy was developed to assist with continued or further strengthening. The theme was the same for each country as all faced the same problems and issues – funding and poor visibility. The plans, which were transmitted to each USAID mission, focused on the following key themes – implement a technical advisory committee comprised of members from other government agencies, academia, and industry to help develop future strategies for advancing the agency (to improve credibility within the government); promote better coordination with other key institutions in the government; promote higher visibility with the media through press releases, interviews, regularly scheduled programs, Internet web pages; develop a risk assessment capability for preventing, reducing and managing risks for extreme natural phenomena (e.g., develop risk atlases); improve information and data processing capabilities; and continue developing sound approaches to system maintenance and upgrading monitoring networks.

DISASTER PREPAREDNESS AND RESPONSE

Many of the DOC activities under the Disaster Preparedness and Response Problem Area involved the implementation of various **training programs and workshops** for the forecast, warning, preparedness, and response agencies. The emphasis of the activities was **capacity building** to better prevent, plan for or respond to disasters or to ensure sustainability of the tools and programs installed and instituted by the Department. Some of these programs involved operations and maintenance of monitoring equipment installed by the Department and others on the collection, analysis, and application of various data and information needed by these agencies to fulfill their missions. Training in this problem area also supplemented various training activities performed in each of the other problem areas. Training activities in Nicaragua included those shown on the following table.

TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
Flood Forecasting Workshop	October – December 1999	United States	INETER
Satellite Meteorology		Costa Rica	INETER
Contaminant Monitoring in Various Media and Chemical Analysis Techniques	April - June 2000	Nicaragua	University of Central America (UCA), Shrimp Processing Industry Representatives
Hydrometeorological Station Design		Nicaragua	INETER
Installation, Operation and Maintenance of Automatic Rainfall and Weather Stations	July - September 2000	Nicaragua	INETER
Operation and Maintenance of PCBASE2 Software for ALERT		Nicaragua	INETER
Operation and Maintenance of DAPS Dial-up Software for GOES-telemetered Hydrometeorological Data		Nicaragua	INETER
Hydrometeorology and Manual Hydrologic Forecasting Techniques		Nicaragua	INETER
Hydrologic Modeling System Operations	October – December 2000	Nicaragua	INETER
ALERT Rainfall Threshold Development		Nicaragua	INETER
Operation and Maintenance of PCBASE2 Software for ALERT		Nicaragua	INETER

TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
Hydrometeorological Data Quality Control and Digitization	October – December 2000	Nicaragua	INETER
Flood Forecasting Workshop and Hydrologic Forecasting and Analysis Course		United States	INETER
Extension Agents to Promote Sustainable Uses of the Gulf of Fonseca Resources		Nicaragua	UCA
Geodetic Surveys	January – March 2001	Nicaragua	INETER
Operation and Maintenance of PCBASE2 Software for Data Acquisition		Nicaragua	INETER
Sampling Techniques for Sediment, Fish, and Crabs		Nicaragua	MAGFOR, UCA, ANDA
Extension Agents to Promote Sustainable Uses of the Gulf of Fonseca Resources		Nicaragua	UCA
Climate Variability and Extreme Events for Central America		Costa Rica	INTER
Tide Gage Regional Technical Training Workshop	April – June 2001	Guatemala	INETER, Empresa Nacional Portuaria
ALERT Concept of Operations for Malacatoya System, Threshold Dev.		Nicaragua	INETER, Civil Defense, System Operators, Local Community

TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
Operations of a Hydrologic Forecast Center (Development of Operations Manual)	April – June 2001	Nicaragua	INETER
RAMSDIS Satellite Workstation Operation, Use of Environmental Data in Meteorological Applications – fire detection, volcanic ash detection, forecasting		Costa Rica	INETER
NWSRFS, Hydrologic Forecast Center Operations (three sessions)	July – September 2001	Nicaragua	INETER
RAMSDIS Satellite Workstation Installation and On-Site Training for Operations		Nicaragua	INETER
Tide Gage Regional Technical Training Workshop	October – December 2001	Costa Rica	INETER, Empresa Nacional Portuaria, Navy
Spill Response and Contingency Planning Workshops		Honduras	INETER, Empresa Nacional Portuaria, Navy
Geodetic Training		Nicaragua	INETER
RAMSDIS Satellite Workstation Operation, Use of Environmental Data in Meteorological Applications		Costa Rica	INETER
Hydrometeorological Monitoring System Maintenance Planning and Logistics Workshop		United States	INETER

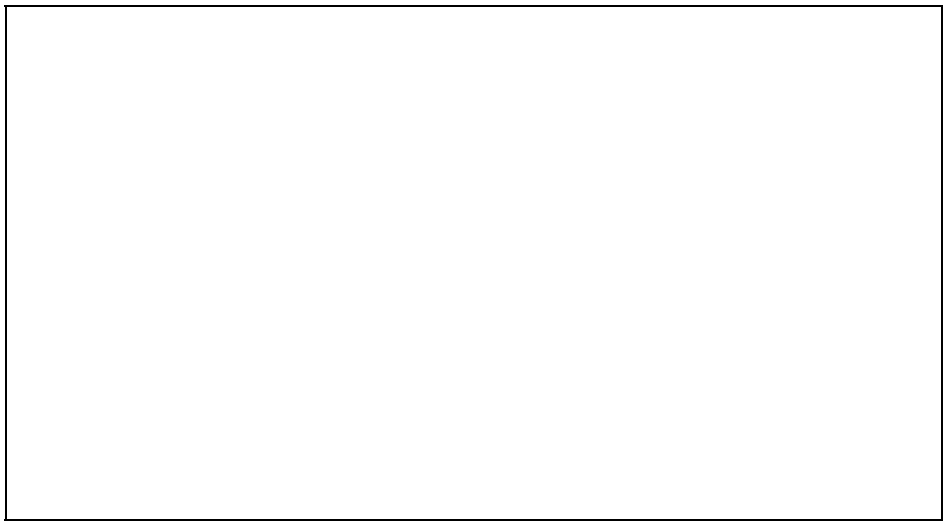
TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
GIS Workshop on Watershed Information NWSRFS Operations	October – December 2001	Nicaragua Nicaragua	MARENA, CIRA/UNAN, NGOs INETER
Operational Meteorology and Hydrology Post Graduate Course	15 Months (2000-2001)	University of Costa Rica	INETER (two students)*
Hydrometeorological and Sea Level Monitoring System Installation, Operation and Maintenance Training (done during installation of equipment)	Entire Program	Nicaragua	INETER

* Thesis Title – Caracterización Del Fenómeno ENOS en Nicaragua

In addition to the training activities discussed above, the Department also accomplished **spill preparedness and response** activities in Nicaragua. These activities provided local response authorities with increased capacity to prevent, plan for, and respond to spills of oil or other hazardous chemicals. This was accomplished through a series of activities, culminating in training and workshops.

Products included **Environmental Sensitivity Indexes** (ESI) for Nicaragua in the Gulf of Fonseca up to the extent of tidal influence and the Caribbean coast. All mapping products are hardcopy atlases and digital data files. Mapping products were developed with significant local expertise input and review. A total of 14 ESI maps were developed for Nicaragua. The ESI maps show coastal habitat types and important biological and human-use resources. Six major categories of biological resources are included in the atlases: marine mammals, terrestrial mammals, birds, reptiles/amphibians, fish and invertebrates. Human-use resources include protected areas, aquaculture sites, subsistence and commercial fishing areas, archaeological and historical sites, water intakes, boat ramps, recreational beaches, ports and marinas. Interviews were conducted with regional experts for each category of biological and human-use resource.

The intertidal coastal habitats of Golfo de Fonseca were mapped during overflights and ground surveys conducted in February 2000. During this work, an experienced coastal geologist delineated the intertidal shoreline habitats directly onto 1:50,000-scale topographic maps. Prior to the overflights, high resolution, black and white vertical aerial photographs obtained in December 1998 under the USGS Open Skies Program were examined to produce an initial classification. The photographs were particularly important in updating the location and extent of recent aquaculture sites, as well as delineating changes resulting from Hurricane Mitch.



Environmental Sensitivity Index Map - San Lorenzo, Honduras

Additional guidance documents and a simple trajectory model for the Gulf of Fonseca were also completed. Scenarios were developed and shortfalls identified for **spill contingency plans** in Nicaragua and other participating countries. Contingency plans, to be completed by the Nicaraguans, identify resources at risk, response priorities, scenarios, and organizational structures for the region and/or for each country. Standard training tools used by NOAA were modified and

translated into Spanish for use in the final one-week workshop in San Pedro Sula, Honduras. An additional training aid, the Trajectory Analysis Handbook, was developed as part of this effort. The following tools and guidance documents were used during the workshop and distributed to all participants:

1. Aerial Observations of Oil. This guidebook contains pictures of various types of oil spilled at sea and includes definitions and standard terminology used to define oil's appearance on the water.

2. Shoreline Assessment Job Aid. Habitat identification and a methodology for identifying, quantifying and recording shoreline oil impact are provided in this field guide. The habitat depictions correlate to those in the Environmental Sensitivity Index work.

3. Coastal Characteristics. Response technologies for habitats identified on ESI and in the Shoreline Assessment Job Aid are evaluated and discussed in this guidebook.

4. Trajectory Analysis Handbook. The physical processes relevant to determining the movement of oil are summarized and presented in this field guide.

5. Computer Aided Management of Emergency Operations (CAMEO). The CAMEO program was translated into Spanish as part of a separate EPA-sponsored effort, but proved quite appropriate for use in this effort. This tool provides access to response information for 6,090 chemicals, including physical property information and over 60,000 synonyms to assist in chemical identification.

6. Automated Data Inquiry of Oil Spills (ADIOS). The ADIOS program was the only tool used as part of the workshop that was not available in Spanish. Because of the extensive nature of the program, it was not initially considered as part of this technology transfer activity. However, during preparatory activities for the training and contingency planning workshops, it was identified as a useful tool by local agencies - even if it only existed in English. This model has a database of approximately 1,000 oil and oil products. By providing local environmental information (such as air and sea temperature, wind speed, wave heights, and salinity), weathering processes of specific oils can be identified (such as evaporation, dispersion, dissolution, etc.) and relevant property changes over time can be calculated (e.g., viscosity, water content).

SUSTAINABLE, RESILIENT COASTAL COMMUNITIES

See Gulf of Fonseca activities section.

ECONOMIC REVITALIZATION

See Regional activities section.

GUATEMALA

The following table summarizes the Department of Commerce activities in Guatemala.

GUATEMALA ACTIVITIES

Base Infrastructure Reconstruction

- Reconstruction and improvement of the geodetic network
- Installation of five automatic weather stations – Puerto San Jose, Huehuetenango, Retalhelhu, Quetzaltenango, and Puerto Barrios
- Installation of ten manual weather stations – Guatemala City Climate Insitute, Airport, Coban, Huehuetenango, Lavor Ovalle, La Fragua, Volcan de Fuego, Santiaguito, Pacaya, Montufar
- Installation of five automatic rain gages – Guatemala City, Sacupular, Santiago Atitlan, Escuintla, Antigua
- Installation of voice radios and a repeater station to improve data and information transmission
- Installation of three rain gages and one stream gage for a flood forecast and warning system – Chilasco, Purhula, Covocte, Teleman (streamgage/rain gage)
- Installation of tide gages at Puerto Quetzal and Puerto Santo Tomas de Castilla
- Installation of a Local Area Network at INSIVUMEH for data and information sharing throughout the agency
- Installation of a rain gage under the DOC Río Lempa Watershed Program
- Installation of satellite workstations under the DOC Regional Program

Forecast and Early Warning Systems

- Installation of a flood forecast and warning system for the Río Polochic
- Development of Strategic Plans for hydrometeorological services
- Development of a climate prediction system under the DOC Regional Program

Disaster Preparedness and Response

- Implementation of training programs for forecast, warning, preparedness, and response institutions
- Implementation of programs to increase capacity for local response authorities to prevent, plan for, and respond to spills of oil or other hazardous chemicals

Sustainable, Resilient Coastal Communities

- No activities

Economic Revitalization

- Development of activities under the DOC Economic Revitalization Regional Program

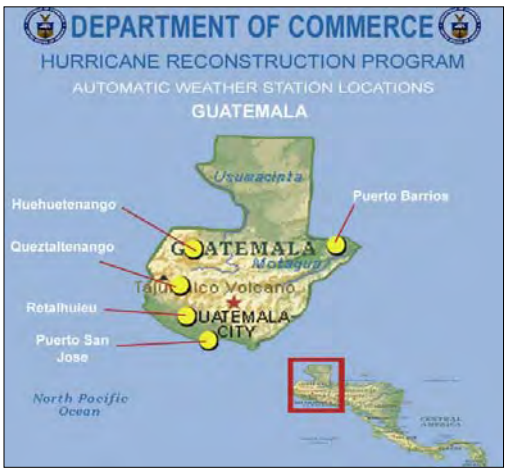
BASE INFRASTRUCTURE RECONSTRUCTION

The Department's objectives for this problem area were to accomplish the following:

- Provide a foundation for ongoing reconstruction efforts
- Reconstruct and improve weather forecast and early warning networks
- Promote safe and efficient air and marine transportation
- Provide for a geo-spatial data and water level reference framework
- Ensure that capacity exists to maintain and expand new base infrastructure

To accomplish these objectives, monitoring equipment was installed at various locations throughout the country and programs were developed to appropriately use the data collected by this equipment for a variety of purposes. The Department's goal was to install the most appropriate technology based on local capacities and resources to ensure the highest probability of sustaining the systems.

The hydrometeorological monitoring network was improved and expanded to support and strengthen the weather forecasting and early warning capabilities of the country. **Automatic weather stations** were installed at Puerto San Jose, Huehuetenango, Retalhelhu, Quetzaltenango, and Puerto Barrios. These stations, which measure wind speed and direction, air temperature, humidity, rainfall, soil temperature, evaporation, solar radiation, and atmospheric pressure on a 10-meter tower will provide critical meteorological data useful for weather forecasting, for flood early warnings, and for monitoring tropical storms and hurricanes. The data collected directly by the automatic weather station are transmitted via the GOES Satellite Data Collection System (DCS) (the GOES DCS is operated by the National Oceanic and Atmospheric Administration – National Environmental Satellite, Data and Information Service, NOAA/NESDIS). INSIVUMEH in Guatemala City accesses the transmitted data from the NOAA/NESDIS computers via telephone modem or the Internet. In addition, each station is manned by an observer who provides visible observations of weather conditions at each station. These visible observations are entered into the weather station computer and then, along with the data recorded on the tower, are transmitted via telephone modem to Guatemala City. INSIVUMEH also employs a voice radio system as a backup. The Department provided additional voice radios and a repeater station in order to expand the INSIVUMEH data transmission network.

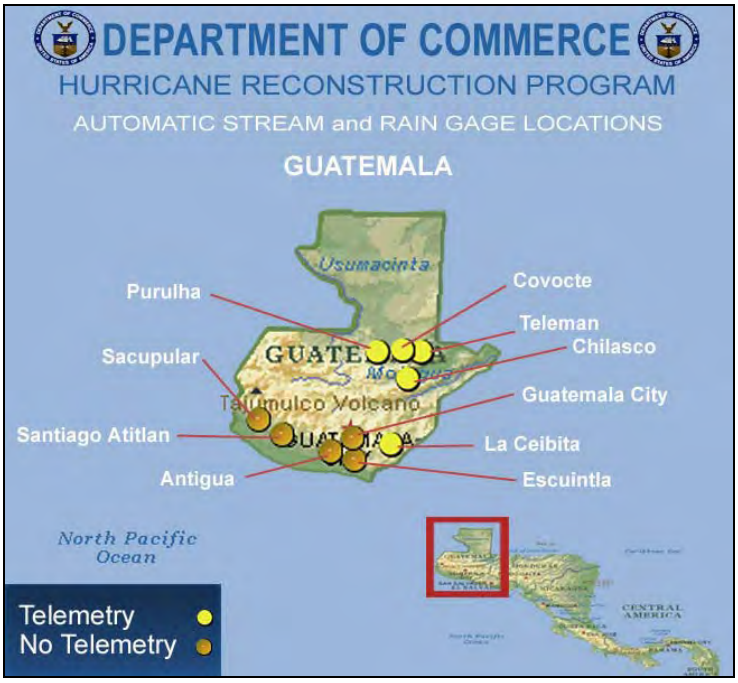


Automatic Weather Station Locations – Guatemala

Retalhuleu Weather Station

Since many of the INSIVUMEH manual weather stations were destroyed during Hurricane Mitch, the Department initially provided 10 basic weather stations in order to get weather information flowing again throughout the country.

In support of flood forecast and warning systems and for local flood warnings, the Department installed and/or provided automatic rain gages and streamgages throughout Guatemala. Although all gages are automatic, some have no direct telemetry back to INSIVUMEH in Guatemala City but have data transmitted via voice radio by a local observer.



Automatic Rain and Stream Gage Locations - Guatemala

The **tide gages** installed at Puerto Quetzal (Puerto San Jose) and Puerto Santo Tomas de Castilla are part of the Water Level Observation Network for Central America (RONMAC) installed by the Department as part of the Hurricane Reconstruction Program. The primary purpose of RONMAC is to provide support for the development and improvement of the geodetic framework of Central America. However, information and data derived from RONMAC will also be used in decision-making by a variety of national and regional agencies responsible for coastal resource management. Coastal management agencies will use these data to assist with monitoring the water quality, impact of sea level rise as a result of global climate change, and preparing coastal zone management plans. Regulatory agencies will use the data for permitting and enforcement and to determine marine boundaries for jurisdiction and managing offshore minerals resources. Emergency management agencies will use the data to prepare storm evacuation maps, to assist with early coastal hazard warnings for hurricanes and tsunamis, and coastal sea level predictions associated with climate change. Data from the RONMAC supports the design, development and construction of harbor facilities to enhance maritime commerce, production of accurate nautical charts, and improvement of marine nowcasts and forecasts. RONMAC stations will also have the capability of providing real-time water level and meteorological data to large vessels (oil tankers, containers, and cruise) and port officials to improve safe navigation and docking operations.
The two stations consist of an air acoustic water level sensor, a backup pressure water level sensor, a protective well, meteorological sensors, a data collection platform (DCP), GOES satellite radio

transmitter, a voice modem, VHF radio, and a permanent bench mark network composed of a minimum of five bench marks. GOES telemetry is the primary mode of data retrieval for RONMAC, telephone retrieval is optional. In addition to the sea level monitoring, it is important to understand coastal processes from the standpoint of "air-sea interaction". To accomplish this, other physical attributes were designed into the system. The additional sensors included the following: sea surface temperature, air temperature, barometric pressure, rainfall, solar radiation, wind speed and direction, and relative humidity.

IGN and INSIVUMEH were the Department's counterpart agencies in Guatemala for the tide gage installations.

Guatemala Tide Gage Locations

The **Puerto Quetzal** (Puerto San Jose) station is shown on the left and the **Puerto Santo Tomas de Castillo** station is shown on the right.

The Department reconstructed and improved **geodetic networks** in Guatemala. Components included: continuously operating reference systems installed in Guatemala City, with dual frequency global positioning system (GPS) receivers, 24 hour continuous tracking capability, and 1-2 cm

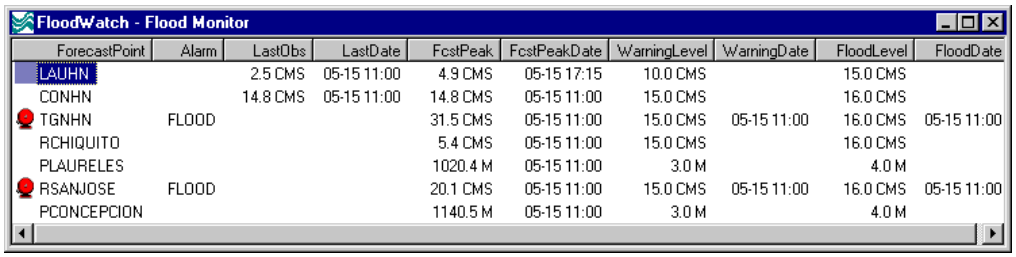
accuracy, analysis and processing of a high accuracy GPS reference network; training in station installation and GPS data processing, and links to international GPS networks. Improvements in local and regional geodetic information and infrastructure will support economic development, the effective management of property and natural resources, and improve preparation for and response to future natural disasters.

The Department installed a **Local Area Network** (LAN) at INSIVUMEH, connecting all sections within the agency. This will allow for easy data and information sharing between the hydrology and meteorology sections – including flood forecast and warning system outputs, satellite imagery, data from automatic weather stations and gaging stations.

Also see the DOC Río Lempa Watershed and Regional Programs sections for additional Base Infrastructure Reconstruction activities.

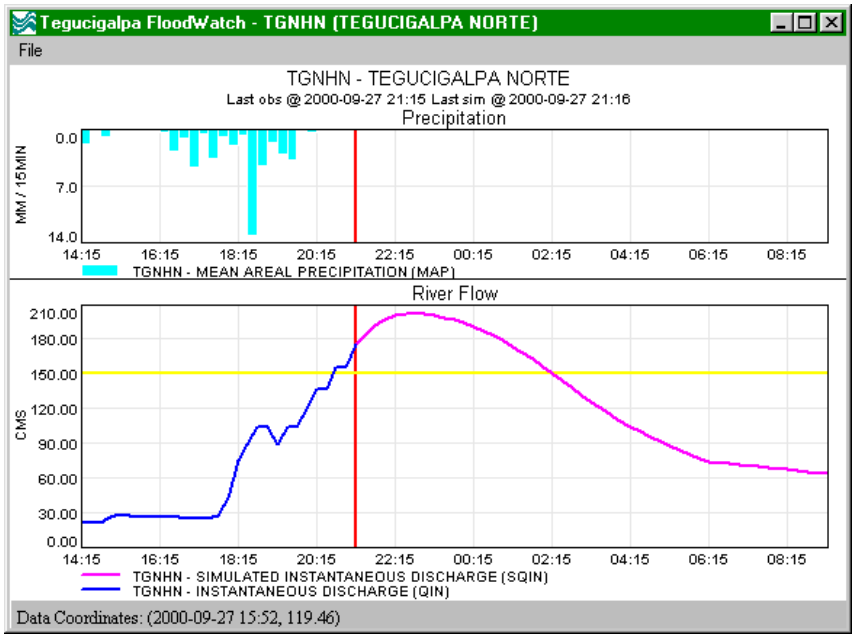
FORECAST AND EARLY WARNING SYSTEMS

The Department installed **flood forecast and early warning systems** in the Río Polochic river basins in Guatemala. This system is comprised of an automatic rain and stream gage monitoring network and hydrologic models calibrated for both basins. The modeling system used in the basin, FloodWatch, simulates the hydrologic response of the basins as a function of input rainfall, observed streamflow, reservoir information, and other data. Streamflow forecasts are generated at points along the river called forecast points – streamgages are located at each forecast point to verify the forecasts. The system is designed to allow operator interaction or to be run in a more automated mode. The operator can also input quantitative rainfall forecast information to further enhance the hydrologic forecasts. The FloodWatch system is installed at INSIVUMEH. Displays are available in tabular or graphical form.



ForecastPoint	Alarm	LastObs	LastDate	FcstPeak	FcstPeakDate	WarningLevel	WarningDate	FloodLevel	FloodDate
LAUHN		2.5 CMS	05-15 11:00	4.9 CMS	05-15 17:15	10.0 CMS		15.0 CMS	
CONHN		14.8 CMS	05-15 11:00	14.8 CMS	05-15 11:00	15.0 CMS		16.0 CMS	
TGNHN	FLOOD			31.5 CMS	05-15 11:00	15.0 CMS	05-15 11:00	16.0 CMS	05-15 11:00
RCHIQUITO				5.4 CMS	05-15 11:00	15.0 CMS		16.0 CMS	
PLAURELES				1020.4 M	05-15 11:00	3.0 M		4.0 M	
RSANJOSE	FLOOD			20.1 CMS	05-15 11:00	15.0 CMS	05-15 11:00	16.0 CMS	05-15 11:00
PCONCEPCION				1140.5 M	05-15 11:00	3.0 M		4.0 M	

Tabular Flood Monitor Example Showing Flood Status at Forecast Points



Graphical Display Example for a Particular Forecast Point

For the Río Polochic system, the primary river forecast point is located at Teleman. The Department installed an automatic streamgage and rain gage at Teleman for input to the modeling system. Other rain gages are installed in the upper portions of the watershed – at Chilasco, Purhula, and Covocte. Key communities in the basin are Teleman and Panzós.

Flood Warning and Forecast Systems - Guatemala

An additional activity under this problem area was the **development of strategic plans** for the operations of the hydrometeorological services and consequent improvement of forecast and early warning capabilities. This activity was deemed important since, in general, these services are poorly funded and do not have high esteem within each government. The purpose of the plans was to provide guidance and direction for strengthening the services, a process begun during the Department's Hurricane Reconstruction Project. During the course of developing the plans, the directors of each service were interviewed regarding current operations, mandates, and vision for strengthening the services. Based on these interviews, a simple, inexpensive strategy was developed to assist with continued or further strengthening. The theme was the same for each country as all faced the same problems and issues – funding and poor visibility. The plans, which were transmitted to each USAID mission, focused on the following key themes – implement a technical advisory committee comprised of members from other government agencies, academia, and industry to help develop future strategies for advancing the agency (to improve credibility within the government); promote better coordination with other key institutions in the government; promote higher visibility with the media through press releases, interviews, regularly scheduled programs, Internet web pages; develop a risk assessment capability for preventing, reducing and managing risks for extreme natural phenomena (e.g., develop risk atlases); improve information and data processing capabilities; and continue developing sound approaches to system maintenance and upgrading monitoring networks.

DISASTER PREPAREDNESS AND RESPONSE

Many of the DOC activities under the Disaster Preparedness and Response Problem Area involved the implementation of various **training programs and workshops** for the forecast, warning, preparedness, and response agencies. The emphasis of the activities was **capacity building** to better prevent, plan for or respond to disasters or to ensure sustainability of the tools and programs installed and instituted by the Department. Some of these programs involved operations and maintenance of monitoring equipment installed by the Department and others on the collection, analysis, and application of various data and information needed by these agencies to fulfill their missions. Training in this problem area also supplemented various training activities performed in each of the other problem areas. Training activities in Guatemala included those shown on the following table.

TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
Flood Forecasting Workshop	October – December 1999	United States	INSIVUMEH
Satellite Meteorology		Costa Rica	INSIVUMEH
Four Week Training Course at the Tropical Desk at NOAA – Training in Tropical Forecasting	July – September 2000	United States	INSIVUMEH
Operation and Maintenance of PCBASE2 software for the Flood Warning System	October – December 2000	Guatemala	INSIVUMEH
Operation and Maintenance of Automatic Weather Stations		Guatemala	INSIVUMEH
Flood Forecasting Workshop and Hydrologic Forecasting and Analysis Course		United States	INSIVUMEH
Operation and Maintenance of Automatic Weather Stations	January – March 2001	Guatemala	INSIVUMEH
Operation and Maintenance of Tide Gages		Guatemala	INSIVUMEH
Four Week Training Course at the Tropical Desk at NOAA – Training in Tropical Forecasting (second trainee)		United States	INSIVUMEH
Climate Variability and Extreme Events for Central America		Costa Rica	INSIVUMEH

TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
Tide Gage Regional Technical Training Workshop	April – June 2001	Guatemala	IGN, Empresa Nacional Portuaria, INSIVUMEH
Operation of Concepts for FloodWatch Software, Concepts of Flood Forecasting, Operations of Hydrologic Forecast Center		Guatemala	INSIVUMEH
RAMSDIS Satellite Workstation Operation, Use of Environmental Data in Meteorological Applications – fire detection, volcanic ash detection, forecasting		Costa Rica	INSIVUMEH
RAMSDIS Satellite Workstation Installation and On-Site Training for Operations	July – September 2001	Guatemala	INSIVUMEH
Tide Gage Regional Technical Training Workshop	October – December 2001	Costa Rica	IGN, Empresa Nacional Portuaria, INSIVUMEH
Operation of FloodWatch Software for the Río Polochic		Guatemala	INSIVUMEH
Spill Response and Contingency Planning Workshops		Honduras	Empresa Nacional Portuaria, Navy, INSIVUMEH
RAMSDIS Satellite Workstation Operation, Use of Environmental Data in Meteorological Applications		Costa Rica	INSIVUMEH

TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
Hydrometeorological Monitoring System Maintenance Planning and Logistics Workshop Geodetic Surveys (January 2002)	October – December 2001	United States Guatemala	INSIVUMEH IGN
Operational Meteorology and Hydrology Post Graduate Course	15 Months (2000-2001)	University of Costa Rica	INSIVUMEH (1 Student)*
Hydrometeorological and Sea Level Monitoring System Installation, Operation and Maintenance Training (done during installation of equipment)	Entire Program	Guatemala	INSIVUMEH, IGN, Empresa Nacional Portuaria, Navy

* Thesis Title – Niebla Sobre el Aeropuerto Internacional 'La Aurora' Ciudad de Guatemala

In addition to the training activities discussed above, scenarios were developed and shortfalls identified for **spill contingency plans** in Guatemala and other participating countries. Contingency plans, to be completed by Guatemala, identify resources at risk, response priorities, scenarios, and organizational structures for the region and/or for each country. Standard training tools used by NOAA were modified and translated into Spanish for use in the final one-week workshop in San Pedro Sula, Honduras. An additional training aid, the Trajectory Analysis Handbook, was developed as part of this effort. The following tools and guidance documents were used during the workshop and distributed to all participants:

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3. Coastal Characteristics. Response technologies for habitats identified on products such as Environmental Sensitivity Indexes and in the Shoreline Assessment Job Aid are evaluated and discussed in this guidebook.

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SUSTAINABLE, RESILIENT COASTAL COMMUNITIES

No activities in this problem area for Guatemala

ECONOMIC REVITALIZATION

See Regional activities section

EL SALVADOR

The following table summarizes the Department of Commerce activities in El Salvador.

EL SALVADOR ACTIVITIES

Base Infrastructure Reconstruction

- Reconstruction and improvement of the geodetic network
- Installation of five automatic weather stations – Acajutla, San Miguel, Ilopango, Santa Ana, La Union
- Installation of two rain gages for a flood warning system – San Francisco Gotera, Chapeltique
- Installation of tide gages at Acajutla, La Union, and La Pita
- Installation of a rain gages under the DOC Río Lempa Watershed Program
- Installation of satellite workstations under the DOC Regional Program

Forecast and Early Warning Systems

- Installation of a flood warning system for the Río Grande de San Miguel
- Development of a climate prediction system under the DOC Regional Program
- Development of Strategic Plans for Hydrometeorological services
- Installation of a river and flood forecast system and a river forecast center under the DOC Río Lempa Watershed Program

Disaster Preparedness and Response

- Implementation of training programs for forecast, warning, preparedness, and response institutions
- Implementation of programs to increase capacity for local response authorities to prevent, plan for, and respond to spills of oil or other hazardous chemicals

Sustainable, Resilient Coastal Communities

- Development of activities under the DOC Gulf of Fonseca Program

Economic Revitalization

- Development of activities under the DOC Economic Revitalization Regional Program

In addition to the bilateral activities accomplished under the Hurricane Reconstruction Program in El Salvador, many other activities were also done under the Río Lempa Watershed Program, also part of the Hurricane Reconstruction Program. The bilateral and Río Lempa activities were complimentary, especially for the areas of Base Infrastructure Reconstruction and Forecast and Early Warning Systems.

BASE INFRASTRUCTURE RECONSTRUCTION

The Department's objectives for this problem area were to accomplish the following:

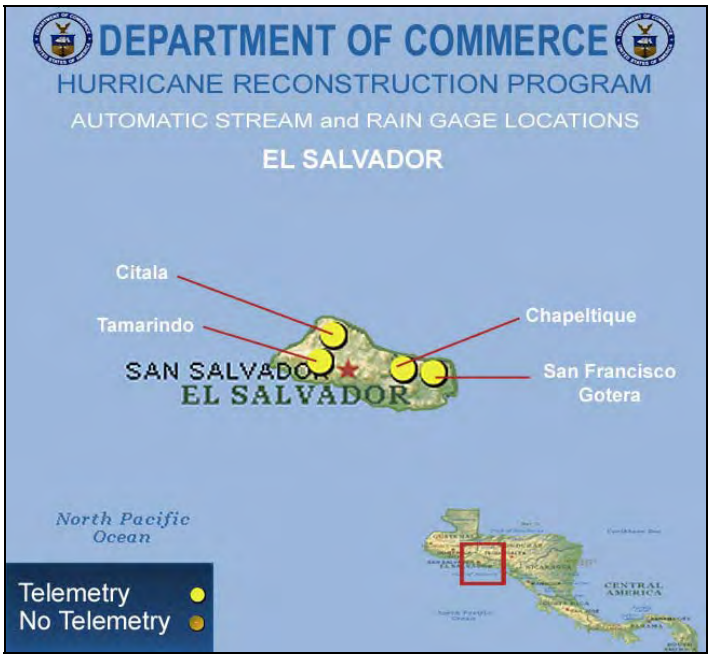
- Provide a foundation for ongoing reconstruction efforts
- Reconstruct and improve weather forecast and early warning networks
- Promote safe and efficient air and marine transportation
- Provide for a geo-spatial data and water level reference framework
- Ensure that capacity exists to maintain and expand new base infrastructure

To accomplish these objectives, monitoring equipment was installed at various locations throughout the country and programs were developed to appropriately use the data collected by this equipment for a variety of purposes. The Department's goal was to install the most appropriate technology based on local capacities and resources to ensure the highest probability of sustaining the systems.

The hydrometeorological monitoring network was improved and expanded to support and strengthen the weather forecasting and early warning capabilities of the country. **Automatic weather stations** were installed at Ilopango, San Miguel, Acajutla, Santa Ana, and La Union. These stations, which measure wind speed and direction, air temperature, humidity, rainfall, solar radiation, and atmospheric pressure on a 10-meter tower, will provide critical meteorological data useful for weather forecasting, for flood early warnings, and for monitoring tropical storms and hurricanes. Each station is manned by an observer who provides visible observations of weather conditions at the station. These visible observations are entered into the weather station computer and then, along with the data recorded on the tower, are transmitted via telephone modem or line-of-site radio to the SNET meteorological forecast center in San Salvador. The data collected directly by the automatic weather station are also transmitted to a Digital Readout Ground Station (DRGS) located at the SNET in San Salvador via the GOES Satellite Data Collection System (DCS) (the GOES DCS is operated by the National Oceanic and Atmospheric Administration – National Environmental Satellite, Data and Information Service, NOAA/NESDIS). The DRGS was installed as part of the Río Lempa Watershed Program.

Automatic Weather Station Locations - El Salvador

In support of the flood warning system on the Río Grande de San Miguel, the Department installed automatic rain gages at San Francisco Gotera and Chapeltique in the upper parts of that river basin. Data from these gages are transmitted to San Salvador via the GOES Satellite Data Collection System (DCS) and received by the DRGS located at the SNET hydrologic forecast center in San Salvador.



Automatic Rain Gage Locations – El Salvador

(Note that the Citala and Tamarindo gages were installed as part of the Río Lempa Watershed Program)

The key counterpart for the hydrometeorological program was the SNET.

The **tide gages** installed at Acajutla and La Union are part of the Water Level Observation Network for Central America (RONMAC) installed by the Department as part of the Hurricane Reconstruction Program. (The tide gage installed at La Pita on the Río Lempa was installed specifically to support the flood warnings for the lower Río Lempa developed under the Río Lempa watershed Program.) The primary purpose of RONMAC is to provide support for the development and improvement of the geodetic framework of Central America. However, information and data derived from RONMAC will also be used in decision-making by a variety of national and regional agencies responsible for coastal resource management. Coastal management agencies will use these data to assist with monitoring the water quality, impact of sea level rise as a result of global climate change, and preparing coastal zone management plans. Regulatory agencies will use the data for permitting and enforcement and to determine marine boundaries for jurisdiction and managing offshore minerals resources. Emergency management agencies will use the data to prepare storm evacuation maps, to assist with early coastal hazard warnings for hurricanes and tsunamis, and coastal sea level predictions associated with climate change. Data from the RONMAC supports the design, development and construction of harbor facilities to enhance maritime commerce, production of accurate nautical charts, and improvement of marine nowcasts and forecasts. RONMAC stations will

also have the capability of providing real-time water level and meteorological data to large vessels (oil tankers, containers, and cruise) and port officials to improve safe navigation and docking operations. The three stations consist of an air acoustic water level sensor, a backup pressure water level sensor, a protective well, meteorological sensors, a data collection platform (DCP), GOES satellite radio transmitter, a voice modem, VHF radio, and a permanent bench mark network composed of a minimum of five bench marks. GOES telemetry is the primary mode of data retrieval for RONMAC, telephone retrieval is optional. In addition to the sea level monitoring, it is important to understand coastal processes from the standpoint of "air-sea interaction". To accomplish this, other physical attributes were designed into the system. The additional sensors included the following: sea surface temperature, air temperature, barometric pressure, rainfall, solar radiation, wind speed and direction, and relative humidity.

IGN was the Department's counterpart agency in El Salvador for the tide gage installations.

El Salvador Tide Gage Locations

The **Acajutla** station is shown on the left and the **La Union** station is shown on the right.

La Pita Tide Gage (Rio Lempa)

The Department reconstructed and improved **geodetic networks** in El Salvador. Components included: a continuously operating reference system installed in San Salvador, with dual frequency global positioning system (GPS) receivers, 24 hour continuous tracking capability, and 1-2 cm accuracy, analysis and processing of a high accuracy GPS reference network; training in station installation and GPS data processing, and links to international GPS networks. Improvements in local and regional geodetic information and infrastructure will support economic development, the effective management of property and natural resources, and improve preparation for and response to future natural disasters.

Also see the DOC Río Lempa Watershed and Regional Programs sections for additional Base Infrastructure Reconstruction activities.

FORECAST AND EARLY WARNING SYSTEMS

The Department installed a **community-based flood warning system (ALERT)** on the Río Grande de San Miguel. The system includes automatic rain gages at San Francisco Gotera and Chapletique and automatic streamgage/rain gages at San Miguel and El Dilirio. The U.S. Geological Survey installed the two automatic stream and rain gages. A computer base station is located at the SNET hydrologic forecast center in San Salvador. Alarms go off at the base station once certain rainfall amount thresholds are exceeded at the up-river gage locations. Once alarmed, the base station automatically transmits a warning via facsimile to Concepcion Batres (the key community downstream) and the central and regional emergency management agency (COEN) offices. The warning is then disseminated via radios provided by the Department to threatened communities along the river. Data are transmitted from the gages to the base station via the GOES Satellite Data Collection System (DCS) and DRGS in San Salvador. In addition to the rain and stream gages, an automatic weather station, installed by the Department in San Miguel is also used to support the issuance of warnings for potential flood conditions along the river.

Flood Warning System Training - El Salvador

Training the Community Leaders - Concepcion Batres

An additional activity under this problem area was the **development of strategic plans** for the operations of the hydrometeorological services and consequent improvement of forecast and early warning capabilities. This activity was deemed important since, in general, these services are poorly funded and do not have high esteem within each government. The purpose of the plans was to provide guidance and direction for strengthening the services, a process begun during the Department's Hurricane Reconstruction Project. During the course of developing the plans, the directors of each service were interviewed regarding current operations, mandates, and vision for strengthening the services. Based on these interviews, a simple, inexpensive strategy was developed to assist with continued or further strengthening. The theme was the same for each country as all faced the same problems and issues – funding and poor visibility. The plans, which were transmitted to each USAID mission, focused on the following key themes – implement a technical advisory committee comprised of members from other government agencies, academia, and industry to help develop future strategies for advancing the agency (to improve credibility within the government); promote better coordination with other key institutions in the government; promote higher visibility with the media through press releases, interviews, regularly scheduled programs, Internet web pages; develop a risk assessment capability for preventing, reducing and managing risks for extreme natural phenomena (e.g., develop risk atlases); improve information and data processing capabilities; and continue developing sound approaches to system maintenance and upgrading monitoring networks.

DISASTER PREPAREDNESS AND RESPONSE

Many of the DOC activities under the Disaster Preparedness and Response Problem Area involved the implementation of various **training programs and workshops** for the forecast, warning, preparedness, and response agencies. The emphasis of the activities was **capacity building** to better prevent, plan for or respond to disasters or to ensure sustainability of the tools and programs installed and instituted by the Department. Some of these programs involved operations and maintenance of monitoring equipment installed by the Department and others on the collection, analysis, and application of various data and information needed by these agencies to fulfill their missions. Training in this problem area also supplemented various training activities performed in each of the other problem areas. Training activities in El Salvador included those shown on the following table.

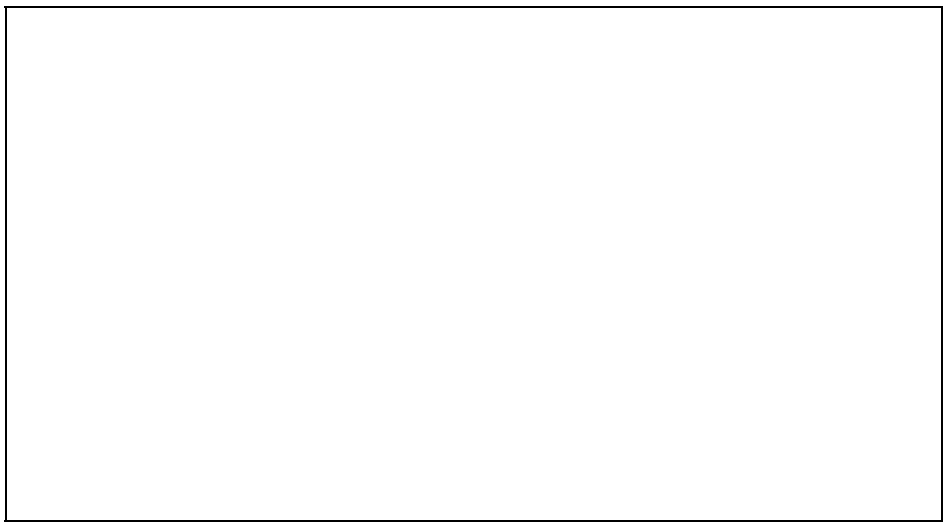
TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
Flood Forecasting Workshop	October – December 1999	United States	SNET
Satellite Meteorology		Costa Rica	SNET
Contaminant Monitoring in Various Media and Chemical Analysis Techniques	April - June 2000	El Salvador	FUSADES, MARN, Ministry of Health, CENDEPESCA, Navy, Univ. of El Salvador, Dept. de Salud (La Union), ESPINSA
Operation and Maintenance of Automatic Weather Stations and Rain Gages		El Salvador	SNET
Operation and Maintenance of PCBASE2 Software for ALERT		El Salvador	SNET
Installation, Operation and Maintenance of Automatic Rainfall and Weather Stations	July - September 2000	El Salvador	SNET
Operation and Maintenance of PCBASE2 Software for ALERT		El Salvador	SNET
Operation and Maintenance of PCBASE2 Software for ALERT	October – December 2000	El Salvador	SNET
ALERT Rainfall Threshold Development		El Salvador	SNET
Operation and Maintenance of Automatic Weather Stations and Rain Gages, Data Quality Control		El Salvador	SNET

TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
Flood Forecasting Workshop and Hydrologic Forecasting and Analysis Course	October – December 2000	United States	SNET
Contaminant Monitoring in Various Media and Chemical Analysis Techniques		El Salvador	FUSADES, MARN, Ministry of Health, CENDEPESCA, Navy, Univ. of El Salvador, Dept. de Salud (La Union), ESPINSA
Extension Agents to Promote Sustainable Uses of the Gulf of Fonseca Resources		El Salvador	FUSADES, MARN, Ministry of Health, CENDEPESCA, Navy, Univ. of El Salvador, Dept. de Salud,ESPINSA
Climate Variability and Extreme Events for Central America	December – March 2001	Costa Rica	SNET
Tide Gage Regional Technical Training Workshop	April – June 2001	Guatemala	INETER, Empresa Nacional Portuaria
ALERT Concept of Operations for Río Grande de San Miguel System		El Salvador	SNET, COEN, Local Community
Operations of ALERT Software		El Salvador	SNET, COEN
Sampling Techniques for Sediment, Fish, and Crabs		El Salvador	FUSADES, MARN, Ministry of Health, CENDEPESCA, Navy, Univ. of El Salvador, Dept. de Salud, ESPINSA
RAMSDIS Satellite Workstation Operation, Use of Environmental Data in Meteorological Applications – fire detection, volcanic ash detection, forecasting	April – June 2001	Costa Rica	SNET

TRAINING DESCRIPTION	QUARTER ACCOMPLISHED	LOCATION	ORGANIZATIONS TRAINED
Operation and Maintenance of Automatic Weather Stations and Rain Gages	July – September 2001	El Salvador	SNET
RAMSDIS Satellite Workstation Installation and On-Site Training for Operations		El Salvador	SNET
Tide Gage Regional Technical Training Workshop	October – December 2001	Costa Rica	IGN
Spill Response and Contingency Planning Workshops		Honduras	PROARCA/COSTAS, Empresa Nacional Portuaria, Navy
Geodetic Training (January 2002)		El Salvador	IGN
RAMSDIS Satellite Workstation Operation, Use of Environmental Data in Meteorological Applications		Costa Rica	SNET
Hydrometeorological Monitoring System Maintenance Planning and Logistics Workshop		United States	SNET
Operational Meteorology and Hydrology Post Graduate Course	15 Months (2000-2001)	University of Costa Rica	SNET (two students)
Hydrometeorological and Sea Level Monitoring System Installation, Operation and Maintenance Training (done during installation of equipment)	Entire Program	El Salvador	SNET, IGN, Empresa Nacional Porturia

In addition to the training activities discussed above, the Department also accomplished **spill preparedness and response** activities in El Salvador. These activities provided local response authorities with increased capacity to prevent, plan for, and respond to spills of oil or other hazardous chemicals. This was accomplished through a series of activities, culminating in training and workshops.

Products included **Environmental Sensitivity Indexes** (ESI) for El Salvador in the Gulf of Fonseca up to the extent of tidal influence. A total of nine maps, similar to the one shown below, were available for El Salvador from a previous study done in 1998. Therefore, the Department developed no maps for the Hurricane Reconstruction Program.



Environmental Sensitivity Index Map - San Lorenzo, Honduras

Additional guidance documents and a simple trajectory model for the Gulf of Fonseca were also completed. Scenarios were developed and shortfalls identified for **spill contingency plans** in El Salvador and other participating countries. Contingency plans, to be completed by El Salvador, identify resources at risk, response priorities, scenarios, and organizational structures for the region and/or for each country. Standard training tools used by NOAA were modified and translated into Spanish for use in the final one-week workshop in San Pedro Sula, Honduras. An additional training aid, the Trajectory Analysis Handbook, was developed as part of this effort. The following tools and guidance documents were used during the workshop and distributed to all participants:

1. Aerial Observations of Oil. This guidebook contains pictures of various types of oil spilled at sea and includes definitions and standard terminology used to define oil's appearance on the water.

2. Shoreline Assessment Job Aid. Habitat identification and a methodology for identifying, quantifying and recording shoreline oil impact are provided in this field guide. The habitat depictions correlate to those in the Environmental Sensitivity Index work.

3. Coastal Characteristics. Response technologies for habitats identified on ESI and in the Shoreline Assessment Job Aid are evaluated and discussed in this guidebook.

4. Trajectory Analysis Handbook. The physical processes relevant to determining the movement of oil are summarized and presented in this field guide.

5. Computer Aided Management of Emergency Operations (CAMEO). The CAMEO program was translated into Spanish as part of a separate EPA-sponsored effort, but proved quite appropriate for use in this effort. This tool provides access to response information for 6,090 chemicals, including physical property information and over 60,000 synonyms to assist in chemical identification.

6. Automated Data Inquiry of Oil Spills (ADIOS). The ADIOS program was the only tool used as part of the workshop that was not available in Spanish. Because of the extensive nature of the program, it was not initially considered as part of this technology transfer activity. However, during preparatory activities for the training and contingency planning workshops, it was identified as a useful tool by local agencies - even if it only existed in English. This model has a database of approximately 1,000 oil and oil products. By providing local environmental information (such as air and sea temperature, wind speed, wave heights, and salinity), weathering processes of specific oils can be identified (such as evaporation, dispersion, dissolution, etc.) and relevant property changes over time can be calculated (e.g., viscosity, water content).

SUSTAINABLE, RESILIENT COASTAL COMMUNITIES

See Gulf of Fonseca activities section.

ECONOMIC REVITALIZATION

See Regional activities section.

DOMINICAN REPUBLIC

The following table summarizes the Department of Commerce activities in the Dominican Republic.

DOMINICAN REPUBLIC ACTIVITIES

Base Infrastructure Reconstruction

- No activities

Forecast and Early Warning Systems

- No activities

Disaster Preparedness and Response

- Implementation of training programs for forecast, warning, preparedness, and response institutions - sponsorship of a student at the University of Costa Rica for post graduate program in operational meteorology and hydrology
- Development of a Reservoir Management Strategy for a key reservoir – inflow forecasting and flood inundation mapping
- Development of a National Early Warning System Implementation Plan

Sustainable, Resilient Coastal Communities

- Assessment and strengthening of technical guidance for housing construction techniques to be more resistant to natural hazards
- Assessment the disaster resistance of facilities that serve a critical function during natural disasters

Economic Revitalization

- No activities

DISASTER PREPAREDNESS AND RESPONSE

As with the countries in Central America impacted by Hurricane Mitch, the Department's focus in the Disaster Preparedness and Response problem area focused on the strengthening and capacity building of counterpart agencies in the Dominican Republic. To accomplish this, the Department identified three activities.

- Sponsorship of a student at the University of Costa Rica for a post graduate course in operational meteorology and hydrology
- Preparation of a report discussing reservoir management strategies
- Preparation of an implementation plan for a National Early Warning System

Post Graduate Course

The Department, in conjunction with the Comite Regional de Recursos Hidraulicos del Istmo Centroamericano (CRRH) and the University of Costa Rica developed and implemented a postgraduate course in operational meteorology and hydrology. The course was approximately 15 months long and held at the University of Costa Rica. The Department, through the Hurricane Reconstruction Program, sponsored one student from the meteorological service in the Dominican Republic – ONAMET. The purpose of the course was to build **operational meteorological and hydrologic capacity** within the country. The student from the Dominican Republic successfully completed the course and graduated. His thesis title was *Variación de las Ondas Tropicales Que Atravesaron la Region del Caribe Durante el Año 2000*.

Reservoir Management Strategies

After Hurricane Georges struck the Dominican Republic in September 1998, concerns were raised because of flooding impacts from the hurricane below the Sabaneta Reservoir where 200 people lost their lives. There were questions concerning proper use of the reservoir for flood control. Of primary interest was, if the proper information and data were available - could the reservoir have been drawn down before the hurricane struck thus allocating storage for the amount of anticipated rainfall runoff. Therefore, this activity was proposed to provide support to the Government of the Dominican Republic in the area of **reservoir management**. The counterpart agency in the Dominican Republic government for this activity is El Instituto Nacional de Recursos Hidráulicos (INDRHI).

Based on available information at the time, the Department first proposed to prepare a framework of a reservoir optimization or decision support system for INDRHI. Using this framework as a guide, INDRHI could then design and procure a system that could be used to help manage the reservoirs through reallocating storage and looking at tradeoffs between flood control and water supplies (including evaluating safety and economic concerns).

However, as pointed out by INDRHI during subsequent fact-finding meetings the primary use of the reservoirs is water supply for irrigation with a secondary function being the generation of electricity. The dams are not designed for flood control and there are no controlled spillways (i.e., with gates). In addition, after reviewing what happened during Hurricane Georges, specific action plans have been drafted by the Emergency Reservoir Committee of the government of the Dominican Republic. These plans address actions required by the dam operators during heavy rainfall events such as tropical storms and hurricanes – especially for the Sabaneta Reservoir, located in the western part of the Dominican Republic.

Though there are many aspects to reservoir management, discussions of enhancements to **existing operations** that take advantage of **existing** (or planned) available information and data may provide INDRHI with a more useful product. Therefore, the Department's report provided overviews of systems for hydrologic forecasting of inflows to the reservoirs and near real-time and forecast inundation mapping for areas below the dams. Application of either of these two actions could help INDRHI with reservoir management as well aid in minimizing downstream impacts of releases from the dams.

The first topic addressed forecasting of inflows to the reservoirs using data from the planned hydrometeorological monitoring network to be installed by INDRHI. Forecasts of inflows, based on current or forecasted rainfall can provide a useful tool in managing the reservoirs. An example application for the Sabaneta Reservoir was included in the report prepared for INDRHI. As discussed in the report, the most beneficial use of a hydrologic forecast system for the Sabaneta Reservoir is to aid INDRHI and the Emergency Reservoir Committee (COEE) to implement the emergency actions required for the dam by providing forecasts of possible dangerous conditions that could jeopardize life and property below the dam and/or compromise the safety of the dam. The system could provide advanced warnings of conditions that can trigger the critical reservoir elevations. A forecast system for reservoir inflows can be used to determine the time it would take to reach a critical reservoir level based on forecast rainfall from a pending storm, for example. Even without forecast rainfall, using the models with measured rainfall from the upper part of the watershed can provide valuable forecast information for inflows and consequent reservoir elevations. Since there is not much that can be done to draw down the reservoir to allow for storage for a pending flood, this extra time could be critical for warning populations downstream of the dam. The modeling system can be used to supplement the Sabaneta Dam Emergency Action Plan requirements. The system can also be used to optimize the use of the water for irrigation and the generation of electricity. Daily turbine operations can be adjusted with knowledge of high or low forecast inflows. However, the most beneficial use for the system would be for flood warnings.

Sabaneta Reservoir Area - Rio San Juan Basin

The second topic-inundation mapping, will be especially useful during extreme rainfall events and, if tied into a reservoir inflow forecast system that in turn is used to forecast outflows, can provide an advanced warning of areas where flooding may occur. Since INDRHI does not consider reservoir

storage reallocations for tradeoffs between flood control and water supplies for their reservoirs, inundation mapping, when used in conjunction with release information, can be a substitute flood early warning system.

Therefore, the purpose of the document prepared by the Department was to provide information regarding inflow forecasting and inundation mapping so that INDRHI can consider application of these enhancements to improve reservoir management in the future. The exact application for both these strategies will vary dependent on the reservoir.

National Early Warning System Implementation Plan

In order to support the strengthening of the Dominican Republic agencies responsible for forecasting and early warning, the Department worked with these agencies to develop an implementation plan for an Early Warning National System (SNAT in Spanish). This system is one reconstruction activity being implemented by the government of the Dominican Republic after Hurricane Georges. The SNAT is financed with World Bank funding. The Department provided the government with experts to assess the country's needs and requirements and then develop the plan. The plan was used as the basis for obtaining money from the World Bank loan.

The SNAT plan included the following components:

- A hydrometeorological observation network whose meteorological component is operated by ONAMET and the hydrologic component by INDRHI (National Institute of Water Resources).
- A telecommunication system used by ONAMET, INDRHI, and Civil Defense to exchange data, information and real time hydrometeorological forecasts
- A computing system to support the data collection and management, and to develop the final products such as forecasts.
- A Local Flood Warning System, that will utilize the real time hydrologic information to produce timely flood forecasts
- A team of experts that will utilize the system resources to produce timely forecasts and flood warnings and other severe hydrometeorological events to mitigate their effects on the infrastructure and the public.

The plan also included equipment specifications, a time line for major milestones, and estimated implementation costs.

SUSTAINABLE, RESILIENT COASTAL COMMUNITIES

The Department's activities in the Dominican Republic under this problem area involved support to the USAID/Dominican Republic Hurricane Georges Recovery and Reconstruction Special Objective covering the areas of Restoration of Shelter (IR2) and Disaster Mitigation (IR5). In addition, the Caribbean/Central American Forum on Building Codes and Economic Development, held in San Juan, Puerto Rico, September 30 to October 2, 1998, resulted in two recommendations related to the Department activities - Develop building codes and handouts which include simplified diagrams and guidelines, directed at the informal housing sector and promote regional cooperation for improving hazard assessment.

In response to these identified needs, the Department worked with the USAID Housing/Disaster Program Manager to develop two key activities for the Hurricane Georges Reconstruction Program for the Dominican Republic. The two activities are as follows:

- **Disaster Resistant Housing for the Informal Sector** – The Department, working with HUD and building officials, contractors, engineers and officials of the Dominican Republic, helped to assess and strengthen the technical basis for a 'hand out' type of guide to assist the informal sector and small contractors on constructing housing that will be more resistant to natural hazards.
- **Assessment of Critical Facilities** – The Department will assist the government of the Dominican Republic (GODR) in conducting assessments of the disaster resistance of selected facilities that serve a critical function in the event of a natural disaster (e.g., hospitals and fire stations).

<u>Disaster Resistant Housing for the Informal Sector</u>

The development of guidance for improving the construction of houses for the informal sector was identified early as being an important need. The Department developed the technical basis for hand out materials for constructing disaster-resistant housing (HUD would prepare the guideline document and conduct training on its application).

The Department's effort consisted of four parts – 1) visiting the countryside to observe and document Dominican house building practices, 2) collecting and critiquing existing hand out guidance for constructing a house, 3) conducting a workshop to get the views of NGOs working with the poor sector of the population to repair and rebuild their homes, and 4) developing technical guidance, relevant to Dominican customs, practices and conditions, and passing this information to HUD. From this work, a training manual for the construction of disaster-resistant housing titled, *Reinforce and Connect to Protect* was developed by HUD. The Department also participated in a workshop to train the *maestro de obras* from various communities held in Barahona. Various examples of guidance and workshop materials wee provided to USAID/Dominican Republic.

Barahona Workshop

Discussion with a Maestro de Obras

Assessment of Critical Facilities

The activity to develop guidance for the assessment of critical facilities resulted from discussions among DOC, USAID, and Defensa Civil. The Department conducted a preliminary inspection of a hospital (José Maria Cabral y Baez) and a fire station in Santiago. After that inspection, a draft document for conducting building assessments was developed for both building codes and current construction practices in the Dominican Republic. A workshop was held to obtain comments form qualified engineers on the draft document. The final document was prepared *Manual for Seismic and Windstorm Evaluation of Existing Concrete Buildings for the Dominican Republic* and transmitted to USAID. A workshop was then held for the purpose of training engineers in the use of the guidance. One day of the workshop involved classroom instruction on the principles of earthquake and hurricane design

and the application of the assessment manual. The second day was devoted to a hands-on field exercise to the Moscoso Hospital and a critique of evaluations.

Building Inspections

REGIONAL PROGRAMS

GULF OF FONSECA, RÍO LEMPA WATERSHED, OTHER REGIONAL ACTIVITIES

INTRODUCTION

Many of the Department of Commerce Hurricane Reconstruction Program activities were more regional in approach rather than design for a specific country. Often DOC was able to implement activities that supported some or all of the Hurricane Mitch – impacted countries. In some cases regional programs were based in a specific country (e.g., Costa Rica, El Salvador) and at other times, spread among the participating countries (e.g., Gulf of Fonseca region). The three regional programs implemented by the Department included the following:

Program	Countries	Host Country
Gulf of Fonseca	Nicaragua, Honduras, El Salvador	All
Río Lempa Watershed	El Salvador, Honduras, Guatemala	El Salvador
Other Regional	Nicaragua, Honduras, El Salvador, Guatemala, Costa Rica (Belize, Panama)	Costa Rica (primary for some activities)

GULF OF FONSECA

HONDURAS, NICARAGUA, EL SALVADOR

The Gulf of Fonseca (on the Pacific Coast spanning Honduras, Nicaragua, and El Salvador) supports shrimp aquaculture and artisinal fishing industries that were severely affected by the hurricane. Much of the shoreline of the rivers and estuaries draining into the Gulf in Nicaragua and Honduras is lined by shrimp ponds, which were created by diking salt flats or clearing mangrove forests. Flooding after the hurricane destroyed dikes, filled ponds with sediment, and apparently mobilized contaminants from upstream areas. The hurricane temporarily changed the course of the Choluteca River in Honduras and destroyed a farm-chemical storage facility, sweeping an estimated 20,000 barrels of chemicals downstream. Elevated concentrations of DDT and other chlorinated pesticides have recently been detected in farmed shrimp in Nicaragua. White spot disease also appeared in shrimp aquaculture facilities after the hurricane. These problems have increased the challenges for small shrimp aquaculture operations to survive.

Gulf of Fonseca Area - Shrimp Ponds

Although ongoing deforestation had increased sedimentation in the area even before the hurricane, the result of the 1998 storm was to completely clog many rivers with sediment and rock, drastically reducing their capacity to store sediment, increasing flooding, and continually flushing sediment downstream. Most of the areas upstream of the shrimp aquaculture ponds are used for growing crops such as melons, vegetables, bananas, and coffee, which require heavy pesticide and fungicide applications. In the past, much of the region was used for cotton production, which required huge applications of pesticides and herbicides.

The Department of Commerce conducted a suite of projects in the Gulf of Fonseca to provide information needed to implement sustainable and resilient management practices for natural resources, which ultimately, should minimize economic and environmental consequences of severe storms. Specifically, the Department conducted the following projects that contribute to an understanding of the Gulf of Fonseca ecosystems and improve management of coastal natural resources in the area:

GULF OF FONSECA ACTIVITIES – HONDURAS, NICARAGUA, EL SALVADOR

- Completion of a baseline survey of the extent and distribution of contaminants in the Gulf of Fonseca, its estuaries, and surrounding areas
- Completion of a study of water circulation patterns in the Gulf of Fonseca
- Development of products that improve the management of protected areas in the Gulf of Fonseca
- Development of extension services for the shrimp aquaculture sectors in Honduras and Nicaragua
- Development of activities designed to improve the capacity of shrimp aquaculture producers in Nicaragua

Hurricane Mitch had severe effects on the environment and industry of Central America. Farms and facilities were destroyed, rivers changed course, and erosion and flooding released tons of sediment to downstream areas, swept pesticide and other farm chemicals from storage depots into the Gulf, and likely mobilized DDT and other persistent chemicals from soil or sediment into watersheds that drain into the Gulf. Shrimp aquaculture facilities that surround the Gulf of Fonseca were severely affected by flooding, erosion, and deposition of sediments. The hurricane may have increased chemical contamination in the area and made shrimp more susceptible to viral and other diseases.

The Department (in partnership with other USG and counterpart agencies) conducted a **baseline survey of the extent and distribution of contaminants in the Gulf of Fonseca**, its estuaries, and surrounding areas. Better knowledge of coastal ecosystems, including human health and environmental threats caused by contaminants mobilized by Hurricane Mitch will provide the basis needed to implement sustainable and resilient management practices for natural resources, which ultimately, should minimize economic and environmental consequences of severe storms.

Contaminant Sampling - Gulf of Fonseca

The goal of this activity was to develop an improved understanding of natural processes in the Gulf of Fonseca in support of sustainable uses of the natural environment by industry (e.g., shrimp aquaculture), artisans, and for subsistence. The following tables summarize the results of the survey.

Gulf of Fonseca Contaminant Survey and Assessment – Survey Overview

Project Components	Ensuring High Quality Data and Information	Chemical Analysis	Evaluating Potential Source Areas	Evaluating Concentrations
Pesticides/metals in water (first flush) Contaminants in sediment, catfish, fiddler crabs Identifying source areas Recommending sustainable monitoring Applications for watershed management	Chemical analysis conducted by laboratories in each country Interlaboratory comparison conducted by Texas A&M University Training and equipment for chemical analysis provided in each country MAGFOR conducted analysis for Nicaraguan stations CESCCO conducted analysis for Honduran stations FUSADES conducted analysis for El Salvador stations All laboratories participated in interlaboratory calibration exercises	Metals Organochlorine pesticides Organophosphate pesticides PAHs	Analyzing data to determine gradients, considering: a) Tidal influence b) Known source areas c) Currents and depositional areas for sediment d) Land use	**Fish Tissue Guidelines** US Food and Drug Administration Action Levels **Ecological Effects (fish reproduction)** Scientific literature **Water Quality Guidelines** Ambient Water Quality Criteria **Sediment Quality Guidelines** ER-L; ER-M values

Gulf of Fonseca Contaminant Survey and Assessment – Results and Findings

Mercury	Arsenic	Copper	PAHs	DDT
Elevated mercury was found in fish, especially in El Tamarindo (El Salvador), also in Estero Real (Nicaragua) and Estero El Pedregal (Honduras) Lowest levels of mercury in sediment in Rio Nacaome **Concentrations at El Tamarindo could be a concern for human health** **Possibility of methylation**	Highest crab concentrations were detected in Estero El Pedregal, Estero Real, and El Tamarindo Highest sediment concentrations were found in the Estero El Pedregal and upstream areas, western Bahia Chismuyo, Honduras Highest water concentrations were found in Estero El Pedregal, at the mouth of the Estero Real, and at El Tamarindo **Possible source upstream of Estero El Pedregal**	Highest concentrations in fish or crab from western Bahia Chismuyo, Bahia San Lorenzo, Honduras; La Union (El Salvador); Estero Torecillas (Nicaragua); Estero El Pedregal (Honduras) Highest concentrations in sediment from upstream areas of El Salvador, Estero Real (Nicaragua), Estero El Pedregal (Honduras) Highest concentrations in water were found at Estero San Bernardo (Honduras), Estero El Pedregal (Honduras), Cedeno (Honduras), Estero Real (Nicaragua) **Concentrations in water are potentially toxic** Possible sources in Estero Pedregal and Estero San Bernardo (Honduras), and Estero Real (Nicaragua)	Highest concentrations in sediment at San Lorenzo (Honduras) Lowest concentrations in Bahia Chismuyo and Rio Nacaome (Honduras) **Concentrations do not exceed toxicity thresholds**	Highest concentrations in fish were detected at La Union (El Salvador) and San Lorenzo (Honduras). Concentrations in fish were also elevated at El Tamarindo (El Salvador) and Estero Torecillas (Nicaragua) Highest concentrations in sediment from Bahia La Union Highest concentrations in water at El Tamarindo (El Salvador), Estero Torecillas (Nicaragua), and Potosi (Nicaragua) **DDT is widespread throughout the Gulf of Fonseca** **Sediment and water concentrations are potentially toxic**

Gulf of Fonseca Contaminant Survey and Assessment – Country Results

El Salvador	Honduras	Nicaragua
Areas of Concern: *El Tamarindo* Elevated concentrations of mercury in fish, but not sediment Elevated concentrations of arsenic in crab and water High concentrations of copper in sediment Elevated concentrations of DDT in fish and water *Bahia La Union* Elevated concentrations of copper in fish, crab, sediment, and water Elevated concentrations of DDT in fish and sediment **Recommended future monitoring:** La Union: Copper and DDT in fish, sediment, water El Tamarindo: Hg, Cu, As, DDT in fish and water Rio Nacaome: Recommended reference area Fish and sediment: analyze once every 2-5 years at the end of dry season	**Areas of Concern:** *San Lorenzo* Elevated concentrations of PAH in sediment Elevated concentrations of DDT in fish and sediment *Bahia San Lorenzo*: Elevated concentrations of copper in fish, crab, and water Elevated concentrations of arsenic in sediment Rerouting of Río Choluteca during Hurricane Mitch appears to have increased contamination *Bahia Chismuyo* Lowest concentrations of PAH in sediment Elevated concentrations of arsenic in sediment Elevated concentrations of copper in fish *Estero El Pedregal* Elevated concentrations of arsenic in crab, sediment, and water Elevated concentrations of DDT in sediment Copper and DDT are bioavailable and potentially toxic	**Areas of Concern** *Estero Torecillas* Elevated concentrations of DDT in fish and water Elevated concentrations of copper in fish, sediment, and water Elevated concentrations of mercury in fish *Puerto Morazon* Elevated concentrations of mercury in fish Elevated concentrations of copper in sediment and water Concentrations of copper in water may be toxic **Recommended future monitoring:** Estero Torecillas: DDT, copper, and mercury in fish, sediment, water Puerto Morazon: DDT, copper, and mercury in fish and water Estero Padre Ramos: Reference area Fish and sediment: analyze once every 2-5 years at the end of dry season Water: analyze once per year just after beginning of rainy season (first flush)

Gulf of Fonseca Contaminant Survey and Assessment – Country Results

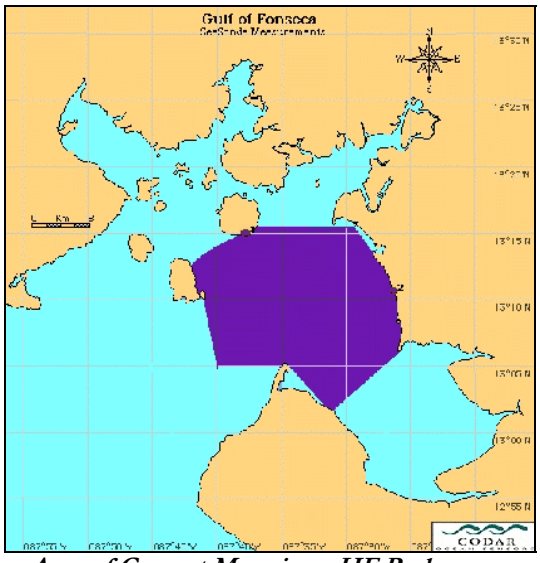
El Salvador	Honduras	Nicaragua
Water: analyze once per year just after beginning of rainy season (first flush) Include analyses of standard reference materials Improve analyses of arsenic in tissue and mercury in sediment	*Estero San Bernardo* Elevated concentrations of copper in sediment and water Elevated concentrations of DDT in water Copper and DDT in water are potentially toxic **Recommended future monitoring:** San Lorenzo: DDT in fish, sediment, water Estero Pedregal: Cu, As, DDT in fish and water Estero San Bernardo: Cu, DDT in fish and water Rio Nacaome: Recommended reference area Fish and sediment: analyze once every 2-5 years at the end of dry season Water: analyze once per year just after beginning of rainy season (first flush) Include analysis of standard reference material Improve capabilities for analysis of trace metals and pesticides in tissue	Include analysis of standard reference materials Improve capabilities for analysis of DDT and metals in sediment and tissue

Based on analysis of water, sediment, fish, and crabs, results indicate that Hurricane Mitch's temporary re-routing of a local river apparently released copper and arsenic. Other results of interest include widespread detection of DDT and copper in water, at levels that are likely to be toxic to shrimp larvae in shrimp aquaculture areas. Most likely sources of these contaminants are historical use of DDT on cotton fields, and contemporary use of copper sulfate on cashew and banana crops as a fungicide. These results will encourage the use of intensive shrimp farming techniques that minimize water exchange with the estuaries. The region has a history of deforestation, which increases erosion of soil from farmland, and has the lowest per-capita income of the western hemisphere. Subsistence and artisinal fishing in the Gulf of Fonseca are vital to the local population.

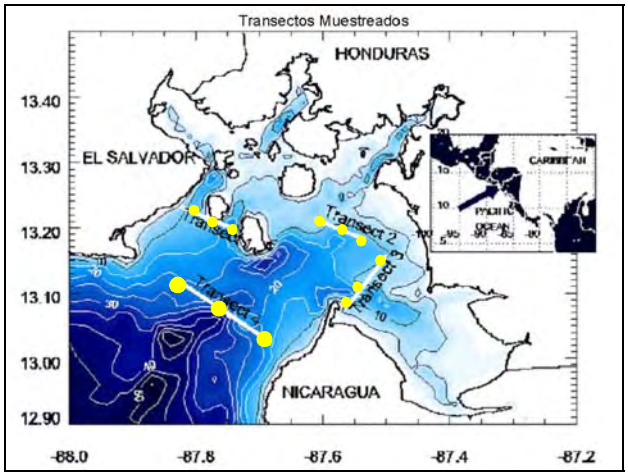
The contaminant survey activity also provided training and equipment to chemical laboratories in El Salvador, Honduras, and Nicaragua, and training for coastal managers in the use of GIS based data and mapping tools for evaluating contaminant data.

The Department implemented a **water circulation survey in the Gulf of Fonseca** to develop and provide an improved understanding of the circulation and major current patterns in the Gulf of Fonseca in support of sustainable uses of the natural environment by industry (e.g., shrimp aquaculture), artisans, and for subsistence. Although ongoing deforestation had increased sedimentation in the area even before the hurricane, the result of Hurricane Mitch was to completely clog many rivers with sediment and rock, drastically reducing their capacity to store sediment, increasing flooding, and continually flushing sediment downstream. Little is understood about the circulation pattern of water within the Gulf that has undoubtedly been altered by the accumulated sediment. Basic questions regarding the transport into and out of the Bay as well as the approximate flushing rates of smaller embayments remain unanswered.

Data were obtained from two distinct observational methods that were combined to elucidate the major circulation patterns. This combination of methods (fixed HF radar and a towed acoustic Doppler current profiler) allowed the resolution of the currents over a large geographic area and a variety of time scales. Observations were collected during spring and neap tides, and during wet and dry seasons to account for known variations in the forcing that affect circulation.

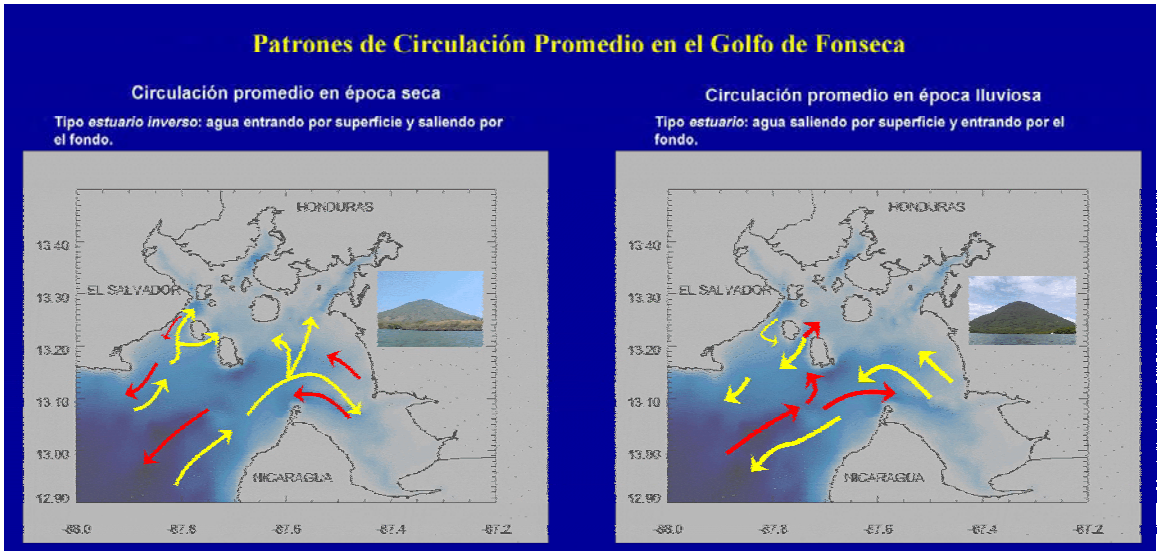


Area of Current Mapping - HF Radar



Acoustic Doppler Current Profiler Transects

Detailed maps of surface currents were obtained during a month long deployment of an HF radar array. Operational constraints prohibit leaving the radars unattended for long periods, however, the extensive coverage and high resolution that resulted from the 14 March to 14 April, 2001 surface current mapping were enough to calculate the principal semidiurnal and diurnal tidal currents, they elucidate the spring/neap cycle, as well as giving an indication of the meteorologically driven events. Data from the radar survey were used to refine the towed current meter survey strategy by revealing areas of high velocity and variability.



Poster Showing Main Circulation Scenarios

During the wet season, salinity tends to increase monotonically seaward. The data indicate that the Gulf of Fonseca illustrates inverse estuarine circulation in the dry season and normal estuarine circulation in the wet season. In the dry season, near-surface waters moved into the Gulf and near-bottom waters in general flowed out of the Gulf. This suggests that there is a probably a 'salt plug' in the Gulf during the dry season that reduces exchange between the tributaries and the open water of the Gulf.

The Department assisted CODDEFFAGOLF (Comité para la Defensa y Desarrollo de la Flora y Fauna del Golfo de Fonseca) in order to facilitate the **development of a management plan for the protected areas** of Las Iguanas and Punta Condega including a Rapid Ecological Assessment (REA). In addition, a decision making process regarding the development of physical infrastructure and co-management strategy for Bahia de Chismuyo was also part of the joint efforts. Out of this effort, the Department provided the following:

- Technical Report of the Rapid Ecological Assessment (REA) has been submitted to CODDEFFAGOLF and the Protected Areas Technical Committee;
- Technical Proposals of Management Plans for both areas - presented in public meetings;
- Physical infrastructure to be utilized as a logistical center not only for fishermen but also for representatives of GO's and NGO's on duty within Bahia de Chismuyo Habitat/Specie Management Area was implemented; and,
- Technical Report of the Bahia de Chismuyo Co-Management Strategy was presented locally and submitted to protected areas authorities for consideration and decision-making.

The Department also provided technical assistance to CODECA (Asociación Coordinación de Comunidades para el Desarrollo del Cacahuatique) for the following:

- Technical Report of the Rapid Ecological Assessment for Conchagua Complex Protected Area was submitted to CODECA and the Ministry of Natural Resources and Environment;
- Technical Proposal of Management Plan for Conchagua Complex Protected Area management plan process was submitted to CODECA and the Ministry of Natural Resources and Environment of El Salvador;
- Physical facilities such as: surveillance facilities and reinforcement of building structures for Conchagua Complex Protected Area located in the Department of La Unión, El Salvador were implemented.

The Department provided technical assistance to SELVA (Asociación Somos Ecologistas en Lucha por la Vida y el Ambiente), in Chinandega, Nicaragua for the following

- Technical Report containing the main outcomes of Community Consultation Workshops;
- Technical Report describing a General Framework for the development of a Management Plan Process for Padre Ramos Natural Reserve located in Chinandega, Nicaragua;
- Technical Report of a Rapid Ecological Assessment (REA) focusing on specific components of this protected area;
- Construction of infrastructure (visitors center) in Padre Ramos Natural Reserve.

As part of its Gulf of Fonseca activities, the Department developed a program of **extension services** for the shrimp aquaculture sectors in Honduras and Nicaragua. The program was designed to effect the reconstruction and development of resilient, sustainable coastal communities in both countries. The goal of the extension service program was to develop an information and technology transfer program to educate and change the attitudes, perceptions and practices of resource users, resource managers, and the general public with relation to the sustainable use of coastal and marine resources in the Gulf of Fonseca. The extension team organized by the Department (six local marine extension agents and two field supervisors) implemented community-based extension techniques (workshops, training, applied research, demonstration projects and publications) to 1) improve citizens' decision-making; 2) protect key ecosystems; 3) promote the sustainable development of coastal and marine resources; 4) change some of the natural resource's use behavior; and 5) minimize

the impact of future disasters. The agents were recruited from the University of Central America (UCA) – Nicaragua (three agents) and Zamorano University (Zamorano) – Honduras (three agents).

The extension agents wee provided with various training opportunities to improve their professional capabilities and professional skills. Included in the training programs were – *Capacity Building Training for Marine Agents, Workshop on Extension for Aquaculture, Standard Methods for Water Quality Analysis, Best Management Practices for Shrimp Farming, International Latin America Mangrove Ecosystem Conservation Conference, Shrimp Farm Management and Economics of Farm Operations,* and *Intensive Culture of Shrimp Using a Closed System in Nicaragua: its Economic Feasibility*.

The Department's agents in Honduras and Nicaragua developed a plan that allowed them to obtain input from resource users in order to provide a 'bottom up' constituent driven approach. Behavior changes were generated in their audiences and clientele through the dissemination of educational information and the coordination of extension activities. Using this approach, a number of behavior changes were observed. The key benefits and accomplishments of the extension program are summarized below.

- Communities of Southern Honduras and Southern Nicaragua were advised and educated on the importance of developing their coastal and marine resources in a sustainable manner
- UCA and Zamorano have created new challenges, changed attitudes, generated incentives, and increased awareness regarding the importance of sustainable development of marine resources and coastal affairs in the Gulf of Fonseca region
- Linkages were developed between schools, coastal communities and scientific and management agencies through implementation of coastal resources conservation projects including solid waste disposal, water quality and reforestation
- Partnerships have been initiated and promoted among municipal, insular and international organizations for specific projects and initiatives
- Resource users and managers were educated on matters related to water quality
- Publication of outreach material such as calendars, fact sheets, one pagers and posters were developed and disseminated at schools, cooperatives, universities, fishing communities, municipal offices and government agencies
- Diversified and practical information related to beach systems, mangroves, solid waste management, water quality, aquaculture/mariculture, and good management practices was produced and disseminated among resource users
- Agents educated communities about the benefits offered by reforestation

Under a **PASA** with the USAID Mission in Nicaragua, the Department instituted a program to assist Nicaragua shrimp farmers in modernizing their technologies to help the industry be economically viable. This activity – **Nicaragua Small Shrimp Producer Assistance Program**, had four primary components:

- **Closed Intensive Shrimp Productive System (Shrimp Farming Demonstration Project)** – The goal was to assist small and medium size producers by testing new, closed production farming techniques in areas known to harbor several aggressive viruses (those that can decimate shrimp stocks). A related goal was to develop a strong extension program to teach and familiarize farmers with the concepts and practices of the new technologies (see earlier discussion on extension agents).
- **Economic Viability and Financial Access** – This component provided economic analyses intended to introduce commercial financial institutions, local development agencies and other possible sources of credit for small and medium size farmers to the benefits and results of the demonstration activity
- **National Professional Aquaculture Capacity** – The goal was to provide education, training, and practical experience for shrimp aquaculture professionals with regard to best practices to maintain food safety standards.
- **Environmental Monitoring** – The goal of this component was to provide knowledge of estuarine water quality to benefit environmental and socioeconomic development.

Shrimp Farming Demonstration Project

The goal of this component was to design and operate a "zero-exchange" shrimp production system in Nicaragua to demonstrate the potential of producing shrimp with a higher level of biosecurity and reduced environmental impact. The project included the design, construction and operation of a cost-effective biosecurity system for incoming farm water and the design, construction and operation of an intensive zero-exchange production unit.

The site selected for the project was the University of Central America (UCA) shrimp farm in Puerto Morazan near the Río Estero Real in west-central Nicaragua. The site was one of the first shrimp farms in Nicaragua and had long been used for shrimp farming using traditional extensive and semi-intensive methods. The farm was totally flooded during Hurricane Mitch.

The principal concept behind the zero-exchange system is efficient recycling of nutrients through the pond that provides for good water quality through nutrification and denitrification. The shrimp are allowed to graze directly on bacterial biomass composed of bacteria and pond nutrients, increasing the recycling of pond nutrients and feeding efficiencies. Water circulation in the pond is induced by the operation of paddlewheel aerators. The water movement scours the pond bottom and keeps the feed, feces, and other detritus in the water column. This allows the aerobic, nitrifying bacteria to consume the waste products. Since production water is maintained within the project, this technologically advanced system does not release effluents (e.g., feces, bacteria) into natural water sources. By filtering and reusing water, the closed system reduces the risk of exposure to viruses and eliminates effluent.

Lined Ponds With Aerators

The zero-exchange production system consists of four one-half hectare production ponds and two one-hectare settling ponds. The ponds were built with high-density polyethylene liners to eliminate erosion from high water velocities generated by the mechanical aerators. Biosecurity against water-borne pathogens (white spot syndrome virus, WSSV) is achieved through water filtration and isolation from the surrounding environment. The farm was managed and operated by local workers who stocked, fed, fertilized, and maintained the ponds.

The demonstration project yielded record production for the country of Nicaragua though the yield was still lower than expected. An approximate total of 20,000 pounds of whole shrimp were harvested from the four ponds. Of significant success was the elimination of the WSSV from the project showing that the zero-exchange system has the capacity to manage viruses. Since the conclusion of the Hurricane Reconstruction Program, the ponds are being operated by UCA.

Economic Revitalization and Sustainability

The goal of this component was to provide information to support more informed decisions regarding public and private investment necessary for the recovery of the Nicaragua shrimp industry. This was done by determining the investment and economic feasibility of a zero water-exchange demonstration, comparing it to existing traditional semi-intensive culture methods, and holding workshops to educate the small scale shrimp farmers and lenders on the economic feasibility of the system.

In summary, the analyses showed that the zero water-exchange system requires a very large initial investment that may discourage many potential investors from considering the system as a profitable alternative to traditional farming. The financial risk associated with a crop failure is much higher with the zero water-exchange system. However, the zero water-exchange system was shown to have several advantages including – sustained higher yields due to high survival rates because of biosecurity practices and higher stocking densities, reduced amount of nutrients released to the environment, less land needed to produce desired production objectives, higher profits per pound harvested (especially higher profits on a per hectare basis), and reduced time needed to prepare pond water for stocking (yields more efficient use of the available growing season).

Two workshops were held – one for lenders and one for shrimp farmers. Topics included traditional semi-intensive method costs and returns budgets, Nicaragua shrimp import-export data and preliminary returns on the zero water-exchange system.

Human Resource Development

The goal of this component was to provide specific education, training, and practical experience for professional in Nicaragua that support the shrimp and aquaculture industry either through academic programs, regulation, or commercial practices. Results of this activity included the development of a cadre of in-country expertise that is prepared to contribute to a higher level of expertise to the shrimp industry. The individuals trained were prepared to provide regulatory, farming, and processing skills and to teach others the same capabilities. Specific training subjects included methods to maintain standards of seafood processing, sanitation control procedures, and specific methods for controlling microbes.

Environmental Monitoring

Under this component, a water quality monitoring program for the Río Estero Real was designed, developed and implemented. The goal of the program was to achieve sustainable development of shrimp aquaculture in Nicaragua through knowledge of estuarine water quality to benefit the environment and socioeconomic development. The activities included the following:

- A network of sample stations was created to cover the main channel of the Estero Real almost in its entirety, and samples two of its principal tributaries approximately 6 km upstream from their confluence with the main channel.)
- Dissolved oxygen is high near the mouth of the Río Estero Real and declined with distance upstream
- Salinity was high at the mouth of the Río Estero Real, while upstream areas of the river had salinities of almost zero (most field sampling to date was conducted during he rainy season)
- Bathymetry, currents, and water levels were measured
- The preliminary data set will increase the base of useful information for future modeling and calculations of impacts of shrimp farming on the water quality of the Río Estero Real

RÍO LEMPA WATERSHED

EL SALVADOR, HONDURAS, GUATEMALA

The Department of Commerce provided support to USAID/G-CAP for the implementation of a program for sound management and disaster mitigation in the Río Lempa transnational watershed. This watershed is shared by Guatemala, Honduras, and El Salvador. This program involved cooperation of various agencies within each country as well as Central America regional agencies such as SICA, CRRH, and CEPREDENAC. As part of the overall management plan for the watershed, the Department's activities focused on providing the tools needed to monitor and manage water resources throughout the basin, including providing the capabilities to mitigate impacts from extreme events such as droughts and floods. To do this required a great amount of planning and coordination with the Central American agencies as well as with other U.S. Government agencies involved in the project. To this end, the Department worked most closely with SICA, the governments of El Salvador, Guatemala, and Honduras as well as with the U.S. Geological Survey (USGS). The USGS and SICA played an integral part in the design and implementation of the Department's program.

Implementation of the Río Lempa program was a unique activity in that it addressed the need for regional approaches to problems in dealing with disasters but also for routine management of natural resources. Many of the Department's activities for this program were never implemented before in the region. Therefore, a large effort was required at the beginning to educate counterparts on the ideas and approach behind the project and to show how the tools that were being provided could be applied to the issues and problems in the watershed. This was done through a series of workshops and training sessions.

Due to the magnitude of the program, sustainability of the equipment and programs installed was, and is still to a lesser degree, a concern. To address this issue as it applied to its activities, the Department held a series of workshops and information meetings designed to educate and 'recruit' stakeholders or users of the data and information generated by its program. This approach appears to have been successful in that the primary stakeholder for managing the water resources, the hydroelectric utility in El Salvador, CEL (Comisión Ejecutiva Hidroeléctrica del Río Lempa), is actively involved in supporting the programs installed by the Department and ensuring their sustainability.

Since much of the Río Lempa basin is located in El Salvador as is the primary stakeholder, CEL, the Department's primary counterparts were Salvadoran agencies. After the El Salvador earthquakes in early 2001, the government of El Salvador decided to reorganize its agencies involved in environmental programs and natural hazard mitigation into one agency – Servicio Nacional de Estudios Territorales, SNET. The SNET, which is located in the Ministry of the Environment, then became the primary counterpart throughout the remainder of the program. During the inauguration ceremonies in El Salvador for the Department's program, the Vice President of the country and the Minister of the Environment stated that the Department's programs are a primary focus for the startup of the agency, recognizing the importance to the country of the new tools and capabilities now available to mitigate water-related natural disasters and to manage the water resources in the watershed.

A summary of the Department's activities is presented in the following table.

RÍO LEMPA WATERSHED ACTIVITIES – EL SALVADOR, HONDURAS, GUATEMALA

- Installation of a river and flood forecasting system for the Río Lempa
- Installation of a river forecast center in El Salvador (computer workstations, local area network, satellite communications downlink system)
- Installation of four automatic rain gages to support the forecasting system – La Ceibita (Guatemala), Citalá (El Salvador), Tamarindo (El Salvador), La Esperanza (Honduras)
- Installation of an automatic weather station at Belen Gualcho (Honduras)
- Installation of a tide gage at La Pita, El Salvador (mouth of the Río Lempa) for flood forecasting
- Implementation of forecasting training programs for system operators

The Department's activities centered on the design and implementation of the National Weather Service River Forecast System (NWSRFS). The NWSRFS has the capability to provide short- (hours to several days) and long-term (months, seasons, year) forecasts of flows and river level in the Río Lempa at specific forecast points throughout the basin. This system is part of the cross-border management plan developed for the Río Lempa watershed. The system is a key element for flood and river flow forecasting and integrated water resources management throughout the watershed. The NWSRFS provides information and data needed for cross-border river forecasting and for early warning of floods along the river.

The NWSRFS software modules provide real-time hydrologic modeling for forecasting, including potential capabilities for reservoir management and long-range (e.g., monthly, seasonal) probabilistic hydrologic forecasting. This regional forecast capability provides input to environmental disaster mitigation efforts for water-related events such as floods and droughts as well as supports integrated water resources management (e.g., important to agriculture, industry, hydroelectric power – which represent potential water conflicts) throughout the watershed. Daily river forecasts are provided to the appropriate agencies and private sector users in each country in the watershed. During periods of flooding, more frequent forecasts will be issued. The primary stakeholder for the system is the hydroelectric power agency – CEL. CEL has provided the operators of the NWSRFS with forecast requirements in order that they can operate their reservoirs more efficiently and safely.

To support the NWSRFS input data requirements, the Department also supplemented existing precipitation gage networks in the watershed – automatic rainfall gages were installed at La Ceibita (Guatemala), Citalá (El Salvador), Tamarindo (El Salvador), and La Esperanza (Honduras). In addition, an automatic weather station (without wind instrumentation) was installed at Belen Gualcho in Honduras. The Department collaborated with the U.S. Geological Survey on the installation of streamflow gages throughout the watershed. All data collected directly by the automatic stations are transmitted to a Digital Readout Ground Station (DRGS) located at the SNET in San Salvador via the GOES Satellite Data Collection System (DCS) (the GOES DCS is operated by the National Oceanic and Atmospheric Administration – National Environmental Satellite, Data and Information Service, NOAA/NESDIS). Data from automatic gages installed for the PAES Project (InterAmerican Development Bank Program) and by CEL are also incorporated into the forecast system.

The Department designed and installed a hydrologic forecast center (Centro de Pronosticos Hidrologia, CPH) in the Ministry of Agriculture building in San Salvador. The CPH includes the

DRGS, a computer workstation for the NWSRFS, a Local Area Network to transmit data and information between computers in the CPH (including the DRGS PC), and Internet access. In addition, DOC installed a web server in the CPH and designed and implemented a web page to post and transmit river forecasts and flood warnings. The forecast products can be accessed at http://200.62.51.152/

The Department worked jointly with the SNET to develop an operations manual for the CPH, including forecast generation procedures, staffing, and coordination with meteorology. A PC and laptop were also provided for CPH operations support.

The Department provided training and support on implementation and operation of the NWSRFS. Examples of training programs for the operators of the system are as follows.

- A workshop on the forecast system and forecast center operations was held in San Salvador. The workshop involved definitions of requirements with all operators and users of the forecast center products
- Operator training occurred in Santa Tecla and in Ft. Collins, CO on system maintenance and operations, UNIX, NWSRFS operations, forecast center operations, data base maintenance, operational forecasting, and use of system Graphical User Interface
- Operations training was held in Nicaragua along with operators from INETER of the NWSRFS installed in Nicaragua
- Operators attended three NWSRFS Users conference meetings in the United States as well as a month-long hydrologic forecasting course in the United States (co-sponsored by NOAA/National Weather Service and the World Meteorological Organization)
- Operations training and forecast product development and generation training was given in San Salvador during installation and implementation of the NWSRFS and web site
- Operations training for the DRGS was given in San Salvador

The DRGS Antenna - CPH

Centro de Pronosticos Hidrologia (CPH)

Río Lempa Monitoring Network

Shown above are the stations installed to support river and flood forecasting for the Río Lempa Watershed. The USGS gages (automatic stream and rain gages) are hydrologic forecast points in the basin. (Note the USGS gage in Honduras was vandalized and destroyed , a new gaging station will be installed downriver in El Salvador.) The automatic weather stations were installed as part of the El Salvador Program and are used primarily for measuring weather conditions throughout the country. The rainfall measurements from these stations provide important input to the CPH operations. The tide gage installed at the lower end of the watershed is used to support flood forecasting on the lower Río Lempa.

REGIONAL PROGRAMS

HONDURAS, NICARAGUA, GUATEMALA, EL SALVADOR, COSTA RICA

Some of the Department of Commerce activities were implemented on a regional basis for Central America rather than on a country-by-country basis. This was done for activities that could support at least all four Mitch- affected countries and that could be done more efficiently and cost-effectively. In general, the Department focused its regional programs in Costa Rica. Costa Rica was selected since the country has the infrastructure to support and sustain these programs, a key regional organization – Regional Committee for Water Resources (CRRH) is based there, and indirectly, new capabilities will be also then be provided to Costa Rica. Regional or country-based training programs (e.g., individual training, workshops) were provided for all activities. A summary of the Department's regionally-based activities is provided in the following table.

REGIONAL ACTIVITIES

Base Infrastructure Reconstruction

- Installation of satellite communications downlink system in Costa Rica for the Central America tide gage network
- Development of regional water level network equipment repository and maintenance capability (for tide gages, current measurements) in Costa Rica
- Installation of a GOES (U.S.) satellite ingest capability for the Central America region in Costa Rica (workstations located in each country)
- Implementation of a field monitoring network equipment maintenance planning workshop

Forecast and Early Warning Systems

- Development of a Regional Climate Prediction System – institutional and technical capabilities located in Costa Rica

Disaster Preparedness and Response

- Implementation of regional training programs and workshops including - river forecast system and hydrologic forecasting, tropical meteorology and climate variability, and increase capacity for local response authorities to prevent, plan for, and respond to spills of oil or other hazardous chemicals
- Support for operational meteorology and hydrology post graduate course
- Development of an approach for a regional hydrometeorological center

Sustainable, Resilient Coastal Communities

- No activities (Gulf of Fonseca Program activity)

Economic Revitalization

- Provide information on regional reconstruction efforts
- Facilitation of U.S. company contacts with reconstruction executing agencies in each country
- Raise awareness in Central America of U.S. companies' skills and expertise
- Facilitate bilateral industry cooperation to make the region more resilient to natural disasters

BASE INFRASTRUCTURE RECONSTRUCTION

As discussed in the country –specific sections, tide gages were installed in Honduras (1), Nicaragua (2), Guatemala (2), and El Salvador (3) as part of the Water Level Observation Network for Central America) (Red de Observacion del Nivel del Mar para America Central, RONMAC). As part of the RONMAC program, a **Data Quality Control Laboratory** (LABCODAT) was installed in Costa Rica. This laboratory is managed by CRRH. Since all the data from the tide gages is transmitted via the NOAA GOES Satellite Data Collection System (DCS), a Digital Readout Ground Station (DRGS) was installed at the by the Department at the LABCODAT facility. The responsibilities of the LABCODAT are managing the hardware and software associated with the DRGS, monitoring the performance of the tide gage sensors and the data transmission, data Quality Assurance/Quality Control (QA/QC), and data archiving. All the equipment related to the water level network, including spares, test equipment, and other measurement equipment (e.g., for current, wave measurement) will be assigned to the LABCODAT and be the responsibility of the CRRH. This approach will provide a **regional equipment repository and maintenance capability** for the water level observation network, lessening the burden on the countries to maintain the equipment.

DRGS Antenna at the LABCODAT, Costa Rica

In order to improve weather forecasting and early warning capabilities throughout the region, the Department installed a **geostationary operational environmental satellite (GOES) data ingest system** at the Instituto Meteorológico Nacional (IMN) in Costa Rica. The system installed in Costa Rica receives the imagery data transmitted from the satellite. The data are then transmitted to two workstations installed in each country via the Internet.

Greg Withee representing the U.S. and Ivan Vicente representing Costa Rica jointly participate in the Ribbon Cutting to inaugurate the Satellite Data Acquisition System for Central America. Linda Jewell representing the U.S. State Department and U.S. Agency for International Development looks on.

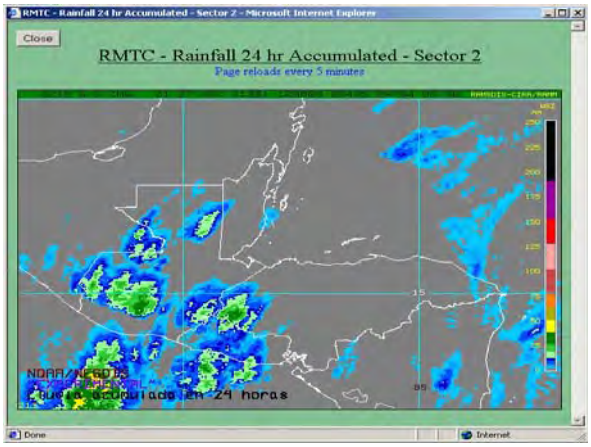
Each workstation (called RAMSDIS) is a desktop computer capable of displaying meteorological data for analysis by meteorologists and hydrologists. This capability provides a constant vigil for the atmospheric "triggers" for severe weather conditions such as flash floods and hurricanes. When these conditions develop forecasters can monitor storm development and track their movements. GOES satellite imagery is also used to estimate rainfall during the thunderstorms and hurricanes for flash flood warnings. The Department installed two RAMSDIS workstations in each of the four Mitch-affected countries plus two in Costa Rica under the Hurricane Reconstruction Project. Other, non-USAID funds were used to install workstations in Belize and Panama in order to provide complete, regional coverage.

RAMSDIS Workstation

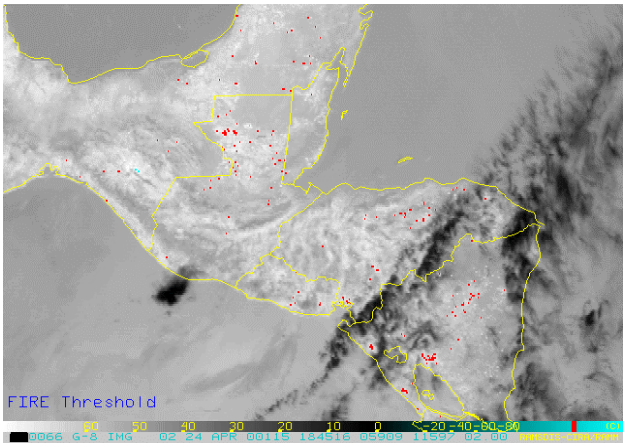
Products Displayed on RAMSDIS

- 1km Visible Imagery
- 4 km Visible Imagery
- 4km Infrared (IR2) Imagery
- 4km IR4 Imagery
- 8km IR4 Imagery
- 8km Water Vapor
- Rainfall Auto-Estimator
- Volcanic Ash Detection Product
- Fire Detection Product

The rainfall auto-estimator provides the region with rainfall estimates based on the satellite imagery. This is an important tool that is used to get estimates of rainfall totals over areas without in-situ raingages – a valuable flood early warning capability.



Rainfall Estimates - Auto Estimator



Fire Detection Product

A **visiting scientist** from the IMN in Costa Rica was hired to evaluate the auto-estimator in the Central America region. The scientist worked in Maryland for 17 months in collaboration with the NOAA scientists who developed the algorithm. Regional rainfall data were collected for the evaluation and a Technical Memorandum is in preparation that describes the results. Although the performance of the auto-estimator to date is generally good, continuous review of the outputs is necessary. Since returning to Costa Rica, the visiting scientist is continuing to collaborate with NOAA on the evaluation and improvement of the auto-estimator in Central America. The Department also coordinated the development of a Regional **GOES Help Desk** at the University of Costa Rica. The Help Desk will aid all countries with operations of the GOES system and play a major role in sustaining the system.

FORECAST AND EARLY WARNING SYSTEMS

One of the Department's activities in the region under the Hurricane Reconstruction Program was to reduce the negative disruption often associated with **climate variability and extreme events** through the development of a climate information and applications system for Central America. To do this, the following activities were accomplished.

ESTABLISH A REGIONAL, SEASONAL CLIMATE PREDICTION SYSTEM

Atmospheric scientists working along with regional based institutions and national meteorological services from Central America have shown great interest in developing capabilities in their own research laboratories for performing numerical model simulations and forecasts of regional climate. A goal in the region is to use information generated from regional forecasts as an additional tool to produce user information for the planning of activities and for the amelioration of socio-economic impacts of regional climate systems.

The main objective of this activity was to generate seasonal climate diagnostics and predictions based on the use of a numerical model that resolves the high spatial resolution forcing elements in Central America. The possible use and implementation of climate forecasts in decision-making for different societal sectors was considered in future (potential) phases of the project. This activity also relied on the network created and information provided through the Climate Outlook Forum process in Central America, as well as through the Climate Variability Training Course sponsored by the Department under the Hurricane Reconstruction Program that was held in San Jose, Costa Rica, in February 2001. The training course contributed to the capacity of the region to utilize climate information in natural disaster mitigation and preparedness efforts, and supported the initiative to develop a climate information and applications system for Central America.

The following was accomplished under this activity:

1. Development of databases

To validate model simulations it is necessary to make use of as much meteorological information as possible (operational and special observations, etc). Participants in this project have reached the objective of defining a complete regional meteorological database.

2. Development of statistical tools

Implementation of multivariate statistical techniques, has been undertaken by Dr. E. J. Alfaro at the University of Costa Rica to develop applications useful for data analysis and prediction.

3. Student training

A number of students from the region currently working towards their post-graduate degrees (Program on Operational Hydrology and Applied Meteorology) at the University of Costa Rica received basic courses on climate prediction. More training activities in the use and applications of numerical models for climate prediction have been developed during the implementation of the project. The participation of students, especially those from Central America, is considered important in the formation of new scientists and the development of a regional capacity in this respect. The International Research Institute for Climate Prediction (IRI), NOAA/OGP and the University of Costa Rica supported the participation of Dr. Erick Rivera, a young meteorologist from the Center for Geophysical Research, in the "Intensive Course on Dynamical Downscaling of

Seasonal to Interannual Climate Prediction" held at IRI, University of Columbia, New York, during the period January 15th – April 6th 2001.

4. Equipment acquisition and implementation

The Department acquired the equipment needed to execute a regional mesoscale meteorological model (MM5) and to implement the databases. The equipment was installed at the University of Costa Rica. Prior to its installation, the Department performed a topological study of the University communication network to ensure proper data transfer, speed and efficiency for climate prediction activities. The University, using its own funds, constructed an additional laboratory to host the Department's activities and purchased equipment.

5. Miscellaneous

Over the past two years, J. A. Amador, V. O. Magaña, and E. J. Alfaro have all attended a number of NOAA/OGP sponsored Climate Outlook forums (Belize, May 2000; Tegucigalpa, June 2001; and San Salvador, August 2001) to help develop seasonal predictions for the Greater Caribbean and Central American regions. The participation of J. A. Amador in the Workshop on Monsoon Applications and Human Dimensions, in Tucson, 18-20 June 2001, provided an opportunity to discuss climate prediction applications that could be implemented or adjusted in the future in the Central America region. A poster, aimed at the general public with some of the project expected results for climate applications, was on display during the University of Costa Rica Expo 2001 last August.

The modeling system (MM5) generated through this project is of regional extent with higher spatial resolution than General Circulation Models, and is driven by time dependent boundary conditions provided by models such including CCM3 and ECHAM2. Advances have been made that should significantly improve the prediction skill of the regional climate system, of the regional scientific infrastructure, and it has provided a unique opportunity to enhance regional collaboration among National Weather and Hydrological Services and other regional institutions.

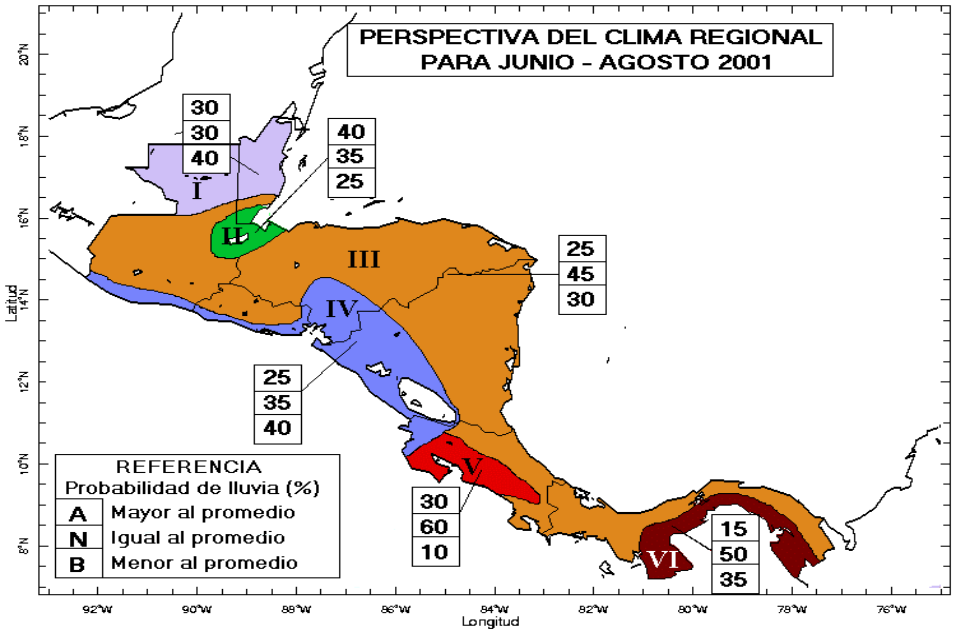
DEVELOPMENT OF A REGIONAL, SEASONAL CLIMATE PREDICTION SYSTEM / COMPLETION OF TRAINING WORKSHOPS IN CLIMATE FORECASTING AND RISK MANAGEMENT

The Department sponsored in part through the Hurricane Reconstruction Project, several Regional Climate Outlook Forums (COFs). These forums played a significant role in capacity building, in strengthening the links between producers and users of climate information, and have stimulated the development of national efforts for the preparation of seasonal climate perspectives in some countries. Forums have also stimulated interest in and created recognition of the impacts of interannual climate variability in the Region and assisted in developing activities that both mitigate against these impacts and help adapt to climate variability.

The COFs have achieved the following set of objectives: (i) bringing together both producers and users of climate information and facilitating the exchange of information between these two groups; (ii) advancing climate forecasting activities in the region; (iii) increasing awareness of the availability as well as the potential usefulness of climate forecasts and other types of climate information; and (iv) electing a regional steering committee to coordinate and oversee the development of climate forecasting and applications activities.

During the course of the Hurricane Reconstruction Project, the Department was involved in three forums – Belize, Tegucigalpa, and San Salvador. The San Salvador forum, building on the success of past Forums, was convened to produce a consensus climate outlook for the months of September.-October.-November 2001. This forum, and the preceding one held in June 2001 in Honduras, were of particular importance due to the severe drought impacting the region. Because of the severity of the drought situation, representatives from the Ministries of Agriculture from each of the 7 Central American countries were involved in the meeting, to share their concerns and to state their information needs. The Ministries of Agriculture used the consensus climate outlook as a decision-making tool in planning for the months ahead to aid with the response to the drought situation

One very important note about the climate outlook forum process is that Central America has taken steps to institutionalize the process and they have taken over coordination of the regional effort. An indication of this is the fact that they held a climate outlook forum in Managua, Nicaragua (April 22-24th. 2002), and they have done all of the planning and coordination without request for outside financial support. These meetings have gained high-level attention due to the ongoing drought situation, and ministers of agriculture are among some of the important decision makers that have been engaged in the process and are eager to learn how to use the outlook to better plan for the months ahead. With the current climate outlook forum in Nicaragua, they are holding a three day meeting: the first two days are the more technical parts of producing the consensus climate outlook, and the third day they are holding a video conference to link up the 6 Spanish-speaking Central American countries. The video conference aspect was a big success when it was first used during the 2001 Central American climate outlook forums, and it allows many other groups and individuals to engage in the process.



Tegucigalpa COF Output

DISASTER PREPAREDNESS AND RESPONSE

As with the country-specific disaster preparedness and response activities, many of the regional disaster preparedness and response activities focused on training and capacity building. For the regional programs, this entailed training courses and workshops, some of which have been discussed in previous sections of this report. Some of the regional workshops included the following.

Water Level Network Workshops

The Department implemented two in-country **tides workshops**. The first workshop was in Antiqua, Guatemala during the week of May 14, 2001. During this workshop, training was presented in water level data processing to technical representatives from the four participating nations. The workshop manual was translated into Spanish and also presented in Spanish. Presentations were also provided on data analysis and the processing database. The second workshop was held in Heredia, Costa Rica October 16-18, 2001. This workshop addressed the operation and maintenance of the Data Collection Platforms and sensors, required leveling, communications, data downloads, trouble shooting, and documentation.

Hydrologic and Meteorological Forecasting and Early Warning Workshops

The Department, through the Hurricane Reconstruction Project, sponsored the attendance of Central America representatives at three **National Weather Service River Forecast System workshops** in the United States. These workshops provided information on the NWSRFS (as installed in Nicaragua and El Salvador) applications and operations as well as sessions on topics such as hydrologic forecasting, forecast center operations and design, product development and dissemination and integration of meteorological operations and products.

The Department sponsored Central America representatives at a one-month **hydrologic forecasting course** in the United States. The attendees learned various hydrologic forecasting techniques and applications.

The Department sponsored Central America representatives at course entitled *Essential Aspects of Tropical Meteorology* in Panama. The three-week course emphasized tropical observations, observing systems, **tropical forecasting techniques**, and the analysis of tropical data for both forecasting and research activities.

Through the Department's sponsorship, Central America representatives attended a two-week course on *Preparing for Climate Variability and Extreme Events in MesoAmerica – A Regional Course on Production and Practical Use of Climate Forecasts*. The course was designed to strengthen the regional capacity to face **climate variability** through practical applications of climate forecast decision-making and to promote the exchange of knowledge and experience between scientists working in the field of weather and climate prediction and the actual and potential users of that information.

The Department, in conjunction with the Comite Regional de Recursos Hidraulicos del Istmo Centroamericano (CRRH) and the University of Costa Rica developed and implemented a post graduate course in operational meteorology and hydrology. The course was approximately 15 months long and held at the University of Costa Rica. The Department, through the Hurricane Reconstruction Program, sponsored up to two students from the meteorological/hydrologic services in the four Hurricane Mitch-affected countries and the Dominican Republic. The purpose of the course was to build **operational meteorological and hydrologic capacity** within the country.

Equipment Maintenance Workshops

As part of its support to base infrastructure reconstruction throughout the region and to improve the sustainability of installed systems, the Department sponsored a **field monitoring network equipment maintenance program workshop** in the United States. Attendees included key maintenance personnel from Honduras, Nicaragua, Guatemala, and El Salvador. The goal of the workshop was to have each country complete a maintenance planning and logistics manual, tailored specifically to each countries equipment, needs and requirements. This was done and country representatives were able to complete a plan that could be implemented as part of their own maintenance program.

Maintenance Planning Workshop

Spill Preparedness and Response Workshops

Standard training tools used by NOAA were modified and translated into Spanish for use in the final one-week workshop in San Pedro Sula, Honduras. An additional training aid, the Trajectory Analysis Handbook, was developed as part of this effort. The following tools and guidance documents were used during the workshop and distributed to all participants:

1. Aerial Observations of Oil. This guidebook contains pictures of various types of oil spilled at sea and includes definitions and standard terminology used to define oil's appearance on the water.

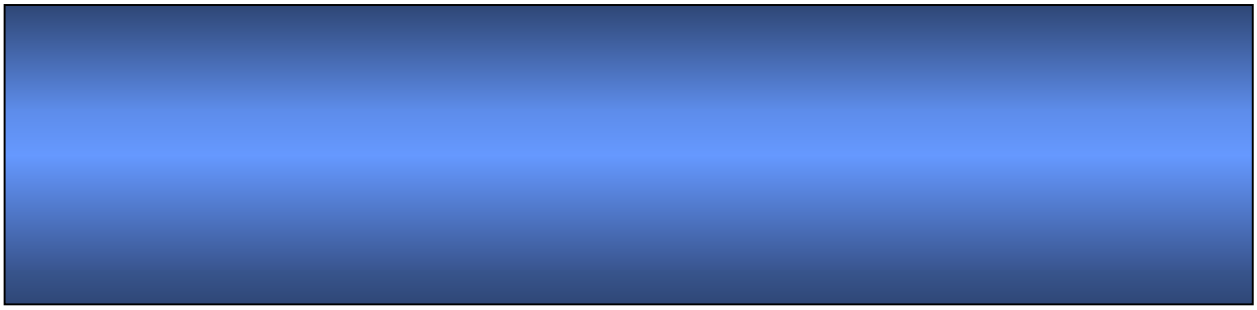
2. Shoreline Assessment Job Aid. Habitat identification and a methodology for identifying, quantifying and recording shoreline oil impact are provided in this field guide. The habitat depictions correlate to those in Environmental Sensitivity Index work, for example.

3. Coastal Characteristics. Response technologies for habitats identified on products such as Environmental Sensitivity Indexes and in the Shoreline Assessment Job Aid are evaluated and discussed in this guidebook.

4. Trajectory Analysis Handbook. The physical processes relevant to determining the movement of oil are summarized and presented in this field guide.

5. Computer Aided Management of Emergency Operations (CAMEO). The CAMEO program was translated into Spanish as part of a separate EPA-sponsored effort, but proved quite appropriate for use in this effort. This tool provides access to response information for 6,090 chemicals, including physical property information and over 60,000 synonyms to assist in chemical identification.

6. Automated Data Inquiry of Oil Spills (ADIOS). The ADIOS program was the only tool used as part of the workshop that was not available in Spanish. Because of the extensive nature of the program, it was not initially considered as part of this technology transfer activity. However, during preparatory activities for the training and contingency planning workshops, it was identified as a useful tool by local agencies - even if it only existed in English. This model has a database of approximately 1,000 oil and oil products. By providing local environmental information (such as air and sea temperature, wind speed, wave heights, and salinity), weathering processes of specific oils can be identified (such as evaporation, dispersion, dissolution, etc.) and relevant property changes over time can be calculated (e.g., viscosity, water content).



Excerpt from *Framework – Center for the Integration of Hydrometeorological Activities in Central America*

In addition to the training and capacity building activities noted above, the Department also worked with regional counterparts to develop a framework for a regional center for hydrometeorological activities in Central America. The Department drafted a document – *Framework – Center for the Integration of Hydrometeorological Activities in Central America* that provides an overview of the center, its functions and mission and an estimate of initialization and operational costs.

The framework developed by the Department was based on research by the *Comité Regional de Recursos Hidraulicos del Istmo Centroamericano* (CRRH) on the needs for regional support to the meteorological and hydrologic services in Central America. The work done by CRRH was through the Department's Hurricane Reconstruction Program. What is described in the framework is a center that can most benefit the Region based on the current condition of the meteorological and hydrologic services.

The idea of a regional center for hydrometeorological activities was raised during evaluations of needs to transform and strengthen the national meteorological and hydrological services (NMHSs) in the region following Hurricane Mitch in October-November 1998. The Department performed these evaluations as part of the Hurricane Reconstruction Program. What was found was a need for

the NMHSs to provide more operational services, especially in the area of early warnings for severe weather-related events such as flooding. Though the idea of a regional center had been proposed in the past – the need for a centralized and integrated approach for continued strengthening of these agencies was most evident after the hurricane. Due to restrictions on financial and personnel resources continued transformation and strengthening by individual country is difficult – as is sustaining existing meteorological and hydrologic programs. Therefore, a regional center, which can act as a focal point for supporting and coordinating the meteorological and hydrologic services and efficiently enhancing their capabilities, is proposed. The goal is to build solid national meteorological and hydrologic services with well thought out and sustainable programs and then enhance their technical capabilities through a central, regional facility that supports each service.

SUSTAINABLE, RESILIENT COASTAL COMMUNITIES

No activities (Gulf of Fonseca Program activity)

ECONOMIC REVITALIZATION

To help U.S. companies participate in internationally-funded reconstruction projects and other trade and investment opportunities in Central America, the Department focused its efforts on four areas: (1) providing information on reconstruction efforts and possible projects, (2) facilitating U.S. company contacts with host countries' executing agencies, multilateral development banks, and potential business partners, (3) raising awareness in Central America of U.S. companies' skills and expertise, and (4) facilitating bilateral industry cooperation to make the region more resilient to natural disasters. ITA also served as an important source of information about other U.S. Government programs available for U.S. companies interested in reconstruction projects. U.S. companies contacted ITA's liaison offices at the Inter-American Development Bank and the World Bank-- the principal multi-lateral development banks funding projects in the infrastructure, transportation, and the social sectors-- for guidance and information on projects and procurement procedures.

Prior to Hurricane Mitch, the Central American countries had made significant progress strengthening democracy and liberalizing their economies. Trade liberalization, macroeconomic stabilization, and the introduction of private investment in previously state-owned enterprises have resulted in significant trade and investment opportunities for U.S. companies. The United States is Central America's most important trading partner and its largest foreign investor, with 1998 U.S. trade with Central America (specifically Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua) totaling $17.6 billion. Top U.S. exports to the region include wheat, rice, oil, and apparel components for assembly and re-export. Top exports to the U.S. include bananas, coffee, sugar, and apparel. Continued growth of these industries, as well as tourism, non-traditional agriculture, and forestry, are critical to Central America's economic reconstruction. U.S. companies played an important role in Central America's reconstruction efforts by providing desperately needed resources and skills, and were well-received by Central American companies.

Theses are the highlights of the Department's activities:

- ***January 1999***-A USDOC team comprised of officials from the Office of the Secretary, ITA and NOAA visited Central America to assess damage from Hurricane Mitch and to determine the role of the U.S. private sector in reconstruction efforts. The team's report was forwarded to the White House.

- ***Late 1999 and early 2000***-Secretary Daley and U/S Aaron participated in several Hurricane Mitch conferences, highlighting the role of the Department of Commerce in marshaling private sector participation in the reconstruction effort. At a Chamber of Commerce event held in early February, U/S Aaron announced his intention to lead a reconstruction mission to Central America in late March.

- ***March 1999***-Ambassador Aaron led a highly successful, 16-company mission, to Guatemala, Honduras, El Salvador and Nicaragua. Besides highlighting U.S. corporate interest in the reconstruction of Central America, the mission underscored the U.S. private sector's compassion for

the citizens of the region. One mission member donated a pre-cast concrete bridge and another donated water purification equipment. Both gifts were made to Honduras, the most severely damaged of the countries in the region. Baker Concrete, which donated the bridge, subsequently won a USAID-funded contract to build temporary bridges in Honduras.

A primary goal for the mission was to enhance the exposure of small and medium-sized U.S. firms to importers and distributors in the target countries, through one-on-one meetings with representatives of potential business associates and to provide U.S. firms a high-profile opportunity to achieve further penetration of this market by meeting with host-country decision-makers in the government and private sectors. As of this writing (two months after completion of the mission), all of the participants were still pursuing leads (ranging from $20,000 to multiple, unquantifiable contracts and several million dollars) that they got during this trip. Most of the participants have already gone back to the region to follow-up on these leads. In addition, during the trip, three of the participating SMEs announced that they were donating equipment to the region. Most of the companies took the time to express their thanks to Department officials to complement the team on the "magnificent job", "very well organized, scheduled, and coordinated" mission, and on the substantial results of the mission.

The mission surpassed participants' expectation in facilitating and establishing meetings between U.S. companies and Central American business leaders . The business delegation participated in several programs, including qualified matchmaker appointments with pre-screened Central American companies, expert market briefings with senior Central American, multilateral development banks (IDB; World Bank) and U.S. Government officials. Ambassador Aaron's leadership allowed the group to meet with the highest levels of Central American leaders ranging from the President to the Reconstruction Cabinet and individual ministers. In addition to one-on-one meeting with potential partners, meetings with the private sector, include American Chamber of Commerce and non-governmental organizations. Both small and large companies found the commercial intelligence gathering portion of the trip very useful.

The mission also sought to provide U.S. Government support of Central America's efforts to achieve greater transparency and even-handedness in procurement. Ambassador Aaron raised those issues in bilateral consultations and at press events. All four countries stated that they either had taken or were taking steps to ensure transparency in reconstruction contracts

In addition, ITA's Office of Textiles and Apparel sponsored a textile trade mission to Guatemala, El Salvador, Honduras, and the Dominican Republic October 2000. The mission consisted primarily of 6-12 apparel fabric manufacturers and suppliers. Participants met individually with buyers, agents and distributors, pre-selected and qualified by ITA.

- ***May 1999***-A/S Mulloy chaired a briefing for the U.S. business community on preparations for the Stockholm Consultative Group meeting of bilateral and multilateral donors. The briefing included the participation of the State Department, USAID, and the Inter-American Development Banks. MAC/OLAC Director Walter Bastian participated as the Commerce Department's representative to the Stockholm CG meeting, where he co-chaired the technical working group for trade.

- ***May 1999*** Commerce Secretary Daley signed a MOU with the USAID Assistant Administrator, Mark Schneider, and with the President and CEO of AF&PA, Henson Moore initiating the Honduras Reforestation Initiative (HRI). The HRI is a precedent-setting public- private partnership developed to complement the State Department's Hurricane Mitch reforestation efforts in Honduras and demonstrate the U.S. industry's Sustainable Forestry Initiative (SFI)SM program. This Initiative will rebuild certain forests in Honduras and set the stage to encourage other countries to adopt U.S. standards for linking business to sound environmental practices. Commerce developed an opportunity through which AF&PA has successfully demonstrated its SFISM program in the international arena to the benefit of USAID's efforts to reforest Honduras. Due to implementation of key components of the SFISM program, the success of future reforestation efforts and long-term land use and resource development in Honduras will be greatly improved due to the technology transfer of better nursery management and forestry practices.

- ***June 1999***- ITA organized seminars for the U.S. business community in key cities in the United States. These seminars focused on U.S. Government programs in support of Central American reconstruction and included representatives from USDOC, the State Department, USAID, Commerce's IDB liaison office, SBA and EX-IM. Each event also featured a luncheon speaker from one of the countries impacted by Hurricane Mitch.

- ***Late August 1999***-ITA representatives organized a follow-up visit and traveled to Central America to meet with the IDB/World Bank representatives, government officials and private sector leaders to assess progress of the reconstruction process, to identify new opportunities for U.S. companies, and to evaluate the administration and procurement of internationally-funded projects.

- ***December 1999***-ITA designed and organized a seminar to encourage a dialogue between the U.S. private sector and the Central American and Caribbean governments and private sectors on creating conditions to reduce the economic impact and vulnerability of investments to natural disasters in the region. This event, held in Miami in early December, attracted about 150 public and private sector participants from the Caribbean, Central America, and the United States, and included representatives from USAID, HUD, and the U.S. Department of State. Mrs. Mary Flores, First Lady of Honduras, delivered a luncheon address at this event. In addition to special plenary presentations by U.S. Government officials and companies, the program featured a series of concurrent

workshops focused on insulating operations in the following industry sectors: agribusiness/forestry; energy; telecommunications; construction/housing; transportation (roads, bridges, airports, ports); water and wastewater and manufacturing. These workshops provided U.S. companies with an opportunity to present their experiences in insulating their investments in countries or regions prone to natural disasters.

- ***June 2000***- ITA expert Regina De Leonardis gave a presentation in Buenos Aires, Argentina, on the private sector's role in disaster preparedness at the Disaster Preparedness Seminar organized by the U.S. Southern Command.

- ***June 2000***- In conjunction with the American Water Works Association Conference and Exhibition held in Denver, June 11-14th, TD's Office of Environmental Technologies Industries organized a reverse trade mission from Central America. The mission featured a series of seminars and over 120 one-on-one meetings with the mission delegates. The reverse mission was composed of key decision-makers in the water sector from the four Hurricane Mitch countries as well as one commercial specialist from each post. Over $1.5 million in sales of U.S. water treatment technologies resulted from this event.

- ***June2000-*** TD, USAID, and the American Forest & Paper Association hosted a delegation of ten Honduran nursery managers as part of the Honduran Reforestation Initiative. The delegates visited Alabama and Georgia to view forest development. The goal of this mission was to demonstrate to Honduras and the rest of Central America that sustainable management of forests is more profitable than the current haphazard cutting practices. In September, Secretary Mineta extended by one year our cooperation agreement with the American Forest & Paper Association.

Reforestation Initiative – Honduran Nursery Managers

- ***September 2000***- The Department held a very successful conference on the insurance sector in El Salvador. Attendees/participants from Central America included insurance regulators, representatives from various ministries, the AmChams, and representatives of U.S.

insurance/reinsurance companies. U.S. participants include representatives from FEMA, the World Bank/IFC, reinsurance companies, claims adjusters, and the Florida State Insurance Commission.

- ***September 2001***- ITA's Office of Environmental Technologies Industries (ETI) led a highly successful reverse trade mission to Mexico City at the Enviro-Pro Tecomex trade show. The mission participants included government officials and key decision makers in the water sector from Central American Mitch countries escorted by FSN's from each market. Mission participants attended Mexico's largest environmental trade event, Enviro-Pro Tecomex, in Mexico City in order to meet with over 40 U.S. exhibitors in the DOC-certified U.S. Pavilion in pre-arranged appointments. The group also participated in a special briefing session presenting environmental business opportunities and projects in their respective markets to U.S. companies

- **Throughout 1999 and 2000,** the Department held a series of "Doing Business in Central America" seminars in various U.S. cities to increase awareness of business opportunities in Central America among the U.S. business community. The Department worked closely with industry associations focusing on sectors prioritized for the region (i.e. infrastructure, construction, agribusiness, energy). The Department undertook an aggressive outreach and education program. Department staff participated in domestic trade shows to increase awareness of reconstruction- related opportunities for US businesses; and talked with trade mission participants to get private-sector perspectives and update on reconstruction efforts, feedback on info on web site, and success stories to post on website. To centralize the dissemination of information, ITA's Trade Information Center (1-800-USA-TRADE) developed a website with extensive links providing information on Central American reconstruction efforts and project opportunities.