# Center for Operational Oceanographic Products and Services
# Implementation Plan

# Water Level Observation Network
# for
# Central America

**US Department of Commerce**
**National Oceanic and Atmospheric Administration**
**National Ocean Service**
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## Background

The Center for Operational Oceanographic Products and Services (CO-OPS) was requested by DOC/NOAA to submit a plan for the reconstruction of the water level observation network in Honduras for the U.S. Department of Commerce's Implementation Plan For Reconstruction Work in Central America (DOCIP). DOCIP is an intergovernmental cooperative effort, funded by Congress, to assist Central American countries affected by hurricane "Mitch" with the reconstruction of damaged infrastructure. USAID missions in Central America reviewed the DOCIP and indicated that it was not necessary to install a dense network of water level stations in Honduras or any of the other affected countries. However, USAID did agree that it was necessary to install water level stations to support the reconstruction and improvement of the Geodetic Control Network in Central America. The following water level network is designed to provide the required mean sea level (MSL) data to support the development of the geodetic control networks described in the implementation document Development and Implementation of a Geodetic Framework for El Salvador, Guatemala, Honduras, and Nicaragua prepared by the National Geodetic Survey, NOAA. An individual country Implementation Plan for the Water Level Observation Network (WLON) will be prepared from this document and provided to the appropriate USAID Mission.

## Objectives

The objectives of this activity are:

1) install 6 state-of-the-art sea level and meteorological monitoring stations, recover historical MSL data and update the local MSL datum at these stations to support the development of a geodetic framework for Central America;
2) develop a national and regional capacity to install and maintain the stations, conduct data acquisition, data analysis, data archiving and data dissemination activities using automated data base management technology; and
3) strengthen professional and technical skills of host country agencies as well as national and regional institutions through technology transfer and capacity building.

Successful implementation of this activity is directly related to the degree of participation provided by host country agencies and national and regional institutions. Presently NOAA is in contact with the Instituto Nicaraguense de Estudios Territoriales (INETER) and the Empresa Nacional Portuaria (ENP) in Nicaragua, the Instituto Geograpfico Nacional (IGN) and the ENP in Honduras, the Instituto Nacional de Sismologia, Vulcanologia, Meteorolgia E Hydrologia (INSVMEH) in Guatemala, and the Instituto Geograpfico Nacional (IGN) in El Salvador.

NOAA will coordinate hands-on training, seminars, and workshops to ensure that the designated host country agencies as well as national and regional institutions are fully capable of operating and maintaining the WLON.

### Water Level Observation Network (WLON)

Final WLON design and site selections will depend on the results of discussions with the host country agency participants and a site reconnaissance of existing and historical water level sites. A reconnaissance will be conducted by representatives of the host country agency and CO-OPS personnel. Some of the site selection criteria consist of:

1) length of the MSL series available;
2) adequate bench mark network,;
3) adequate facilities and security for long term measurements; and
4) for existing site, does the MSL data represent an open coast environment.

The following list was prepared from information in the CO-OPS historical water level archives, station lists from host country agencies and from meeting with officials from the ENP in Nicaragua and Honduras. The US Department of Transportation, Maritime Administration was requested by the ENP to conduct a Port Damage Assessment and several stations were identified by the ENP as critical to port operations and safe navigation as a result of this assessment. The final WLON will consist of 6 stations selected from the list of historical and existing stations in each country (Fig. 1). USAID requested that NOAA added a new site to the WLON. The new site is at the entrance to the Rio Lempa River in El Salvador and is required to assist with regulating river flow during dam discharge operations upstream. Timing the discharge with the falling tide or low waters is critical to mitigating upstream flooding.

EL SALVADOR

| *Station* | *Latitude (N)* | *Longitude (W)* | *Years* |
|---|---|---|---|
| La Union | 13º 20.0' | 87º 49.3' | 19 |
| Rio Lempa | New Site | | |

GUATEMALA

| *Station* | *Latitude (N)* | *Longitude (W)* | *Years* |
|---|---|---|---|
| Puerto San Jose | 13° 55.0' | 90° 49.8' | 20 |
| Matias DeGalvez | 15° 41.6' | 88° 37.2' | 6 |

HONDURAS

| *Station* | *Latitude (N)* | *Longitude (W)* | *Years* |
|---|---|---|---|
| Puerto Cortes | 15° 50.1' | 87° 57.2' | 19 |
| Puerto Castilla | 16° 01.0' | 86° 02.0' | 13 |
| San Lorenzo | IGN Site | | |

NICARAGUA

| *Station* | *Latitude (N)* | *Longitude (W)* | *Years* |
|---|---|---|---|
| Puerto Cabezas | 14º 01.2' | 83º 22.9' | 11 |
| Corinto | 12º 28.7' | 87º 10.1' | 4 |
| Sandino | 12° 11.0' | 86° 46.0' | 1 |

## Station Configuration

A typical station in the Central American WLON consists of an air acoustic water level sensor, a backup pressure water level sensor, a protective well, meteorological sensors, a data collection platform (DCP), a Geostationary Earth Orbiting Satellite (GOES) radio transmitter, a voice modem, a 12 V battery and 35 W solar panel, and a permanent bench mark network composed of a minimum of five survey monuments (Fig. 1). The DCP provides on-site data acquisition, storage, and telemetry options, which include GOES satellite, telephone, line-of-sight radio, and on-site download via an RS232 port. GOES telemetry is the primary mode of data retrieval for the WLON , telephone is optional. Since GOES transmission time is critical, the DCP's will be equipped with a GPS board to ensure the system is on the precise UTC time. WLON station design and components comply with the minimum standards of the Global Sea Level Observing System network of the Intergovernmental Oceanographic Commission (UNESCO 1990) and consistent with the sea level stations in the Caribbean: Planning for Adaptation to Global Climate Change network (Martin, et. al. 1998).

NOAA shall provide engineering support to investigate the possibility of acquiring high quality tsunami measurements (Gonzalez, et. al. 1993) from WLON stations to enhance the Tsunami Warning System (TWS) on the Pacific Coast and to initiate the installation of a warning system on the Caribbean Coast in response to growing concerns of the Tsunami hazard (UNESCO, 1996) in that tectonically active region.

## Equipment Procurement and Station Installations

Equipment procurement and the installation and the operation and maintenance (until December 31, 2001) shall be accomplished through an existing cooperative agreement between NOAA and the General Secretariat of the Organization of American States (GS/OAS) in accordance with Section II.A. of the Agreement for Technical Cooperation. CO-OPS shall provide GS/OAS with a set of specifications for the required equipment and a statement-of-work (SOW) for the proper installation, operation, and maintenance of the stations and have GS/OAS manage the contracting requirements. A project monitor shall be provided by NOAA/CO-OPS to ensure compliance with the equipment specifications and SOW.

## Data Acquisition, Data Analysis, and Data Dissemination

Data acquisition of the GOES telemetry data shall be accomplished via a USGS/NWS GOES ground station located in Central America. National and Regional users will have direct access to all of the data over the INTERNET node being developed by USGS and NWS to support the data collection networks established by each of those agencies (Fig. 2). NOAA shall provide on-site

assistance with any operational problems and on-site training on database management and quality control and quality assurance procedures, in addition to providing training at NOAA facilities. Data analysis and data archiving capabilities will be developed within the host country agencies and Regional institutions. However, NOAA shall process and analyze one year of sea level (tide) data from each of the 6 stations in the WLON. During this time, NOAA shall work closely with National agencies and Regional institutions to provide technical assistance in developing the WLON to it's fullest capacity.

## Geocentric Fixing of Tide Stations

A minimum of one bench mark at each WLON station shall be occupied with GPS to precisely position the stations in the International Terrestrial Reference Framework (ITRF). Multiple days of GPS observations shall be conducted with GPS receivers and antenna that meet geodetic standards to obtain geodetic quality 3-D positioning of the stations. CO-OPS shall provide on-site training to host country agency staff on the standard procedures for conducting precise GPS surveys at each WLON station. Precise positioning of WLON stations in the ITRF provides National and Regional consistency to the network. More importantly, this provides an opportunity to monitor crustal motion at the National and Regional level and determine absolute sea level change in the area.

## Sustainability

To ensure the long-term viability and sustainability of the Water Level Observation Network for Central America, the project is engaging in three important initiatives: Establishing a Trust Fund, Implementing Technical and Institutional Capacity Building, and Developing and Strengthening an Institutional Framework.

*(1) Trust Fund*

NOAA proposes that a Trust Fund be established to assist with emergency maintenance, training, and other needs after the Mitch Reconstruction project has officially concluded December 31, 2001. Seed money for the fund would come from the NOAA Mitch allocations. Additional funding may be obtained from external sources.

*(2) Capacity Building*

Long-term sustainability and viability is also being ensured by a significant investment in technical and institutional capacity building and local participation. Specifically, designated agencies from each country will participate in the final site selections, instrument installations, and GPS observations. Country participation will be facilitated and supported by appropriate training and capacity building. This will help to ensure that local, national, and regional agencies are capable of operating, maintaining, and utilizing the Network to its full potential. In addition, the project will serve to help develop regional infrastructure. Participating countries will be able to utilize this infrastructure for a wide variety of uses and in many different sectors.

NOAA and contract personnel shall provide on-site training to host country staff during these activities and coordinate the development of in-country tides workshops. These in-country workshops shall be coordinated with the National Weather Service training activities. In addition to the on-site training, NOAA shall provide in-house training to the staff from the designated agencies on the proper installation, operation, and maintenance of water level stations at a NOAA facility to ensure full capability in all aspects of operating and maintaining the WLON stations. NOAA shall also make available and provide training on the use of quality control and quality assurance and sea level analysis software to assist with processing and archiving the data. NOAA considers the capacity building aspect of the project an essential component to its sustainability. It will strengthen professional and technical skills of host country agencies and regional institutions through technology transfer and capacity building.

*(3) Institutional Framework*

As indicated above, a fundamental aspect in the Water Level Observation Network for Central America is the development of a strong institutional framework. That framework will be made up of local, national, and regional organizations, institutions, and governments that will both support and utilize the Network. Capacity building activities will be focused on these groups as will much of the data analysis. The Network's ultimate sustainability will be highly dependent on this framework, thus its development and strengthening are imperative.

## Benefits to Other Projects/activities in the Region

The primary purpose of the WLON is to provide support for the development and improvement of the geodetic framework of Central America. However, information and data derived from WLON will 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 tsunami, and coastal sea level predictions associated with climate change (Pugh, D. T. and Maul G. A., 1999).

Data from the WLON supports the design, development and construction of harbor facilities to enhance maritime commerce, to produce accurate nautical charts, and to improve marine nowcasts and forecasts. WLON stations will also have the capability of providing real-time water level and meteorological data to large vessels (oil tankers, containers, and cruise) to improve safe navigation and docking operations.

## References

UNESCO, 1990. "Global Sea Level Observing System (GLOSS) Implementation Plan". Intergovernmental Oceanographic Commission Technical Series 35.

Martin, D. et. al. 1998. “Caribbean Sea Level Monitoring Network”. Proceedings International Symposium on Marine Positioning, Melbourne, Florida.

Gonzalez, F. et. al. 1993. “U.S. Tsunami Measurement Capabilities”. Proceeding of the Third US-Japan Tsunami Workshop in Japan.

UNESCO, 1996. “IOCARIBE Tsunami Warning System Workshop”. University of the Virgin Islands, St. John, Virgin Islands, May 23-24, 1996.

Pugh, D. T. and Maul, G. A., 1999. “Coastal Prediction for Climate Change.” Coastal Ocean Prediction, Coastal and Estuarine Studies 56, Pages 377-404, American Geophysical Union.

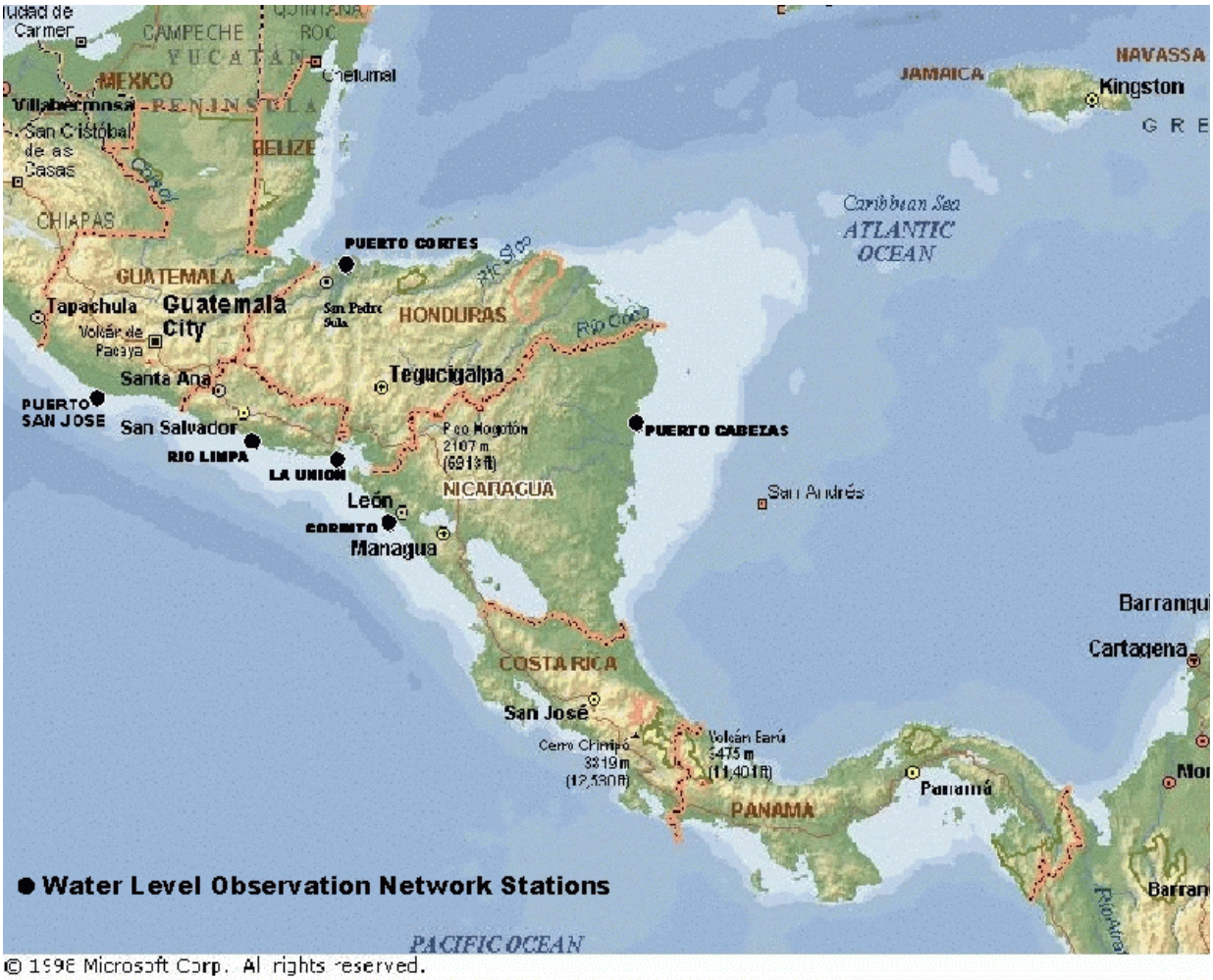



Fig. 1 Water Level Observation Network Stations to support Mitch Reconstruction

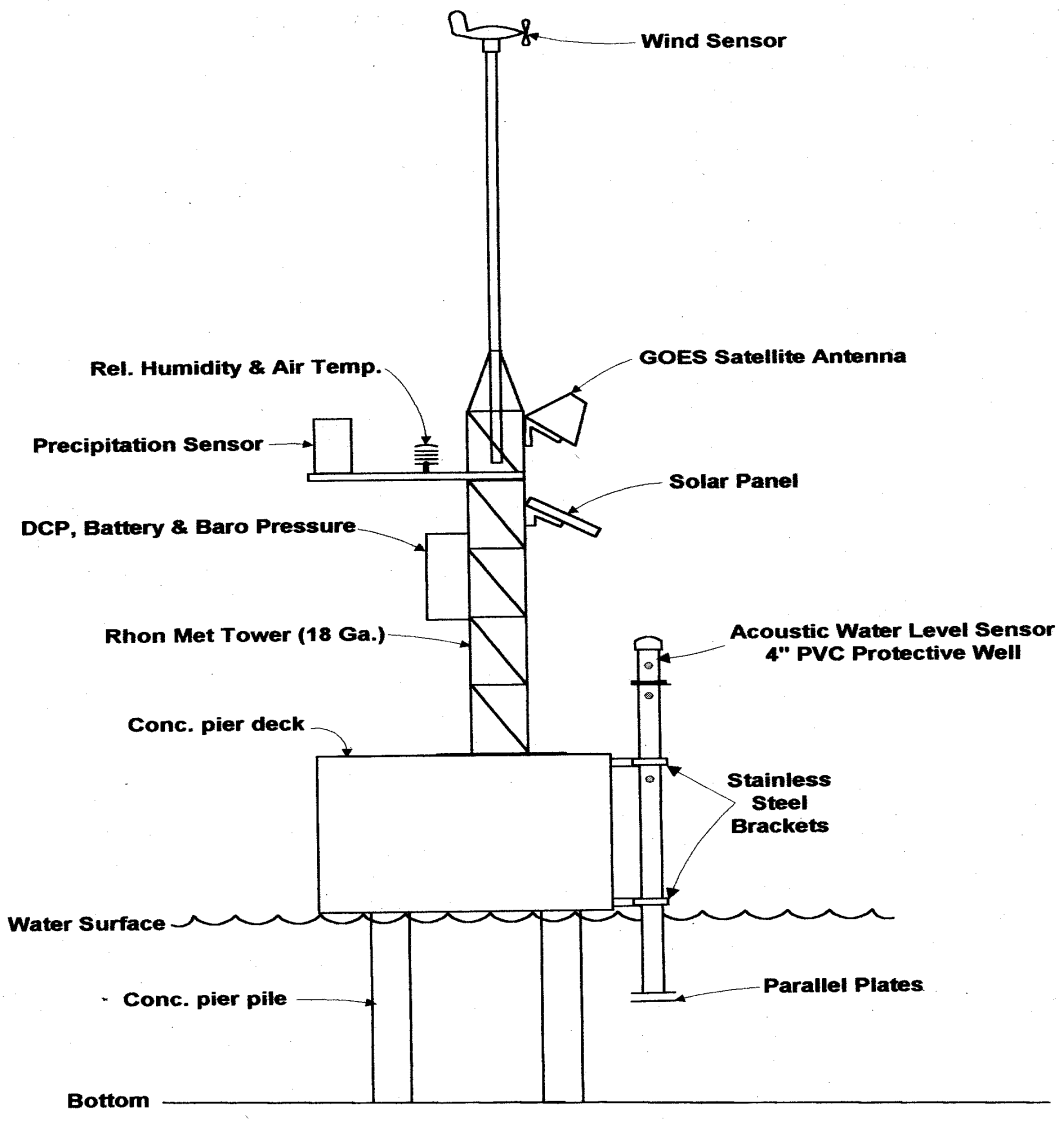


Fig. 2 Typical WLON station configuration.

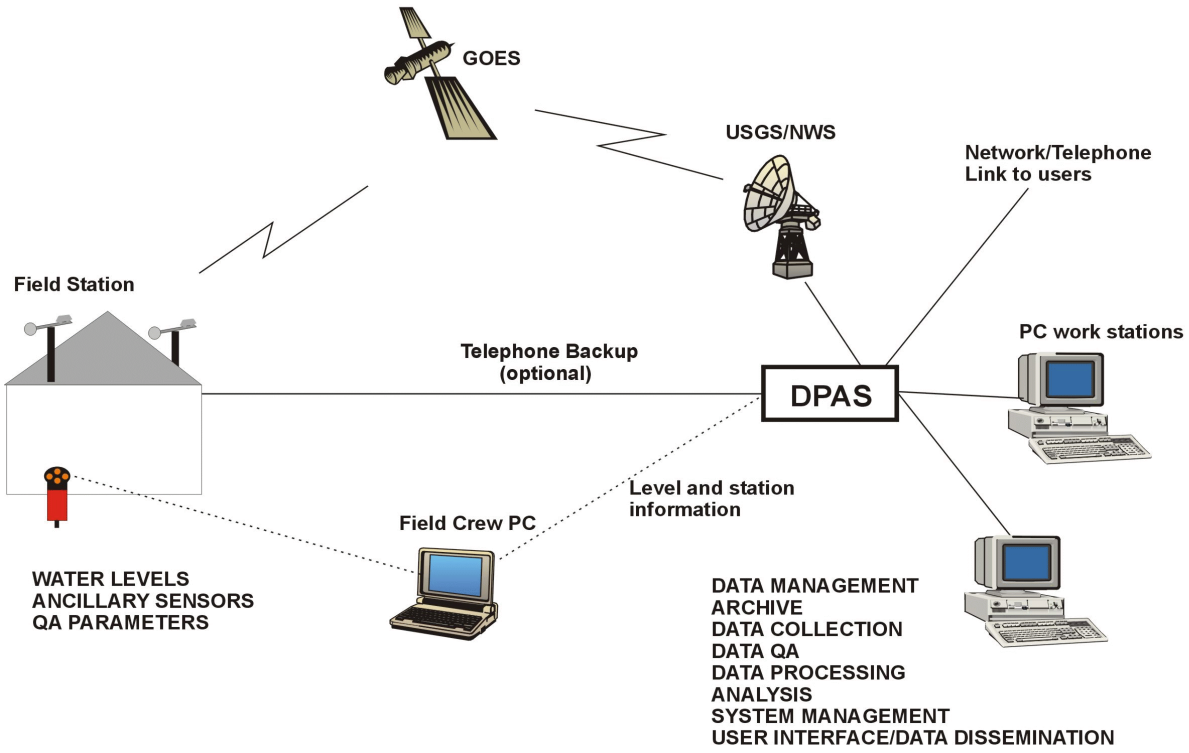


Fig. 3 Data acquisition, data analysis, and data dissemination system