Eighth Session of the Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE EWS-VIII)  
Port of Spain, Trinidad and Tobago  
29 April –May 1, 2013

Working Group 1  
Monitoring and Detection Systems, Warning Guidance Report

The purpose of Working Group I is to review and recommend to the ICG priorities and actions required towards the full establishment of a coordinated regional tsunami warning system. Its functions are to:

1. Advise member states on the monitoring and detection capabilities needed for operating national tsunami warning centers.
2. Define the threshold criteria for the monitoring and warning systems.
3. Assure the compliance with the agreed standards for the detection systems.
4. Ensure the effectiveness of the warning system by promoting the open exchange of seismic, sea level and other observational data in real time.
5. Promote the sharing of experience and expertise and capacity building essential to the effective monitoring and issuance of warnings.
6. Ensure the establishment of a fully interoperable regional tsunami warning system.

The current membership of Working Group I is:
- Emilio Talavera M, Instituto Nicaragüense de Estudios Territoriales, Nicaragua, Chair
- Miguel Palma, Vice Chair (Seismology), FUNVISIS, Venezuela
- Sebastien Deroussi, Vice Chair (Sea Level), Observatoire Volcanologique et Sismologique de la Guadaloupe, France
- Gloria Romero, FUNVISIS, Venezuela
- Daniel E. McNamara - NEIC (USGS), United States of America
- Christa G. von Hillebrandt-Andrade, Caribbean Tsunami Warning Program (USA) - Invited Expert
- Lloyd Lynch, Research Fellow-Instrumentation-, Seismic Research Unit -Invited Expert
- Arthur Rolle, Director, Meteorological Service, Bahamas
- Marie Paule Bouin, Sismologue, Observatoire de la Guadeloupe, France
- Jean-Marie Saurel, Engineer, Observatoire de la Martinique, France.
- Capitán de Corbeta Nelson Murillo, DIMAR, Colombia
- Claudio Martínez, ONAMET, Republica Dominicana
- Mr. Venantius Descartes, Deputy Director, Saint Lucia Met. Services
- Allison Allen, NOAA National Ocean Service, USA
- Jennifer Larreynaga, Ministerio del Medio Ambiente y Recursos Naturales, El Salvador
Donald Simon, Antigua and Barbuda Meteorological Service
Doug Wilson, IOCARIBE-GOOS Regional Project Coordinator
Marvin Ryan Forde, Caribbean Institute for Meteorology and Hydrology, Barbados – Invited Expert
Pedzi Grigori, Meteorological Department Curaçao (MDC), Curacao
Mark Oduber, Departamento Meteorologico ArubaAruba
Andre Anglade, Observatoire Volcanologique et Sismologique de la Guadaloupe, France
Hampden Lovell, Department of Meteorology, Barbados
Bernard Naigre, Conseil Général de la Martinique, France

Working Group Activity: During the intersessional period the Working Group did not meet. Three of the members of the Working Group or their representative attended the Third IOC-GLOSS-IOCARIBE-CARIBE EWS Caribbean Training Course for Operators of Sea Level Stations which took place from June 5-9, 2012 in Mérida, Mexico and discussed several issues pertaining to the sea level component of the Working Group. During the remaining part of the intersessional period communication was via emails, the monthly reports on the status of the sea level and seismic stations were distributed to all the members of the working group and key regional data partners. Very limited feedback was received regarding the email communications. On April 25 all members were invited to participate in a conference call to review report and recommendations of WG1 for ICG VIII, only 5 members participated, though others provided input virtually.

Seismic Stations and Data Availability

Seismic data is critical for the timely and accurate issuance of tsunami alerts and also for tsunami research. The CTWP has been tracking data availability from the CARIBE EWS seismic stations in real time for tsunami warning purposes and at IRIS for research applications. As of March 2013, 85% (112/132) of the seismic stations of the CARIBE EWS implementation plan are contributing in real time (Figure 1). The most significant development was the addition of Venezuela stations, France also added some stations and stations were repaired in Dominican Republic.

The CTWP has also been tracking data availability from the CARIBE EWS seismic stations submitting their data to IRIS for research applications. During February, 57% of the stations are also contributing their data to IRIS, this is up from 47% in February 2012. This is data is important as it is very important for seismological and tsunami research.

According to the CARIBE EWS Implementation Plan, the goal of data availability per station is at least 90%. According to the CTWP, for February 2013, at PRSN 67% (up from 54%) had a data availability of 90-100%, at WCATWC 65% (up from 55%) had a data availability of 90-100% and for IRIS 59% (up from 57%) of the stations had data availability in the range of 90-100%. With respect to the data availability last year for the Hispaniola region, two stations from the Dominican Republic were reintegrated into the system, but still only 1 station from Haiti is transmitting data to the Centers.
On IRIS a virtual seismic network was established to view the status of seismic data from Caribbean seismic stations being archived at the Data Management Center (http://www.iris.edu/gmap/_CARIBE-EWS). The PRSN also has a graphical tool where one can view data from seismic stations contributing to the warning component of the system (http://prsn.uprm.edu).

Guadeloupe has installed 4 new additional BB stations. Martinique has installed 3 new additional BB stations, while 4 additional BB stations in Dominica, St. Lucia, Antigua and Cariacou are scheduled in 2013 in collaboration with SRC, through Interreg TSUAREG project. Two more stations are planned in 2013, one in Martinique and one in Saint-Barth. All the data are and will be available in real-time through IPGP data center seedlink server. The archived and validated data will also be available through IPGP data center. This total of 15 stations across the Eastern Caribbean are equipped with three sensors: a broadband seismometer, an accelerometer and a continuous GPS (some of them will be Coconet stations).

PRSN installed a full (GPS, Accelerometer and Seismometer) station in the Virgin Gorda, British Virgin Islands and repaired the Punta Cana station in Eastern Dominican Republic. PRSN also installed two additional stations in Guayama and Patillas in southeastern Puerto Rico, the data of these stations is also being sent to IRIS and the TWC’s.

UASD installed a new broad band station in Santiago, Dominican Republic. This station replaced the PUCM station.

SRC and the Earthquake Unit, Jamaica received a grant from CCRIF to upgrade the region’s strong motion instrument network. Fifteen accelerometers were purchased and these will be deployed in accordance with the following table during the course of the year 2013.

<table>
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<tr>
<th>Island</th>
<th>Site/Contact Person</th>
<th>Application/Strategy</th>
<th>Sensor</th>
<th>Digitizer</th>
<th>Ext. Comms</th>
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<tr>
<td>Barbados</td>
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<td>5TC</td>
<td>DM24S6EAM</td>
<td>Corporate Internet</td>
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<td>CMG-5TDCE</td>
<td>UWI Internet/ C@aribNET</td>
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<td>W/l to AP (SRC)</td>
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<td>Antigua</td>
<td>Frias Hill</td>
<td>SM Upgrade + SPV</td>
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<td>Boggy Peak</td>
<td>3 Ch. Upgrade of BB</td>
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<td>W/l to AP (C&amp;W)</td>
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<td>5TC</td>
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**Legend**

5TC – Guralp compact triaxial, force-feedback accelerometer with a large dynamic range
DM24S6EAM – Authenticated 6 channel digitiser with acquisition module
DM24S3EAM – 3 channel digitiser with acquisition module
5TCDE – Compact digital accelerometer with acquisition module
ADSL Assymetrical Digital Subscriber Line,
C&W – Cable and Wireless, W/l - Wireless
SM – Strong Motion, BB – Broadband seismometer, SPV – Short Period Vertical Seismometer
AP – Access Point, TBD – To be decided, DMO – Disaster management organization

The countries in the pink area of the table will be the focus for the first six months of the year. Some of the instruments will be installed in urban centres near critical facilities while others will be installed near urban centres on hard rock. Installations with six/four channel digitizers will be furnished with accelerometers and a triaxial /a vertical seismometer. Data transmission is via the Internet.

Two new strong motion stations were installed at Diego Martin and Couva in Trinidad. The Pointe-a-Pierre (TPP) seismic station was upgraded to digital with accelerometer and a 30 second seismometer. Data transmission is via spread spectrum radio.

Several activities are planned for the ICG VII-IX intersessional period. Nicaragua is planning on installing 8 new BB stations. PRSN, Baylor University and UASD will relocate the equipment of the old PUCM station in Santiago to San Francisco de Macoris in Dominican Republic. FUNVISIS will be installing a new joint seismic and GPS station on Aves Island. Another four strong motion station deployments are planned for Trinidad and Tobago over the next six months. SRC reported four new broadband/high dynamic range stations are scheduled to be installed in Dominica, St. Lucia, Antigua and Cariacou in 2013. These stations were funded by
INTERREG. The first of these four stations was completed between 18 March - 4 April 2013 at Bisee, St. Lucia. Data transmission is via Satellite.

Figure 1. Seismic stations in the Caribbean (March, 2013).

The USGS National Earthquake Information Center (NEIC) has produced numerical models to determine the minimum magnitude threshold, detection time, earthquake location error for the seismic network in the Caribbean region. This model was run on three network scenarios based on a) the existing seismic stations available in real time to the CTWP and PTWC in 2006 (Figure 2), the existing seismic stations available in real time to the CTWP and PTWC in 2013 (Figure 3) and the existing and planned real time seismic stations (Figure 4).

As seen in Figure 2, in 2006 very few seismic stations in the area were available to the PTWC and consequently the seismic network performance standards, required by WG1, were poorly met throughout the region. The exception was in the vicinity of Puerto Rico, where earthquake could be detected in less than one minute. Outside of the Puerto Rico region, earthquake detection time was on the order of many minutes.

As of April 2013, the CORE existing real-time seismic stations available to the CTWP and PTWC nearly meet the performance standards established by WG1 (Figure 3). Recent network additions (Nicaragua, Colombia, Mexico, Cayman Islands, Venezuela) have reduced detection threshold, time and location error throughout much of the Caribbean region and Central America. For example, Figure 3 shows that earthquakes in the Caribbean can be detected within 1 minute. Exceptions to this are northern South America and portions of Mexico.
Figure 2 Modeled detection time using existing real-time seismic stations available to the CTWP and PTWC in 2006. Red lines represent trenches where earthquakes are likely to occur. Seismic network performance standards were poorly met throughout the region except in the vicinity of Puerto Rico, where an earthquake could be detected in less than one minute.

Figure 3. Modeled detection time using existing real-time seismic stations available to the CTWP and PTWC. As of April 2013. Red lines represent trenches where earthquakes are likely to occur. Seismic network performance standards are nearly met throughout the region where an earthquake could be detected in less than one minute. Weaknesses in earthquake detection
time still exist in the north in the Gulf of Mexico and along the northern regions of South America where earthquake hazard is low.

Figure 4. The map shows the regional P-wave detection time model for the complete CORE network. The “CORE” network is currently composed of existing seismic stations (white triangles) that currently contribute data in real-time to the CTWP, stations that do not yet exist but fill gaps in the network (red triangles) and planned stations (green triangles) that do not yet exist. Red lines represent trenches where earthquakes are likely to occur. Seismic network performance standards are nearly met throughout the region where an earthquake could be detected in less than one minute. Weaknesses in earthquake detection time with the existing real-time network (Figure 2b) are improved in the north in the Gulf of Mexico and along the northern regions of South America.

Figure 4 shows that adding planned and other Caribbean stations to the Existing-RTX network, the network detection time is improved over the current existing real-time network (Figure 2b) and meets performance standards established by WG1, throughout the entire region. Further analysis is needed to determine the minimum number of seismic stations that need to be added to the monitoring network so that the performance standards can be met. Gaps were already identified in northern Colombia, Panama, Honduras, Guatemala, Yucatan Peninsula and Jamaica/Haiti region. In addition, due to the limited distribution of island, ocean bottom seismometers (OBS) should be considered in order to fill gaps in the existing land-based seismic network. Nevertheless, if the presently available seismic stations that are operational in the region, including those of local and regional networks and CTBTO stations are used, the performance criteria could be met. Therefore the ICG/CARIBE-EWS encourages network operators that have stations currently operational to make them available in real time.

Sea Level Stations and Data Availability

Real-time data sea level networks are one of the essential components of tsunami warning centers. After the seismic information has been received and analyzed, certain seismic parameters are met establishing a potential tsunami threat; sea level and water pressure data allow to confirm the hazard and forecast its severity or to declare the threat is over. In the case that the tsunami is generated by a non-seismic source, the sea level data will be the primary tool
for the detection and evaluation of the threat. There are different types of sea level data that can be used to detect tsunami waves: data from coastal tsunami ready tide gauges, HF radar, Deep-ocean Assessment and Reporting of Tsunami (DART) Ocean buoys and coastal sea level stations.

As of April 2013, a big improvement on the number of available coastal sea-level stations is to be noted. Over the past years, the network has grown from a handful of stations to 43 stations (Figures 5 and 6) sending data in real-time. The implementation plan included 111 coastal (104) and 7 DART buoys, for an implementation of 39%. The number of those coastal sea-level stations in the Caribbean and Western Atlantic that meet Technical and Logistical and Administrative Requirements of the Regional Tsunami Warning Center for the CARIBE EWS in support of the Caribbean Tsunami Warning Center (Doc. ICG/CARIBE –EWS IV/13) is currently still growing. A core network of sea level stations based on the most likely sources that will generate regional and Caribbean wide tsunamis has been defined and is presented in Figure 7 and has been used as a basis for recommending and supporting new installations.

One of the requirements is that all sea level data should be made available through the GTS for a broad and more robust data sharing. The US is making every effort to accommodate the entire requests for high rate slots (at least 6 minutes) on GOES, from where it is easy to load into the GTS. It has established with the CARIBE EWS a process for the submission and approval of requests for high rate slots and has been very successful, all requests for GEOS transmissions have been addressed favorably. Alternatives to GOES DCS for robust high rate transmission and getting data into the GTS still need to be explored by the IOC, WMO and the station operators. Alternate sharing method should also be explored for the Tsunami Warning Center, and in order to decrease the data latency for very short fused events. Even in case GOES transmission is available, a second transmission media should be used for enhanced data availability.

Tools have been developed to view and analyze sea level data. Tools like those developed by NOAA (Tide Tool), by VLIZ/IOC Sea Level Monitoring Facility (http://www.sealevelstation.net) or the PRSN DANIS tsunami tool kit (http://www.prsn.uprm.edu) are used to monitor and display the regional sea level data. Tsunami Tide Tool has been developed, maintained and distributed by PTWC and ITIC and supported by the CTWP has been installed by data centers and station operators to analyze sea level data. Tide View of the West Coast and Alaska Tsunami Warning Center and commercial packages are viable another alternatives for sea level data acquisition, processing, distribution and analysis. The sustainability of the sea level stations needs to be ensured. A maintenance and training program , as well as associated manuals/materials that need to be translated (eg. GLOSS) for the operators and the users of sea level monitoring networks has to be developed and implemented for ICG purposes. The multipurpose applications is also very important for the sustainability of the stations and links with other partners in the sea level, climate and hydro met community need to be explored. It should be noted that the WG1 requirements for sea level stations make them well suited as multi-purpose stations.
Figure 5. DART buoy locations (from website: http://www.ndbc.noaa.gov/dart.shtml, April 2013)

Figure 6 Caribbean Sea Level Monitoring Stations (updated March, 2013; http://www.ioc-sealevelmonitoring.org/map.php) green means online, red means down, blue means data are available elsewhere
During the intersessional period, with US funding, UHSLC forand PRSN installed three tide gauges in Colombia (2) and Panama and PRSN and ONAMET installed a tide gauge in Barahona, south west coast of Dominican Republic. A new station was also installed in Barbados (UNESCO-Barbados-CTWP). Also, during the intersessional 2012-2013 period, France installed a new sea level station in Deshaie, Guadeloupe. Existing sea level stations in Guadeloupe (Pointe à Pitre), Martinique (Prêcheur) and Guyane (Iles du Salut) were upgraded for satellite transmission capability. A sea level station is under construction in Martinique (le Robert). Data from Deshaie and Prêcheur are under quality control process before being sent in real-time to IOC sea-level facility and warning centers through the GTS communication system.

Additional funding from Brazil and St. Vincent and the Grenadines has been provided thru UNESCO to CARIBE EWS to also strengthen sea level observations in the Caribbean. This funding included upgrades/new installations and a training course. As part of this effort several installations are to take place in the upcoming intersessional period: 2 stations in Haiti, 1 in Cayman Islands, 1 in Guatemala, 1 St. Kitts and Nevis and St. Vincent. UNESCO/IOC has submitted an additional request for a station for Corn Island in Nicaragua. FUNVISIS is also conducting analysis of sea level equipment to be installed over the 2013-2014 intersessional period along the northern coast of Venezuela.

A Sea Level Capability study was conducted to identify the advances of the sea level observation system as well as document gaps for sea level observation. For this, a very simple calculation was done which we take the distance between points on the maps and the sea level station locations using coordinates with a spherical earth model. The speed of the tsunami wave is kept...
constant at 700 km/h which corresponds to velocity of the wave at 4000 meter depth, at shallower depths the wave will propagate much slower, therefore the travel times in coastal areas would be larger. Three stages of sea level station coverage were used: Pre CARIBE EWS/2006 (Figure 8), April 2013 locations of sea level stations contributing in real/near real time (Figure 9) and Proposed CARIBE EWS Coverage per Implementation Plan (Figure 10). The succession of maps demonstrates the significant growth in coverage from when for some areas of the Caribbean it would have taken hours to detect a tsunami to now where for most coastal areas tsunamis could be detected in 10-30 minutes. This modeling can further be improved by taking into consideration water depth when calculating the travel times.

The Third IOC-GLOSS-IOCARIBE-CARIBE EWS Caribbean Training Course for Operators of Sea Level Stations took place from June 5-9, 2012 in Mérida, Mexico. The course was organized within the framework of the Project "Strengthening sea-level observation network and coordination activities in the Caribbean" the Intergovernmental Oceanographic Commission IOC of UNESCO jointly with the US National Oceanic and Atmospheric Administration (NOAA) and the National Mareographic Service of the Universidad Autónoma de Mexico (UNAM). The purpose of the course was to provide the sea level station operators and data analysts in the region lectures and hands on training on the science and operations of sea level stations for tsunami and other coastal hazards warning purposes. The workshop included 4 days of lectures, presentations and exercises and two field trips to stations operated by the UNAM. 37 sea level station professionals from the Caribbean, Central America, northern South America, Mexico, US Mainland, Puerto Rico and Hawaii participated in the training activity.

![Travel time to nearest sea level station](image)

Figure 8. Pre CARIBE EWS (2006) travel times to sea level stations transmitting data in near/real time.
Figure 9. Current (April 2013) CARIBE EWS tsunami travel times to sea level stations transmitting in near/real time.

Figure 10. Tsunami Travel Times to sea level stations if all stations proposed in the CARIBE EWS Implementation Plan were operational and contributing data in near/real time.
In 2010, IOCARIIBE and the CTWP developed a Google Map interface to view the status of sea level stations in the Caribbean and Adjacent regions. It can be accessed thru the Caribbean Tsunami Warning Program website (http://www.srh.noaa.gov/srh/ctwp/). In 2012 PRSN developed a data availability web base tool tik, that monitors data received via GOES by the PRSN http://www.prsn.uprm.edu/Spanish/EstacionesV2/mareografos.php. Most sea level stations can also be viewed at the IOC Sea Level Monitoring Facility site (http://www.ioc-sealevelmonitoring.org/). To date, no regional repository for all sea level data has been identified.

Figure 11 highlights the history of sea level stations in the Caribbean for the past 50 years. Currently the number of stations is clearly on the rise, nevertheless it is important to keep taking measures that support the maintenance of these stations and thus avoid situations in the past where stations fell into disrepair.

GPS Stations

The CARIBE EWS ICG has recommended that the system take into consideration and support the installation of GPS stations for both sea level monitoring and potential tsunami warning applications. In 2010 the National Science Foundation started funding the Continuously Operating Caribbean GPS Observational Network (COCONet). COCONet will be installing 50 new continuous Global Navigation Satellite System (cGNSS) and meteorology stations in the Caribbean and Central America, refurbish an additional 15 stations, and archive data from 62 cGNSS stations (managed by various institutions committed to free and open data access) that
are already or will soon be in operation (Figure 12). This project will infuse and complement existing large-scale, state of the art geodetic and meteorological infrastructure in the Caribbean, forming the backbone for a broad range of Earth and atmospheric science investigations and enabling research on process-oriented science questions with direct relevance to geohazards. The observational infrastructure will serve as a regional platform for more focused topical geophysics studies by members of an international community of scientists. Although the main purpose of the GPS is for tectonic and weather research, there is interest in using the data in real time tsunami and earthquake information and warning systems. The infrastructure will also serve as a platform for international partnerships for science and societal applications. Two meetings of US and Caribbean stakeholders and researchers were held in 2011 and another in 2012.

The CARIBE EWS has encouraged the participation of the member states and the tsunami warning centers in this project. There are other remote sensing efforts to detect incoming tsunamis like direct Satellite observations, and optic and electric properties of the ionosphere.

During the inter-sessional period the Seismic Research Centre (SRC) continued to extend and upgrade its network of monitoring instruments. Two new cGPS stations were added to the network. These are located at Bisee, St. Lucia (SLTA) and (Bellvue Choppin, Dominica (BVCN). Both station are furnished with Trimble NetR8 receivers, TRM51579 antennas and are configured to upload hourly files that are sampled at one second and thirty second streams. These two installations bring the total number of stations operated by the SRC to thirteen. Data from these station are available from the SRC’s FTP site. The SRC also has access to date streams from the Guadeloupe (1), Martinique (1) and Montserrat (1) volcano observatories as well as Lands and Surveys division in Trinidad (5).

![Figure 12. Current available stations of CocoNet network in the Caribbean (March, 2013; http://coconet.unavco.org/).](image-url)
**Tsunami Warning Centers**

The U.S. reported in 2012 that it continued with its adopted a phased approach to developing a Caribbean Tsunami Warning Center. There are three phases: 1) Enhance tsunami outreach and education capacity in the Caribbean; 2) Strengthen Caribbean Regional Tsunami monitoring; and 3) Establish a Regional Tsunami Warning Center at the University of Puerto Rico Mayaguez.

**Caribbean Tsunami Warning Program.** On February 1, 2010 NWS established the Caribbean Tsunami Warning Program (http://www.srh.noaa.gov/srh/ctwp), co-located with the Puerto Rico Seismic Network (PRSN) at the University of Puerto Rico in Mayagüez. This was the first step in the U.S. phased deployment of a Caribbean Tsunami Warning Center. The CTWP works with local, national and international stakeholders and partner to improve tsunami monitoring (Sea Level, Seismic and GPS), warning (existing and new warning and forecast models), communications and education and preparedness efforts, including the TsunamiReady program. Below are some of the activities that were carried out by the CTWP during the intersessional period (March 2012- March 2013) in support of WG1:

- **Staffing.** The CTWP is currently staffed by the Manager and one Student. Plans are underway to hire additional staff when budget permits. During the summer an additional student worked at the CTWP in support of the CARIBE WAVE 13 exercise.

- **Facilities.** The CTWP relocated to new facilities that were remodeled by the UPRM for this purpose. The site on lease to the NWS is in close proximity to the PRSN and is in addition to the space it leases within the PRSN to use as its operations center.

- **Tsunami Warning and Forecasting.** CTWP is collaborating with NOAA’s Pacific Marine Environmental Laboratory (PMEL) for the development, validation and implementation of an Internet-based Tsunami Forecasting System. It also is working with the U.S. Tsunami Warning Program in the evaluation of products issued by the tsunami warning centers and the socialization of the proposed enhanced PTWC products for the region.

- **Communications.** In addition to the CTWP website (http://www.srh.noaa.gov/srh/ctwp), the Program also maintains a Facebook Fan Page and Twitter account. It also uses Webinar and Conference Call facilities for meetings with stakeholders.

- **Seismic Data.** The CTWP provided monthly reports on Seismic Data Availability for the stations contributing to PRSN and IRIS under CARIBE EWS.

- **Sea Level Data.** CTWP maintains a database on sea level stations in the Caribbean and Western Atlantic, as well as the Interactive Sea Level Stations Google Map on its website. CTWP helped organize the Third Caribbean Sea Level Operators Workshop in Mexico in June 2012. CTWP also supported the installation of a tsunami capable sea level station in Barbados. PTWC, CTWP and NOAA’s National Satellite Service jointly advise on the assignment of GOES slots for sea level data transmission.

- **GPS.** CTWP maintains communications with the US NSF COCO Net (Caribbean GPS Network) project team in support of GPS applications for sea level monitoring and tsunami warning operations.

- **Funding.** In addition to base funding, the CTWP was awarded $70,000 for the U.S. Contribution to the World Meteorological Organization Voluntary Cooperation Program.
managed at NOAA’s NWS to implement the Project: Enhancing Multipurpose Sea Level Monitoring and Forecasting Capabilities in the Caribbean and Adjacent Regions in 2012-2013.

- **Training.** In addition to the third sea level workshop in Mexico in June 2012, the CTWP provided training to hotel and tourism officials of the Dominican Republic on tsunamis, presented at the Tsunami Vertical Evacuation in Puerto Rico in June 2012. It was attended by over 100 officials from Puerto Rico and the Caribbean. The CTWP also provided organizational support.

- **Exercises.** CARIBE WAVE/LANTEX 2013 regional tsunami communications exercise was conducted on March 20, 2013. The CTWP supported the organization of the test along with the TWCs and international stakeholders as the CARIBE EWS Task Team Lead. 45 Member States and Territories participated in the exercise, almost a 20% increase over the first exercise conducted in 2011.

Nicaragua continues with its plans for upgrading the operations of the INETER to further develop their capacities as an additional tsunami warning centre. A proposal of Nicaragua at the II Tsunami Meeting of Central America for the establishment of a Central America Tsunami Warning Center in Nicaragua was supported. The proposal was to be presented to the Council of Representatives of the Centre for the Prevention of Natural Disasters in Central America (CEPREDENAC), November 2011 and at the meeting of Presidents of Central America.

**In light of the June meeting and the communication among working group members, the recommendations of Working Group 1 to the ICG VIII are to:**

- **Consider** the report of Working Group 1 on Monitoring and Detection Systems, Warning Guidance and having reviewed the status of the observational data availability in the Caribbean and Western Atlantic;

- **Recognize** the effort of Member States and Regional organizations in the installation of new stations, maintenance of existing stations and advances in open data sharing for the advancement of the national regional warning and research capabilities for the Caribbean and Adjacent Regions bringing up to 85% implementation of the seismic network and 39% of the sea level network plans and

- **Urge** seismic and sea level station and data gaps continue to be addressed in support of tsunami warning and research in accordance with CARIBE EWS approved requirements and Implementation Plan and in addition to new stations, try to leverage other regional efforts;

- **Encourage** enhanced robustness of the existing seismic network and stations, by improving data quality and efficiency and reducing their vulnerabilities and by conducting network resilience study;

- **Recommend** that WG1 establish a task team to conduct a sea level network capability study, determining the minimum detection time of tsunamis to coastal stations and
tsunameters within the Caribbean and Adjacent Regions and present its findings and recommendations on siting of stations at ICG IX.

- **Acknowledge** the support of NOAA NWS Caribbean Tsunami Warning Program provides to the CARIBE EWS and Working Group 1, especially with the preparation and distribution of seismic and sea level status reports and

- **Request** the CTWP to complement the Monthly Reports with monthly phone calls among the operators of the seismic and sea level stations in the CARIBE EWS;

- **Urge again** the USA to continue the phased implementation for the establishment of the Caribbean Tsunami Warning Centre to serve the Caribbean and Western Atlantic Basin by December 2012;

- **Request again** the USA to present a schedule for fulfilling the requirements approved by the ICG/CARIBE EWS for the Caribbean Tsunami Warning Centre including its full staffing at the Eighth session of the ICG;

- **Request again** Nicaragua to present a report on the status of the establishment of a Central America Tsunami Warning Center at INETER.

- **Request again** the Bolivarian Republic of Venezuela’s continued efforts and technical advances for the establishment of an additional Regional Tsunami Warning Center in support of the Caribbean Tsunami Warning Centre;

- **Continue to Encourage** other nations to further develop their capacities and additional tsunami warning centers in support of the Caribbean Tsunami Warning Centre.

- **Recommend** that the warning guidance functions of Working Group 1 be integrated into a restructured and renamed Working Group 3, Tsunami Services, as proposed in the 2013-2017 CARIBE EWS Implementation Plan.

- **Support** the efforts towards the establishment of a regional GPS data center in support of COCO Net and other national and regional GPS efforts.

- **Recognize** the success of the Sea Level Network Operators Course held in Mexico in 2012 for the advancement of the sea level network in the region and

- **Continue to Urge** the planning and execution of technical training for seismic and sea level network operators, on the proper installation, maintenance and usage of instruments and the need for funding for such activities.