CPACC

Caribbean Planning for Adaptation to Global Climate Change Project

MIDTERM REVIEW

Report on Regional Archiving Centers Participating in Component 1:
Design and Establishment of Network of Tidal Gauges and Weather Monitoring Stations

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TABLE OF CONTENTS

Introduction

The Caribbean: Planning for Adaptation to Global Climate Change (CPACC) project is being implemented by the World Bank. The OAS is the Executing Agency. CPACC is a multifaceted effort to quantify the potential impacts of global change on the regional scale. The aspect of CPACC reported herein, Component # 1: Design and Establishment of Network of Tidal Gauges and Weather Monitoring Stations, is that associated with the eighteen operational sea-level/weather-monitoring stations installed in 1998-1999 by the project with the assistance of the Acting Regional Network Coordinator (ARNC), the CIMH Technical Officer, the NOAA Coordinator, and the twelve national technical counterpart institutions. The report is based on visits to Vitel, Inc., to the Caribbean Institute for Meteorology and Hydrology (CIMH) in Barbados (formally the Caribbean Meteorological Institute – CMI), and to the Institute of Marine Affairs (IMA) in Trinidad & Tobago. Accordingly there are three elements of this CPACC Midterm Review:

(1) Visit the CPACC Component # 1 equipment manufacturer, Vitel, Inc. in Chantilly VA, to gain some first-hand exposure to the actual satellite ground-station system, its physical characteristics, software, and interface to the Internet.

(2) Assess the status of the CIMH's assumption of Mr. Chapin's role as Regional Network Coordinator. To that end we met with Dr. Colin Depradine, Principal of CIMH who discussed their commitment and ideas for accomplishing the task. Also with Mr. Ronald Leslie, Technical Officer at CIMH who will solve technical matters from the field meteorological officers in each of the twelve countries where there are monitoring sites; he will also maintain the spare parts inventory, perform sensor calibration, and sensor rotation. And with Mr. Frank Farnum, Deputy Principal at CIMH, who will assume the administrative responsibilities of the Regional Network Coordinator.

(3) Assess the status and capacity of the CIMH and IMA to assume the responsibility of archiving and delivering access to data and derived products, which would include their potential capacity to operate the satellite ground-station. To that end we visited the CIMH as in #2 above and looked at their preparations for delivering data and products to the Internet, including their capabilities for maintaining a complex system. We also met with principals at IMA (Ms. Hazel McShine, Acting Director, and Ms. Shelley-Ann Jules-Moore, Chief of Information Services) to look at their preparations for archiving and delivering data and products to the Internet, including their capabilities for maintaining a complex operational system.

Terms of Reference

A Mid-Term Review forms an integral part of the monitoring and evaluation program of the CPACC Project. Section 34 of the Project Document provides for additional reviews or studies to be contracted by the General Secretariat of the OAS (GS/OAS) as input into the Mid-Term Review.

As input into this process, the GS/OAS contracted the services of Dr. George A. Maul, Professor of Oceanography and Director of the Division of Marine and Environmental Systems of the College of Engineering, Florida Institute of Technology, Melbourne, Florida to conduct an evaluation on the performance of regional archiving centers participating in Component 1 of the project.

His terms of reference were:

The Consultant will evaluate the functions and responsibilities assigned to the Caribbean Institute for Meteorology and Hydrology ("CIMH") and the Institute of Marine Affairs for the implementation of Component 1, *Design and establishment of a sea level and climate monitoring network.*

Specifically the Consultant will complete the following tasks:

1. Review all background information on project implementation and particularly on Component 1. The Acting Regional Network Coordinator ("ARNC") and the RACs will assist the Consultant in collecting these documents.

2. Travel to Chantilly, Virginia, USA (one day, June 7, 1999), to visit the manufacturer of the monitoring systems and become familiar with their physical characteristics and expertise required for the operation and maintenance of the earth groundstation.

3. Travel to the offices of CIMH in Barbados (three days, June 8-11, 1999) and IMA in Trinidad and Tobago (two days, June 14-15, 1999) to assess the institutional, human and technical capacities of both institutions to carry on the various responsibilities under Component 1. Special emphasis should be put in the evaluation of these two institutions to host, operate and maintain the earth groundstation and their capacity to analyze and disseminate data from the gauges.

Visit to Vitel and GS/OAS, *Washington, D.C.*

During the morning of June 7th, Dr. Maul and Mr. Chapin visited with Mr. John Koval, President of Vitel, Inc., manufacturers of the CPACC Component No. 1 data communications equipment. The discussions reviewed the technical details of data transmission from the eighteen CPACC sea-level/weather sites via the Geostationary Environmental Operational Satellite (GOES) back to the ground-station temporarily established at Vitel, Inc. in Chantilly, Virginia (http://www.vitelinc.com/datacommandnt). The GOES ground-station equipment includes a three-meter dish antenna, a small standard electronics rack for the receiver, and a standard Pentium-based PC with software to create data files from the GOES data stream. The equipment is very robust and probably will require very little maintenance except that it should be all kept in a climate-controlled environment for maximum reliability, security, and longevity. The PC is connected to the CPACC Internet website, and is the key to providing the sea-level/weather data to the users via FTP. During the visit, Mr. Koval demonstrated the data files and showed information from all eighteen sites.

During the same afternoon, Dr. Maul and Mr. Chapin met with Mr. Claudio Volonte, CPACC Technical Coordinator, at OAS Headquarters and discussed in detail the present mission and the background correspondence noted above. It was made clear that Vitel, the CIMH, and the IMA are successfully fulfilling their roles in CPACC, and that the OAS is pleased with the project's progress. The next phase, that of transferring data archiving and dissemination responsibility to the region, is crucial to CPACC

because these data must be readily accessible and usable to create a climate of interest and demand. From these discussions the following will be emphasized: institutional and technical arrangements established at CIMH to absorb the responsibilities as the Regional Network Coordinator; evaluation of arrangements at CIMH and IMA to fulfill their roles as Regional Archiving Centers for CPACC data; and evaluation of these two institutions to host, operate and maintain the GOES ground-station and their capacity to analyze as well as to disseminate data from the gauges.

Visit to the Caribbean Institute for Meteorology and Hydrology, *Barbados*

Prior to meeting with personnel from the CIMH and the CPACC Regional Project Implementation Unit (RPIU) offices in Barbados, Mr. Chapin and Dr. Maul briefly viewed the sites of the permanent GPS (global positioning system) receiver and the Bridgetown CPACC sea-level/weather station. The GPS observatory is located on the building roof of the Government of Barbados' Coastal Zone Management Unit (CZMU) at an elevation of approximately 10 meters above sea-level. It is a substantial installation and seems quite capable of measuring land motion provided that the GPS receiver plate is regularly surveyed into the surrounding vertical datum benchmarks. While the building seems stable, settlement is a potential problem that must be discounted through direct physical measurements. It is noted that the **output from the GPS is not fed to meteorological organizations** where the data could provide atmospheric information (notably integrated water vapor – a variable of considerable interest in hurricane and other forecasts). It is also noted that data from the GPS receiver is not regularly checked locally (data are downloaded daily to the NOAA National Geodetic Survey in the USA via FTP) **nor made available for differential GPS applications**.

The sea-level/weather station is in an ideal location for observing sea-level and marine meteorological conditions. It is located near the end of the main quay in Bridgetown harbor, where it is well exposed to the elements. However, as with many of these CPACC sites, the instrumentation are in the wind shadow of the island. Thus as a cautionary point, persons studying these data need to be aware that the urbanization associated with Bridgetown will affect the temperature measurements, both air and sea. However, Barbados is in a particularly enviable position, as the University of Miami has a complete meteorological observatory on the east (windward) coast (at Ragged Point) with which to compare these CPACC data. Also, the CZMU has moved the old sea-level gauge from Bridgetown to Conset Bay, an east coast site. Thus Barbados is well positioned to conduct several valuable scientific investigations into the climatic stability of sea-level and weather in the western tropical Atlantic Ocean.

On the morning of June 9th, Mr. Chapin and Mr. Ronald Leslie familiarized Dr. Maul with the CPACC operations at CIMH. Mr. Chapin continued his training of Mr. Leslie for his future role as CPACC Regional Network Coordinator (RNC). **Mr. Leslie seems well prepared to assume these RNC duties, and is an interested and enthusiastic partner**. Mr. Leslie may require additional training, particularly in servicing the data acquisition modules at the sea-level/weather stations; Mr. Chapin should see to this before being relieved of his ARNC duties.

A two-hour meeting on Wednesday afternoon was held with Dr. Colin Depradine, Mr. Selvin Burton (CIMH Senior Meteorologist), Mr. Chapin, and Dr. Maul. The issue of Internet connectivity was discussed at length; it was determined that CIMH has decided to continue the existing contract with a commercial Internet provider and upgrade the connection from 28K-baud to a 56K-baud telephone line rather than install a server on their campus. This plan on their part is due to financial and personnel considerations as well as the logistics of acquiring the necessary infrastructure. Based on the same

considerations, **CIMH is unwilling to accept the responsibility of operating the CPACC GOES ground-station**.

Regarding the issue of data product development, CIMH is well along in their planning for quality assurance (QA) and quality control (QC) of the meteorological data from the eighteen CPACC sites (including sea surface temperature); they have no plans to QA/QC the sea-level data; this responsibility will be taken on by the IMA. The CPACC data automatically enters the operational meteorological data-stream via the NASA - STAR4 site at Wallops Island, and there is no need for CIMH to become involved in the near real-time supply of that information.

The CPACC data stream is fully automated which presents a different scenario for the existing CIMH QA/QC routine. Because of this, **it is suggested that Mr. Burton take advantage of observing the U.S. NOAA/National Weather Service "QA/QC on-the-fly" software**, which has been offered. CIMH's QA/QC oversight will include daily checks of the information, but the major effort will be in the development of non-operational products such as climatology, and supporting the research community. The QA/QC is planned to be accomplished using CIMH's existing "CLICOM" software, which they are successfully applying to the data from the GTS. The focus of meteorological products at CIMH from CPACC will be to integrate these new data (except sea-level) into their existing data-bases and into their existing data products for purposes associated with their charter – namely education and research.

In the early afternoon, Mr. Chapin and Dr. Maul met with Mr. Frank Farnum, Deputy Principal of CIMH. Mr. Farnum is expected to assume the administrative duties of the CPACC Regional Network Coordinator. It was made clear that Dr. Depradine will take a very active role in the project. Mr. Farnum encouraged us to meet with Mr. Tyrone Sutherland, newly appointed Principal at the Caribbean Meteorological Organization (CMO), while in Trinidad & Tobago next week, for the purpose of informing CMO of the CPACC activity. Much of the discussion revolved around the CPACC Trust Fund for instrumentation maintenance and calibration, of which Mr. Farnum was not fully informed. It was encouraging however to hear Mr. Farnum speak of involving many more CIMH staff members in the CPACC Project in the future. The issue of hurricane protection for the workspaces was discussed, and we were assured that adequate preparations were already made.

Late afternoon was spent with Mr. Ronald Leslie, who is expected to assume the technical duties of the CPACC Regional Network Coordinator. Mr. Leslie is the senior technical officer at CIMH and is well qualified; he has been trained by Mr. Chapin in these new duties. We toured the calibration facility where CPACC instruments would be repaired and serviced. The workspace seems adequate for the task, although not luxurious. Mr. Leslie will also continue his teaching duties at CIMH, through which he has gotten to know most of the technicians at the eighteen CPACC sites. **Without a doubt, Mr. Leslie will be the key to the operational success of the network**. Exactly how best to support him and to foster his efforts will need to be resolved before Mr. Chapin is reassigned.

CIMH administrative policy is more structured than the American model, and it is difficult to appreciate how certain issues will evolve. For example, **the customs officials within CARICOM seem to view with uncertainty the status of passing scientific instruments without imposing duties.** This will be a continual difficulty if CPACC instruments are held in bonded status because the rotation between sites depends on the units from the recently refurbished site to be made available for the next site. While this issue will require high-level attention, it impacts directly on the ability of the Regional Network Coordinator to perform his tasks.

Thursday, June 10th, Dr. Maul and Mr. Chapin also met with Dr. O.D. "Neville" Trotts (RPIU Director), Mr. Ian King, and Mr. Leslie Walling at the RPIU; Dr. Leonard Nurse (CZMU Director) joined the meeting. The essence of the conversation was directed to the next phase after CPACC of the RPIU's activities in the region. The notion of creating at the University of the West Indies a "Climate Change Center" was discussed as one option of this follow-on effort. Dr. Maul suggested the model of Earth System Science Education (ESSE) as a vehicle for a unique graduate education centered on climate change (ESSE is a program of the Universities Space Research Association (http://www.usra.edu), funded by NASA); the Florida Institute of Technology is a funded ESSE university. A sense of common interest developed between the RPIU, CZMU, and Florida Tech to explore this idea further – perhaps as an initiative funded by the Inter-American Institute for Climate Change Research. A visit, tentatively in September, by Dr. Nurse, Dr. Trotts, and several other colleagues to Florida Tech was generally agreed to, with the express purpose of furthering these discussions and for a site visit to survey the university's facilities to support collaboration with the Climate Change Center.

Prior to leaving Barbados on Friday June 11th, Mr. Chapin, Mr. Leslie, and Dr. Maul toured the site of the University of Miami's air sampling station at Ragged Point (13º 09.9'N, 59º 26.0'W), and the site of the CZMU tide gauge at Conset Bay (13º 10.8'N, 59º 28.0'W) in the morning, which was found to be out of service. The flight to Trinidad & Tobago was Friday afternoon.

Visit to Charlotteville, *Trinidad and Tobago*

June 12th was a day to visit the CPACC sea-level/weather station in Port of Spain, Trinidad and to write portions of this report. On Sunday, June 13th, Mr. Chapin and Dr. Maul flew to Tobago and drove to a national tide gauge site in Scarborough (11º 10.7'N; 60º 44.1'W), which was found to be out of service. We then drove to the CPACC sea-level/weather station site in Charlotteville. The instrumentation was found in good order on busy piers at both stations. Mr. Chapin reset electronic station parameters at Charlotteville, and checked the station clock against GPS time. We had occasion to meet Mr. Ronald P. Tiah (ron@opus.co.tt or 868-660-4941), a local PADI dive instructor, whose shop is near the CPACC station. Mr. Tiah is interested in the station data and offered to help if such an occasion should arise. Mr. Chapin gave Mr. Tiah the CPACC website address.

The visit with Mr. Tiah raises the issue of **making these data readily available to a wide audience in the region**. Mr. Tiah had a computer with a modem, and that is his entrée to the information. Most other potential users would not have computers, and thus to many locals the information is not accessible. At the pier in Charlotteville, a read-out would benefit many residents and visitors because the pier is the central structure of the town; at Port of Spain, this is not the case, and a radio voice-report might be a better medium. Thus it is suggested that the value of CPACC data to the local communities would be improved if some means were found to broadcast the station reports.

Visit to the Institute of Marine Affairs, *Trinidad and Tobago*

On June 14th Mr. Chapin and Dr. Maul flew from Crown Point, Tobago to Port of Spain, Trinidad, where Ms. Shelley-Ann Jules-Moore from the Institute of Marine Affairs met us. The first stop was to visit Mr. Eli Henry (Acting Director) and the staff at the Weather Service of Trinidad & Tobago. The instrument maintenance shop at the Weather Service's Airport Office is a well-equipped facility that seems quite

capable of supporting the CIMH in its CPACC responsibilities. We then drove to Guayaguayare to inspect the CPACC sea-level/weather station on the southeastern end of the main island.

The trip to Guayaguayare is a two-hour affair. It took us past one of the sites of the Discovery Channel's story "Is Trinidad Drowning?" The CPACC sea-level/weather station at Guayaguayare, with the GPS tie, is well positioned to quantitatively answer the question of subsidence. While observing the fallen coconut palms along the beach it would at first sight seem that the area is experiencing significant relative sea-level rise. However, some of the tree stumps were covered with barnacles, suggesting that the process has been ongoing for some time. In any case, the data from Guayaguayare will be very important in this story.

Mr. Chapin and two technicians from the Trinidad & Tobago Weather Service spent several hours trying to repair the air and sea surface temperature sensors at the Guayaguayare monitoring site, but the temperature sensor balance circuits seem to be in need of further manufacturer level maintenance. The site is well protected from vandalism but this one site has experienced recurring technical problems. The cause of these problems and their solutions is the subject of a separate report by Mr. Chapin.

On June 15th, Tuesday, Mr. Chapin and Dr. Maul met in the IMA Director's Office with Ms. Hazel McShine (Acting Director) and University of the West Indies (UWI) Prof. Ramsey Saunders (Chairman, IMA Board of Governors). The conversation was joined by Mr. Alan Duncan and Dr. Neville Trotz prior to Dr. Maul presenting a lecture on tsunami hazards (see Annex II for an overview). A frank discussion ensued regarding the intentions of IMA regarding a long-term commitment to CPACC. Concern was expressed by Mr. Chapin and Dr. Maul regarding the open IMA Director's position, and we were assured by Prof. Saunders that a replacement to Dr. Wagh would be selected by September of 1999. Prof. Saunders remarked that there was to be an IMA Board of Governors meeting on June 16th, and the vacancy would be a major topic of discussion. Prof. Saunders offered that as Board Chairman, he would write a letter to Mr. Vermeiren clearly stating the interest and support of the IMA to continue the CPACC project and expressing their very keen interest in hosting the GOES ground-station on the IMA campus. **All present came to the understanding that IMA priorities will not preclude maintenance of the GOES ground-station, including supplies and personnel as necessary.**

In a visit to Ms. Shelley-Ann Jules-Moore's office, Mr. Chapin and Dr. Maul became acquainted with the technical infrastructure to support the GOES ground-station. The computers, server, and qualified programmers are evident, all in a protective concrete-block air-conditioned building. It is important to mention however, that **the IMA has not as yet established an adequate Internet connection for their server**. Exactly when this will be accomplished is unknown. A preliminary survey for the ground-station antenna site was chosen on the east wall of the Information Systems building, a short run for the antenna cable to the receiver (if the IMA site is selected). In addition to infrastructure, Ms. Jules-Moore showed her department's initiative in developing a website for the CPACC data and that they were already considering the data as a whole (both oceanographic and meteorological). However, Ms. Jules-Moore, upon being queried about QA/QC-ing all data from each CPACC site for oceanographic applications, was reluctant to reply until she could discuss it with her staff. Ms. Jules-Moore however did describe their QA/QC procedure for the sea-level data, and it seems quite adequate to provide to the CARICOM region reliable information.

In general, our meeting at IMA was productive and we are favorably impressed by the Institute's personnel, infrastructure, and professional attitude. The charter of the IMA is significantly more entrepreneurial than that of the CIMH, which as noted above is more focused on education than on research. While both charters are quite appropriate, the focus at IMA and their obvious collaboration with the UWI provides strong support to CPACC at this stage of its maturing. This latter remark is made with

the cognizance that CPACC has many other components than the one being considered herein. While it is clear that the meteorological expertise rests with CIMH, the broader and integrated scope of IMA offers a rich diversity of expertise of great benefit to almost all CPACC components.

General Conclusions

It is satisfying to report that both institutions discussed herein are actively involved in the CPACC project and seem sincere in their commitments. It is our judgment that they are both capable of fulfilling the commitments discussed in the reference documents.

Regarding the locating of the GOES ground-station, the choice seems clear in view of Dr. Depradine's statement that CIMH is not prepared to assume the responsibilities. It is also clear that **IMA is actively interested in assuming the role of GOES ground-station operations**, one that will be sustained by the UWI through Prof. Saunders' interest and supporting infrastructure.

There are several **issues with IMA that we think must be settled before CPACC commits to moving the GOES ground-station** from Vitel to IMA:

1. The dedicated Internet line must be installed and connectivity to the server tested for robust operation and its suitability to interface with the GOES ground-station system.
2. The Director of IMA must be named and interviewed to assess his or her prioritization of the CPACC project in the Institute's affairs.
3. The exact antenna site in relation to the receiver and the server must be agreed to by IMA and the ARNC.

Overall, the aspects of Component # 1 reported on herein seem to be in proper order. We have a gnawing sense however that the principals may regard CPACC as somewhat intrusive. What may be lacking is a strong sense of ownership. One would hope that with time and a growing appreciation of the CPACC contribution to regional science, research, and infrastructure, a shift in our perception will occur. In the meantime, a continued partnership at all levels by extra-nationals involved in the project will demonstrate a permanent commitment by national, regional, and international organizations to this most valuable environmental project.

Postscript: Suitability of using CPACC Infrastructure for Tsunami Monitoring

During the visit to Vitel, Mr. Koval and Dr. Maul took time to discuss possible future applications of CPACC data for near-real time observations associated with tsunami hazards. CPACC sea-level/weather stations could be modified for this purpose, but the more important question of suitability was discussed. The general feeling is that for the purposes of a tsunami system, the CPACC communications model (sea-level/weather site – satellite – GOES ground-station) is the best method of data transmission, and that the inclusion of the existing CPACC sea-level/weather stations is less important. This conclusion is based on consideration of vulnerability of CPACC sites to a tsunami (most would be destroyed by a 3-meter tsunami), that they are not placed in optimal locations for tsunami watch and warning broadcasts, and finally that the CPACC mission of long term monitoring might be compromised by additional responsibility.

However, two thoughts concerning the CPACC sea-level/weather system including the ground-station have come to mind. One is to add an inexpensive GPS receiver to each field site primarily for the purpose of providing precise time, but with the secondary purpose of positioning. Second is to program the replacement EPROM's to continuously operate the acoustic tide gauge once per second. Then, with a rate-of-rise algorithm, the existing CPACC stations could be effectively used as ancillary sensors in a natural hazards mode and be incorporated into the Intra-Americas Sea Tsunami Warning System. A second ground-station at the site of the seismic center (not at CPACC expense) could then integrate CPACC equipment-generated tsunami wave alarms. Thus at minimal expense, the existing field stations would make a significantly wider contribution to the region.

References

Official Correspondence between the GS/OAS, the CPACC/RPIU and the Caribbean Meteorological Institute (CMI) regarding their role in data quality monitoring, system calibration and maintenance, and production of meteorological products. (Correspondence dated Sept. 15, 1998, Sept. 28, 1998, Nov. 11, 1998)

Official Correspondence between the GS/OAS, the CPACC/RPIU and the Institute of Marine Affairs (IMA) regarding their role in data quality monitoring and production of oceanographic products. (Correspondence dated Sept. 1998, Nov. 5, 1998, Nov. 13, 1998 and April 20, 1999)

Agreement between the General Secretariat of the Organization of American States and the Caribbean Meteorological Institute for participation in the CPACC Project, 20 May 1997

Agreement between the General Secretariat of the Organization of American States and the Institute of Marine Affairs for participation in the CPACC Project, 8 June 1998

Caribbean: Planning for Adaptation to Global Climate Change Project, Project Document, January 1997

Acronyms

ARNC	Acting Regional Network Coordinator
CARICOM	Caribbean Community
CIMH	Caribbean Institute of Meteorology and Hydrology
CMO	Caribbean Meteorological Organization
CPACC	Caribbean: Planning for Adaptation to Global Climate Change
CZMU	Coastal Zone Management Unit (Government of Barbados)
DCP	Data Collection Platform
ESSE	Earth System Science Education
Florida Tech	Florida Institute of Technology
FTP	File Transfer Protocol
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning Station
GS/OAS	General Secretariat of the Organization of American States
GTS	Global Telecommunications System (of the World Meteorological Organization)
IMA	Institute of Marine Affairs
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
GS/OAS	General Secretariat of the Organization of American States
QA/QC	Quality Assurance (QA) and Quality Control (QC)
RNC	CPACC Regional Network Coordinator
RPIU	Regional Project Implementation Unit
USDE	Unit of Sustainable Development and Environment
UWI	University of the West Indies

Schedule of Activities

DATE	ACTIVITY		
6 June 1999	Delta #1940 Delta #1547	Depart Melbourne at 545PM Depart Atlanta at 810PM	Arrive Atlanta at 710PM Arrive DC at 1003PM
7 June 1999	Morning: Visit Vitel, Inc.; Afternoon: Visit OAS		
8 June 1999	AA #4989 AA #1385	Depart Washington DC at 630 AM Depart New York at 930AM	Arrive New York at 745AM Arrive Barbados at 222PM
9 June 1999	Visit Caribbean Institute of Meteorology and Hydrology		
10 June 1999	Visit RPIU and Continue CIMH Visit		
11 June 1999	BWIA #427	Depart Barbados at 110PM	Arrive Trinidad at 205PM
12 June 1999	Visit CPACC Sites in Trinidad		
13 June 1999	Visit CPACC Site in Tobago		
14 June 1999	Visit Institute of Marine Affairs		
15 June 1999	Continue IMA Visit; lecture on tsunami hazards		
16 June 1999	AA #1818 AA #824	Depart Trinidad at 820AM Depart Miami at 145PM	Arrive Miami at 1120AM Arrive Orlando at 246PM

Tsunami Hazards of the Atlantic Basin

A presentation by

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Sponsored by the

♦

Institute of Marine Affairs
Trinidad and Tobago

June 15, 1999
10:00 AM

Tsunami Hazards of the Atlantic Basin

Outline of the Talk

- **A Brief Historical Introduction**
  - **What is a Tsunami and Where do they Occur?**
  - **Examples of Tsunami Waves from Tide Gauges**
- **Elementary Physics of Tsunami Waves**
  - **Celerity, Energy, and Waveheight**
  - **Tsunamigenic Faults and Coupling to the Sea**
  - **Earthquake Magnitude and Tsunami Run-up**
- **Distant or Teletsunami Events**
  - **Modeling the 1755 Lisbon Earthquake and Tsunami**
  - **Numerical Simulation of the 1755 Event – a Video**
- **Hazards within the Intra-Americas Sea**
  - **Modeling the submarine volcano "Kick'em Jenny"**
  - **Observations of the 1867 Virgin Islands Tsunami**
  - **Photographs from the 1918 Puerto Rico Event**
- **Lies, Damn Lies, and Statistics**
  - **Caribbean Fatalities and Destructive Tsunami Events**
  - **Four-Region Comparison of Tsunami Fatalities**
- **A Revisit of the 1867 Virgin Islands Tsunami**
  - **The Setting Today**
  - **Population Growth and Coastal Development**
- **Towards an Intra-Americas Sea Tsunami Warning System**
  Education • Warning • Management • Research
- **Summary and Conclusions**

Intra-Americas Sea Tsunami Warning System

Education • Warning • Management • Research

- **General Concept**
- **Warning System Operational Components**
  - **Seismic Subsystem**
  - **Sea level Subsystem**
  - **Communications Subsystem**
- **Management and Administration**
- **Implementation**
- **Budget**

Summary and Conclusions

- **Tsunami events have been recorded in the Intra-Americas Sea since the 16th Century**
- **The Caribbean Tectonic Plate is marked by active surface and subsurface volcanoes and by numerous earthquakes**
- **In the last 150 years, there may have been as many as 1,922 tsunami-related fatalities in the region**
- **Preventing a major disaster was the focus of workshops in St. John (1996), Puerto Rico (1997), and Costa Rica (1999)**
- **Each attendee at the 1997 workshop was charged with informing his or her head-of-state about the tsunami threat**
- **Local tsunami events, if detected by an operational system, could be forewarned by minutes to more than an hour**
- **No known national or intergovernmental tsunami hazard mitigation plan has a western Atlantic component**
- **Creation of an Intra-Americas Sea Tsunami Warning System is now a formal proposal to the Intergovernmental Oceanographic Commission of UNESCO**
- ***Education* is the most important element in mitigation plans**

Tsunami Hazards of the Atlantic Basin

Annex 2