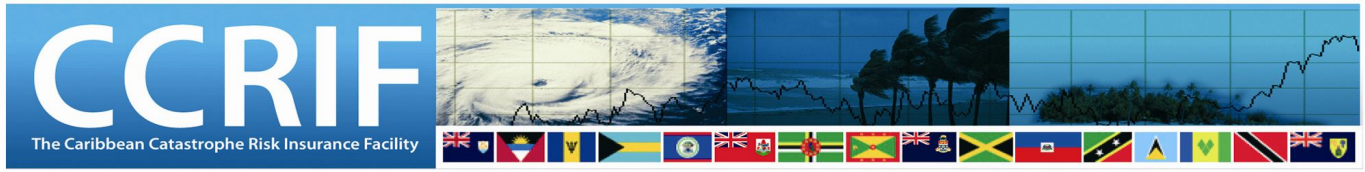




# GEM and the Seismic Research Centre (SRC) in the Caribbean- Their Role in Catastrophe Risk Reduction

**By**

**Myron W. Chin[1], PhD, CEng, FICE, FIStructE, FAPETT and Lloyd Lynch[2], BSc**

**[1]Senior Research Fellow and GEM Operational Manager for the Caribbean**

**[2]Research Fellow, Instrumentation,**

**Seismic Research Centre, The University of the West Indies, St. Augustine, TRINIDAD & TOBAGO**

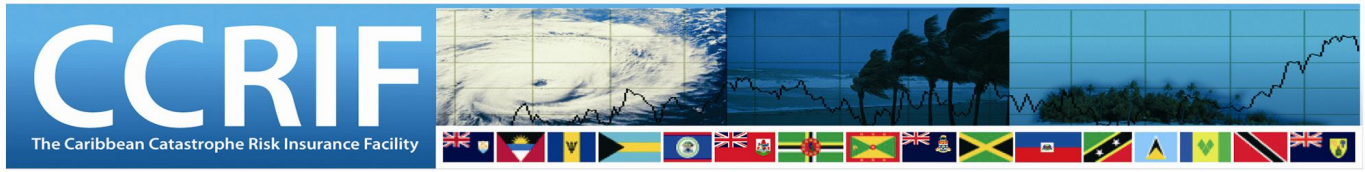
**Presentation**

**at the**

**Meeting of the World Forum of Catastrophe Programmes**

**October 24-27, 2011**

**Half Moon Resort, Montego Bay, Jamaica**



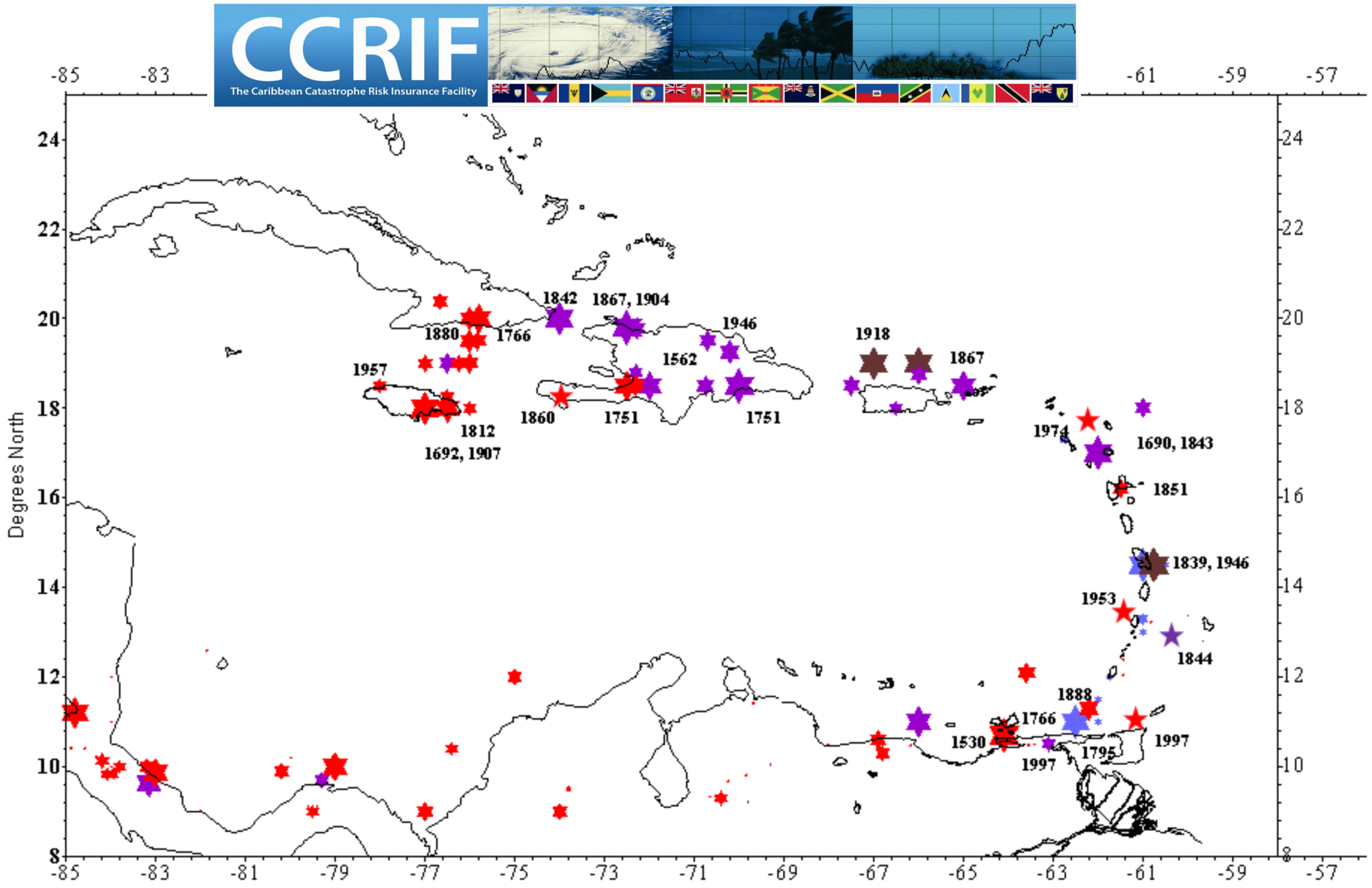


# SUMMARY OF PRESENTATION

- INTRODUCTORY REMARKS
- TYPES OF NATURAL HAZARDS IN THE CARIBBEAN
- SOME EXAMPLES OF DAMAGE DONE BY RECENT EARTHQUAKES AROUND THE WORLD
- KEY LESSONS THAT THE CARIBBEAN CAN LEARN FROM THESE EVENTS
- CURRENT AND PLANNED SRC INITIATIVES
- LAUNCH OF GLOBAL EARTHQUAKE MODEL (GEM) IN THE CARIBBEAN
- REGIONAL WORKING GROUPS
- PRESENT AND PROPOSED ACTIVITIES
- *ACTIVE FAULTS –CENTRAL RANGE FAULT, T&T*
- *MICROZONATION OF PORT OF SPAIN, T&T*
- *BUILDING INVENTORY- KINGSTON, JAMAICA*
- *PROPOSED ACTIVITIES*
- CONCLUDING REMARKS


# INTRODUCTORY REMARKS

- The entire Caribbean Basin is prone to socio-natural and man-made disasters
- ECLAC estimates that the disaster impact is over 1.5 billion US dollars/year
- A number of national, regional (ODPM, SRC, CDEMA, APRM, ACS, CCRIF) and international organizations (PAHO, OAS) are currently working in this area.
- Now we have GEM




# Large and Damaging Earthquakes of the Insular Caribbean

GEM Global Earthquake Model

| Year | Location – Depth (km) | Magnitude Max MMI | Macro-seismic | Deaths Injured | Homeless/ Damage |
|---|---|---|---|---|---|
| 1999 | Izmit, Turkey | 7.5, XI | SS, Fault Rupture | >17K, >44K | 120K bldgs destroyed |
| 2001 | Gujarat, India 16 | 7.9, IX | Strong Shaking(SS) | >20K, >167K | 600K Homeless |
| 2003 | Bam, Iran - 10 | 6.6, IX | Strong Shaking | >26K, >30K | 100K Homeless |
| 2004 | Indian Ocean 29 | 9.1, IX | Tsunami | >230K, >125K | 1.7M Homeless |
| 2005 | Kashmir, Pakistan, 30 | 7.6, VIII | Landslides | >86K, >106K | >32K bldgs collapsed |
| 2007 | Pisco, Peru | 8.0, X | Tsunami | ~0.5K, 1366 | 36K bldgs destroyed |
| 2008 | Sichuan, China | 8.0 | Landslide | >70K, >374K | 4.3M homeless |
| 2010 | PaP, Haiti, 10 | 7.0, VIII | Strong Shaking | >230K, >20K | >100K homeless |
| 2010 | Maule, Chile | 8.8, XI | Tsunami | 1.7K, Many | >200K bldgs damaged |
| 2011 | Christchurch, NZ | 6.5, VIII | SS, Liquefaction. | <200, Many | >200K bldgs damaged |
| 2011 | Sendai, Japan | 9.1, XI | Tsunami | 14K | |

A large portion of fatalities and damage costs are attributed to:

Lack of, obsolete or ineffective building regulation system and inappropriate development planning. Careless design, poor workmanship and deficient quality control are also strong contributors.

| Year | Location – Depth (km) | Magnitude Max MMI | Macro-seismic | Deaths Injured | Homeless/ Damage |
|---|---|---|---|---|---|
| 1999 | Izmit, Turkey | 7.5, XI | SS, Fault Rupture | >17K, >44K | 120K bldgs destroyed |
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| 2011 | Sendai, Japan | 9.1, XI | Tsunami | 14K | |
| | | | | | |

## Early Warning Systems save lives:

The huge loss of lives in the Indian Ocean was largely due to the lack of effective EWS. Large near-surface earthquakes are strong candidates for tsunami generation. A TEWS has been under construction for the Caribbean region since 2005.

| Year | Location – Depth (km) | Magnitude Max MMI | Macro-seismic | Deaths Injured | Homeless/ Damage |
|---|---|---|---|---|---|
| 1999 | Izmit, Turkey | 7.5, XI | SS, Fault Rupture | >17K, >44K | 120K bldgs destroyed |
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One factor that is common to these two disasters was that the regulatory systems were heavily overwhelmed in the decades immediately before the earthquakes. As a consequence, many buildings and infrastructure that were erected during this period were heavily damaged or destroyed during the earthquakes.

| Year | Location – Depth (km) | Magnitude Max MMI | Macro-seismic | Deaths Injured | Homeless/ Damage |
|---|---|---|---|---|---|
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Even a modest sized earthquake near a densely populated centre can inflict huge casualties and/or losses. Montego Bay, and Kingston, Jamaica; San Fernando, Trinidad, Santo Domingo, Dom. Republic and Santiago de Cuba, Cuba are all located near-surface active faults that could generate strong ground motion upon rupture. These cities should accelerate their earthquake risk reduction programmes.

| Year | Location – Depth (km) | Magnitude Max MMI | Macro-seismic | Deaths Injured | Homeless/ Damage |
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| 1999 | Izmit, Turkey | 7.5, XI | SS, Fault Rupture | >17K, >44K | 120K bldgs destroyed |
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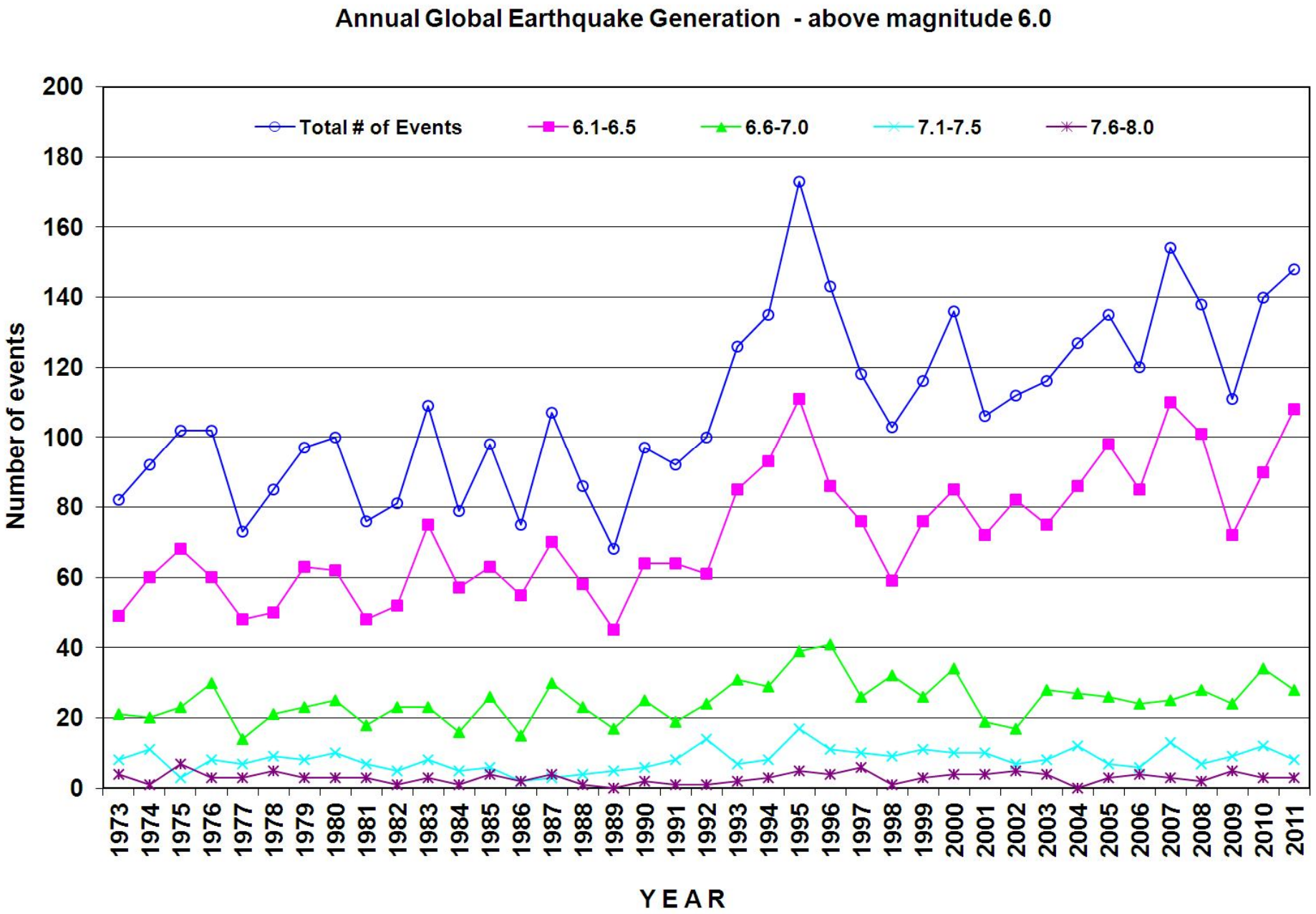
Through consistent investment in earthquake risk reduction activities such as building regulation systems, catastrophe funds, emergency response systems and so on, these countries have become resilient to earthquakes. Even when assailed by a devastating event, the recovery time is relatively short.


Annual Global Earthquake Generation - above magnitude 6.0
Total # of Events
6.1-6.5
6.6-7.0
7.1-7.5
7.6-8.0
Number of events
0
20
40
60
80
100
120
140
160
180
200
1973
1974
1975
1976
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2011
YEAR

# Earthquake Risk Reduction Priority Actions for Latin America and the Caribbean

- Establish sustained public awareness program with a focus on earthquake risk to bring public knowledge of the threat to a critical level more conducive with hazard adjustment.
- Strengthen institutional capacities to make vast improvements in development planning and building regulation processes.
- Eradicate or at best minimize corruption and mal-practice
- Improve the safety of existing stock giving preference to essential, critical and high risk facilities.
- Establish disaster pre-finance programs aimed at reducing the contingent liabilities of future catastrophes that may precipitate from earthquakes
- Set specific commitments, targets and indicators for disaster reduction.

# Caribbean Earthquake Risk/Hazard Reduction Projects

- **EUCENTRE/UWI** Seismic Hazard Maps, Eastern Caribbean →
- **DRRC-UWI** - Caribbean Risk Atlas – Earthquake Section
- **CROSQ** Regional Building Standard - Earthquake Hazard Maps
- **GOTT** - Trinidad and Tobago Seismic Microzonation Project
- **UNESCO-IOC –TWS** Tsunami Smart Project →
- **UNESCO-IOC –TWS** Tsunami Warning Protocol Project →
- **UNESCO-IOC –TWS** Training Workshop for Tsunami Focal Pt →
- **UNESCO-IOC –TWS** Network Exp. (Seismic and T/ Gauge)→
- **NGI/UWI** Tsunami Risk Assessment of Bridgetown Barbados
- ***IPGP/UWI*** *– Regional Tsunami Alert Project*
- **CCRIF** - Caribbean Strong Motion Network Project
- ***COCONet*** *– Caribbean GPS Network Infrastructure Upgrade*
- **GEM -** Global Earthquake Model – Caribbean Programme


# CARIBBEAN NATURAL HAZARDS

## Geological:

- Earthquakes
- Volcanic activity
- Tsunamis
- Landslides

## Meteorological:

- Hurricanes
- Storm surge and wave action
- Torrential rains

# THE GLOBAL EARTHQUAKE MODEL (GEM)

"A collaborative effort devised and launched by OECD's Global Science Forum, aimed at **engaging the global community** in the design, development and deployment of uniform open standards and tools for earthquake risk assessment worldwide"

# GEM FEATURES

**A comprehensive interactive model:** Calculating and communicating hazard, risk (exposure and vulnerability) and impacts on the society and the economy

**State-of-the-art:** Latest developments in science and technology

**Community based:** Community involved in designing and implementing GEM procedures, software, tools, methods, collecting data etc.

**Open access:** Open source software, transparent tools and accessible global datasets

**Global coverage:** Global and regional coverage. Interaction with Regional Programmes

**Serving Multitude of Users:** Intuitive, customised interfaces and users needs assessments

**Dynamic ("alive"):** Updatable, modular, flexible models and tools

**Public / Private Partnership:** Combines strengths and objectives of public and private sectors

**Application beyond GEM:** Expandable to other perils

# PUBLIC-PRIVATE PARTNERSHIP

10 countries have adhered so far

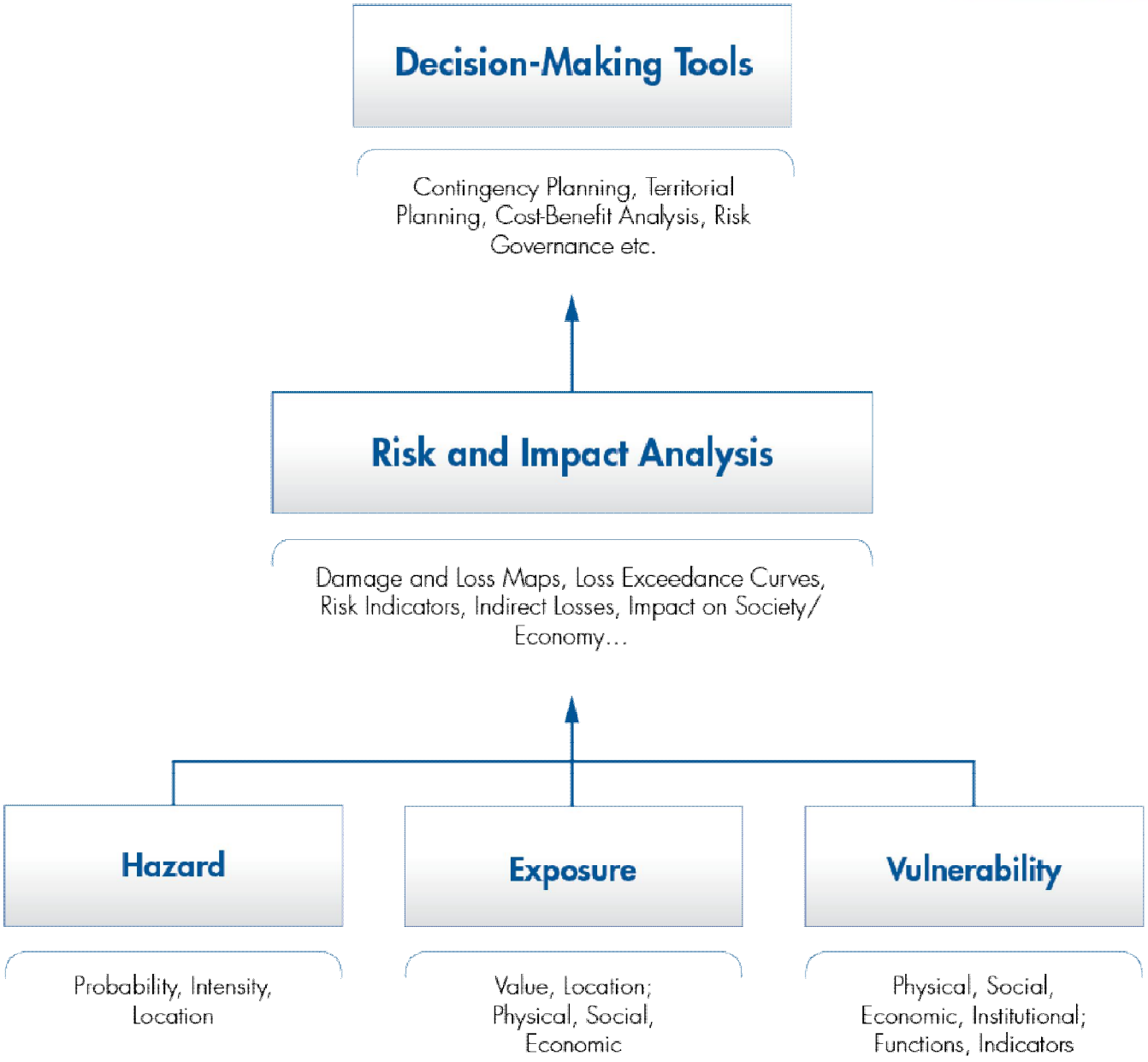
discussions and negotiations are ongoing with 15+ others

7 private organisations have partnered up with GEM so far

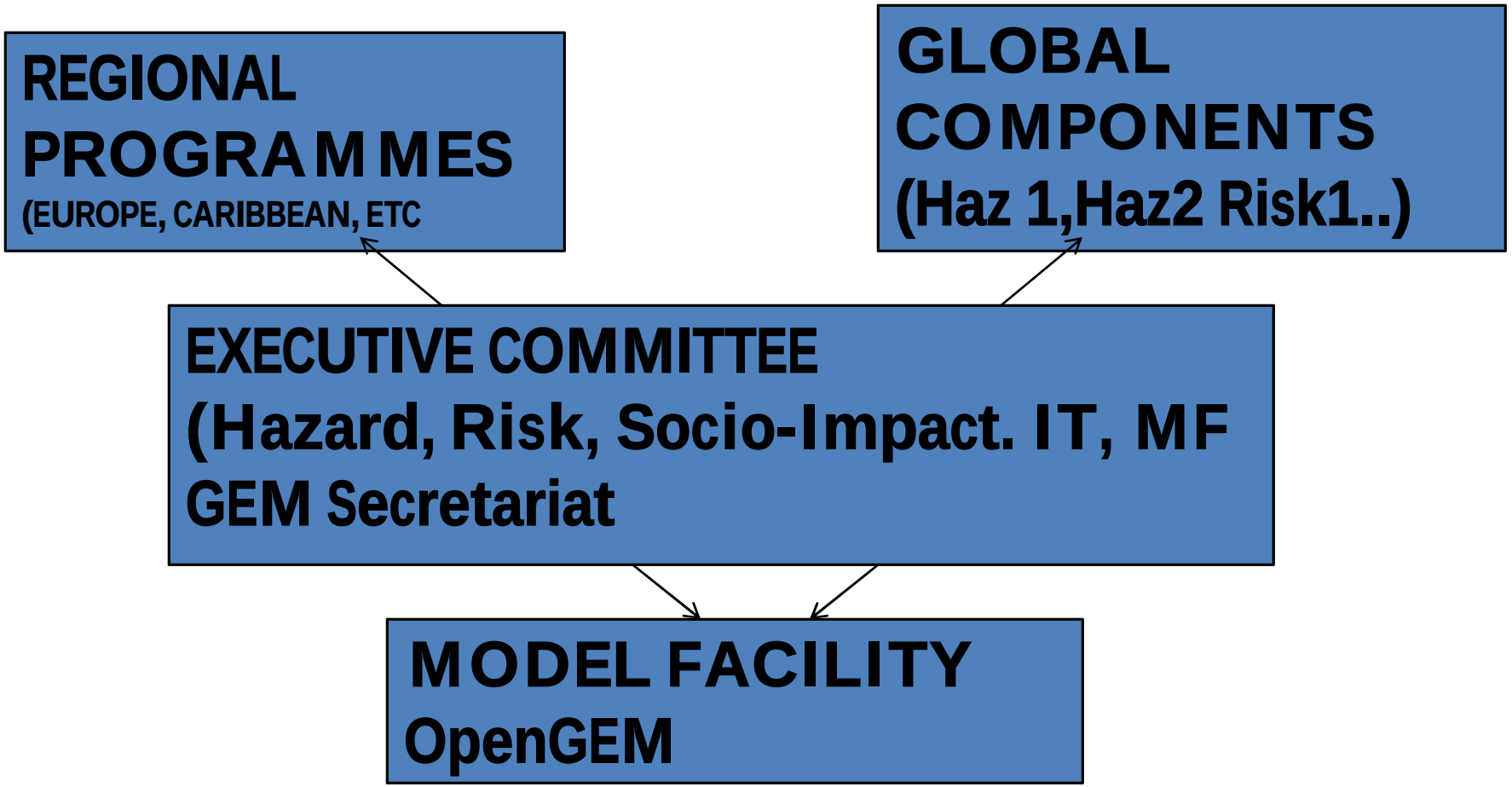
they contribute 13.6 M Euro


the OECD, World Bank, UNESCO, UN/ISDR, IAEE and IASPEI are associate participants

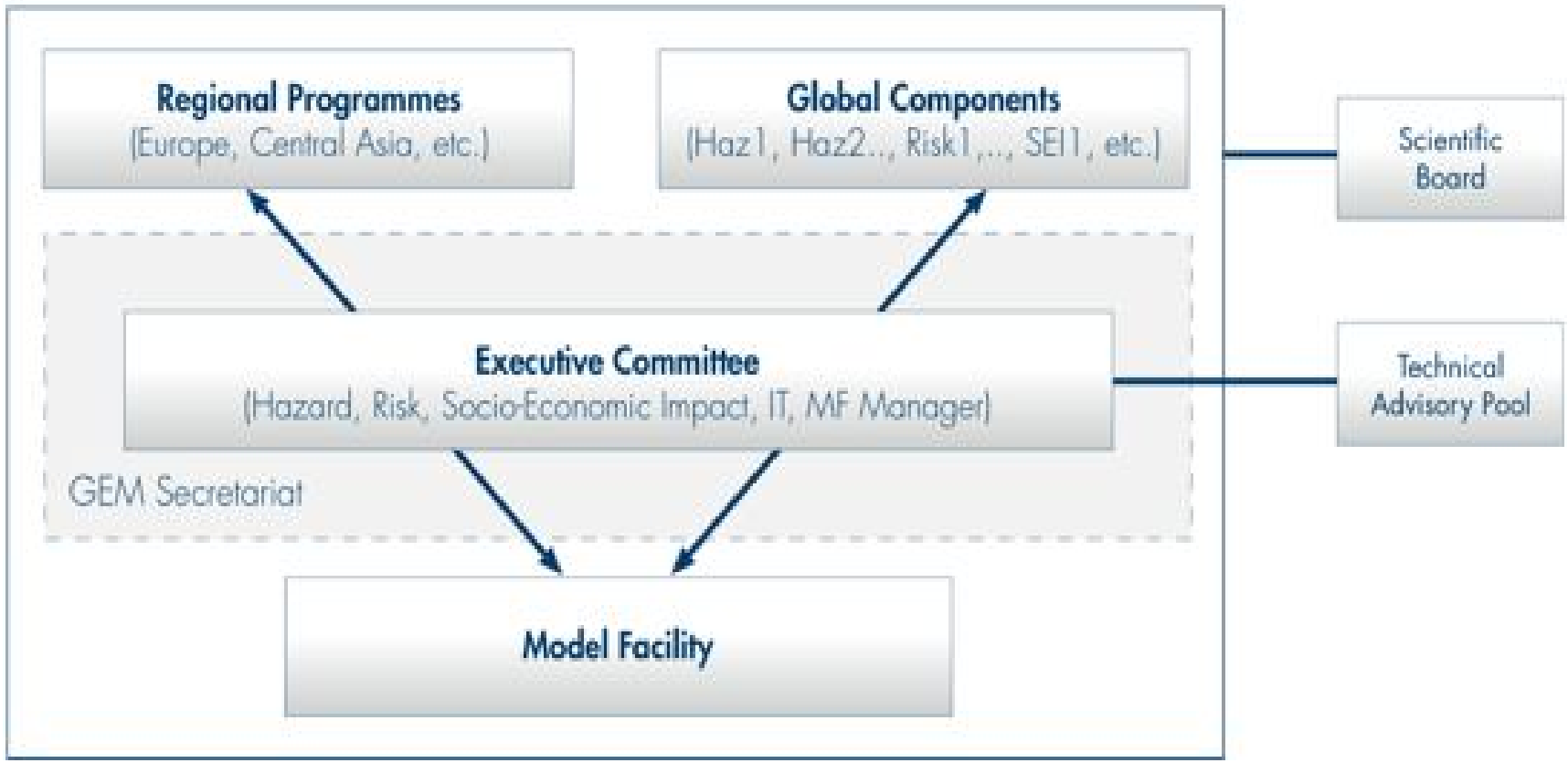
# SCIENTIFIC FRAMEWORK OF GEM



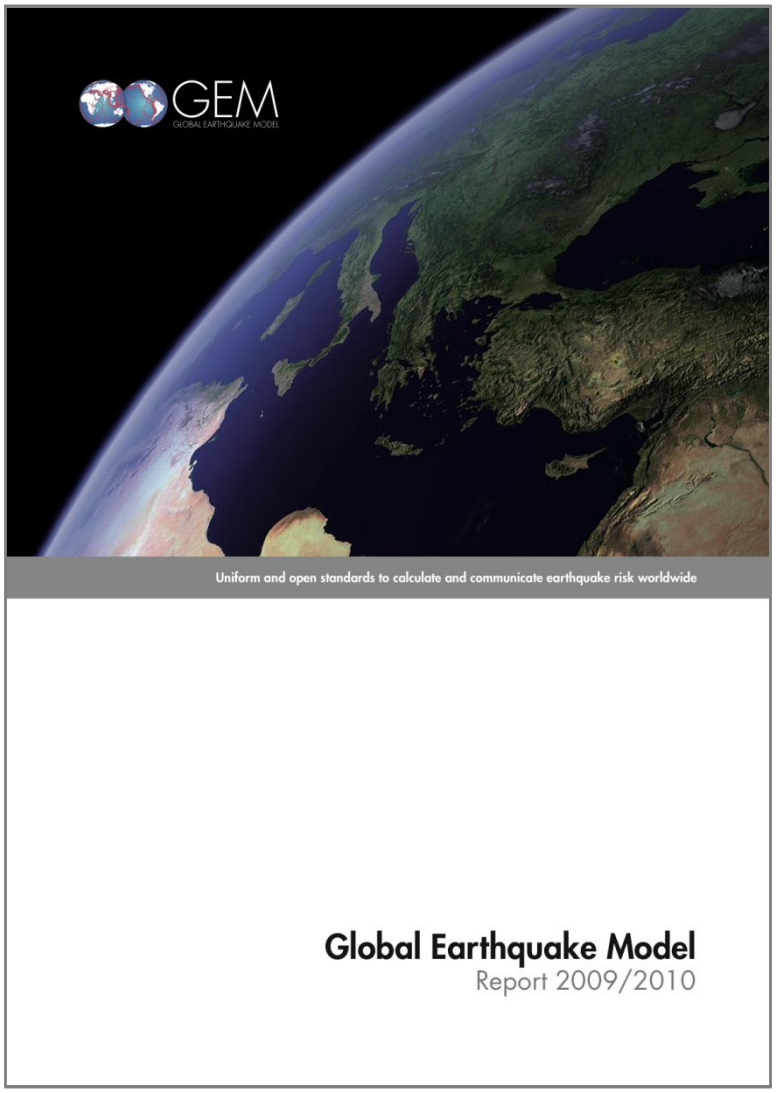
# CURRENT DEVELOPMENT OF GEM IS BASED ON GLOBAL COMPONENTS, REGIONAL PROGRAMMES AND THE MODEL FACILITY



# ROLE OF GEM'S EXECUTIVE COMMITTEE IN BRINGING ACTIVITIES OF VARIOUS COMPONENTS TOGETHER



# STAY UPDATED




## GEM Website

- Most update source of information
- News, results, calls, …

**www.globalquakemodel.org**

## GEM Report 2009/2010 v2

- Available from website and hard-copy

## Bi-monthly e-Newsletter

- Sign-up at website

# LAUNCH OF GEM CARIBBEAN PROGRAMME

-The development of Regional Programmes (RPs) is the main mechanism through which the GEM tools will be transferred with a view to creating a uniform globally used standard. The RPs involve local experts using GEM software and tools, who generate local data and validate the data and standards that are being created on the global level.

-The Institution of Structural Engineers (Caribbean Division) hosted a presentation
of the GEM project at the Normandie Hotel in Trinidad on 15 October 2010.

# LAUNCH OF GEM CARIBBEAN REGIONAL PROGRAMME (Cont'ed)

-In January 2011, the GEM Foundation (hereinafter referred to as GEM) engaged The Seismic Research Centre (SRC) of The University of the West Indies, St. Augustine, to promote the GEM vision in the Caribbean. Funding became available in March 2011 at which time the GEM Operational Manager, Dr. Myron Chin, was appointed. He will, in collaboration with all players/stakeholders from the Caribbean community, spearhead the implementation of the GEM initiative in the Insular Caribbean and the effective functioning of the GEM Regional Programme (RP) for the Caribbean

# HIGHLIGHTS OF GEM THREE-DAY WORKSHOP- MAY 2-4,2011 TO LAUNCH GEM REGIONAL PROGRAMME IN THE CARIBBEAN

**-OPENED BY HON. MINISTER OF SCIENCE, TECHNOLOGY AND TERTIARY EDUCATION**

**- PRESENTATIONS BY DRS. RUI PINHO,MARCO PAGANI AND HELEN CROWLEY OF GEM SECRETARIAT AND TWENTY OTHERS**

**-ACTIVE PARTICIPATION BY SOME 68 PARTICIPANTS FROM NINE CARIBBEAN COUNTRIES**

**- SEVEN REGIONAL WORKING GROUPS FORMED**

**- FULL DETAILS OF WORKSHOP CAN BE FOUND AT:**

**http://uwiseismic.com/General.aspx?id=91**

# HON. MINISTER FAZAL KARIM OPENS GEM WORKSHOP

# PRESENTATION BY DR. RUI PINHO –SECRETARY-GENERAL OF GEM

# PRESENTATION BY DR. MARCO PAGANI – GEM CO-ORDINATOR FOR HAZARD

# PRESENTATION BY DR. HELEN CROWLEY – GEM COORDINATOR FOR RISK

# GEM WORKSHOP –2-4 MAY 2011
# GROUP PHOTOGRAPH

# GEM CARIBBEAN SEVEN REGIONAL WORKING GROUPS

***HAZARD-*** *OVERALL CO-ORDINATOR –Dr. Walter Salazar (Co-opted on 2011-05-19)*

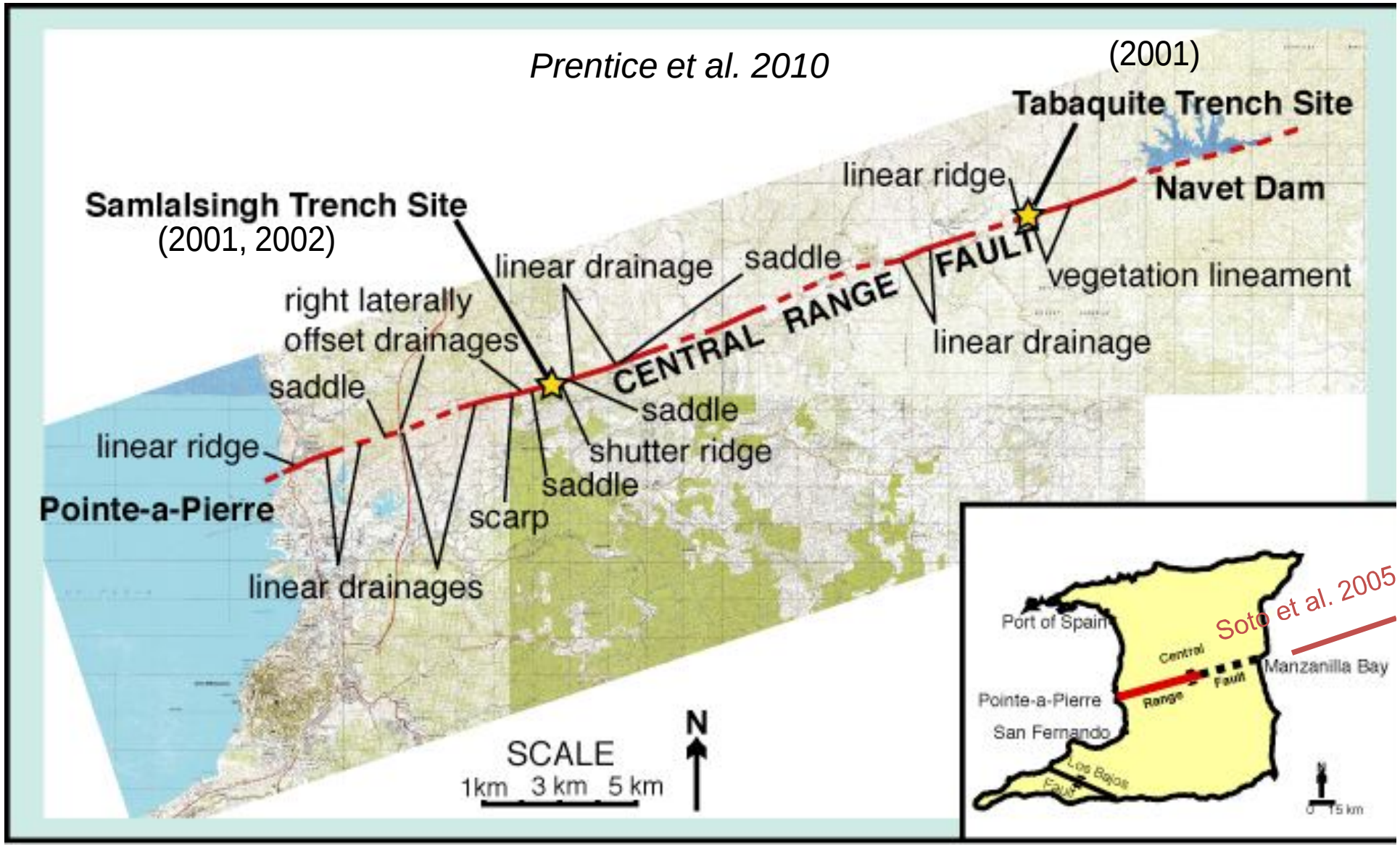
## Group 1: Active Faults

**Project Leader: Rafi Ahmed (MONA GEOINFORMATICS – UWI MONA, JAMAICA)**

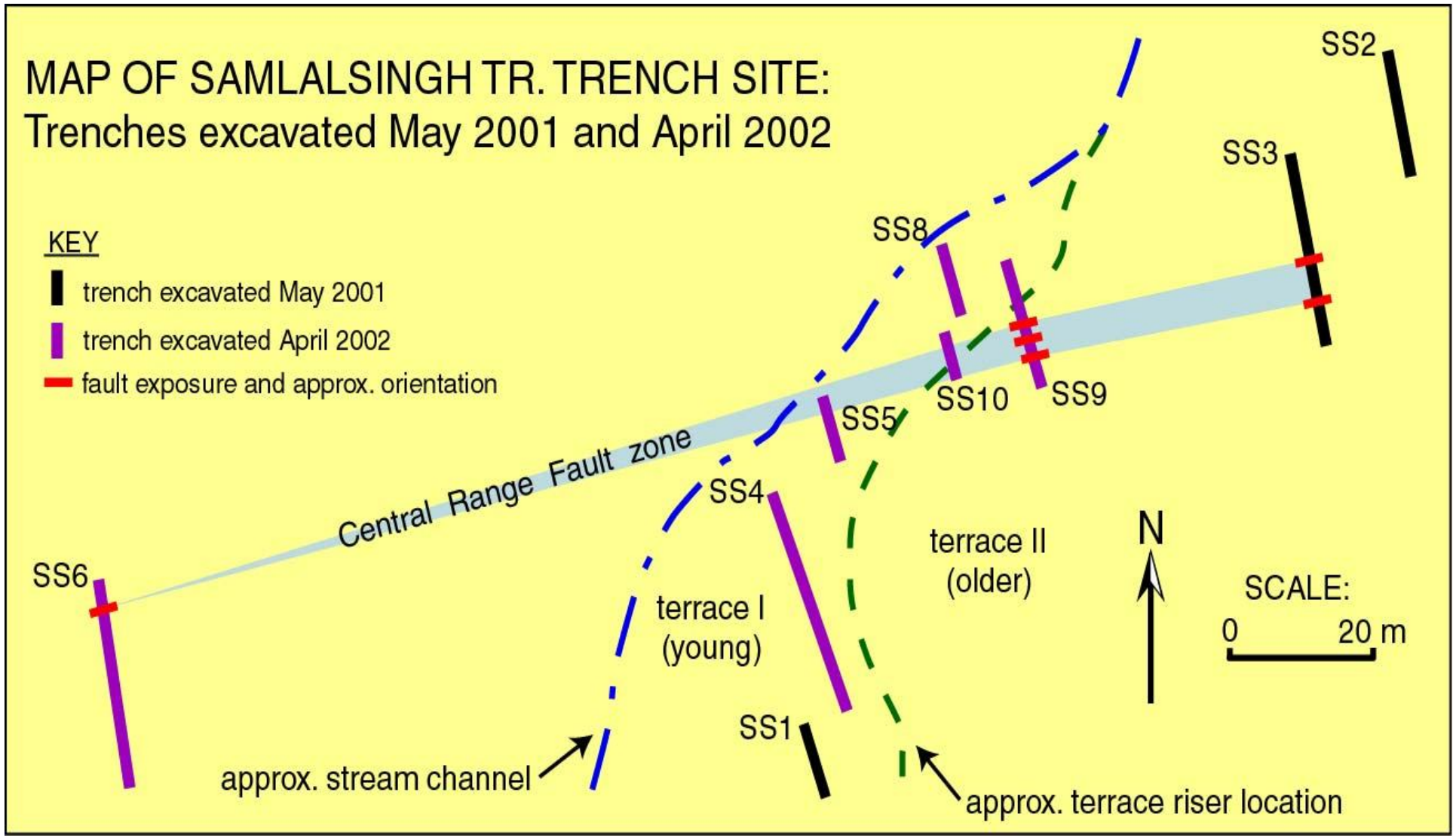
**Participants:**

**Franck Audemard y Luz Rodríguez (FUNVISIS, Venezuela)**
**Lyndon Brown (Earthquake Unit, UWI Mona, Jamaica),**
**Wayne Adams (Consultant Jamaica)**
**Barbara Carby (DRRC, UWI Mona, Jamaica)**
**Joan Latchman SRC, UWI, Trinidad**
**Enrique Arango, CENAIS, Mexico**
**Krishna Persad, Krishna Persad & Assoc. Ltd, Trinidad**

# Paleoseismology: locked or creeping CRF?(after Weber)



# CENTRAL RANGE FAULT (AFTER WEBER)



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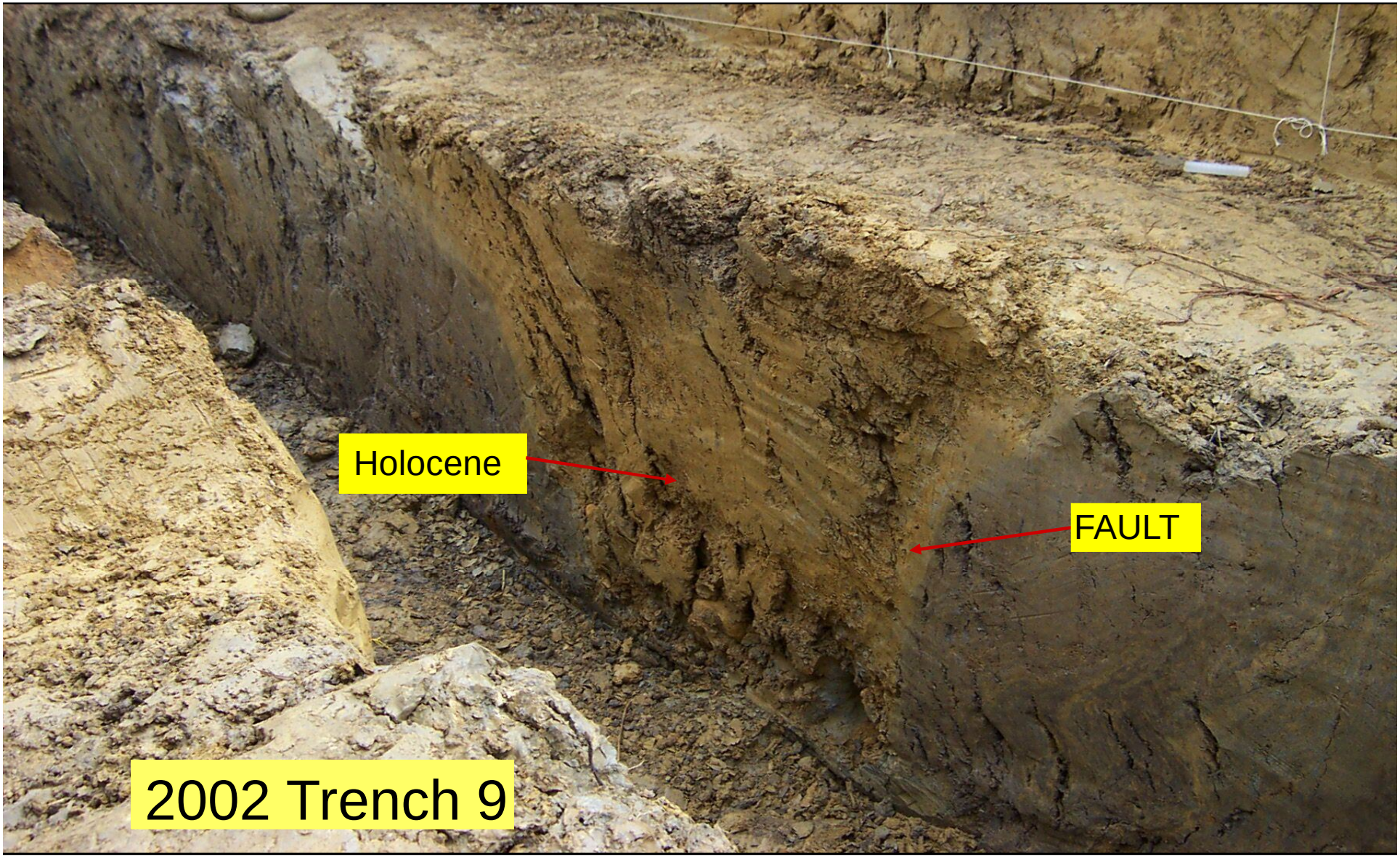


***HAZARD-* OVERALL CO-ORDINATOR –Dr. Walter Salazar (Co-opted on 2011-05-19) (Cont'ed)**

# Group 2: Seismicity (Instrumental and Historical)

**Leader: Lloyd Lynch and Joan Latchman (Seismic Research Centre, UWI Trinidad)**

- **Julio García:** ISTITUTO NACIONALE DI OCEANOGRAFICA E DI GEOFISICA SPERIMENTALE (OGS), ITALIA.
- **Herbert Rendón y Leonardo Alvarado (FUNVISIS, Venezuela)**
- **Walter Salazar (SESMIC RESEARCH CENTRE, UWI Trinidad).**
- **Bladimir Moreno, CENAIS, Cuba**
- **Alia Juman, SRC, UWI, Trinidad**

**Group 3: PSHA and GMPE's for the Caribbean and Central American region**

**Project Leader: Walter Salazar (SESMIC RESEARCH CENTRE, UWI).**

**Participants:**

- **Julio García: ISTITUTO NACIONALE DI OCEANOGRAFICA E DI GEOFISICA SPERIMENTALE (OGS), ITALIA.**
- **Carlo Lai, Elisa Zuccolo, Francesca Bozzoni (EUCENTRE, ITALIA)**
- **Herbert Rendón, Oscar Andrés López y Jorge González (FUNVISIS, VENEZUELA)**
- **Derek Gay (DEPARTMENT OF CIVIL ENGINEERING, UWI)**
- **Lyndon Brown (EARTHQUAKE UNIT – UWI MONA, JAMAICA)**
- **Alvaro Climent (INSTITUTO COSTARRICENSE DE ELECTRICIDAD)**
- **Leonardo Alvarez (CENAIS), Cuba**
- **Jillian St. Bernard, SRC, UWI, Trinidad.**

***<u>HAZARD-</u> OVERALL CO-ORDINATOR –Dr. Walter Salazar (Co-opted on 2011-05-19) (Cont'ed)***

**Group 4: Site Effects**
**Project Leader: Rafi Ahmed (MONA GEOINFORMATICS – UWI MONA, JAMAICA)**
**- Cecilio Morales, Michael Schmitz (FUNVISIS, Venezuela)**
**- Carlo Lai, Elisa Zuccolo, Francesca Bozzoni (EUCENTRE, ITALIA)**
**-Walter Salazar (SESMIC RESEARCH CENTRE, UWI Trinidad)**
**- Leonardo Alvarez, CENAIS, Cuba**

# GEM CARIBBEAN –GROUP 2

GEM-Caribbean
Group 2: Historical (1500 - 1900?) and Instrumental (1900 – 200?) Seismicity.

**Aim of the project:**

The main goal of the project will be to compile a “homogeneous”-“consensual” **Caribbean and Central American** parametric **Earthquake Catalogue** and a **Database** of primary data, to serve as a fundamental tool for understanding the seismicity of our region and a reliable and robust input for the seismic hazard assessment that should be performed in the frame of the GEM-Caribbean project.

# GEM CARIBBEAN -7 REGIONAL WORKING GROUPS (Cont'ed)

***RISK*- *OVERALL CO-ORDINATOR -Dr. Myron Chin***

**Group 5: Exposure**

**Leaders of Sub-Groups:**

- **Building Codes: Carlos Buron**
- **Critical Facilities: Wayne Adams**
- **Retrofitting: Didier Deris**
- **Expert Judgement: Anthony Farrell**
- **Building Inventory: Kevin Granger**

**Members: Jacob Opadeyi, Jan Vermeiren, Cassandra La Barrie, Mona GeoInformatics ( Sub-group co-opted on 2011-05-12)**

- **Databases: Myron Chin, SRC, UWI, Trinidad**

**Members:to be co-opted by Leaders of Groups/SubGroups**

# DEVELOPMENT OF CARIBBEAN RISK ATLAS FOR EARTHQUAKE HAZARDS (RISK ATLAS PROJECT)

Walter Salazar, Richard Robertson, Michael Higgins, Cassandra La Barrie, Lloyd Lynch, Joan Latchman, Alia Juman, Jillian Bernard

*Port of Spain, Trinidad May 3rd 2011*


SEISMIC RESEARCH CENTRE

# DEVELOPMENT OF CARIBBEAN RISK ATLAS FOR EARTHQUAKE HAZARDS (RISK ATLAS PROJECT)

- Project Manager: U.W.I Disaster Risk Reduction Centre (DRRC) at Mona, UWI in Jamaica.
- Main Sponsor: World Bank
- Completion Date: December 2011.


SEISMIC RESEARCH CENTRE

- OBJECTIVES

To develop a methodology for seismic risk assessment in the Caribbean for *three pilot States*: **Jamaica, Grenada and Barbados**.

To provide guidelines and open-source software for the estimation of earthquake loss using available socio-economic data.


SEISMIC RESEARCH CENTRE

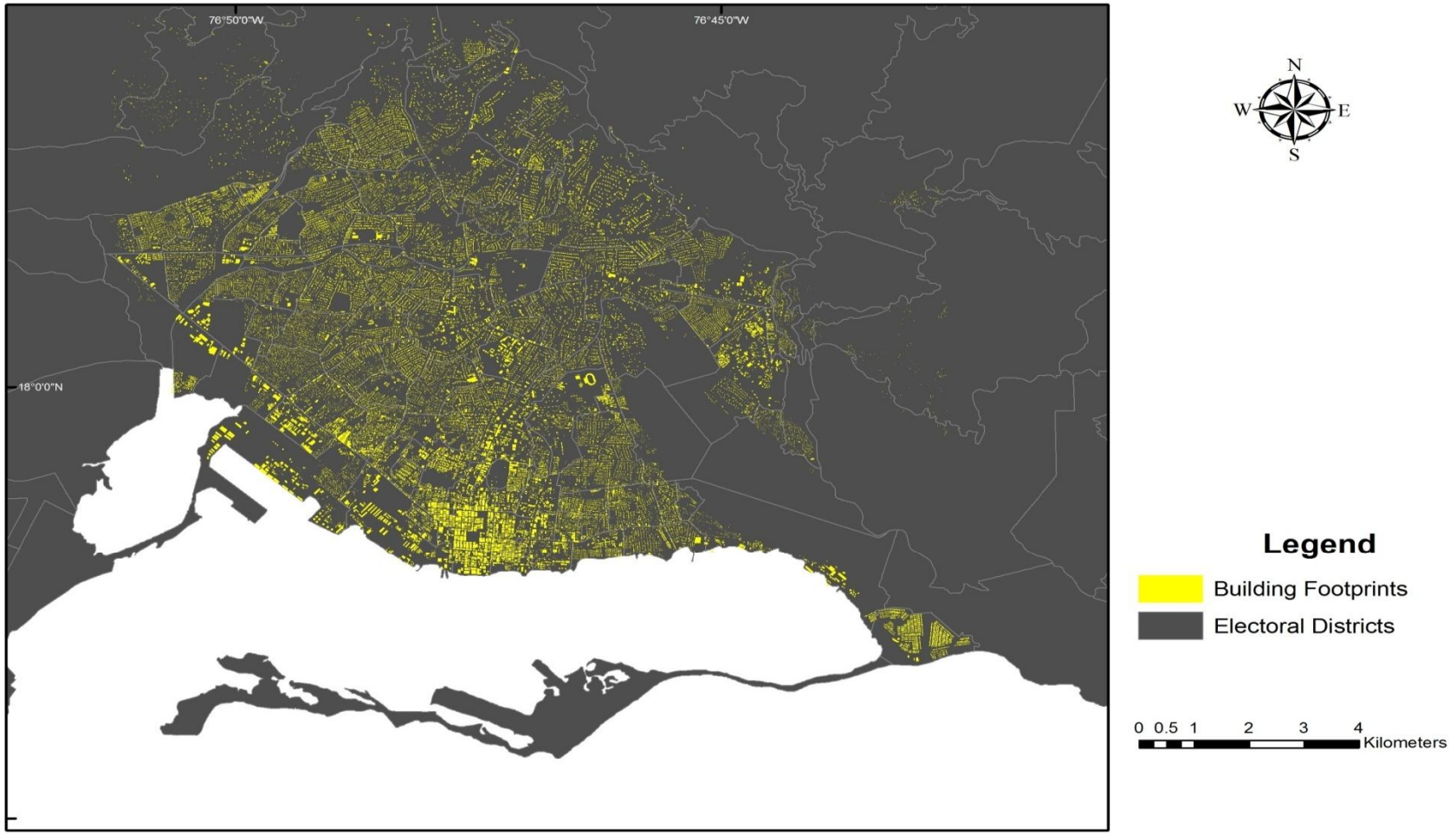
# Project Components

- Seismic hazard assessment for Jamaica in terms of PGA and spectral ordinates for 0.2s and 1.0s
- For Barbados and Grenada: we will use the seismic hazard results of the Eastern Caribbean Project (SRC/EUCENTRE).
- Development/Adapted Fragility Curves
- Modification, testing and validation of ELE software
- Determination of data requirements and collection of geo-referenced data
- Risk evaluation


SEISMIC RESEARCH CENTRE

# VULNERABILITY AND BUILDING STOCK

## Building Footprints for Kingston Metropolitan Area



# SURVEY ON DECEMBER 2010 - Kingston

Precast houses

Masonry Houses

Reinforced concrete apartments

Historical Buildings

Modern Reinforced Concrete Building at New Kingston

Reinforced concrete buildings on slopes

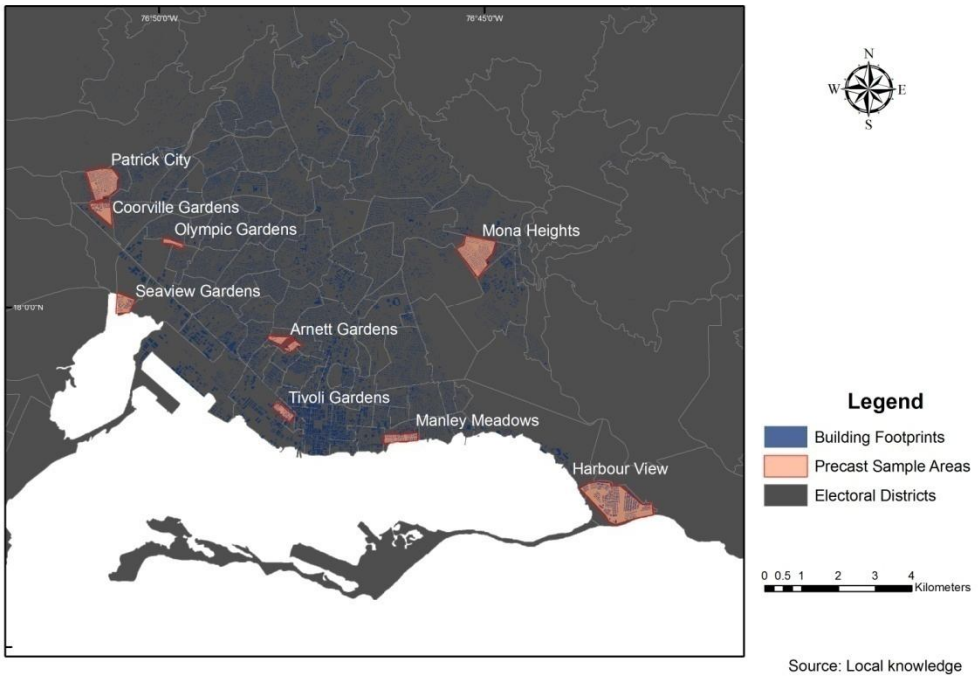
Wooden house

# DEVELOPMENT OF FRAGILITY CURVES FOR pre-cast houses

Heavy roof

Connections between panels are effected by welding together matching metal angle sections embedded in the edge ribs of the panels.

Pre-cast Housing Sample Areas for Kingston Metropolitan Area




Source: Local knowledge

# CURRENT WORK

- GEM collaboration:

  - Collaboration with GEM in terms of assistance with the OpenQuake software development.

  - Two of our Research Assistants from SRC are spending two months at the GEM Headquarters from end August to end October 2011 to learn about OpenQuake and to analyse the data collected under the DRRC Risk Atlas Project in order to assess its applicability to the Caribbean Region.

# GEM Caribbean Regional Programme Workshop

## Group 5 - Exposure
## Building Inventory

# PROJECT OVERVIEW

The main objective of this group/project is to compile a building stock or inventory for all the buildings within the Region. The method of classification proposed is based on the HAZUS taxology and as such will comprise of the following:

- The structural parameters which affect the structural capacity and response
    - Basic structural system (e.g. steel moment frame, unreinforced masonry bearing wall )
    - Building height (e.g. low-rise, mid-rise, high-rise)
    - Seismic design criteria (e.g. seismic zone)
- Occupancy (affecting casualties, business interruption and contents damage)
- Regional building practices
- Variability of building characteristics within the classification.

At this time, GEM is in the process of developing their Inventory Data Capture Tools (IDCT). These tools are expected to address the inventory and the damage data development needs of the GEM user community by developing input into the Global Exposure database. This project is expected to last 30 months and cost 750k Euro. GEM also plans to validate the tool by focusing on Padang in Indonesia (inventory and damage), and having beta testing on Istanbul (inventory) and Haiti (damage).

In the interim it is important for our workgroup to conduct a parallel project where we compile our own building inventory for a sample area within the Region. This study will then allow us to more accurately calibrate the IDCT developed by GEM to take into consideration the variability associated with our regional building practices, topography and the true geometry of out structures.

# GEM CARIBBEAN -7 REGIONAL WORKING GROUPS (Cont'ed)

## Group 6: Vulnerability

**Tentative Leader: Dr. R. Clarke**

**Members: -Col. Dave Williams, Mr. Allan Stewart, Grisel Morejon, CENAIS, Cuba, Jillian St. Bernard, SRC, UWI**

**Leader of Sub-Group: Tony Gibbs**

**-Effectiveness of Compliance Mechanisms**

**Members: - Didier Deris, Jan Vermeiren**

## Group 7: Socio-Economic Impact (SEI)-

***OVERALL CO-ORDINATOR – Myron Chin***

**Leader of Sub-Group:- Jan Vermeiren**

**-Disaster Financing:**

**Members-Didier Deris, C. Rogers, Tony Gibbs, Fernando Guasch, CENAIS, Cuba**

**- Valuation –real estate**

**Leader of Sub-Group: Stacey Edwards ( Co-opted by M. Chin)**

- **Education and Outreach**
- **Members: Alia Juman, SRC, UWI, Ibia Vega, CENAIS, Cuba**

**GEM Caribbean Regional Programme**
**Working Group on *Effectiveness of Compliance Mechanisms***
Chairman: Tony Gibbs
Member: Didier Deris

# A Code Enforcement Grading System

A code enforcement grading system is an excellent example of the positive impact GEM could have on the effectiveness of public systems. Education and communications are essential to this effort. This would entail GEM assessing the organisation, staffing, mechanisms and quality controls of government agencies charged with the responsibility of issuing building permits (before construction) and occupancy certificates (for completed buildings). The agencies would then be graded in a comparative way. Sensibly, vulnerability levels in the state should relate to the achieved grades of the relevant regulatory agency.

The region should implement a code enforcement grading system. Such a system which relates both code adoption and code enforcement to a specific country's vulnerability will promote implementation of better code requirements and enforcement standards. Introduction and implementation of this concept should be pursued by GEM.

It has to be admitted that there is little incentive at present to having codes effectively enforced.

The proposal for a Code Enforcement Grading System (CEGS) should be communicated to building officials and others in government to sound out the practicality of introducing such a programme.

A CEGS should facilitate more professional, effective and generally better building authorities. It should also encourage the adoption of more effective building codes. CEGS could also address the vulnerability of the existing building stock by obtaining an historical retrospective of each country's code adoption and enforcement patterns. (This can only be done for a few Caribbean countries.) Also, the CEGS would also determine each country's use of a programme for inspection of existing buildings and mandatory retrofit programmes.

Other groups that should be concerned about the issues of effective enforcement and should therefore join GEM in the promotion of the CEGS are:
the insurance industry;
- standards organizations;
- building official organizations;
- consumers;
- architects' and engineers' associations.

Tony Gibbs
01 June 2011

# CONCLUDING REMARKS

**In concluding this Presentation, it is appropriate to quote my co-authorLloyd Lynch which he made in his presentation at the GEM CARIBBEAN LAUNCHING Workshop:-**

# Thank You
# For your attention.
# Any Questions?