Eastern Caribbean
Climate Resilient Infrastructure
Workshop

PROCEEDINGS

Part of the:
Regional Disaster Vulnerability Reduction Program (RDVRP)
Pilot Program for Climate Resilience (PPCR)

Ministry of Transport & Works
Kingstown, Saint Vincent and the Grenadines
National Insurance Scheme Conference Facility
January 26-27, 2012
1) **Introduction & Background:**

The Government of Saint Vincent and the Grenadines and the Ministry of Transportation and Works hosted the Eastern Caribbean Climate Resilient Infrastructure (CRI) Workshop to tackle the challenge of integrating climate considerations into future public works engineering designs. The goal is to improve the resilience of key infrastructure by integrating future climate and natural hazards impacts in the design and engineering process. This CRI workshop was designed to support and foster regional collaboration aimed at improving infrastructure engineering designs, standards and technologies in order to advance climate adaptation member countries of the Organization of Eastern Caribbean States (OECS). The workshop was broadly attended and included national ministry focal points, development partners, private enterprises, regional experts and international practitioners.

Current global climate modeling assessments suggest that changing climate-related weather patterns pose exogenous threats to Eastern Caribbean countries. These countries (Small island Developing States, SIDS) are regularly exposed to the impact of natural events, such as hurricanes, rain, and drought, which often result in significant damaging effects to national and local economies. Every sector is affected, including commerce, tourism, fishing, and agriculture and, it is clear that both the government and private sector need to integrate climate impact analyses into physical planning process, in order to improve the resilience of infrastructure investments in the Eastern Caribbean.

To develop climate adaptation strategies in the Eastern Caribbean, four countries including Dominica, Grenada, Saint Lucia (SLU), and Saint Vincent and the Grenadines (SVG) have been selected to participate in the Caribbean region.

**Pilot Program for Climate Resilience** (PPCR). This program aims to pilot and demonstrate ways in which climate risk and resilience may be integrated into core development planning in the Caribbean. Additionally, in Dominica, Grenada, Saint Lucia and SVG, the **Regional Disaster Vulnerability Reduction Program** (RDVRP) is leveraging PPCR and World Bank financing to support regional collaboration to improve disaster risk management (DRM) by sharing risk analyses, technologies, data improvements, and investments strategies. Thus, it is critical that Eastern Caribbean national governments and regional agencies exchange knowledge and data related to local engineering conditions and infrastructure designs.

**Workshop Objectives:**
- Discuss engineering design challenges related to infrastructure in SIDS the Caribbean.
- Improve access to data, models and practical new technologies to support improved construction designs
- Increase the capacity of engineers and policymakers to strengthen the design, construction standards and methods to build climate resilient infrastructure in SIDS in the Caribbean.
- Support the creation of a technical engineering community to share information and international best-practice to provide inputs for regional development of standards, codes, models, etc.

**Expected Outputs:**
- Increased understanding of national, regional and international engineering design standards, building codes and technologies;
- Establish a formal working group of the regional engineers from among the conference participants;
- Establish next steps and activities for participants to foster knowledge exchange related to infrastructure through a formal regional association.

**Expected Outcomes:**
- Improved understanding of building codes, design standards and policy recommendations;

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1 Formed in 1981, the Organization of Eastern Caribbean States (OECS) is an inter-governmental organization dedicated to economic harmonization and integration, protection of human and legal rights, and the encouragement of good governance between countries and dependencies in the Eastern Caribbean. The seven member states are Antigua and Barbuda, Dominica, Grenada, Montserrat, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines.

2 The PPCR is financed by the Climate Investment Fund [http://www.climateinvestmentfunds.org/cif/ppcr](http://www.climateinvestmentfunds.org/cif/ppcr).

3 It is expected that Dominica and Saint Lucia will also become part of the RDVRP in 2012.
• Strengthened designs, TORs and standards for long-term durability of regional infrastructure investments that prevent and mitigate climate-related disasters in the Eastern Caribbean;
• Improved access to international codes, models, technologies related to and climate resilient infrastructure;
• Improved methods applied to plan infrastructure investments made through the PPCR/RDVRP.

Participation:
Government representatives came from various ministries and faculties, namely ministries of works, transport, finance, physical planning, public utilities, and ports. A complete participant list is included in Annex 2. The participant profile was:
• Ministry of Works engineers (Chief technical officers) or engineering staff;
• National procurement specialists or project coordinators responsible for construction contracts and their supervision.

A total of 64 persons participated in the workshop, including government representatives from ten countries and territories in the Caribbean, including Antigua & Barbuda, Barbados, Belize, British Virgin Islands, Dominica, Grenada, Haiti, Jamaica, Saint Kitts & Nevis, Saint Lucia, Saint Vincent and the Grenadines (SVG), as well as ten regional and international development partners: the Caribbean Development Bank (CDB), Consulting Engineers Partnership Ltd., FM Global, Organization of Eastern Caribbean States (OECS), Smith Warner International, The Nature Conservancy (TNC), University of Bristol, U.S. Army Corps of Engineers (USACE), U.S. Agency for International Development (USAID), and the World Bank.

2) Summary of Key Recommendations
& Next Steps

There was unanimous agreement to form a regional technical association that would develop a long-term plan to address specific challenges in the OECS. Noteworthy issues include: addressing the lack of capacity and human resources, the need for education and training, development of uniform building codes, strengthened legislation, and improved enforcement mechanisms and design standards. Participants from across the region provided ideas and committed national support to create a regional association whose goal would be to improve technical capacity, share human resources and exchange lessons learned. Comments during the forum are consolidated in Annex 1, section 13. Key discussion points and activities are included in the following observations:

• There is a need for continuing education and technical training to improve understanding of engineering issues, which could be advanced by engaging the University of West Indies (UWI) to build curriculums to increase awareness among students and contractors;
• An Eastern Caribbean engineering association could work as a line of communication between countries so that experiences, information, and technical knowledge can be shared across the region; the target audience would be engineers from various line ministries, particularly ministries of works and transportation;
• Seek to utilize expertise from the other national ministries to share competence as a region and to develop a pool of engineering practitioners and experts as part of an independent engineering association;
• Need to consolidate national associations of professional engineers, and receive the necessary funding and facilitation;
• Consider creation of Regional Centers of Excellence for key activities such as geotechnical engineering, watershed management, coastal zone engineering;
• Chief technical officers from Grenada (Cecil Harris) and SVG (Brent Bailey) will initiate contact with national and regional technical associations;
• U.S. Army Corps of Engineers (USACE) is a key partner in the Eastern Caribbean and can provide resources, technical training, and project support;
• Efforts to be made to harmonize national physical regulatory codes, standards and registration requirements in an attempt to streamline planning, design and construction practices in the Eastern Caribbean.

3) Opening Ceremony

Keynote Address was provided by Honorable Senator Julian Francis, Minister of Transport, Works, Urban Development and Local Government (MTW) Saint Vincent and the Grenadines (SVG). He stressed the urgent need to develop regional
mechanisms and national strategies to confront climate change and risks related to natural hazards, particular with respect to building designs and engineering solutions. In SVG there is a lot of need for developing a better mechanism to use available local data and collect new data to increase the quality of designs. This also requires that terms of reference specify specific studies and data requirements to be included in national works and infrastructure projects throughout the region.

Opening Remarks were made by Gerald Meier, Disaster Risk Management Specialist from the Latin America and the Caribbean Region of the World Bank. He expressed the importance that engineering-quality data at the local level be integrated into the engineering design process, including identifying data gaps and measures to obtain such data. He noted benefits of relatively recently available and robust modeling techniques for improving engineering designs, and cited the availability of international resources that are available to the region. He also emphasized the need for improving data collection, use of data in decision-making, and building codes in order to secure better engineering practices in the region to instill more climate resilience.

Technical sessions were led by speakers from various regional agencies and international practitioners. The complete agenda can be found in Annex 1.

4) Island Case Study: SVG Langley Park
Brent Bailey, Chief Engineer, Ministry of Transport and Works, SVG

Mr. Bailey provided an in-depth overview for the infrastructure design processes for each phase of implementation, including site assessment, data collection, hydrologic and hydraulic studies, soil analyses, as well as procurement considerations, construction, and supervision. He shared that many investments are planned under the current PPCR/RDVRP and he reviewed the concepts of project cycle management detailing the four project phases including initiating, design, construction (and procurement), and close-out. He illustrated two recent hydrological and meteorological events that took place in SVG, namely a flash flood in Marriaqua and Hurricane Thomas (both in October 2010), which exposed the vulnerabilities of key infrastructure that negatively impacted surrounding communities and populations.

Mr. Bailey recommended the need to integrate these knowledge areas of engineering: scope, time, cost, quality, procurement, risk analysis, human resource, and communication. The foremost challenges include forecasting meteorological hazards and measuring the infrastructure life cycle against event return-period, which presently suffers from significant data gaps, such as limited access to time-series data. He also noted that there is currently insufficient human capacity in the project management unit to support the entire project cycle. Additional discussion points noted by participants are presented in the summary below.

Discussion Summary

- During the construction phase, environmental safeguards, monitoring and supervision are considered and are included in the contract specifications; however the contract itself does not stipulate the penalty in cases of violating environmental regulation and safeguards.
- There are consistent challenges with contractors in the project management, including lack of reporting and monitoring mechanisms, lack of communication, and difficulty in completing paperwork (e.g. bidding documents).
- Emergency financing should be obtained in the shortest time possible by appealing to agencies to finance emergency recovery projects; we must be able to shorten the timeframe between the event and the start-up and implementation of necessary works. Current processes before implementation and before actual construction are too lengthy and cumbersome.
- Suggested to have specialized and experienced unit in the region to conduct a rapid appointment of a “special team” that can provide damage assessment surge support following a disaster and to provide technical support to initiate and supervise the recovery process.
- One solution to increase efficiency is having terms of reference (TORs) and contracts that are ready to be processed immediately after an emergency.
- Fast implementation is not always the best; the works need to be done correctly, it is critical to
invest in infrastructure that is more resilient while always aspiring to improve the quality of core infrastructure in a long-term perspective.

- While damage assessment may be done quickly, implementation is the main challenge, partly due to difficulty with procurement standards.

5) Building Codes, Standards and Best Practices

Christopher Westbrook, P.E. Structural Engineer
U.S. Army Corps of Engineers (USACE)

Mr. Westbrook, P.E. presented sea level change scenarios used by the USACE and their approach to seal level change (SLC). His presentation included an overview of the USACE design and construction criteria, including use of customized building codes, drawing standards, guide specifications, and construction quality processes. He gave a review of building codes, standards and best practices that are applicable to island environments with special focus on survivability of infrastructure for bridges and public buildings. Mr. Westbrook facilitated discussions using different examples of how to integrate design codes and standards into the total engineering process: i.) design, ii.) implementation, and iii.) supervision. He used a case study of the Hotel Montana in Haiti, in which he showed the devastating effects of the earthquake and gave explanations for the collapse of the building that included poor concrete quality, inadequate and poorly detailed reinforcing, and apparent lack of code-based analysis when new floors were added to the original structure.

One of the main discussion points relayed to the audience was the increase of SLC (see graph below), which he explained different scenarios. He also included in his presentation a strategic, multi-tiered decision-making process for assessing the potential impacts of SLC on various project alternatives.

His full presentation, USACE Approach to SLC, Design & Construction Criteria and Quality Processes4 provides many useful links and resources that he mentioned are offered for public use. These

are located in the full presentation that is located on the workshop webpage. He also provided a information about the Haiti Toolkit Web Portal, which was highlighted as a useful set of guidelines and resources that can be obtain by contacting the Nation Institute of Building Sciences (NIBS). His final recommendation to the audience was to create a long-term building strategy, which he suggested could be facilitated by adopting/adapting design and construction criteria and quality practices maintained by National Institute for Building Sciences (NIBS) available on their Whole Building Design Guide website: http://www.wbdg.org/. Mr. Westbrook also provided technical information and documents offered by the USACE that are all publicly available on their website, that he suggested could be adopted or used as guidelines for the Eastern Caribbean.

**Highlighted USACE Building Resources**

- HQUSACE Publication Site: http://140.194.76.129/publications/
- Engineering and R&D Center: http://www.erdc.usace.army.mil/
- Whole building design guide: www.wbdg.org/
- Other resources mentioned in the full presentation are building design documents, which are large PDF files that can be obtained by email ( blyon@worldbank.org / christopher.h.westbrook@usace.army.mil)

**Discussion Summary**

- Hospitals should be fully functional immediately after earthquake and should use appropriate design calculations to comply with standards and building codes.
- Independent reviews of USACE designs are conducted by the same office, but not by the same persons responsible for the design. For larger projects the review is conducted by an outside office within the USACE, and in some particular projects, the external review is completed from someone outside the agency.
- For coastal protection works it is important to keep records of calculations to document the design process; particularly if you are rebuilding or retrofitting, you need to know what has been done before in order to know how to proceed.
- Design calculations and projected scenarios should use standard methodologies that are drawn from international documents and studies.

**6) Engineering Project Cycle Management & TQM – Subhash Seth, Infrastructure Engineer, Latin American & the Caribbean, World Bank**

Mr. Seth connected virtually from his home country of India to give a web-based presentation, in which he provided a detailed review of infrastructure implementation, operations, and engineering project cycle management, specifically total management quality (TQM).

Mr. Seth discussed the guiding principles of construction design, which are: economic efficiency, cost effectiveness, all eligible bidders should be given opportunity to compete, and local participation should be encouraged. During his presentation, he explained the World Bank procurement process for works, goods and consulting services, including how to carry out a transparent procurement process for the selection of consultants and contractors in accordance with the World Bank Procurement Guidelines. He reviewed each of the different types of works activities, namely new construction, rehabilitation, upgrading, retrofitting, routine maintenance, periodic maintenance, major repairs, minor repairs relating to civil works for roads and building; and he emphasized the need for planning.

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5. www.worldbank/lcrdm/criworkhop  
7. Ryan Colker (rcolker@nibs.org) please contact him for further information, and/or request information online http://www.nibs.org/index.php/newsevents/haititoolkit/portalaccessrequest/  
design construction, and supervision using the principles of TQM⁹.

**TQM Principles**

- Customer-focused
- Total employee involvement
- Process centered
- Integrated system
- Strategic and systematic approach
- Continual improvement
- Fact-based decision making
- Communications

**Discussion Summary**

- It is critical to recognize the need for following and enforcing appropriate design standards and technical specifications for the safety of all types of infrastructure works.
- Monitoring and evaluation should be part of the project design, and through discussions, it should be agreed upon by all stakeholders. For example, after completion of a new road project, the travel time could be decreased through the increase in design speed from 30 km/hr to 80 km/hr.
- Construction parameters and indicators should be included in the designs, and all stakeholders should discuss all viable options and their potential consequences.
- After construction is completed, a project evaluation report should measure the results vis-à-vis the expected outcomes in the achievement of its planned objectives (e.g. economic indicators, social indicators, and long-term benefits).
- Due to lack of experience, it is often difficult for the local firms to meet the required qualification criteria in order to win contracts for public works, therefore the local firms should form associations with the international firms to gain the experience and build their capacity. The local firms will be able to compete for contracts if they can grow to meet the qualification criteria.
- According to WB procurement procedures there are two methods for the procurement of civil works: (a) National competitive bidding (NCB); and International competitive bidding (ICB). The threshold for ICB in terms of the value of contract depends upon the capacity of local contractors and the local procurement procedures in a country and it is agreed between the government and the World Bank during the procurement planning process.
- To further build capacity of local contractors it is recommended to build an association with international contractors in order to gain years of experience and improve technical expertise. If for example, a local contractor could gain experience implementing a project with an international contractor, the project amount can be raised to >2 mil$ USD, and so forth, until 5 mil$ USD.

7) **PCU Expectation for line Ministries – Janelle Quow, Engineer, Central Planning Division, Ministry of Finance & Economic planning, SVG**

Ms. Quow detailed the procurement process from the perspective of the project coordination unit (PCU) in which she addressed the role of line ministries in supporting the entire procurement cycle. This included details for international bidding processes (ICB), expressions of interest (EOIs), feasibility studies, etc. Simply said, procurement functions are to find the right product, right quantity, right quality, and right price at the right time. She added the importance of stakeholder (client agency) participation, particularly ministries of works, and the need to collaborate together throughout all processes, including pre-tender and tendering activities, evaluations and contract awarding, supervision and procurement planning.
During the bidding process and procurement, timing is crucial and often the contractor does not have control of time, because arrival time (waiting period) turns out to be longer estimations and delays deliveries.

Managing time is important, but due to location and the limited availability of supplies in OECS countries, it is not always possible for the contractor to control, and therefore deliveries and arrival times are not always reliable, which can add to the overall project costs.

During the planning phase it is important to spend as much time as possible to create as tight and reliable a schedule as possible. If the supplier indicates three months, then you should try to add as much time as possible to ensure that the delay is minimal with consideration to the “worst case scenario” basis.

One recurrent observation that delays implementation is that in many cases contractors are placing orders too late.

It is important that local contractors benefit from the projects being implemented, though many small contractors in the OECS are not commercial entities. As a best practice, works contracts should not be signed with individuals as the contractor, but with registered companies even if the companies are sole proprietorships.

CUBiC aimed to create earthquake-resistant and wind loading standards, among others, for the Commonwealth Caribbean that could be adopted nationally. CUBiC contains five sections:

1. Administration & Enforcement of CUBiC
2. Structural Design Requirements
3. Occupancy, Fire Safety & Public Health Requirements
4. Services, Equipment and Systems.
5. Small Buildings

He discussed the evolution and adoption of CUBiC with examples from across the region and challenges of legislature, regulations, and enforcement of building standards in the Caribbean. He also addressed the potential effects and damage caused by various scenarios of wind loads due to climate change and the need to enhance the resiliency of structural designs in the Caribbean.

Discussion Points

- Caribbean is a multi-hazard area and is required to create disaster risk management strategies.
- The traditional design philosophy is to protect lives rather than property. This is not good enough for facilities, such as referral hospitals, which must operate to optimum efficiency immediately following severe events.
- The example of the 1967 earthquake in Caracas, Venezuela illustrates the need to pay special attention to geological and geotechnical conditions.
- One answer to why are there different averaging [return] periods for wind loading in various countries, is that wind spectrum can be more important than wind speed; some require longer periods of measurement and data collection than others. International Organization for Standardization (ISO) and Canada are sampling wind speed over longer periods (10 minutes and 1 hour respectively) than some others (eg. USA, Australia).
- The CUBiC countries and their current status (see Annex 3) are Barbados, Belize, and nine

8) Building Codes, CUBiC & Wind Loading in SLU – Tony Gibbs, Civil Engineer, Consulting Engineers Partnership Ltd.

Mr. Gibbs provided an overview of building codes in the Caribbean, including the history of the Council of Caribbean Engineering Organizations (CCEO)\textsuperscript{10}, which helped to initiate the development of the Caribbean Uniform Building Code (CUBiC)\textsuperscript{11}.

\textsuperscript{10} 1991, the Council of Caribbean Engineering Organizations (CCEO) conducted a review of CUBiC and agreed in recommending a regional effort to update and maintain CUBiC, including the completion of the sections outstanding or being reviewed.

http://198.246.230.18/titanweb/cdb/webcms.nsf/AllDoc/E36EB1A9B0D37C0425743500729103?OpenDocument

\textsuperscript{11} The conception of CUBiC was conceived in 1979 during the Caribbean Disaster Preparedness Conference in St. Lucia. In 1982, CDB approved a Grant of USD$60,000 to CARICOM for part-financing the cost of the development of the CUBiC.
Mr. Smith provided an overview of water resource engineering modeling applications of hydrologic and hydraulic models, including their engineering applications and data requirements. In addition to a host of other modeling platforms specifically related to hydrological, hydraulic, and hydrodynamic coastal processes, Mr. Smith offered a more common code application for use within the region to be the suite of software developed through the Hydrologic Engineering Center (HEC) in Davis, California. This particular suite of software has direct application relevance to the region in terms of rainfall/runoff response and hydraulic performance and design criteria for critical infrastructure. In discussing hydrology and weather patterns of small islands, he provided an explanation and diagram (see image 3) of the orographic effect, and its specific characteristics that uniquely affects islands.

### Characteristics of Orographic Effects on Rainfall

1. Topography of foothills/mountains causing air mass to rise, drop in temperature, exceed dew point, and precipitate
2. Orographic effects are significant on most Caribbean islands – with prevailing moist, easterly winds and central mountain ridges
3. Maximum rainfall tends to occur on windward (north and east) side and near mountain peaks
4. Rainfall is lower on the landward (south and east) side of the mountains due to rain shadow effect

He emphasized that data is the key for engineering modeling as the “output is only as good as what you put in!” In discussing water resources, he noted the most important aspects are quantity, quality, timing, and distribution. He also identified core modeling applications and public resources that used by USACE and are available for download.
10) Panel Discussion: Building Codes, Standards, and Forecasting Returns – Brent Bailey, Tony Gibbs, Christopher Westbrook, Sean Smith
Moderator: Gerald Meier

The moderator, Gerald Meier provided a review of day one, including potential regional applications of building standards, codes and modeling to improve infrastructure design. The panel discussion began with these two main questions below and allowed for further discussion points.

**What can we do to improve the survivability of infrastructure, integrating a long-term perspective?**

**How can we integrate the tools and ideas we’ve discussed here, in today’s building for the future?**

**Discussion Points**

- Given that climate change is a reality, we need to adapt our building codes to climate change effects, including wind speed, precipitation, and sea level rise. Currently CUBiC only addresses wind without the effects of climate change; there is one study funded by WB addressing the effects on wind speeds for structural designs. Sea level rise is not an issue for building codes; it is an issue for planning.

- Civil engineers have the capacity needed, but we have challenges with human resources. Under the RDVRP/ERL in SVG, there is not enough staffing to take care of all of the projects. The management team, with the assistance from the PCU, will be hiring new persons.

- A well-designed roof system for a strong hurricane depends on shape of the roof, topography, height of the roof, and structural manners of the roof. There are too many variables to say that if you have a certain wind speed, then you can use this type of roof system; the multiple variables make it more complicated. It is difficult to draw the line between design codes and budget, because some specifications are too expensive to move forward. Doing a cost-benefit analysis is a good starting point, but a key building philosophy is “pay more now, or pay it later”; in cases of schools that are also shelters and have multipurpose use, it is important that you have met specifications so that the shelter functions in case of disaster. “The most expensive building is the one that fails”.

- We don’t have the capacity to do cost-benefit analyses, etc.

- An example of a subduction zone is in Chile where the tectonic plate is moving approximately 60 mm a year, which is an indication to how frequent earthquakes will happen.

- The importance of applying of building codes is usually ranked by hospitals, water infrastructure, communication, etc.

- With regards to codes, laws and enforcement (Annex 3), it is difficult to know what to do on technical level and on a policy level, to improve the regulatory system.

- Suggestion to have all infrastructure projects insured; look at example of Guadeloupe or Martinique where they have a simple design control system that involves no taxpayer money; it is required by insurers and is effective.

- One key reason why building codes have not been adopted in the Eastern Caribbean is due to politics and lack of political will to enact the legislation; lack of human resources prevents the use of codes, as well as cost, but lack of political will is a big reason; there are electrical codes in the Eastern Caribbean, but we don’t have

“What matters is what we build, where we build it, and how we build it; climate change, per se, is not the ultimate problem.”

– Malcom Anderson, MoSSaiC
enough human resources for effective enforcement of all aspects of buildings.

- Codes for roads/bridges do exist and utilized for construction planning and supervision, such as testing cement standards and so forth; in the British Virgin Islands (BVI), there is no one on island with this capacity, so we need to bring in personnel from abroad.
- As we don’t often have human capacity to follow-up after construction, so we have to trust that the job has been done well in regards to standards.
- Electrical and mechanical supervision is expensive. It comes back to political will – they might pass laws, but enforcement human resources are still lacking.
- Suggestion to create a “resource-sharing program” between OECS, that could include capacity-sharing, similar to a center of excellence; For example, create a specific center of excellence for buildings, or create an expert group that goes from island to island; In SVG they do this between ministries. This would enable all the islands to assist one another and lessen any one island bearing the burden of cost for maintaining a full-service grouping of personnel.
- Create a group to develop regional uniform building codes for the OECS to avoid recreating the wheel.
- There are changes to the seismic maps for the Eastern Caribbean; there is ongoing research, including an active program being conducted by the Seismic Research Center (SRC) in Trinidad and Tobago. In 2010, EU Centre for Training and Research in Earthquake Engineering (EUCENTRE) and SRC published the most comprehensive study ever carried out for the sub region. Research is leading to adjustment of those lines in French islands, Jamaica, Cuba, and Dominican Republic. Barbados is rising, not as rapidly as sea-level rise.
- The USACE has resources for green building programs, and can provide contact persons.
- Considering residential construction built on sand dunes, you may consider filling in walls or do cross-bracing. Others suggest that buildings should never be built on sand dunes.
- There were eight countries originally committed to implementing CUBiC, but they did not follow through; “We have so much information already, why should we use much money on getting new building codes, when nobody is using them?”.
- We need tools, information and data; standards by themselves cannot standalone. There has to be legislation, and professional engineers association where these tools are being enforced.
- Building codes need to be tied to legislation.
- The World Bank is in the process of making a debt restructuring, Development Policy Loan (DPL), which means that governments will have to focus on certain legislative aspects such as climate resilience, disaster risk management and legislation. Top-down doesn’t work; bottom-up doesn’t work; it has to be a combination.
- Many of our technicians study abroad in different areas, and learn different codes, and therefore it is difficult to streamline a common code within/for the OECS. Engineers need to be informed and up to date on new codes.

**Climate Change and Engineering Perspectives**

*Cecil Harris, Chief Technical Officer, Ministry of Works, Grenada*

Mr. Harris provided a vivid presentation on geo-engineering, design considerations and policy matters, referencing studies and policies by overseas engineering associations. He addressed climate change mitigation, adaption, and geo-engineering alternatives, such as artificial trees, algae, cool-roof technology, space-based Mirrors, cloud-seeding ships.

He provided the results of a report specific to the region as reported by collaboration between the Caribbean Community Climate Change Center (CCCCC) and UNDP that states that “even though CARICOM contributes less than 1% of GHG emissions, these countries are expected to be among
the earliest and most impacted by climate change in the coming decades.” This fact has significant policy implications with regards to developmental priorities of small island states in the OECS. The impacts of sea level rise and storm surge on the region were discussed along with the adaptations required in the sectors of energy, transportation, communication and water.

Mr. Harris concluded that with the onset of climate change, adaptation in each sector is necessary and new technologies need to be explored, which in itself presents new opportunities for innovation. This will require education and training to be versatile, as well as to be able to create a new mindset among engineers to compete with changing and increasingly unknown challenges. Other constraints are a centralized infrastructure system (while more economical, it is less resilient because of the lack of redundancy), and a regulatory environment across different government departments, which have not yet specifically addressed climate change issues. Geoengineering is developing new solutions to help create sustainable adaptation strategies. Some of the barriers to adaptation are finance and the consequences on the environment and mankind of large-scale failure.

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down roof mounted equipment\textsuperscript{21}. Hurricane Andrew was an eye-opener for many, especially seeing the results of FM Global’s risk mitigation measures that prevented serious damage to a clients’ building, compared to a neighboring building that suffered millions of dollars in losses.

Standards are important, but it is also important to build accordingly and to follow up and perform necessary maintenance. Mr. Anderson reviewed online resources and datasheets for FM Global Guidelines\textsuperscript{22} that are available to the general public. He drove home the message: “Being vulnerable is a choice. Why settle for being vulnerable? – it will happen.” With the onset of increasing climate change and variability, Mr. Anderson noted that as our vulnerability increases, our margin for error needs to decrease.

\textbf{Discussion Points}

- A \textit{Seismic Gas Shutoff Valve}\textsuperscript{23} (see image below) is an important device used to address the seismic hazard of fire following earthquake; it is triggered before piping would break in a building that otherwise meets seismic design standards.
- The seismic gas shut-off valve can dramatically change the outcome of an earthquake event; from a fire following standpoint; an ideal opportunity where this standard could be introduced into building standards is for all hospitals throughout the OECS.
- We understand that many engineering aspects are driven by having information, standards and so on, but in Caribbean there is not a lot of data and information available so it’s difficult to address standards.
- Suggest having engineers and researchers on our teams, and the use of satellite data to create our own data.

\begin{itemize}
  \item Given FM Global’s workforce of engineers, it is assumed you have regular maintenance and schedules for visits to client locations. How do you decide where and when to visit and what to focus on (based on risk?), and how do you handle non-compliance?
  \end{itemize}

\begin{quote}
\textbf{“Being vulnerable is a choice. Why settle for being vulnerable? – it will happen.”}

– Denis Anderson, FM Global
\end{quote}

\begin{itemize}
  \item FM global uses engineers and schedules based on the significance of the hazard, and is also depends on risk and type of building, size of facility and ultimately the business risk to the client.
  \item Regarding non-compliance, FM Global judges the risk quality of all inspected locations along with planned improvements, which then impact the insurance terms and conditions. FM Global only insures companies that are philosophically aligned and motivated to reduce vulnerability and comply with the guidance and advice.
\end{itemize}

\textbf{12) Coastal Zone Infrastructure – David Smith, Coastal Engineer, Smith Warner International Ltd.}

Mr. Smith led a discussion of engineering considerations and tools for climate resilient, coastal zone management. He addressed various coastal hazards, including sea-level rise, storm surge, erosion, and degradation. He explained that the most important focus area is data collection, particularly bathymetric data – chart, LIDAR or boat based. Additionally, he emphasized the need for topographic data, shoreline profile data, waterline position data, and location of buildings within coastal strip (+10 meter of elevation), characteristics of building stocks, demographic profile of coastal zone, offshore/nearshore wave climates, and hurricane history.
Data coordination should be prioritized and have a dedicated person to coordinate and manage data repository. Also, in order to indicate long-term trends, coastal zone monitoring should be a consistent activity. Currently, there is limited to no monitoring in the Eastern Caribbean, though he noted that Barbados has been monitoring beaches since 1984 and has good data available.

Dr. Smith presented a case study of Jamaica Palisadoes Sea Defences, which detailed the engineering that went into the design of sea defense works for a critical roadway. The roadway in question connects the city of Kingston to the international airport and to the old historic community of Port Royal.

13) Slope Stabilization Modeling in the Island Tropics – Malcolm Anderson, Co-founder of MoSSaiC; Professor of School of Geography and the Environment, University of Bristol

Professor Anderson connected remotely to present from Jamaica, where he was currently working on a community-based slope-stabilization intervention using a methodology called MoSSaiC\(^{24}\) (Management of Slope Stability in Communities). He provided examples of landslip analysis modeling, data collection requirements, and slope stabilization techniques. He detailed those data requirements for slope engineering designs, and also discussed landslide risk analysis as an interdisciplinary problem, which is required to understand slope stability. As houses are built on slopes, the problems worsen. “What matters is what we build, where we build it, and how we build it; climate change, per se, is not the ultimate problem.” The MoSSaiC methodology is outlined in the book *Community-Based Landslide Risk Reduction - Managing Disasters in Small Steps*, authored by Malcolm Anderson and Liz Holcombe, and was published by the World Bank in January 2013.


Participants and speakers had an opportunity to discuss and brainstorm ideas to improve the engineering environment in the Eastern Caribbean. Members of the panel included Cecil Harris, Dennis Anderson, David Smith, and Chris Westbrook.

One commentator stated that we build, but we do not put resilience sufficiently into consideration. Often, the contractors are not aware of these [climate] conditions and need continuing training and awareness building. The need was discussed to engage these issues with University of West Indies (UWI), in order to build awareness among students and contractors. It was noted that we also need to build the capacities of local contractors, so that they can build better, more resilient, which hopefully also can allow them to contribute, to a greater extent, in international projects such as those current projects under the World Bank.

Regional Technical Engineering Association

Mr. Meier presented one of the main considerations of the workshop was to develop an association that could work as a line of communication where experiences, information, and knowledge can be shared across the Caribbean. The target audience would be engineers from various ministries, namely ministries of works. All countries in the OECS experience the same problems and challenges, such as coastal erosion, landslips, water problems, etc., and the World Bank has the resources that potentially could support such a group, under our current programs. It could a means to pool information and improve regional sharing to improve capacity and competence. Ideas could include sharing TORs for similar projects, sharing experiences and lessons learned, discussing contractual issues and ways to build resilience into the construction of infrastructure.

\(^{24}\) http://www.mossaic.org/
The World Bank might be able to contribute with training, lectures, bringing in speakers, assembling us together as a group, and bring in relevant specialists. Formalizing such events for the entire region would be best, and we have the capacity to help out in several ways to move towards a more climate resilient infrastructure development path.

He suggested that this regional group would need to be driven, owned and developed by national practitioners and experts of the region. However the World Bank could provide help to initiate the process. USACE has similar practices and technical associations with lists of centers of excellence, which may allow the Caribbean to receive and provide training, instead of going outside the region.

**Discussion Points**

As discussion followed, participants offered the following:

- The technical association is a very interesting idea to utilize the expertise of the ministries and share competence. As a region, we could develop a pool of experts, similar to a “ministries-of-works-pool”, or an independent association.

- I think this is an excellent idea and would benefit from help of the WB Disaster Risk Management (DRM) team. I would propose for the World Bank to establish a grant to create this group in order to create a regional capacity that all countries of OECS could tap into whenever necessary. This would not be just something within the existing projects, but that the World Bank could take this opportunity to create a new grant that can help create an association of the mentioned kind, where we could create these centers of excellence throughout the region.

- This should absolutely be a regional association, where we could share and gain knowledge and develop centers of excellence together.

- There is the Council of Caribbean Engineering Organizations (CCEO) with national affiliates throughout the region since 1969, but the only active national associations in the OECS are in Grenada, Saint Lucia and Dominica. It is difficult to keep them alive, but the suggested initiative would be an opportunity to revive a regional association for professional engineers in OECS. If the World Bank could help to consolidate an association of professional engineers, and provide the necessary funding and facilitation, this could lead to a renewal of an important entity in the region. This would be extraordinary, and especially if you could help strengthening associations that are already existing, specifically in the OECS, that would be a step forward.

- Consideration for a geotechnical center of excellence for the OECS? Perhaps this could provide training for other countries, which is what some other countries do; additionally, we may want to consider a center of excellence for watershed management and coastal zone management.

- To formalize this group it is necessary to have some people to sign up, get involved, and work on ways to improve regional communication. If

“In my opinion, a [technical association] gives us the opportunity to resolve challenging issues; as to the fact that we are using a whole slew of codes, but there is no common practice throughout the region. We need an enforcing authority to follow up. This might give us an opportunity to enforce unified codes.”

– Workshop participant
this is established, and initiatives come from this association, the World Bank has the capacity to provide assistance as it is already involved in the region through current programs.

- Mr. Harris from Grenada stated that Chief Engineers and Chief Technical Officers (CTOs) should initially be the people involved from each country; this would help us get to the level where we can use the same codes and standards throughout the region. “I support the idea, and when I get back to Grenada, I will follow up and present this to fellows in Grenada to try to move this forward.”
- A representative from Dominica shared that he is very supportive; at least on the level of communication and sharing information, we are onboard. Mr. Lewis mentioned that he is not the Chief Technical Officer (CTO), but based on interests of Dominica’s CTO, he believes Dominica will be supportive.
- This association could bring education, further training, communication, and motivation to the region. One way to achieve this is to have a consolidation with the already existing associations in the region.
- This workshop in itself is a great start to a regional association, as we will have the contact information of everybody; and if I have any problems later, I know that I can contact other participants of this workshop.
- There is a lot of information through the USACE as well that could support regional engineering activities, codes, etc.
- Suggestion to start with a group email with all the CTO/Chief Engineers and later get together and sit down to decide who of their engineers they want to include later on.
- This is a regional initiative and thusly will have to be driven forward by CTOs in the region.
- It is important that all ideas are articulated to formulate proposals to gain support from other agencies; also to agree on how you would want to communicate amongst yourselves moving forward.

- The CTOs from Grenada and SVG, Brent Bailey and Cecil Harries respectively, were appointed as the main point of contacts for this initiative; Mr. Harris will lead this idea by contacting the current association in Grenada and discuss within his ministry.

15) Conclusion

The Eastern Caribbean states are among some of the most vulnerable areas in the world and susceptible to increasing climate variability and natural hazards. The risk of disaster in the region is the result of a substantially built environment and public infrastructure that is highly exposed to these hazards, and is compounded by engineering designs that have not adequately incorporated key data inputs to improve climate resilience. Engineering quality data is not effectively employed in the designs and there are no common standards and building codes to enforce. Even where there are building codes, enforcement is lacking due to human and financial resource constraints. The recognition of these challenges, by key government representatives, acknowledge the need for more focused regional collaboration to tackle these challenges by sharing experience, information, technical expertise and human resources, and knowledge. As a result of this forum, there is a concerted decision to establish regional technical association to address these issues by developing a long-term plan for the OECS.
### ANNEX 1:
### Workshop Agenda

#### DAY 1: Building the Foundation

<table>
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<th>TIME</th>
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| 08:30 – 09:15 | **Opening Ceremony:**  
  - Prayer, national anthem, vote of thanks  
  **Keynote Address:** “Climate Change & Planning for the Future”  
  **Keynote:** Honorable Senator Julian Francis, Minister of Transport and Works, SVG  
  - Future climate change scenarios and economic planning, public works, and the integration of line ministries in Saint Vincent and the Grenadines (SVG).  
  **Opening Remarks:**  
  **Facilitator:** Gerald Meier, Project Specialist, World Bank  
  - Workshop expectations, objectives, agenda review, introductions.                                                                                                                                                                                                                             |
| 09:15 – 10:00 | **Island case-study: Saint Vincent & the Grenadines (SVG) – Langley Park**  
  **Presenter:** Brent Bailey, Chief Engineer, Ministry of Transportation & Works, SVG  
  - An SVG perspective on the infrastructure design process, including a case-study on Langley Park and data gaps;  
  - A discussion of challenges in forecasting meteorological hazards, and the infrastructure return-period;  
  - An overview of planned works under the PPCR/RDVRP.                                                                                                                                                                                                                                                                 |
| 10:00 – 10:45 | **Overview of Building Codes, Standards and Best Practices**  
  **Presenter:** Christopher Westbrook, P.E. Structural Engineer, Bridge Safety Program Manager, US Army Corps of Engineers (USACE)  
  - Overview of USACE, design criteria, drawing specifications, construction quality;  
  - Review of codes, standards and best practices applicable to island environments, with emphasis on survivability and infrastructure (bridges and buildings);  
  - Discussion of examples of integrating design codes and standards into the total engineering process, including design, implementation, supervision, examples.                                                                                                                                 |
| 10:45 – 11:00 | **AM BREAK**                                                                                                                                                                                                                                                                                                                                 |
| 11:00 – 11:45 | **Building Codes & CUBiC & Wind Loading in St. Lucia**  
  **Presenter:** Tony Gibbs, Civil Engineer, Caribbean Uniform Building Code  
  - Overview of building codes, history of CUBiC and national adoption in the Eastern Caribbean;  
  - Development of earthquake-resistant standards (hazards and engineering) in the Commonwealth Caribbean;  
  - Development of wind loading standards (hazards and engineering) in the Commonwealth Caribbean;  
  - Laws, regulations and enforcement of building standards in the Commonwealth Caribbean;  
  - Effect of climate change on wind loads for structural design in the E. Caribbean.                                                                                                                                                                                                                           |
| 12:00 – 13:00 | **LUNCH**                                                                                                                                                                                                                                                                                                                                 |
| 13:00 – 13:45 | **Engineering Project Cycle Management and TQM**  
  **Presenter:** Subhash Seth, Infrastructure Engineer Consultant, The World Bank
13:45 – 14:15

**PCU Expectation for Line Ministries**
*Speaker: Janelle Quow, Engineer, Central Planning Division, Ministry of Finance & Economic Planning, Saint Vincent & the Grenadines*
- Detailed review of infrastructure implementation, operations and engineering project cycle management.
- Discussion of the procurement process of PCU, including international bidding process, EOIs, feasibility studies, etc.;
- Expectations of Line Ministries to support the entire procurement cycle.

14:15 – 15:00

**Engineering Models & Data Limitations & Forecasting Returns**
*Presenter: Sean Smith, Chief, Water Resources Engineering Branch, US Army Corps of Engineers (USACE)*
- Overview of hydraulics & hydrology models, engineering applications, data requirements.

15:00 – 16:15

**Panel Discussion: Building Codes, Standards & Modeling Technologies**
*Panelists: Brent Bailey, Tony Gibbs, Christopher Westbrook, Sean Smith*
*Moderator: Gerald Meier*
- Regional application of building standards, codes and modeling to improve infrastructure design.

16:15 – 16:30

CLOSE of Day 1

17:00 – 18:00

Cocktail Hour (Mariners Hotel)

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**DAY 2: Laying the Bricks**

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| 08:30 – 09:15 | **Climate Change & Engineering Perspectives**  
*Presenter: Cecil Harris, Chief Technical Officer, Ministry of Works, Grenada*  
- A presentation on geo-engineering, design considerations and policy matters as currently configured by overseas engineering associations. |
| 09:15 – 10:15 | **Design Standards: A private insurance perspective**  
*Presenter: Dennis Anderson, VP & Engineering Application Manager, FM Global*  
- An exposé on risk assessment and wind hazard. Examination of vulnerabilities, building designs and their weaknesses, and practical solutions to integrate. |
| 10:15 – 10:30 | AM Break |
| 10:30 – 11:30 | **Coastal Zone Infrastructure**  
*Presenter: David Smith, Coastal Engineer, Smith Warner International Ltd.*  
- Discussion of engineering considerations and tools for climate resilient coastal zone management. |
| 11:30 – 12:30 | LUNCH |
| 12:30 – 13:15 | **Slope Stabilization Modeling in the Island Tropics**  
*Presenter: Malcolm Anderson, Professor of School of Geography and the Environment*  
- Land slip analysis modeling, data collection and slope stabilization techniques; |
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<th>Time</th>
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<td><em>Facilitator:</em> Gerald Meier</td>
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<td>14:15 – 14:30</td>
<td>PM Break</td>
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<td>14:30 – 15:30</td>
<td>Association of Engineers &amp; Next Steps</td>
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<td><em>Facilitator:</em> Gerald Meier</td>
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<td>• Discussion on next steps for technical community of engineers and</td>
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<td>expectations of strategic partners, agencies, and government ministries.</td>
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<td>15:30 – 16:00</td>
<td>CLOSING CEREMONY</td>
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<td>18:00 – 20:00</td>
<td>RECEPTION (Mariners Hotel)</td>
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- Data requirements for engineering designs.
ANNEX 2:  
CUBiC Status in Caribbean Countries (as of 2011)

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## Annex 3:
### Participant List

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<tr>
<th>Country or Organization Represented</th>
<th>Mr. Mrs. Ms. Dr.</th>
<th>Last Name</th>
<th>First Name</th>
<th>Work Title</th>
<th>Organization or Ministry</th>
<th>Division or Department</th>
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<td>Rolston</td>
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