CICH-Engineers Canada
Honduras Bridges Assessment
Climate Change Vulnerability Project
March 2013 - Final Report - Executive Summary

Preface

The project produced several reports, some in English and others in Spanish. Not all reports have been translated. Following is the list of documents that compose the final deliverables of the project.

- Executive Summary (English and Spanish)
- Report 1 - Risk Assessment report (Spanish with some appendices in English)
- Report 2 – Procurement and Construction Practices in Honduras and Comparison with Canada (Spanish only)
- Report 3 – Procurement and Construction Practices in Canada (English only)
- Educational Material – University level lectures in 5 modules with slide presentations and lesson plans (English and Spanish)
- March 21 2013 project closing presentations (English and Spanish)
- Progress Reports: March, July and October 2012, January 2013 (English only)

Acknowledgements

Funding was provided by the International Branch of **Environment Canada**. The project was managed by **Engineers Canada** in partnership with the **Colegio de Ingenieros Civiles de Honduras**.

The success of the project was made possible by a dedicated team of Canadian and Honduran professionals – their contributions are highly appreciated. The team is particularly grateful of the guidance provided by David Lapp. P.Eng., FEIC, of Engineers Canada.

Table of Contents

1. Introduction

It is fundamentally clear that climate change represents a profound risk to the safety and economic viability of engineered systems and to public safety around the world. As such, engineers must address climate change adaptation as part of our primary mandate – protection of the public interest, which includes life, health, property, economic interest and the environment. Climate change results in significant changes in statistical weather patterns resulting in a shifting foundation of fundamental design data. Physical infrastructure systems designed using this inadequate data are vulnerable to damage and critical failure, compromising public safety.

These challenges have been recognised by the World Federation of Engineering Organizations (WFEO), an international body comprised of national engineering organizations and individuals from over 90 countries representing more than 15 million engineers. Engineers Canada is a member of the WFEO, representing the Canadian engineering profession and currently hosts and chairs the WFEO Standing Committee on Engineering and the Environment (WFEO-CEE)[1].

Civil infrastructure in Latin American and Caribbean countries is considered at risk to the impacts of current climate as well as future climate brought about by climate change. Honduras has been identified as the third highest country in the world impacted by climate change. As such there is a need to identify the critical infrastructures that are at greatest risk to the impacts of climate, particularly severe weather events and extremes in climatic parameters. Moreover, it is incumbent on the Honduran engineers to engage themselves to address this issue.

Adaptation of infrastructure is a necessary strategy to reduce the risks and impacts of extreme weather events in the future. Engineers, planners, managers, operators and other professionals including climate scientists are needed to work as a multi-disciplinary team to respond to this risk. While adaptation of infrastructure to the changing climate is a huge problem, it is a manageable one with proper assessment and planning, including proper operations and maintenance. The question is – how do we adapt infrastructure to climate change – where do we start? The answer is risk assessment.

[1] This project was conducted by Engineers Canada in its role as a member of WFEO and chair of the standing committee.

Engineering vulnerability/risk assessment forms the bridge to ensure the changing climate change is considered in engineering design, operations and maintenance of civil infrastructure. Identifying the highly vulnerable components of the infrastructure to climate change impacts enables cost-effective engineering/operations solutions to be developed.

Engineers Canada has developed a procedure to assess the engineering vulnerability of civil infrastructure to the impacts of a changing climate. Known as the PIEVC Engineering Protocol (the "Protocol"), this engineering vulnerability/risk assessment procedure systematically reviews historical climate information and projects the nature, severity and probability of future climate changes and events compared to the adaptive capacity of an individual infrastructure as determined by its design, operation and maintenance. It includes an estimate of the severity of climate impacts on the components of the infrastructure (i.e. deterioration, damage or destruction) to enable the identification of higher risk components and the nature of the threat from the climate change impact.

This information can be used to make informed engineering judgments on what components require adaptation as well as how to adapt them e.g. design adjustments, changes to operational or maintenance procedures.

In 2012, the protocol had been successfully applied to more than 30 case studies of infrastructures in Canada and abroad, across four infrastructure categories that include buildings, storm water/wastewater systems, roads and associated structures (e.g. bridges and culverts) and water supply and management systems.

The PIEVC Engineering Protocol is essentially a "bottoms-up" approach to the detailed identification and estimated level of risks associated with climate change impacts on the components of individual infrastructures which include not only the physical components, but also cover operations, maintenance and management practices and procedures.

This Executive Summary provides the highlights of work completed on the project "Knowledge Development and Capacity Building Program – Assessment of Climate Risk and Construction Practices for Highway Bridge Infrastructure in Honduras" funded by Environment Canada's International Branch and managed by Engineers Canada in collaborations with the Colegio de Ingenieros Civiles de Honduras (CICH).

2. Project Description

2.1 Objectives

The first project objective was to develop in-country knowledge and capacity for the assessment of climate related vulnerabilities and risks, and for the development of adaptation measures. This was achieved through a case study approach whereby engineering vulnerability assessments of four representative bridge types in Honduras were completed using the PIEVC Engineering Protocol.

The emphasis was to train engineers, planners, climatologists and scientists as well as other related professional and technical personnel within the country to build its capacity to understand and define the risks that climate change poses on the country's infrastructure and to propose locally generated, engineering-based solutions that mitigate the impacts within the resources available.

The second objective was to perform a comparative analysis between procurement and construction practices in Canada and in Honduras to identify potential and possible improvements. This was achieved through research of each country's practices for procurement, contracting, design (for example, codes and standards), quality assurance and quality control, operations and maintenance.

The third objective was to develop university level educational material for Centro-American universities. This project component, not initially planned, was made possible because of savings from team efficiencies in various project categories. The goal was to produce material related to infrastructure

Project Objectives

Capacity building

- Analysis of vulnerabilities and risk assessment of infrastructure due to climate change applying the PIEVC protocol
- Development of recommendations for adaptation solutions
- Transfer of knowledge through team work (Canada, Honduras) and educational material

Risk assessment and adaptation recommendations for bridges in Honduras

- Selection of 4 bridges on major transportation routes in distinct climate zones
- Application of Protocol to selected infrastructure

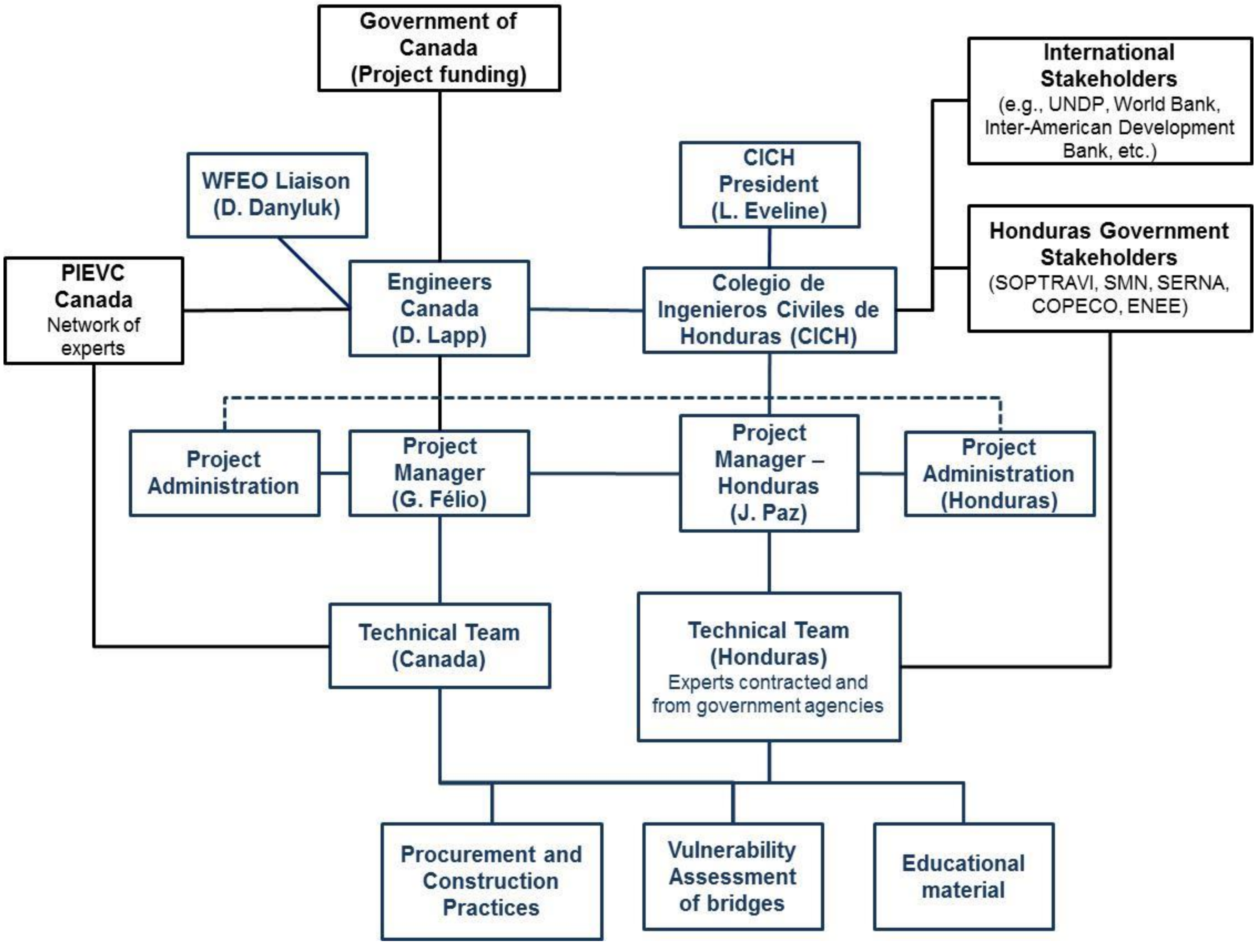
Comparative analysis of procurement and construction processes in Canada and Honduras

management, risk assessment, climate change and the use of the PIEVC Protocol supported by the results the study of the four bridges in Honduras, the Costa Rica assessment of a sanitary sewage system, and other Canadian case studies.

2.2 Organizational Structure and Project Team

Since one of the key objectives of the project was to build capacity in Honduras, it was decided to put together a project specific team of Honduran expert engineers and support personnel (as opposed to giving the contract to a consulting firm to do the work, thus reducing the reach of the knowledge transfer). This team was supported by a group of Canadian experts and by representatives from Honduras government agencies.

The Figure next page illustrates the organizational chart for the project. A brief description of the various functions follows.



Project Organizational Chart

2.2.1 Project Management and Administration

Engineers Canada provided the overarching management and administration of the project, including finance, contracts and accounting functions.

The general project management function was contracted to the Canadian consultant with support from the Honduran project manager.

2.2.2 Stakeholder Liaison

Stakeholders for the project included national (Honduras) and international agencies.

Engineers Canada maintained, throughout the project, a close liaison with the Committee on Engineering and Environment (CEE) of the World Federation of Engineering Organizations (WFEO), the international voice national engineering societies from 90 countries.

Locally in Honduras, the CICH maintained liaisons with government agencies, technical and trade associations, as well as international aid agencies such as the United Nations Development Program (UNDP) and the Inter-American Development Bank (IBD).

2.2.3 Risk Assessment

The risk assessment component of the project was led by three Honduran senior engineers with extensive knowledge of bridge design and analysis across Honduras. These leading experts, chosen through a rigorous interview process, where contracted to provide project leadership in the fields of bridge structural mechanics, hydraulics and hydrology, and geotechnical and foundations engineering. These lead engineers where assisted by intermediate and junior Honduran engineers.

The Honduran risk assessment team was supported by Canadian experts in the fields of risk assessment, environmental and water resources engineering and climatology. A Special Advisor from Costa Rica was added to this support group. This civil engineer from the Colegio Federado de Ingenieros y Arquitectos (CFIA) of Costa Rica was the project manager of a previous application of the PIEVC Protocol in this country. He not only brought to the Honduran project this invaluable experience, but also local knowledge and technical competence.

2.2.4 Joint Procurement Working Group (JPWG)

A Joint Procurement Working Group (JPWG) was created to perform the comparative analysis between procurement, design and construction practices in Canada and Honduras. The JPWG was composed of three Canadian and three Honduras engineers with knowledge and experience in the field. The group was supported by engineering students (two in Honduras and one in Canada) that provided the background research for the work of the JPWG.

2.2.5 Educational Material Development

The educational material was prepared by selected team members with experience in infrastructure management, the application of the PIEVC Protocol and case studies in Canada, Costa Rica and Honduras.

The Universidad Politecnica de Ingenieria (UPI) of Honduras provided support with the preparation of this educational material.

The list of project members is shown in the table next page.

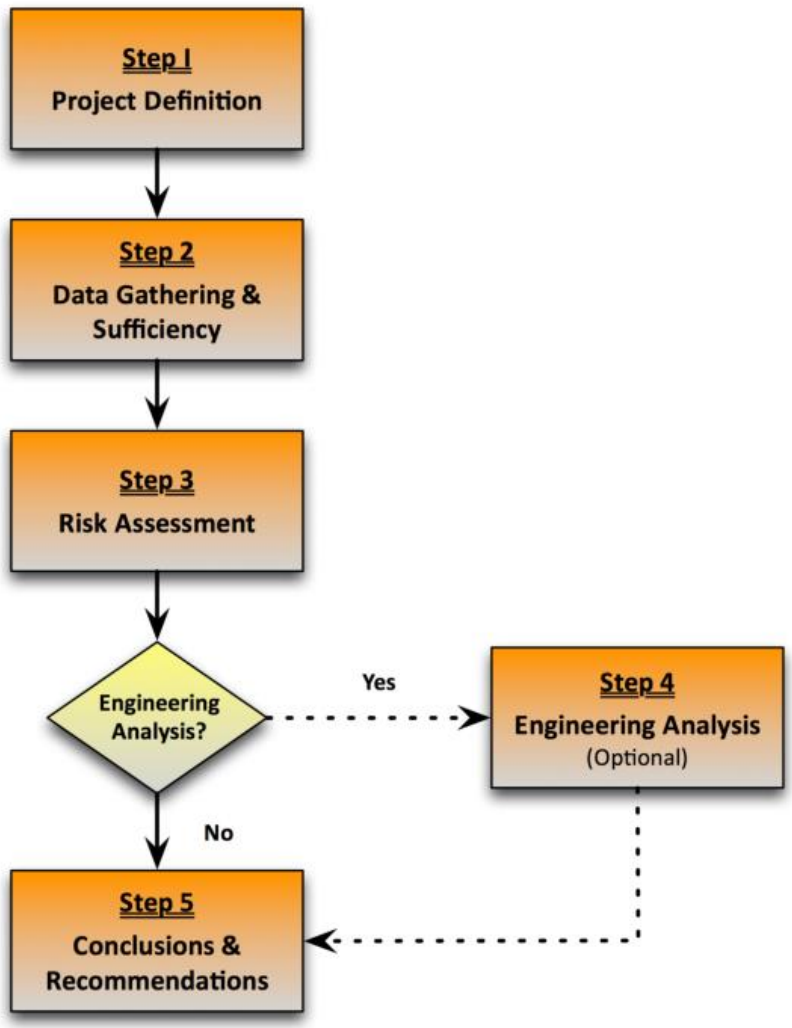
<table>
<tr><th colspan="2">Project Team</th></tr>
<tr><th colspan="2">Project Management</th></tr>
<tr><td>Engineers Canada:
• David Lapp, P.Eng., Project Director
• Darrel Danyluk, P.Eng., WFEO liaison
• Accounting, Finance and Contracting officers</td><td>Project Manager:
• Dr. Guy Félio, P.Eng.
Project Manager (Honduras)
• Ing. Jorge Paz, CICH</td></tr>
<tr><th colspan="2">Risk Assessment Team</th></tr>
<tr><td>Risk Assessment Support (Canada)
• Jeff O'Driscoll, P.Eng., Technical Manager
• Heather Auld, Climate
• Roger Remper, P.Eng., Risk Assessment
• Ing. Freddy Bolaños, CFIA (Costa Rica), Special Advisor</td><td>Risk Assessment Team (Honduras)
Lead Engineers
• Dr. Ing. Joaquin Torre, Structural Mechanics
• Dr. Ing. Raul Flores, Geotechnical
• Ing. Eddy-Nelson Larios, Hydrology and Bridge Hydraulics
Assistant Project Manager (Honduras)
• Ing. Ana Borjas, Structural
Junior Engineers
• Ing. Eliseo Fajardo
• Ing. Manuel Bermudez</td></tr>
<tr><th colspan="2">Joint Procurement Working Group</th></tr>
<tr><td>Canada
• Dr. Guy Félio, P.Eng. (Co-Chair)
• Warren McCulloch, P.Eng., Consultant
• Hani Farghali, P.Eng., Ministry of Transport of Ontario
• Cameron Loeb, Student</td><td>Honduras
• Ing. Jorge Paz, CICH (Co-Chair)
• Ing. José-Ramón Cálix, CICH
• Ing. José Velasquez, Consultant
• Sara Lanza, Student
• Roberto Ramirez, Student</td></tr>
<tr><th colspan="2">Agency Support</th></tr>
<tr><td>SOPTRAVI (Honduras Ministry of Transport)</td><td>SMN (National Meteorological Services of Honduras)</td></tr>
</table>

2.3 Methodology

This section describes briefly the various steps for the risk assessment and the comparative analysis of procurement and construction processes. The detailed description of the methodology is provided in the full reports.

2.3.1 Risk Assessment

The risk assessment of the four bridges followed the PIEVC Protocol procedure. Essentially, the Protocol calls for the following steps:



The selection of the bridges considered factors as shown in the table below.

Site Selection Criteria		**Criteria Weighting** 1 (less important) to 5 (more important)
Infrastructure	Infrastructure Age	4
	Variety of Infrastructure	3
Data Availability	Current Weather Data Available (weather stations)	4
	Historic Weather Data Available (temperature, precipitation)	4
	Availability of Infrastructure Data	3
Environment	Occurrence of Extreme Environmental Events	5
	Variety of Terrain	2
	Expected Climatic Change - Temperature	1
	Expected Climatic Change - Precipitation	4
	Climatic Regions	2
Other Criteria	Traffic Volumes	3
	Strategic Importance of Route	4

A preliminary list of more than 80 bridges was analysed from which 12 bridges were selected for further review. With the help of the Honduran Ministry of Transportation, the meteorological services and other agencies, four bridges were selected for the study.

A series of workshops where conducted to train the Honduran team on the application of the protocol and to guide them in their work.

2.3.2 Comparison of Procurement and Construction Practices

This phase consisted of three stages that encompassed a review of existing standards, policies and procedures followed by the development of recommendations for changes to accommodate current and future climate risks.

Preparation of Research Papers

Two members of the Joint Working Group (JWG) – one each from Canada and Honduras, were assigned to overview the work of students doing research and summarize the design codes and standards that were used for each of the four bridges being assessed in Phase I. In addition the procurement and construction policies and practices used for each bridge was documented and initially compared to identify any significant differences between them.

Review of Institutional Design and Construction Procurement Policies and Procedures

Using the research papers as the basis, the Joint Working Group reviewed the documents from the four bridges to determine any gaps or poorly defined specifications or requirements that may contribute to less than ideal design or operation/maintenance. This work included a review of construction inspection and acceptance procedures as well as the integrity of the procurement and construction process.

Recommended Changes and Adjustments to Design and Construction Codes, Standards, Procurement Policies and Procedures

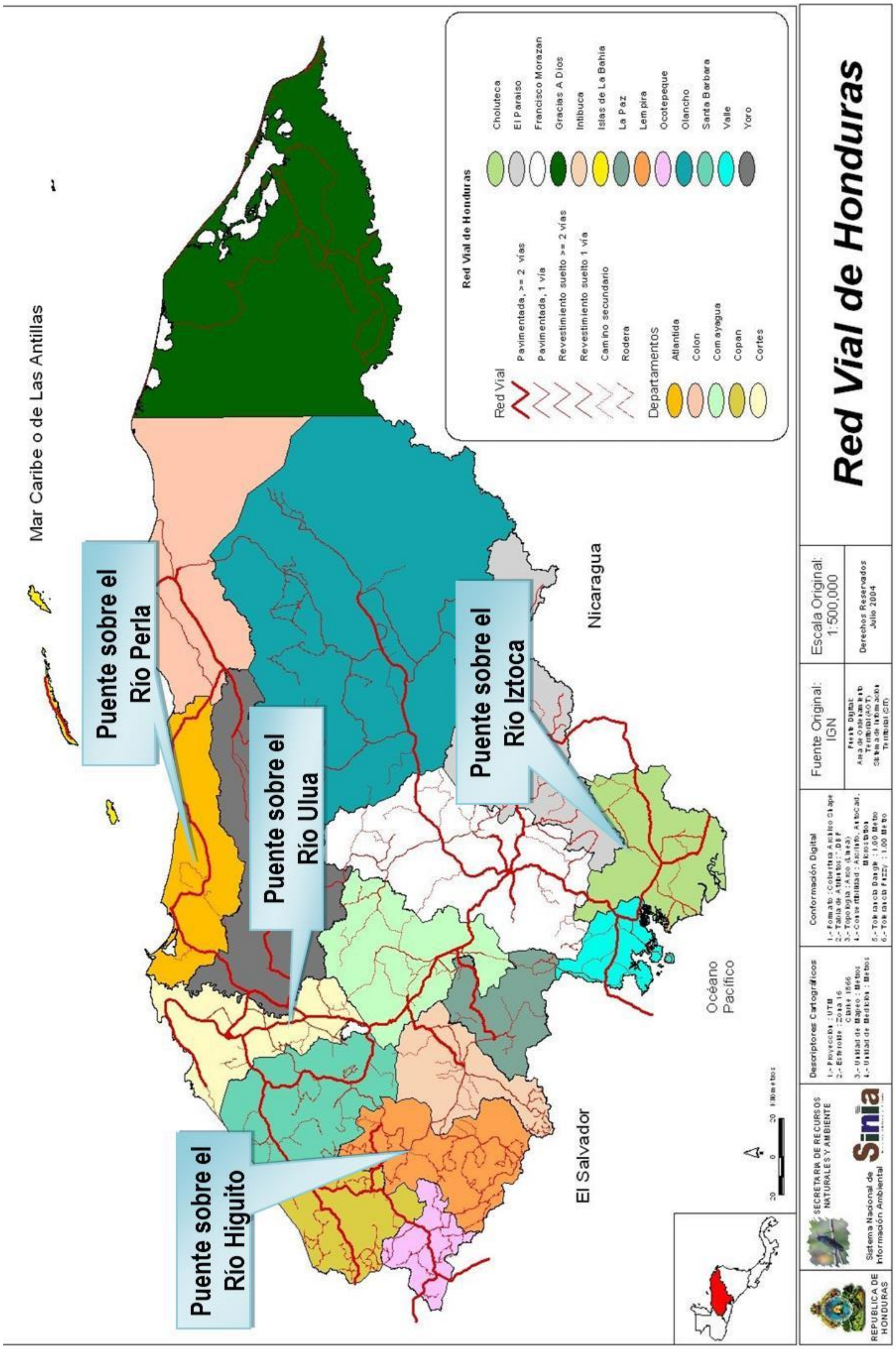
Following completion of the previous tasks, where gaps and weaknesses were identified, the Joint Working Group recommended changes or additions to design and construction codes and standards, procurement policies and procedures as well as inspection and acceptance.

3. Summary of Results

This section presents a brief summary of the risk assessment and of the comparative analysis of procurement, design and construction practices in Canada and Honduras. The details of each of these project phases are given in the full reports.

3.1 Risk Assessment

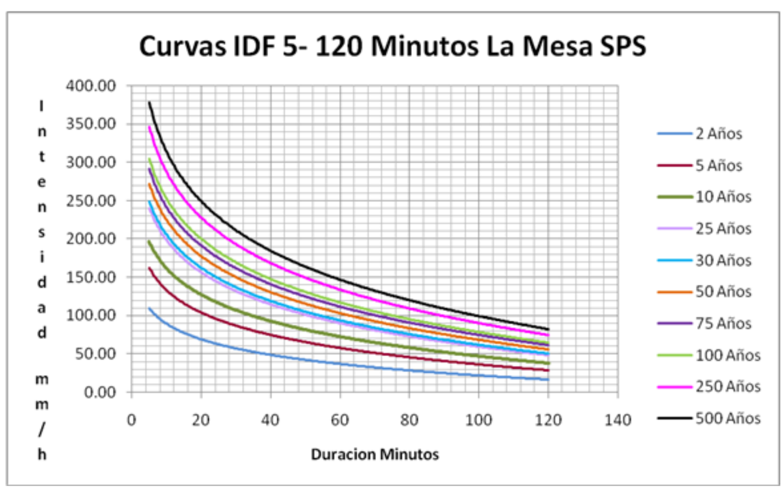
The bridges selected for the risk assessment are shown in the figure next page.


Red Vial de Honduras
Mar Caribe o de Las Antillas
Puente sobre el Río Perla
Puente sobre el Río Ulua
Puente sobre el Río Iztoca
Puente sobre el Río Higuito
Nicaragua
El Salvador
Océano Pacífico
Red Vial de Honduras
Red Vial
Pavimentada, >= 2 vías
Pavimentada, 1 vía
Revestimiento suelto >= 2 vías
Revestimiento suelto 1 vía
Camino secundario
Rodera
Departamentos
Atlantida
Colon
Comayagua
Copan
Cortes
Choluteca
El Paraiso
Francisco Morazan
Gracias A Dios
Intibuca
Islas de La Bahia
La Paz
Lempira
Ocotepeque
Olancho
Santa Barbara
Valle
Yoro
Escala Original: 1:500,000
Fuente Original: IGN
Derechos Reservados Julio 2004
REPUBLICA DE HONDURAS
SECRETARIA DE RECURSOS NATURALES Y AMBIENTE
Sistema Nacional de Información Ambiental
Sinia

Due to the scarcity of information on these bridges, particularly recent inspection data, the team conducted visual inspections for each of the structures. Other data on the river basin (hydrology, hydraulics, geology and geotechnical properties) was gathered from available reports with the Ministry of transportation or other sources.

The figures below show examples of the type of information available to the team.

Climate information was initially gathered from existing sources such as the Honduran Meteorological Services, the Ministry of the Environment of Honduras, and international studies. As the project progressed, locally available data was collected and analysed to support the risk assessment. The figure below shows site specific intensity-duration-frequency curves produced by the Honduras Meteorological services for one of the bridges.



The team used the risk assessment methodology of the PIEVC Protocol to generate the risk matrices for each of the bridges under study for which an example is shown below.

COMPONENTES DE LA INFRAESTRUCTURA	Tormentas Tropicales ,				Huracanes				Crecidas Instantáneas				Evento Referencia				Empuje Frío			
	Presente				Presente				Presente				Presente				Presente			
	Intensidad de lluvia = 800 mm en 5 Dias				Vv >118 km/hr				Intensidad de Lluvia = 220 mm en 1 día								Intensidad de lluvia de 400 mm en 1 día			
HIDROLOGÍA E HIDRAULICA	S/N	P	S	R	S/N	P	S	R	S/N	P	S	R	S/N	P	S	R	S/N	P	S	R
Cuenca hidrográfica:																				
Estado/condiciones de la Cuenca																				
Unidades hidrológicas (afluentes)																				
Hidráulica:																				
Tipo de río (joven, adulto)																				
Planicies de inundación (son almacenamiento temporal de agua																				
Pendientes predominantes																				
Socavación																				
Sedimentación																				
Zonas de Deslizamiento																				
Rugosidad del cauce																				
Puntos de control																				
ESTRUCTURA:	S/N	P	S	R	S/N	P	S	R	S/N	P	S	R	S/N	P	S	R	S/N	P	S	R
Superestructura:																				
Posición del puente																				
Losa de rodadura																				
Vigas																				
Diafragmas																				
Apoyos																				
Pretiles																				
Carpeta Asfaltica de rodadura																				
Aproximaciones																				
Sistema de drenaje																				
Señalización Vertical																				
Sub estructura:																				
Pilas																				
Estribos																				
Aletas del estribo																				
Cimentación																				
GEOLOGÍA Y GEOTECNIA:	S/N	P	S	R	S/N	P	S	R	S/N	P	S	R	S/N	P	S	R	S/N	P	S	R
Geología:																				
Ubicación de fallas																				
Morfología																				
Unidades geológicas																				
Geotecnia:																				
Clasificación del suelo																				
Propiedades del suelo (Ángulo de fricción, peso específico,)																				
Capacidad del suelo																				
Consolidación/Asentamiento																				
Licuefacción																				

Based on the matrices, the team identified low, medium and high risks for each of the bridges under current and future climate – defined based on the estimated remaining life of the structure. An example of the results for one of the bridges is shown on the figure next page.

40

**RIESGO ACTUAL Y FUTURO PARA PUENTE RÍO PERLA
COMPONENTES DE ESTRUCTURA**

Componente Estructural	Tormentas Tropicales		Fenómenos extremos		Crecidas instantáneas		Empuje Frío	
	Actual	Futuro	Actual	Futuro	Actual	Futuro	Actual	Futuro
Losa de rodadura	6	8	6	8	4	5	4	6
Vigas	15	20	15	20	12	15	8	12
Diafragmas	15	20	15	20	12	15	8	12
Apoyos	6	8	6	8	4	5	4	6
Pretiles	6	8	6	8	4	5	4	6
Carpeta Asfáltica de rodadura	6	8	6	8	12	15	4	6
Aproximaciones	15	20	15	20	12	15	10	15
Sistema de drenaje	12	16	12	16	12	15	8	12
Señalización Vertical							8	12
Pilas	12	16	12	16	12	15	8	12
Estribos	12	16	12	16	12	15	8	12
Aletas del estribo	12	16	12	16	12	15	8	12
Cimentación	6	8	6	8	8	10	4	6

Componentes de Riesgo medio para Tormenta Tropical y Huracanes
Vigas
Diafragmas
Aproximaciones

A summary of the risk assessment conclusions follows.

- The vulnerability analysis through the application of the Protocol PIEVC on the four bridges that were selected, represented an excellent opportunity for the Honduran team to acquire a knowledge that involves aspects related to climate change that can be used for future studies for the team.
- The application of the Protocol PIEVC through the combination and the work of a multidisciplinary team gave the opportunity - probably for the first time in Honduras - for a study of this nature with the immediate and direct contribution between professionals in engineering and meteorology. As a result, the engineering professionals obtained a clearer understanding on the climatological information, the interpretation of data and considerations related to climate change.
- The project allowed to identify information deficiencies relating to infrastructure and climate data, which will need to be corrected for future studies associated with the vulnerability of infrastructure to changing climate, and to apply the methodology of the PIEVC Protocol or similar tools.

- Results of the risk evaluations show that some of the components of the four bridges are at an average risk based on the qualitative analysis of engineering. Design of corrective measures will require a more extensive analysis for its implementation.
- In each of the four bridges, the project identifies certain damages and specific situations that must be met in the shortest possible time, related to the procedures of maintenance and regular repairs necessary to maintain the capacity and the functionality of the bridges at an adequate level.
- The climate parameters that contribute to a greater degree to a potential vulnerability in the four bridges are tropical storms, hurricanes, flash floods and cold fronts (in one of them). Data and records of historical evidence of these events served as the basis for the analysis of climate interactions with the components of the infrastructure for the present time and also for the future. Undoubtedly, it is impossible to accurately predict the intensity and frequency of these events in the future, therefore, the projections made by the team over the behavior of these climatic phenomena was based on their professional judgment.
- In regards to the results of the analysis of the vulnerability of the four evaluated bridges, the team concludes that they have sufficient capacity to respond appropriately to the impacts caused by climate change, in the time horizon of 40 years that was defined. For greater reliability on this conclusion, however, the recommendations suggested in the report must take care to reduce the possibility of adverse effects caused by the combination of climatic events and situations that increase impacts.

The risk assessment therefore offers the following recommendations:

- Recommendations common to the four bridges:
    - Geotechnical studies should be conducted at each site and concrete core samples should be collected and tested for the superstructure and substructure components. These data should allow the quantitative analysis for the behaviour of the structure against the loads produced by climatic events.

- Rio Perla bridge:
    - Construction of dams for the retention of sediments in tributaries in the sub-basins that have greater potential to contain loose soil, which during

precipitation of regular intensity and duration, is drawn into the vicinity of the bridge;
    - Construction of diversion canals in the vicinity of the bridge, prior to the start of the rainy season primarily;
    - Implement watershed management practices; and
    - Improve overall storm water drainage around the bridge to minimize contact with some of the components of the bridge.

- Rio Higuito bridge
    - Construct retention dams to retain sediments in the middle and upper basins at points susceptible to drag large diameter material bottom sediments.
    - Remove remains of a failed structure which still remains on the left bank of the river;
    - Carry out repair work on the pillars of the right bank that have suffered deterioration, to the extent of partially losing concrete cover by impact and/or friction against them;
    - Protect the abutments and wings with gabion walls;
    - Repair the parapets upstream; and
    - Seal the expansion joints

- Rio Ulúa bridge
    - Protect the approach ramp from the north end by covering the slope exposed to flooding with gabion type materials and placing culverts 42-inch (1 m) diameter each, 10 meters away from the lower end of the approach;
    - Immediate reconstruct the beam from one edge of the sections of the far right (South) that has exposed steel reinforcement;
    - Sealing expansion joints.

- River Iztoca bridge
    - Build protection works with gabion in the left abutment wall system
    - Clean the undergrowth on the approaches next to the bridge.

- General recommendations:

- Development and implementation of a program of inspection, maintenance and repair, as well as updated inventory and registration of the main bridges across the country.
- It is recommended the Honduran code of construction and the highway Manual of SOPTRAVI be revised to incorporate the provisions relating to climate change and its potential effects. Alternatively, codes and manuals can be modified so that the infrastructure vulnerability assessment studies are included, in specific cases and where necessary, so that a more in-depth evaluation of the infrastructure to be designed or evaluated is performed.

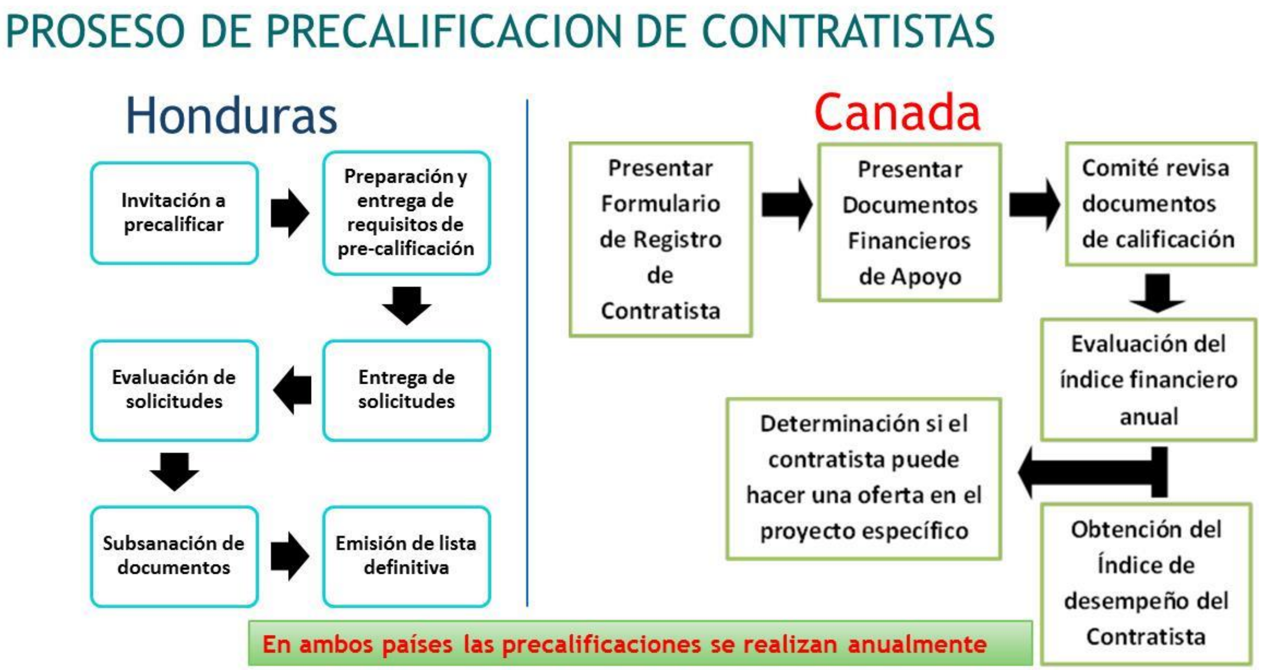
3.2 Comparative Analysis: Procurement, Design and Construction

Since “design-bid-build” is by far the most widely used project delivery method in Canada and in Honduras, the country specific reports concentrated on procurement practice for Engineering Service Providers (ESP’s) and construction contractors related to design-bid-build project delivery method. Although not specifically detailed in the reports, other project delivery strategies such as design-build, construction management, general contractor/turn-key projects, and public-private partnerships are equally important in certain situations.

The reports focused on the following procurement areas:

- Procurement of Engineering Services
- Procurement of Construction Services
- Procurement of Maintenance Contracts
- Prequalification and Procurement Processes for Engineering and Construction Services

In order to facilitate the comparison between the two countries, a standard format of analysis and reporting was adopted, which included summary flow diagrams of the processes. A typical comparative flow diagram for the pre-qualification process is shown in the figure next page.



The major differences between the Canadian and Honduras processes identified by the Working Group are as follows:

- Maintenance contracts, usually with a term of five years, are often used in Canada to ensure an adequate level of service in the road network. Very little or no maintenance is done on bridges or roads in Honduras.
- The consultant's professional liability in Canada is considered from the formulation of the terms of reference for the project – this does not happen in Honduras.
- The performance of the contractor on past projects is not a criterion used in the procurement process in Honduras while it is often used as a parameter for future consulting and construction in Canada.
- No quality assurance and control (QA/QC) processes are in place in Honduras, while they are an integral part of the procurement and construction process in Canada, which have resulted in a high level of quality, with two basic components:
    - The quality control is the responsibility of the contractor.
    - The quality assurance is the responsibility of the supervisor.

- Warranty periods established in Canada are from 1 to 5 years, during which times are carried out evaluations and if deficiencies exist, the contracts require the contractor to make the repairs.

The Honduras team has therefore formulated the following recommendations:

Review alternative methods of contracting for the stages of maintenance and operation of the road network (e.g., public-private partnerships)

Award contracts for maintenance at established levels for service for long-term periods (e.g., 5-year terms)

Incorporate the past-project performance evaluation as part of the qualification in tender processes.

Include the responsible design professional in the elaboration of the terms of reference for the construction contracts.

Codes and standards for the design of infrastructure must incorporate aspects related to climate change in order to consider its effects during the life-cycle of the work.