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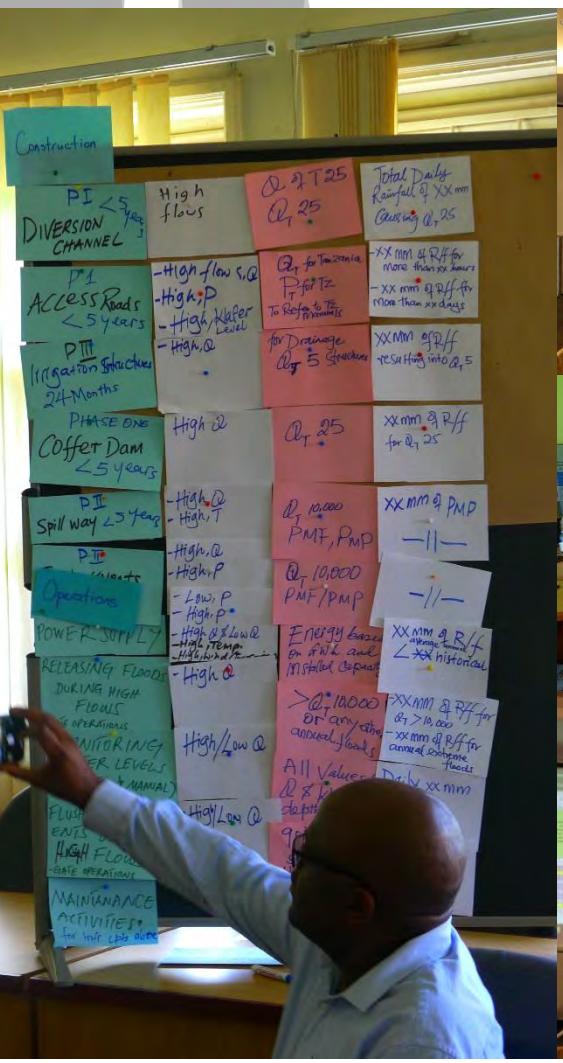

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giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

NILE BASIN INITIATIVE

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1.0 Full Project Description

In September 2017, Engineers Canada signed a grant agreement with the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH, also known as GIZ, to apply the Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol in the GIZ "Enhanced Climate Services for Infrastructure Investments (CSI) Project". The CSI project is being executed in three countries: Brazil, Costa Rica and Vietnam as well as the Nile Basin Initiative (NBI), working with local partners and local staff employed by the GIZ organization.

Engineers Canada served as an adviser to GIZ by contributing the Protocol and the expertise and experience of its professionals in Canada towards the CSI Project. Wood was contracted to Engineers Canada to support the Vietnam and NBI projects.

A series of capacity development workshops, focused on the PIEVC Protocol, were planned as a primary component of this assignment. The overarching objective of the workshops has been to build the institutional capacity in Vietnam and the NBI to undertake assessments on infrastructure vulnerability to the impacts of the changing climate. However, the workshops focused on the application/implementation of the PIEVC Climate Change Vulnerability Assessment Protocol with the support of Wood/GIZ/Engineers Canada as a learning-by-doing "exercise". Please note also that Risk Sciences International (RSI) was also directly contracted to Engineers Canada to support the Vietnam project.

The role of the Canadian team has been to provide mentorship, facilitation, advice, consultation and review to the local in-country assessment teams and workshop participants, to develop, build and expand their capacity for water resources infrastructure risk and vulnerability assessments using the PIEVC Protocol.

1.1 Social and / or Economic Benefits

Engineers Canada was supported by the German Corporation for International Cooperation GmbH (GIZ) to apply the PIEVC Protocol in the GIZ "Enhanced Climate Services for Infrastructure Investments (CSI) Project". The CSI project was executed in three countries: Brazil, Costa Rica and Vietnam as well as the Nile Basin Initiative (NBI) in Africa, working with local partners and local GIZ staff. Engineers Canada served as adviser to GIZ contributing the Protocol and expertise and experience of Canadian professionals towards the CSI Project. Wood was contracted by Engineers Canada to provide PIEVC Protocol expertise and support services for the Vietnam and NBI projects.

The overarching project objective was building of institutional capacity to undertake climate change vulnerability assessments. Workshops were held in Vietnam, as well as numerous webinars, focused on the PIEVC Protocol. The workshops focused on the application/implementation of the PIEVC Protocol with the support of Wood, Risk Sciences International, GIZ, and Engineers Canada as a learning-by-doing "exercise". Wood's role was to provide mentorship, facilitation, advice, consultation and review to the local Vietnamese assessment team and workshop participants, and to develop, build and expand their capacity for water resources infrastructure vulnerability assessments using the PIEVC Protocol.

The Cai Lon-Cai Be Sluice Gate Project was selected as an in-country case study for climate change vulnerability assessment using the PIEVC Protocol and to support the project's capacity development goals. This project is considered representative of other infrastructure in the Mekong Delta (MKD) making it a great example to demonstrate the value of vulnerability assessment of infrastructure systems as part of the design process and risk management and decision making more broadly. Understanding the level of vulnerability contributes to better, more informed decision-making and priority setting.

Artist's rendition of the Cai Lon Sluice Gate Project, Vietnam

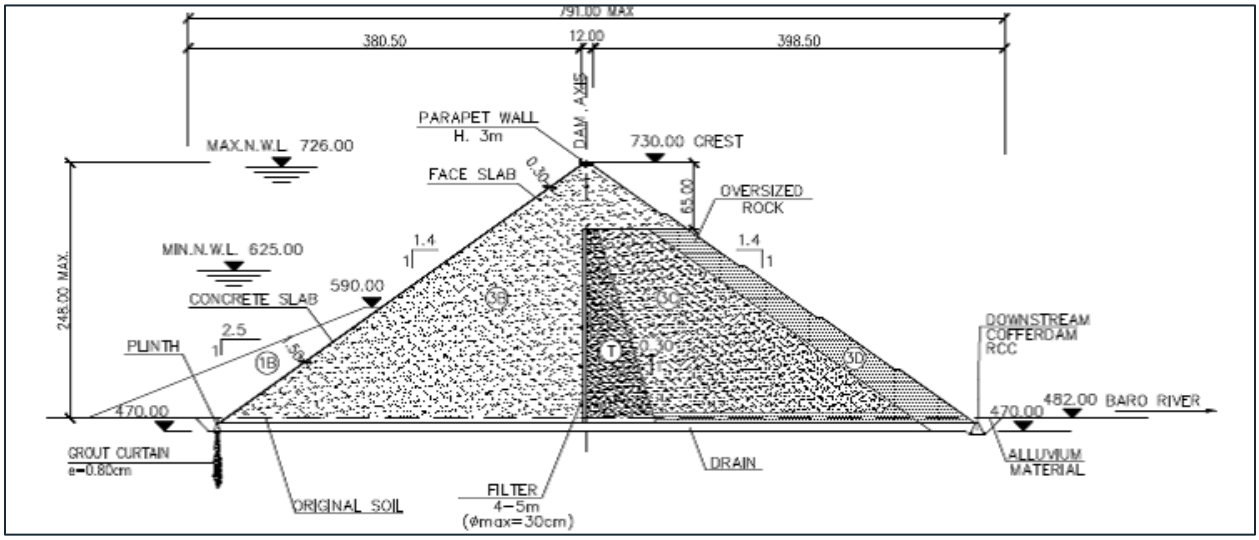
Artist's rendition of the Cai Be Sluice Gate Project, Vietnam

The MKD is one of key economic regions in Vietnam, generating about 20% of Vietnam's GDP. Agriculture in the MKD covers about 4.1 million hectares and provides food security and livelihoods for approximately 21 million people.

The Cai Lon-Cai Be Sluice Gate Project is a multi-objective project. It includes water resources infrastructure (i.e. sluice gates, dam), land transportation infrastructure (roads, bridges, appurtenant infrastructure, etc.), water transportation infrastructure (i.e. the lock system), and recreational facilities. Its primary objective is to control seawater intrusion into agricultural areas of the MKD and support irrigation water supply for agriculture and aquaculture. Adapting to climate change and investment in resilient infrastructure supports long-term safety and sustainability of MKD activities and livelihoods.

A similar effort was also undertaken with the NBI with workshops in Uganda and Ethiopia supporting vulnerability assessment of two planned multi-objective dams; the Tams Hydro Power Project and the Borenga Dam Project.

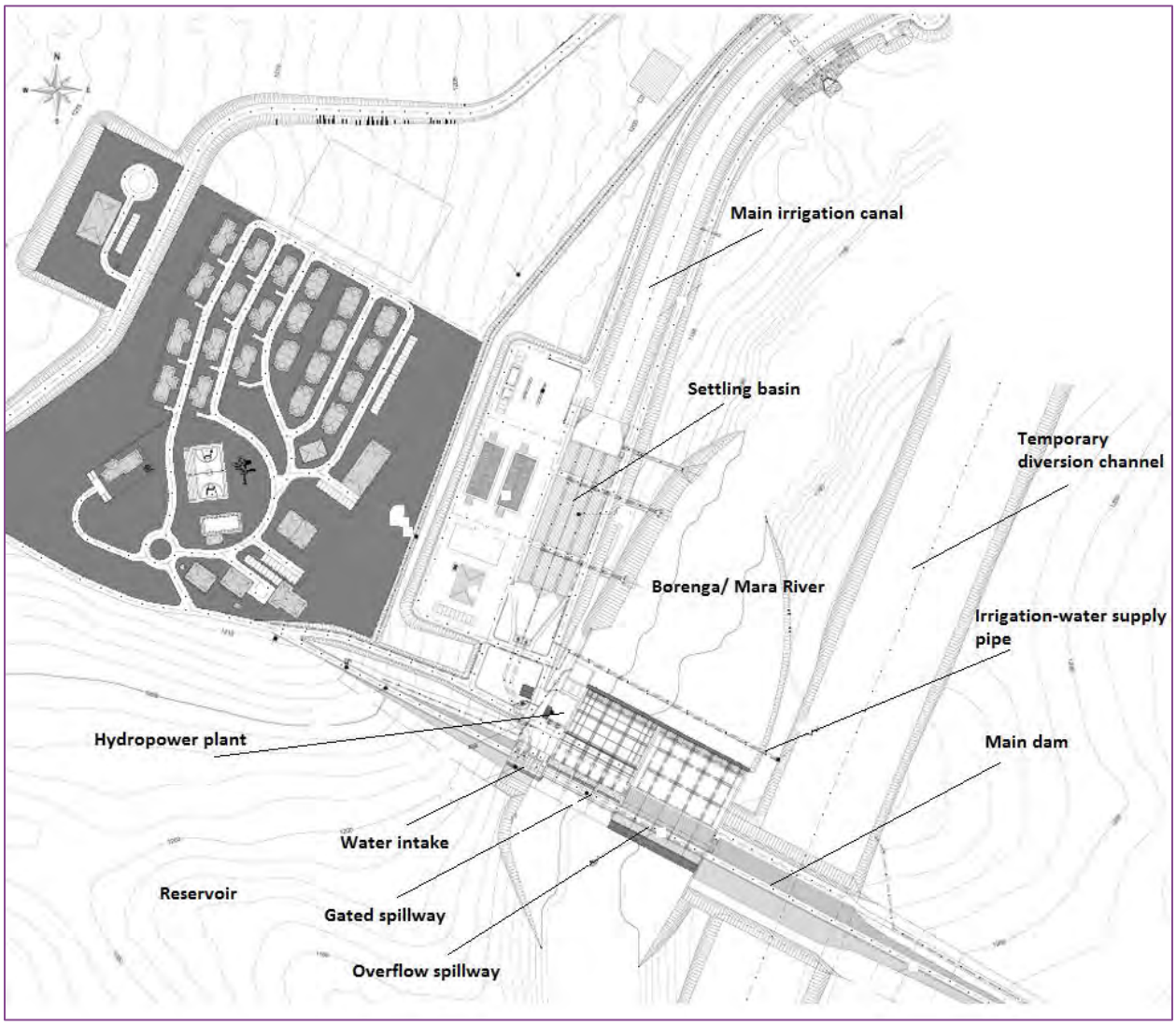
The Tams Hydro Power Project (HPP) is located in the Baro River basin in the south-west area of Ethiopia. Planning of the Tams HPP begun in the early 1990's and the project is designed as a multi-purpose plant. Its primary function will be to produce electricity with an estimated as average annual net generation of approximately 5.5 GWh. This electricity production will satisfy the demand of the region with surpluses being potentially made available to other countries. The dam will regulate almost the entire Baro Watershed (approximately 21,000 km^2), making available about 5 billion m^3 of water for irrigation during the dry season. The project will also serve to provide flow augmentation for downstream aquatic habitat and navigation, as well as, provided potable water for the downstream community. The dam is planned to be of concrete faced rock filled (CFRD) construction with a dam height (above the foundation) of 248 m. A component of the project feasibility study was conducted based on the projected trends of precipitation for the period 2006-2100 obtained from the simulations of global climatic model IPSL-CM5A-MR run by the Institute Pierre-Simon Laplace (IPSL), France.



Tams Hydro Power Project (Ethiopia) – Main Dam Cross-Section

The Borenga Dam is proposed to be located in Tanzania, on the Mara River about 80 km upstream of the wetland system through which the river connects to Lake Victoria. The reservoir created by the dam will provide water to support water demands for irrigation, livestock watering and aquaculture development. In addition, it is also proposed that a centralized potable water supply use the Borenga reservoir as its source. The total annual abstractions for the full development of the project have been estimated at 146 million cubic metres (MCM). An additional 7 MCM per annum are targeted for the use of villages located downstream from the dam. It is noted in the Mara Valley Project design report that climate change is not predicted to have a negative effect on the naturally available river flow and it is generally expected to lead to an increase in the severity of extreme floods. It is also noted, however, that current predictions

incorporate too much uncertainty to be considered as design values even though it is also noted that climate change represents a risk to the project with regards to water balance, extreme floods and upstream land use and sedimentation potential.



Borenga Dam Project (Tanzania) – Key Project Elements

1.2 Technology Transfer

The project was specifically structured to facilitate technology/knowledge transfer. The overarching project objective was institutional capacity development to undertake climate change vulnerability assessments using the Made-in-Canada Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol.

The project was comprised of a series of in-country workshops, and webinars, focused on the application/implementation of the PIEVC Protocol with the support of Wood, Risk Sciences International,

GIZ, and Engineers Canada as a learning-by-doing "exercise". Wood's role was to provide mentorship, facilitation, advice, consultation and review to local assessment teams and workshop participants, and to develop, build and expand their capacity for water resources infrastructure vulnerability assessments using the PIEVC Protocol.

Two multi-day workshops were held in Vietnam, as well as numerous webinars, focused on the assisting the local assessment team in their application of the PIEVC Protocol to the Cai Lon-Cai Be Sluice Gate Project which was selected as an in-country case study. The local Vietnam team was comprised of the Ministry of Agriculture and Rural Development (MARD) and its Project Management Unit #10; the Southern Hydro-Meteorology Administration and the Southern Institute for Water Resources and Planning (SIWRP).

Vietnam PIEVC Workshop – Ho Chi Minh City, Vietnam - October 18, 2018

The NBI is an intergovernmental partnership of ten (10) Nile Basin countries, namely Burundi, Democratic Republic of the Congo, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, The Sudan, Tanzania and Uganda. Eritrea participates as an observer. The NBI was established in 1999 to provide a forum for consultation and coordination among the Basin States for the sustainable management and development of the shared Nile Basin water and related resources for win-win benefits. The highest decision and policy-making body of the NBI is the Nile Council of Ministers (Nile-COM), comprised of Ministers in charge of Water Affairs in each NBI Member State. The Nile-COM is supported by the Nile Technical Advisory Committee (Nile-TAC), comprised of twenty (20) senior government officials, two from each of the Member States. There are two Subsidiary Action Programs (SAPs) offices, namely the Eastern Nile Technical Regional Office (ENTRO) for the Eastern Nile Subsidiary Action Program (ENSAP) and the Nile Equatorial Lakes Subsidiary Action Program Coordination Unit (NELSAP-CU), for the Nile Equatorial Lakes Subsidiary Action Program (NELSAP).

Similarly, three multi-day workshops and numerous webinars were held with the NBI assessment teams. The case study projects selected were Tams Hydro Power Project located in the south-west area of Ethiopia and the Borenga Dam in Tanzania. The local NBI team was represented by Technicians (civil engineers and hydro-climatologists) from the NBI in Entebbe (Uganda) and two branch offices in Addis Ababa (Ethiopia) and Kigali (Rwanda).

NBI PIEVC Workshop - Entebbe, Uganda - November 14, 2018

1.3 Environmental Benefits

It is expected that our changing climate will be a primary driver for significant impacts in the Mekong Delta of Vietnam and the Upper Nile River Basin in Africa. The MKD has already experienced major climate events that have resulted in large shifts in the economic, agricultural, and geographic makeup of the area. Rising sea levels are driving salt water into rice fields which is causing the substantial decreases in agricultural yield. Further, infrastructure in the MKD has experienced pre-mature weathering which is expected to be exacerbated by climate change influenced by increasing salinity and frequency and intensity of typhoons. In the Upper Nile River Basin, climate change is expected to increase rainfall but also increase the frequency and longevity of hot and dry weather. These conditions are expected to result in hardship for small agricultural producers, reduce hydropower generation, and diminish the water available for people and industry.

Vulnerability assessment is a key element supporting understanding of the potential impacts of climate change and to effectively incorporate adaptation to changing climate into engineering design, development and management of existing and planned infrastructure. Vulnerability assessments support adaptation planning in several ways by:

- Identifying areas impacted by projected changes in climate.
- Building an understanding of vulnerabilities.
- Assessing the effectiveness of coping strategies.
- Identifying adaptation options.

Overall, vulnerability assessment contributes to informed decision-making and priority setting, as well as, long-term resilience and sustainability of built infrastructure.

Time Period / khoảng thời gian 2080		Climate and Other Variables and Events / Biến đổi khí hậu và các biến cố và sự kiện khác																																	
Infrastructure Components / Thành phần cơ sở hạ tầng (Sheet 1 of 1) (Trang 1/1)		High Temperature / Nhiệt độ cao (7 unchanged)				Heat Wave / Sóng nhiệt (1 to 2)				Heavy Rain / Mưa lớn (5 to 6)				5 day Total Rain / Tổng cộng 5 ngày mưa (6 unchanged)				Thunderstorm/ Lightning / dông | tia chớp (7 unchanged)				Tropical Storm | Depression / Bão nhiệt đới |phiền muộn (3 unchanged)				Drought | Dry Period / hạn hán | Thời gian khô (7 unchanged)				High Wind / Gió cao (2 to 3)				Tornado / vòi rồng (1 to 2)				Water Level / mức nước (7 unchanged)				Water Salinity / Nước mặn (7 unchanged)			
		A				B				C				D				H				I				J				K				L				M				U			
		Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R
Administration	*cách cai trị*																																											
Personnel	Nhân viên	Y	7	4	28	Y	2	6	12	Y	6	4	24	Y	6	2	12	Y	7	7	49	Y	3	7	21	Y	7	3	21	Y	3	4	12	Y	2	7	14								
Sluice Gate Structure	*Cấu trúc cửa cống*																																											
Pile foundation	Móng cọc																																											
Waterproof pile foundation	Nền móng cọc chống thấm																																											
Pillar footing	Trụ cột																																											
Bottom beam	Chùm dưới																																											
Pillar	Trụ cột					Y	2	3	6																													Y	7	2	14	Y	7	2	14
Gate tower / Gate hanger	Cổng tháp / Móc treo cổng					Y	2	3	6																																			
Cast-in-situ concrete composition	Thành phần bê tông đúc tại chỗ					Y	2	3	6																																	7	2	14	
Ship Lock	*Khóa tàu*																																											
Lock chamber	Buồng khóa					Y	2	2	4																													Y	7	4	28	Y	7	2	14
Lock head	Đầu khóa					Y	2	2	4																													Y	7	4	28	Y	7	2	14
Filling and discharge culverts	Cống và cống xả					Y	2	2	4																																	Y	7	2	14
Leading jetty	Cầu tàu hàng đầu					Y	2	2	4																																	Y	7	2	14
Other Infrastucture	*Cơ sở hạ tầng khác*																																											
Bridge Surface	Cầu bề mặt					Y	2	4	8													Y	3	2	6											Y	2	3	6								
Hand Rail	Tay vịn																																					Y	7	2	14								
Lighting System	Hệ thống chiếu sáng																																														
Traffic Sign Post	Traffic Sign Post																																														
Retaining walls	Tường chắn					Y	2	2	4																																			Y	7	2	14
Gabion	Gabion																																														
Connected embankments	Kè kết nối					Y	2	2	4																	Y	7	4	28															Y	7	2	14
Rip-rap embankments sections	Phần kè kè Rip-rap					Y	2	2	4																																			Y	7	2	14
Riverbank	bờ sông																																														
Stilling basin	Lưu vực																																													
Operation house	Nhà điều hành					Y	2	2	4	Y	6	3	18									Y	3	3	9					Y	3	3	9	Y	2	6	12	Y	7	3	21				
Park	công viên					V	2	3	6	Y	6	3	18									Y	3	7	21	Y	7	4	28	Y	3	4	12	Y	2	7	14	Y	7	3	21				
Gates (large and small)	*Cánh cổng (lớn và nhỏ)*																																													
Hydraulic Cylinder	Xi lanh thủy lực																																										Y	7	3	21
Gates (large and small)	Cánh cổng (lớn và nhỏ)													Y	6	3	18					Y	3	6	18					Y	3	5	15	Y	2	5	10	Y	7	4	28	Y	7	3	21
Water tight gasket	Nước gasket chặt chẽ	Y	7	4	28	Y	2	6	12																																	Y	7	2	14
Electric Power	*điện*																																													
Transmission Lines	Đường truyền									Y	6	2	12					Y	7	7	49	Y	3	5	15					Y	3	5	15	Y	2	7	14								
Power Supply	Cung cấp năng lượng									Y	6	2	12					Y	7	7	49	Y	3	3	9									Y	2	3	6								
Standby Generators	Máy phát điện dự phòng																	Y	7	7	49													Y	2	3	6								
Transportation	*vận chuyển*																																													
Supplies Delivery	cung cấp vật tư									Y	6	2	12	Y	6	2	12					Y	3	7	21											Y	2	7	14								
Communications	*truyền thông*																																													
Telephone, Telemetry	Điện thoại, Từ xa									Y	6	2	12	Y	6	2	12	Y	7	7	49	Y	3	7	21					Y	3	5	15	Y	2	7	14								
Other Systems	*Hệ thống khác*																																												
Fire extinguishing systems	Hệ thống chữa cháy																																													
Operation systems	Hệ thống vận hành									Y	6	2	12	Y	6	2	12	Y	7	7	49	Y	3	5	15																				
Control Systems	hệ thống điều khiển																	Y	7	7	49	Y	3	7	21																				
Maintenance Systems & Procedures	Hệ thống bảo trì và thủ tục																																												
Monitoring systems	hệ thống giám sát									Y	6	2	12	Y	6	2	12	Y	7	7	49	Y	3	7	21									Y	2	7	14								

PIEVC Risk Assessment Matrix – Cai Lon-Cai Be Sluice Gate Project

1.4 Complexity

The project required that the project team travel to Vietnam, Uganda and Ethiopia. International business travel and logistics planning can be daunting. Travel preparation was not insignificant with regard to medical preparations, visa requirements and in-country travel logistics.

We were fortunate for our Vietnam trip to have on our team an expatriate Vietnamese who came to Canada at a young age as a refugee. While in-country she acted as translator and facilitated a variety of logistics using her personal connections. She was also able to make a number of presentations and facilitated discussions during a project workshop in Vietnamese.

For our Uganda and Ethiopia trips we were fortunate to be supported by the GIZ local staff who assisted us with in-country logistics planning.

All of our trips were very successful and the few incidents that deviated from our plans were not insurmountable with a coordinated effort between Wood, Engineers Canada, GIZ and local in-country

staff and assessment teams.

1.5 Meeting Owner's Needs

Engineers Canada is one of the more than 90 organizations that are members of the World Federation of Engineering Organizations (WFEO). Engineers Canada completed an eight-year term as host and chair of the WFEO Committee on Engineering and the Environment (WFEO-CEE) in December 2015. Over this period, one of the central themes that the WFEO-CEE pursued was to understand infrastructure climate vulnerability and risk internationally. As an outcome of this experience, the Vietnam and NBI projects were developed in a partnership between Engineers Canada and GIZ. The project objective was building of institutional and intellectual capacity for local organizations, engineers, planners and other technical practitioners and decision makers to undertake climate change vulnerability assessments.

Engineers Canada contracted with Wood, knowing its water resources infrastructure expertise and competence using the Protocol, to assist it to meet its obligations under the CSI Project to deliver PIEVC Protocol capacity building support services.

Wood's role was to provide mentorship, facilitation, advice, consultation and technical review services to the local Vietnamese and NBI assessment teams and workshop participants, and to develop, build and expand their capacity for water resources infrastructure vulnerability assessments using the PIEVC Protocol.

Wood assisted with the organization and facilitation of three workshops, one in Vietnam (Ho Chi Minh City) and two in Africa (Entebbe, Uganda and Addis Ababa, Ethiopia), and prepared all educational materials specific to engagement with the PIEVC Protocol. Wood support was further provided through 19 online webinars with project participants.

Successful Completion of Workshop #2 – Ho Chi Minh City, Vietnam - October 18, 2018