Document of
The World Bank

FOR OFFICIAL USE ONLY

Report No: PAD321

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED GRANT

FROM THE PILOT PROGRAM FOR CLIMATE RESILIENCE

OF THE STRATEGIC CLIMATE FUND

IN THE AMOUNT OF US$ 6.8 MILLION

TO

JAMAICA

FOR AN

IMPROVING CLIMATE DATA AND INFORMATION MANAGEMENT PROJECT

July 2, 2015

Environment and Natural Resources Global Practice
Caribbean Country Unit
Latin America and the Caribbean Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective June 4, 2015)

Currency Unit	=	Jamaican Dollar
JMD 100	=	USD 0.86
USD 1	=	JMD 115.78

FISCAL YEAR
April 1 – March 31

ABBREVIATIONS AND ACRONYMS

CARDI	Caribbean Agricultural Research and Development Institute
CC	Client Connection
CCD	Climate Change Division
CCCCC	Caribbean Climate Change Community Centre
CDEMA	Caribbean Disaster Emergency Management Agency
CEHI	Caribbean Environmental Health Institute
CIF	Climate Investment Funds
CIMH	Caribbean Institute for Meteorology and Hydrology
CMO	Caribbean Meteorological Organization
CRFM	Caribbean Regional Fisheries Mechanism
DA	Designated Account
DL	Disbursement Letter
DRM	Disaster Risk Management
EDMSS	Emergency, Disaster Management and Special Services Branch
ENSO	El Niño Southern Atlantic Oscillation
EU	European Union
GA	Grant Agreement
GCM	General Circulation Model
GDP	Gross Domestic Product
GOJ	Government of Jamaica
IADB	Inter-American Development Bank
ICDIMP	Improving Climate Data and Information Management Project
IECC	Information, Education, and Communications Campaign
IFR	Interim Financial Report
MSJ	Meteorological Service Jamaica
MLGCD	Ministry of Local Government and Community Development
MOAF	Ministry of Agriculture and Fisheries
MOH	Ministry of Health
MTR	Mid-Term Review
MWLECC	Ministry of Water, Land, Environment, and Climate Change
NEPA	National Environment and Planning Agency
NSDMD	National Spatial Data Management Division
ODPEM	Office of Disaster Preparedness and Emergency Management
PAD	Project Appraisal Document
PIOJ	Planning Institute of Jamaica, Ministry of Finance and Planning
PPCR	Pilot Program for Climate Resilience

RADA	Rural Agricultural Development Authority
SLR	Sea Level Rise
SPCR	Strategic Program for Climate Resilience
UNFCCC	United Nations Framework Convention on Climate Change
UWI	University of West Indies
WA	Withdrawal Application
WB	The World Bank
WMO	World Meteorological Organization
WRA	Water Resources Authority

Vice President:	Jorge Familiar
Country Director:	Sophie Sirtaine
Senior Global Practice Director:	Paula Caballero
Practice Manager	Emilia Battaglini (Acting)
Task Team Leader:	Enos E. Esikuri

TABLE OF CONTENTS

PAD DATA SHEET

Jamaica

Improving Climate Data and Information Management (P129633)

PROJECT APPRAISAL DOCUMENT

LATIN AMERICA AND CARIBBEAN
ENVIRONMENT AND RESOUCES GLOBAL PRACTICE

Report No.: PAD321

Basic Information			
Project ID	EA Category		Team Leader
P129633	B - Partial Assessment		Enos E. Esikuri
Lending Instrument	Fragile and/or Capacity Constraints [ ]		
Investment Project Financing	Financial Intermediaries [ ]		
	Series of Projects [ ]		
Project Implementation Start Date	Project Implementation End Date		
2-October-2015	31-October-2020		
Expected Effectiveness Date	Expected Closing Date		
1-October-2015	30-April-2021		
Joint IFC			
No			
Practice Manager/Manager	Senior Global Practice Director	Country Director	Regional Vice President
Emilia Battaglini	Paula Caballero	Sophie Sirtaine	Jorge Familiar

Approval Authority
Approval Authority
Board/AOB Decision

Recipient: Jamaica

Project Financing Data (in USD Million)					
[ ] Loan	[ ] IDA Grant	[ ] Guarantee			
[ ] Credit	[X] Grant	[ ] Other			
Total Project Cost:	7.50		Total Bank Financing:	6.80	
Financing Gap:	0.00				

Financing Source	Amount
Recipient	0.70
Strategic Climate Fund Grant	6.80
Total	7.50

Expected Disbursements (in USD Million)

Fiscal Year	2016	2017	2018	2019	2020	2021	
Annual	0.2	3.0	2.0	1.0	0.3	0.3	
Cumulative	0.2	3.2	5.2	6.2	6.5	6.8	

Institutional Data

Practice Area / Cross Cutting Solution Area

Environment & Natural Resources

Cross Cutting Areas

[X] Climate Change

[ ] Fragile, Conflict & Violence

[ ] Gender

[ ] Jobs

[ ] Public Private Partnership

Sectors / Climate Change

Sector (Maximum 5 and total % must equal 100)

Major Sector	Sector	%	Adaptation Co-benefits %	Mitigation Co-benefits %
Public Administration, Law, and Justice	Public administration-Information and communications	100	75	5
Total		100		

☐ I certify that there is no Adaptation and Mitigation Climate Change Co-benefits information applicable to this project.

Themes

Theme (Maximum 5 and total % must equal 100)

Major theme	Theme	%
Environment and natural resources management	Climate change	80
Social protection and risk management	Natural disaster management	15
Social protection and risk management	Vulnerability assessment and monitoring	5
Total		100

Proposed Development Objective(s)	
The project development objective is to improve the quality and use of climate related data and information for effective planning and action at local and national levels.	
Components	
Component Name	**Cost (USD Millions)**
Component 1: Upgrading Hydro-Meteorological Data Collection, Processing and Forecasting Systems	4.01
Component 2: Climate Resilient Planning and Hydro-meteorological Information Services	1.39
Component 3: Climate Change Education and Awareness towards Behavioral Change	0.72
Component 4: Project Management, Monitoring and Evaluation	0.68

Systematic Operations Risk-Rating Tool (SORT)	
Risk Category	**Rating**
1. Political and Governance	Moderate
2. Macroeconomic	Substantial
3. Sector Strategies and Policies	Low
4. Technical Design of Project or Program	Moderate
5. Institutional Capacity for Implementation and Sustainability	Moderate
6. Fiduciary	Moderate
7. Environment and Social	Moderate
8. Stakeholders	Low
OVERALL	Moderate

Compliance		
Policy		
Does the project depart from the CAS in content or in other significant respects?	Yes [ ]	No [X]
Does the project require any waivers of Bank policies?	Yes [ ]	No [X]
Have these been approved by Bank management?	Yes [ ]	No [ ]
Is approval for any policy waiver sought from the Board?	Yes [ ]	No [X]
Does the project meet the Regional criteria for readiness for implementation?	Yes [X]	No [ ]

Safeguard Policies Triggered by the Project	**Yes**	**No**
Environmental Assessment OP/BP 4.01	**X**	

Natural Habitats OP/BP 4.04		**X**
Forests OP/BP 4.36		**X**
Pest Management OP 4.09		**X**
Physical Cultural Resources OP/BP 4.11		**X**
Indigenous Peoples OP/BP 4.10		**X**
Involuntary Resettlement OP/BP 4.12		**X**
Safety of Dams OP/BP 4.37		**X**
Projects on International Waterways OP/BP 7.50		**X**
Projects in Disputed Areas OP/BP 7.60		**X**

Legal Covenants

Name	Recurrent	Due Date	Frequency
Implementation and Other Arrangements	**X**		Continuous

Description of Covenant

The Recipient shall establish and maintain a Project execution unit (PIU), the PPCR Steering Committee and cause the PIOJ to carry out the project with technical collaboration of Technical Implementation Agencies in accordance with the terms of the Operational Manual, as further described and set forth in Section I.A, B and C of Schedule 2 to the Grant Agreement (GA).

Name	Recurrent	Due Date	Frequency
Environmental and Social Safeguards	**X**		Continuous

Summary: The Recipient shall ensure and cause the PIOJ to ensure that the Project is carried out in accordance with the Environmental Management Framework, as further described and set forth in Section I.E of Schedule 2 to the GA.

Name	Recurrent	Due Date	Frequency
Project Reports	**X**		Annual

The Recipient shall prepare Project Reports and the Completion Report and furnish to the World Bank, as further described and set forth in Section II.A of Schedule 2 to the GA.

Conditions

Source Of Fund	Name	Type
PPCR	PIOJ Memorandum of Understanding (MOU)	Effectiveness

Description of Condition

The PIOJ MOU has been executed on behalf of the Recipient and PIOJ. Section 5.01 (b) of Article V of the GA.

Source Of Fund	Name	Type
PPCR	Retroactive Financing	Withdrawal

Description of Condition

Withdrawals up to an aggregate amount not to exceed $300,000 equivalent may be made for payments made prior to the date of the Grant Agreement but on or after May 22, 2015, for Eligible Expenditures.

Section IV. B.1 of Schedule 2 to the GA.

Team Composition

Bank Staff

Name	Title	Specialization	Unit
Enos E. Esikuri	Senior Environmental Specialist	Team Lead	GENDR
Keiko Ashida Tao	Environmental Specialist	Climate Change	GENDR
Makoto Suwa	Disaster Risk Management Specialist	Hydro-met	GCCDR
Michael J. Darr	Consultant	Environmental Safeguards	GENDR
Martin Henry Lenihan	Sr. Social Development Specialist	Social Safeguards	GSURR
Yingwei Wu	Senior Procurement Specialist	Procurement	GGODR
Kerry Natelege Crawford	Financial Management Specialist	Financial Management	GGODR
Tatiana O. de Abreu	Finance Officer	Disbursements	WFALN
Nightingale Rukuba-Ngaiza	Senior Counsel	Legal	LEGLE

Non Bank Staff

Name	Title	City

Locations

Country	First Administrative Division	Location	Planned	Actual	Comments
Jamaica	Kingston	Parish of Kingston	X		

I. STRATEGIC CONTEXT

A. Country Context

1. **Jamaica is a small Caribbean island country with a population of 2.715 million people (2013) and gross national income per capita of $5,220 (2013)[1].** The country is well endowed with natural resources – marine assets (fish, coral reefs and beaches), fertile soils and high value minerals. The key sources of foreign exchange are tourism (about 1.9 million tourists each year for the past 10 years), remittances, and bauxite mining (the fifth largest exporter of bauxite in the world.) The Millennium Development Goal of universal primary education has been achieved, life expectancy at birth is 73 years and the country is on track for eradicating extreme hunger. Jamaica's ranking on the United Nations' Human Development Index (HDI) in 2014 is 96th out of 187 countries with a score of 0.715, compared with the 1995 HDI of 0.728 and a ranking of 101 out of 159 countries.

2. **Jamaica's economic performance has been less than expected, despite Jamaica's rich endowment of natural assets, its proximity to US markets and foreign direct investment** (averaging 3.2% of GDP over the last five years). During 1973-2007, annual average economic growth was 0.8% while labor productivity declined by 1.5%. It is among the most indebted countries in the world with a public debt-to-GDP ratio at 137% in March 2015. The sustained, high public debt service obligations and associated large refinancing needs have spiked the country's risk premiums, partially crowding out and distorting private sector investment, and left the country vulnerable to shifts in market sentiment. Consequently, very low growth, high public debt, and serious social challenges have persisted over the past three decades.

3. **The poorest Jamaican households were disproportionately affected by the economic contraction.** Poverty continued to rise moving from 17.8% in 2010 to 19.9% in 2012. Among poor households, 52.3% was headed by females and the poverty rate for female-headed households also rose from 13.8% in 2010 to 15.9% in 2012. By region poverty remained highest in Rural Areas (21.3%) although it was slightly lower than in 2010 (23.2%). The unemployment rate was 14.3% in 2012 being higher among females (17.8%) than males (10.3%). Youth unemployment was high, 42.6% among young females compared to 27% among young males.

4. **Since May 2013, the Government of Jamaica (GOJ) has been undertaking strong macro-economic and financial sector regulatory reforms** to tighten fiscal policy and achieve increased local tax revenues, with support from an International Monetary Fund (IMF) US$932 million Extended Fund Facility for the period of April 2013 to March 2017. The World Bank (WB) and the Inter-American Development Bank (IDB) each indicated support of US$510 million to Jamaica for the same period. Together, the three multilateral organizations are supporting a set of ambitious structural reforms designed to stabilize the economy, reduce debt and create the conditions for growth and resilience. The GOJ is also implementing a comprehensive debt management strategy including the take out of high interest Government bonds with lower yielding, longer term debt, aimed at reducing public debt and containing public sector interest costs.

[1] World Development Indicators, The World Bank.

B. Sectoral and Institutional Context

5. **Jamaica is one of 18 countries[2] participating in the Pilot Program for Climate Resilience (PPCR).** The PPCR—a funding window of the Climate Investment Funds (CIF)—helps developing countries integrate climate resilience into development planning, provides incentives for scaled-up action, and initiates a shift from "business as usual" to broad-based strategies for achieving climate resilience at the national and regional levels. As Phase I of the PPCR, Jamaica developed the Strategic Program for Climate Resilience (SPCR) to assess sectoral vulnerabilities to climate impacts, identify priority sectors and action plans, and propose investment components for PPCR finance. The proposed Project is the first of the three investment projects identified under the SPCR. The Jamaica SPCR including the financing to these projects was approved by the CIF in October 2011.

6. **Natural disasters and vulnerability to climate change have been identified as major challenge to economic growth of Jamaica.** The country lies within a region of traditionally high hurricane activity and experiences frequent direct impacts and indirect storm damages. Between 2001 and 2012 Jamaica experienced 11 storm events (including 5 major hurricanes) and several flood events. These events combined resulted in loss and damage amounting to approximately J$122 billion[3]. In one case (Hurricane Ivan, 2004) the loss was equivalent to 8.0% of GDP. The damage and losses result in a heavy fiscal burden, increased indebtedness, and redirection of resources from medium-term development plans. Approximately 82% of the population lives in coastal towns and communities located within 5 km of the 1,022 km long coastline. The coastal zone contains an estimated 75% of productive industries and service sectors and is responsible for contributing an estimated 90% to the country's GDP. Settlement patterns and location of major infrastructure along the coast increase vulnerability to natural hazard impacts. Also, inadequately managed urban growth has contributed to unplanned settlements in marginal and environmentally sensitive lands in flood plains and on unstable slopes. Environmental degradation of watersheds and coral reefs has decreased the ability to provide critical environmental services such as coastal protection from storm surge.

7. **Jamaica's vulnerability to global climate change will likely increase in a number of ways.** Based on recent projections by the Intergovernmental Panel on Climate Change (2013), small island countries such as Jamaica will be severely threatened by the direct and indirect impacts of climate change, most of which are projected to accelerate in the coming decades. Jamaica is estimated to have a high economic risk exposure to two or more natural hazards: 96.3% of the national population is exposed to two or more hazards, as is 94.9% of the national territory and 96.3% of the country's GDP[4]. The World Bank's *Turn Down the Heat Report No. 3* (2014) identifies key climate risks in the Caribbean region to include higher El Niño Southern Oscillation (ENSO) and tropical cyclone frequency, precipitation extremes, drought, and heat waves. Data

[2] The Caribbean countries participating in the PPCR are: Jamaica, Haiti, St Lucia, Grenada, Dominica, and St. Vincent and the Grenadines. The PPCR is being implemented by the WB, the IDB, and other multilateral organizations and involves both public and private sector entities and Non-Governmental Organizations (NGOs).

[3] Derived from Damage and Loss Assessment Reports for various events, PIOJ.

[4] Disaster Risk Management in Latin America and the Caribbean Region: GFDRR Country Notes, Jamaica, 2010, Global Facility for Disaster Reduction and Recovery (GFDRR)/the World Bank.

from climate models downscaled[5] for Jamaica as part of the SPCR also indicates that the country likely will experience significant changes in temperature, precipitation and sea level rise by 2050. The models predict that by 2050 increased climate variability likely will result in 20% increase in the frequency of intense rains. Flooding of interior basins is common after intense rainfall due to a distinctive drainage pattern characterized by the mountainous interior surrounded by mostly narrow coastal plains. On the other hand, the country will be drier in the mean (up to 60% by 2080) due to a decrease in rainfall during the traditional wet period (May through November). These will lead to risks of reduced water availability, crop yields, food security, and coastal safety. Furthermore, the country will likely suffer from accelerated coastal erosion in some areas caused by sea level rise; increased flood risk leading to loss of land and disruption to productive sectors and social infrastructure, most importantly health centers and hospitals which directly impacts the population during and after major climate-related events; saline intrusion into coastal water tables; loss of protective coastal systems such as coastal vegetation and coral reefs partly due to higher ocean surface temperatures and acidification; consequently loss of livelihoods, especially in climate-and weather-sensitive sectors such as tourism, agriculture and fisheries. Slope instability is characteristic of many areas, and intense rainfall combined with deforestation and inappropriate land use practices gives rise to degraded conditions to make landslide vulnerability another feature of Jamaica's hazard profile.

8. **The poor are particularly vulnerable to climate change impacts due to the heavy reliance on climate sensitive sectors.** Groups that are vulnerable to climate change impacts include the rural population including farmers whose economic productivity are weather-dependent, providing the bulk of labor in food production activities and are most likely to be directly impacted by food security issues. Especially, a large proportion of the poor in Jamaica lives in upland areas and are engaged in climate-sensitive small-scale agriculture. Among the rural population (46% of total), poverty remains relatively high (21.3% in 2012) and women, who make up 48.1% of the rural poor, provide the bulk of labor in food production activities, and are the primary vendors of crops and of fish, are most likely to be directly impacted by food security issues. Also a large population of the poor living in coastal areas is exposed to risks of hurricanes and storm surges, and those living in watersheds are prone to water shortage or flooding. Moreover, poor areas have lower levels of protective infrastructure, and housing is of low quality and is much less likely to withstand a flood or hurricane. Climate-related disasters and climate change impacts will likely exacerbate existing gender inequalities as poor women are amongst the hardest hit by the effects.

9. **The proposed Project would establish the critical foundation for the country's efforts to integrate climate change in decision-making process by improving hydro-met data collection and capacity to deliver relevant information services.** Jamaica's current capacity to develop appropriate climate adaptation measures is critically limited due to inadequate capacity and resources to collect reliable climate data. Jamaica's hydro-met system managed principally by the Meteorological Service Jamaica (MSJ) and the Water Resources Authority (WRA) has deteriorated over time as a consequence of inadequate financial resources for appropriate levels of

[5] Global Circulation Models (GCMs) used for climate projections are run at coarse spatial resolution and need to be downscaled to better represent the influence of topography and regional climate patterns, especially for small islands, on both the average and variation in climate and to more accurately and completely assess future climate impacts.

maintenance or for replacement and expansion of the capital stock of equipment. The original network of 23 climatological stations has dwindled to six functioning stations[6]. The 16-year old Doppler Weather Radar at Cooper's Hill managed by MSJ is obsolete and subject to periodic malfunctions. Capacity to process hydro-met data, develop products, and deliver information and services is not at sufficient level. Upgrading these systems and providing necessary training to these public hydro-met data providers will greatly enhance the capacity of the country to predict and prepare for various climate-related and natural hazards. This is paramount for increasing the resilience of Jamaica to climate impacts and ultimately for promoting sustainable economic growth of the country.

10. **The health sector as well as agriculture and water sectors are among the priority sectors identified in the SPCR as vulnerable to climate change.** The proposed Project would support the preparation of vulnerability assessments of the selected priority sectors, particularly the health sector by supporting the preparation of a costed resilience strengthening plan for climate-proofing the nation's health facilities and operations. Jamaica's 2.7 million people are served by a health-care system comprising 313 health centers and 23 hospitals. The climate-proofing of the sector is currently marginal, resulting in substantial structural damages and disruption to business continuity in the event of hurricanes and natural disasters. Furthermore, the country has experienced many outbreaks of vector borne diseases, particularly dengue fever, and more recently, the Chikungunya Virus which are spread by mosquitoes. The climate is conducive to the development of the larvae which require sufficiently high temperatures and rainfall. Further increases in temperature coupled with unpredictable rainfall patterns are likely to exacerbate these conditions and result in increased incidence of diseases.

11. **The focus on agriculture and water sectors is equally critical** since (a) some of the most vulnerable and poor communities in Jamaica are farmers, (b) food security in Jamaica is closely linked to the impacts of climate variability and change (e.g., pests and increasingly longer droughts, floods, storms) which affect productivity, and (c) Jamaica is increasingly faced with either too much water (due to heavy and intense rainfall leading to floods) or too little water (due to frequent droughts). The economy-wide knock-on effects of reduced agricultural productivity and or too little/too much water tend to be negative almost always and in most cases increases the vulnerability of poor communities/households to climate related hazards. Jamaica's SPCR clearly articulated some of these issues and the Project is designed to contribute to implementing measures in areas that were consultatively identified in the SPCR as priority sectors.

12. **The methodologies and outcomes obtained under the proposed Project would be shared with and replicated by the Government and other players in other priority sectors identified in the SPCR** through the companion projects and other climate and disaster risk management initiatives in Jamaica. The other project proposed under the SPCR is *the Adaptation Program and Financing Mechanism for the PPCR Jamaica project* (formerly *the Institutional Mainstreaming and Sectoral Adaptation project* and *the Climate Change Adaptation and Disaster Risk Reduction Financing project*) (US$10 million in loan and US$7.90 in grant) supported by the IDB. The other complementary operations in Jamaica include *Enhancing the Resilience of the Agriculture Sector and Coastal Areas to Protect Livelihoods and Improve Food Security* (Adaptation Fund, US$9.97 million grant), *the Promoting Community-based Climate Resilience in the Fisheries Sector Project* (WB P151302, US$5 million grant), *the Adaptation Program and*

[6] Under Phase I of the PPCR, the expansion and upgrading of the network commenced.

Financing Mechanism for the PPCR Jamaica Project (IDB, US$17.9 million grant and loan), and the Caribbean regional-track PPCR project (IDB, US$10.5 million grant) (see Annex 2 for more details).

C. Higher Level Objectives to which the Project Contributes

13. **The proposed Project would directly contribute to the Government's national strategy in addressing climate change—*Vision 2030 Jamaica - National Development Plan,* specifically Outcome No. 14: Hazard Risk Reduction and Adaptation to Climate Change.** *Vision 2030 Jamaica* – National Development Plan sets out that this is to be achieved through "greater emphasis on hazard risk management activities and programmes for reducing our existing and future vulnerability. …[I]ncorporate climate change scenarios in future economic and land use planning and provide a framework to … reduce the risks associated with natural hazards by integrating hazard considerations into our country's development planning".

14. **The Project objective is aligned with the PPCR's objective to pilot and demonstrate ways in which climate risks reduction and resilience building may be integrated into core development policies and plans at the national and local levels.** The proposed activities are also in concert with the five thematic areas of the Jamaica SPCR, namely (i) mainstreaming climate change into Jamaica's planning and policy formulation processes; (ii) strengthening institutional arrangements to ensure the effective mainstreaming of climate change; (iii) building capacity for climate data management, forecasting and planning; (iv) facilitating sectoral adaptation measures; and (v) climate change education and awareness. The Project's awareness program will use proven innovative approaches including the use of demonstration projects and the creative music/arts. The PPCR financing will cover the additional costs of "public good" benefits from the proposed activities to update and rehabilitate of hydro-met networks, flood and drought early warning messaging, and strategic sector planning of pre-emptive humanitarian responses.

15. **The Project's goal to help the country transform to a climate resilient development path is consistent with the PPCR objective and the WB's twin goals to end extreme poverty within a generation and boost shared prosperity in a sustainable manner** by directly supporting the vulnerable groups of the Jamaican population to be able to utilize improved climate and weather information and to adapt current and future livelihood activities to the variability brought about by climate change (see Paragraph 7 for the description of vulnerable groups.)

16. **The proposed Project is also consistent with the World Bank Group's Country Partnership Strategy (CPS) for Jamaica FY2014-2017** (Report No. 85158-JM, discussed by the Executive Directors on April 29, 2014) that underscores the need to addressing climate change vulnerabilities as a condition for fostering sustained improvements in shared prosperity. The proposed Project would contribute to achieving the CPS' Theme 3: Social and Climate Resilience, Outcome 8: Improved institutional capacity to plan and respond to climate change events and natural disasters, in particular (i) building institutional capacities to identify, assess and understand disaster and climate risks in terms of their economic and fiscal impacts.

II. PROJECT DEVELOPMENT OBJECTIVES

A. PDO

15. The Project Development Objective (PDO) is to improve the quality and use of climate related data and information for effective planning and action at local and national levels.

B. Project Beneficiaries

16. **The main beneficiaries of the proposed Project would be public sector providers of weather, climate, and hydrological data and related information services, and its users in Jamaica and elsewhere.** The primary public sector provider is the Ministry of Water, Land, Environment and Climate Change (MWLECC), in particular the Meteorological Service Jamaica (MSJ) and the Water Resources Authority (WRA) which are responsible for data collection, processing, management, and operation and maintenance (O&M) of equipment. MSJ and WRA would benefit from capacity building and direct investments to be made in new and replacement equipment. These investments also would benefit the data collection needs of the Rural Agricultural Development Authority (RADA) in the Ministry of Agriculture and Fisheries (MOAF) and the information management capacity of the climate and risk data node of the National Spatial Data Management Division (NSDMD) under the MWLECC.

17. **Various end users with different intentions would benefit from hydro-met and agro-met data and information services**, including the agricultural commodity boards and farmers, the Ministry of Health and health facilities, tourism centers (hotels), civil aviation authority and airlines, and the Coast Guard. It would also provide the data sets needed for the economic activities of the private sector such as insurance, construction, and engineering companies. More broadly, given the public goods nature of hydro-meteorological services, the population as a whole would benefit from better warnings of hydro-meteorological hazards and more accessible, timely and quality-assured climate information and services (see Annex 3 for more details).

18. **Climate-related disasters and climate change impacts may exacerbate existing gender inequalities as women**, especially poor women, lacking capital assets buffers[7] and access to credit, are often times amongst the hardest hit by the effects. In Jamaica, most of the women involved in agriculture are practicing subsistence farming and many are involved in the services sectors and so are at higher risk than men to unemployment and income loss as a result of climate change impacts. Improvement in the climate information database and institutional mechanisms for effectively disseminating early warning messages and agricultural knowledge and adaptation interventions would assist poverty reduction and food security issues and by extension, be of direct benefit to both male and female-headed households, agricultural workers and fishers/fish vendors.

19. **There would also be considerable benefits to the international hydro-met community** which would be able to access more reliable observation data from the Jamaica territory, contributing to more accurate regional forecasting and planning throughout the Caribbean region. Particularly, the partners of the PPCR Caribbean Regional-track project, including University of West Indies (UWI), Caribbean Institute for Meteorology and Hydrology (CIMH), Caribbean Meteorological Organization (CMO), Caribbean Agricultural Research and Development Institute

[7] The average land space utilized by female farmers is 1.4 hectares in comparison to an average of 2.6 hectares of land cultivated by male farmers.

(CARDI), Caribbean Regional Fisheries Mechanism (CRFM), Caribbean Environmental Health Institute (CEHI), and Caribbean Disaster Emergency Management Agency (CDEMA) would directly benefit from the outcomes of the Project.

C. PDO Level Results Indicators

20. The key performance indicators for the proposed Project are the following:

(i) Increased satisfaction of the users of improved climate data and information services[8];
(ii) Integration of climate data and information into a health sector plan[9]; and
(iii) Number of people (disaggregated by gender) supported by the Project to cope with climate change and risks, specifically through targeted early warning messaging for vulnerable groups and other measures[10].

III. PROJECT DESCRIPTION

A. Project Components

21. **Component 1: Upgrading Hydro-Meteorological Data Collection, Processing and Forecasting Systems (US$4.009 million).** This component will support investments for upgrading and providing critically needed new equipment, systems, and operator training for data collection, and processing for improved hydro-meteorological and agro-meteorological forecasts in order to ultimately enhance the availability and reliability of data for climate change scenario modelling, risk analysis and warning systems, and knowledge sharing. The Project will support carrying out activities to upgrade existing and/or provide new systems for hydro-meteorological data collection, processing and forecasting, including: (a) supplying and installing equipment for sea-level monitoring, meteorological, hydrological, and agro-meteorological activities, provision of training for staff of MSJ, WRA, RADA and voluntary observers of the monitoring network on operation and maintenance of the equipment; and purchasing of spare parts; (b) replacing the outdated weather Doppler radar, including rehabilitation of the Cooper's Hill station facility and training of MSJ staff in operation and maintenance of the new radar; (c) strengthening the capacity of staff of MSJ, WRA and RADA on data management, quality assurance of data collection, processing, and weather forecasting through provision of consulting services and training.

22. **Component 2: Climate Resilient Planning and Hydro-meteorological Information Services (US$1.386 million).** This component will provide technical assistance support to promote Jamaica's readiness for climate events through: (a) updating the downscaled high resolution[11] climate change scenarios and using said scenarios to prepare the State of the Jamaican Climate 2015 and 2019 reports (including the summary for policy makers); and provision of

[8] This contributes to PPCR Core Indicator #4: Extent to which vulnerable households, communities, businesses and public sector services use improved PPCR supported tools, instruments, strategies and activities to respond to climate variability or climate change.
[9] This contributes to PPCR Core Indicator #1: Degree of integration of climate change in national, including sector, planning.
[10] This contributes to PPCR Core Indicator #5: Number of people supported by the PPCR to cope with the effects of climate change.
[11] The country specific modeling would be to a 10 km^2 grid with some mid-century time slices at 4 km^2 grid where possible. The resolution will depend on available data and cost.

training on sector specific climate resilient planning based on said scenarios; (b) preparing national vulnerability assessments in selected priority sectors to complement the modeling outputs mentioned above and to define priorities and actions on climate resilience; (c) preparing detailed health sector vulnerability assessments and costed resilience strengthening plans to assist health facilities and operations withstand and respond to climate related hazards; (d) carrying out a community-based risk profiling to assess the communities' vulnerability to various climate related hazards and developing early warning messaging for vulnerable groups; and (e) upgrading the multi-agency climate and natural risk data and information sharing system to integrate climate data and making the data user friendly and accessible to the public.

23. **Component 3: Climate Change Education and Awareness towards Behavioral Change (US$0.725 million).** This component will provide technical assistance support to promote climate change awareness at the national and local levels through (a) carrying out climate change information, education and communication (IECC) campaigns, and (b) conducting targeted attitude and behavioral change initiatives to address climate change adaptation needs and influence behavioral change of targeted groups, as part of the Communications Strategy Action Plan developed under the PPCR Phase 1. Campaigns are aimed at influencing and bringing about changes in attitudes and behavioral practices to assist targeted groups to adopt practical means of coping with severe weather events, climate variability and climate change.

24. **Component 4: Project Management, Monitoring and Evaluation (US$0.68 million).** This component will provide support to PIOJ for Project implementation, including overall technical management, financial management, procurement, environmental and social safeguards implementation, monitoring and evaluation of Project activities, data collection, supervision of works through the provision of consulting services, non-consulting services, goods, and Operating Costs.

B. Project Financing

25. The Project would be financed by the PPCR under the Strategic Climate Fund Grant of the Climate Investment Funds in the amount of US$6.8 million and in-kind contribution by the Government in the amount of US$0.7 million. The financing instrument would be an Investment Project Financing.

Table 1: Project Cost and Financing (US$ million)

Project Components	Total Project Cost	PPCR Financing	% Financing
1. Upgrading Hydro-Meteorological Data Collection, Processing and Forecasting Systems	4.009	4.009	100
2. Climate Resilient Planning and Hydro-meteorological Information Services	1.386	1.386	100
3. Climate Change Education and Awareness towards Behavioral Change	0.725	0.725	100
4. Project Management, Monitoring and Evaluation	1.38	0.68	49%
Total Costs			
Total Financing Required	**7.5**	**6.8**	91%

26. Withdrawals up to an aggregate amount not to exceed $300,000 equivalent may be made for payments made prior to the date of the Grant Agreement but on or after May 22, 2015, for Eligible Expenditures.

C. Lessons Learned and Reflected in the Project Design

27. **It is important to engage partner agencies and community groups from the beginning of the project preparation in order to foster their buy-in.** (EU/Global Climate Change Alliance: Climate Change Adaptation and Disaster Risk Reduction Project in Jamaica[12].) Since the proposed Project will be implemented by multiple agencies, a Focal Point and a core team in each Technical Implementing Agency have been designated. The Planning Institute of Jamaica (PIOJ) managed the Project Preparation Grant for the proposed Project and has gained the capacity to handle the fiduciary responsibilities which will be conducive to the readiness for the Project implementation. As part of Project preparation, Panos Caribbean—a non-governmental organization (NGO) specialized in mass communication on sustainable development issues—was involved to advance communication and awareness raising activities.

28. **The readiness and ability of countries to increase their resilience to climate change impacts greatly depends on the institutional capacity, knowledge of vulnerabilities and risks and their preparedness to reduce these vulnerabilities and risks.** (WB: Mainstreaming Adaptation to Climate Change Project, 2009, Report number: ICR00001163). These are the core design of the proposed Project. The proposed Project has already developed a Communications Strategy Action Plan in order to foster true partnership of various stakeholders and create strong country ownership.

29. **The Project-funded behavioral change campaigns would consider different strategies for men and women** based on their different needs and circumstances and will make use of lessons learnt from recent climate change awareness projects to reach vulnerable groups. (USAID/Jamaica Rural Economy and Ecosystems Adapting to Climate Change Project, the Voices for Climate Change, and EU Communication Project)

30. **In 2005, a baseline knowledge, attitudes and practices (KAP) survey was carried out to ascertain knowledge and views in Jamaica regarding the causes and impacts of climate change and the measures people could take in their own lives to adapt.** A subsequent KAP survey was carried out in 2012 under Phase 1 of the PPCR. Recommendations emerging from the results of the 2005 and 2012 surveys indicated that there was need for "creative and bold" messaging to change present behavioral practices**,** to foster stronger inter-agency collaboration and partnership to implement climate readiness strategies and to formulate practical interventions for changed practices. The proposed Project would focus on influencing changes in attitudes and promoting specific behavioral practices amongst targeted groups to adopt practical means of coping with climate change.

[12] http://www.gcca.eu/national-programmes/caribbean/gcca-jamaica

IV. IMPLEMENTATION

A. Institutional and Implementation Arrangements

30. **The Planning Institute of Jamaica (PIOJ)**, a statutory body within the Ministry of Finance and Planning, is the executing agency for the proposed Project. The PIOJ plays a number of critical roles including sustainable development planning, overseeing the implementation of *Vision 2030 Jamaica – National Development Plan*, and is the national Focal Point for the PPCR and for the implementation of the proposed Project developed under the SPCR[13]. As the executing agency, the PIOJ will establish a central executing and fiduciary services unit (PIU) to be responsible for coordinating all activities of the proposed Project and to provide fiduciary support to the Technical Implementing Agencies.

31. **The Government has established an umbrella PPCR Steering Committee (PPCR-SC)** to serve as the main body responsible for providing advice and oversight to the implementation of PPCR and other associated projects. Under the proposed Project, the PPCR-SC would serve as the Project Steering Committee to be responsible for ensuring that the Project is effectively and expeditiously implemented in line with its development objectives, results framework and budget, and for ensuring coordination among the various agencies and addressing any inter-agency strategic level issues and risks that may adversely affect the implementation of the Project. The PPCR-SC will review relevant Project documents for endorsement on an 'absence of objection' basis (AOB) within a defined timeframe, not to exceed 8 working days in order to ensure expeditious execution of the Project. The PPCR-SC is chaired by the PPCR Focal Point—currently the Deputy Director General, Sustainable Development and Regional Planning of the PIOJ. Members of the PPCR-SC are drawn from a cross-section of stakeholders with technical interest in and knowledge of natural hazards, risk and climate change issues, including relevant Government Ministries, Departments and Agencies, private sector bodies, academia, and civil society. International development partners are offered observer status on the Committee.

32. **Direct responsibility for and technical oversight of the various components of the Project will be assumed by the respective Technical Implementing Agencies**, namely MSJ, WRA, Climate Change Division (CCD) and NSDMD under the MWLECC, RADA under the MOAF, the Office of Disaster Preparedness and Emergency Management (ODPEM) under the MLGCD, and the Emergency, Disaster Management and Special Services Branch (EDMSS) under the Ministry of Health (MOH). Each Technical Implementing Agency has nominated a Project Focal Point to coordinate and oversee day-to-day Project activities and report to the PIU.

B. Results Monitoring and Evaluation

33. **The PIOJ through the PIU in collaboration with the Technical Implementing Agencies will be responsible for the overall monitoring and evaluation (M&E) of the Project activities**. The M&E plan will form a part of the annual work plan of the PIU and the Technical Implementing Agencies. The M&E indicators, targets, data collection methodology, etc. are presented in Annex 1 Results Framework. M&E of Project implementation will be conducted

[13] In addition to the three PPCR-funded projects, the PIOJ managed the recently completed EU-funded *Climate Change Adaptation and Disaster Risk Reduction Project* and is currently managing Jamaica's Adaptation Fund Program: *Enhancing the Resilience of the Agriculture Sector and Coastal Areas to Protect Livelihoods and Improve Food Security*.

through: (a) routine activities of the PIU and the Technical Implementing Agencies; (b) semi-annual progress reviews by the PPCR-SC; (c) progress reviews during World Bank implementation support missions; (d) mid-term review of Project implementation; and (e) terminal evaluation to be conducted jointly by the PIOJ/PIU and the Technical Implementing Agencies, and the PPCR-SC. The Implementation Completion and Results Report (ICR) will be prepared within six months after closing of the Grant based on, among other things, the terminal evaluation report prepared by the Government.

C. Sustainability

34. **The sustainability of the proposed Project is expected to be high**. This is because the Project is designed as part of a larger climate resilience program for Jamaica, namely the PPCR, to complement the other PPCR projects and the Caribbean Regional-track project. This would provide the proposed Project a better chance of sustainability than being a stand-alone operation. The Project's outcomes would also contribute to the on-going and future WB investment projects on climate resilience, disaster risk management and community development. These projects altogether would build long-term climate resilience of Jamaica's economy and society (see Section B and Annex 2).

35. **Ultimately, it is the demand from users (other government agencies and the public at large) for useful end-products that will ensure sustainability of the investments.** To this end, detailed technical studies were undertaken and recommendations agreed with the Implementing Agencies as part of Project preparation, e.g., required specifications for hydro-met equipment based on the international standards, the coverage needs of various types of equipment; the standardization of equipment (for ease of operators and holding of spare parts); the introduction, where appropriate, of specialized open-source software; and the coordinated record keeping for long term/historic data collection.

36. **Also, the Project would seek to secure increased resources for the data provider agencies (MSJ, WRA, and RADA) for the operation and maintenance (O&M) of the modernized observing system to ensure its sustainability.** This is a critical issue which is often overlooked in many developing countries, leading to inadequate conditions after the Project financing ends. Considering the current fiscal constraints, it might affect the sustainability of the Project investments. However, the Government has been securing the O&M budget in the past for more than 20 years and continues to show its willingness to support the O&M costs. Additionally, updating the equipment with newer technologies would indeed result in less O&M costs.

V. KEY RISKS AND MITIGATION MEASURES

A. Overall Risk Rating and Explanation of Key Risks

37. **The overall risk rating of the Project is Moderate.** Due to strong macroeconomic and financial sector regulatory reforms currently taking place in the country, the macroeconomic risk is considered substantial. Although the budget for the Project has been programmed in Jamaica's Public Sector Investment Program for the next five years in which the Project is expected to be implemented, a fiscal space in the Capital Budget will need to be secured and authorized by the Ministry of Finance and Planning (MOFP) for the planned project activities each fiscal year. If the fiscal space is not sufficient, it could potentially cause delay in procurement processes,

consequently in implementation progress. The Planning Institute of Jamaica (PIOJ) will work closely with the Ministry of Finance and Planning early on in the budgeting process each year to secure the necessary fiscal space.

38. **Investments are straightforward and build on existing hydro-met data collection networks,** proven regional scale climate modeling techniques and vulnerability assessments, and pre-project phases of public information, education and communications campaigns. The PIOJ has a robust system for fund management. The multi-sectoral PPCR-SC will regularly oversee Project management. Lack of experience and coordination among different implementing agencies are considered a moderate risk. The capacity risk would be mitigated by establishing and locating a dedicated executing unit (PIU) in the PIOJ staffed with the requisite managerial and fiduciary competencies to service all the Technical Implementing Agencies and designating a Focal Point in each Technical Implementing Agency. The PIOJ has successfully executed and coordinated the Project Preparation Grant of the proposed Project and several World Bank-funded projects in the past, and so is able to provide leadership and guidance to the Technical Implementing Agencies. In addition, the PPCR-SC will ensure inter-agency coordination and address cross-sectoral matters requiring higher level management attention.

VI. APPRAISAL SUMMARY

A. Economic and Financial Analysis

38. **Even with the most conservative set of assumptions, including an assumption that no climate change takes place and that the benefits of the Project only last for 5 years, the benefit-cost ratio for the Project is 3.2, i.e., the expected benefits from the Project are 3.2 times higher than the expected costs of US$6.8 million (in present value terms)** (see Annex 5 for details). Extending the period over which the benefits of the Project accrue from five years to a more plausible 10 years or 15 years increases the benefit-cost ratio to 6.6 and 8.7 respectively with the same assumption that no climate change takes place. Thus, the estimates derived indicate that the Project is economically justified even in the absence of climate change. Acknowledging climate change, and the concomitant increase in the frequency or severity of extreme meteorological events, simply increases the benefit-cost ratios for the Project, increasing its estimated economic justification.

39. **The impact of the Project's financing on Jamaica's debt sustainability would be positive given that the Project is fully grant funded.** The Grant for the Project is US$6.8 million over a 5 year period with no repayments or commitment fee required. The time scale of the PPCR Grant aligns favorably with the structural reform program aimed at swapping external debt. One of the first tasks of the PIU will be to work with each of the Technical Implementing Agencies to finalize their respective work plans taking into account not only the capacities of each agency but also, with guidance from the PIOJ, annual expenditure ceilings set for the country.

B. Technical

40. **The proposed Project investments are technically sound.** The Project design was informed by previous research carried out under PPCR Phase 1 and by a detailed hydro-met assessment of the existing data collection network and capabilities of the responsible agencies. The Project's three main components reflect the needs of MSJ, WRA, RADA, CCD, ODPEM and

NSDMD to improve their hydro-met services in a comprehensive manner, including replacement of obsolete hydro-met equipment, capacity building and serving the users of climate data with more accurate and timely information.

41. **Design parameters of the meteorological and hydrological instruments will follow the World Meteorological Organization (WMO) standards.** The performance of the forecasting and hydro-met system will be benchmarked to internationally recognized measures. Technical specifications for the major equipment purchases were scoped during preparation and will be completed by the Technical Implementing Agencies in consultation with regional authorities during the first 12 months of implementation. During Project preparation, emphasis was placed on the specifications and location of hydro-met equipment that will not only underwrite MSJ's and WRA's existing weather forecasting capabilities but also fill spatial and temporal gaps in climate data that is needed for verifiable climate change scenario modeling at a country scale. The Project will support investments in robust climate modeling and vulnerability assessments that will involve knowledge exchange between the Government agencies and the University of the West Indies (Mona) and other leading regional scientific institutes.

C. Financial Management

42. **The Planning Institute of Jamaica (PIOJ) will be responsible for the Project fiduciary functions.** A Financial Management (FM) capacity assessment of the FM arrangements existing at the PIOJ was conducted by the Bank during the Project preparation. The FM arrangements were deemed to be adequate and are acceptable as per the requirements of the WB Operational Policy (OP) 10.00 (Investment Project Financing). The FM function will be intertwined with the PIOJ's existing FM structure. The current segregated USD designated account used for the PPF will be used for this grant, and a Project local currency account will be opened once it becomes effective. Annual external audits of the Project's financial statements covering the period ending March 31st are required and should be submitted to the World Bank within 6 months after period end. Quarterly Unaudited Interim Financial Reports (IFRs) should be submitted to the Bank 45 days after each quarter period end. The Bank will monitor the project FM risk during Project implementation (see details in Annex 3).

D. Procurement

43. **The Bank conducted an assessment of the capacity of the PIOJ during the Project preparation as the entity to implement procurement actions under the Project.** The assessment reviewed the organizational structure for implementing the Project and the interaction between the PIOJ with related Project agencies in terms of organizing evaluation committees. The assessment found that there is adequate capacity in the PIOJ to carry out the procurement. The PIOJ confirms that the Bank's procurement policies and procedures will be used for the implementation of the proposed Project. Procurement under the Project will be carried out by the PIOJ Internal Procurement Committee, supported by the PIU in line with the Bank Guidelines (see details in Annex 3).

E. Social (including Safeguards)

44. **Given that generation and use of hydro-met data is a public good, the entire population of Jamaica may be expected to benefit from or be impacted by the Project.** Project

design drew on the extensive coverage and findings of the 2005 and 2012 *Climate Change Knowledge, Attitude and Behavioral Practice (KAP) Surveys*. Also, as part of Project preparation, communication and awareness raising activities were successfully implemented by Panos Caribbean—a non-governmental organization (NGO) specialized in mass communication on sustainable development issues. Information generated and made accessible under the Project will be transmitted through the community access points at schools, public libraries, post offices and other centers across the country in order to reach the vulnerable groups throughout the country. Targeted groups, including teachers, school children, and farmers (small and large scale) will receive tailored awareness raising messages and tools to address their specific adaptation needs. The public will also participate in the monitoring and evaluation through the user surveys to measure satisfaction of the data and information produced and made available under the Project. Although the social impact of the Project is expected to be positive, as a precaution, preliminary screening was carried out during Project preparation and it is not anticipated that the Project will result in any negative social impacts.

45. **No involuntary resettlement will take place under the Project, thus the WB OP 4.12 (Involuntary Resettlement) is not triggered.** At most the Project will only involve minor civil works associated with the installation of weather recording equipment and refurbishment of existing radar and tidal gauge equipment and structures. During Project preparation, the sites for Project activities were screened for potential resettlement impacts, and none were identified.

46. **In Jamaica, men and women play different roles within the private and public spheres and are affected differently by climate-related disasters and impacts.** The vulnerability assessments supported by the proposed Project will take into consideration gender aspects and differential vulnerability profiles depending on socio-economic background. Also, the attitude and behavioral change campaigns will target both men and women and be tailored specifically for that purpose.

F. Environment (including Safeguards)

47. **The Project is classified as an Environmental Risk Category B project.** The WB OP/BP 4.01 (Environmental Assessment) applies to the Project. Works and activities that could have potential negative impacts were identified during Project preparation, which include refurbishment of an existing radar facility and upgrading of existing hydro-met stations. Since most of the activities will involve upgrading of existing equipment at existing sites, the expected environmental footprint of any installations would be minimal/negligible, with standard measures adequate for management of any environmental issues arising.

48. **During Project preparation, consultations took place with all of the Technical Implementing Agencies (generators of data and providers of information) and the National Environment and Planning Agency (NEPA).** Site inspections were made to the replacement radar equipment (Cooper's Hill) and installation of a tidal gauge (Port Royal or other suitable locations), as well as select hydro-met monitoring stations. A preliminary screening was carried out in the field to guide the preparation of an Environmental Management Framework (EMF) in accordance with OP/BP 4.01. The public consultations for the EMF were held at the PIOJ in January 2014 and the National Volunteer Center of Council of Voluntary Social Services in March 2014. Participants included sector representatives, community development agencies, community based groups, non-governmental organizations, citizens of affected communities, statutory

agencies of the GOJ, Parish Council, and departments of the University of the West Indies. Although natural habitats and physical cultural resources are not expected to be affected, exclusion criteria were developed in the EMF to ensure that no activities that negatively impact natural habitats or physical cultural resources are financed by the project. In addition, chance finds procedures are also included in the EMF.

49. **Many of the activities funded are consultancy studies and technical assistance with minimal adverse environmental impacts.** Environmental concerns that may arise are related to Component 1 where the Project will finance minor civil works associated with the upgrading of hydro-met monitoring stations and refurbishment of an existing radar facility. The adverse environmental impacts associated with the small works are expected to be limited, short lived and can either be avoided altogether through careful designs and good construction practices, or reversed or otherwise effectively mitigated as they occur during construction by use of environmental mitigation requirements that will be attached to all works contracts.

50. **As the precise location of any new hydro-meteorological equipment to be installed will only be known during Project implementation, an EMF was prepared by the GOJ, approved by the Bank and disclosed by the GOJ as part of Project preparation.** The EMF requires each sub-component to undergo environmental screening of its location and type of activity, in order to identify relevant environmental concerns and, as needed, to prepare environmental requirements to be attached to all small works contracts. The Technical Implementing Agencies (i.e., MSJ, RADA and WRA) will manage the screening and monitoring of civil works activities using the EMF, and the Project will be subjected to two environmental evaluations by the Bank in the mid-term review and last year of implementation.

G. World Bank Grievances Redress

51. Communities and individuals who believe that they are adversely affected by a WB-supported project may submit complaints to existing project-level grievance redress mechanisms or the WB's Grievance Redress Service (GRS). The GRS ensures that complaints received are promptly reviewed in order to address project-related concerns. Project-affected communities and individuals may submit their complaint to the WB's independent Inspection Panel which determines whether harm occurred, or could occur, as a result of WB non-compliance with its policies and procedures. Complaints may be submitted at any time after concerns have been brought directly to the WB's attention, and Bank Management has been given an opportunity to respond. For information on how to submit complaints to the WB's corporate GRS, please visit http://www.worldbank.org/GRS. For information on how to submit complaints to the WB Inspection Panel, please visit www.inspectionpanel.org."

Annex 1: Results Framework and Monitoring

JAMAICA: IMPROVING CLIMATE DATA AND INFORMATION MANAGEMENT PROJECT

Project Development Objective: To improve the quality and use of climate related data and information for effective planning and action at local and national levels.

Indicator Name	Core	Unit	Cumulative Target Values						Frequency	Data Source/ Methodology	Responsibility for Data Collection
			Baseline	YR1	YR2	YR3	YR4	End Target			
Project Development Objective Indicators											
Increased satisfaction of the users of improved climate data and information services	*Contributes to PPCR Core Indicator 4*	% increase	TBD in YR 3 when the information platform and other systems are upgraded			Baseline TBD (Platform and other systems upgraded)	+10% of baseline	+15% of baseline	Annual starting in YR3	Survey	NSDMD, CCD
Integration of climate data and information into a health sector plan	*Contributes to PPCR Core Indicator 1*	Yes/ No	Climate lens noted but not in detail			A Health Sector Vulnerability Assessment developed		Phased and costed investment plan developed	Annual starting in YR3	Project progress reports	EDMSS
Number of people (disaggregated by gender) supported by the Project to cope with climate change and risks, specifically through targeted early warning messaging for vulnerable groups and other measures	☒ *Contributes to PPCR Core Indicator 5*	Number of people	0			TBD (of which 30% is women)	TBD (of which 30% is women)	TBD (of which 30% is women)	Annual starting in YR3	Project progress reports	RADA, MSJ, WRA, CCD, ODPEM, NSDMD, EDMSS
Intermediate Results Indicators: Component 1: Upgrading Hydro-Meteorological Data Collection, Processing and Forecasting Systems											
1.a: Improved quality (*i.e. accuracy, lead time, and coverage*[14]) of extreme weather forecasts[1]	*Contributes to PPCR Core Indicator 3*	% increase	TBD (No verification system in place)	Introduce forecast verification system	24h forecast: +1% of baseline	24h forecast: +2% of baseline	24h forecast: +3% of baseline	24h forecast: +5% of baseline	Annual	Project progress reports	MSJ

[14] Coverage means reducing gaps of coverage.

1.b: Improved quality[15] (*i.e. data from weather stations reaching data processing center in line with WMO performance standard*) of climate recording network and data collection instruments	*Contributes to PPCR Core Indicator 3*	% increase	MSJ - TBD; WRA - TBD	Equipment procured and installed	+3% of baseline	+7% of baseline	+ 11% of baseline	+ 15% of baseline	Annual	Project progress reports	MSJ, WRA, RADA
1.c: Technical staff and other personnel (e.g., voluntary observers) trained under the Project	☒	number of people	0	100	150	200	250	300	Annual	Project progress reports	MSJ, WRA, RADA
1.d: Percentage of meteorological, hydro-met and agromet equipment installed and operational	*Contributes to PPCR Core Indicator 3*	% of planned procure-ment	0	20%	75%	100%	-	100%	Annual	Project progress reports	MSJ, WRA, RADA
1.e: Doppler Radar installed and operational	*Contributes to PPCR Core Indicator 3*	Yes/No	Radar is obsolete	Specs defined	Yes	-	-	Yes	Annual	Project progress reports	MSJ
Intermediate Results Indicators: Component 2: Climate Resilient Planning and Hydro-meteorological Information Services											
2.a: Accurate and high resolution national and sectoral climate change scenarios developed	*Contributes to PPCR Core Indicator 3*	Yes/No	Low resolution (50 km) scenarios available		High resolution CC scenarios for short-, mid- and long-term developed		Update the scenarios with more data	Accurate and high resolution CC scenarios for 2030, 2050 and 2080 available	MTR and EOP	Project progress reports	PIOJ
2.b: Improved access to early warning messaging for targeted vulnerable groups	*Contributes to PPCR Core Indicator 3*	# of targeted vulnera ble groups	TBD			TBD (to be defined in YR1)		TBD (to be defined in YR1)	Annual	Project progress reports	ODPEM, RADA

[15] Quality improvement is measured by calibration of equipment as a proxy.

Intermediate Results Indicators: Component 3: Climate Change Education and Awareness towards Behavioral Change											
3.a: % increase in climate change knowledge, attitude and practice (KAP)	*Contributes to PPCR Core Indicator 4*	% increase	2012 KAP survey			+10% of baseline		+20% of baseline	MTR and EOP	KAP survey	CCD

NOTES:

1: Verified using standard methods for forecast verification WMO WWRP-WCRP.

.

Annex 2: Detailed Project Description

JAMAICA: IMPROVING CLIMATE DATA AND INFORMATION MANAGEMENT PROJECT

1. **Jamaica, a small island developing state, is particularly vulnerable to climate change and climate related disasters.** Over the 12 year period 2001-2012, hydro-meteorological hazards alone have caused damage and losses estimated at US$1.24 billion. On average over this period, the damage and loss suffered amounted to approximately 1-2% of national Gross Domestic Product (GDP). Approximately 82% of the population of 2.7 million people lives in coastal towns and communities located within 5 km of the 1,022 km long coastline. The coastal zone contains an estimated 75% of productive industries and the service sectors and is responsible for contributing an estimated 90% to the country's GDP. At the same time, a large proportion of the poor lives in upland areas and are engaged in climate-sensitive small-scale agriculture. The mountainous interior is surrounded by mostly narrow coastal plains and gives rise to a distinctive drainage pattern. The central backbone acts as the major drainage divide between north and south flowing rivers. The island's geology is dominated by limestone and the resulting karstic features dominate much of the landscape and interior drainage characteristics. Flooding of interior basins after prolonged rainfall is common and the consequent disruption of agriculture, tourism and other productive sectors and social infrastructure will likely be exacerbated by the projected increase in intensity and variability of extreme weather events as a result of climate change. Slope instability is characteristic of many areas, and intense and prolonged rainfall combined with deforestation and inappropriate land use practices has given rise to degraded conditions, making landslide vulnerability another feature of Jamaica's hazard profile. The Kingston metropolitan area, in which there is a large concentration of critical infrastructure including the international harbor and airport, is built on reclaimed land and is prone to sea level rise and storm surge.

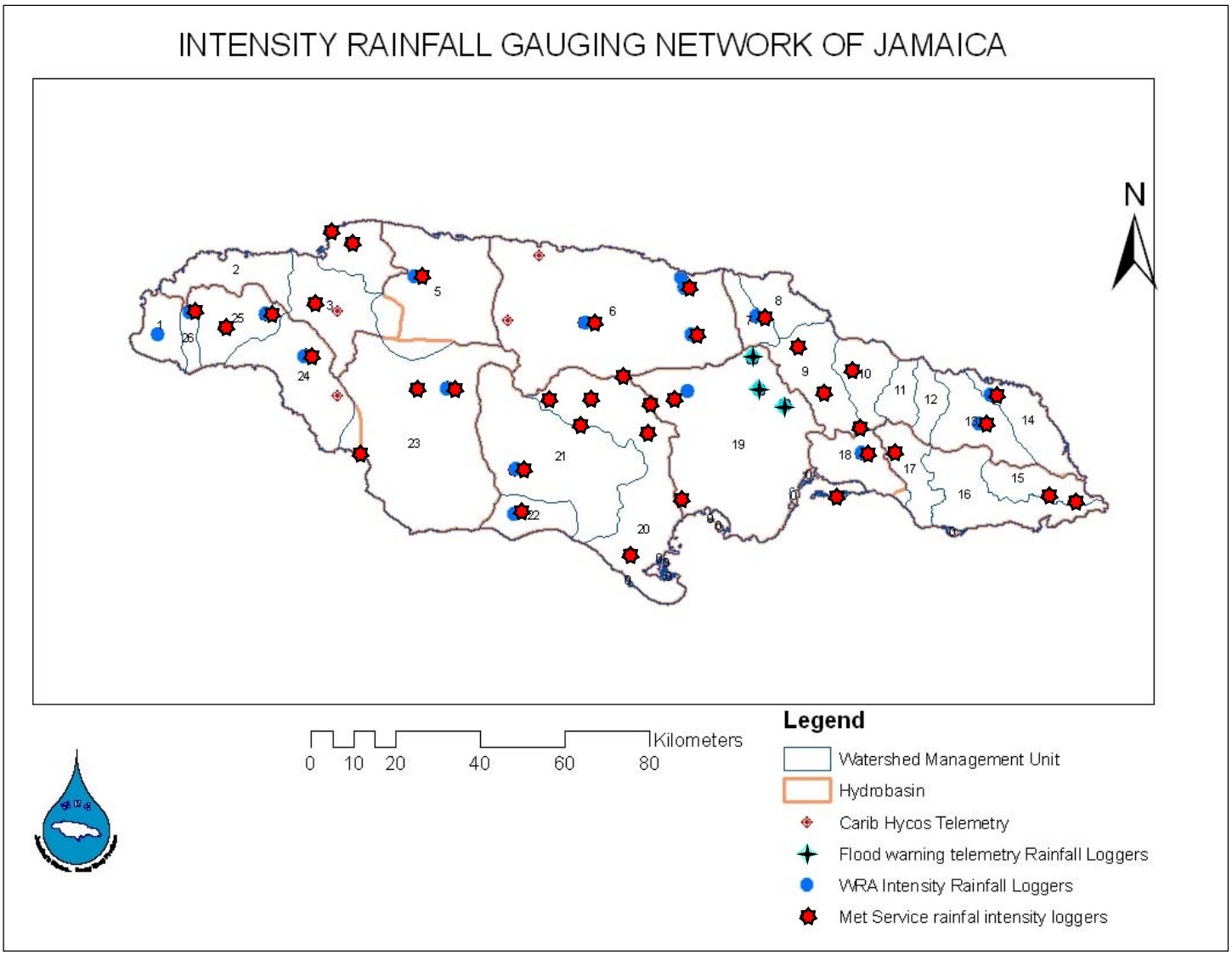
2. **Jamaica likely will experience significant changes in temperature, precipitation and sea level rise by 2050** according to data from global climate models downscaled for the development of the Strategic Program for Climate Resilience (SPCR). In summary, the models have indicated increased climate variability likely will result in: a) 7-8% decrease in the length of the rainy season; b) 6-8% increase in the length of the dry season; and c) 20% increase in the frequency of intense rains towards the end of the century. Consequently, more impacts and damages are anticipated: sea level rise leading to accelerated coastal erosion in some areas; increased flood risk and loss of land; saline intrusion into coastal water tables; increased destructiveness of tropical storms; loss of protective coastal systems, such as coastal vegetation and coral reefs partly due to higher ocean surface temperatures; and loss of livelihoods, especially in climate-and weather-sensitive sectors such as tourism, agriculture and fisheries.

3. Therefore, **improving the country's capacity to accurately monitor, model and predict and build in adaptation measures to the impacts of climate change is a priority for the Government of Jamaica (GOJ)**. Failure to implement adaptation measures will likely impede the achievement of the country's sustainable development goals as set out in *Vision 2030 Jamaica - National Development Plan*. By integrating climate risk management into the national level, the proposed Project seeks to transform the long-term resilience of vulnerable populations and the country's assets to climate-related stresses. The Project will allow climate change considerations

to be integrated into Jamaica's future national planning for climate resilience, thus providing the basis for long-term transformational change in the country.

4. **A challenge constraining the development of appropriate climate adaptation measures in Jamaica is the limited capacity, obsolete equipment, and lack of coordination and data exchange among the agencies responsible for hydro-met data collection and information services.** Indications are that Jamaica's hydro-met system has deteriorated over time as a consequence of inadequate financial resources for either appropriate levels of maintenance or for replacement and expansion of the capital stock of equipment. The original network of 23 climatological stations has dwindled to six functioning stations. The 16-year old Doppler weather radar at Cooper's Hill is obsolete and subject to periodic malfunctions. Of the 27 WRA gauges, 19 of them are within less than 10 km of a MSJ gauge, and 7 are within 5 km of a MSJ gauge. This represents considerable overlap in the two rain gauge networks.

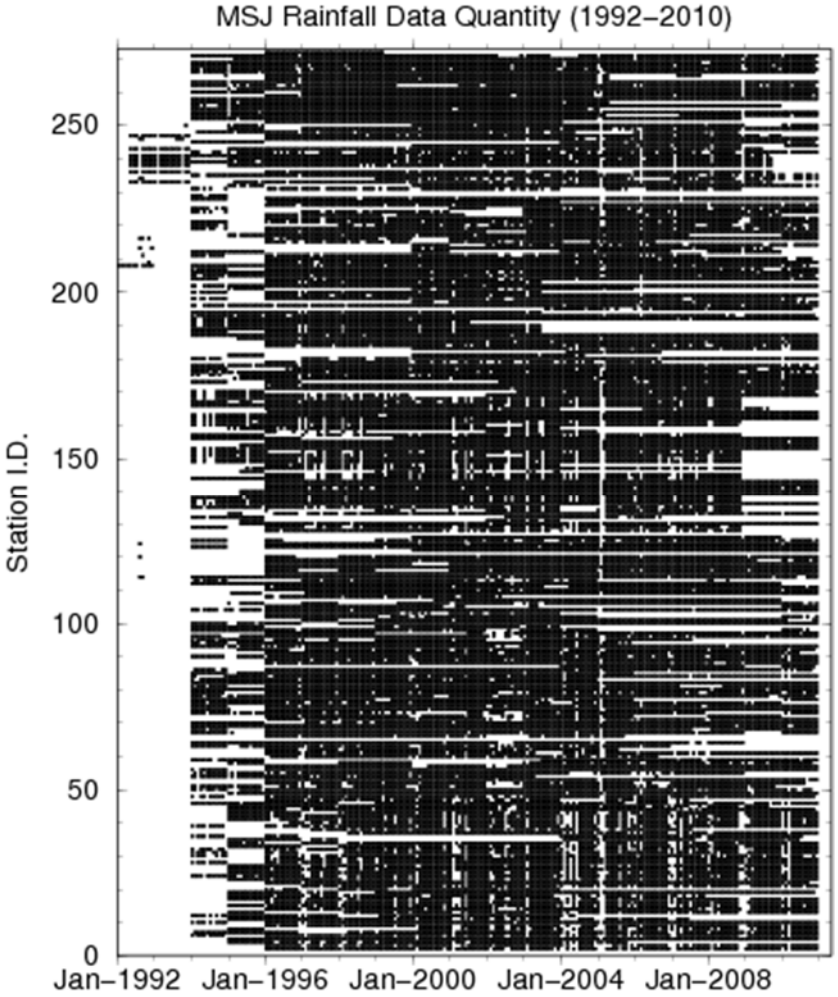
Figure A2.1: Distribution of MSJ meteorological station and WRA rain gauges across Jamaica



Map produced by Water Resources Authority of Jamaica, August 30, 2013.

5. Data gaps must be greatly reduced to be of use for climate change modeling. For the purposes of spatial and statistical analyses, having a long period of data is essential. A fire destroyed many paper rainfall records at MSJ in 1992. This loss included a large number of rainfall records. Beginning in 1992 MSJ started installing automatic recording meteorological stations to improve data quality. The MSJ monthly rainfall data from 1992-2010 include many periods of missing data. Figure A2.2 below shows the nature of the monthly rainfall database by plotting months with/without data for each of the 271 stations over the period of record. Data infilling is one partial solution, depending upon the distance to nearby stations. The current rainfall network is adequate for infilling of monthly values except above 600 m elevation, but is likely inadequate for infilling of daily values in many locations, and hourly values in most locations. Depending upon the integration interval (hourly, daily, monthly), data gap filling is difficult without several nearby stations within the correlation length for that time interval.

Figure A2.2: Tapestry plot showing quantity of data in MSJ' monthly rainfall database



Note: Each small black square denotes one monthly value of rainfall at one station. Missing squares (white spaces) denote missing data. There were intermittent network-wide gaps, especially before 1996 and after 2009 when a significant number of stations were discontinued.

6. **Improving Jamaica's hydro-met data collection and monitoring network will allow for the generation of products, archival records and potential research areas to provide highly-relevant information to policy makers regarding the impacts of climate change.** The Project Development Objective is to improve the quality and use of climate related data and information for effective planning and action at local and national levels. The Project will support the improvement of weather, climate and hydrological data collection and the development of a number of products based on climate change scenarios that are relevant at the scale of individual watersheds. It will also support strengthening of early warning capacity for severe weather events to reduce human and property losses incurred by such events. These products will allow evaluation of risk and testing of proposals to improve the nation's response and resilience to climate change. In order to develop these products, a sufficient quantity of high-quality hydro-meteorological data must be available to support the complex modelling.

7. The Project will support four components, as described below:

8. **Component 1: Upgrading Hydro-Meteorological Data Collection, Processing and Forecasting Systems (US$4.009 million).** This component will support investments for upgrading and providing critically needed new equipment, systems, and operator training for data collection, and processing for improved hydro-meteorological and agro-meteorological forecasts in order to ultimately enhance the availability and reliability of data for climate change scenario modelling, risk analysis and warning systems, and knowledge sharing. The Project will support carrying out activities to upgrade existing and/or provide new systems for hydro-meteorological data collection, processing and forecasting, including: (a) supplying and installing equipment for sea-level monitoring, meteorological, hydrological, and agro-meteorological activities, provision of training for staff of MSJ, WRA, RADA and voluntary observers of the monitoring network on operation and maintenance of the equipment; and purchasing of spare parts; (b) replacing the outdated weather Doppler radar, including rehabilitation of the Cooper's Hill station facility and training of MSJ staff in operation and maintenance of the new radar; (c) strengthening the capacity of staff of MSJ, WRA and RADA on data management, quality assurance of data collection, processing, and weather forecasting through provision of consulting services and training.

9. ***Sub-component 1.1: Acquisition of sea-level monitoring, meteorological, hydrological, and agro-meteorological equipment, including installation, spare parts and training of MSJ, WRA and RADA staff.*** The sub-component will support procurement of meteorological, hydrological, and agro-meteorological equipment and high priority spare parts, installation, calibration, and training for staff of MSJ, WRA and RADA on the operation of equipment. Based on the assessment by the three agencies, the equipment of high priority has been identified and is described as follows:

- 26 all-weather stations and spares (including universal towers and bases, calibration equipment, and data transmitter);
- 8 agro-meteorological stations;
- Upgrades to (real-time) data transmission system of the existing stations;
- 25 automatic recording rain gauges (including stands, batteries and associated equipment) to augment/replace the existing manual gauges;

- stream flow/river gauging loggers for flood and drought forecasting (6 new[16], 9 replacements and upgrades[17]);
- upgrades to the rainfall intensity gauging network[18];
- 11 ground water monitoring loggers;
- 14 soil moisture probes[19] for drought and landslide risk; and
- 2 back-up power supplies (1 for MSJ, 1 for WRA).

10. During the initial stage of implementation, the specificity of equipment and locations for installation will be further examined and agreed by the three agencies in order to avoid redundancy and maximize the efficiency of the investment.

11. Under this sub-component, a state-of-the-art tidal gauge with complete weather monitoring station and data logger will also be purchased and installed at Port Royal, Kingston Harbor (or an alternative location based on the existing EMF). It will come with water level sensor, seawater temperature, air temperature, barometric pressure and wind speed and direction high resolution measuring capabilities, run from an internal rechargeable sealed battery. The instrumentation is required for the purpose of monitoring sea level rise brought about by climate change and will be capable of acquiring, storing and reporting water level measurements to a high degree of accuracy. Telemetry will be by telephone modem and/or satellite transmission using GOES and/or GMS systems.

12. ***Sub-component 1.2: Replacement of the outdated weather Doppler radar, including rehabilitation of the Cooper's Hill station facility, and training for MSJ staff in operation and maintenance of the new radar.*** The sub-component will replace the existing timeworn S-band weather radar system with Doppler capabilities that was acquired in 1999 and sited at Cooper's Hill, northwest of Kingston. The system is an older model and is subject to periodic malfunctions. Spare parts are hard to obtain, and occasionally must be custom made. In addition to the new radar equipment, a structural assessment of the Cooper's Hill station facility, including the supporting tower, office facility, and water supply, will be conducted and the necessary rehabilitation will be carried out.

13. During the Project preparation, a detailed technical analysis on the weather radar was conducted and the following minimum specifications were recommended:

- S-band, coherent transmitter with 750-850kW peak transmit power;
- Dual polarization;
- Doppler signal processor;
- 1-degree nominal half-power beam-width steerable antenna, with first side lobe < -27dB;
- Pedestal with rotation speed up to 8 degrees per second. Vertical angle range from -1 to 60 degrees;
- >460 km max range with 1.0 km max gate spacing;
- >220 km unambiguous velocity retrievals with 1.0 km max. gate spacing;

[16] New stream flow loggers at Montego River, Rio Nuevo, Spanish River, Plantain Garden River, Gut Alligator Hole and New Savannah River.
[17] Replacement and upgrade stream flow loggers at Lucea River [2], Rio Bueno White River [2], Milk River [1], Black River [2], and Deans Valley River [2].
[18] Rainfall intensity gauging upgrade includes 5 loggers at Lucea River, Spanish River, Swift River, Drivers River and Morant River and 13 telemetric rain gauges using cell phone transmission technology (GSM).
[19] Soil moisture probes will be placed in each parish.

- Signal processing software with full remote operation, velocity azimuth display (VAD), plan position indicator (PPI), and range height indicator (RHI) display;
- Disk-based data archive/retrieval system based on redundant array of independent disks (RAID) technology;
- Compressed data storage system with filtering of insignificant returns;
- Archival storage of selectable scan images in non-compressed image format (e.g. Graphics Interchange Format (gif);
- Engineered tower designed for category 5 hurricane;
- Back-up diesel power system for radar site with 4 day capacity;
- Back-up power system for remote operations site with 4 day capacity;
- Secure wireless Ethernet network control link;
- Essential spares for power, transmitter, receiver, and signal processor electronics;
- Robust earthing (grounding) system to prevent damage from lightning strike; and
- On site operator training and warranty service for first year of operation.

14. Considering a number of factors summarized below, the replacement of the existing radar system at Cooper's Hill was chosen to be a suitable option over a new location to be developed under the Project. The existing radar at Cooper's Hill has the disadvantage of being relatively close to the Blue Mountains that rise to 2,300 m elevation and cause significant beam blockage towards the East. Increasing the antenna elevation angle to 2-degrees so as to 'look over' the obstruction would reduce the blocked sector to 30-degrees but causes the beam height to increase to over 13 km at a range of 250 km. Siting of additional all weather stations in the vicinity was considered but would not address the limitations of the blind spot regarding approaching weather. The beam blockage problem therefore requires that MSJ continue to obtain data from the Cuban authorities to obviate the 'blind spot' limitations of the site. Notwithstanding this limitation, the new radar equipment will reduce the current significant risks of an extended downtime as the current equipment is no longer easily serviceable. Also, the Cooper's Hill site requires minimum additional works (e.g., a structural assessment for the existing tower and repair, replacement of existing fence, refurbishment of existing office and water supply) and no resettlement issues are involved as it is on the parcel leased by the Government.

15. The analysis also looked at alternative site options to assess the validity of the Cooper's Hill site. The alternative sites had been identified by MSJ and were located in southeast St. Ann and Trelawny parishes (See Table A2.3).

Table A2.1: Geographic coordinates and elevations of the three radar sites evaluated.

Site	Latitude	Longitude	Elevation (m)
Cooper's Hill, St. Andrew parish	18:04:23N	76:51:10W	761
St. Ann parish	18:15:17N	77:16:27W	809
Trelawny parish	18:13:41N	77:30:26	982

Note: Optimal locations determined using Google Earth, and verified against SRTM topography data.

16. The St. Ann site suffers much less from beam blockage than the Cooper's Hill site. The St. Ann's site is approximately 60 km North of May Pen in the Cockpit Country on a privately owned, undeveloped piece of land. The site is 2-3 hours' drive from the MSJ offices in Kingston and one km from an existing access road, requiring the construction of an all-weather access road. Given

that the site is undeveloped, an environmental impact assessment would be required to identify the environmental and social impacts of the new development and environmental mitigation measures would need to be put in place before any works could commence. With these issues, the economic costs of the associated civil works are estimated at over US$ 1.2 million which is higher than the Cooper's Hill site. In addition, the costs for staff to travel a long distance from Kingston must be considered. As MSJ only has four engineering technicians on its staff to cover the whole country, it is not possible to station one staff full time at St Ann's to oversee operations of the equipment.

17. The Trelawny site has no beam blockage at 0.5-degrees beam elevation angle. However, the site is located towards the western end of Jamaica which diminishes the ability to see tropical systems approaching the island from the east, the most common direction of hurricane approach. For that reason it was not considered further.

18. ***Sub-component 1.3: Provision of training and technical assistance to improve data management, quality assurance, and weather forecasting.*** The sub-component will complement the equipment investments (Sub-components 1.1 – 1.2 above) with a number of activities to (i) fill current spatial and temporal gaps in the climate data records (data rescue[20], data infilling software and data back-up arrangements where appropriate[21]); and (ii) staff training and mentoring on hydro-meteorological data quality assurance, data management and weather forecasting, including the exploration, introduction and appropriate use of proven open-source database software (such as mySQL, PostgresSQL and the CUAHSI hydrologic information system database).

19. Data quality assurance is an institutional performance target of the key Technical Implementing Agencies. All data collection personnel in the field require an understanding of what the data being collected should look like and be able to note and report on any equipment and sensor malfunctions. Non-telemetered data need to be examined by office staff for consistency, and telemetered data need to be passed through a checking program to identify potential problems with data or sensors. Values that are out of the expected range would generate an alert and follow up by an appropriately qualified technician or district office on a daily basis. Similarly, data processing personnel in the agencies need to be responsible for editing, flagging suspect or bad data, and applying calibration factors or shifts to the constant flow of incoming data so as to prevent any backlogs in data processing.

20. Provision of data products and services using information technology is variable between agencies. WRA is presently providing data online, and has been for some time, while other agencies anticipate building capacity in this area in the near term. To optimize online data provision services, reduction of duplication efforts in the interest of consistency and quality is important. This will ultimately improve linkages with climate resilience programs throughout the region. The Project's focus will be on information management skills, and the value of online data availability for optimal use of water resources, energy savings, education and outreach. The Project will support provision of consultancy to mentor, give guidance, and train MSJ, WRA, and RADA staff in order to build capacity to operate, coordinate and maximize the use of both

[20] Data rescue and digitization of historic data (microfiche) is being undertaken by MSJ with the International Environmental Data Rescue Organization.

[21] For example, use of cost-effective cloud computer services provided by reputable vendors to ensure data permanence and regular transfer of basic data to approved agencies such as WMO or U.S. National Climatic Data Center for archival storage.

monitoring networks, quality assurance of data collection processes, and defining the specifications of equipment to be procured under Component 1.

21. **Component 2: Climate Resilient Planning and Hydro-meteorological Information Services (US$1.386 million)**. This component will provide technical assistance support to promote Jamaica's readiness for climate events through: (a) updating the downscaled high resolution[22] climate change scenarios and using said scenarios to prepare the State of the Jamaican Climate 2015 and 2019 reports (including the summary for policy makers); and provision of training on sector specific climate resilient planning based on said scenarios; (b) preparing national vulnerability assessments in selected priority sectors to complement the modeling outputs mentioned above and to define priorities and actions on climate resilience; (c) preparing detailed health sector vulnerability assessments and costed resilience strengthening plans to assist health facilities and operations withstand and respond to climate related hazards; (d) carrying out a community-based risk profiling to assess the communities' vulnerability to various climate related hazards and developing early warning messaging for vulnerable groups; and (e) upgrading the multi-agency climate and natural risk data and information sharing system to integrate climate data and making the data user friendly and accessible to the public.

22. ***Sub-component 2.1: Updating downscaled high resolution climate change scenarios to prepare the State of the Jamaican Climate 2015 and 2019 reports and to develop training in sector specific climate resilient planning based on said scenarios.*** Building on methodologies developed as part of Project preparation, the sub-component will support: (a) updating statistically downscaled high resolution climate change scenarios, (b) building capacity for sector specific climate resilient planning based on the scenarios produced, and (c) updating the *State of the Jamaican Climate* report.

(a) ***Updating downscaled high resolution climate change scenarios.*** The PPCR supported to develop a near-term climate scenarios for Jamaica, using the dominant method called "statistical downscaling", which involves using statistical correlation between large scale climate features (temperature, precipitation) and small scale features adjusted for local conditions (topography, slope, aspect, and vegetation). The Project will update these downscaled high resolution (10-4 km^2 blocks[23]) climate change scenarios and produce results at time slices 2030s, 2050s, and 2080s, taking into account available data, costs and watershed size, to be applied in priority sector development plans. The balance is between when a climate change signal has establish itself and when variability (inter-annual and decadal) still dominates, especially for rainfall. For the 2020s, the discussion for Jamaica should center around the decadal signal which will likely have a dominant and profound effect through variation of the Atlantic Multi-decadal Oscillation and changes in the frequency of the ENSO phenomenon. Discussion for the 2020s however based more on variability than climate change modelling. By 2030s, it begins to see climate change added on top of that in a clearer way hence choice of time slices for modelling. Downscaling require high-quality surface hydro-meteorological measurements data over long periods of time, at enough points to describe spatial variability, at consistent intervals and locations, over a long time period. Therefore, consistent, continual, data collection of indefinite

[22] The country specific modeling would be to a 10 km^2 grid with some mid-century time slices at 4 km^2 grid where possible. The resolution will depend on available data and cost.

[23] The modelling will be done primarily at 10 km. Some mid-century time slices may be offered at 4 km. The resources to do a continuous 100 year run at 4 km are too costly presently.

duration is required and the Component 1 investments and staff training/mentoring are aimed at filling the spatial and temporal gaps in the country's hydro-meteorological data.

(b) ***Preparation of State of the Jamaican Climate 2015 and 2019.*** The *State of the Jamaican Climate 2012* report was prepared under the PPCR Phase 1 to present an initial reference point for a description of Jamaica's climate, its variability and trends and future projections. It served key sectors and persons who wished to engage in climate change adaptation work with respect to Jamaica and who needed to determine the climate state being adapted to. It was also intended to be an initial reference point for persons seeking out other sources of information which documented how key sectors for Jamaica might be influenced by climate change. The sub-component will update the report and prepare *State of the Jamaican Climate 2015 and 2019*. The former will build upon data up to 2015 (both historical and modelled). The latter will include the high resolution modeling that will start in 2016.

(c) ***Training in sector specific climate resilient planning based on climate scenarios.*** Subsequently, manuals and guidelines will be developed and training for professionals will be provided in sector specific climate resilient planning and design based on the climate scenarios produced. Applying a climate lens to sector planning will involve examining (i) the extent to which a strategy/policy/plan/program would be vulnerable to risks arising from climate variability and change; (ii) the extent to which climate change risks have been taken into account during the formulation of the particular strategy/policy/plan/program; (iii) the extent to which the strategy/policy/plan/program might increase vulnerability or, alternatively, might miss important opportunities arising from climate change; and (iv) when existing strategies/policies/plans/ programs are under review, what amendments might be called for in order to address climate risks and opportunities. By applying a climate lens to upstream sector strategies/policies preparation and reviews would result in enhanced climate-resilient programs and on-the-ground projects and investments.

23. ***Sub-component 2.2: Preparation of vulnerability assessments in selected sectors.*** The sub-component will support the preparation strategic vulnerability assessments in selected priority sectors identified in the SPCR, such as agriculture and water, based on climate change scenarios developed under Sub-component 2.1 for a better understanding of the impacts of climate change to the sector (for example, changes in rainfall and temperature, increase in extreme weather events and coastal erosion, sea level rise, and similar). The vulnerability assessments will complement the climate change modeling outputs of Sub-component 2.1 and so are to be incorporated into the preparation of manuals and guidelines for sector specific climate (and natural hazard) resilient planning and design. The vulnerability assessments will take into consideration gender aspects and differential vulnerability profiles depending on socio-economic background, e.g., some basic gender concepts including examination of the household as a site of uneven gender power relations. The analysis then considers the direct and indirect impact of climate-related events attempting to quantify the unrecorded losses that accrued to women specifically.

24. Under Jamaica's SPCR, the Government and other players are expected to replicate the methodologies and outcomes obtained under the proposed Project to other sectors (e.g., infrastructure) through companion projects. These projects include the *Adaptation Programme and Financing Mechanism for the PPCR Jamaica project* (supported by the IDB) which will facilitate the incorporation of climate change in development planning, institutional capacity building to address climate change within the government entities, community vulnerability

assessments, a knowledge management program including dissemination of climate change information, and also the implementation of some adaptation measures in two critically degraded, yet important watersheds—Rio Minho and Rio Bueno. It will also improve access by small and medium-scale operators in the agribusiness and related sectors to resources for financing adaptation initiatives through competitive loans and trust funds. *The PPCR Promoting Community-based Climate Resilience in the Fisheries Sector of Jamaica project* (supported by the WB) will strengthen the fisheries policy and regulatory framework including making it climate-smart, develop viable alternative livelihoods that enhance sustainable fisheries, and build capacity and raise awareness among the fishing communities. Jamaica also participates in *the Caribbean regional-track PPCR.* The Regional PPCR will develop land use plans in strategic coastal zones of the participating pilot countries including Jamaica, including maps, action plan and recommended regulations; enhancement of regional climate data collection networks and near real-time transmission of data; and development and implementation of appropriate adaptation interventions in agriculture for climate risk reduction and resilience, measuring climate change impacts on fishing communities and marine resources, promoting water augmentation and harvesting for resilience, and establishing early warning system to reduce dengue outbreak. *Enhancing the resilience of the Agriculture sector and coastal areas to protect livelihoods and improve food security* (Jamaica Adaptation Fund Project) will protect livelihoods and food security in vulnerable communities by: improving land and water management for the agricultural sector; strengthening coastal protection; and building institutional and local capacity against climate change risks.

25. ***Sub-component 2.3: Preparation of a detailed health sector vulnerability assessment and a costed resilience strengthening plan for climate-proofing the nation's health facilities and operation*s**. Health facilities in the Caribbean are overwhelmingly affected by storm (75%) and flooding (21%) than any other disaster events[24]. In Jamaica, Hurricane Gilbert in 1988 damaged or destroyed 24 hospitals and health centers, resulting in 5,085 hospital beds being lost. Under the WHO/PAHO "Safe Hospitals in the Caribbean" Project, the structural condition of Jamaica's ten main hospitals[25] was assessed, primarily regarding their ability to withstand seismic risk. Eighty percent (80%) of the hospitals were found to have satisfactory structural resilience to various hazards but the functional safety of the hospitals is less satisfactory: 81% of hospitals do not have a functioning disaster committee; 57% do not have established evacuation procedures; and 48% of emergency routes are inaccessible, poorly labelled or obstructed.

26. Building on the Safe Hospitals assessments, this sub-component will support a Health Sector Vulnerability Assessment and encompass the following:

(i) Determine what aspect of the health sector is to be assessed and in what locations, for example:

- Major hospital - selected parish;
- Health facilities/clinics - selected parish;
- Central Government Capacity – MOH;
- Disease control - Vector identification and management;
- Parish focus - health facilities and services;

[24] WHO/PAHO, 2012 Annual Report: Emergency Preparedness and Disaster Relief.

[25] Annotto Bay, Black River, Bustamante, Cornwall Regional Hospital, Falmouth, Mandeville, Princess Margaret, Spanish Town, St Ann's Bay, University Hospital of tethe West Indies.

- Emergency Response Capacity - parish, national; and
- Public Health capacity /parish/urban center, rural towns.

(ii) Hazard identification, for example:

- History of flooding at selected location(s) - incidence, impact on health facilities and supporting infrastructure;
- Hurricane/Storm - history of impact at selected location – health facility, supporting infrastructure and services; and
- Landslides - Disruption of road communication.

(iii) Detailed vulnerability assessment, for example:

- Structural Vulnerability - Engage structural engineer to identify areas of weakness and to recommend mitigation measures;
- Assess vulnerability of site to flooding;
- Assess vulnerability of access routes to flooding and landslides;
- For each facility, assess the following:
  - Emergency water supply – storage capacity , accessibility;
  - Emergency power supply - standby generation, fuel, battery availability, appropriateness of site;
  - Food supply - system for and safety of stores of non-perishables, access to supplies in event of emergency;
  - Pharmaceuticals/medicines – system for and safety of stores, system to access and preposition emergency supplies;
  - Other supplies – system for and safety of stores, system to access and preposition emergency supplies;
  - Waste management capacity - general waste, medical waste;
  - System for grounds management – removal of debris to facilitate access of emergency vehicles and staff;
  - Records management - safety, back-up; and
  - Emergency response capacity - staffing roster, vehicles, supplies.

(iv) Phased and costed investment plan for implementing main recommendations.

27. ***Sub-component 2.4: Carrying out community risk profiling and developing targeted early warning messaging for vulnerable groups.*** The sub-component will support the scaling up of community risk profiling activities making use of facilitated, participatory planning approaches and resulting in local/sub-parish (district/community) level resilience mitigation and adaptation plans that can be self-resourced and implemented by communities. Early warning communication messages will be developed for targeted vulnerable groups (for example, low income groups living in unplanned settlements in hazard-prone locations, persons with disabilities, elderly, etc.).

28. An effective early warning system not only strengthens the country's resilience to risks from current hydro-met hazards but also mitigates future risks of climate change and variability, thus it is considered as a cost effective investment. In addition, risk, vulnerability and exposure information to be obtained from the improved hydro-met data collection will contribute to the future development of "impact forecasting," which facilitates the translation of hazard information into more actionable impact based messaging. These activities have been designed by taking into account the current system and filling identified gaps.

29. ***Sub-component 2.5: Upgrading a multi-agency climate and natural hazard risk data and information sharing system and clearing-house with public access.*** The sub-component will provide support for upgrading a multi-agency climate and natural hazard risk data-sharing platform and clearing-house with public access network, based on a detailed assessment of existing data collection agencies' mandated responsibilities and data collection and storage formats, protocols and metadata standards in use, and an assessment of end-user needs (with an especial focus on vulnerable communities) and desired formats. This activity will build on the Government's on-going multi-agency, national networked geographical information system (GIS) for Jamaica and is aimed at strengthening the central clearing-house functions for climate and risk data sharing—the proposed Climate Change and Risk Information Data Node. A fully functioning portal will support data storage and integration of data from multiple organizations, and provide the users with one-stop interface to search, access, share and view the data collected. Measures such as cloud storage will be put in place for to ensure data security and continuity.

30. The National Spatial Data Management Division (NSDMD) under the MWLECC currently has responsibility for coordinating, implementing and managing Jamaica's National Spatial Data Infrastructure and provides metadata and geospatial data discovery, retrieval, update and management services via the Land Information Council of Jamaica (LICJ) WebMap. The LICJ was approved by Cabinet in 1992 and consists of over 50 member agencies from the Government, Parish Councils, private sector and academia and meets on a monthly basis. The Secretariat of the LICJ operates from within the NSDMD. The GOJ WebMap was originally developed to support the National Spatial Plan. Today, the database consists of around 260 datasets (including basic climate and risk data layers and attribute tables) that are sourced from and updated by the member agencies of the LICJ. It provides for the storage and management of Government entities' geospatial data and allows for search, retrieval, updates and management of metadata records and allows users to access a variety of geospatial data including environmental and climate change data from international geo-database repositories. The data is accessed free of cost by member agencies and also can be distributed by means of a free viewer for non-GIS users (or presented in ArcView's 'Layout View' suitable for Adobe Reader©). All users need to be registered with NSDMD which has a responsibility to ensure that any data is made available according to any restrictions set by the source-agency. Since 2008, the GeoData Sharing Access Council, assisted by NSDMD monitors and clears the release of Jamaican agency data for overseas users. The portal supports many activities such as site identification and selection, development approvals, management of land resources and for informing decisions affecting communities.

31. The NSDMD has immediate high priority needs to increase bandwidth to approximately 100mbps to improve upload and download speeds for users; to procure database management software to support various file formats; and to procure data discovery/portal management software to perform three fundamental functions: (i) discovery content; (ii) hosting and maintaining the index of content; and (iii) providing an application for end users. The design of the upgraded platform will need to take into account improved access between agencies and computerized entities and develop policies regarding cost recovery for raw and manipulated data by public sector agencies. Whilst agencies currently do provide data, it frequently is not in a format that is readily usable and may require cleaning of data sets before use (for example, conversion of data, projecting the map layers to new data frame coordinate systems, converting vector files to raster files, etc. requiring GIS-literacy that may not be available in every agency).

32. Whilst Jamaica has a supportive policy and legislative framework for accessing information (the Information and Communications Technology (ICT) Policy, 2011 and the Telecommunications (Amendment) Act, 2012), there is a relatively low level of broadband access[26] for the majority of the population (22.6% of households in 2012) and 68.5% of households in 2012 did not have access to a computer. Therefore the design of the upgraded platform also will need to incorporate and scale up connectivity with existing Parish and village level networks to facilitate public access to the data in appropriate formats. This might involve, for example, data being transmitted through the 205 community access points[27] at schools, public libraries, post offices and other centers across the country, public libraries; public broadcasting services; cell/mobile phone providers; the Jamaican Information Service; and farmers' organizations and extension services).

33. The upgrade of the multi-agency climate and risk data-sharing platform therefore will involve (i) meeting the immediate high priority equipment and software needs of NSDMD; (ii) a gap analysis/design of the existing platform to meet inter-agency protocols and public access to climate data in usable formats; and (iii) implementation of the dissemination network (including possible scale up of the use of the community access points).

34. **Component 3: Climate Change Education and Awareness towards Behavioral Change (US$0.725 million).** This component will provide technical assistance support to promote climate change awareness at the national and local levels through (a) carrying out climate change information, education and communication (IECC) campaigns, and (b) conducting targeted attitude and behavioral change initiatives to address climate change adaptation needs and influence behavioral change of targeted groups, as part of the Communications Strategy Action Plan developed under the PPCR Phase 1. Initiatives are aimed at influencing and bringing about changes in attitudes and behavioral practices to assist targeted groups to adopt practical means of coping with severe weather events, climate variability and climate change. The approach is to implement simple, effective and targeted communication of the above-prepared climate change scenarios and risk assessments with structured messages for different target groups and audiences. Without effective mechanisms for timely dissemination of understandable and usable forecasts, as well as information on appropriate responses, the potential benefits associated with upgrading hydro-met systems will not be fully realized. Campaigns are aimed at influencing and bringing about changes in attitudes and behavioral practices to assist targeted groups to adopt practical means of coping with severe weather events, climate variability and climate change.

35. In 2005, a baseline knowledge, attitudes and practices (KAP) survey was carried out to assess knowledge and views in Jamaica regarding the causes and impacts of climate change and the measures people could take in their own lives to adapt. The KAP 2005 baseline survey involved the completion of 1,700 household interviews with an additional 300 done among representatives of the public and private sectors, media, international donor agencies and children. A subsequent KAP longitudinal survey was carried out in 2012 under Phase 1 of the PPCR. It encompassed a national survey of households (N = 1,484); a survey of online users of climate information (N = 503); and a focus-group based sector survey (N = 276) targeting agencies and

[26] About 786,680 broadband mobile subscription were recorded in 2013.

[27] The Community Access Point facilities are funded by the Universal Service Fund and are equipped with computers, associated equipment, and internet access. The services at the facilities are provided for free or at minimal cost.

specialists in the sectors of agriculture, construction (built environment and human settlements), energy, health, tourism and water.

36. In light of the KAP survey findings and recommendations, the Project will move beyond merely sharing information and spreading awareness, and will focus on influencing changes in attitudes and promoting specific behavioral practices amongst targeted groups to adopt practical means of coping with climate change, through development and use of materials such as cartoons, animation, and support materials for school curriculum, and training. The Project will also foster stronger inter-agency collaboration and partnership to implement climate awareness campaigns targeting specific groups so as to facilitate improved practices.

37. ***Sub-component 3.1: Climate change information, education and communication campaigns (IECC).*** The sub-component will build upon on-going initiatives such as "*Voices for Climate Change Education and Communication*" funded by a number of external partners. The initiative is a national communication and education strategy related to climate change and biodiversity issues and adaptation strategies. Since 2008, it has supported local popular artistes who have specially formulated climate change messages through song, dance performances, and drama to 24 community centers throughout the country. It has generated enthusiasm and "buzz and sizzle" at the community and national levels. The IECC will use creative arts to further promote climate awareness at the community and national levels.

38. ***Sub-component 3.2: Implementation of targeted attitude and behavioral change initiatives.*** Under the coordinating framework provided by the recently adopted comprehensive "*Communication and Climate Resilience 2012-2017: National Communication Strategy and Action Plan*", the sub-component will develop and promote tailored awareness raising activities and practices to address the adaptation needs of specific targeted groups, including teachers, school children, and farmers (small and large scale) through development and use of materials such as cartoons, animation, and support materials for school curriculum, and training.

39. The Component will be implemented primarily by the Climate Change Division (CCD) under the MWLECC, including design, supervision and monitoring of the activities. The CCD will ensure that the activities are accurately based on the latest scientific knowledge generated by Components 1 and 2, and use proven social marketing techniques. A working group for awareness raising and behavioral change led by the CCD will be established early on to develop appropriate strategies for achieving behavioral change and for ensuring gender sensitivity and reaching vulnerable groups.

40. **Component 4: Project Management, Monitoring and Evaluation (US$0.68 million).** This component will support to carry out the Project, including overall technical management, financial management, procurement, compliance with environmental and social safeguards, monitoring and evaluation of data collection, supervision of works through the provision of consulting services, non-consulting services, goods, and Operating Costs. Specifically, this component will support the PIOJ's central executing and fiduciary services unit (PIU) in project management and implementation including, but not limited to, technical, administrative and fiduciary support, namely procurement, financial management, and environmental and social safeguards, monitoring and evaluation, reporting, stakeholder involvement and coordination. The PIU is to be located within the PIOJ, consisting of Project Manager, Project Accountant, Procurement Officer, and Project Assistant. The PIOJ will be responsible for executing the proposed Project in close collaboration with the Technical Implementing Agencies, namely the

MWLECC (MSJ, WRA, CCD and NSDMD), the MOAF (RADA), the MLGCD (ODPEM), and the MOH (EDMSS).

41. Specific budget for M&E will be secured to ensure project-level results are fully reflected into the program-level reporting of the PPCR core indicators at the country and regional levels. Since the objective of the PPCR is to pilot and demonstrate ways to integrate climate risk into core development planning and the proposed Project is deemed innovative, and building on what has been done during the Project preparation (e.g., innovative climate change awareness campaigns, robust near-term sector specific climate scenarios, the most sophisticated and candid economic evaluation of hydro-met systems, etc.), mechanisms for capturing and sharing lessons with the rest of the PPCR community and a wider WB portfolio would be formulated and implemented throughout the Project.

Annex 3: Implementation Arrangements

JAMAICA: IMPROVING CLIMATE DATA AND INFORMATION MANAGEMENT PROJECT

I. Organizational Structure and Roles and Responsibilities

1. **Planning Institute of Jamaica (PIOJ).** The PIOJ is a statutory body within the Ministry of Finance and Planning, and is the executing agency for the proposed Project. The PIOJ plays a number of critical roles including sustainable development planning, coordination of Jamaica's Development Plan, *Vision 2030 Jamaica*, and is the national Focal Point for the PPCR. The PIOJ managed the EU-funded *Climate Change Adaptation and Disaster Risk Reduction Project* (closed in December 2013) and is currently implementing the Jamaica's Adaptation Fund Program: *Enhancing the Resilience of the Agriculture Sector and Coastal Areas to Protect Livelihoods and Improve Food Security*.

2. As the executing agency, the PIOJ has established a central executing and fiduciary services unit (**PIU**) to be responsible for coordinating all activities of the Project and providing fiduciary support to the Technical Implementing Agencies, including procurement, financial management, environmental and social safeguards, and consolidated project reporting in accordance with the Grant Agreement and the POM. In addition, the Unit will act as secretariat to the PPCR Steering Committee. The PIU consists of the Project Manager, the Accountant, the Procurement Officer, and the Project Assistant. The Unit will report to the Project Coordinator, the Deputy Director General, Sustainable Development and Regional Planning, PIOJ.

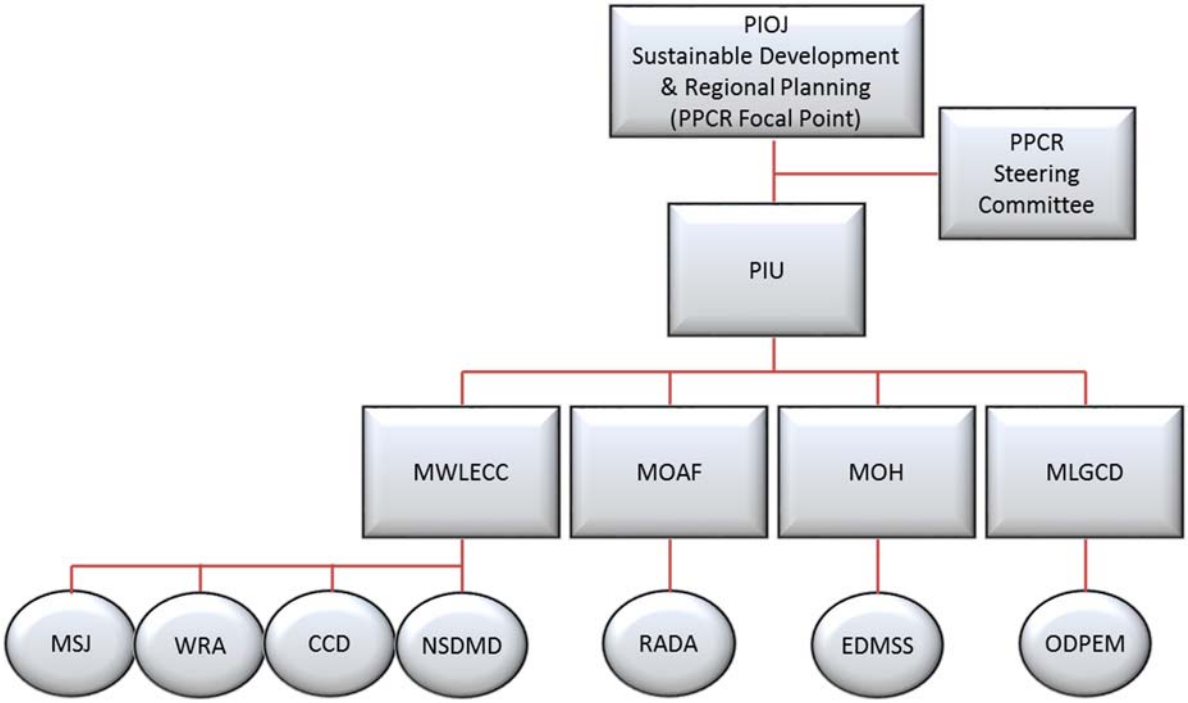
3. **PPCR Steering Committee (PPCR-SC).** The Government has established an umbrella Steering Committee to serve as the main body responsible for providing advice and oversight to the implementation of PPCR. Under the proposed Project, the PPCR-SC would serve as the Project steering committee to be responsible for ensuring that the Project is effectively and expeditiously implemented in keeping its development objectives, results framework and budget and for addressing any inter-agency and strategic level issues and risks that may adversely affect the implementation of the Project. The PPCR-SC is chaired by the PPCR Focal Point—currently the Deputy Director General, Sustainable Development and Regional Planning of the PIOJ. Members of the PPCR-SC are drawn from a cross-section of stakeholders with technical interest in and knowledge of natural hazards, risk and climate change issues, including relevant Government Ministries, Departments and Agencies, private sector bodies, academia, and civil society. International development partners are offered observer status on the Committee.

4. **Implementation Agencies**. Direct responsibility for and technical oversight of the various components of the Project will be assumed by the respective Technical Implementing Agencies, namely MSJ, WRA, CCD and NSDMD under the MWLECC, RADA under the MOAF, the Office of Disaster Preparedness and Emergency Management (ODPEM) under the Ministry of Local Government and Community Development (MLGCD), and the Emergency, Disaster Management and Special Services Branch (EDMSS) under the Ministry of Health (MOH). Each Technical Implementing Agency has nominated the Project Focal Point to coordinate and oversee day-to-day Project activities and to report to the PIU. This includes ensuring that detailed Terms of References for consulting services and technical advisory work and specifications for goods (equipment) and small works are prepared in accordance with agency needs, sitting on evaluation

panels for the procurement of the goods/services and for checking and certifying the quality of inputs received before payment by the PIU is authorized.

5. The Project will be implemented in accordance with the Project Operational Manual (POM) and all relevant legal documents. The POM includes: (i) detailed descriptions of Project components and cost estimates; (ii) implementation and governance arrangement; (iii) funds flow mechanisms; (iv) detailed Project cost estimates; (v) a procurement plan; and (vi) an Environmental Management Framework (EMF). The POM is a 'living document' and will be amended periodically by the PPCR-Steering Committee to incorporate adjustments during Project implementation in agreement with the Bank.

Figure A3.1: Project Implementation Arrangements



6. The Project Organization Chart is shown in Figure A3.1. The findings of an assessment of the main Technical Implementing Agencies' capacities to implement the Project are summarized below:

7. **Ministry of Water, Land, Environment and Climate Change (MWLECC).** MWLECC is a large complex ministry that was created in January 2012 and spans four functional areas, comprising several agencies/divisions, including MSJ, WRA, NSDMD, and CCD, involving reporting relationships with numerous internal and external stakeholders. The multi-layered executive management structure comprises the Permanent Secretary as well as a Director General and Chief Technical Director. The corporate governance structure is sound with an experienced and large senior management team, demonstrated strategic planning capacity, established reporting and oversight mechanisms, and an entrenched risk assessment.

8. **Meteorological Service Jamaica (MSJ)** under the MWLECC. MSJ is a division of approximately 60 persons that has an experienced management team headed by a Managing Director and organized into three branches, namely the Weather Branch, Climate Branch and the Administrative Branch. MSJ does not have its own finance, accounting, procurement or IT functions, which are managed by the Ministry. MSJ has experience in implementing donor-funded projects by the Global Environment Fund, and European Union. A project office was set up at MSJ to handle the latter but relied on additional support from the PIOJ project management unit.

9. **Water Resources Authority (WRA)** under the MWLECC. WRA is an organization headed by a Managing Director with a staff complement of approximately 50 persons. Corporate governance is sound with an experienced management team, demonstrated board oversight, good internal controls and a recognized history in providing quality on-line information. WRA has its own finance and accounts section headed by a Director, and the agency has a substantial prior record and apparent success in handling earlier projects funded by the World Bank, International Atomic Energy Agency, etc.

10. The activities under Component 1 to upgrade hydro-meteorological data collection, processing and forecasting system will be implemented primarily by the MSJ and WRA.

11. **Climate Change Division (CCD)** under the MWLECC. CCD was created in January 2012 with the mandate to implement the Climate Change Policy and to ensure the efficient coordination of climate change matters across the public sector, the NGO community, and the private sector. CCD will be the main driver to coordinate the dissemination and targeting of climate change awareness and behavioral change activities under Component 3 with messages derived from the robust, downscaled climate change modelling and vulnerability assessments under Component 2. It is also expected to provide inputs to the upgrading of the climate and natural hazard risk information platform proposed under Component 2.

12. **National Spatial Data Management Division (NSDMD)** under the MWLECC. The NSDMD is the government entity charged with the task of providing national strategic direction, policy development, leadership, management and implementation of Jamaica's spatial data infrastructure and provides metadata and geospatial data discovery, retrieval, updating, and management services via the Land Information Council of Jamaica (LICJ) WebMap. Its responsibilities make it central to the promotion and growth of Jamaica's geospatial sector and most importantly an enabler for national development. The NSDMD will lead the upgrading of the multi-agency climate and natural hazard risk data and information sharing system and clearing-house with public access under Component 2.

13. **Rural Agricultural Development Authority (RADA)** under the MOAF. The Ministry of Agriculture and Fisheries is a large ministry comprising several agencies, including the RADA, and a number of commodity boards. The corporate governance structure at the Ministry, which was an early adopter of the Performance Management Evaluation Systems, appears sound with demonstrated strategic planning capability, comprehensive reporting and oversight mechanisms, and an established risk assessment and internal audit process. RADA is an executive agency with its own board and management structure. RADA will assist in the scaling up of community risk profiles under Component 2, and will benefit from agro-met stations to be acquired under Component 1.

14. **Ministry of Health (MOH).** The MOH is a large ministry comprising several regional authorities and is required to manage a very complex staffing and infrastructural network. The

MOH through the Emergency, Disaster Management and Special Services Branch (EDMSS) will be responsible for the preparation of a detailed vulnerability assessment and costed plan for climate proofing health facilities and operations under Component 2. The MOH has a prior history in managing project funds and with the assistance of a project fiduciary services team based at the PIOJ.

15. **Office of Disaster Preparedness and Emergency Management (ODPEM)** under the MLGCD. Following the June 1979 floods that devastated sections of Western Jamaica, the Government established a permanent Office of Disaster Preparedness and Emergency Relief Coordination (ODIPERC) which in 1993 was subsequently legislated as a statutory body named the Office of Disaster Preparedness and Emergency Management (ODPEM) with responsibility for coordinating and monitoring of the response to hazards and for educating the national public on all aspects of disaster management. ODPEM under the MLGCD has its own Board of Directors and Director General with five operational Divisions under it, namely Corporate Services, Human Resources, Preparedness and Emergency Operations, Projects, and Mitigation Planning and Research. ODPEM will have the coordination and oversight responsibilities in the preparation of national vulnerability assessments for priority sectors in collaboration with the relevant line agencies. ODPEM has primary responsibility for the community risk profiles for selected vulnerable communities under Sub-component 2.2.

II. Project Management Instruments

16. **Project Operational Manual (POM)** defines the institutional arrangements, procedures, requirements, and guidelines for the management and implementation of the Project. It is also intended to help in ensuring that the Project is implemented in a transparent manner. The POM is a working document and its contents will be subject to periodic review and updating as necessary over the life of the Project given the flexibility required by the Project conditions that could be encountered during implementation. Such changes are subject to approval of the World Bank.

17. **Annual Operating Plan (AOP) and Procurement Plan (PP)**. The PIU is responsible for preparing AOP and PP in consultation with the Technical Implementing Agencies. The AOP should provide a plan for the Project implementation of each year including the overall goal, planned activities, timeframe and budget. The PP reflects procurement activities required to implement the planned activities. The PIOJ sends the AOP and PP to the PPCR-SC for endorsement on an 'absence of objection' basis (AOB) within a defined timeframe (not to exceed 8 working days). Once endorsed by the PPCR-SC, the AOP is then sent to the World Bank for no objection.

III. Monitoring and Evaluation of Project Results

18. The PIOJ through the PIU in close consultation with the Technical Implementing Agencies will be responsible for the overall monitoring and evaluation (M&E) of the Project and its implementation in accordance with the POM and the Grant Agreement. This includes: (a) the extent to which Project objectives are being achieved, (b) the administrative, physical and financial progress of implementation of the Project components; and (c) the extent to which required implementation procedures are being complied with. The M&E plan will form a part of the annual work plan of the PIU and the Technical Implementing Agencies. Monitoring and evaluation of Project implementation status and results will be conducted through: (a) day-to-day activities of the PIU and each Technical Implementing Agency; (b) quarterly progress reviews by the PPCR-

SC; (c) semester progress reviews during the Bank's implementation support missions; (d) mid-term review of Project implementation to be conducted jointly by the PIOJ/PIU, Technical Implementing Agencies, PSC, and the World Bank; and (e) terminal evaluation to be conducted by the PIOJ/PIU, Technical Implementing Agencies, and PPCR-SC. The reports to be prepared include: (a) quarterly progress reports, (b) aide memoires upon completion of the Bank's implementation support missions, (c) annual implementation progress reports to be submitted to the Bank no later than 45 days after the end of the period covered; (d) mid-term review report; and (e) the terminal evaluation report to be submitted to the Bank by the date defined in the Grant Agreement. The reports will indicate the progress made under the different components of the Project and measure performance against the results indicators established in the results framework (Annex 1).

IV. Financial Management

19. **FM Risk.** The PIOJ has satisfactory financial management procedures in place and usually comply with them in the daily operations. The overall FM Risk is thus assessed as Moderate. The following risks with corresponding mitigation measures have been identified during the assessment.

Table A3.1 Financial Management Risk Ratings

Risk	***Risk rating***	***Risk issues/measures***
Inherent Risk		
Country level	S	
Entity and project level	M	FM arrangements are in place and functioning adequately.
Control Risk		
Budgeting	M	A budget for the entire life of the Project will be prepared with assistance from the WB Task Team
Internal controls	S	Internal controls need strengthening
Accounting/Financial Reporting	M	
Funds Flow/Disbursement	M	
Staffing	S	The Finance Officer not yet identified.
External audits	M	One audit will be performed for each year of the Project.

20. **Staffing.** As the finance unit of the PIOJ will be responsible for the financial management aspects of the Project, the finance manager and Director of Corporate Governance and Management will have direct oversight of the Project's accounting. Additionally, a staff member from the unit will be assigned to carry out the functions of finance officer at early stages of implementation, with similar salary arrangements as the PPF grant (salary premium) for the proposed Project. Thereafter, a Project Accountant will be hired on a full-time basis.

21. **Budgeting.** A budget for all the activities of the grant for the entire implementation period will be prepared at the beginning of the grant by a team comprising; i) Technical Specialists, ii) Corporate Governance and Management unit, iii) Relevant Ministries, Departments and Agencies (MDAs). The budget will be revised each fiscal year and on an ad hoc basis based on implementation progress and will form a part of the MOFP estimates in the GOJ's annual budget. The steering committee will review the budget process as well as assess the risk of major areas highlighted by the monthly variance analysis.

22. **Accounting and Financial Reporting.** It is recommended that accounting records of the Project are kept in the PIU's accounting system "Great Plains". This should be updated and monitored by the Finance Officer in accordance with the operations manual. The PIOJ will be responsible for producing the Interim Financial Reports (IFRs) on a quarterly basis and for submitting no later than 45 days after the end of each reporting period to the Bank. These reports would provide required monitoring information and should be made available to both the internal and external auditors.

23. **Disbursements and Funds Flows.** Disbursement of project funds will be based on Statement of Expenditures and the following methods will be used: Advance, Reimbursement and Direct Payment. The Minimum Application value for disbursements (except for Advance) will be US$ 50,000 equivalent. Funds should only be used for implementation of the components as set out in the Grant Agreement and must comply with the disbursement categories. The current segregated USD designated account used for the Preparation grant will be used for this grant and a project local currency account will be opened once it becomes effective. The Project may request advances for an amount up to US$ 2,000,000. The Debt Management Branch in the MOFP will maintain the USD account and review and sign the IFRs and Withdrawal Applications before submission to the Bank. Applications documenting expenditures paid from the Designated Account will be submitted quarterly. Retroactive Financing will be allowed for payments made prior to the date of the grant agreement but after May 22, 2015, up to US$ 300,000 equivalent under Components 1, 2, 3 and 4.

24. **Taxes.** Grant proceeds will not be used to finance taxes associated with Project's expenditures. The expenditures submitted for financing under the Project would be net of taxes, including goods, works, non-consultant services, consultants' services, training and operating costs. The Statement of Expenditures (SOEs) submitted as supporting documents of the withdrawal applications should states that no taxes are included. During implementation support missions, the Bank task team will confirm that invoices submitted to the Bank are exclusive of taxes.

25. **Internal Control and Internal Audit.** The internal auditor currently only performs an audit on the systems of the PIU. It was agreed that going forward Project records will be included in the sampling. The internal auditor reports to the Finance and Audit Committee that meets quarterly. It was noted however, that there is no mechanism in place to feedback the Project's external audit results to the Audit Committee. The Bank team recommended establishing a mechanism to feedback audit results to the PIOJ's Audit Committee or steering committee. The operations manual does not prescribe in detail the financial management arrangement of the Project. It was agreed that the operations manual of the Finance Department will be shared with the Bank FM team and revised if necessary to include processes specific to the Project.

26. **External Audit.** An external audit is required annually, covering the period up to March 31st, on the Project's financial statements and will be due within six months after the fiscal year end. The financial accounts of the Project are to be audited by an independent auditor acceptable to the Bank and this could include the Recipient's Auditor General. The financial audit TOR will require the independent auditor to confirm, in addition to the normal scope of the audit, that expenditures submitted to the Bank were net of taxes.

27. **Supervision Strategy.** The supervision strategy for this Project is based on its FM risk rating, which will be evaluated on regular basis by the Bank FM Specialist in line with the FM Sector Board's FM Manual and in consultation with the task team leader.

V. Procurement

Procurement

28. **General.** Procurement for the Project would be carried out in accordance with the World Bank's "Guidelines: Procurement of Goods, Works, and Non-Consulting Services under IBRD Loans and IDA Credits & Grants by World Bank Borrowers", dated January 2011, revised July 2014; and "Guidelines: Selection and Employment of Consultants by World Bank Borrowers", dated January 2011, revised July 2014; and the provisions stipulated in the Grant agreement. Various items under different expenditure categories are described below in general.

29. **Procurement of Works.** No major works are foreseen. Minor works for refurbishing the office for the Doppler radar and the installation of Hydro- and agro-met equipment under shopping for small value contracts shall be applied as agreed with the Bank.

30. **Procurement of Goods and Non-consulting Services (NCS).** Goods procured under this Project include, but are not limited to: all-weather hydro-met stations and spares, communication repeaters, automatic recording rain gauges, stream flow/river gauging loggers, ground water monitoring loggers, soil moisture probes, back-up power supplies, tidal gauge, and Doppler radar (Component 1), enterprise computer server and computers, etc. (Component 2), and campaign materials, etc. (Component 3) and office equipment, etc. (Component 4). The procurement would be carried out using the World Bank's SBD for ICB processes and Shopping (Request for Quotations) documents agreed with or satisfactory to the World Bank.

31. **Selection of Consultants.** Consulting services would be required under this Project for vulnerability assessment and behavioral change campaigns etc. Individual consultants would be selected following the procedures set forth in Section V of the Guidelines, whereas consulting firms would be selected following Quality and Cost Based Selection (QCBS), Least-Cost Selection (LCS), Selection Based on Consultant's Qualifications (CQS) etc.

32. **Operating Costs** means the reasonable incremental operating expenses incurred by the Recipient on account of the Project implementation, management, monitoring and reporting including on account of operation and maintenance costs of office and office equipment; office supplies, additional staff costs, travel and supervision costs, *per diem*, but excluding the salaries and indemnities of officials and public servants of the Recipient.

33. **Procurement Plan.** The procurement plan for implementation of the proposed Project for the first 18 months was agreed between the Recipient and the Project Team on May 20, 2015 with summary of major packages subject to international selection in Table A below. The plan shall be made available at web address http://www.worldbank.org/procure within 30 days of the signature of the Grant agreement. It would be updated annually and the updated procurement plan shall be disclosed at this site after clearance by the Bank. The recommended thresholds for the use of the procurement methods specified in the Grant agreement are the basis for the agreed procurement plan.

34. **A General Procurement Notice (GPN)** would be published in the UN "Development Business" on -line around the period of Loan Negotiation. For ICB goods and works contracts

and large-value consultants contracts (more than US$200,000), a Specific Procurement Notice would be advertised in the Development Business on-line and in the national press.

35. **Frequency of Procurement Supervision.** Supervision of procurement would be carried out through prior review supplemented by supervision missions with post review at least once a year.

36. **Procurement Risk Assessment and Management** of the capacity of the PIOJ was carried out in August 2013, updated in November 2014 and May 2015 for the Project by the Bank's procurement accredited staff in the team in line with the Procurement Risk Assessment and Management System (PRAMs) Module by the World Bank. Questionnaire for PRAM was shared with the PIOJ and the officials in the PIOJ were interviewed on the assessment of the Procurement. The PIOJ has extensive experience with procurement and its procurement management system follows a clear and defined cycle of procurement planning to the delivery of goods and services as part of the procurement cycle.

37. Procurement to be conducted by the PIOJ shall be carried out in compliance as agreed in the Project Operations Manual, the Project Appraisal Document (PAD) and Grant Agreement. This includes the use of relevant templates, bearing in mind the types of goods and services to be undertaken.

38. *Action Plan in Strengthening the Capacity to Implement Procurement Actions:*

a. A procurement officer (PO) shall be hired to work in the PIU under this Project.

b. The procurement and Project staff in the PIU shall attend procurement training in the WB regional fiduciary workshop.

c. The procurement plan for the implementation of the Project during the first 18 months has been agreed at preparation of the Project and included in the PAD.

d. Tender/selection documents for the first year's procurement under ICB and QCBS in the procurement plan should be prepared by the PIU and submitted to the Bank for review by the effectiveness of the Project (not to be the condition for effectiveness).

Table A: Procurement Plan (for the first 18 months)

No.	Contract Category and Type	Description of Contract	Estimated Cost (US$)	Procurement Method	Review by Bank (Prior/Post)	Estimated date of award
1.	Consultancy Services	Technical Specifications for equipment and development of training plan		QBS	Prior	Nov 2015
2.	Consultancy Services	Update Climate Change Scenarios Pathways Modelling		SSS	Prior	May 2016
3.	Consultancy Services	National vulnerability assessment (Health)		QCBS	Prior	June 2016
4.	Consultancy Services	High resolution national vulnerability assessment		QCBS	Prior	Sept 2016
5.	Consultancy Services	Behavioral change campaigns		QCBS	Prior	May 2016

VI. Social

39. The Social and Land Acquisition review of Project components was carried out during Project preparation to analyze direct and indirect social risks and impacts likely to be caused by the Project activities. Also, the sites for project activities were screened for potential resettlement impacts, and none were identified. Therefore, the Project does not trigger any social safeguards policies. A full explanation of the approach to social (and environmental) safeguards is provided in the Integrated Safeguards Data Sheet (ISDS) and the Environmental and Management Framework (EMF).

40. *Project beneficiaries*: The main beneficiaries of the Project will be public sector providers of meteorological and hydrological data and related information services and its users in Jamaica and elsewhere. The primary public sector provider is the Ministry of Water, Land, Environment and Climate Change (MWLECC), in particular through the Meteorological Service Jamaica (MSJ) and the Water Resources Authority (WRA). MSJ and WRA will benefit from capacity building and direct investments to be made in new and replacement equipment. These investments also would benefit the data collection needs of the Rural Agricultural Development Authority (RADA) in the Ministry of Agriculture and Fisheries and the capacity of the climate and risk data node of the National Spatial Data Management Division (NSDMD).

41. The end-users of meteorological and hydrological services will benefit from the more reliable and consistent climate data to be collected, the associated climate modelling and vulnerability assessments to be prepared and the establishment of a common-user climate data information platform. The primary beneficiaries range across both the public and private sector and include:

- Ministry of Health and health facilities;
- Bureau of Mines, Mines and Geology Division;
- National Water Commission;
- Office of Disaster Preparedness and Emergency Management;

- Forestry Department of Jamaica;
- Rural Agriculture Development Agency;
- National Irrigation Commission;
- Agricultural commodity boards and producers (large and small scale);
- Construction, Engineering and hydrological consultants and companies;
- Insurance companies;
- Civil aviation authority and airlines;
- The Coast Guard;
- Hotels and tourism companies; and
- NGO's, schools and university researchers.

42. Given the public goods nature of hydro-meteorological services, the entire population will benefit from better warnings of hydro-meteorological hazards and more accessible, equitable and quality-assured climate information and services. Information will be provided in specific forms most useful to different end-users and in close cooperation with existing end-user organizations, and wherever possible, accompanied by tailored, practical and simple to apply behavioral change messages and adaptation advice. This will be of particular importance to the promotion of climate resilient agriculture (such as planting hurricane-resistant crops, salt and drought tolerant crops) and protection of coastline infrastructure including key health facilities and major tourism centers. MWLECC's recently established (2012) Climate Change Division will be the main driver of and receive support to implement the climate change education and awareness towards behavioral change campaigns to disseminate as widely as possible, the information derived from robust, downscaled climate change modelling and vulnerability assessments.

43. **Gender considerations.** Most of Jamaican society is vulnerable to the extreme weather events associated with climate change. Whilst "gender" does not only refer to women, because of the fact that in many societies women have less power and fewer opportunities than men, there has been an explicit attention to women's empowerment and engagement in the design of Project activities. In Jamaica, men and women at times play different roles within the private and public spheres and in some respects have different priorities and perspectives. Given the role that men play in agriculture, the messages would need to target both men and women and be tailored specifically for that purpose.

44. Among the rural population (46% of total), poverty remains relatively high (21.3% in 2012[28]) and women, who make up 49.2% of the rural poor, provide the bulk of labor in food production activities and are the primary vendors of crops and fish, are most likely to be directly impacted by food security issues. Climate-related disasters and climate change impacts will likely exacerbate existing gender inequalities as poor women are amongst the hardest hit by the effects. Improvement in the database and institutional mechanisms for early warning systems and agricultural knowledge and adaptation interventions will assist poverty reduction and food security issues and by extension, be of direct benefit to female-headed households and female agricultural workers and fishers/fish vendors.

45. Dissemination of information and the reporting of the core indicators will be gender disaggregated and, in the case of the latter, used to specifically track, monitor and positively influence the gender impact of the Project.

[28] Jamaica Survey of Living Conditions, 2012.

VII. Environment

46. All Implementing Agencies are responsible for ensuring that they carry out their respective sub-components of the Project in accordance with the Environmental Management Framework (EMF) that has been prepared by the Government and was disclosed in-country on May 31, 2014 and revised on October 30, 2014 and on the World Bank's external website on November 14, 2014.

47. A review of the Project investment activities carried out during Project preparation in terms of their location, handling, and transportation associated with their use, their construction/ civil works needs, and operations and maintenance requirements concluded that only Component 1 activities funded under the Project are likely to have minimal environmental impact requiring mitigation, namely:

(i) C1.4 Doppler RADAR:

- Transportation from port to site
- reconditioning of the tower with metal cleaning, welding and repainting
- Refurbishing of the building - removal of worn carpets, cleaning of walls, windows and doors, replacement of windows and doors, repair of roof etc.
- Disposal of waste and transportation from the site must be executed with best practice.
- Upgrade water storage - sustainable water supply - install rainwater harvesting system - remediate existing tanks - connect rainwater catchment to tank
- Install Standby power generation to support existing power supply. Install solar powered system.

(ii) WRA equipment:

- Installation of stream gauges (new and replacement)
- Rainfall intensity gauges (new and upgraded)
- Construction of instrument shelters
- Site selection, transportation and installation
- Soil moisture probes
- Loggers on monitoring wells.

48. Overall it was assessed that:

(a) There will be no land acquisition required under the Project for any reason since all activities will be located or undertaken at sites already leased by the Government of Jamaica. Therefore, there will be no adverse social impact in terms of land use.

(b) Any adverse environmental impact, where it occurs at any stage, will be small if not negligible, local, and confined to the immediate vicinity where it may occur and can be readily avoided and or easily mitigated through widely available and tangible mitigation measures.

49. Therefore, in compliance with the laws and policies of Jamaica and with the World Bank's Operational Policy on Environmental Assessment OP4.01, the Project satisfies the requirements of an Environmental Assessment for an Environmental Risk Category B project.

50. In terms of the requirements for category "B" projects in OP4.01, the Government has prepared an Environmental Management Framework (EMF) and Environmental Management Plan (EMP) to mitigate impacts from the small scale construction activities associated with installing the hydro-met equipment and small scale refurbishment of existing buildings such as the control tower and offices at the Cooper's Hill radar station. The EMP provisions will be integrated

into the technical design and contracts for all civil works, and where necessary will also be adopted by MSJ and WRA for any measures to be adopted during operation and maintenance of equipment installed under the Project. The cost of implementation of the mitigation measures will be included in the individual civil works and procurement contracts/specifications and included as pay items in the Bills of Quantities or Day Works.

51. The World Bank will conduct an ex-post audit review during its supervision missions of the implementation of these management measures in the EMF.

52. *Consultations and Disclosure*: During Project preparation, there were consultations on the EMF with the key stakeholders drawn from various spheres of Jamaican society. A full record of these consultations can be found in the EMF. The EMF has been reviewed and cleared by the World Bank, and has been disclosed locally in-country on May 31, 2014, revised on October 30, 2014 and in the World Bank's external website on November 14, 2014

Annex 4: Implementation support plan

JAMAICA: IMPROVING CLIMATE DATA AND INFORMATION MANAGEMENT PROJECT

Implementation Strategy

1. The strategy for implementation support has been developed based on the nature of the Project and its risk profile. It will aim at making implementation support to the client more flexible and efficient, and will focus on implementation of the risk mitigation measures for institutional capacity for implementation and sustainability risks (rated "moderate") and Environment and Social risks (rated "moderate").

2. *Institutional Capacity for Implementation and Sustainability Risks.* Bank missions will confirm that the PIU is fully staffed with qualified technical, procurement and FM specialists. Missions will also review the staffing and the work of consultants supporting the Technical Implementing Agencies on Project components.

3. The Bank will maintain regular contact with key officials of the PIOJ and the IAs to exchange views on strategic issues of Project implementation and address any critical issues, e.g., potential or actual non-compliance with important Project covenants.

4. The FM and procurement specialists will provide necessary training to relevant PIU staff before commencement of the Project implementation. They will review the efforts of the PIOJ in implementing financial management and procurement in accordance with agreed formats. They will monitor disclosure of Project information on the Project and PIOJ websites, the effectiveness of internal control arrangements to address possible fraud and corruption, and review the auditor's reports regarding weaknesses in controls and cases of fraud and corruption. The FM specialist and the procurement specialist will both be supported by Bank staff based in the Country Office to provide timely support. Supervision of financial management and procurement will be carried out semi-annually as part of the implementation support plan and additional support will be provided on an as-needed basis in response to client needs.

5. The environment specialist will ensure that any site specific EMP to be prepared is consistent with the EMF based on detailed designs, and confirm that they are acceptable to the Bank. They will confirm that the required safeguard staffing is in place at the NEPA, and have been provided the required training to carry out their responsibilities. They will make field visits on at least an annual basis to ensure that the EMF is being implemented in a satisfactory manner.

Implementation Support Plan

6. The table below indicates the focus areas and skill needs from the Bank project team required to provide implementation support during the initial and subsequent periods of the Project.

Time	***Focus***	***Skills Needed***	***Resource Estimate***	***Partner Role***
First twelve months	Establishing the project management structure and getting the project implementation on track	Project management, Procurement, FM, Disbursement, Technical expertise, Safeguards	17 staff weeks	Project management, technical coordination, fiduciary management

12-48 months	Support and monitoring for achieving intended outcomes	Thematic expertise, safeguards	72 staff weeks	Project management, technical coordination, fiduciary management

7. Table below indicates the staffing needs for implementation support.

Skills Needed	***Number of Staff Weeks per year***	***Number of Trips per year***	***Comments***
• TTL/Environmental Specialist	4 sw	2	
• Climate Adaptation Specialist	4 sw	2	
• Environmental Management	1 sw	1	
• Hydro-met Specialist	2 sw	2	
• Communications	1 sw	1	
• Project management	1 sw	Local	
• Procurement	1 sw	1	
• FM	2 sw	Local	
• Disbursement	1 sw	N/A	
• Legal	1 sw	N/A	

Annex 5: Economic and Financial Analysis

JAMAICA: IMPROVING CLIMATE DATA AND INFORMATION MANAGEMENT PROJECT

A. Introduction

1. Realizable gains are anticipated both from reduced disaster losses and enhanced economic productivity, particularly in agriculture. Currently Jamaica issues severe weather warnings but the accuracy and timeliness of predictions have been found wanting. This leaves enormous potential for diminishing the loss of lives, livelihoods and assets in this highly climate-vulnerable country. Similarly, whilst there are official seasonal forecasts and planting and harvesting advisories, downscaled climate change modeling would allow for more geographically sensitive advisories that could enhance the productivity of farmers, particularly as climate change undermines the predictive value of historical climate knowledge and associated traditional practices. These key services, among others, would be delivered under the Project.

2. This Annex presents an economic analysis of the Improving Climate Data and Information Management Project for Jamaica. The Project has four related objectives: (i) to upgrade Jamaica's hydro-met system so as to enhance climate monitoring, weather forecasting and early warning systems; (ii) to assess the expected consequences of climate change for selected sectors of the economy using climate scenarios, and to enhance climate resilient planning and decision making in these sectors; (iii) to put in place a comprehensive risk information platform; and (iv) to improve public knowledge, attitudes and practices towards climate change.

3. The analysis identifies the types of benefits generated by the Project and, where feasible, presents first- cut estimates of the magnitudes of the benefits. These estimates form the basis of a cost-benefit analysis. This cost-benefit analysis likely underestimates the magnitude of benefit s, because a number of the benefits generated by the Project cannot be quantified given available data. In particular, benefits associated with the second and fourth objectives listed above are difficult to quantify.

B. Benefits of Improved Climate Data and Information Systems

4. **Types of Benefits**. A wide range of benefits have been attributed to upgrading hydro-met systems and to improving dissemination of information about meteorological conditions and hazards. The benefit s are associated with improved forecasts of extreme meteorological events such as hurricanes , storms, floods, and droughts, as well as improved forecasts of routine weather and climate conditions[29]. Improved forecasts of extreme meteorological events and effective dissemination of information about their effects and appropriate responses to them can substantially reduce economic losses caused by the events. Improved forecasts of routine climate can result in increased enterprise profits (or reduced costs) and improved decision making by households. Table A6.1 presents examples of these benefit s, emphasizing benefits associated with forecasts of routine climate, which are often less apparent. The examples illustrate the pervasive importance of climate forecasts to economic activity.

[29] For brevity, the term "climate" is used to refer to both "weather" and "climate" when a distinction between the two is not important. Weather refers to atmospheric conditions over a period of days or weeks, whereas climate refers to atmospheric conditions over a longer period of time, such as months, seasons, years or decades.

5. **Existing Estimates of Benefits**. A large number of studies have attempted to estimate the economic benefits of climate forecasts. Surveys of these studies can be found in Nichols (1996), Anaman et al. (1998), Stem and Easterling (1999, Chapter 5), Houston et al. (2004), Katz and Murphy (2005), Weiher et al. (2005), Teisberg and Weiher (2009), and Rogers and Tsirkunov (2010).

6. A small subset of this literature focuses on estimating the benefits of improvement s in hydro-met systems. Instead of estimating the total benefits of existing, or hypothetical perfect, climate forecasts, this body of literature estimates the incremental benefits associated with improved forecasts resulting from upgrading hydro-met systems. This distinction between total and incremental benefits is emphasized by Freebaim and Zillman (2002). Much of the work on incremental benefits has been associated with evaluations of investments in upgrading hydro-met systems in countries of the former Soviet Union. Salient examples of such evaluations can be found in SEEDRMAP (2008) and World Bank (2008, 2009, 2010).

Table A6.1: Examples of Benefits from Improved Climate Forecasts

Sector	Period of Forecast	Benefits from Forecast
Agriculture	Short-Range Forecasts	Information on daily precipitation is vital to pesticide application decisions, as heavy rains can wash away recently applied pesticides.
	Medium- Range Forecasts	Accurate medium term precipitation forecasts inform farmers whether or not they need to irrigate, and by how much.
		Yields for many crops and ideal seeding rates are sensitive to the weather conditions in the days and weeks following planting.
		Harvesting time decisions can be improved.
	Seasonal Forecasts	Having more accurate data on the seasonal climate can aid farmers in determining which crops will yield more value.
		Crop insurance programs can benefit from reduced uncertainty of weather patterns.
		Agencies can anticipate food shortages earlier with better seasonal forecasts.
Household	Short-Range Forecasts	Weather forecasts are used to make everyday decisions, such as what to wear, or whether or not to take an umbrella.
	Medium- Range Forecasts	Early warnings of major storms can signal the need for a household to stock up on essentials in case of power outages or road closures, or for potentially lifesaving evacuations in cases of extreme events.
	Seasonal Forecasts	Seasonal forecasts can inform households on many decisions, ranging from whether or not and how much insurance to purchase, to what type of household fortifications and improvements to undertake.
Energy Sector	Short-Range Forecasts	Daily weather patterns have an effect on peak energy use patterns, and more accurate weather forecasts can inform power plants when to increase or decrease electricity production.
	Seasonal Forecasts	Hydro-electric generators benefit from improved stream flow forecasts.
Recreation and Tourism	Short-Range Forecasts	Golf course management, recreational fishing, and other outdoor and marine-based activities benefit from more accurate temperature and precipitation forecasts.

Sector	Period of Forecast	Benefits from Forecast
	Seasonal Forecasts	Tourist resorts make staffing and investment decisions based on expected tourists in a given season, which can be very sensitive to seasonal weather.
Transportation and Shipping	Short-Range Forecasts	Routing decisions of trucks, ships, and airplanes can be affected by dailyweather conditions.
	Medium- Range Forecasts	Cargo ships travelling around unexpected storms can add considerable cost and time to delivery.
Water Resource Management	Seasonal Forecasts	Improved forecasts can lead to more efficient reservoir operations and savings from avoiding groundwater pumping to augment reservoirs.
Fisheries	Medium- Range Forecasts	Fishing vessels rely on weather forecasts to determine when to set sail, how long to stay at sea, and where to navigate to avoid adverse weather conditions.
Emergency Response	Short-Range Forecasts	Adequate warning before extreme weather disaster can significantly reduce losses to life. First responders and emergency rescuers can pre-position emergency response assets to places where they will be most effective for rescue operations.

Notes: Short-range forecasts are forecasts beyond 12 hours and up to 72 hours. Medium-range forecasts are forecasts beyond 72 hours and up to 240 hours. Seasonal forecasts are descriptions of averaged weather parameters over the next 3 to 6 months, excluding individual events.

7. A related body of literature has examined the benefits of early warning systems. This literature examines the benefits from improved forecasts of extreme meteorological events and effective dissemination of information about these events and appropriate responses to them. Detailed studies have been conducted of early warning systems for floods, cyclones, and el Nino in various Asian countries (Bangladesh Water Development Board 2006 and Subbiah et al. 2008), as well as of early warning systems for floods, hurricanes and tornadoes in the U.S (Carsell et al. 2004, Simmons et al. 2005, Teisberg and Weiher 2009, and Lazo and Waldman 2011).

8. For the purposes of this analysis, the literatures on incremental benefits and early warning systems are the most relevant given that a salient objective of the Project is to improve Jamaica's hydro-met system and the dissemination and application of the information that it generates, including improved early warning systems. The literature on total benefits, rather than incremental benefits, would be the more relevant one if the objective of the analysis were to estimate the benefits of having a hydro-met system, i.e., the benefits of going from a scenario with no hydro-met system to one with a hydro-met system. The objective of this analysis is, instead, to estimate the benefits of going from the current hydro-met system to an improved hydro-met system.

9. **Factors that Influence the Magnitude of Benefits.** It bears emphasis that the magnitudes of benefits associated with improved forecasts are very much setting specific. The value of a forecast depends on a multitude of factors. Among the most important are (e.g., Mjelde et al. 1989, Stern and Easterling 1999, Blench 1999, Houston et al. 2004, and Teisberg and Weiher 2009, Lazo and Waldman 2011):

- time frame (span) of the forecast, e.g., forecasts can be made of tomorrow 's weather or next summer's average weather;
- lead time of the forecast, i.e., the length of time between the issuance of a forecast and

the time of the event forecasted ;
- spatial resolution of the forecast;
- set of weather parameters forecast, e.g., rainfall, temperature, etc.;
- perceived and actual accuracy of the forecast-perceived accuracy can differ from actual accuracy, especially if past forecasts have been wrong;
- timely dissemination of the forecast in a format that is understandable and useful to users, be they households , enterprises, or government agencies;
- ability of users to benefit from modifying their decisions/actions in light of the information contained in the forecast, e.g., a very accurate flood forecast with limited lead time might enable households to flee a flood zone, but might not give them time to move their belongings to higher ground.

10. These factors imply that benefits estimates derived using benefits transfer[30], as is done here, should be viewed as indicative rather than exact.

11. On an economy-wide level, the value of improved forecasts varies across sectors. Some sectors of the economy are more climate sensitive than others, and are therefore more likely to benefit from improved forecasts. The sectors generally considered to be climate sensitive are: agriculture, aviation, construction, surface and water transportation, water resources, energy, fisheries, forestry, health, and tourism and recreation (Houston et al. 2004 and World Bank 2008).

12. **The Jamaican Context.** Jamaica's location in the tropics makes its climate especially variable. This variability implies a greater need for, and larger benefits from, high quality climate forecasts. This observation is reinforced by Jamaica's status as one of the countries most susceptible to extreme meteorological events. It is estimated to have the second highest economic risk exposure to two or more natural hazards: 96.3% of the national population is exposed to two or more hazards, as is 94.9% of the national territory and 96.3% of the country's GDP (GFDRR 2010). The dominant natural hazards are hurricanes, tropical storms, floods, and droughts. As Table A6.2 shows, extreme meteorological events have imposed large economic costs in virtually every year of this century. In terms of the sectors of the Jamaican economy that are most affected, the Strategic Program for Climate Resilience identifies water resources, agriculture, tourism, human health, and human settlements as priority sectors (Planning Institute of Jamaica 2011).

13. The benefits from improving a country's hydro-met system depend on the current state of the system and on the nature and magnitude of the improvements being evaluated. Available evidence indicates that Jamaica's hydro-met system has deteriorated over time. The original network of 23 climatological stations has dwindled to 6 functioning stations. The 20-year old Doppler Weather RADAR in place is now obsolete and subject to periodic malfunctions. This suggests that there is scope for sizable benefits to be realized from even modest investments in the hydro-met system such as those proposed in this Project. Given the onerous debt burden carried by the Jamaican government (at 137% of GDP in March 2015), it is unlikely that these investments will be made by the Jamaican government on its own.

[30] Benefits transfer is a commonly used technique that makes use of benefits estimates derived in one setting to estimate benefits in another, similar setting.

Table A6.2: Major Damage-Causing Meteorological Events, 2000-2010

Event	Year	Damage (Billion $J, Current Prices)	Damage (Million US$, Constant 2010 Prices)	Damage as Percentage of GDP (Official Exchange Rates)
Tropical Storm Nicole'	2010	20.60	235.75	,1.76%
Tropical Storm Gustav'	2008	15.50	262.35	2.01%
Hurricane Dean'	2007	23.80	519.08	4.09%
Hurricanes Dennis and Emily'	2005	5.98	170.84	1.54%
Hurricane Wilma'	2005	3.60	102.85	0.93%
Major Drought"	2005	0.38	16.74	0.15%
Hurricane Charley'	2004	0.44	14.74	0.14%
Hurricane Ivan[1]	2004	36.99	1,239.14	12.18%
Floods 5/21/02-6/4/02J	2002	2.47	130.95	1.35%
Hurricane Michelle'	2001	2.52	150.49	1.65%
Floods 12/29/00-1/4/2001J	2001	0.20	11.94	0.13%
Major Drought'	2000	0.25	16.74	0.19%

[1] Planning Institute of Jamaica (2011)
[2] Government of Jamaica Ministry of Agriculture & Fisheries (2010)
[3] United Nations and IDB (2007)

C. Overview of Analytical Approach

14. Estimates are developed for the three broad classes of benefits described above:

i. benefits of improved forecasts, and associated early warning systems, of extreme meteorological hazards;
ii. benefits to enterprises of improved forecasts of routine climate and dissemination of these forecasts;
iii. benefits to households of improved forecasts of routine climate and dissemination of these forecasts.

15. Particular emphasis is placed on deriving estimates of the first class of benefits, given Jamaica's high susceptibility to extreme meteorological hazards.

16. Estimates of all three classes of benefit s are derived using benefits transfer given the absence of benefits studies for Jamaica itself. Because of uncertainty about the suitability of the estimates transferred, the values of these estimates are varied as part of a sensitivity analysis. The uncertainty about the estimates stems from the factors listed in paragraph 9[31]. Throughout the analysis a concerted effort is made to be conservative when estimating benefits, especially those benefits that are subject to a high degree of uncertainty, and to avoid double counting of benefits.

17. Forecasts are of value only if they are disseminated in a timely manner and in a format that users can understand and make use of. Users must also trust the accuracy of forecasts if they are to act on them (e.g., Stern and Easterling 1999, Chapter 4; Blench 1999, World Bank 2008, Chapter 2). In the case of early warning systems, providing information to users on how to best respond to

[31] This is particularly true given the absence of precise, quantitative information on the improvements in forecast quality and dissemination that would be generated by the project.

the warnings is often also critical to the effectiveness of such systems, especially in poor communities (Subbiah et al 2008; World Bank 2008, Chapter 2; Webster 2012). Without effective mechanisms for timely dissemination of understandable and usable forecasts, as well as information on appropriate responses, the potential benefits associated with upgrading hydro-met systems will not be fully realized. The benefits estimates presented here assume that these mechanisms are in place, or are put in place, as indicated under Components 2 and 3.

18. **Improved Forecasts of Extreme Meteorological Hazards and Early Warning Messaging**. The benefits associated with predicting extreme meteorological hazards are measured in terms of the expected reduction in economic losses resulting from improved forecasts and associated early warning systems. Data on losses in Jamaica from extreme hazards during this century, broken down by sector, are used to derive projections of future expected losses in the without-project scenario[32]. The effects of the expected increase in the frequency of natural hazard s due to climate change on economic losses are estimated using predictions developed by the Caribbean Climate Risk Insurance Facility (2010) for Jamaica. These predictions are of aggregate losses from natural hazards (winds and floods, specifically) between 2009 and 2030 for various climate change scenarios.

19. Reductions in expected losses with the Project are based on percentage loss avoided estimates drawn from existing studies conducted elsewhere that examine the benefits of improved forecasts and associated early warning systems. To the extent possible, the percentage loss avoided estimates used in this analysis are drawn from studies of countries facing hazards similar to those faced by Jamaica and with similar geographies and economies. The percentage losses avoided are assumed to remain constant over time, absent is information on how they might change.

20. The approach taken to estimate reductions in expected losses is similar to that employed in previous economic analyses of investments in hydro-met systems, with some important differences. Unlike the situation faced in some countries, fairly detailed estimates of economic losses from extreme meteorological hazards are available for Jamaica, and these loss estimates are central to the analysis conducted[33]. This study's reliance on benefits transfer to derive estimates of the reduction in expected losses with the Project stems from the absence of percentage loss avoided estimates for Jamaica. The benefits estimates presented here could be refined by collecting information from Jamaican sector experts on the likely percentage of losses that would be avoided with the Project. Such expert-opinion-based estimates have been developed for evaluations of other, much larger, investments in hydro-met systems (e.g., World Bank 2008, 2009, 2010).

21. Improved Forecasts of Routine Climate. To estimate the benefits to Jamaican enterprises of improved forecasts of routine climate (the second class of benefits listed above), this study relies on benefits transfer, making use of available estimates in the literature. Useful, transferable estimates are only available for a very small number of sectors. Accordingly, the estimates for this

[32] An alternative approach to estimating expected future losses would be to make use of information on return frequencies of different types of extreme meteorological events, together with estimates of the losses that each event would generate. Given the difficulty in estimating the losses caused by each of a large set of possible extreme events, this approach was not pursued. A further difficulty with this approach is estimating, with any degree of accuracy, the return frequencies of extreme events for a country as small in area as Jamaica.

[33] In contrast, the benchmarking method employed to evaluate hydro-met investments in countries of the former Soviet Union (World Bank 2008, 2009, 2010) derives estimates of losses for some sectors of the economy using available data on the weather-sensitivity of those sectors, the economic structure of the country, and the state of the country's hydro-met systems.

class of benefits are very conservative-they capture only a small subset of the benefits to all climate-sensitive sectors of the Jamaican economy.

22. The benefits to Jamaican households of improved forecasts of routine climate are based on the findings of a detailed survey of U.S. households' willingness to pay for improved forecasts (Lazo and Chestnut 2002). The willingness -to-pay estimates derived from these so-called contingent valuation studies are sensitive to income levels. They are also sensitive to individuals' preferences, which can plausibly differ in a systematic manner across countries and cultures. Accordingly, the U.S. per- household estimate of willingness to pay is adjusted to reflect such differences.

23. The benefits of improved forecasts of routine climate are likely to increase as climate becomes more variable and as the number of enterprises and households rises. However, quantifying this increase in benefits resulting from more variable climate has not yet been attempted in the literature. In absence of estimates of this potential increase and 20-year-out projections of per capita income and the number of households in Jamaica, this study assumes that the benefits of improved routine forecasts do not increase in magnitude over time. This is a conservative assumption given that it likely underestimates benefits.

24. To assess the robustness of the conclusions drawn from this analysis, a variety of sensitivity analyses are conducted using:

- alternative values of the transferred benefits estimates;
- alternative time horizons (5, 10, 15 and 20 years);
- alternative real discount rates (4%, 10% and 12%);
- alternative assumptions about the increase in expected losses from extreme meteorological hazards over time due to climate change; and
- alternative assumptions about adaptation by households and enterprises that reduces damages from more frequent, or more intense, extreme meteorological hazards even without the Project.

D. Estimated Benefits of Improved Forecasts of Extreme Hazards and Early Warning Messaging

25. The method used to estimate the benefits of improved forecasts of extreme meteorological hazards and associated early warning messaging consists of several steps. First, the average annual economic loss from extreme meteorological hazards in Jamaica over the period 2000-2010 is calculated by sector. These average losses form the basis for predictions of expected losses from extreme events in future years given alternative assumptions about the severity of climate change. The percentage of losses that would be avoided with the Project in each sector is then estimated using benefits transfer from existing studies. Expected annual benefits are then calculated by multiplying expected annual sector losses for each year by the percentage loss avoided estimate for that sector. These sector benefits are aggregated for each year. Finally, the discounted present value of annual benefits is calculated for 5-, 10-, 15-, and 20-year time horizons.

26. In previous studies of improving hydro-met systems losses from meteorological events were not available, so total damages were used (World Bank 2008, 2009, 2010). However, sector losses are available for Jamaica for many recent meteorological events, and these values were used to improve expected damage and benefits estimates. By disaggregating expected damages by sector, it is possible to arrive at a more accurate estimate of total expected benefits than if a single,

damage mitigation multiplier were used . Every sector in the economy is affected differently by meteorological hazards, depending on the type of meteorological event, the sector's exposure to weather, and the value of its assets. In addition, this study is estimating incremental benefits, rather than total benefits, and thus must take into consideration each sector's current ability to mitigate damages, and how effective an improvement in the hydro-met early warning system will be. For instance, a hotel in Jamaica's bustling tourism industry is likely to be a very sturdy structure that will take little damage from hurricane force winds, regardless of how much advanced warning is given. In contrast, the home of a Jamaican farmer may be much more vulnerable to strong winds and rain, and a very small increase in the amount of preparation time the farmer has to fortify his property and move his possessions could result in a significant decrease in damages.

27. In order to calculate average annual economic losses from extreme meteorological hazards, this analysis considers an 11-year period from 2000-2010. Extreme hazards are separated into four categories: hurricanes, tropical storms, floods, and droughts. Table A6.2 (above) lists the 12 extreme meteorological events that occurred in Jamaica over this period. Accurate estimates of losses do not exist for smaller events that also caused damages during this time period, and they are therefore excluded from this study. The loss estimates in this study are therefore conservative.

28. The losses (or damages) from each event are decomposed into 10 sectors (see Table A6.3). Both direct losses, which are losses of physical and natural capital, as well as indirect losses, which consist mainly of losses to profits, are included. Where available, these decompositions are taken from existing damage assessments[34]. For events for which damage decompositions are not available, as is the case for Hurricane Charley (2004) and the January 2001 flooding event, this study computes average damage percentages by sector and hazard type for events for which damage decompositions are available, and then applies these average percentages to events for which damage decompositions are not available. For example, in the case of Hurricane Charley, the average percentage of damages experienced by each sector for all other hurricanes over the period 2000-2010 is calculated. These percentages are then used to decompose total damages from Hurricane Charley. Table A6.3 illustrates this procedure. An analogous procedure was used for the other hazard types.

Table A6.3: Average Damages from Hurricanes by Sector (USD M, Constant 2010)

Sector	Michelle	Ivan	Dennis & Emily	Wilma	Dean	Percent of Damages
Agriculture, Livestock, & Fisheries	32.33	286.42	22.15	7.11	204.90	25.6%
Emergency Operations	0.07	9.30	0.73	0.07	13.15	1.1%
Environment	-	125.77	1.97	-	2.62	6.0%
Government & Institutions	1.24	27.03	0.03	91.39	17.56	6.4%

[34] Damage assessments by sector are taken from: Planning Institute of Jamaica (2004, 2005a, 2005b, 2007, 2008, 2010 and 2011), Economic Commission for Latin America and the Caribbean (2001 and 2002), Government of Jamaica Ministry of Agriculture & Fisheries (2010), United Nations and IDB (2007), and Economic Commission for Latin America and the Caribbean (2001 and 2002).

Sector	Michelle	Ivan	Dennis & Emily	Wilma	Dean	Percent of Damages
Health	0.85	25.40	1.58	1.29	6.51	1.6%
Housing	13.46	373.98	5.82	1.03	130.02	24.3%
Industry	-	108.37	1.39	-	44.27	7.1%
Tourism	2.00	53.29	0.07	-	0.95	2.6%
Transportation	94.21	109.21	122.37	-	44.65	17.1%
Utilities	6.53	121.00	14.63	3.03	30.38	8.1%
Total	150.67	1,239.77	170.75	103.92	495.01	100.0%

Note: Damage totals here may be slightly different from totals in Table A6.2 due to missing sectors and small discrepancies in totals between different sources.

29. Due to the nature of extreme meteorological hazards, it is impossible to reliably forecast their number and severity years into the future. To derive estimates of expected losses from such hazards in the future, it is assumed that absent changes in climate or the values of assets at risk, expected annual losses from extreme hazards in future years are equal in magnitude to average annual losses over the period 2000- 2010. These "baseline loss estimates" are then adjusted to reflect the likely increase in the frequency and intensity of extreme meteorological hazards due to climate change, and the expected increase in the values of assets at risk. The adjustments are made using estimates developed by the Caribbean Catastrophe Risk Insurance Facility (CCRIF).

30. Using 2009 as a base year, CCRIF estimates that by 2030, economic losses in Jamaica from extreme hazards will increase 28%, 46%, or 76%, given no changes in climate, "moderate" changes, or "high" changes, respectively (CCRIF 2011). Assuming losses increase linearly, this translates to loss increases of 1.3%, 2.2%, or 3.6% of the baseline, per year. These percentages are applied to the baseline loss estimates described above to obtain estimates of expected future losses.

31. After computing expected annual losses, by sector, for each hazard type, the reduction in losses with the Project are estimated by applying estimates of the percentage loss avoided (PLA) with the Project. The percentage loss avoided will generally vary across sectors and hazard types. Because of this heterogeneity, a separate PLA estimate is applied to each sector for each hazard type.

32. As noted earlier, given the lack of Jamaica-specific information, the analysis relies on PLA estimates derived in similar studies of other regions. The estimates used are drawn from a variety of studies as indicated in Table A6.4 below. If only one PLA estimate is available for a given sector/hazard, this value is treated as the high value. The low value is taken to be 50% of the high value. Where multiple PLA estimates are available, the lowest value is taken to be the low value, and the highest value is taken to be the high value. The middle value is the average of the two values.

33. Given the scope of this study and limitations of the existing literature, for some sectors/hazards it was necessary to use PLA estimates from countries that are dissimilar to Jamaica. Specifically, for some sectors/hazards, estimates developed as part of an evaluation of a hydro-

met system upgrade in Tajikistan (World Bank 2009) are used. The PLA values taken from this study are reduced by 50% to be conservative and to acknowledge differences in the climate, geography, economic structure, and hydro-met systems of the two countries.

34. Multiplying the PLA estimates by the expected annual losses for each sector/hazard, yields estimates of the expected annual benefits associated with improving forecasts of extreme hazards and early warning systems. However, these estimates implicitly assume that forecasts are perfectly accurate. In reality, forecasts are subject to uncertainty, especially those made in the tropics. It is therefore important to acknowledge the likelihood of incorrect forecasts and the costs associated with these forecasts (e.g., the costs of evacuating people unnecessarily)[35]. Following Subbiah et al. (2008), it is assumed that the cost of an incorrect forecast is equal in magnitude to the benefit of a correct forecast[36]. Assuming that average forecast accuracy is 80%, this implies that estimates of expected annual benefits need to be multiplied by a correction factor of 0.6 (= 80% - 20%). This correction factor reflects the fact that benefits of improved forecasts are only enjoyed 80% of the time, while costs of incorrect forecasts are incurred 20% of the time.

Table A6.4: Estimates of Percentage Losses Avoided with Project

Sector	Hurricane/Tropical			Flood			Drought		
	Low	Middle	High	Low	Middle	High	Low	Middle	High
Ag., Livestock, & Fisheries	13.0%[4]	19.5%	26.0%[1]	10.0%[1]	40.0%	70.0%[1]	1.8%[4]	2.7%	3.6%[3]
Emergency Operations	1.8%[4]	2.7%	3.6%[3]	1.8%[4]	2.7%	3.6%[3]	Not Applicable		
Environment	1.8%[4]	2.7%	3.6%[3]	Not Applicable			Data Not Available		
Government & Institutions	7.5%[4]	11.3%	15.0%[1]	5.0%[1]	10.0%	15.0%[1]	Not Applicable		
Health	1.8%[4]	2.7%	3.6%[3]	1.8%[4]	2.7%	3.6%[3]	Not Applicable		
Housing	5.0%[2]	7.5%	10.0%[2]	2.0%[1]	19.0%	36.0%[1]	Not Applicable		
Industry	1.8%[4]	2.7%	3.6%[3]	1.8%[4]	2.7%	3.6%[3]	Data Not Available		
Tourism	1.8%[4]	2.7%	3.6%[3]	1.8%[4]	2.7%	3.6%[3]	Data Not Available		
Transportation	3.0%[4]	4.5%	6.0%[3]	0.0%[1]	6.9%	13.7%[2]	Not Applicable		
Utilities	2.1%[4]	3.2%	4.3%[3]	0.0%[1]	6.9%	13.7%[2]	Data Not Available		

[1] Subb1ah et al. (2008)
[2] Bangladesh Water Development Board (2006)
[3] World Bank (2009)
[4] Calculated as 50% of the value of the high value.

35. Table A6.5 presents estimates of the resulting expected annual benefits for the year 2014 (the first year of the Project) assuming, hypothetically, that potential annual benefits are fully realized in that year.

[35] This correction is appropriate given that there is no evidence that the PLA estimates drawn from the literature account for forecast error.
[36] This assumption is made given the absence of information on the costs of incorrect forecasts.

Table A6.5: Expected Annual Benefits of Improved Forecasts of Extreme Hazards and Early Warning Systems, Baseline Year (USD M, Constant 2010)

	Hurricanes	Tropical Storms	Floods	Droughts	Total
Low Value	7.17	1.06	0.24	0.03	8.49
Middle Value	10.75	1.59	1.28	0.04	13.66
High Value	14.34	2.12	2.33	0.05	18.84

Note: These estimates incorporate a correction factor that reflects the costs of inaccurate forecasts.

36. In reality, it is unlikely that potential annual benefits will be fully realized in the first year of the Project. Absent further information, it is assumed that 20% of potential annual benefits are realized at the end of the first year of the Project, and an additional 20% of benefits are realized at the end of each of the four subsequent years. From 2018 onwards, 100% of potential annual benefits are realized in each year.

37. The estimates in Table A6.5 assume that as a result of experiencing more, or more intense, extreme meteorological hazards, Jamaican households and enterprises do not adapt to the hazards, reducing the damages they cause. For example, households can respond to more extreme hurricanes by living in dwellings made of concrete rather than wood. It is unclear to what extent Jamaican households and enterprises have already undertaken such adaptation measures, and to what extent these measures would increase over the next 5-20 years (the time horizon of this analysis). The available empirical literature is quite silent on this issue. A recent study of adaptation to tropical cyclones using data from across the world (Hsiang and Narita 2012) indicates that only about 3% of the losses from incremental changes of countries' current tropical cyclone climates are "adapted away" in the long run. A part of the sensitivity analyses conducted here, a scenario is considered assuming that damages in each year are reduced by 10% due to such long-term adaptation. (Accordingly, the benefits estimates presented in Table A6.5 would each be reduced by 10%). The assumption that damages in all sectors are reduced by 10% in each year due to adaptation is a liberal one given the aforementioned long-run estimate of 3% for a global cross-section of countries. The assumption guards against potentially overstating the benefits of the proposed Project as a result of ignoring the consequences of adaption measures that are undertaken even in the absence of the Project.

E. Estimated Benefits of Improved Forecasts of Routine Climate

38. **Benefits to Enterprise**s. A large number of studies have been conducted examining the value of climate forecasts to enterprises in various climate-sensitive sectors of the economy[37]. A small subset of the studies examines the value of improved forecasts. The results of these studies are typically very setting specific and provide estimates that are difficult to transfer to other settings. However, a few studies do provide estimates that can be transferred with some degree of confidence. But these studies cover only a very small number of climate-sensitive sectors. Specifically, Adams et al. (2003) report increases of 0.3- 2% in the value of crops produced in five Mexican states as a result of improved ENSO forecasts. Teisberg et al. (2004) and Yeh et al. (1982)

[37] See Houston et al. (2004) and Weiher et al. (2005) for a compendium of estimates.

report increases of 0.04-0.1% in GDP from the U.S. electricity, gas and sanitary services sector from improved short-term forecasts of temperature and long- term forecasts of precipitation[38].

39. Table A6.6 below presents the results of applying these estimates to the corresponding sectors of the Jamaican economy. The table shows the benefits in these sectors for the year 2014 assuming, hypothetically, that potential annual benefits are fully realized in this year. When incorporating these benefits in the calculation of project benefit-cost ratios, it is assumed that the benefits are realized in 20 percentage-point increments over the first five years of the Project (as is done for the benefits associated with extreme hazards). It bears emphasis that these estimates capture only a fraction of the benefits to enterprises of improved forecasts of routine climate given the large number of sectors omitted.

Table A6.6: Expected Annual Benefits of Improved Forecasts of Routine Climate for Selected Sectors (USD M, Constant 2010)

	Low Value	Middle Value	High Value
Agriculture, Forestry & Fishing	1.94	7.43	12.93
Electricity and Water Supply	0.19	0.33	0.46

Note: Estimates were calculated only for sectors for which benefits transfer was, feasible.

40. **Benefits to Households.** A number of survey-based studies have estimated the benefits to households of weather forecasts[39]. Far less common are studies that examine the benefits to households of improvements in forecast quality, which is the relevant measure for this analysis. A notable exception is a very detailed 2002 study by Lazo and Chestnut that estimates the value to U.S. households of improving the quality of one-day and multi-day weather forecasts from their then-current levels to maximum possible levels[40]. Lazo and Chestnut find that, on average, U.S. household s were willing to pay USD 12 to USD 17 per year to improve the quality of the forecasts, with a best estimate of USD 16. To transfer this benefit estimate to Jamaica, the USD 16 per household estimate is first adjusted for differences in per capita income between the U.S. and Jamaica, and then expressed in 2010 US dollars. Absent information about the precise nature and magnitude of the improvements in forecasts that would achieved by the Project being evaluated, or about the nature of differences in household preferences for such improvements between the U.S. and Jamaica, it is conservatively assumed that the value to Jamaican households of the improvement achieved by the Project is one-half of this value, or USD 1.033 per year[41].

[38] These values are in line with values employed by Hallegate (2012) to estimate the benefits of improved hydro-met services in developing countries. He assumes value added gains between 0.1% and 1% in weather-sensitive sectors.

[39] See Lazo et al. (2009) and Houston et al. (2004) for surveys of these studies, which focus on developed countries, and World Bank (2008) for a study conducted in Azerbaijan and Serbia.

[40] The accuracy of one-day forecasts was assumed to increase from 80% to 95%; for multiday forecasts, 14-day forecasts were assumed to become as accurate as current 5-day forecasts. The study focused on valuing improved forecasts of day-to-day weather rather than extreme events, hence double counting of benefits should not be an issue.

[41] This value is plausible given the results of studies conducted in Azerbaijan and Serbia, countries with GDP per capita similar to Jamaica's, indicating that households are willing to pay USD 12-16 per year to support national hydro-met services-a total, rather than incremental, benefit measure (World Bank 2008, p 71).

Multiplying by the 881,078 households in Jamaica (Statistical Institute of Jamaica 2011) yields a total annual benefit estimate of US$910,154. As with the benefits to enterprises, these benefits to households are assumed to be realized in 20 percentage-point increments over the five years of the Project.

F. Estimated Costs of the Project

41. The total cost of implementing the Project is US$6.8M. For the purposes of the economic analysis, it was conservatively assumed that the entire cost would be borne at the beginning of Year 1 (although in practice, it is likely that the bulk of expenditures will be made in Years 2 and 3). Annual costs of maintaining and operating the improved hydro- meteorological system were not anticipated to increase significantly. The new RADAR will eliminate the relatively high maintenance costs associated with the current 16-year old system, and the installation of automated monitoring and information transmission systems will free up staff resources for other purposes.

G. Benefit-Cost Ratios for the Project

42. Given the above estimates and assumptions, benefit/cost ratios for the Project are calculated for 5, 10-, 15-, and 20-year time horizons, using discount rates of 4%, 10%, and 12%. These benefit-cost ratios are presented in Tables A6.7a-7c for the three different climate change scenarios, and for the low, middle and high estimates of benefits.

43. Examining the tables it can be seen that the benefit-cost ratio is well above one in all cases. For the most conservative case-no climate change, "low" benefits estimates, 5-year time horizon and 12% discount rate-the benefit-cost ratio is 3.5 (left-hand panel of Table A6.7a). The ratio rises to 10.7 when the project time horizon is extended to 20 years, with all else remaining constant. For the "middle" benefits estimates (middle panel of Table 7a), the benefit-cost ratios are nearly twice as high, and for the "high" benefits estimates they are approximately two-and-a-half times higher. Comparing the values in Tables A6.7a-A6.7c reveals modest variations in benefit-cost ratios across the three climate change scenarios. This can be attributed to the relatively short time horizons being considered in the context of climate change.

44. The benefit-cost ratios for the "middle" and "high" benefits estimates may seem unusually large, however previous studies of the returns to investments in hydro-met systems have, in a number of cases, yielded very large benefit-cost ratios. Subbiah et al. (2008) report a benefit-cost ratio of 40 for development of a cyclone early warning system in Bangladesh, and benefit-cost ratios of 0.9 to 558 for flood early warning systems in Sri Lanka and Bangladesh, respectively. An evaluation of post-civil-war investment in Mozambique's hydro-met system estimated a benefit-cost ratio of 70 (World Bank 2008, p. 5). The large benefit-cost ratios obtained in this study reflect, in large part, Jamaica's high susceptibility to extreme meteorological hazards.

45. The benefit-cost ratios presented in Tables A6.7a-A6.7c assume that Jamaican household s and enterprises do not adapt to more frequent or more intense extreme meteorological hazards, reducing the damages they cause in the future, even in the absence of the proposed Project. As discussed in paragraph 37, to evaluate the sensitivity of the benefit-cost ratios to such adaptation, an alternative scenario is considered in which the estimated expected damages from extreme meteorological events are reduced by 10% in each year as a result of adaptation. The benefit-cost ratios for this alternative scenario are presented in Tables A6.8a-A6.8c. As can be seen, the ratios are only reduced by a modest amount, and each is still well above one. For the most conservative

case considered in paragraph 43, the benefit-cost ratios diminish from 3.5 to 3.2 and from 10.7 to 9.9.

H. Additional Observations and Caveats

46. The analysis presented is best viewed as an effort to develop first-cut estimates of the benefits and costs of the proposed Project. A number of observations about the estimates and about the appropriate time horizon for the analysis are worth noting.

47. Given the nature of the equipment being installed as part of the Project, a 20-year time horizon may well be too long. The current 16-year-old RADAR system is considered outdated and unreliable, and this will likely be true of the new RADAR system 20 years hence. The 10- and 15-year horizons are likely to be more reasonable.

48. The incremental costs, both capital and recurring, of upgrading the hydro-met system itself are likely to be adequately captured by the project implementation costs. As noted above, the new equipment will likely result in reduced maintenance costs and in staff resources being freed up for other purposes.

49. However, the costs of ensuring that the benefits of improved forecasts are fully realized may not be adequately captured in the project implementation costs. For the benefits to be fully realized, citizens, enterprises, civil society organizations, and government agencies must be effectively informed about the forecasts in a timely manner. No less importantly, they must be educated on how best to interpret and make use of the improved forecasts. This is not an inconsequential task, especially given that forecasts are imperfect.

50. Another cost that is only implicitly considered in the analysis is the cost of additional measures taken to reduce losses from extreme meteorological events given improved forecasts. Examples are the costs of building additional emergency shelters or the costs borne by homeowners of protecting their dwellings given earlier warnings of storms. The analysis assumes that these avoidance (or prevention) costs are netted out of the percentage loss avoided estimates that are employed. It is unclear from the literature whether this is always true. In some cases the costs may be small enough, in relative terms, that omitting them is inconsequential.

51. As has been emphasized, only a subset of the benefits of the Project has been quantified. This is especially true of the benefits to enterprises of improved forecasts of routine climate. The benefits are only quantified for two sector aggregates (agriculture, forestry and fishing, and electricity and water supply), but there are other climate-sensitive sectors of the Jamaican economy that are likely to reap significant benefits from improved forecasts.

52. One class of benefits that has not been mentioned is a reduction in deaths as a result of improved warnings of extreme events. Given the relatively small number of deaths due to extreme meteorological events in Jamaica, benefits of this type are likely to be relatively small[42].

53. An important component of the Project is developing higher-resolution climate change scenarios for ·Jamaica in order to enhance climate-resilient planning and decision making. The benefits associated with this effort are very difficult to quantify, but they are likely to be

[42] The largest number of deaths that have been reported in this century are for Hurricane Ivan, with 17 direct deaths and 14 indirect deaths (Planning Institute of Jamaica 2004).

substantial. It is not implausible to posit that the unquantified benefits of the Project outweigh any unquantified costs of the Project.

I. Key Conclusions

54. The first-cut estimates of the benefits and costs of the proposed Project indicate that in all of the alternative scenarios considered, the benefits of the Project exceed the costs by a considerable margin. Even with the most conservative set of assumptions, including an assumption that no climate change takes place and that the benefits of the Project only last for 5 years, the benefit-cost ratio for the Project is 3.2, i.e., the expected benefits from the Project are 3.2 times higher than the expected costs of US$6.8M (in present value terms).

55. The benefits of the Project are experienced by a very broad swath of the Jamaican economy, and stem in large part from a reduction in expected damages from extreme meteorological hazards, such as storms, hurricanes and floods. Given the onerous debt burden carried by the Jamaican government (currently at 137% of GDP), it is unlikely that the investments embodied in the Project will be made by the Jamaican government on its own.

56. Extending the period over which the benefits of the Project accrue from 5 years to a more plausible 10 years or 15 years, increases the benefit-cost ratio to 6.6 and 8.7, respectively. Again, assuming no climate change takes place and otherwise maintaining the most conservative set of assumptions.

57. Thus, the estimates derived indicate that the Project is economically justified even in the absence of climate change. Acknowledging climate change, and the concomitant increase in the frequency or severity of extreme meteorological events, simply increases the benefit-cost ratios for the Project, increasing its estimated economic justification.

Table A6.7a: Project Benefit-Cost Ratios Assuming *No Climate Change* for Alternative Benefits Estimates

	Discount Rate								
	Low			Middle			High		
Time Horizon	4%	10%	12%	4%	10%	12%	4%	10%	12%
5 Year	4.5	3.7	3.5	8.7	7.1	6.7	12.9	10.6	9.9
10 Year	11.1	8.0	7.2	21.4	15.3	13.8	31.7	22.6	20.4
15 Year	16.8	10.7	9.4	32.3	20.6	18.0	47.7	30.4	26.6
20 Year	21.7	12.5	10.7	41.5	24.0	20.4	61.3	35.4	30.2

Table A6.7b: Project Benefit-Cost Ratios Assuming *Moderate Climate Change* for Alternative Benefits Estimates

	Discount Rate								
	Low			Middle			High		
Time Horizon	4%	10%	12%	4%	10%	12%	4%	10%	12%
5 Year	4.6	3.8	3.5	8.8	7.2	6.8	13.1	10.7	10.1
10 Year	11.5	8.2	7.4	22.0	15.7	14.1	32.5	23.2	20.9
15 Year	17.6	11.1	9.7	33.4	21.2	18.5	49.3	31.3	27.4
20 Year	22.9	13.1	11.1	43.4	24.9	21.2	63.9	36.7	31.2

Table A6.7c: Project Benefit-Cost Ratios Assuming *High Climate Change* for Alternative Benefits Estimates

	Discount Rate								
	Low			Middle			High		
Time Horizon	4%	10%	12%	4%	10%	12%	4%	10%	12%
5 Year	4.7	3.9	3.6	9.0	7.4	6.9	13.4	10.9	10.2
10 Year	12.1	8.6	7.7	22.9	16.3	14.6	33.7	24.0	21.6
15 Year	18.8	11.8	10.3	35.3	22.3	19.4	51.9	32.8	28.6
20 Year	24.8	14.0	11.9	46.5	26.4	22.4	68.1	38.8	32.9

Table A6.8a: Project Benefit-Cost Ratios Assuming *No Climate Change* and Reduced Damage Due to Mitigation for Alternative Benefits Estimates

	Discount Rate								
	Low			Middle			High		
Time Horizon	4%	10%	12%	4%	10%	12%	4%	10%	12%
5 Year	4.2	3.4	3.2	8.2	6.7	6.3	12.2	10.0	9.4
10 Year	10.3	7.4	6.6	20.1	14.3	12.9	29.8	21.3	19.2
15 Year	15.6	9.9	8.7	30.2	19.3	16.8	44.9	28.6	25.0
20 Year	20.1	11.6	9.9	38.9	22.4	19.1	57.6	33.3	28.4

Table A6.8b: Project Benefit-Cost Ratios Assuming *Moderate Climate Change* and Reduced Damage Due to Mitigation for Alternative Benefits Estimates

	Discount Rate								
	Low			Middle			High		
Time Horizon	4%	10%	12%	4%	10%	12%	4%	10%	12%
5 Year	4.3	3.5	3.3	8.3	6.8	6.4	12.3	10.1	9.5
10 Year	10.6	7.6	6.8	20.6	14.7	13.2	30.5	21.8	19.6
15 Year	16.2	10.3	9.0	31.3	19.9	17.3	46.3	29.5	25.7
20 Year	21.2	12.1	10.3	40.6	23.3	19.8	60.0	34.5	29.3

Table A6.8c: Project Benefit-Cost Ratios Assuming *High Climate Change* and Reduced Damage Due to Mitigation for Alternative Benefits Estimates

	Discount Rate								
	Low			Middle			High		
Time Horizon	4%	10%	12%	4%	10%	12%	4%	10%	12%
5 Year	4.4	3.6	3.3	8.5	6.9	6.5	12.6	10.3	9.6
10 Year	11.1	7.9	7.1	21.4	15.2	13.7	31.7	22.5	20.3
15 Year	17.3	10.9	9.5	33.0	20.8	18.2	48.7	30.8	26.8
20 Year	22.9	12.9	11.0	43.3	24.0	20.9	63.8	36.3	30.9

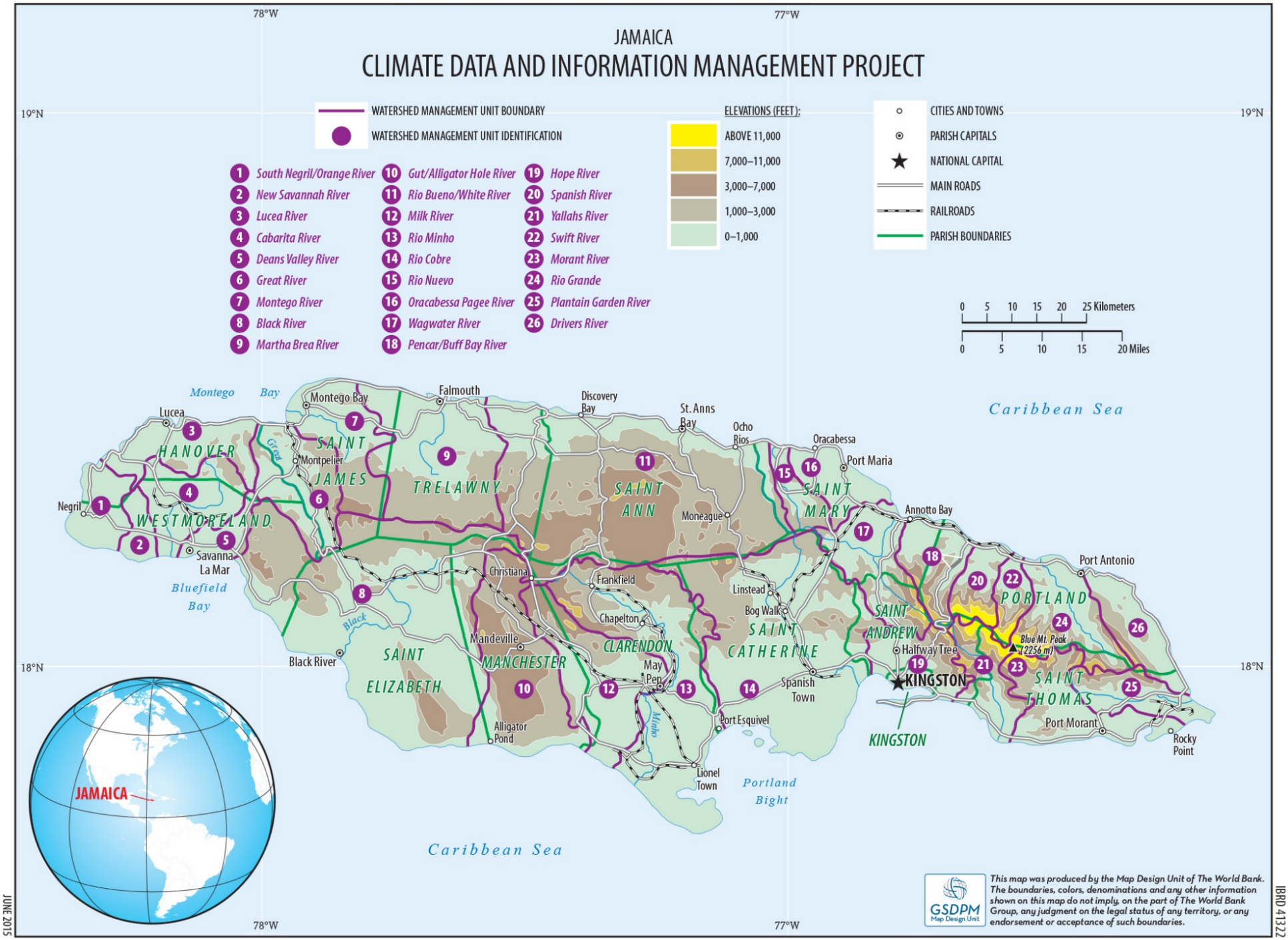
Financial Analysis

58. **Debt sustainability.** According to the most recent IMF Country Report (December 2013) Debt Sustainability Analysis, Jamaica's public debt burden is on a downward trajectory but continues to exceed the benchmark for emerging market economies and remains extremely vulnerable. The fiscal adjustment program is critical to managing down the debt path. Jamaica's public debt remains at a very high level, 137% of GDP (March 2015) and external public debt stood at 61% of GDP (May 2014)[43] and continues to remain one of the highest in the Caribbean region. However, the country has made a positive start to implementing its economic reform program under the Extended Fund Facility aimed at overcoming the long-standing problems of low growth and high debt.

59. The impact of the Project's debt on Jamaica's debt sustainability would be marginal (indeed positive given that the Project is fully grant funded). The Grant for the Project is US$6.8 million over a 4.5 year period with no repayments or commitment fee required. The time scale of the PPCR Grant aligns favorably with the structural reform program aimed at swapping external debt. Most of the investments in assets are to replace existing equipment that is no longer serviceable. New hydro-met equipment is to in-fill gaps in the existing data collection network and improve the time in which data is transmitted from field stations to receiving stations and not to expand the coverage. As part of the associated staff training, the Project will provide technical assistance for staff in the agencies to update and implement asset management plans to ensure that operations and maintenance costs are efficient and that the full life-cycle benefit is derived from the equipment.

[43] Jamaica: 2014 Article IV Consultation and Fourth Review under the Extended Arrangement under the Extended Fund Facility and Request for Modification of Performance Criteria, International Monetary Fund Country Reports, 14/169.

Annex 6: Map


JAMAICA
CLIMATE DATA AND INFORMATION MANAGEMENT PROJECT
78°W
77°W
19°N
18°N
WATERSHED MANAGEMENT UNIT BOUNDARY
WATERSHED MANAGEMENT UNIT IDENTIFICATION
ELEVATIONS (FEET):
ABOVE 11,000
7,000–11,000
3,000–7,000
1,000–3,000
0–1,000
CITIES AND TOWNS
PARISH CAPITALS
NATIONAL CAPITAL
MAIN ROADS
RAILROADS
PARISH BOUNDARIES
1 South Negril/Orange River
2 New Savannah River
3 Lucea River
4 Cabarita River
5 Deans Valley River
6 Great River
7 Montego River
8 Black River
9 Martha Brea River
10 Gut/Alligator Hole River
11 Rio Bueno/White River
12 Milk River
13 Rio Minho
14 Rio Cobre
15 Rio Nuevo
16 Oracabessa Pagee River
17 Wagwater River
18 Pencar/Buff Bay River
19 Hope River
20 Spanish River
21 Yallahs River
22 Swift River
23 Morant River
24 Rio Grande
25 Plantain Garden River
26 Drivers River
0 5 10 15 20 25 Kilometers
0 5 10 15 20 Miles
Caribbean Sea
Montego Bay
Lucea
Montego Bay
Falmouth
Discovery Bay
St. Anns Bay
Ocho Rios
Oracabessa
Port Maria
HANOVER
SAINT JAMES
TRELAWNY
SAINT ANN
SAINT MARY
Negril
WESTMORELAND
Savanna La Mar
Bluefield Bay
Moneague
Annotto Bay
Port Antonio
Christiana
Frankfield
Linstead
Bog Walk
Chapelton
Mandeville
Black River
SAINT ELIZABETH
MANCHESTER
CLARENDON
SAINT CATHERINE
SAINT ANDREW
PORTLAND
SAINT THOMAS
Halfway Tree
Blue Mt. Peak (2256 m)
KINGSTON
Spanish Town
May Pen
Port Esquivel
Alligator Pond
Lionel Town
Port Morant
Rocky Point
Portland Bight
Caribbean Sea
JAMAICA
GSDPM Map Design Unit
This map was produced by the Map Design Unit of The World Bank. The boundaries, colors, denominations and any other information shown on this map do not imply, on the part of The World Bank Group, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries.
JUNE 2015
IBRD 41322