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Report No: PAD1414

INTERNATIONAL DEVELOPMENT ASSOCIATION

PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED CREDIT

IN THE AMOUNT OF SDR 79.8 MILLION
(US$113 MILLION EQUIVALENT)

TO THE

PEOPLE'S REPUBLIC OF BANGLADESH

FOR A

BANGLADESH WEATHER AND CLIMATE SERVICES REGIONAL PROJECT

May 13, 2016

Social, Urban, Rural and Resilience Global Practice
South Asia Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective: April 30, 2016)

Currency Unit	=	Bangladesh Taka (BDT)
US$1.00	=	BDT 78.62
BDT 1.00	=	US$ .0127
US$1.00	=	SDR 0.70555199

FISCAL YEAR

July 1 – June 30

ABBREVIATIONS AND ACRONYMS

AGAWS	Agricultural Automatic Weather Station
AIS	Agricultural Information Service
ARG	Automatic Rain Gauge
AWOS	Aviation Weather Observation System
AWS	Automatic Weather Stations
BAMIS	Bangladesh Agrometeorological Information System
BARI	Bangladesh Agricultural Research Institute
BCR	Benefit-Cost Ratio
BJRI	Bangladesh Jute Research Institute
BMD	Bangladesh Meteorology Department
BRRI	Bangladesh Rice Research Institute
BSRI	Bangladesh Sugarcrop Research Institute
BT	Benefits Transfer
BWCSRP	Bangladesh Weather and Climate Services
BWDB	Regional Project Bangladesh Water Development Board
C&AG	Comptroller and Auditor General
CAP	Common Alerting Protocol
CBA	Cost-Benefit Analysis
CPP	Cyclone Preparedness Programme
DA	Designated account
DAE	Department of Agricultural Extension
DDM	Department of Disaster Management
DDS	DCP Data Service
DEM	Digital elevation model
DPD	Deputy Project Director
EMF	Environmental Management Framework
EMP	Environmental Management Plan
EWS	Early Warning System
FAPAD	Foreign Aided Project Directorate
FFGS	Flash Flood Guidance
FFWC	Flood Forecasting and Warning Center
FM	Financial Management
GAAP	Governance and Accountability Action Plan
GDP	Gross Domestic Product
GEO	Group on Earth Observations
GIS	Geographic Information System
GOB	Government of Bangladesh
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GTS	Global Telecommunications System
HPC	High Performance Computing
HWRF	Hurricane Weather Research and Forecasting
ICB	International Competitive Bidding
ICT	Information and Communication Technologies
IDA	International Development Association
IMD	India Meteorological Department
IT	Information Technology
IUFR	Interim Unaudited Financial Report
JICA	Japan International Cooperation Agency

JTWG	Joint Technical Working Group
M&E	Monitoring and evaluation
MOA	Ministry of Agriculture
MOD	Ministry of Defense
MOWR	Ministry of Water Resources
MSSI	Meteorological Systems and Services Integrator
NCB	National Competitive Bidding
NFCS	National Framework for Climate Services
NGO	Nongovernmental organization
NHMS	National Hydrological and Meteorological Services
NMS	National Meteorological Services
NOAA	National Oceanic and Atmospheric Administration
NPV	Net Present Value
NWP	Numerical Weather Prediction
O&M	Operations and Maintenance
PCU	Project Coordination Unit
PD	Project Director
PDO	Project Development Objective
PIU	Project Implementation Unit
POM	Project Operations Manual
PSC	Project Steering Committee
PV	Present Value
QPE	Quantitative Precipitation Estimation
QPF	Quantitative Precipitation Forecast
RAP	Resettlement Action Plan
RCC	Regional Climate Centre
RDBMS	Relational Database Management System
RPF	Resettlement Policy Framework
RSMC	Regional Specialized Meteorology Center
RTKGPS	Real Time Kinematic GPS
SAARC	South Asia Association for Regional Cooperation
SAR	South Asia Region
SASCOF	South Asian Climate Outlook Forum
SIM	Subscriber Identity Module
SMF	Social Management Framework
STORM	Severe Thunderstorm Observation and Regional Modeling
TDS	Total Dissolved Solids
TOR	Terms of reference
WASA	Water Supply and Sewerage Authority
WIS	WMO Information System
WMO	World Meteorological Organization
WRF	Weather Research & Forecasting
WRSI	Water Resources System Integrator
WTP	Willingness to Pay

Regional Vice President:	Annette Dixon
Country Director:	Qimiao Fan
Senior Global Practice Director:	Ede Jorge Ijjasz-Vasquez
Practice Manager:	Bernice K. Van Bronkhorst
Task Team Leader(s):	Poonam Pillai, Nadia Sharmin

PEOPLE'S REPUBLIC OF BANGLADESH
Bangladesh Weather and Climate Services Regional Project (BWCSRP)

TABLE OF CONTENTS

Page

PAD DATA SHEET

Bangladesh Weather and Climate Services Regional Project (P150220)

PROJECT APPRAISAL DOCUMENT

SOUTH ASIA

Social, Urban, Rural and Resilience Global Practice

Report No.: PAD1414

Basic Information			
Project ID P150220	EA Category B - Partial Assessment		Team Leader(s) Poonam Pillai, Nadia Sharmin
Lending Instrument Investment Project Financing	Fragile and/or Capacity Constraints [ ]		
	Financial Intermediaries [ ]		
	Series of Projects [ ]		
Project Implementation Start Date 01-July -2016	Project Implementation End Date 30-Jun-2022		
Expected Effectiveness Date 01-July-2016	Expected Closing Date 31-Dec-2022		
Joint IFC No			
Practice Manager/Manager	Senior Global Practice Director	Country Director	Regional Vice President
Bernice K. Van Bronkhorst	Ede Jorge Ijjasz-Vasquez	Qimiao Fan	Annette Dixon

Borrower: Government of Bangladesh			
Responsible Agency: Bangladesh Meteorology Department (BMD)			
Contact:	Shamsuddin Ahmed	Title:	Director
Telephone No.:	88-02-9135742	Email:	shamsbmd@yahoo.com
Responsible Agency: Bangladesh Water Development Board (BWDB)			
Contact:	Md. Saiful Hossain	Title:	Superintending Engineer
Telephone No.:	880-28121492	Email:	se.pffc@bwdb.gov.bd
Responsible Agency: Department of Agricultural Extension (DAE)			
Contact:	Dr. Mazharul Aziz	Title:	Additional Deputy Director
Telephone No.:	8801712119259	Email:	azizdae@gmail.com

Project Financing Data(in USD Million)											
[ ]	Loan	[ ]	IDA Grant	[ ]	Guarantee						
[X]	Credit	[ ]	Grant	[ ]	Other						
Total Project Cost:		128.73				Total Bank Financing:		113.00			
Financing Gap:		0.00									

Financing Source	Amount
BORROWER/RECIPIENT	15.73
International Development Association (IDA)	113.00
Total	128.73

Expected Disbursements (in USD Million)

Fiscal Year	2017	2018	2019	2020	2021	2022	2023			
Annual	4.50	15.00	20.00	30.00	25.00	15.50	3.00			
Cumulative	4.50	19.50	39.50	69.50	94.50	110.00	113.00			

Institutional Data

Practice Area (Lead)

Social, Urban, Rural and Resilience Global Practice

Contributing Practice Areas

Water Global Practice, Environment Global Practice, Climate Change Solutions Area

Cross Cutting Topics

[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	General public administration sector	30	100	
Water, sanitation and flood protection	General water, sanitation and flood protection sector	70	100	
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	%
Social protection and risk management	Natural disaster management	40
Environment and natural resources management	Climate change	30
Environment and natural resources management	Water resource management	30
Total		100

Proposed Development Objective(s)

The Project Development Objective of this project is "to strengthen Bangladesh's capacity to deliver reliable weather, water and climate information services and improve access to such services by priority sectors and communities."

Components

Component Name	**Cost (USD Millions)**
Component A- Strengthening Meteorological Information Services	67.52
Component B- Strengthening Hydrological Information Services and Early Warning Systems	45.30
Component C- Agrometeorological Information Systems Development	15.91
Component D- Contingent Emergency Response	0.00

Systematic Operations Risk- Rating Tool (SORT)

Risk Category	**Rating**
1. Political and Governance	Substantial
2. Macroeconomic	Moderate
3. Sector Strategies and Policies	Moderate
4. Technical Design of Project or Program	Substantial
5. Institutional Capacity for Implementation and Sustainability	Substantial
6. Fiduciary	Substantial
7. Environment and Social	Moderate
8. Stakeholders	Moderate
9. Other	
OVERALL	Substantial

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 [X]
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**
Institutional Arrangements (Project Coordination Unit)	Yes	By no later than one (1) month after the Effective Date	Throughout implementation
Description of Covenant			
The Recipient, through BWDB, shall establish and thereafter maintain the Project Coordination Unit ("PCU") with functions and resources satisfactory to the Association, and with staff in adequate numbers and with qualifications, experience and terms of reference satisfactory to the Association.			
Name:	**Recurrent**	**Due Date**	**Frequency**
Institutional Arrangements (Project Implementation Units)	Yes	By no later than one (1) month after the Effective Date	Throughout implementation
Description of Covenant			

The Recipient shall and thereafter maintain in each of the Implementing Agencies, a Project Implementation Unit with functions and resources satisfactory to the Association, and with staff in adequate numbers and with qualifications, experience and terms of reference satisfactory to the Association.

Name:	Recurrent	Due Date	Frequency
Institutional Arrangements (Joint Technical Working Group)	Yes	By no later than one (1) month after the Effective Date	Throughout implementation

Description of Covenant

The Recipient shall establish and thereafter maintain, throughout the period of implementation of the Project, a Joint Technical Working Group with functions, membership and resources satisfactory to the Association.

Name:	Recurrent	Due Date	Frequency
Institutional Arrangements (Memorandum of Understanding)	Yes	By no later than twelve (12) months after the Effective Date and prior to incurring on expenditures	Throughout implementation

Description of Covenant

The Recipient through each of the Implementing Agencies, as the case may be, shall enter into memoranda of understanding with the Partner Agencies, under terms and conditions acceptable to the Association, in order to ensure close cooperation and coordination during Project implementation.

Name:	Recurrent	Due Date	Frequency
Use of Goods, Works and Services under Part A of the Project	Yes	N/A	Throughout implementation

Description of Covenant

The Recipient shall ensure that all goods, works and services provided for the carrying out of the activities to be financed under Part A of the Project are not used either directly or indirectly for a military and/or or paramilitary purpose.

Name:	Recurrent	Due Date	Frequency
Operations Manual	Yes	By no later than one (1) month after the Effective Date	Throughout implementation

Description of Covenant

The Recipient, through the Implementing Entities, shall adopt, and thereafter maintain, the Project Operations Manual in form and substance satisfactory to the Association.

Name:	Recurrent	Due Date	Frequency

Safeguards (General)	Yes	N/A	Throughout implementation

Description of Covenant

The Recipient shall ensure that the Project is carried out in accordance with the provisions of the EMF, the RPF, the SECVDF and the relevant Safeguard Assessments and Plans

Name:	**Recurrent**	**Due Date**	**Frequency**
Safeguards (Specific)	Yes	N/A	Throughout implementation

Description of Covenant

Whenever an additional or revised Safeguard Assessment and Plan shall be required for any proposed Project activity in accordance with the provisions of the EMF and the SMF, as the case may be, the Recipient shall: (a) prior to the commencement of such activity, proceed to have such Safeguard Assessment and Plan; (b) thereafter take such measures as shall be necessary or appropriate to ensure compliance with the requirements of such Safeguard Assessment and Plan; and (c) in the case of any resettlement activity under the Project involving Affected Persons, ensure that no displacement shall occur before necessary resettlement measures consistent with the RAP applicable to such activity have been executed, including, in the case of displacement, full payment to Affected Persons of compensation and of other assistance required for relocation, prior to displacement.

Name:	**Recurrent**	**Due Date**	**Frequency**
Safeguards (Reporting)	Yes	Biannually	Throughout implementation

Description of Covenant

The Recipient shall collect, compile and submit to the Association on a bi-annual basis (or such other frequency as may be agreed with the Association) consolidated reports on the status of compliance with the EMF, the RPF, the SECVDF and the Safeguard Assessments and Plans.

Name:	**Recurrent**	**Due Date**	**Frequency**
Contingency Emergency Response	Yes	N/A	N/A

Description of Covenant

The Recipient shall prepare and furnish to the Association for its review and approval, a Contingent Emergency Response Implementation Plan which shall set forth detailed implementation arrangements for the Emergency Response Part of the Project.

Name:	**Recurrent**	**Due Date**	**Frequency**
Contingency Emergency Response	Yes	N/A	N/A

Description of Covenant

The Recipient shall undertake no activities under the Emergency Response Part unless and until the following conditions: (a) the Recipient has determined that an Eligible Crisis or Emergency has occurred and (b) the Recipient has ensured the preparation and disclosure of all Safeguard Assessments and Plans

in accordance with the EMF and the SMF.

Name:	Recurrent	Due Date	Frequency
Audits	Yes	N/A	Annually

Description of Covenant

The Recipient through the Implementing Agencies shall have Financial Statements audited in accordance with the provisions of Section 4.09 (b) of the General Conditions. Each audit of the Financial Statements shall cover the period of one (1) fiscal year of the Recipient. The audited Financial Statements for each such period shall be furnished to the Association not later than six months after the end of such period.

Conditions

Name:	Type:
Contingency Emergency Response	Disbursement

Description:

No withdrawal shall be made for Emergency Expenditures under Category (2), unless and until the Association is satisfied, and has notified the Recipient of its satisfaction, that all of the following conditions have been met in respect of said activities:

(i) the Recipient has determined that an Eligible Crisis or Emergency has occurred, has furnished to the Association a request to include said activities in the Emergency Response Part in order to respond to said Eligible Crisis or Emergency, and the Association has agreed with such determination, accepted said request and notified the Recipient thereof;

(ii)the Recipient has ensured that all safeguards instruments required for said activities have been prepared and disclosed, and the Recipient has ensured that any actions which are required to be taken under said instruments have been implemented, all in accordance with the provisions of Section I.E of this Schedule;

(iii)the entities in charge of coordinating and implementing the Emergency Response Part have adequate staff and resources, in accordance with the provisions of Section I.E of this Schedule, for the purposes of said activities; and

(iv)the Recipient has adopted the Contingent Emergency Response Implementation Plan (CERIP) in form, substance and manner acceptable to the Association and the provisions of the CERIP remain or have been updated in accordance with the provisions of Section I.E of this Schedule so as to be appropriate for the inclusion and implementation of the Emergency Response Part.

Team Composition

Bank Staff

Name	Role	Title	Specialization	Unit

Poonam Pillai	Team Leader (ADM Responsible)	Senior Environmental Specialist		GSURR
Nadia Sharmin	Team Leader	Environmental Specialist		GSURR
Ishtiak Siddique	Procurement Specialist	Senior Procurement Specialist		GGODR
Mohammad Reaz Uddin Chowdhury	Financial Management Specialist	Financial Management Specialist		GGODR
Jorge Luis Alva-Luperdi	Senior Counsel	Senior Counsel		LEGES
Satish Kumar Shivakumar	Finance Office	Finance Officer		WFALN
Shakil Ahmed Ferdausi	Safeguards Specialist	Senior Environmental Specialist		GENDR
Sabah Moyeen	Safeguards Specialist	Senior Social Development Specialist		GSURR
Arati Belle	Team Member	Senior Climate Change Specialist (Cons.)		GSU18
Diego Juan Rodriguez	Team Member	Senior Economist		GWADR
Makoto Sawa	Team Member	Senior DRM Specialist		GFDRR
Mohammad Sayeed	Team Member	Disbursements		GSURR
Syed Ahmed Ali	Team Member	Procurement		GGODR
Hisham A. Abdo Kahin	Counsel	Lead Counsel		LEGES
Guillermo Siercke	Team Member	Operations Analyst		GSURR
Luis Corrales	Team Member	Consultant		GSU19
Angie Harney	Team Member	Program Assistant		SACBD
Marie Florence Elvie	Team Member	Program Assistant		GSURR
Vladimir Tsirkunov	Peer reviewer	Lead Specialist		GFDRR
Kanta K. Rigaud	Peer reviewer	Lead Environmental Specialist		GCCPT
Xiaolan Wang	Peer reviewer	Sr. Operations Officer		GSURR
Nagaraja Rao Harshadeep	Peer reviewer	Lead Environmental		GENGE

		Specialist		
Marcus Wijnen	Peer reviewer	Sr. Water Resources Sp.		GWA01

Extended Team

Name	Title	Office Phone	Location
Mannava Sivakumar	Agromet Expert Consultant		Geneva
Jeff Lazo	Sr Economist (Hydro-Met) Consultant		Denver
Mark Heggli	Hydromet Expert, Consultant		California

Locations

Country	Administrative Division	Location	Planned	Actual	Comments
Bangladesh	Barisal Division		X		
	Chittagong Division		X		
	Dhaka Division		X		
	Khulna Division		X		
	Rajshahi Division		X		
	Rangpur Division		X		
	Sylhet Division		X		
	Mymensingh Division		X		

Consultants (Will be disclosed in the Monthly Operational Summary)	
Consultants Required	Consulting services to be determined

I. STRATEGIC CONTEXT

A. Regional and Country Context

1. **The South Asia Region (SAR) is highly prone to water related hazards such as floods, drought, tropical cyclones and thunderstorms that frequently cut across national borders**. Some parts of the eight countries of this region - Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka - are hit every year by one or more disasters, taking a heavy toll on life and property and causing enormous suffering to thousands of families. In the past two decades, over 50 percent of South Asians, i.e., more than 750 million people have been affected by at least one natural disaster. Between 1970 and 2010, floods and cyclones together constituted almost 79 percent of all recorded natural disaster events. These hazards with social and economic costs, estimated at 2-6 percent of SAR's gross domestic product (GDP), jeopardize long term efforts to end extreme poverty and boost shared prosperity, and can reverse hard-won development gains.

2. **In addition to the costs of natural disasters, the productivity of key economic sectors such as agriculture is also compromised by limited access to information services relating to trans-boundary and local weather phenomenon by sectors and communities.** The South Asian monsoon system is a key determinant – with small variations in the timing and quantity of rainfall having profound consequences – for water availability, agricultural productivity and food security in the entire region. Yet, in most countries in SAR (with the exception of India), despite demand, access to weather based information services is limited and the monitoring, forecasting, technical human resource capabilities and organizational arrangements that contribute to the supply of such information products and services, are not adequately in place.

3. **The societal vulnerability to extreme weather events in South Asia is clearly illustrated in the case of Bangladesh, one of the most densely populated countries in the world**. Located at the delta of the Ganga-Brahmaputra-Meghna river systems, Bangladesh is regularly exposed to extreme weather events such as tropical cyclones associated with storm surges, floods, severe thunderstorms and drought. These impose substantial costs on the national economy, disproportionately affecting the poor. Damages and losses associated with a single extreme event such as the 2007 cyclone Sidr, estimated at US$1.7 billion and 2.6 percent of the GDP, indicate the staggering effects natural disasters can have on the country's economy. Repeated exposure to such hazards, often pushes the poor, particularly rural poor, into chronic poverty. This is likely to get worse with climate variability and change and increases in both temperature and mean precipitation as projected by the latest Intergovernmental Panel on Climate Change (IPCC) assessments for Bangladesh.

4. **In the past decade, Bangladesh has made steady economic gains with GDP growing at the rate of almost 6 percent each year.** The percentage of people living below the poverty line declined from 58.6 percent in 2000 to 24.7 percent in 2015 with a per capita GDP at US$ 1,212. There have also been impressive gains in a number of social indicators including improvements in literacy, life expectancy, and per capita food consumption. To maintain and build on these development gains, leverage ongoing governance and economic reforms, and meet its ambitious goal of becoming a middle-income country by 2021, strengthening preparedness to natural hazards and improving the provision and access to weather, water and climate based information services is critical.

5. **Despite substantial IDA investments in critical infrastructure and in preparedness and response, particularly with respect to tropical cyclones, investments by Government of Bangladesh (GOB) in basic weather, water and climate information services that are important for disaster preparedness and to the productivity of key sectors, have been limited.** GOB with support from the World Bank is investing over a billion dollars in investments on coastal infrastructure and cyclone shelters through the (i) Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP) (US$ 221 million) (ii) Coastal Embankment Improvement Project Phase 1 (CEIP) (US$ 400 million) and the (iii) Multipurpose Disaster Shelter Project (MDSP) (US$ 370 million). In addition, the Bangladesh Urban Resilience project of US$ 123 million is focusing on seismic risk and fire hazard in Dhaka and Sylhet. The US$ 130 million Bangladesh Climate Change Resilience Fund is supporting several stand-alone projects on climate resilience including the Community Climate Change Project with NGOs (US$12.5 million) and the Climate Resilient Participatory Afforestation and Reforestation Project (US$33.8 million). Bangladesh is also considered exemplary in community response to tropical cyclones through the Cyclone Preparedness Programme (CPP) in the coastal districts. However, despite these investments, the country's hydro-meteorological information infrastructure over land, atmosphere and ocean, basic public weather services, forecasting, multi-hazard end-to-end early warning systems (EWS) and provision of climate information services remain weak and need to be strengthened. Stakeholder demand suggests that weather and climate dependent sectors such as aviation, agriculture, urban flood management, and fisheries need tailored weather and climate data, products, information and services to improve planning and decision-making and to mitigate the adverse effects of weather and climate variability and change. Provision of such services at present is not adequate and needs to be strengthened.

6. **While strengthening hydro-meteorological services and associated institutions in Bangladesh is an essential first step, regional collaboration is crucial**. First, climate and weather patterns such as tropical cyclones, monsoons and severe thunderstorms impacting Bangladesh are trans-boundary and best monitored, understood and predicted by taking a regional and global perspective. Second, there is a demand in Bangladesh for regional information on weather and climate (such as tropical cyclone forecasts over the Bay of Bengal or regional drought forecasts) and a demand from regional centers--for example, from the Regional Specialized Meteorology Center (RSMC) located at the Indian Meteorological Department (IMD)--for weather and climate information (such as for atmospheric observations over Bangladesh) to enable them to make improved forecasts of regional and sub-regional weather phenomenon (such as severe thunderstorms) that can benefit all affected countries. Regional collaboration can help facilitate this exchange. Third, there are economies of scale in regional collaboration. For instance, at present, Bangladesh does not have the capacity to forecast extreme events such as cyclones, thunderstorms and flash floods with sufficient lead time and accuracy, or the capacity for long term climate monitoring and prediction. Regional collaboration can allow Bangladesh to build on information products and forecasts already being produced by regional entities rather than investing in developing such capacity from the start. It can also allow Bangladesh to learn from and contribute to innovation in the development and delivery of weather, water and climate based services in key sectors such as disaster risk management, urban management and agriculture that commonly affect various countries in the region.

B. Sectoral and Institutional Context

South Asia Regional Initiatives

7. **The need for effective regional cooperation is pronounced and is urgent to mitigate climate related risks and strengthen disaster preparedness.** The Hyogo Framework for Action 2005-2015 and its successor, the Sendai Framework for Disaster Risk Reduction 2015-2030, which have been adopted by most South Asian countries, provide a global blueprint for disaster risk reduction and identify the need to cooperate regionally and internationally. While there has been a small but encouraging shift in the willingness of the countries of South Asia to engage in a discussion of regional integration generally, South Asia has to date struggled to find suitable arrangements for regional cooperation despite the multitude of common problems the region is facing and shared natural resources that require coordinating policies and programs. The South Asia Association for Regional Cooperation (SAARC) – South Asia's official organization for facilitating regional cooperation –has reiterated the need to strengthen and intensify regional cooperation "to address the challenges posed by climate change and natural disasters." At the SAARC Heads of State Eighteenth Summit held in Kathmandu in November 2014, members agreed to establish a cross-border information sharing and regional cooperation mechanism to fight climate change and to minimize the risks of natural disasters.

8. **The agenda for strengthening weather and climate services at a sub-regional/ regional level is evolving and the Bank can play a catalytic dual role in these efforts at the national and regional levels.** Recognizing the risks posed by trans-boundary weather patterns on key economic activities and livelihoods of people, South Asian countries already engage and collaborate through other fora, notably the South Asian Climate Outlook Forum, which is convened annually to generate the outlook for the summer monsoon season. These events also form part of the demonstration phase for a World Meteorological Organization (WMO) Regional Climate Centre (RCC) for South Asia, at the IMD, currently undergoing the RCC pilot phase. However, to attain benefits from regional cooperation, strengthening national capacity is an essential first step. This project, therefore seeks to strengthen national capacity for weather and water related service delivery and disaster risk management in Bangladesh with the broader aim of contributing to improved resilience at a regional level.

Bangladesh Country Context

9. **In Bangladesh, the Bangladesh Meteorology Department (BMD), under the Ministry of Defense (MOD) is the main provider of meteorological services while the Bangladesh Water Development Board (BWDB) under the Ministry of Water Resources (MOWR), is the main provider of water resources information and flood forecasting services.** These two agencies provide weather, water and climate services to a range of user sectors. BMD is mandated to provide weather and climate related services. Services provided by it such as routine weather forecasts are directly provided to the general public. Other data and information in the form for instance, of rainfall data used for flood forecasting by BWDB, or severe weather warnings for thunderstorms or cyclones disseminated by the Department of Disaster Management (DDM) or high tide warnings for fishermen, the Department of Fisheries (DOF) and Port Authority are provided by BMD to users that can then use this information to inform affected communities or generate more tailored information and secondary information products

for meeting the needs of their own sectors. BWDB's Hydrology Division and Flood Forecasting and Warning Center (FFWC) provides flood forecasts and warnings to the DDM which then disseminates it to District level Disaster Management Committees, media and local communities. Sectors such as aviation, agriculture, disaster risk management, urban water and sanitation authorities, are amongst the range of users that rely on weather and water services provided by these two main agencies—BMD and BWDB.

10. **At present, the BMD can issue only 24-hour general weather forecasts and does not have the required land, ocean or atmospheric observation network, hardware, software or human resource capacity for issuing accurate short term weather or longer range climate forecasts that can be used at the national level or regional levels.** The country's meteorological observation network managed by BMD is primarily manual. Even though BMD operates doppler radars (established through JICA support) it does not have a sufficiently dense rainfall monitoring network to calibrate the radars to provide reliable Quantitative Precipitation Estimation/Forecasting (QPE/QPF). The network density of upper air observation and ground monitoring stations, is not adequate as per WMO standards to address tropical mesoscale phenomena. Monitoring of the ocean system and land/ocean interface is critical for BMD to assess cyclone strength and storm surges along Bangladesh coastline and contribute this information with RSMC that can then be used for improving forecasts for the region. However, at present, BMD does not operate any buoys in the Bay of Bengal or operate any coastal stations for measuring storm surge. A critical limitation for BMD is the bandwidth of its Global Telecommunications System (GTS) / WMO Information Systems (WIS) link through which data is exchanged regionally and globally. For instance, coastal radar data are currently not sent back to IMD for assimilation into IMD's numerical models for cyclone forecasting for the Bay of Bengal. Further, due to bandwidth limitations, BMD can only receive certain data already regionally and globally available in the form of images and not in a digital form for assimilation into models. Strengthening bandwidth of communication channels will therefore contribute to regional and global exchange of data and product generation (such as regional cyclone forecasts) for the South Asia region as a whole and also facilitate in BMD's own forecast generation. There is limited reliable bathymetric data for the 710 kilometer coastline including important habitats such as the Sunderbans, the largest single block of tidal halophytic mangrove forest in the world. Though BMD has access to numerical weather prediction models, it uses them only on an experimental basis due to lack of high computing resources. Because of its limited computer storage capacity, it is also unable to store regional data for use in research for seasonal forecasting, needed for the agricultural sector. At present, while BMD collects and digitizes data about several climate parameters, it does not have the resources or capacity for climate forecasting or prediction at an operational level. It also needs regional and local climate modelling tools for assessing long term changes in climate and assessing impacts on priority sectors. Currently BMD has 120 Meteorologists and Engineers and 1200 technicians. Its staff need training in a number of areas such as tropical meteorology, weather forecasting, cyclone forecasting, radar meteorology, numerical weather prediction, agricultural meteorology, oceanographic meteorology, and many others. In Bangladesh, there are no University-level Departments of Meteorology that can support development of a cohort of professionals who could help foster public or private sector delivery of meteorological services.

11. **The hydrological network, managed by the Hydrology Division of the BWDB, remains primarily manual with manual data collection, transmission and storage with only limited**

real time hydrological and flood forecasting. This affects the quality, accuracy and frequency with which data is collected and transmitted, and constrains BWDB's capacity for providing a range of hydrological services and real time flood forecasting and early warnings to user agencies and communities. BWDB's network capacity is mainly along the major rivers and relatively insufficient on smaller rivers, urban catchments, remote areas and trans-boundary rivers. Models used by BWDB for flood forecasting cover only three fourths of the country and do not cover the coastal areas. At present, BWDB does not have the data or modeling tools to undertake inundation forecasting in its highly vulnerable coastline. Management of groundwater and improved information of aquifer structure in hotspot areas such as the coast and major urban areas is critical for Bangladesh. Yet the country's groundwater network is mainly manual and should be modernized to enable improved management of this important resource and help address a whole host of critical issues such as salinity intrusion in coastal areas and develop targeted services based on this information. Though BWDB has led the way in implementing many water resource projects in Bangladesh, its important Hydrology Division has received relatively less attention by way of investments either from the GOB or development partners. Currently the Hydrology Division has 131 technical staff that is supported by 309 contractual staff (gauge readers, surveyors, office cleaners etc.). Approved technical staff is 261 and there is room to strengthen the technical capacity of this division under BWDB. For the Hydrology Division to move from mainly data collection and provision of flood forecasting services to developing a range of user driven hydrological services, a significant shift in orientation in terms of systematically understanding user needs, network modernization and technical capacity strengthening is needed. In northeastern districts of Bangladesh, there is also a need to further strengthen ongoing regional collaboration, strengthen the information base for communities at risk and improve community based early warning services in those areas.

12. **Even though the weather and water dependent agriculture sector that contributes to almost 16 percent of the country's GDP and provides employment to about 45 percent of the people, farmers in Bangladesh do not get any systematic agro-meteorological advisories or bulletins to be able to make appropriate decisions and adjust to weather variability at the farm level.** In Bangladesh, major crops such as rice, jute, tea and wheat are primarily rainfed. As such, agricultural productivity of these crops is highly dependent on rainfall and weather patterns. Rice is the staple food in the everyday diet of Bangladeshis and 2 or even 3 crops of rice are harvested each year. While it is grown mainly for domestic consumption, jute and tea are the main export earners. There are approximately 30 key agro-ecological zones in Bangladesh. However, neither BMD, the Department of Agricultural Extension (DAE) or research institutions such as the Bangladesh Agricultural Research Institute (BARI) or the Bangladesh Rice Research Institute (BRRI) have a systematic way of combining meteorological information and forecasts with agriculture related information to produce tailored Agro-Meteorological advisories for farmers in the different agro-ecological zones to enable them to make appropriate decisions about planting, harvesting, applying fertilizers, irrigation, adjusting cropping patterns at the farm level. There is also scope to improve the enabling conditions for private sector engagement in this context.

13. **This project seeks to transform the provision of weather, water, disaster risk and climate information services in Bangladesh by significantly reorienting these institutions – BMD, BWDB and DAE - towards developing and delivering user need based information products and services.** Strengthening the capacity of the suppliers of weather, water and climate

services, meeting the demands of selected user sectors, and strengthening the linkages between these is at the crux of this project. Here, BMD is the supplier of weather and climate services and also a potential beneficiary from the modernization of BWDB's network and services. BWDB is both a provider of water resources information and flood forecasting services and also relies on meteorological data for delivering its services. The Department of Agricultural Extension (DAE) is considered a user of hydro-meteorological information services while also producing in collaboration with BARI, BRRI and other research institutions such as Bangladesh Jute Research Institute (BJRI) and Bangladesh Sugarcrop Research Institute (BSRI), sector specific information and services to meet the demands of the farming community. Other agencies such as the Department of Disaster Management and Municipal agencies are also considered as important user sectors of hydromet services in this project. An improved understanding of user needs and broadening the range of services BMD and BWDB provide, will be a core aspect of the project's transformational role. It is expected that such services can be used to mitigate multi-hazard risk, plan investments, reduce communities' vulnerability and strengthen the resilience of the key productive sectors of the economy.

14. **Strengthening the capacity for hydro-meteorological services in Bangladesh has important national and regional benefits**. National benefits include strengthened BMD, BWDB and DAE capacity to meet the country's own national service delivery mandates and improve services in the important agricultural sector. It has important synergies with ongoing investments in disaster risk management, water, climate and priority projects such as the National Agricultural Technology Program II. Improved monitoring, collection and digitization of weather and climate data shared through existing mechanisms such as the WMO Global Telecommunications System (GTS) will also enable improved forecasting and prediction of regional and trans-boundary phenomenon (such as cyclones, drought, thunderstorms, floods, etc.) which at present is not fully possible. For instance, in the pre-monsoon season between March-May, severe thunderstorms develop that affect Bangladesh but also neighboring northeast India, Bhutan, and Nepal. Though not as visible as tropical cyclones, they result in damages to livelihoods and property worth millions of dollars in Bangladesh and across the sub-region. Improved monitoring of upper air parameters over Bangladesh and sharing this information with regional entities will enable improved forecasting of such severe weather phenomenon. Similarly, improved efforts to monitor sea level rise across the coast of Bangladesh can contribute to improved understanding of changes in sea level rise in the Bay of Bengal. Improved understanding of disaster related risks (e.g. through flash floods and thunderstorms) in northeastern districts can also contribute to improved cooperation and risk management at the cross-border level.

C. Higher Level Objectives to which the Project Contributes

15. **The Bangladesh Weather and Climate Regional Services Project will support the World Bank Group's dual goals of ending extreme poverty and promoting shared prosperity.** Bangladesh's gains in poverty reduction can be undermined by weather shocks. By strengthening the country's capacity to provide tailored weather and climate data, products, information and services, the project will contribute to the government's priorities and also the Bank's twin goals. The project is fully aligned with and will help implement the South Asia Regional Integration Strategy (2014) that identifies improved hydromet modernization, disaster

preparedness and climate resilience as a high priority area to support regional integration. The project is also fully consistent with the World Bank Group's Country Partnership Framework for Bangladesh for 2016-2020, dated April 5, 2016 (Report 103723-BD). By supporting improved weather, water and climate information services and disaster related early warning systems (EWS), the project contributes to the CPF's priority focus on strengthening disaster and climate resilience and also supports the Bank's broader efforts to promote regional cross-border cooperation on resilience.

II. PROJECT DEVELOPMENT OBJECTIVES

A. PDO

16. The Project Development Objective of this project is "***to strengthen Bangladesh's capacity to deliver reliable weather, water and climate information services and improve access to such services by priority sectors and communities.*****"**

17. This will be done by strengthening hydro-meteorological monitoring and forecasting, and service delivery related to weather, water, agriculture and multi-hazard disaster risk management early warning systems at the national level while laying the foundation for strengthening resilience at the regional level. The project will also contribute to implementing the framework for regional cooperation on natural disasters and climate change embedded in the joint declaration made at the 18th SAARC summit.

B. Project Beneficiaries

18. Project beneficiaries (namely persons who have access to goods or services developed by the project) includes people who are at risk from weather- and water-related disasters and whose productivity could increase from higher quality hydro-met information. At the economy-wide level, improved weather and hydro-met services will benefit Bangladesh's general public and key economic sectors. The institutional beneficiaries of the project are government institutions that provide weather, water and climate related services. These are: BMD which is considered the producer of weather and climate services; BWDB which provides water resources information and flood forecasting services. It also includes the DAE, which through this project will be able to develop the capacity to provide agro-meteorological advisories, information and products to farmers through activities supported by the project. Public service providers at these agencies and their local offices will also benefit from training and equipment enhancing the capacity to deliver improved weather and hazard information services. Improved meteorological services will also benefit users in a wide range of sectors including Department of Disaster Management, civil aviation, water infrastructure, fisheries, and municipal agencies.

19. The project will also support community level early warning systems for extreme weather events such as thunderstorms and flash floods in two districts, Netrakona and Sunamganj and drought early warning systems in the districts of Rajshahi and Naogaon benefiting approximately 10 percent of the combined population of the 4 selected districts (approximately 1 million people). The development and delivery of the agrometeorological services will directly benefit approximately 30,000 "lead farmers" or "farmer groups," who in turn are expected to disseminate the information to their membership. In addition, through the establishment of the

Bangladesh Agrometeorological Information System (BAMIS) portal, agromet information kiosks in 487 Upazila and agromet display boards at 4051 Union Parishads and the use of existing and planned Agricultural Information Service (AIS) cells in 250 villages, a much wider reach of the agromet information products and services is expected. It is estimated that at least 300,000 farmers will have access to information provided by the BAMIS.

20. The project is also expected to have regional and global beneficiaries. These include national hydromet agencies in neighboring countries such as Bhutan and Myanmar and the Regional Specialized Meteorological Center for SAR located at New Delhi. Further, data shared through the GTS or the WIS will also benefit agencies engaged in weather and climate modeling and prediction at the regional and global levels. The international aviation industry flying aircrafts into and out of Bangladesh is also a beneficiary of this project. Bangladesh will benefit from information from other countries since they will pursue similar programs which will be coordinated at the regional level. Improvements in monitoring transboundary weather patterns such as thunderstorms by Nepal, Bhutan, Bangladesh and India when shared and pooled together can be used for forecasting weather extreme that affect all of the relevant countries affected by such extreme events.

Table 1: Project Beneficiaries by type of service

Service	Potential User Group	Estimated Project Beneficiaries
Public weather system	Entire country, sectors including aviation, DRM, transport, urban infrastructure, flood management	General Public
Agro-meteorological information system	Direct beneficiaries include lead farmers and members of farmer groups Indirect Beneficiaries	30,000 lead farmers (of which 25 percent are women) At least 300,000 farmers
Community based flood and drought EWS	Population of pilot districts (approximately 10 million)	Flood/drought vulnerable communities in selected districts (10 percent of the combined population of the 4 selected districts)
Data shared through the GTS/WIS	RSMC, WMO, other agencies such as National Aeronautics and Space Administration (NASA) engaged in regional and global modeling	At least 5 regional and global agencies

C. PDO Level Results Indicators

21. Progress regarding PDO achievement, specifically, the capacity to deliver climate information services will be measured by PDO 1 and 2, while the quality and access of services will be measured by PDO 3 (details in Annex 1). PDO 2 and 3 include the gender dimension (data being disaggregated by gender). PDO 3 also contributes to reporting on citizen engagement as user satisfaction will be key feature in the ongoing improvement of service delivery.

- PDO 1: Improved capacity for weather forecasting: This indicator will measure the *Improvement in Forecast Skill (of 24 hour public weather forecasts for mean temperature and precipitation).*

- PDO 2: Improved service delivery to targeted agriculture sector beneficiaries: The service delivery to targeted agriculture sector beneficiaries will be assessed by the *Percentage of targeted farmer groups receiving agro-advisories (of which female percent).*

- PDO 3: Systematic measurement of user satisfaction in place to measure improvements in weather information service delivery: This indicator will assess and report on the progress made in the *Establishment of a user satisfaction measurement system.*

III. PROJECT DESCRIPTION

A. Project Components

22. The project has four main Components. These are briefly described below and detailed in Annex 2.

23. **Component A: Strengthening Meteorological Information Services (Total US$ 67.52 million of which IDA: US$ 58.88; GOB US$ 8.64 million):** This Component will help achieve the PDO by strengthening the BMD's meteorological monitoring network, forecasting capacity and delivery of weather and climate services. It has three sub-components.

(a) ***Sub-component A1: Modernization of Meteorological Observation Systems and Forecasting*** **(IDA US$ 34.64 million)*:*** This sub-component will support modernization of BMD's surface, marine and upper air observation networks, communication and ICT systems, improvement in numerical weather prediction and weather forecasting systems.

(b)Sub-component A2: Technical and Institutional Capacity Strengthening, Regional Collaboration, Project Management, Monitoring and Evaluation **(IDA US$ 13.87 million)*:*** This sub-component will provide support to BMD for technical design and documentation relating to different aspects of the surface, air and marine observation network, assessment and design of forecasting needs, training, project management, monitoring and evaluation, implementation of the social and environmental management frameworks, Governance and Accountability Action Plan (GAAP) and regional collaboration.

(c) Sub-component A3: Strengthening Weather Services, Early Warning Systems and Climate Services Delivery* (IDA US$ 10.37 million)*: This sub-component will focus on understanding user needs, weather, hazard and climate product development, dissemination and improving access to services.

24. **Component B: Strengthening Hydrological Information Services and Early Warning Systems (Total US$ 45.3 million of which IDA: US$ 40.62 million and GOB: US$ 4.68 million):** The main objective of this component is to improve hydrological observation, forecasting, and early warning systems. The component would be implemented by the BWDB and includes the following:

(a) ***Sub-component B1: Strengthening Hydrological Observation Network and Forecasting (IDA US$ 27.42 million):*** This sub-component will support modernization of BWDB's monitoring network, data management and forecasting.

(b) ***Sub-component B2: Technical and Institutional Capacity Strengthening, Regional Collaboration, Project Management, Monitoring and Evaluation (IDA US$ 10.1 million)***: This sub-component will support the BWDB's PIU with technical design support, regional collaboration, project management, monitoring and evaluation and implementation of the social and environmental management frameworks and GAAP.

(c) ***Sub-component B3: Strengthening Hydrological Services and Flood Early Warning Systems (IDA US$ 3.1 million):*** This sub-component will support improved understanding of user needs for hydrological services, development of hydrological products and piloting community based flood early warning systems.

25. **Component C: Agrometeorological Information Systems Development (Total US$ 15.91 of which IDA: US$ 13.5 and GOB: US$ 2.41 million):** The objective of this component is to provide agro-meteorological services to farmers in order to increase agricultural productivity and assist them in coping with weather and climate extremes. The main sub-components are:

(a) **Sub-component C1:** ***Establishment of the Bangladesh Agrometeorological Information System (BAMIS) (IDA US$ 3.9 million):*** This sub-component will support development of a decision support system for agro-meteorological services at the DAE. This will include development of agricultural and agro-meteorological databases, setting up a comprehensive web-portal for BAMIS, development of advisories, and information products for farming communities.

(b) ***Sub-component C2: Training, Capacity Building, Project Management, Monitoring and Evaluation (IDA US$ 4.41 million):*** This sub-component will support training for DAE staff, preparation of technical studies, support for the Joint Working Group and Agromet Advisory committees at district and upazila levels, support to implementation of the GAAP action plan, project management, monitoring and evaluation for DAE activities.

(c) ***Sub-component C3: Agricultural Disaster Risk Management through Agrometeorological Information Dissemination (IDA US$ 5.19 million):*** This sub-component will support dissemination of agrometeorological advisories and products to farming communities in different upazilas and feedback from farmers.

26. **Component D: Contingent Emergency Response Component (US$0.00):** Following an emergency, this component may be used to reallocate or channel additional funds, as available, to support disaster response, recovery and reconstruction.

B. Project Financing

27. The cost of the project is US$ 128.73 million. It will be financed through IDA credit of US$ 113.00 million equivalent with contributions from counterpart funding in the estimated amount of US$ 15.73 million equivalent. IDA funding will include national IDA (in the amount of US$ 82 million equivalent) as well as regional IDA (US$ 31 million equivalent). Regional IDA will fund activities that contribute to regional resilience and have a regional dimension most of which fall under Component A of the project. Amount of counterpart funding will be approximately 12.22 percent of total project costs. The GOB contribution will cover, both, in kind and cash contributions including but not limited to salaries, office space, honorarium, sitting allowances, customs duties (CD), value added taxes (VAT) and other taxes. A maximum of 15 percent of IDA financing will go towards taxes. Separate budget/accounts would be kept for counterpart funds. Breakdown of cost by Component is provided in Table 2 below.

Table 2: Project Cost and Financing

Project Components	**Project Cost (US$m)**	**IDA Financing (US$m)**	**% Financing**
A. Strengthening Meteorological Information Services (BMD)	67.52	58.88	87
B. Strengthening Hydrological Information Services and Early Warning Systems (BWDB)	45.30	40.62	90
C. Agrometeorological Information Systems Development (DAE)	15.91	13.50	85
D. Contingent Emergency Response	0.00		
Total Project Costs	**128.73**	**113.00**	88

E. Series of National Level Projects to lay groundwork for Regional Resilience

28. **The Bank's Program to support South Asian countries to build resilience to hydro-meteorological hazards is embedded in the conceptual shift from management of water related disasters to management of risks and provision of services.** At the national level, the Bank has been supporting hydromet related activities as part of numerous water, disaster risk management and environment projects including the India Hydrology projects. However, several countries in South Asia, including Nepal, Bhutan, Bangladesh, Pakistan, Afghanistan among others, have inadequate hydro-meteorological information and forecasting systems and are unable to fully meet their national mandates for delivering weather, water and climate services, use data and forecasts already available in the public domain (regionally and globally) to forecast severe weather or contribute national level data and information for better forecasting of regional weather and climate phenomena.

29. **The World Bank's South Asia Regional Program on Hydromet, Disaster Risk Management and Climate Resilience builds on ongoing activities and follows a dual approach: (i) strengthening regional collaboration with respect to disaster risk management and climate resilience; and (ii) enhance national capacity for the same, both of which are mutually reinforcing.** The Programmatic Approach aims to strengthen the capacity of participating countries and institutions to respond to water related hazards and climate risks at the national and regional levels, by strengthening the knowledge base for improvements in monitoring, weather and flood forecasting, community based early warning systems and weather/water and climate services. The approach is to start from the bottom up and strengthen national capacity for weather, water and climate services which are required for sub-regional and regional level collaboration. A cross-border information sharing and regional cooperation mechanism can only function if the inputs from national systems are robust. Important contributions of the Programmatic Approach have been to help initiate strategic technical assistance such as the Roadmap for Hydromet Modernization in Bhutan that has been published and was launched by the Department of Hydromet Services, Royal Government for Bhutan in November 2015. It has also helped initiate dialogue relating to sub-regional collaboration with key partners in the region including IMD and helped identify a sequence of national level projects with regional dimensions that can contribute to development of a regional platform for DRM and Climate Resilience in SAR. Most projects are within national borders but have important regional dimensions and of vital relevance for regional cooperation. These are now at varying stages of development and implementation as discussed below.

30. **The Nepal Building Resilience to Climate Related Hazards project, which supports objectives and investment activities similar to the Bangladesh project, is considered a forerunner amongst a sequence of national level projects.** It is currently under implementation and is supporting the country to upgrade its existing hydro-meteorological and agricultural management information system, development of multi-hazard disaster related early warning systems, and enhancing capacity. Important training activities between Nepal and India (specifically in cooperation with the India Meteorology Department (New Delhi) along with the International Crops Research Institute for the Semi-Arid Tropics **(**ICRISAT) Hyderabad) have already been supported through this project through World Bank facilitation. **The Bangladesh Weather and Climate Services Regional Project is conceived as the second in this sequence of national level projects being initiated in South Asia.** Like the Nepal project, it also has important regional aspects. The **Bhutan Weather and Disaster Improvement Regional Project,** which is under preparation, is considered the third in the sequence. Each project is being initiated based on country demand/request, when it is ready. The timing and dialogue in each country is at different stages. However, they all have similar objectives and will contribute to national and regional capacity development for weather, water and climate related services. The Bangladesh project will have a 6 year time frame for implementation. Overall regional program is expected to take place over 5-8 years. Such national level, bottom up capacity strengthening activities will also support national development goals, and also help implement key Regional Agreements relating to environment, disaster and climate resilience reflected in the Kathmandu Declaration made at the 18th SAARC Summit in November 2014.

31. **Investment projects in Nepal, Bhutan and Bangladesh are expected to be complimented by a regional activity –supported by the European Union (EU) – and in coordination with the India Meteorology Department (IMD), which is the WMO designated Regional**

Specialized Meteorological Center (RSMC) for SAR. The EU has already signed an administrative agreement with the Bank to support Regional Disaster Risk Management Capacity Strengthening in SAR. RSMC at IMD will be supported to strengthen regional collaboration and coordination between the national agencies and also move from its pilot phase as the WMO Regional Climate Center (RCC) to full status accorded as such by the WMO. Regional consultations are being discussed for next year. These consultations are expected to build on ongoing bilateral and regional collaboration on specific issues such as development of regional climate outlooks[1] between SAR countries, and help consolidate it into a more comprehensive platform for regional collaboration on resilience.

32. This regional project meets criteria for accessing regional IDA funds in the following ways. First, the sequence of projects **includes three countries—Nepal, Bhutan and Bangladesh.** National level capacity strengthening and **participation of the three countries is critical for each to contribute to generating a pool of data** that can be used by a mandated regional entity—in this case RSMC, located at IMD, New Delhi for preparing and sharing regional weather and climate forecasts, services and information products, thus contributing to the overarching goal of regional resilience. The Nepal and Bhutan projects mentioned earlier, consist of similar activities and will contribute important information and data sharing at the regional level. Data sharing is a basic requirement for climatology. WMO member states are obliged to share certain data and metadata with other states under various WMO Resolutions. Through the Global Telecommunications System (GTS) and the WMO Information Systems (WIS), which are tiered national, regional and global telecommunications systems, WMO member countries already have communication protocols, data format, timeliness and distribution requirements, required to maintain a regional and global operational flow of information in real time. Building on this, during the project period, through facilitation by the World Bank, active consultations will be held to further cooperate on data sharing and pooling arrangements at the regional level to further improve forecasting and early warning systems for transboundary climate and weather extremes, eventually saving lives and assets. Second, by improving monitoring and forecasting at the national level, each of the **national projects will also generate significant spillover benefits**. Improvements in meteorological observations and national telecommunications network supported through this project will enable Bangladesh as a member of the WMO, to develop and share its data with the RSMC in New Delhi and globally through the GTS/WIS. For instance, sharing of marine data and information through the GTS/WIS will enable the RSMC located in Delhi to improve cyclone forecasting for all of the SAR countries exposed to tropical cyclones such as Myanmar, Nepal and Bhutan. Enhanced monitoring and sharing of upper air parameters in each of the three countries including India can contribute to improving forecasting of thunderstorms that commonly affect all four countries. India has already initiated a pilot program on this. However, to scale it up, modernization of the upper air network in all countries is needed. Third, **there is strong ownership by each of the countries** as substantiated by requests from Ministries of Finance from each of the participating countries—Nepal, Bangladesh, Bhutan- for World Bank support on strengthening disaster and climate resilience. There is also strong commitment by the IMD, designated since 1949 as a Regional Specialized Meteorological Center (RSMC) by WMO, which already provides services to other countries in

[1] https://www.wmo.int/media/sites/default/files/consensus%20statement_2015_22_april_2015_v3%20(3).pdf

the region such as provision of cyclone forecasts, training, climate monitoring and development of long range forecasts through its Regional Climate Center located in Pune[2]. Fourth, the project helps contribute to the implementation of the regional declaration made by SAARC member countries in 2014 in Kathmandu[3] (to implement SAARC Agreement on Rapid Response to Natural Disasters), SAARC Convention on Cooperation on Environment, and Thimphu Statement on Climate Change which has disaster and climate resilience at its core.

33. In view of the above, regional IDA will fund activities mainly in Component A of the project and targeted activities in Component B and C focusing on regional cooperation. Under Component A, these include improvements in monitoring network with a regional benefit (such as AWOS stations, buoys, improvements in bandwidth to GTS/WIS, coastal stations for monitoring sea level rise, improved monitoring, digitization and sharing of climate data, etc). Meteorological data shared through the GTS/WIS for example, will contribute to improving the regional and global modeling of climate systems[4]. Strengthening of marine meteorology will also have important positive externalities and will contribute to improved modeling and prediction of phenomena such as sea level rise in the Bay of Bengal of relevance to a number of countries in the region. Improved hydromet monitoring of Sunderbans ecosystems can contribute to improved management of this shared ecosystem between India and Bangladesh. While most of the contribution from regional IDA will be towards Component A, regional IDA will also fund regional studies and consultations on transboundary disaster risk management and early warning systems including but not limited to shared river basins under Component B. Under Component C, it will fund regional collaboration between SAR countries on the delivery of agro-weather services. For instance, agriculture is a key sector in most SAR countries. All of the projects in the series including Nepal, Bangladesh and Bhutan focus on improvements in development, delivery and access to agro-meteorological services to different degrees. Regional collaboration in the development and delivery of agrometeorological services will be actively supported during the implementation of this project.

F. Lessons Learned and Reflected in Project Design

34. The Bank is scaling up investments in hydromet related operations in all regions. These have been structured in different ways, as stand-alone projects or as part of broader disaster risk management projects and programs. While first generation hydromet projects supported by the Bank tended to focus primarily on improving the monitoring network and forecasting related to weather and water, more recent projects (e.g. in Uruguay, Nepal) are putting a greater emphasis on service delivery with focus on sectors such as agriculture and disaster mitigation. This is being done by more direct and targeted support to user sectors to develop decision support systems and weather/water/climate based services that can cascade down all the way to the community level. Lessons from implementing such projects have informed project design.

35. **First, investments in hydromet monitoring, forecasting and service delivery are unlikely to be sustainable without significant and concerted efforts in capacity building**. Operational

[2] http://www.imdpune.gov.in/Clim_RCC_LRF/Index.html#)
[3] http://www.jagranjosh.com/current-affairs/18th-saarc-summit-issued-kathmandu-declaration-1417169743-1
[4] http://www.imd.gov.in/section/rth/static/country_net.htm

weather agencies are relatively new entrants for Bank support and as such have little experience in managing projects of this scale. As such, for all three components, capacity building and training – technical as well as project management, contract management and procurement - will be frontloaded and heavily prioritized by the project. .

36. **Second, an important lesson from past projects is that investments in hydromet systems and services must be demand responsive and be tailored to user needs to ensure long term sustainability**. Building on this, this project takes user needs and priorities as a starting point for design of service delivery systems and builds demand responsiveness into the structure of the project as exemplified by the component on agriculture. Moreover, to facilitate close coordination between users and suppliers of services, a Joint Technical Working Group (JTWG) including members of service providers and users is included as part of the project's implementation arrangements.

37. **Third, an important lesson regarding use of Systems Integrator (SI) firms-- a model that has had mixed success in World Bank funded projects, is that while there are challenges with the performance of such firms, they continue to play an important role in supporting project implementation.** This is especially the case in Bangladesh where technical capacity of implementing agencies is limited, and there are no university level programs on Meteorology and Weather Services. The performance of such firms can however be improved in a number of ways such as preparation of clear firm terms of references, strong contract management by PIUs, and requirements for in-country presence by team leaders for such firms. Further, experience suggests that it is easier to find firms that specialize in meteorology or hydrology but it is harder to find firms that have expertise in both. Building on these lessons, the PIUs have prepared clear terms of references for SI consultancies. They will receive training in contract management at the early stages of project implementation. Further, BMD and BWDB will be supported by two systems integrator firms and DAE will be supported by an agromet technical specialist.

38. **Fourth, existing projects show that the supply and delivery of hydromet services require significant inter-agency coordination**. For example, carrying out impact based forecasting is likely to involve coordination between multiple agencies including BMD, BWDB and DDM. Coordination issues have been addressed in multiple ways—through the formation of the JTWG, signing of several MOUs and/or using existing MOUs between agencies (as discussed in the next section and in Annex 3).

39. **Finally, an important lesson from regional projects (e.g. Regional Wildlife project in SAR) is that a single project involving multiple countries is difficult to implement due to a variety of reasons not the least of which includes variations in capacity of partnering countries, differences in country policies, procedures and priorities, and differences in implementation arrangements between countries.** Building on these lessons, this project has been structured as a national project with regional dimensions but as part of a sequence of projects as discussed earlier. As such, the Bangladesh project will be implemented like other national projects with its own monitoring and evaluation framework, reporting and fiduciary arrangements. Activities funded through the project have significant regional dimensions which will be undertaken in collaboration with other countries in SAR (funded through other similar national projects that are part of the sequence) and facilitated by the Bank.

IV. IMPLEMENTATION

A. Institutional and Implementation Arrangements

40. **Overall Project Management:** The Government of Bangladesh (GOB) is responsible for project management and coordination through its Ministry of Defence (MOD), Ministry of Water Resources (MOWR), and Ministry of Agriculture (MOA). The purpose of project management is to ensure (i) Project Oversight and Policy Direction, (ii) Project Coordination and Overarching Management, and (iii) Project Implementation. To carry out the above functions, (i) a Project Steering Committee (PSC), convened by the Senior Secretary/Secretary of the MOD will represent an apex platform/forum for overall guidance, policy advice/decision, and coordination of project activities addressing inter-agency issues that may arise during project implementation, (ii) a Project Coordination Unit (PCU), headed by a Project Coordinator (PC) for coordination among the three implementing agencies, and (iii) three Project Implementation Units (PIUs) each at BMD, BWDB and DAE will be established (Details of implementation arrangements are described in Annex 3).

41. **Project Implementation Units (PIUs):** The project has three implementing agencies: (i) BMD (ii) BWDB and (iii) DAE. Each is in the process of establishing a PIU. The Project Director (PD) and a full time dedicated Deputy Project Director, both officers according to the GOB set standard, of each agency will be appointed by the parent government body. The PDs of the PIUs will each have officers and staff appointed by the parent department to work in the PIU, including a Deputy Project Director (DPD) who will provide ongoing backup to the PD. In addition to the PD, and Deputy PD, each PIU shall consist of: (i) project technical coordinator in the case of BMD and BWDB and an agromet specialist in the case of DAE (ii) a procurement specialist and (iii) a financial management specialist, (iv) a monitoring and evaluation specialist, (v) an environmental focal person, and (vii) a social/communication focal person in the case of BMD and communication specialist/consultant for DAE. The social and communication consultant for the PCU will also serve the same function for the BWDB PIU. Each PIU can hire full time support staff and contractual support staff for project implementation. The three implementing agencies will develop sound monitoring mechanisms to track implementation progress, and arrange for independent reviews of implementation progress and evaluations at midterm and end-term, including conducting three user satisfaction surveys (baseline, midterm and end-term). Appropriate procurement and financial management systems and processes as prescribed in the government rules would be followed by the project which include but are not limited to budgeting, accounting, book keeping, financial reporting and auditing including adequate internal control arrangements (see Annex 3). These systems and procedures will be complemented by GAAPs for each agency; in the case of BWDB and DAE, GAAPs for on-going IDA projects will be updated to incorporate incremental actions, customized to agency activities.

42. **Inter-Agency Coordination:** The Implementation of this project requires close coordination between the different government agencies. The coordination is needed around several issues including (i) cooperation to install monitoring equipment (such as between the Ministry of Water Resources, Ministry of Local Government and Ministry of Roads and Bridges to get permission

to install water level stations under brides.); (ii) cooperation around data sharing and development of services (e.g. development of agro-weather advisories and bulletins) and (iii) cooperation around delivery of district level flood and drought early warning services. For cooperation on installation of monitoring equipment, Memoranda of Understanding (MOUs) between MOD and relevant agencies and between MOWR and relevant agencies will be prepared. All the expenses of the project will be made from PIUs directly and no direct fund transfer in any of the bank accounts of DDM or research organizations (such as BARI etc.) to incur any project expense will take place.

43. To facilitate coordination on service delivery, a Joint Technical Working Group (JTWG) will be established (as detailed in Annex 3). It will be chaired by the Director of BMD. The JTWG will focus on providing a user interface between users and providers of weather, water and climate information. In addition to the representatives of the main implementing agencies, representatives of other users such as municipal agencies will be important members of this working group. The JTWG will also provide technical support to the implementation of two community level activities embedded in Components A and B, implemented by BMD and BWDB respectively, and will be undertaken in full coordination with the Department of Disaster Management (DDM). Coordination on DRM activities is already facilitated through the existence of the Standing Order on Disasters, thus a new MOU is not needed. On regional weather and climate aspects, coordination between SAR countries will be supported with participation from Bangladesh and other countries including RSMC for the region. This will be done in collaboration with the WMO and facilitated through the World Bank.

44. Development of agro-weather advisories and information products for farmers requires modeling and technical integration of weather, water and climate data with agricultural data and information. This technical work will be done by research institutions namely, BARI, BRRI, BJRI and BSRI. Thus, activities undertaken by DAE (under Component C) will be implemented in close coordination with the relevant research institutions. MOUs between DAE and research organizations will be prepared for cooperation on crop modeling. Activities implemented by DAE will also build on the MOA's existing Agriculture Information Service (AIS) which at present, does not share any weather related information nor has information infrastructure at the upazila or union levels. The AIS at present includes a call center in Dhaka and Agriculture Information Communication Centers (AICCs) located at farmer group sites (e.g. ICM/IPM clubhouse). Activities supported by the DAE Component are complimentary to the existing AIS structure and will be linked to its technology and information delivery infrastructure established at different administrative levels. Since the DAE and AIS are both under MOA, a formal MOU between these two agencies is not deemed necessary.

B. Results Monitoring and Evaluation

45. The project will have a strong monitoring and evaluation framework to track and report progress made by the three agencies, evaluate the achievement towards project development objectives, and ensure feedback loops that inform implementation. It will comprise of (a) a results framework that captures progress towards the project development objective (three indicators) and intermediate outcomes (seven indicators), (b) development and implementation of a logical framework for monitoring and reporting on project activities, inputs, outputs and their contribution to project outcomes, (c) design and implementation of baseline and two additional surveys to identify beneficiaries, capture user needs and monitor user satisfaction for

services delivered by each of the three agencies (BMD, BWDB and DAE) and (d) midterm and end-term assessments.

46. The results framework includes three PDO level indicators and seven intermediate indicators that measure progress in establishing the various capacity, institutional and civic engagement elements necessary for Bangladesh to develop a sound system for delivering quality weather and climate services sought by its populace.

47. The Project coordination consultant at the PCU will be responsible for coordinating monitoring and for overall reporting on project implementation. S/he will collate and submit overall project reports - quality quarterly and annual reports as well as other periodic reporting meeting World Bank and GOB guidelines - based on the reports provided by the PIU M&E consultants. The M&E specialists in each PIU will be responsible for (i) providing ongoing inputs on monitoring and reporting to their own PIUs and also to the project coordination consultant, (ii) overseeing of M&E activities such as the development of the methodological framework M&E tools, a baseline survey on project indicators in the results framework in the first year of the project, and subsequent user satisfaction surveys, as well as comprehensive beneficiary analysis, and (iii) contributing to mid-term and end-term assessments that contribute to project evaluation. The PIU M&E specialists will work closely with the Project Coordination Consultant to ensure consistent and timely monitoring and reporting across the project.

48. In view of the weak capacity on M&E in the agencies and in the country in general, specialized technical M&E consultancies will be procured by the three agencies to (i) develop the detailed M&E framework and tools necessary for monitoring and reporting on the indicators in results framework in the PAD as well as other input, output and intermediate indicators as needed, (ii) develop the user satisfaction index and put in place a system for measuring changes in user satisfaction, and (iii) provide capacity to the project coordination consultant, the three M&E specialists in the PIUs and the staff of the implementing agencies on the use of M&E tools and methods. The M&E framework and methods will be elaborated in the Project Operations Manual and updated during the life of the project.

C. Sustainability

49. For long term project sustainability, two issues are critical. These include: (i) adequate budget for operation and maintenance of the modernized hydro-meteorological network and services; and (ii) adequate staff capacity to manage the enhanced service delivery system. Several actions are incorporated in the project design to address these issues. First, procurement packages for the observation networks will be structured so that the supplier will install and maintain the observation systems during the project implementation period. This will allow BMD and BWDB time to get the required training to operate and maintain the systems. Additional Operations and Maintenance (O and M) costs during project period (e.g. in the form of electricity for transmitting data, staff time, etc.) will be covered by the implementing agencies and included in the counterpart funding estimate. Second, based on available estimates, current operating budget for BMD for FY 2015-16 is US$ 6 million and for the hydrology division at BWDB is US$ 11.4 million. However, most of this is spent on staff salaries. Thus, O and M budget for each agency for maintaining the enhanced network will be gradually increased during the project period to accommodate the needs of an upgraded system. In order to facilitate this, a

systematic needs assessment of O&M for the modernized systems will be done by BMD and BWDB, which will assess the budgetary requirements necessary to maintain the improved system. This aspect is captured in the intermediate results indicator IR 1: Improved Financial Sustainability to maintain Hydromet and Agromet Networks (as measured by the *Percentage of Target O&M Budget for delivery of weather and climate services available in BMD, BWDB and DAE*).

50. Third, training will be prioritized and frontloaded for all the implementing agencies. In Bangladesh, there are no university level dedicated Departments of Meteorology or Agro Meteorology which are critical for developing professionals in this area and laying a strong foundation for provision of weather related research and services. As such, the project will support development of a University level Department of Meteorology in collaboration with Dhaka University and provide funding for the design of such a department, basic lab facilities, modeling facilities, course development, and partnership/collaboration with other universities. The project will also support training for BMD staff in specialized areas such as radar meteorology, Numerical Weather Prediction, cyclone forecasting, climate analysis and predictions and for DAE and BARI officials in the new area of agro-meteorology. For all three agencies, systematic training needs assessments will be undertaken and training plans developed including topics, modalities of training (for example, in-situ training, study visits, twinning arrangements, distance learning programs) and timeline for training.

V. KEY RISKS AND MITIGATION MEASURES

A. Overall Risk Rating Explanation

51. **The overall risk for BWCSRP is considered Substantial.** Key risks for achieving the project development objectives are related to (i) capacity constraints in the implementing agencies; (ii) critical need for coordination between the implementing agencies and key partner agencies, as well as regional coordination; (iii) technical complexity of the project; (iv) broader governance constraints in terms of delays resulting from government procedures and systems for planning and executing projects; and (v) fiduciary aspects.

52. **Several risk mitigation measures have been taken into account in project design and implementation arrangements**. A substantial risk facing project activities relates to limited institutional capacity for implementing this project. Further, the BWCSRP is a highly technical project for which adequate expertise is not available within the implementing agencies. As discussed in the Sustainability and Lessons Learnt sections, capacity strengthening is embedded in every component and as a part of key procurement packages. In a number of areas, where lack of internal technical expertise has been identified as an important constraint, external assistance from technical consultants recruited internationally has been programmed for all three Components. Sufficient in country presence of the team leader and relevant specialists of technical firms will be a requirement for contract signing to ensure that technical firms help design systems based on ground realities, provide adequate support on procurement and tender preparation and help integrate different aspects of the network. The project also has clear implementation arrangements designed to facilitate project implementation. Each of the PIUs will receive operational and project management training to facilitate their functioning. The

Bangladesh Meteorology Department and the Bangladesh Water Development Board will be supported by technical firms that will support them in systems integration while the Department of Agricultural Extension will receive systematic support from an international agro-meteorology specialist. The Government will also ensure sustainability of highly technical equipment by allocating sufficient operating and maintenance costs through GOB funds after the project ends. Additionally, risk mitigation measures for improving procurement and financial management are proposed in the Appraisal section. Bangladesh is a high risk environment in terms of political and governance risks due to weak capacity and bureaucratic delays, weak legal framework for corporate governance and public sector regulation. To mitigate this risk, a high level Project Steering Committee is embedded in the implementation arrangements to address any bureaucratic delays or inter-agency issues requiring attention. Moreover, an enhanced complaints mechanism will be established to ensure transparency and accountability. Successful service delivery is significantly dependent on strong coordination between three implementing agencies under three different Ministries and the regional aspect of the project. This coordination challenge will be addressed by establishing a PCU with strong leadership. Detailed governance-related risk mitigation measures are outlined in the GAAP (Annex 5) and also elaborated in the section on Sustainability.

VI. APPRAISAL SUMMARY

A. Economic and Financial Analysis

53. To estimate the value of strengthening Bangladesh's hydro-meteorological services, a Cost-Benefit Analysis (CBA) was undertaken. The desired outcome of analysis is to verify the economic justification for the project, guide the project's priorities and investments during implementation, position the value of Bangladesh's hydro-met services in a wider sociopolitical context, and create a baseline against which progress can be compared. Details regarding the analysis are described in Annex 6.

54. *Costs:* At the time of the economic analysis, estimated costs for the Bangladesh project were US$127.5 million. Operation and maintenance costs are estimated to begin after the six year project implementation.

55. *Benefits*: For the benefit estimates in this phase of the analysis, two different estimation approaches were utilized: i) benchmarking analysis, and ii) combined benefit transfer (BT) and value of statistical life (VSL). Benchmarking is carried out with data and estimates from other countries and expert judgment to define and adjust two benchmarks for each country: a) average annual direct economic losses caused by hydro-met hazards as a share of GDP; and b) potential changes in annual losses with modernization as a percentage of the total level of losses. The benchmarking analysis is based on a series of exercises conducted in Eastern Europe and Central Asia Region which concluded that the mean annual losses from met/hydro hazards and events varies between 0.1 percent to 1.1 percent of GDP and that that the share of preventable or prevented losses ranges from 20 percent to 60 percent of total weather and climate-related losses. As shown in Table 3, a top down benchmarking estimate indicates a potential annual value of improved hydro-met services of over US$347.6 million/year in Bangladesh. A sector level benchmarking using the same factors generates the same benefit estimates.

Table 3: Benchmarking Calculation	
GDP	US$ 173.8 billion
Vulnerability Factor	1%
Loss Reduction Factor	20%
Benchmarking Benefit Estimate	US$ 347.6 million

56. The project identifies primary project benefits accruing to (1) members of the general public from improvements in public weather systems (PWS), (2) farmers from improvements in and development of agro-meteorological (Agro-Met) information Decision Support Systems (DSS), and (3) vulnerable populations from improvements in community based flood and drought early warning systems (EWS). To derive baseline benefits estimates (i) for values of general improvements in weather information (PWS) a benefits transfer was implemented from a study of willingness to pay (WTP) for improved weather services in Mozambique; (ii) for agro-met information (DSS) values a benefits transfer was implemented from a study of WTP for improved climate and seasonal forecasts for farmers in Zimbabwe; and (iii) for the value of early warning systems (EWS) a value of statistical lives saved (VSL) calculation was implemented for an assumed reduction in hazardous hydro-met related fatalities.

57. Summation of the three benefits estimates qualitatively adjusted for potential double counting yields an annual benefit upon full program implementation of US$103.5 million as summarized in Table 4.

Table 4: Baseline Variables for CBA Calculations	
Key Variables	**Value**
First year of costs	2017
First year cost of investment (millions US$)	10.00
Subsequent cost of investment (next four years) (millions US$)	95.70
Timeline of initial investment (Years)	6
Annual depreciation (% of initial investment)	10%
Annual maintenance and maintenance (% of initial investment) – starting in 2023	10%
Analysis period	100 years
Timeline of increasing depreciation costs (starts with investment) (Years)	6
Baseline Aggregate Benefits (PWS+DSS+EWS) (millions US$)	103.5
Discount rate	12%

58. **Using the baseline variable values, the project results in a Net Present Value (NPV) of US$414.3 million and a benefit-cost ratio (BCR) of 2.67, indicating the economic feasibility of the project (Table 5). The Internal Rate of Return (IRR) is 75.07 percent.** This IRR represents a significantly better return than a relevant comparison Economic Rate of Return (ERR) of private sector Bangladeshi interest rates averaging 7.25 percent.

Table 5: Results of Baseline CBA Calculations	
Total Present Value (PV) Benefits	US$ 661.7million

Total PV Costs	US$ 247.4 million
Net Present Value (NPV)	US$ 414.3 million
Benefit-Cost Ratio (BCR)	2.67
Internal Rate of Return	75.07 %

59. A sensitivity analysis was conducted using i) different benefits estimates; ii) a lower discount rate; iii) an analysis of no ongoing investment in program upkeep and operations and maintenance; and iv) a shortened analysis timeline. Using a lower bound (most conservative) benefit estimate would bring the program into question with respect to standard CBA policy criteria. On the other hand, using the largest benefit estimate, a significant NPV of US$4.6 billion and BCR 19.39:1 are derived. Using a 3 percent discount rate rather than 12 percent indicates a NPV of US$3,022.6 million and BCR of 3.57. If ongoing budgets don't support replacing depreciated capital and operations and maintenance, the NPV and BCR is reduced considerably and the BCR is less than 2.0. This indicates that if there is no commitment to ongoing support of the initial investment, the policy decision may question the initial investment. Using a project analysis timeline of 15 years rather than 100 years still indicates that the basic policy conclusion does not change although the NPV and BCR fall somewhat, but not significantly.

B. Technical

60. The project's technical design builds on country and regional context, international good practice, extensive technical work prior to preparation and consultations with stakeholders. The design benefitted from engagement from a range of international expert consultants including from WMO, academia and the World Bank. The project combines investments in institutions (to ensure the efficiency, effectiveness and sustainability) with investments in infrastructure (to deliver tangible benefits) for the provision of hydromet information services. Design of the hydromet modernization program conforms to best practices established by the WMO, which is the intergovernmental body responsible for coordinating the international exchange of information needed to maintain and improve weather, water and climate services.

C. Financial Management

61. A financial management (FM) capacity assessment was carried out to evaluate the overall financial management capacity in the country and within BMD, BWDB and DAE. The key FM risks for the project are (i) failure to generate an accurate and timely financial report including Interim Unaudited Financial Reports (IUFRs) due to not having robust financial management systems, (ii) quality of internal audit reports of BWDB and failure to have internal audit function under other agencies, (iii) shortage of financial management experts within the implementing agencies, (iv) absence of an updated financial management manual which incorporates all of the most recent changes in rules and regulation of Bangladesh Government, and (v) weakness in record keeping. An FM action plan, to mitigate these risks, has been agreed with the implementing agencies and its elements are discussed below (details are noted in Annex 3).

62. The following arrangements will govern the project financial arrangements: (i) a FM Specialist in each agency, with terms of reference (TOR) agreed with the Bank, will be recruited

within one month after credit effectiveness and will be retained for the project duration; (ii) three designated bank accounts in the form of CONTASA will be opened for implementing this project; (iii) all payments will be made directly by the PD from the PIU; no payments are anticipated to be handled through the divisional offices; (iv) the accounting system of the BWDB will be used for accounting and reporting the project expenditures. An off the shelf accounting software will be procured and installed by all three agencies; (v) Interim Unaudited Financial Reports (IUFR) will be prepared and submitted to the Bank within 45 days from the close of each calendar quarter; (vi) annual external audit of BMD and DAE will be carried out by the Comptroller and Auditor General (C&AG) of Bangladesh, through its Foreign Aided Project Directorate (FAPAD) and the annual external audit of BWDB will be carried out by a private audit firm and the reports will be submitted to the World Bank within six months from the close of a financial year; and (vii) two performance audits will be carried out by the PCU for all three implementing agencies, the first one 6 months before the mid-term and the second one, a year before the project closes. The performance audits will be carried out by an independent private auditor on the basis of TOR and selection process acceptable to the Bank; and (viii) the project will use traditional transaction based disbursement method. A Project Operations Manual with the FM section elaborating various measures to be taken to monitor and track project expenses will be prepared within one month after Effectiveness.

D. Procurement

63. Both BWDB and DAE have experience in implementing multiple Bank financed projects. BMD, however, has not implemented any Bank financed projects. The main drivers of the risks are associated with the acute capacity constraints of BMD, DAE, and Metrological Department of BWDB in performing procurement related activities, delay in processing procurement activities, inadequate record management system, and vulnerability of the agencies with respect to inappropriate bidding practices under taken by the bidders. A range of procurement risk mitigation measures are (and/or will be put) in place, as described in Annex 3, to minimize procurement related risks, including: (i) formation of bid/proposal evaluation committees, (ii) introduction of the Systematic Tracking of Procurement Exchanges System (STEP), (iii) identification of procurement focal points and hiring of procurement consultants in the three agencies, (iv) hiring of international technical and procurement experts for BMD for ICB contracts, (v) use of Electronic Government Procurement system for NCB contracts and use of a number of due-diligence measures. The project procurement plan will be disclosed on the project website and will also be detailed with procurement related arrangements in the Project Operations Manual.

E. Social (including Safeguards)

64. The scale of physical infrastructure related activities under the project will be relatively small in terms of land and space usage, and the activities will be mainly carried out within the existing premises of the implementing agencies. It is not anticipated that at this stage any land acquisition or related displacement will take place, and hence no land expenditures are considered. The option has however been kept open for future phases in case of the improbable situation where small amounts of land acquisition becomes absolutely necessary after exhausting other options such as willing buyer willing seller, voluntary donation etc. OP 4.12 Involuntary Resettlement is triggered for the project keeping in mind the very slim chance mentioned above. Since the exact

locations and/or exact land requirements cannot be determined at this stage, a Resettlement Policy Framework has been prepared to provide guidance on site-specific Resettlement Action plans if required. The project will be implemented nationwide and although specific geographical locations have not been identified at this stage it is probable that it will be implemented in areas where indigenous/tribal/small ethnic minorities live. OP 4.10 Indigenous Peoples is also triggered for the project.

65. A Resettlement Policy Framework (RPF) and a Small Ethnic Communities and Vulnerable Peoples Development Framework (SECVDF) have been prepared for the project based on Bank safeguard policies and GOB regulatory/policy requirements. These two frameworks include social screening formats for the subcomponents; resettlement policies and process following the World Bank's policy (OP 4.12); consultation communication, information dissemination and feedback framework; grievance redress mechanisms, gender considerations; institutional arrangement and capacity building; and framework for monitoring and mitigation of adverse impacts. The framework for small ethnic/tribal and vulnerable community development is a standalone document that includes guidance on consultation strategies and participatory processes to gather feedback effectively and efficiently in a culturally appropriate and gender sensitive manner so that appropriate mitigation measures can be designed. Grievance mechanism and institutional arrangements are also discussed. The RPF and SEVCDF were approved by the Bank and the documents with Bangla versions were disclosed in the implementing agencies website (www.bmd.gov.bd;http://www.bwdb.gov.bd/index.php/site/digital_archive; http://dae.portal.gov.bd/site/page/414d0961-fb21-44dd-af68-3c7f79ddb5ab) on December 23, 2015 and the Bank's Infoshop on January 9, 2016 for public comments. Hard copies of the document have also been made available in implementing agencies. The disclosure notification was published in one Bangla and one English daily newspaper.

66. The RPF and the SECVDF will be utilized to prepare site specific Resettlement Action Plans (RAPs) or abbreviated RAPs and/or Small, Ethnic Communities and Vulnerable Peoples Development Plans once the sites are identified, screened and assessed via the SIA and screening process, and if resettlement impacts are anticipated and/or indigenous people are identified as living there. The RPF and SECVDF will focus on consultation and communication strategies with a lens on gender, ethnic people and other vulnerable communities/households.

67. The project will ensure citizens' engagement in appropriate components including Component A (Strengthening Meteorological Information Services), Component B (Strengthening Hydrological Information Services and Early Warning Systems) and Component C (Agro-meteorological Information Systems Development). Relevant indicators have been developed to measure citizens' engagement. Sub-component C3 will support dissemination of agrometeorological advisories and products to farming communities in different upazilas and obtain feedback, providing an excellent opportunity to engage the farming communities in the project. PDO 3 in results framework (systematic measurement of user satisfaction in place to measure improvements in weather information service delivery) also includes indicators in the users' survey on their engagement in the weather information service delivery process.

F. Environment (including Safeguards)

68. This project is not expected to create any significant environmental impact with its focus being on developing institutional capacity for developing climate information services. However, the project will support both (i) Strengthening Meteorological Monitoring, Forecasting and Disaster related Early Warning System and (ii) Strengthening Hydrological Monitoring and Forecasting. These will include acquisition of hardware and software and installation of small physical infrastructure and repair/maintenance of existing facilities. Any likely adverse impacts are expected to be reversible in nature that can be addressed by standard mitigation measures. Thereby the project is classified as Category 'B' and the Bank environmental safeguard policy OP/BP 4.01 Environmental Assessment has been triggered. An Environmental Management Framework (EMF) has been prepared based on: (i) a detailed review of the project activities; (ii) experience of similar projects in the region; (iii) stakeholder consultations during project preparation; and (iv) identification of the institutional barriers and capacity building needs for environmental management. The EMF was found to have met the requirements of the World Bank Environment Safeguard Policy. The EMF includes the requirements of the Department of Environment (DOE), Bangladesh and the World Bank's environmental safeguard policies. All site-specific installation of equipment and physical interventions under the project will go through an environmental screening process. The EMF describes the procedure for environmental screening, assessment, preparation and implementation of Environmental Management Plan (EMF), application of Environmental Code of Practice (ECoP), monitoring, and reporting. Additional details are noted in Annex 3.

69. **Consultation and Disclosure.** The EMF was prepared in consultation with the key stakeholders including the implementing agencies officials both at central and field levels. A national consultation workshop on the EMF was organized by the implementing agencies on November 25, 2015 with all the stakeholders and feedback incorporated. Consultations will be held during the environmental screening/assessment of each site specific intervention. The EMF document with Bangla version was disclosed both in all three implementing website (www.bmd.org;http://www.bwdb.gov.bd/index.php/site/digital_archive; http://dae.portal.gov.bd/site/page/414d0961-fb21-44dd-af68-3c7f79ddb5ab) and the Bank's Infoshop. Hard copies of the document are also available in implementing agencies offices.

G. Other Safeguards Policies Triggered

70. OP/BP 7.50 on International Waterways has also been triggered because the project will support water resource surveys including bathymetric survey in the coastline of Bangladesh, installation of coastal storm surge stations, buoys in the ocean, and installation of hydro-meteorological and weather related monitoring system. While most of these project interventions will be in-land, some will take place in the Bay of Bengal, an international waterway to which the policy requirements are applicable. The Bank has determined that the project meets the criteria defined in paragraph 7(b) of OP 7.50 providing for an Exception to the Riparian Notification Requirement on the basis that: (a) the project is located in the lowest downstream riparian country from where the river drains into the Bay of Bengal, and (b) that the limited scope of the physical interventions and expected negligible impacts will not adversely change the quality or quantity of water flow to other riparian countries, and will not be adversely affected by the other riparian's possible water use.

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

Annex 1: Results Framework and Monitoring

Bangladesh Weather and Climate Services Regional Project (P150220)

Project Development Objective (PDO) is *to strengthen Bangladesh's capacity to deliver reliable weather, water and climate information services and improve access to such services by priority sectors and communities.*										
	Baseline value (2016)	**Annual Targets**						**Frequency of data collection**	**Data source**	**Responsibility for Reporting**
		Year 1	**Year 2**	**Year 3**	**Year 4 MTR**	**Year 5**	**Year 6 End Term**			
PDO Level Indicators[5]										
PDO 1: Improved capacity for weather forecasting										
Improvement in Forecast Skill (of 24 hour public weather forecasts for mean temperature and precipitation)	No verification in place	System for verification established	All forecasts are verified and Baseline skill level established		10% Increase in skill over baseline		25% Increase in skill over baseline	Annually	Project Monitoring Reports	BMD, BWDB,
PDO 2: Improved service delivery to targeted agriculture sector beneficiaries										
Percentage of targeted farmer groups (15,000) receiving agromet information services (of which female %)			10% 5%	20% 10%	40% 15%	60% 25%	70% 40%	Annually	Project Monitoring Reports	DAE
PDO 3: Systematic measurement of user satisfaction in place to measure improvements in weather information service delivery										
Establishment of a user satisfaction measurement system	User Satisfaction not measured	Framework and Baseline for user		Survey is conducted		Survey is conducted		Survey during Baseline MTR End-Term	Project Reports; User Satisfaction	BMD, BWDB, DAE

[5] Details in Annex 1.1

Project Development Objective (PDO) is *to strengthen Bangladesh's capacity to deliver reliable weather, water and climate information services and improve access to such services by priority sectors and communities.*										
	Baseline value (2016)	**Annual Targets**						**Frequency of data collection**	**Data source**	**Responsibility for Reporting**
		Year 1	**Year 2**	**Year 3**	**Year 4 MTR**	**Year 5**	**Year 6 End Term**			
		satisfaction Index developed							Survey results	
Intermediate Indicators[6]										
IR 1: Upgraded and modernized hydromet related network established										
Percentage of Network upgraded			10%	25%	35%	50%	70%	Annually	Project Monitoring Reports	BMD, BWDB, DAE
IR 2: Strengthened capacity for delivery and use of weather and climate services										
Percentage of planned training completed			Training plan in place	15% targeted training completed	40% of targeted training completed		75% of targeted training completed	Bi-Annually	Training Plan and Project Monitoring Reports	BMD, BWDB, DAE
IR 3: Improved financial sustainability to maintain hydromet networks										
Percentage of Target O&M Budget for delivery of weather and climate Services			O&M study conducted ; Baseline and Target O&M for the modernized network identified		Post project operational plan developed	Post project operational plan approved	50%	Annually	Project Monitoring Reports	BMD, BWDB, DAE
IR 4: Greater regional cooperation on weather services										

[6] Details in Annex 1.1

Project Development Objective (PDO) is *to strengthen Bangladesh's capacity to deliver reliable weather, water and climate information services and improve access to such services by priority sectors and communities.*										
	Baseline value (2016)	**Annual Targets**						**Frequency of data collection**	**Data source**	**Responsibility for Reporting**
		Year 1	**Year 2**	**Year 3**	**Year 4 MTR**	**Year 5**	**Year 6 End Term**			
Improved sub-regional Information exchange		Regional Consultations commence and areas of collaboration are identified	Improved provision by BMD to WIS		Improved accessibility by BMD to regional RSMC climate/cyclone forecasts		Joint partnerships for regional product development strengthened	Annually	Project Monitoring Reports and Regional Meeting summaries	BMD
IR 5: Increase in weather, water and climate products developed										
Targeted weather and climate products are developed and tested			JTWG supporting product development is established and functioning		EWS developed and implemented in 2 districts		Customized Agro advisories; Improved PWS; QPF; QPE; Nowcasting;	Annually	JTWG minutes; Project Monitoring Reports	BMD, BWDB, DAE and JTWG
IR 6: Improved access to agromet information at the Upazila level										
Number of Upazilas with Agromet kiosks installed and receiving BAMIS information			BAMIS is in place; 5%		30%		50%	Annually	Project Monitoring Reports	DAE , BMD, Research Organizations
IR 7: Community Early Warning Systems strengthened in 4 districts										
Number of people who receive early warning alerts for significant weather and water hazards in time		Baseline estab.		EWS is established and fully functional in 4 districts	30,000 persons in affected districts		100,000 persons in affected districts	Annually (after significant events)	Baseline Project Monitoring Reports	BMD, BWDB

Annex 1.1: Indicator Descriptions and Methodology

A. PROJECT DEVELOPMENT INDICATORS

PDO 1: Improved capacity for weather forecasting

This indicator will measure the *Improvement in Forecast Skill (of 24 hour public weather forecasts for mean temperature and precipitation)*. The baseline is unverified public weather forecasts for 24 hrs. A forecast verification system will be designed and put in place in the first year and the baseline skill level established by the second year of project implementation. Subsequently, there will be ongoing monitoring of changes in skill levels.

PDO 2: Improved service delivery to targeted agriculture sector beneficiaries

The service delivery to targeted agriculture sector beneficiaries will be assessed by the *Percentage of targeted farmer groups receiving agro-advisories (of which female %)*. Agromet information services will be targeted towards 15,000 farmer groups all over the country. The project will provide mobile Subscriber Identity Module (SIM) cards to these farmer groups and develop mobile applications through which agromet information will be accessed. In addition, agrometeorological kiosks will be established in each of the 487 Upazilas. Agromet advisories will be disseminated through these kiosks. Access by farmer groups and farmers of agromet advisories will be recorded in multiple ways: access through mobile applications, through the BAMIS webportal, through agromet kiosks at upazila level. Feedback will be monitored to inform on the extent of demand and user needs in further developing agromet information services. It is expected that since the accessibility is targeted nationwide and farmer groups will provide onward dissemination services, agromet information services will likely reach a large portion of the 30 million farmers in Bangladesh.

PDO 3: Systematic measurement of user satisfaction in place to measure improvements in weather information service delivery

This indicator will assess and report on the progress made in the *Establishment of a user satisfaction measurement system.* The project will develop the methodological framework for the periodic measurement and tracking of user satisfaction (including the development of user satisfaction indices), including the feedback loops that can be used to strengthen the quality of the weather and climate information services delivered through the implementing agencies. Each implementing agency will be conduct 3 surveys (one baseline and 2 additional surveys) to establish a baseline and track changes in user satisfaction for services delivered by the three agencies BMD, BWDB and DAE under this project.

(a) Meteorological user satisfaction index – This will include the public weather service users (broader community), users of community early warning systems as well as specific sectoral users accessing BMD services and products.
(b) Hydrological user satisfaction index – This will include users of hydrological information and early warning alerts, including specific sectoral users and communities in coastal and hotspot areas.
(c) Agro-climate user satisfaction index – This will include farmers.

One aspect associated with measuring user satisfaction with hydromet services in countries, which are undergoing a transformative modernization of the hydromet infrastructure and service delivery is that user satisfaction trends may not correlate in the same direction with increasing investments in the system. Often when starting with extremely low or poor information levels, the expectations for services are also similarly low. These expectations can rise much faster in the initial phase of the project when awareness of project activities is increased, resulting, possibly, even in decreasing satisfaction with services. Once the service delivery quality is made evident, towards the later part of the project, it is likely that user satisfaction will rise closer to the rising expectations. It will be important to benchmark the user satisfaction appropriately based on the type and quality of services provided. Systematic measurement of user satisfaction over time will provide the hyromet service delivery agencies in customizing and improving products and services to meet user needs.

B. INTERMEDIATE INDICATORS

IR 1: Upgraded and modernized hydromet related network established

This indicator will measure the *percentage of Network upgraded* for service delivery, based on investments by the three implementing agencies – BMD, BWDB and DAE. Details of the Network to be upgraded are provided in Annex 2.

IR 2: Strengthened capacity for delivery and use of weather and climate services

This indicator will report on the *percentage of planned training completed* by the project. The project training activities will be targeted towards technical and professional staff of the three implementing agencies, officials at the district/upazila and other decentralized level, and community members (farmers, schools etc.).

IR 3: Improved financial sustainability to maintain hydromet networks

The project will report on the *Percentage of Target O&M Budget for delivery of weather and climate Services* committed by each of the three implementing agencies, BMD, BWDB and DAE. An O&M study will be conducted by Year 2 of project implementation. It will assess current funding going towards O&M, estimate the target O&M necessary for maintaining the functionality of the modernized network. The O&M study will explore the satisficing optimum and other scenarios of operational capability in terms of maintenance costs for the observation network. The indicator will measure the level of financing committed for O&M towards the targeted O&M as identified in the O&M study. In addition, by year 4 of project implementation, a post-project operational plan will be developed, to be in place before the end of the project.

IR 4: Greater regional cooperation on weather services

This indicator will capture (qualitatively) progress made towards greater regional cooperation focusing in particular on *Improved sub-regional Information exchange* among participating sub-regional countries. The first step would be the initiation of the Regional Consultations on

Weather where areas of collaboration are identified. An information exchange note will be developed which will lay out the opportunities for improving access of regional information by BMD and also steps for improved sharing of information by BMD to the RSMC and WMO.

IR 5: Increase in weather and climate products developed

This indicator will assess the extent to which *Targeted weather and climate products are developed and tested* with the support of the project. As a first step, a list of the existing products and services will be developed. The indicator will report qualitatively on the progress made towards the development of new or improved products and services such as EWS developed and implemented in 4 targeted districts; Customized Agro-advisories; Improved PWS; Quantitative Precipitation Forecasts and Estimates (QPF, QPE); Nowcasting; Impact Forecasting etc. The indicator will report on the geographic coverage where such products/services are developed for and delivered as well as on their quality. This indicator will also assess and report on the strength of institutional coordination that is necessary for the development of these products through the establishment and functioning of the *Joint Technical Working Group (JTWG).* The first step would be the formal establishment of the JTWG and development of a TOR which will detail its structure, mode of functioning (including number of expected meetings), roles and responsibilities of the WG and its members, areas for coordination and steps/processes to be put in place for information exchange and joint product development. The TOR could also identify details of possible self-assessment by the group to ensure effectiveness and quality of coordination. The group will include participation by representatives from DAE, BMD, BWDB, BARI, DDM (and other relevant institutions as needed).

IR 6: Improved access to agromet information at upazila level

This indicator will assess the improved access to agromet information at the upazila level by reporting on the *Number of Upazilas with Agromet kiosks installed and receiving BAMIS information*. As a part of the BAMIS network, Agromet kiosks will be put in place at each upazila. This indicator will report on the number of upazilas where agromet kiosks are installed. The design of BAMIS will identify the number and type of planned agro-advisories (such as daily, weekly, monthly, yearly, special), which will be delivered to farmers through the agromet kiosks. The agromet kiosks will log and report on the number of service requests completed at the upazila level where agromet information is delivered to farmers.

IR 7: Community early warning systems strengthened in 4 districts

This indicator will assess the progress made in strengthening community early warning systems in 2 flood prone districts (Netrakona and Sunamganj) and 2 drought prone districts (Rajshahi and Naogaon). It will report on the *Number of people who receive early warning alerts for significant weather and water hazards in time*. A baseline will be established to assess the population of vulnerable persons and for the time period of early warning in the case of various weather and water hazards. Rapid surveys of affected communities after extreme events will provide information on the number of persons who actually received the alert as planned.

Annex 2: Detailed Project Description

Bangladesh Weather and Climate Services Regional Project (BWCSRP)

1. The Bangladesh Weather and Climate Services Regional project will support modernization of the country's weather, water and climate information infrastructure, strengthening both the supply of hydro-meteorological data, information and services and delivery to sectors and communities. It will do so by modernizing meteorological and hydrological monitoring systems, forecasting, strengthening sector specific information services and targeted community based hazard early warning activities in selected districts. This project is part of a SAR regional sequence of projects, the first of which, Nepal Building Resilience to Climate Hazards is under implementation and Bhutan Weather and Disaster Improvement project under preparation.

2. The Bangladesh Weather and Climate Services Regional project has three implementing agencies: the Bangladesh Meteorological Department (BMD), the Bangladesh Water Development Board (BWDB) and the Department of Agricultural Extension (DAE). BMD under the Ministry of Defense is considered the producer of weather and climate services which will also benefit from modernization of BWDB's network and data. BMD is the main agency responsible for producing weather forecasts. It is also responsible for issuing warnings and alerts for various extreme events such as thunderstorms, cyclones, and meteorological drought. BMD's mandate includes production of short, medium range and seasonal weather forecasts, development of climate scenarios and long term climate prediction. Timely and accurate weather related information produced by BMD has the potential to benefit a wide range of economic sectors such as civil aviation, agriculture, disaster risk management, water, fisheries, maritime activities, urban infrastructure services and flood management. BWDB under the MOWR is both a user of weather services and a provider of water services to various sectors and stakeholders. DAE under the MOA is considered a user of hydro-meteorological information services also producing sector specific information and services to meet the needs of the farming community. The BWDB's Hydrology Division, has the mandate for monitoring the country's surface and groundwater monitoring networks, and for providing hydrological forecasting services with flood forecasting done by its Flood Forecasting and Warning Center (FFWC). The DDM has a critical role to play in the success of this project as it is the main agency responsible for disaster preparedness and post disaster response activities. It is also a user of BMD's extreme weather information and forecasts and flood forecasts issued by the FFWC. Close coordination between BMD, BWDB and DDM will be needed particularly in the implementation of community based hazard early warning activities and sharing critical data for the development of respective products.

3. The design of this project is based on the recognition that while weather and hydro-meteorological hazards have national level impacts, they are also shaped by weather patterns and systems at regional and global scales. As such, both national capacity strengthening and regional collaboration are critical to improving hydro-meteorological services in Bangladesh. However, for Bangladesh to access already publicly available resources and forecasts, strengthening national level capacity and ICT infrastructure systems is essential. This will need to be complimented by targeted regional and sub-regional consultations to leverage economies of scale

and strengthen collaboration with regional partners. This project will support engagement at both levels to harness the linkages between the two.

4. The Project has 4 Components:

(a) Component A: Strengthening Meteorological Information Services (US$ 58.88 million)
(b) Component B: Strengthening Hydrological Information Services and Early Warnings Systems (US$ 40.62 million)
(c) Component C: Agro-Meteorological Information Systems Development (US$ 13.5 million)
(d) Component D: Contingent Emergency Response Component (US$0)

5. **Component A: Strengthening Meteorological Information Services (IDA US$ 58.88 million).** The component seeks to strengthen BMD's capacity to improve public access to weather and climate services through the enhancement of meteorological observation network, forecasting capacity and delivery of weather and climate services. This Component has three Sub-Components as follows:

6. **Sub-component A1: Modernization of Meteorological Observation Systems and Forecasting (IDA US$ 34.64 million).** This sub-component will modernize BMD's observation networks, communication and ICT systems, and improve numerical weather prediction and weather forecasting systems. It comprises of the following activities:

(a) Sub-Component A1.1 Modernization of surface, ocean and upper air monitoring networks and ICT systems: This includes (1) support for a Meteorological Systems and Services Integrator (MSSI) consultancy to assess, design, prepare technical documentation and support BMD in the implementation of key project activities; (2) upgrade 35 existing synoptic stations and 440 agricultural automatic weather stations (AGAWS); (3) strengthen urban resilience through the addition of 65 new automatic rain gauges (ARGs) in Dhaka, Chittagong, Khulna, Rajshahi and Sylhet; (4) installation of three C/X band Doppler Weather Radars to measure radar reflectivity to derive quantitative precipitation estimates (QPE) to support civil aviation and extreme urban rainfall events in nearby cities; (5) installation of AWOS and other instrumentation to support civil aviation at the three international airports; (6) install Coastal-Marine Automated Network (C-MAN) comprised of 40 new coastal marine stations to detect meteorological state parameters, wave height, wave period, and storm surge; (7) installation of 5 buoy stations for measuring ocean temperature, current, wave dynamics, and other parameters; (8) digital elevation map and bathymetric survey; (9) purchase of 11 portable hydrogen generators to support upper air measurements; (10) upgrade of existing equipment maintenance, repair, and calibration equipment at BMD; and (11) Strengthen BMD ICT and Data Center with computer servers and software to help store and process data, GTS upgrade to WIS and expansion of GTS/WIS bandwidth, installation of dedicated and reliable high speed internet communications between BMD offices in Dhaka and Rangpur, Sylhet, Barisal Khulna, Rajshahi and Chittagong.

(b) Sub-Component A1.2: Improving Infrastructure for Forecasting: This includes installation of 5 Nowcasting workstations (hardware and software) at BMD headquarters, three airports at (Dhaka, Chittagong and Sylhet) and at Divisional office for providing

advisories on short lead time (less than 6 hours) events; (13) installation of 7 weather workstations (hardware and software) for preparing daily, short, medium and long range weather forecasts and to synthesize and visualize data from various sources such as satellite, the modernized surface observing network, radar data, upper air data, model output and wind shear warning system; (14) procurement of a HPC to improve weather and oceanographic forecasting; (15) consultancy to perform digitization and data rescue; (16) Design and implementation of forecast verification system; (17) Consultancy to install, configure and provide training on WRF as applied to the BMD HPC system; and (18) Consultancy to install, configure, provide training on storm surge and wave models as installed on HPC.

7. ***Sub-Component A1.1: Modernization of the surface, ocean and upper air monitoring networks:*** A priority activity for BMD is to recruit a Meteorological Systems and Services Integrator (MSSI) consultancy to support it on systems assessment, design of different aspects of the modernized network, forecasting and services, preparation of tender documents and technical support through the duration of the project. Such expertise is not adequately available at BMD. It will help BMD PIU both in technical aspects but also in all phases of the procurement process, including the preparation of complete bid documents, pre-bid meetings, bid evaluation review leading to contract award, evaluation of progress during the course of contracted work, and final acceptance of work. Some aspects of the observation and forecasting systems require detailed assessment and design; others can be procured with relatively quick upstream technical work. Moreover, while some tasks will need to be contracted out to other more specialized firms, the MSSI will support the PIU in the envisioning, procurement and integration of these activities. Substantial in country presence of the team leader will be essential for the success of this consultancy.

8. At present, BMD operates 35 synoptic stations, from which weather related data is manually observed and transmitted. Synoptic stations follow a common format and transmit weather data to the GTS at synoptic time to be used by other NMHSs and research institutions, and also in global weather forecast models. However, automatic recording and transmission of data is currently not possible under the existing manual system. This sub-Component will fund automation of the surface synoptic station network that will enable exceptional events such as extreme rainfall and wind events to be automatically recorded and transmitted back to BMD with minimal risk of human error. All upgraded synoptic stations will report observation to the international community through GTS/WIS making this data available for use by NMHSs around the world for assimilation in global and regional numerical weather prediction efforts. Data will also be available in real-time to national counterparts and the public in general. Automation is expected to improve data quality, temporal resolution and the timeliness of the information while also providing a richer data set. It will also enhance present weather observations and provide an improved historical record of weather events to be used by both the national and international community. Since information from the synoptic stations will be used in global weather analysis and as input to global and regional weather forecast models, it has clear regional and global benefits.

9. Currently, the agro-meteorological community in Bangladesh only has the surface synoptic stations to help support their crop management decisions. This network is not dense enough to characterize micro-scale weather and climate information necessary for farmers. The project will

thus support installation of 200 AWS stations that can collect data needed for preparing information, advisories and services for farmers in different agricultural zones and inform farm level decision-making. There are 487 upazilas in Bangladesh; of these, 47 upazilas will already contain an AWS station (35 synoptic stations being upgraded, and the lot of 12 being added). The 200 AGAWS stations are expected to be installed at DAE compounds. The exact number and sequencing of AGAWS to be installed will be determined after further analysis and so the tender document will consist of two phases, the first phase for up to 106 AGAWS stations at established Ag Extension offices and the remainder to be placed after BMD performs a study on network density requirements, physical layouts and locations within the DAE compounds. Data from AGAWS stations can benefit the region in developing climate indicators that will help frame climate variability in Bangladesh and the region in general.

10. Extreme rainfall events cause disruption to transportation and the general well-being of the urban community. For instance, water pumping plants require rainfall information in order to effectively plan for the removal of water where it has accumulated. However, at present, there are an insufficient number of rain gauges in the major urban areas. As such BMD is unable to provide effective information relating to extreme rainfall events to users such as Dhaka WASA. Sub-Component A1.1 will strengthen precipitation monitoring in four major urban areas that will receive a total of 65 new automatic rain gauges (ARGs) that report in real-time. Of these, 20 stations will be placed in Dhaka, 15 in Chittagong, 10 stations each in Khulna, Rajshahi and Sylhet. For Dhaka, these could be located on Dhaka/WASA premises. The locations of automatic rain gauges in Chittagong, Khulna and Rajshahi have to be decided. The need for installing additional rain-gauges will be determined based on assessment and design undertaken by the MSSI consultancy. Rain gauge stations will employ the mobile network GSM radio technology, with two SIM cards using two different network providers as available. This information will be primarily used for urban flooding modeling and input to Nowcasting and numerical forecasting systems. It can also be used to provide a signal of climate variability and the impact on urban areas at the regional level. It is expected that the new rainfall data can be used to calibrate the radar-rainfall relationship so that the weather radars can be effectively used to provide Quantitative Precipitation Estimates (QPE) and short term (~< 60 minutes or more) Quantitative Precipitation Forecasts (QPF). Grant funding from JICA led to the acquisition and installation of 6 rainfall stations that report in real time. The maintenance of these 6 stations will be included as part of the goods and services to be provided to support the urban rainfall network. Upgrading the rain gauges will also help to calibrate the existing radars used by BMD. Proper calibration of the radar network to derive radar – rainfall estimation will in turn be very useful for hydrological forecasting (to be conducted by BWDB).

11. BMD operates a network of 5 S-Band radars that provide coverage of Bangladesh and surveillance out over the Bay of Bengal to detect the speed, movement, and intensity of approaching cyclones. The S-Band radar is ideally suited for long range reconnaissance, but in exchange for the long range of the radar, sensitivity to lightly precipitating or developing clouds is compromised. This is especially important in the vicinity of airports, where wind shear leading to turbulence can disrupt and cause harm to civil aviation. For this reason, 3 X/C-Band radars are required to observe rain and wind patterns over the three international airports of Dhaka, Chittagong, and Sylhet. These radars will also monitor rainfall over the three urban areas that are adjacent to the three airports and provide value to the urban rainfall detection and

measurement cited earlier. They will have regional and global benefits assuring safeguards to civil aviation from weather related events at the international airports in Bangladesh. It is expected that the data from the new three X/C-Band radars will be made available and displayed on both the Nowcasting and general weather workstations. Radars should be located sufficiently far enough away from the airport to effectively monitor runway approach and departure runways while keeping in mind the surveillance over the nearby urban areas. This procurement will include a provision to store the data in an open format on BMD, and will also include the integration of the legacy radar network data with the new radar network into a single open source (non-proprietary) database for use as BMD requires. This will include developing a mosaic that will show both radar networks on the same display.

12. While the new radar systems at the three international airports that support civil aviation and safe air navigation, they will not help with clear air wind shear events. To address the latter, Sub-Component A1.1 will support setting up an Aviation Weather Observation System (AWOS) that can be used to support civil aviation in all instances, including clear air wind shear events where radar is ineffective. AWOS will be installed at international airports at Dhaka, Chittagong, and Sylhet. The AWOS stations will include computer systems to collect and process the information and provide guidance and warning to flight controllers and other civil aviation staff as well as the international aviation community.

13. Bangladesh's coastal areas are highly vulnerable to tropical cyclones associated with highly destructive storm surges. In order to improve the accuracy and lead time of its cyclone forecasts and develop capacity for storm surge forecasting, BMD needs to strengthen its marine information network and database. However, at present, BMD has no coastal observations of meteorology and oceanographic conditions in support of the severe risk prone coastal region where many lives have been lost due to storm surge and resulting inland inundation. The Bangladesh Inland Water and Transport Authority (BIWTA) operates 17 tide level gauges to support navigation on inland rivers, but these are not designed to focus on the dynamic effects of a cyclone on wave conditions, especially storm surge. Sub-Component A1.1 will support Coastal-Marine Automated Network (C-MAN) consisting of the installation of 40 coastal marine automatic stations placed along the Bangladesh coast line. The coastal surge stations automatically measure general state weather parameters (temperature, relative humidity, wind speed, wind direction, atmospheric pressure, and rainfall), and sea level, wave height, and wave period. They will be especially useful in detecting the impact of cyclones on storm coastal wave height and period. The stations will report through mobile network GSM data telecommunications, utilizing dual sim cards from different mobile network operators. The measurement of storm surge inundation is critical in characterizing the inundation from storm surges. It is expected that this data will be vital in calibrating and validating surge inundation models. It is envisioned that these 40 storm surge stations will use a single pole, and radar water level device. The stations will utilize the mobile network GSM Data transmission system to transmit data in real time. The storm surge station, as with all stations, should also log all data, holding a minimum of one year's worth of data. These stations can be operated with very low power consumption, so using a larger battery with semi-annual or annual battery changes may eliminate the need of a solar panel which is often target of theft and damage. These stations and equipment could be temporarily removed during periods where there is no threat of storm surge or inundation from inland flooding, and re-installed just prior to the season when coastal

inundation generally occurs. The purpose of doing this is to minimize the opportunity to vandalize the equipment. The coastal monitoring network can help develop the regional long-term trends of storm surge. Also, the improved coastal observation systems can also benefit adjacent coastal communities in both India and Myanmar, provided the data is shared in real-time.

14. BMD does not have any Oceanographic buoy monitoring stations in the Bay of Bengal, an area where cyclones approach the coast of Bangladesh. Sub-Component A1.1 will support purchase and installation 3 buoy stations. The MSSI contractor will undertake an assessment of type of buoys needed, costs of operation and maintenance, prepare the tender and do site selection in consultation with BMD. The buoy network will be used for improved navigational safety and planned management of marine resources, directly contributing to reduce risks related to economic activities over maritime areas of Bangladesh. A buoy network would be established to monitor open sea conditions, including wave height and period and meteorological state parameters. The information will be used for issuing immediate advisories as well as input to storm surge forecast models. At a regional level, information from buoys can also be shared with IMD and used to improve cyclone forecasting for the Bay of Bengal (BoB) countries including for countries such as Bhutan that also experience cyclones but do not have the infrastructure or capacity to invest in forecasting this hazard.

15. A present, BMD does not have the capacity to undertake storm surge modeling and forecasting due to lack of high resolution Digital Elevation Models (DEM)s or bathymetric data. With support from JICA, the Survey of Bangladesh is carrying out a DEM but the resolution is not sufficient for storm surge modeling. Moreover, there is no baseline bathymetric data for the 710 km coastline despite its extreme vulnerability to cyclone associated storm surges. To address this gap, Sub-Component A1.1 will support preparation of high resolution bathymetric survey. A combination of methods such as Light Detection And Ranging, sonar will be considered for carrying out the survey. The data will publicly available so that it can be used by various stakeholders. Improved bathymetric data once publicly shared will also have clear regional benefits to help improve storm surge modeling and forecasting in neighboring countries.

16. BMD operates 3 upper air stations that report a vertical profile of atmospheric conditions, including temperature, relative humidity, wind speed, wind direction, and atmospheric pressure heights. From this, dozens of derived parameters can be deduced. Data gathered by the upper air (radiosonde) stations are used to measure atmospheric parameters at all levels, and contribute to the international set of radiosonde data that is integrated into global and regional Numerical Weather Prediction (NWP) models and, in particular, would be used in running BMD's WRF and Hurricane Weather Research and Forecasting models. In addition to the three, one more station will be procured through IMD's STORM project. There are also a number of pibal stations in operation. The upper air stations are especially useful to and assimilated in global and regional Numerical Weather Prediction (NWP) models which in turn are used by BMD as well as the region. Radiosonde and pibal measurements require balloons filled with hydrogen to perform observations in the boundary layer as well as the upper atmosphere. The current operation of these measurements has been hampered by the lack of capacity to produce hydrogen gas. Sub-Component 1.1 will support purchase of 11 portable hydrogen gas generators to provide hydrogen gas to fill radiosonde and pibal balloons and to continue these measurements. The biggest challenge in maintaining upper air stations is relatively high recurrent cost as they require

regular purchase of consumables including sondes and balloons. Recognizing the regional benefits of this activity, IMD, Delhi is already supporting BMD with 1 station for the Severe Thunderstorm, Observations and Regional Modeling (STORM) pilot program. Launching of more upper air balloons will allow the use of data from existing stations to be more routinely included in global weather analysis and as input to global and regional weather forecast models.

17. Upgrade of the existing equipment maintenance, repair and calibration facility at BMD: The existing BMD repair facilities are suitable for manual equipment. However, with the introduction of new automatic systems the existing calibration methods and equipment will need to be updated. Sub-Component A1.1 will support strengthening of BMD sensor maintenance, repair and calibration facility. This will include the acquisition of new temperature, relative humidity calibration systems, wind tunnel system, pressure calibration facility, solar radiation, and rainfall (tipping bucket) calibration system as well as portable calibration facility. This is key to maintaining the newly acquired equipment as part of this project and other bi-lateral activities. This facility will have direct consequences on the quality of all data BMD collects for national and international purposes, including information coming from synoptic stations shared with the regional and international community.

18. The modernization and expansion of BMD's observation network and improvement in forecasting and service delivery, will require significant improvements in its ICT capacity. Sub-Component A1.1 will support purchase of server(s) for data storage, quality control, product production, and analysis. It will also support purchase of office equipment (computers, printers, copiers, fax machines, and software) to support an efficient public weather service. ICT improvements will touch all BMD offices and allow the storage/retrieval of any data collected by BMD. Communication systems strengthening will include installation of highly reliable and dedicated high speed internet communications between the BMD offices of Dhaka, Rangpur, Sylhet, Barisal, Khulna, Rajshahi, and Chittagong. This will be required to improve services and the flow of information, forecasts, warnings and general communication within BMD. At present, BMD does not have sufficient bandwidth to receive data and information products that are issued by the Indian Meteorological Department (IMD) (such as tropical cyclone forecasts for the Bay of Bengal). Sub-Component A1.1 will also support expansion of BMD's bandwidth and GTS link and upgrade to the WMO Information System (WIS). This will be done in collaboration with national telecommunication companies and also regional meteorological agencies/WIS's Global Information System Centers (GISC) particularly IMD. This activity will have potential benefits to the region and international community, as the efficient movement and storage of information collected in Bangladesh will allow the information to be more readily shared to these communities.

19. ***Sub-Component A1.2: Improving infrastructure for Weather Forecasting:*** Currently BMD prepares forecasts through weather charts maps that are prepared manually and uses observation systems that are not tightly integrated. It uses computers to display products individually, making it difficult to assimilate information while taking precious time. This is not adequate to do forecasts for weather, extreme weather related events such as tropical cyclones and climate prediction. As the meteorological observation system is modernized, there will be an abundance of information arriving at BMD which will require hardware and software tools to integrate the data to develop forecasts. To support this, Sub-Component A1.2 will support purchase of 7

weather workstations which will be located at BMD headquarters (4 workstations) and one each at the three international airports. The weather workstations will focus on providing a visual interface to data and products that the duty forecaster can use to help prepare forecasts. It is expected that workstations will be dedicated to given forecast activities, which is presently not the case. For instance, of the BMD weather workstations, one workstation will be dedicated to preparing short-mid range forecasts, another workstation to long range forecasts, another to help prepare marine forecasts, and another to prepare civil aviation forecasts. The decision as to the function of each weather workstation will be taken up by BMD in consultation with the MSSI. The workstations will perform Next Generation 4-D Forecast System and decision support. These workstations will be able to integrate the weather radar data, satellite data, and surface weather data, NWP model data, among other data sets as available at BMD. They will also facilitate the preparation of public weather forecasts, aviation forecasts, marine forecasts, severe weather forecast, cyclone forecasts, storm surge forecasts, urban weather forecasts and other forecasts of interest to BMD and other users. Quite often the formulation of weather forecast in a given country considers the forecasts being developed in adjacent countries. Thus, forecasts developed by Bangladesh can be shared throughout the region, especially countries such as India, Myanmar, Nepal and Bhutan.

20. At present, BMD does not have the capacity to detect hazardous meteorological events such as extreme precipitation events in real time. To do so, Sub-Component A1.2 will support acquisition of five Nowcasting workstations which include software to assimilate radar data, surface observations, and satellite pictures among other products. Nowcasting workstations are specifically geared towards rapid processing and assimilation of real-time data and detection of hazardous meteorological events. The workstations will be located at the three international airports, Dhaka, Chittagong, and Sylhet, with one Nowcasting workstation at BMD headquarters and the BMD office in Rajshahi. The 5 workstations will have client software working with the server side software located at the BMD data center. The server side software will be the central collection point of all data used by the client software at the 5 locations. The server software will be able to display data from the newly acquired ARG's and AWS's, radar (new and legacy) data and radar derived products (i.e. Quantitative precipitation estimation (QPE), and Quantitative precipitation Forecasts (QPF)), satellite data, forecast maps, and the newly instituted Flash Flood Guidance (FFGS). The enhanced observational and assessment capabilities facilitated through the workstations are expected to improve civil aviation safety as well as extent the lead time for issuance of weather-hazard related emergency warnings to at risk sectors and vulnerable communities. This network will be one server based at BMD Dhaka, and five workstations that will work with the server in displaying data and annunciating hazardous conditions.

21. BMD currently provides 24 hour forecasts online and 72 hour forecasts in the form of Weather Research & Forecasting (WRF) model products. In order to provide longer term forecasts, and provide cyclone and climate forecasts, Numerical Weather Prediction will require strengthening. This improvement of technical capacity would require High Performance Computing (HPC) to run a series of models. BMD does not have this capacity at present. Sub-Component A1.2 will support purchase of a High Performance Computer that will need to be properly designed to accommodate the number of models, model runs per day over the domain and grid size to support the specific forecast activity. The High Performance Computing (HPC)

facility will run a series of models, including but not limited to WRF ensemble forecasts, climate models, cyclone models, and storm surge forecast tools simultaneously. This will require an assessment of the models to be run, benchmarking of computer system and selection of the most effective HPC system. The MSSI will undertake an assessment of the requirements for the HPC system and prepare tender documents. The HPC system would be used to provide improved guidance for the duty weather forecaster as well as for research activities, including testing a wide variety of meteorological models to help improve the quality of the services provided. Use of Model Output Statistics (MOS) and forecasts issued by BMD by regional partners will also help the latter in their own operational forecasting practices.

22. An important objective of this project is to improve the accuracy and lead time of weather related forecasts and services delivered. A forecast verification system will help in quantifying the degree of improvement and will be supported through Sub-Component A1.2. Design of the verification scheme will be done by the MSSI contractor. Improvement to forecasts can be quantified with the use of a forecast verification system. As forecasters record their forecasts and the forecasts are later verified, they will know which forecasts where in error, and what the error is. If the forecasts have a certain bias, then the forecasters can use this knowledge to remove the bias. The first step is to record and verify the forecasts, which is the intent of this activity.

23. Currently, BMD does not currently store spatial data, such as raw radar data, satellite pictures, weather charts, and other such information. If this information was stored, BMD or researchers could use this information in studies that could be used to improve understanding of weather systems over Bangladesh and forecasts. To store this type of data and the historical record of meteorological data collected by it, BMD will require a database server of sufficient size. Some storage may need to be offline, in order to conserve costs, but all information will be saved for post analysis as needed. This will require the use of an existing server or a purchase of a new server as required, storage/retrieval software to store all of the spatial and forecast products. MSSI contractor will write the TOR in consultation with BMD to identify all target data sources. Sub-Component A1.2 will support a consultancy on data digitization that will gather the data and products, digitize them and put them on the appropriate servers.

24. Once the new HPC is installed a consultancy to install all of the models will be required. A partial list of models includes WRF and HWRF. Additional models and ensemble models will be identified by the MSSI consultancy, and will target climate, storm surge, and cyclone movement among other objectives. This activity will include at a minimum Meteorological NWP, cyclone, climate and storm surge models and will have both national and regional benefits. The installation of these models will require thorough training and documentation as part of the consultancy to install the models.

25. ***Sub-Component A2: Technical and institutional Capacity Strengthening, Regional Collaboration, Project Management, Monitoring & Evaluation (IDA US$ 13.87 million):*** The main objective of this component is to support technical capacity building of BMD, regional collaboration support project management, monitoring and evaluation. This includes the following:

(a) Sub-Component A2.1: Technical and institutional Capacity Strengthening and Regional Collaboration which includes: (1) consultancy on training needs assessment; (2) training for BMD officials through a combination of in-house training, study tours, targeted training courses in collaboration with other meteorological agencies, twinning arrangements; (3) development of a legal and regulatory framework and data sharing policy for BMD; (4) consultancy to support refurbishment of BMD and Divisional offices; (5) refurbishment of BMD and divisional offices; (6) regional technical studies; and (7) support to scaling up ongoing regional pilot programs which include developing linkages to GEO and necessary downscaling of the FFGS.

(b) Sub-Component A2.2: Project Management, Monitoring and Evaluation which will support (9) supporting PIU functions through hiring of technical experts and consultants, technical studies and monitoring and evaluation.

26. ***Sub-Component A2.1: Technical and institutional Capacity Strengthening and Regional Collaboration which includes:*** One of the most critical aspects of this challenging program is to strengthen the technical capacity of BMD. Further, BMD has not implemented a project of this scale before and in additional to technical training, needs training in project management and contract management at the beginning of the project. Lessons from other projects have shown that frontloading this type of training can be significantly beneficial to the PIU. Sub-Component A2.1 will therefore support training on project and contract management for BMD officials. It will help BMD PIU to effectively manage the numerous contractors that will be obtained during the course of this project. BMD modernization will introduce many new ways of conducting meteorological practices. Sub-Component A2.1 will support a consultancy on training needs assessment and development of a well thought out training plan. It will be based on an assessment of the current capacity of BMD staff, identification of training needs and involve development of a time-bound plan for areas of training, phasing, and modalities and institutions through which specific training will be provided. Training for BMD officials through a variety of means such as in-house training, short term study visits to other NHMSs, twinning arrangements, study tours, and other modalities such as distance learning will be included. Technical areas where BMD needs to build capacity include but are not limited to technical skills to support and operate observing networks, weather forecasting, climate modeling, sector specific products development and many others. At present, there are no dedicated Departments of Meteorology or agro-meteorology within the University system in Bangladesh. This is a major gap. Modernization of the scale envisioned in the project can only be sustainable if there is a regular and strong cohort of professionals to undertake meteorology related research and operational work. This Sub-Component will support design and development of a Department of Meteorology at the University of Dhaka. Physical implementation will be agreed during development of MOU. BMD PIU will handle the funds directly and there will be no fund transfer.

27. At present, BMD does not have a legal and regulatory framework that is geared towards service delivery. Sub-Component A2 will support development of a legal and regulatory framework for BMD operations, in line with other countries NMSs and in coordination with related laws in Bangladesh. Such a framework will strengthen BMD's mandate to provide authoritative meteorological alerts and warnings and help confirm its role as the institution with

the responsibility to issue warnings of meteorological and oceanographic hazards. Regulation will also classify the responsibilities of other government agencies and organizations, which are affected by these hazards, ensuring more timely and effective responses that will help mitigate weather-related disasters. BMD does not have a data sharing policy and preparation of such a policy will also be supported through the Sub-Component A2. Open access to data sharing between organizations will make every organization that is involved in data sharing more effective, invite private sector actors to get involved and play a greater role in innovating in services and improve overall service delivery. A data sharing policy must be devised and implemented without hesitation. The data sharing policy will need to be negotiated between the various stakeholders. It will rely on open, non-proprietary, methods of data sharing where all partners can exchange data seamlessly and automatically. An example of this is the DCP Data Service (DDS) supported by the United States Weather Service. The DDS only includes the automatic exchange of data, the envisioned data sharing in Bangladesh will need to also include products.

28. Refurbishment of BMD headquarters and Divisional offices: BMD will expand office space to house the new data center, high performance computer, and forecast workstations among space requirements that will come with expanded services and service delivery. At present, the existing office space at BMD headquarters is insufficient for the above activities. Similarly, office space at the divisional offices will need to be improved and re-designed to provide functional workspace to the extent required by the staff and expanded service expected from the divisional offices. The office space will be designed by a consultancy that will also prepare the building specifications that will lead to office improvement at the 7 BMD offices targeted.

29. Roadmap and Scaling up Regional Collaboration: Sub-Component A2.1 will support technical studies including consultancy to develop a roadmap on regional collaboration. Based on consultations with regional and sub-regional partners, it will include assessment of areas where BMD is already collaborating with regional partners, areas where this collaboration can be further strengthened, areas where it needs support from regional partners and areas where it can provide support to others. Based on this, the Sub-Component will also support scaling up ongoing regional and sub-regional programs such as the STORM program, Severe Weather Forecasting Demonstration Project in the Bay of Bengal, the SASCOF process; improved collaboration with IMD to improve tropical cyclone forecasting in Bangladesh, improved forecasting for thunderstorms and others.

30. ***Sub-Component A2.2: Project Management, Monitoring and Evaluation:*** Sub-Component A2.2 will support project management activities, technical studies, participation in regional consultations, and monitoring and evaluation. At present, BMD does not have adequate capacity for managing project activities on a day to day basis. To support this, Sub-Component A2.2 will support hiring of consultants including a national project technical coordinator to steer the project, procurement consultant, financial management consultant, monitoring and evaluation consultant and communication consultant.

31. ***Sub-Component A3: Strengthening Weather Services, Early Warning Systems and Climate Service Delivery (IDA US$ 10.37 million):*** This sub-Component aims to strengthen

BMD service deliver for weather services, disaster related early warning systems and climate services. It comprises of the following activities:

(a) Sub-Component A3.1: Weather and Disaster Early warning Services: which includes (1) Baseline survey to assess user needs, (2) consultancy to develop software, integrate and share weather and climate data, information and products within BMD and among BMD and stakeholders (such as BWDB, DDM) as an automated subscribed service; (3) consultancy to design and implement the Common Alerting Protocol (CAP) system (involving computers, software and end user facilities) in collaboration with the Department of Disaster Management, the BWDB and other end-users; (4) design and implement software (Data Factory) to provide automated product generation based on requirements from stakeholders.

(b) Sub-Component A3.2: Community Based Early Warning Services: which includes support to Community based early warning system for drought and extreme meteorological events in (north east districts):

(c) Sub-Component A3.3: Climate Services: which includes (1) Consultancy to install software, configure, and provide training on climate prediction model and seasonal prediction; (2) consultancy on divisional level climate services, (3) upgrade existing BMD webpage into a climate services portal; (4) public education and outreach.

32. ***Sub-Component A3.1: Weather and Disaster Early Warning services:*** Identifying the main users of BMD's services and assessing user needs is a first step to improving service delivery. While BMD provides services to the general public and other stakeholders, it has so far not undertaken any systematic assessment of user needs and priorities. The project will support initiation and institutionalization of this activity. Sub-Component A3.1 will support design and implementation of a baseline survey to assess user needs for weather and climate services. This will allow BMD to understand user needs, provide the basis for designing and developing user targeted services and make necessary improvements delivering those services. The user survey will also provide baseline information for monitoring and evaluation of project activities.

33. The preparation and timely delivery of timely products to users can be highly automated in a scenario where data is automatically collected and stored on systems. Sub-Component A3.1 will support a consultancy to design and program automated delivery of user services. It will be based on an assessment of stakeholder needs, the format and timing at which specific meteorological services are needed by users. Programs developed by this consultancy will integrate the information that the user requires and support automated delivery of services. The consultancy will support automation of user requests, programming the automatic assimilation of information, and delivering this information on a schedule. Sub-Component A3.1 will also support development of software to integrate and share data within BMD and among BMD and stakeholders. This is envisioned to be a data service that runs automatically that makes data available among stakeholders, and any agency subscribing to the service. The model for this service is the DCP Data Service (DDS), which is used by the National Oceanographic and Atmospheric Administration (NOAA), in the distribution of hydro-meteorological data to various sectors.

34. At present BMD does not have the capacity to produce standardized alerts and warnings. Sub-Component A3.1 will also support installation of a Common Alerting Protocol (CAP) which is an international standard that is used to send public alerts and warnings. It is a digital format for changing emergency alerts that allows a consistent alert message to be disseminated simultaneously over many different communication systems. As more systems are built or upgraded to CAP, a single alert can trigger a wide variety of public warning system, increasing the likelihood that intended recipients receive the alert by one or more communication pathways. The MSI will develop a contract language that will result in the set up for CAP for BMD, while coordinating these activities with first responders, such as local community leaders and DDM.

35. ***Sub-Component A3.2: Community Based Early Warning Services:*** This sub-component will support community level drought early warning systems in two of the most drought prone districts of Bangladesh, Rajshahi and Naogaon (to be confirmed). At present, residents of these districts do not receive any drought early warning services. Activities will focus on making drought early warning messages (developed by BMD) understandable to farmers and community members and will be carried out in collaboration with BWDB, Department of Disaster Management (DDM) and DAE. It will build on experience gained through the widely acclaimed Cyclone Preparedness Program (CPP) which is active in the coastal districts, has a large volunteer base and an excellent mechanism for disseminating alerts and warnings to the communities in the context of tropical cyclones. The proposed community level activities will use a similar model and involve training, working with the disaster management committees at the district, upazila and community levels, building a volunteer base in the drought prone districts, developing and disseminating understandable messages and promoting drought preparedness amongst farmers, sharecroppers and local communities.

36. ***Sub-Component A3.3: Climate Services:*** At present, BMD's Climate Division mainly involves staff involved in digitizing data. The division does not have the capacity to run climate models, interpret and use climate model outputs, prepare climate products or provide climate services to specific sectors. Component A3.3 will support strengthening the capacity of BMD's Climate Services Division and enable it to gradually evolve into a climate forecast application research unit. Climate forecasts and scenarios prepared by BMD will significantly contribute to regional understanding of climate risks. A small group of BMD officials will focus on current and emerging methods of climate forecasting and provision of climate services. Sub-Component A3.3 will support consultancy to install, configure appropriate climate model and software on the HPC and train BMD officials, which is needed for preparing long term scenarios. The selection of climate model and prediction system will be undertaken by the MSSI in consultation with BMD. The software will lead to seasonal forecasts as well as forecasts of 1, 3 and 6 months. The intended use of the model output will be as guidance to users that would be most interested in rainfall and temperature anomalies as well as likelihoods of extreme events such as droughts and floods where applicable. Seasonal forecasts would be used to enhance the guidance and technical assistance provided to communities interested in rainfall and temperature anomalies, such as the start of the rainy season, and temperature and rainfall outlooks, directly contributing to the protecting farmers' livelihoods and improving their food security situation.

37. Sub-component A3.3 will also support development of a portal for climate data distribution. A consultancy will be commissioned by BMD to upgrade the existing BMD web portal into a

full climate services and meteorological dissemination portal which will also help it to become more visible and easy to use. All of the observation data, products, and forecasts prepared by BMD will be automatically posted on the portal. Based on assessment done by MSI regarding divisional level user needs assessment for products, ICT, staff, training needed, development of climate products, tailored to specific sectors and to communities at the divisional level at Sylhet, Chittagong, Khulna, Barisal, Rajshahi, and Rangpur and supporting enhancing the capacity of these offices as climate centers. It will fund community outreach, education and training activities to improve the capacity and capabilities of the various sectors to utilize weather and climate data and information for decision making. This will also help these sectors to act as effective translators of BMD products and services to ensure that those who need the information can use it effectively.

38. Sub-Component A3.3 will support development of a National Framework for Climate Services (NFCS) in Bangladesh. This will draw on WMO guidance on Global Framework for Climate Services (GFCS) and be based on Bangladesh's own experience with providing services in the agriculture and other sectors as supported through this project. Development of the NFCS for Bangladesh will be supported through a consultancy under Sub-Component A3.3 and be prepared in the 4th year of project implementation. The National Framework for Climate Services will involve broad stakeholder engagement and provide a platform for the exchange of knowledge, know-how, and climate information needs among stakeholders in all climate sensitive sectors. It will also guide the priority activities of its National Climate Center. Essential for an effective climate service is the connection with the end users – communities and individuals, and ensuring that information is properly translated into an understandable form that can be used for everyday decisions by users.

39. **Component B: Strengthening Hydrological Information Services and Early Warning Systems (IDA US$ 40.62 million)**: The main objective of this component is to improve the provision of hydrological services in Bangladesh by strengthening hydrological observation, forecasting, and early warning systems. The component would be implemented by the BWDB and includes the following:

40. ***Sub-Component B1:*** **Strengthening Hydrological Observation Network and Forecasting (IDA US$ 27.42 million):** The main objective of this sub-Component is to modernize BWDB's hydrological monitoring, ICT systems and forecasting. This comprises of the following activities:

(a) Sub-Component B1.1: Strengthening Hydrological Monitoring and ICT systems: This will include (1) support for a Water Resources System Integrator (WSI) consultancy to assess, design, prepare technical documentation and support BWDB in the implementation of key project activities; (2) upgrading 308 manual water level stations to be equipped with automatic data collection and reporting in real-time; upgrade 257 rain gauges to automatic and real time; upgrade 10 existing climate stations operated by BWDB; and upgrade or establish 1100 groundwater stations and nests of various configurations to automatically report measurements; (3) purchase of 4 catamarans and 4 survey boats for coastal hydrographic survey and stream gauging; (4) purchase 10 vertical profiling ADCPs; (5) purchase of 20 water quality sondes for measuring salinity and total dissolved solids (TDS); (6) purchase 8 echosounders to support river gauging and river morphology measurements;

and purchase of 2 survey grade echosounders; (7) 40 land based coastal storm surge inundation stations; (8) 15 handheld TDS meters (9) acquisition of 8 total stations (used for aiding river morphology surveys), 13 RTK-GPS, 6 DGPS beacon receiver, 4 first order digital leveling machine and 2 Sub bottom profiler 5-10m penetration capacity; (9) upgrade of the existing hydrological measurement equipment maintenance, repair and calibration facility at BWDB; and (15) upgrading BWDB ICT systems and communication systems including links with local offices.

(b) Sub-Component B1.2: Hydrological and Flood Forecasting: This includes (16) purchase of 4 Nowcasting workstations for short lead time events and development of flash flood forecasts for flash flood prone areas; (17) upgrade existing flood forecast models to cover coastal areas; (18) hardware and software for development of medium range (weeks up to a month) and long range (seasonal) forecasts and capacity for 24/7 flood forecasts during pre-monsoon, monsoon and post monsoon season as needed.

41. While BWDB has significant technical expertise, it needs the support of a Water Resources Systems Integrator (WRSI) consultancy to perform analysis, ensure systems integration as the Hydrology Division modernizes, support preparation of technical documents and work with the BWDB PIU to efficiently guide project implementation. The consultancy will prepare tender documents in World Bank format for BWDB to review, and provide assistance in all facets of tender execution, including attending pre-bid meetings, providing technical assistance with selection, assist with equipment acceptance and acceptance testing, evaluate progress of various goods, works, and consultancy contracts.

42. BWDB's surface water level monitoring network is largely manual with observations that are taken only a few times per day. Much of the data is delivered by post, with some data received for data entry days/weeks after it is collected. The coastal area of Bangladesh is highly influenced by tides and approximately 40 percent of the river gauging stations are tidal and in the coastal area. The upgrade of these stations to automatic stations will result in a complete record of water level, and discharge in some cases, which will be used to more accurately characterize water level trends and capture peak values. 308 manual water level stations will be upgraded to automatically collect data and transmit it back to BWDB's data center. Installation of additional water level stations in hotspot areas will be determined based on further assessment and design carried by the WRSI consultancy. These stations will consist of non-contact measuring techniques to the extent possible using radar and ultrasonic water level sensors. There will be several categories of stations including bridge mount stations which are most desirable; pole mount stations (in the river bed); and stations that have the sensors cantilevered out over the water from the shoreline. The Mobile Network GSM data network will be used for these stations. The WRSI will be required to perform a survey to make sure communication is available at every site. Regardless of telemetry, all stations will be required to store at least one year of time tagged 15 minute water level measurements. The use of Iridium or VSAT is discouraged because of the high annual recurring cost of service.

43. Rain gauges are very important to understanding runoff from process. This is exemplified where flash floods occur due to locally heavy rainfall. The current manual nature of rain fall measurements does not allow the data to be used for fast developing flood events caused by high

intensity, short duration rainfall events. Sub-Component B1.1 will support upgrading of BWDB's 257 rain gauges to measure rainfall automatically and deliver data in real-time. It will allow BWDB to be notified of very quick responding events and prepare near term forecasts for flash flood. The Mobile Network GSM Data system will be used for this network. All rain gauges and repeaters will be located on BWDB land; otherwise private property should be sought whereby the landowner can assure the safety of the station from vandalism and/or theft.

44. BWDB currently manually operates 10 climate stations (located closer to the ground than typical meteorological AWS stations). This data is important for the determination of physical parameters that are used for flood models. Sub-Component B1.1 will support upgrade of these stations to collect and relay data automatically so that it can be integrated into flood models. Data transmission can occur over GSM/GPRS, as this data is not considered vital in real time.

45. In Bangladesh, groundwater is important both for drinking water supply and irrigation. Over 97 percent of all drinking water supply comes from groundwater. Groundwater fed irrigation also supports dry season cultivation helping Bangladesh to be food self-sufficient and secure. Some of the major challenges facing shallow groundwater resources including water quality issues and also decline of water storage in urban areas. Currently, BWDB already has a large ground water network comprising of over 1100 stations that are mostly manually operated. Data are collected by local contractors and sent to sub-divisional offices and eventually to Dhaka for storage and analysis. Modernizing will improve the quality and frequency of data and also improve the chain of custody of the data. To support improved monitoring and management of groundwater resources, Sub-Component B1.1 will support upgrading these stations and nests (group of boreholes) to automatically report measurements. Modernization will allow BWDB to have a better assessment of the country's ground water resource both in terms of quality and quantity measuring parameters like water level and salinity; the component will strengthen the monitoring network of stations (at varying depths) in the country including coastal districts and in urban areas. With a high population density, the pressure on water supply and water quality in Bangladesh will continue to increase and need to be monitored to assure a safe water supply. Further, Sub-Component B1.1will support purchase of 10 water quality sondes that will be used to measure salinity and total dissolved solids. The sondes will be portable and used along various reaches of the river. They will come with all accessories to perform measurements and calibration within the country. BWDB has manual in built calibration but there is no process of automatic data transmission.

46. Acoustic Doppler Current Profiling (ADCPs) are useful for instantly measuring discharge at any river cross-section and also to document changes in the river cross-section and channel morphology. Hydrology Division at present has 3 ADCPs. Sub-Component B1.1 will support purchase of 10 vertical profiling ADCPs to make discharge measurements along numerous cross sections of various rivers in Bangladesh. This equipment will be equipped with all of the accessories to effectively use the ADCP's in the Bangladesh environmental context. Sub-Component B1.1 will also support purchase of 4 catamarans and 4 survey boats to be acquired for coastal stream gauging. These boats will be relatively large boats able to navigate the larger rivers and coastal areas in Bangladesh during peak discharge periods. The sub-Component will also support purchase of 8 new echosounders and 2 new survey grade echosounders to improve

mapping of channel bottom and morphology thus helping an improved understanding of water carrying capacity of the river channels.

47. Bangladesh is a country of constant land changes. The constant changes caused by sediment movement and land subsidence elevation have a dramatic impact on protection offered by embankments. The survey of land, especially in areas of structural flood control measures, is a constant process. In order to continue and expand surveying efforts Sub-Component B1.1 will support purchase of 12 RTK-GPD, 6 DGBS beacon receivers, 4 first order digital level machine and 2 sub-bottom profiler with 5-10 m of penetration capacity.

48. As BWDB acquires a wealth of automatic measurement systems, there will be a need to repair and calibrate these sensors. Sub-Component B1.1 will support upgrade of BWDB's calibration facilities which will include calibration area to be refurbished/established with new equipment to calibrate rain gauges and test data collection platforms and sensors. BWDB also operates a tow-tank to calibrate stream gauging equipment. The tow device will be automated so that the tow device can be operated remotely.

49. Strengthening BWDB's observation network, forecasting and hydrological services will require considerable upgrade of BWDB's ICT facilities. Sub-Component B1.1 will support the strengthening of connectivity within BWDB and also between the Dhaka offices and BWDB zonal offices. This funding will assure improved facilities for storing and visualizing data, computing, ensuring that all functions have enough bandwidth to carry out communications and deliver services in a timely manner. Funding will also support establishing video conference facilities at all divisional offices and headquarters. As assessment of the ICT needs and preparation of associated technical documentation for hydrology and flood forecasting will be undertaken by the HIS consultancy.

50. ***Sub-Component B1.2: Strengthening Infrastructure for Hydrological Forecasting:*** Despite the manual nature of its observation system, BWDB's FFWC has made significant strides in flood forecasting, currently doing 3 day flood forecasts on major rivers. However, the flood forecasts mainly focus on riverine flooding and FFWC's capacity to forecast rain-fed floods or flash floods in the river plains is limited. Further, in terms of geographic coverage, its flood models cover only three fourths of the country and FFWC does not have the capacity to forecast flooding or inundation in the coastal areas. Finally, FFWC can also extend the lead time of hydrological forecasts of value to users such as the agriculture community.

51. BWDB's capacity to integrate data from newly installed water level and rain-gauges, radar data provided to BWDB by BMD in near real-time, is at present limited. Sub-Component B1.2 will support purchase of 4 Nowcasting workstations including software to process and view all of this data. The software will allow BWDB to integrate BMDs radar data, satellite data while overlaying the rain gauge network and river gauging networks and will allow for extreme rainfall events to be quickly detected along with rapidly changing river conditions that can appear throughout the country or enter Bangladesh from India. The Nowcasting systems will be especially well suited in detecting short lead time events, that may have otherwise gone undetected in advance of causing harm to a given community.

52. The wealth of new automatically collected data in real-time will be used to add value to BWDB's flood/flash flood and drought forecast capabilities. It is anticipated that medium range, long range, and extended range river forecasts, and river outlooks can be further improved, especially in the 0-6 hour's Nowcasting time domain. With new data sources along the coastal region and in hotspot areas, models will be upgraded to utilize the real-time information in preparing early warning in the Nowcast time domain (0-6 hrs). Sub-Component B1.2 will also support model develop and calibration to support flood forecasting in the coastal region, and expand hydrological forecasting beyond flood forecasting.

53. ***Sub-Component B2: Technical and Institutional Capacity Strengthening, Regional Collaboration, Project Management and Monitoring & Evaluation (IDA US$ 10.1 million):*** The main objective of this Sub-Component is to strengthen BWDB Hydrology Division's technical capacity, regional collaboration, project management, and monitoring and evaluation. This includes the following:

(d) Sub-Component B2.1: Technical and institutional Capacity Strengthening and Regional Collaboration which includes: (1) consultancy on training needs assessment, (2) training for BWDB officials through a combination of in-house training, study tours, targeted training courses in collaboration with other hydromet agencies, twinning arrangements, (3) development of data sharing policy for BWDB, (4) consultancy to support refurbishment of BWDB and Divisional offices; (5) refurbishment of BWDB and divisional offices; (6) regional technical studies and consultations, and (7) support to scaling up ongoing regional initiatives and programs.

(e) Sub-Component B2.2: Project Management, Monitoring and Evaluation which will support project management by supporting PIU and PCU functions through hiring of technical experts and consultants, technical studies and monitoring and evaluation.

54. ***Sub-Component B2.1: Technical and institutional Capacity Strengthening and Regional Collaboration:*** As with BMD, strengthening the technical capacity of the Hydrology Division officials in will be critical to long term sustainability of the project. Even though BWDB has extensive experience in working with the World Bank, its Hydrology Division has not implemented a project of this scale. Sub-Component B2.1 will support training on project and contract management for Hydrology Division officials which will be critical in supporting the BWDB PIU to effectively manage the numerous contractors that will be obtained during the course of this project. Modernization of hydrological information services will introduce many new ways of providing hydrological services. This will require the development of a well thought out training plan. Thus, Sub-Component B2.1 will support implementation of training needs assessment and development of a training plan. This training plan will be based on an assessment of the current capacity of the Hydrology division staff, identification of training needs and development of a time-bound training plan. Sub-Component B2.1 will also support training for BWDB officials through a variety of means such as in-house training, short term study visits, study tours, and distance learning programs. Technical areas where BWDB needs to build capacity include but are not limited to technical skills to support observing networks, forecast models, especially using storm surge forecasts to predict inundation in storm surge

prone areas along coast, database management, instrument maintenance and calibration, impact based forecasting, and so forth.

55. At present BWDB does not have a data sharing policy that allows for real-time data to be shared with stakeholders. Developing a data sharing policy is a key to the overall success of the modernization program and will be supported through Sub-Component B2.1 in close coordination with Sub-Component A2.1 where a similar policy will be developed for meteorology. It will rely on open, non-proprietary, methods of data sharing where all partners can exchange data seamlessly and automatically. Sub-Component B2.1 will also support refurbishment of BWBD and Divisional offices. It will also support regional consultations on transboundary disaster risk management, technical studies and strengthening ICT systems to support improved disaster risk management, particularly relating to flooding on transboundary rivers.

56. ***Sub-Component B2.2: Project Management, Monitoring and Evaluation:*** Sub-Component B2.2 will support project management activities, technical studies and monitoring and evaluation. Funding will be used to hire a project technical advisor, procurement consultant, financial management consultant, environment consultant, monitoring and evaluation and social and communication consultant. This Sub-Component will also provide support for project coordination activities undertaken by the PCU located at the BWDB.

57. ***Sub-Component B3: Strengthening Hydrological Services and Flood Early Warning Systems (US$ 3.1 million):*** This sub-Component aims to strengthen BWDB service delivery for hydrological and flood forecasting services. It comprises of the following activities:

(a) Sub-Component B3.1: Hydrological and Flood Early warning Services: which includes (1) Baseline survey to assess user needs, (2) GIS design, software & training; (3) software to share data within BWDB and with BWDB stakeholders, along with exchanging observation data in real-time with BMD (such as BWDB automatically sending BMD rainfall data, and BMD automatically sending BWDB rainfall data, QPE/QPF's, as an automated subscribed service etc. (4) product development; (5) installation of web-portal for sharing data and products with stakeholders; (6) implement software to provide automated product generation based on requirements from stakeholders; and (6) consultancy to design and implement the Common Alerting Protocol (CAP) system (involving computers, software and end user facilities) in collaboration with the Department of Disaster Management, the BWDB and other end-users;

(b) Sub-Component B3.2: Community Based Early Warning Services: which includes support to Community based early warning systems for flash flooding in two districts in the north east of Bangladesh.

58. ***Sub-Component B3.1: Hydrological and Flood Early warning Services:*** While BWDB provides data and services to various users and stakeholders, at present, there is no systematic process in place to assess user needs for hydrological services. This is important in order to make necessary improvements and meet the growing needs of stakeholders for water resources and hazard related information and building to a more rich user-driven data, product, and service

portfolio. Sub-Component B3.2 will support carrying out a baseline survey to assess user needs and satisfaction with hydrological and flooding early services. This information can then be used as a basis for designing and improving targeted services. The user survey will also provide baseline information for monitoring and evaluation of project activities.

59. As with BMD, Sub-Component B3.1 will support BWDB to strengthen its user orientation product development and service delivery. This will be done through support for GIS center, design, software and training, consultancies to develop hydrological information products, design and sharing of products and data through upgrading BWDB's existing web-portal. A GIS system is a proven way to look at many data sets together to provide decision support. A GIS center will be need to be designed, GIS software, products and data sets procured. This sub-Component will also support development of software to integrate and share data within BWDB and among BWDB and stakeholders. This is envisioned to be a data service that runs automatically that makes data available among stakeholders, and any agency subscribing to the service. The model for this service is the DCP Data Service (DDS), which is used by NOAA in the distribution of hydro-meteorological data to various sectors. This will be developed jointly with BMD in a single tender with BMD and BWDB sharing costs. Sub-Component B3.1 will also support introduction and establishment of the Common Alerting Protocol (CAP), for the distribution and exchange of public warnings and emergencies. CAP allows warning messages to be consistently disseminated simultaneously over many warning systems to many applications. This activity should run in coordination with BMD's establishing of the CAP system. This sub-component will also support development of a decision support system for impact based forecasting and coastal inundation in Bangladesh.

60. ***Sub-Component B3.2: Community Based early warning systems for two flash flood prone north east districts:*** This sub-component will support community level early warning systems in two of the most flash flood prone districts of Bangladesh, Netrokona and Sunamganj (to be confirmed). At present, residents of these districts do not receive any early warnings for flash floods with sufficient lead time. Activities will be carried out in collaboration with BMD and the Department of Disaster Management (DDM). It will build on experience gained through the CPP program. Using a model similar to the CPP, the activity will involve mapping flood vulnerable communities, training, working with the disaster management committees at the district, upazila and community levels, building a volunteer base in the flash flood prone districts, developing and disseminating understandable messages and promoting flood preparedness amongst flood vulnerable communities.

61. Component C. Agrometeorological Information Systems Development (IDA USD 13.5 million): The main objective of this component is to develop and deliver agro-meteorological services for farmers to support decision-making at the farm level. It has three sub-Components. These include the following:

62. ***Sub-Component C.1: Establishment of the Bangladesh Agrometeorological Information System (BAMIS) (US$ 3.9 million).*** This sub-component supports the establishment of BAMIS web portal, which will be dedicated to the provision of data, information, agrometeorological advisories and products such as crop and weather bulletins, drought and heat indices, climate-weather risk maps and services such as short and medium range weather forecasts and seasonal climate outlooks to stakeholders on the web. Specifically, this sub-component will support the

following activities: (1) Setting up a Comprehensive web-portal for BAMIS at DAE; (2) BAMIS infrastructure, (3) development of upazila level agromet databases, (4) agromet data analysis and future scenario development, (5) development of advisories, and (6) risk mapping of climate vulnerable communities.

63. Agriculture in Bangladesh occupies some three-quarters of the scarce land space of the country and supports the livelihoods of the majority of the population as some 67 percent of the population live in rural areas and over 43 percent of the country's total labor force engaged in agriculture. Crops, livestock, forestry, and fisheries contribute to 17 percent of the GDP. Despite the importance of the agriculture sector for the national economy, the contribution of agriculture to the country's economic output has declined over the past decade. The country is regularly hit by natural disasters that severely impact the economy, disproportionally affecting the infrastructure and agriculture sectors, as well as vulnerable groups.

64. The objective of this component is to provide improved agrometeorological services to farmers of Bangladesh in order to increase agricultural productivity and assist them in coping with weather and climate extremes. The component will support establishment of a science-based agro-meteorological information system to develop appropriate information and products, and deliver them through a number of dissemination mechanisms that will provide the agricultural sector with a decision support information system to mitigate climate-related agricultural production risks. The component will also support the strengthening of capacity at different levels to enable the development and effective delivery of climate information services to the agricultural sector.

65. Component C will be implemented by the Department of Agricultural Extension (DAE), with the support of the Agricultural Meteorology Division of the Bangladesh Meteorological Department (BMD). The main sub-components include: Sub-Component C1: Establishment of the Bangladesh Agrometeorological Information System (BAMIS); (C2): Training, Capacity Building, Project Management, Monitoring and Evaluation and Sub-Component C3: Agricultural Disaster Risk Management through Information dissemination. A detailed description of each of these sub-components is given below.

66. Setting up a comprehensive web portal for BAMIS at DAE: The project will contract a consultancy to assess information and user needs and design BAMIS and procure necessary hardware, software, and other technological components to create and maintain an effective and sustainable BAMIS. These include an optical line between BMD and DAE, several high speed computers, monitors, high speed color printers, digital color scanners, plotters and a relational database management system (RDBMS), and suitable backup system, for archiving and disseminating agrometeorological data. Software such as ArcView 10 and ArcGIS Spatial Analyst software to facilitate the analysis and display of geospatial data and to aid in the preparation of agricultural weather products will be installed on the BAMIS computers. BMD will host the dedicated web-server for BAMIS.

67. Development of linkages to BAMIS through acquisition of infrastructure (software and hardware) at BMD. Development of agrometeorological products and their dissemination through BAMIS will carried out in close collaboration with the Agricultural Meteorology Division of BMD. The component will support acquisition of equipment (software and hardware,

including a high speed server, computers and color laser printers) as well as the establishment of a dedicated fiber optic line between DAE and BMD to ensure high speed access to the RDBMS and web server.

68. Development of upazila level agrometeorological databases: The project will support the digitization of historical and current agricultural data on the land holdings, crops/cropping systems cultivated by farmers, average crop yields in different upazilas etc., (currently available as hard copy documents). In addition, under component A, 200 Automatic Weather Stations (AWS) will be installed at the upazila level, and will provide real time data on all important weather variables. Under the technical guidance of an International Agrometeorological Consultant, DAE, with BMD support, will integrate the AWS weather and agricultural data and compile agro-meteorological databases for the 487 upazilas, which will be located in the BAMIS at DAE. These agrometeorological databases will be used to conduct a variety of agrometeorological analyses and to generate information and products for use by the farming communities in different upazilas.

69. Agrometeorological data analysis and future scenario generation: The Project will support a technical consultancy on conducting agrometeorological data analyses, future scenario generation, including the use of crop models and downscaling the scenarios to block level. Currently BMD operates 12 agrometeorological stations (out of its 57 weather stations) with long term data for over 40 years for most of the stations. The consultancy will help DAE develop computations of climatological norms for rainfall and maximum and minimum air temperatures, rainfall probabilities, and combine them with the upazila databases to prepare crop suitability maps for different agroclimatic regions in the country. The consultant will guide DAE, with support from DAE, BARI, BRRI, BJRI, BSRI and BMD, in developing agrometeorological products for decision support including selection of optimal planting dates based on expected climate conditions etc. The consultant will also provide assistance in training and capacity building of DAE, BARI, BRRI, BJRI, BSRI and BMD staff on using agrometeorological data, generation of information on soil and crop management practices, and on using a variety of crop models and other tools.

70. Development of agrometeorological advisories and products for the farming communities: The project will support the procurement of a consultancy to guide DAE and BMD in the development of agrometeorological advisories and products and their timely delivery to farming communities to help the farmers better manage weather and climate risks. The consultancy will help DAE to use the agrometeorological databases, and develop agrometeorological advisories and products for use by farmers to make tactical decisions such as planting when adequate soil moisture is present or forecasted, harvesting before damaging extreme weather events such as heavy rainfall, hail storms etc., and implementing crop protection measures when risk of pests and diseases is elevated. It is important to highlight that some products such as the determination of best planting dates based on expected climate conditions require specific expertise and research and cannot be implemented without adequate capacity building (sub-component C.2).

71. Risk mapping of climate-vulnerable farming communities: Given the frequent incidence of weather and climate extreme events and the large impact they have on the agriculture sector, identifying the vulnerability of farming communities is critical. The component will support the procurement of a consultancy in DAE to conduct agricultural disaster risk analysis based on

weather and climate information, socio economic factors such as farmer land holdings and indebtedness, soils information, crops/cropping patterns etc. The analysis will be done at the agro-ecological zone level. Each climate risk can be identified by its natural characteristics, the nature of its impacts in different geographical areas, time of year it is most likely to occur and its severity etc., The consultant will guide the preparation of the climate risk vulnerability maps for all 487 upazilas to identify the areas at risk and vulnerable members of the community and train DAE and BMD in risk mapping. The component will also explore areas for collaboration with the students from appropriate Universities in this task.

72. Sub-component C.2 Training, Capacity Building, Project Management and Monitoring and Evaluation (US$ 4.41 million). This Sub-Component aims to strengthen agrometeorological capacity development, project management and monitoring and evaluation of project activities. It includes the following activities:

(a) Sub-Component C2.1 Provision of technical training to staff which includes training, participation in degree courses, study tours, (2) technical studies, (3) district and local level workshops for training farmers in portal tools, (4) support for activities related to the JTWG.

(b) **Sub-Component** ***C2.2 Project management, Monitoring and Evaluation.***

73. Sub-Component C2.1 will support provision of technical training to professional staff of DAE and BARI: This includes, organization of workshops/seminars at the BAMIS headquarters in agrometeorological data analysis and development of products and (b) organization of short term training and exposure visits to appropriate institutions and organizations abroad to promote a better understanding of the current methods and approaches in the development of agrometeorological advisories and products. Currently there are no personnel with post-graduate degrees in agrometeorology in DAE, BMD or BARI. In order to enhance the long term capacity in agrometeorological research and applications at DAE and BARI, steps will be undertaken to depute staff for post-graduate degrees in agrometeorology. Given the diversity of weather and climate in different agroecological regions in the country and the range of crops and cropping systems which farmers cultivate, there are a number of critical weather, climate and agriculture issues on which advanced information will be needed to develop effective strategies to maintain agricultural productivity. Hence priority issues will be identified which require detailed technical studies and this component will support the recruitment of a Consultant to organize such technical studies. As DAE has a good network of offices in the 64 districts providing information to farmers, this network will be used for the organization of workshops at the regional and district levels for officials in the use of BAMIS Portal tools.

74. The vision for the Agrometeorological Information Systems in Bangladesh is an integrated system in which the meteorological community (BMD) and the agricultural community represented by DAE, and BARI work together to produce and disseminate climate and weather information relevant to agriculture thus enhancing climate resiliency and food security in the country. This requires close collaboration between the different agencies responsible for agrometeorological data collection and analysis, agricultural research and extension. This collaboration will be facilitated by the Joint Technical Working Group (JTWG) which will include participation of experts from DAE, BMD, BWDB, BARI, BRRI, BJRI, and BSRI. Support will be provided for the effective functioning of the working group and for the implementation of the decisions taken by the group.

75. Sub-Component C2.2 will support costs associated with the PIU, operational costs related to DAE operations, cost of internal/performance audit, additional technical studies, activities associated with M&E, social outreach and other operational activities.

76. ***Sub-Component C.3: Agricultural Disaster Risk Management through agrometeorological information dissemination (US$ 5.19 million)***. This subcomponent will support the awareness building of and dissemination to farmers of a variety of customized agrometeorological products and tools that will help them to better utilize weather and climate risk in their planning and cope with agricultural disaster risk. The activities include: (1)assessment of farmer's needs for weather and climate services; (2) installation of automatic rain gauges and agrometeorological display boards at the Union Parishad locations; (3) establishment of kiosks, (4) development of mobile apps; (5) organization of roving seminars and (6) feedback from farmers.

77. This sub-component will support a consultancy to develop a baseline survey for a detailed assessment of farmer's needs for weather and climate services. Feedback from farmers will guide quality improvements in agrometeorological products and their dissemination mechanisms. Given the diversity of crops and cropping systems in the 64 districts around the country, the needs assessment will contribute to the development and dissemination of need-based advisories and products.

78. Installation of automatic rain gauges and agrometeorological display boards at the Union Parishad locations for provision of agrometeorological information to farmers. There are 4,051 Union Parishads and currently BMD has installed agrometeorological information display boards in eight Union Parishad offices. This sub-component will support DAE to procure and install agrometeorological information display boards and automatic rain gauges in the remaining 4043 Union Parishad locations. This will be done in collaboration with BMD as it has significant experience in already doing so. This activity is consistent with GOB's "Access to Information (a2i) Programme" which aims to deliver services at the citizen's doorsteps (a2i.pmo.gov.bd) through the Union Information Service Centers (UISC).

79. Establishment of agrometeorological kiosks in the 487 upazilas. The sub-component will also setup agrometeorological kiosks with data display screens, computers and printers in the Upazila Agricultural Offices to cater to the specific information needs of the farming community. The touch screen kiosks will provide one stop access to information needs of individual or group of farmers with minimum literacy standards. The kiosks allow users to navigate information on a number of aspects including current weather data, agrometeorological advisories, crop cultivation practices, agriculture inputs, crop diagnostic kit, management time table, farm machinery, market information etc.,

80. Development and use of mobile and web-based applications for disseminating agrometeorological advisories through mobile phones and Internet: There has been a remarkable growth in the adoption of mobile devices among various communities in Bangladesh. This component will support a study by consultants to assess the various technical options for using mobile devices and apps with the objective of reaching a large number of farming communities in a cost effective and useful way. The component will support the procurement and adaptation of mobile apps to fit the Bangladesh context and the mechanism for implementing dissemination of agrometeorological advisory information through mobile devices. Farmers can use mobile Apps which can give them instant access to information and communication such as current

weather, expected weather and the related impacts on crop growth and development and advice on controlling any emerging pests and diseases etc.

81. Organization of Roving Seminars for farmers to raise their awareness of weather and climate and improve their capacity to cope with agro-climatic risks:_A key part of the project is the support provided by the component to raise the awareness of the farming communities regarding crop weather and climate, projected climate change and its impacts through the organization of Roving seminars. The component will also provide thermometers and rain gauges as needed to encourage decentralized collection and use of agromet information. These seminars would (a) help farmers better understand how weather and climate information can be used to improve decision making on their farms and (b) provide an opportunity to DAE and BMD to directly interact with farmers to describe the use of BAMIS decision support tools and solicit the feedback from farming communities to improve the tools. Direct interactions between farmers and agricultural weather information providers can help educate both groups about each other's services and requirements.

82. Feedback from farmers on the utility of the agrometeorological advisories and products. As the project implementation progresses, by the end of the first year, this component will support a study by consultants to obtain the feedback from farmers on the utility of the agrometeorological advisories and products which they have received during the year. This feedback assessment will be carried out at the end of each of the following four years in order to ensure that appropriate changes are made to improve the agrometeorological advisories and products to meet the needs of farmers. For instance, DAE with the technical support from BARI, BJRI, BRRI, BSRI would use data from BMD and BWDB to develop tailored agromet advisories disseminated to farmers in various districts and Upazilas (through a variety of user-accessible media) while new technologies such as Nowcasting would allow for accurate and specific early warning alerts to vulnerable communities.

Annex 3: Implementation Arrangements

Bangladesh Weather and Climate Services Regional Project

Project Institutional and Implementation Arrangements

1. For achieving the PDOs, the institutional arrangements must service the following functions.
   a. Project Oversight and Policy Direction
   b. Project Coordination and Management and
   c. Project Implementation

Project administration mechanisms

2. To carry out the above functions the following Committees will be set up:
   a. A Project Steering Committee (PSC) for Project Oversight and Policy Direction
   b. A project Coordination Unit (PCU) for Project Coordination and Overarching Management
   c. Three Project Implementation Units (PIUs) each at BMD, BWDB Hydrology Division and DAE for Project Implementation.
   d. A Joint Technical Working Group (JTWG)

3. Figure 3.1 below shows the project implementation arrangements.

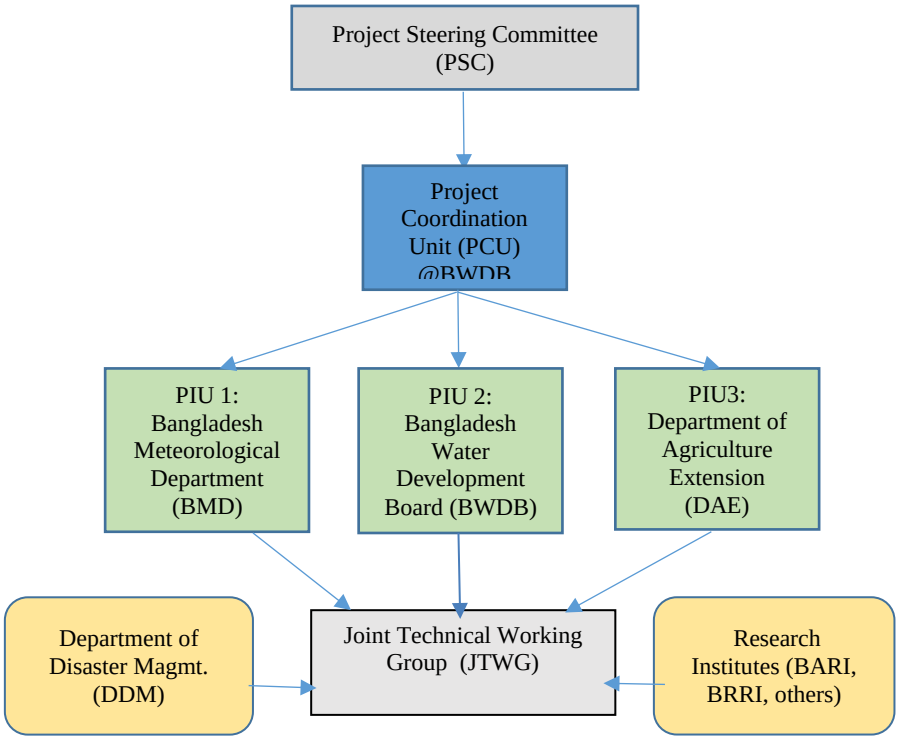


Figure A3.1: Project Implementation Setup

4. **Project Steering Committee (PSC):** The Project Steering Committee (PSC) will be responsible for overall project oversight. It will provide an Apex platform/forum for overall guidance, policy advice/decision, and coordination of project activities addressing inter-agency issues that may arise during project implementation. The PSC will be convened by the Senior Secretary of the MOD. The PSC will include the Secretaries, or their representatives from the Ministry of Finance, Ministry of Water Resources, Ministry of Agriculture, & Ministry of Disaster Management and Relief and any additional Government Stakeholders. Secretariat support will be provided by the Project Coordination Unit (PCU) office at BWDB. The main responsibilities of the PSC are as follows:

- To meet once annually (unless exceptional circumstances demand otherwise) to review project implementation
- To provide oversight and policy guidance
- To facilitate inter-agency coordination so as to ensure compliance and adherence to the project development objectives
- To resolve disputes or conflicts related to the project, if any
- To endorse all changes in the project implementation arrangements
- To endorse any policy, regulatory, and institutional recommendations from the project.

5. **Project Coordination Unit (PCU):** For coordinated project management of three implementing agencies, BWDB Head Office will create a Project Coordination Unit (PCU) headed by a Project Coordinator (PC) who will be the Chief Planning of the BWDB. The PCU which will be an expanded version of the BWDB PIU, will work under the guidance of the Director General, BWDB and work in coordination with all three implementing agencies. In addition to the Project Coordinator, the PCU will include a Social and Communication Consultant, a Project Coordination Consultant and Environmental Consultant for the duration of the project. The Project Coordination consultant, Environmental consultant and Social and Communication Specialists will be fully embedded within the BWDB PIU and will report to the PC. The Project Coordination Specialist will also be responsible for overall reporting on M&E at the project level. S/he will do this by coordinating with the M&E Specialists in the three PIUs. PCU members will be fully connected to the PIUs and will report to the PC. The three above mentioned consultants wills support all three implementing agencies. Since the environmental and social impact of this project is expected to be minimal, there will be no separate environment and social consultants in the PIUs. The BWDB PIU office will serve as the secretariat to the PSC. The main responsibilities of the PCU are as follows:

- The Projector Coordinator will call for a meeting quarterly with all three Project Directors and will assess the progress of each component.
- To review the implementation of the project in a timely manner and in accordance with GOB and Bank requirements and agreed implementation plan
- To liaise with Project Directors and report on funds flow and physical progress
- To undertake overarching coordination and review of monitoring and evaluation and ensure overall quality of the project
- To proactively manage overall project risks
- To keep the Bank informed of implementation progress

- To ensure regular coordination and information sharing among the relevant ministries and agencies that will have a role in project and implementation
- To collect and share consolidated progress/monitoring/financial reports from all three PIUs for onward transmission to the concerned Ministries, the Implementation Monitoring and Evaluation Division (IMED), the Economic Relations Division (ERD) and the World Bank.

6. **Project Implementation Unit (PIU):** The project has three implementing agencies: (i) BMD (ii) BWDB and (iii) DAE. Each would create a project implementation unit (PIU). The Project Director, a full time dedicated GOB set standard level official of the concerned implementing agencies will be appointed by the parent government body. The PDs of the PIUs will each have officers and staff appointed by the parent department to work in the PIU, including a full time Deputy Project Director (DPD) who will provide ongoing backup to the PD. Each PIU shall consist of: (i) required technical specialists/consultants (ii) procurement specialist/consultant and (iii) financial specialist/consultant, and (iv) Environmental focal person (v) Social focal person (vi) communication specialist/consultant and (vi) Monitoring and Evaluation specialist/consultant. Each PIU can hire full time support staff and contractual support staff for project implementation. The three implementing agencies will arrange for independent reviews of implementation progress, coordinate monitoring, evaluation as well as impact assessment. Each PIU will have the following responsibilities:

- The PDs will have full freedom to make decisions related to the project as well as financial management decisions independently within the financial powers delegated to the PD under the "Delegation of Financial Powers for Development Projects" issued by GOB. Each PIU will submit the Withdrawal Application separately.
- The PDs will have responsibility for ensuring compliance with the fiduciary requirements of GOB and the World Bank
- Approving the work plans and budgets in coordination with their own Ministries to be submitted to the PCU and subsequent submission to higher authorities for approval
- Executing the activities approved by the PSC
- To ensure the provision of adequate and appropriate staffing for project execution at the implementing agency level
- To oversee the work of the various consultants
- Approval of the tender and proposal dossiers and calls for proposal dossiers and tender
- Executing payments from the project account, ensuring that project activities are well coordinated and that necessary preconditions are met concerning post-project ownership, operation, maintenance and sustainability
- To review the implementation of project activities on a monthly basis and report to the PCU
- Informing the Project Coordinator of any event which might jeopardize the success of the project
- Setting up the necessary departmental technical committees (DTC) and overseeing their functioning

- Accounting and financial management controls related to their respective project components
- Overseeing and managing the contracting of consultants

7. **Joint Technical Working Group**: A joint technical working group (JTWG) will be established. It will be chaired by the BMD and include representatives from BMD, BWDB, DAE, BARI/BRRI/BJRI/BSRI, DDM and other stakeholders. Its main function will be to facilitate information sharing between respective agencies for development of weather and water related services and to provide technical support to the development and delivery of such services. There are a number of areas of collaboration between these agencies and a preliminary table of information products, users and service providers is attached below.

Table A3.1: Illustrative Services, Service Providers and Users

Data/Product/Service	Source	Users	Purpose
Real-time Rainfall Data	BMD	BWDB	Populate Nowcasting Workstation
Real-time Rainfall Data	BMD	DAE	BAMIS, development of agro-meteorological products and advisories
Real-time Rainfall Data	BWDB	BMD	Calibration of Radar Data for the calculation of QPE/QPF
Real-time Rainfall Data	BWDB	BMD	Populate Nowcasting Workstations
Real-time Rainfall Data	BWDB	BMD	Verify QPF
QPF	BMD	BWDB	Flood Forecast Input
QPE	BMD	BWDB	Populate Nowcasting Workstation
QPF	BMD	DAE	Decision Making of Agricultural Sector (Irrigation, Pest Abatement, etc.)
Radar Data	BMD	BWDB	Populate Nowcasting Workstation
Satellite Imagery (Visible/Infrared)	BMD	BWDB	Populate Nowcasting Workstation
FFGS	BMD	BWDB	General Guidance of Possible Flash Floods
FFGS	BMD	DAE	General Guidance of Possible Flash Floods
Flash Flood Forecast	BWDB	DAE	Flash Flood along Agricultural Communities along River Systems
Ground Water Quantity and Quality	BWDB	DAE	Water use for agricultural users
Coastal Inundation	BMD	DAE	Agricultural Impact and Planning in coastal region
River Forecast	BWDB	DAE	Flooding along Major River Systems affecting Agricultural Community
Precipitation Forecast	BMD	WASA	Manage pumping system in the city for flood management
Additional to be added	TBA	TBA	TBA
Additional to be added	TBA	TBA	TBA

8. BMD and BWDB will generate information for which there will be numerous users. To enhance service delivery, these agencies will meet regularly to exchange ideas, review product usefulness, develop new products, improve the content and/or timeliness of existing products and get feedback regarding their operations. In addition, BMD and BWDB have number of cross-cutting areas to share the data. Frequent meetings and dialogue will encourage a healthy and useful dialogue between BMD, BWDB and their users. Other potential technical working group members (on an as needed basis) DWASA, Fisheries, Civil Aviation, and groups tasked as first responders during exceptional meteorological and hydrological events. To facilitate coordination, additionally four core MOUs identified will be needed between (i) MOD and Local Government Division (LGD); (ii) DAE and BARI, (iii) MOWR and Ministry of Road Transport and Bridges and (iv) MOU between MOWR and LGD. There is already an MOU between MOD and MOA. With reference to this, MOD agreed to send a letter to MOA for installing the AGAWS.

9. **Non-Military Status of BMD:** The BMD is a non-military, government organization under the administrative control of the MOD. Its staff is recruited through the Public Service Commission, the apex body for recruiting the civil servants. BMD does not have any prior experience in preparing or implementing World Bank funded projects, though it has experience working with other donor agencies particularly JICA. BMD's administrative location under the MOD does not hinder its ability to receive IDA funding. Its location under MOD should not constrain in any respect, the World Bank's ability to supervise project activities and exercise its fiduciary oversight responsibilities.

Financial Management, Disbursements and Procurement

Financial Management

Fiduciary Capacity

10. A financial management capacity assessment was carried out to evaluate the overall financial management capacity prevailing in the country and within the implementing agencies including BMD, BWDB and DAE. Currently there are three projects funded by the Bank being implemented by BWDB, namely Emergency 2007 Cyclone Restoration Project (ECRRP), Water Management Improvement Project (WMIP) and the Coastal Embankment Improvement Project (CEIP). DAE is currently implementing the National Agricultural Technology Project (NATP) but BMD is yet to implement any Bank funded project. The overall financial management risk is assessed to be **"substantial"** partly because of the limited experience of BMD and DAE in managing Bank funded project and other capacity constraints identified in all the three agencies.

11. It was also noted during the assessment that there are shortage of professional financial management staffing in all the three agencies, therefore, financial management consultants will need to be hired in all the three PIUs to assist the PDs on day to day financial management of the project. DAE and BMD will be audited by Comptroller and Auditor General Office but BWDB will be audited by a private professional accounting firm each year to meet the statutory requirement. Amongst the three implementing agencies, only BWDB has its own accounting

system which is being implemented since 2006. However it has not been updated due to shortage of resources. An off the shelf accounting software will be required in all three agencies to account for and report on the project expenses. Although BWDB has its own Internal Audit Department, the other two agencies are yet to establish an Internal Audit function within their organizations.

12. The key FM risks for the project appear to be (1) weakness to generate an accurate and timely financial report including Interim Unaudited Financial Reports (IUFR), (2) quality of Internal audit reports of BWDB and lack of internal audit function under other agencies, (3) absence of financial management experts, (4) absence of a robust financial management manual, (5) lack of adequate financial management software, and (6) weakness in record keeping. In order to mitigate these risks, an FM action plan has been agreed with the implementing agencies under the project which will be monitored by the World Bank.

Planning and Budgeting

13. *Budgeting*: A budget will be maintained for the entire term of the Project, and detailed budgets for each fiscal year will also be produced to provide a framework for financial management purposes. The annual budget will be prepared on the basis of the procurement plan and any other relevant annual work plans. These budgets will be monitored periodically to ensure actual expenditures are in line with the budgets, and to provide input for necessary revisions.

Internal Control

14. *Filing and Record-Keeping*: The PCU and PIUs will preserve all procurement records and financial records/documents in accordance with the provisions of the PPA 2006. These records must be made readily available on request for audit/investigation/review by the Government and the Bank. All project-related documents must be filed separately to facilitate internal and external audits, as well as reviews by the Bank.

15. *Project Operations Manual*: A Project Operations Manual (POM) will be prepared under the project which will include a financial management part mainly to guide the project financial management staff on the financial rules and regulations mandatory for any development project in Bangladesh. The Operations Manual is expected to be ready within 30 days after project effectiveness. A Financial Management manual has already been prepared by BWDB which may be tailored for the purpose of this project. The POM will have all the ready references to financial rules and regulations of the Government along with the project requirements from the Bank side.

16. *Financial Management System:* In the absence of a robust organization wide financial management software in any of the implementing agency, an off the shelf accounting software will be purchased under the project for each agency and be installed accordingly in order to account for and report on the project expenses. Contract package for the purchase of the software will also include training of FM staff on the operation of the software and a separate maintenance contract may also be signed with the vendor for the life of the project.

17. *Performance Audit*: The purpose of the performance audit is to ascertain effectiveness of expenditures, ensure adherence to rules and regulations of the Government/Implementing agencies in the payment process and management of project assets and funds. Internal audit of BWDB will be carried out by its own internal audit directorate. However, professional accounting/auditing firm will be hired by the PCU to conduct performance audit of the project for all three PIUs at least twice during the life time of the project, the first one 6 months before the mid-term and the second one, preferably a year before closing the project with selection process and TOR acceptable to the Bank. Going beyond the financial aspects, the audit would also look into the effectiveness and efficient use of project resources, and conduct an independent appraisal of the workings of the PIUs and other partners in the implementing arrangements. The key internal audit function will be: (a) ascertaining whether the system of internal checks and controls for preventing errors, fraud and corruption within the organization, is effective in its design as well as operation; (b) ensuring reliability of accounts and other records, as well as ensuring that accounting methods provide the necessary information for the preparation of correct financial statements; (c) determining the extent to which the project entity's assets are safeguarded from any unauthorized uses or losses; (d) undertaking physical verification of assets/goods and (e) establishing whether administrative and financial regulations of the Government and instructions issued by the Treasury as well as donors' legal requirements are complied with.

18. *Assets and Payments:* All project payments will be made by the PDs of each PIU using the banking system (except for small petty cash expenses). The project will maintain assets tracking system for ensuring annual physical verification and reporting on assets procured under the project.

19. "Incremental Operating Costs" means the reasonable costs required for the day-to-day coordination, administration and supervision of project activities, including leasing and/or routine repair and maintenance of vehicles, equipment, facilities and office premises, fuel, office supplies, utilities, consumables, communication expenses, translation, printing, photocopying and postal expenses, bank charges, advertising expenses, insurance, costs of clearing, forwarding, inspection, survey and transportation of goods, project-related meeting expenses, project-related travel; excluding salaries, per diem, allowances and honorarium of officials of the recipient's civil service and/or other sitting allowances and honorarium of any other nature.

20. "Training" means the reasonable costs required for the participation of personnel involved in training activities, workshops and study tours under the project which have been approved by the Association in writing on annual basis, including: (a) travel, hotel, and subsistence costs for training, workshop and study tour participants provided that such allowances are paid directly to the eligible recipient using the banking system; and (b) costs associated with rental of training and workshop facilities, preparation and reproduction of training and workshop materials, costs of academic degree studies, and other costs directly related to training course, workshop or study tour preparation and implementation; but excluding salaries of civil servants and sitting allowances and honorarium of any other nature.

Governance and Oversight Arrangements

21. *External Audit*: External audit of BMD and DAE will continue to be carried out annually by the Foreign Aided Project Audit Directorate (FAPAD) of C&AG but the annual external audit of BWDB will be carried out by a private audit firm to be consistent with the country system. The accounting system of the BWDB will be used for accounting and reporting of project expenditures. The annual audit reports will be submitted to the Bank within six months from the end of each financial year and this will be monitored in the Bank system (PRIMA). The audited financial statements will be made available for public disclosure. If there are any audit objections, it will be the responsibility of the PDs to follow up and take remedial actions, with the assistance from the Financial Management Specialist and the program implementing sections relevant to the audit objections. There is no outstanding audit report from any of these agencies as of the current date.

Financial Management Considerations in the Fiduciary Assessment

22. *Staffing:* The PD at the each PIU will be responsible for the overall financial management of the project and will also provide overall guidance/directions on a day to day basis to the Financial Management Specialist to be recruited under the project. Each PIU will hire a Financial Management Specialist within two months from the date of signature of the financing agreement. TOR of these Financial Management Specialists will need to be shared with the World Bank for its review and concurrence. The contracts will be "Prior Review" for this services.

23. *Accounting and Reporting:* All the implementing agency will require to maintain a satisfactory financial management system, including keeping all the mandatory books of accounts, preparing quarterly and yearly financial statements. Quarterly IUFRs will be submitted to the Bank by the project (to be consolidated by PCU) within 45 days from the end of each quarter. IUFRs will need to be prepared from the financial information directly produced by the accounting software. In order to aid the book keeping and reporting, financial management software will need to be purchased and installed within the project within three months from credit effectiveness.

Table 3.2 Financial Management Action Plan

SL No.	Description	Deadline	Responsibility
01	Start hiring process for FM consultants in all 3 PIUs; TOR Preparation	June 30, 2016; DAE will sign contract with FM consultants after approval of the project by ECNEC and effectiveness of the Credit.	Project Office

02	Review TOR of FM consultants	June 15, 2016	WB
03	Hiring of FM consultants completed	August 30, 2016	Project Office
04	Procurement of off the shelf accounting software in all 3 agencies to account for and report on the project expenses	Three months after credit effectiveness	Project Office
05	Annual Budget submission to WB	Yearly	Project Office
06	Review of Annual Budget		WB
07	Preparation of Internal Audit TORs and share with the World Bank by BWDB	August 31, 2016	Project Office
08	Completion of hiring process of Internal Auditors	March 31, 2017	Project Office
09	Submission of Internal Auditors Report to the Bank	Within 15 days from the receipt of final report	Project Office
10	Submission of IUFRs	Quarterly within 45 days of end of each calendar quarter	Project Office
11	External (FAPAD) audit report	Before December 31 each year	
12	Preparation of Project Operations Manual comprising FM part	Within one month of Project effectiveness date.	Project Office

Disbursements

24. Disbursement categories for the project are shown in Table 3.3.

Table 3.3: Disbursements (in SDR)

Category	**Amount of the Financing Allocated (expressed in SDR)**	**Percentage of Expenditures to be Financed**
(1) Goods, non-consulting services, consultants' services, Training and Incremental Operating Costs for:		**(inclusive of Taxes (except for customs duties and value-added taxes on imports))**
(a) BMD under Part A of the Project	40,900,000	100%
(b) BWDB for Part B of the Project	28,100,000	100%

(c) DAE for Part C of the Project	9,550,000	100%
(2) Emergency Expenditures under Part D of the Project	0	100% inclusive of taxes
(3) Refund of Preparation Advance	1,250,000	Amount payable pursuant to Section 2.07 of the General Conditions
TOTAL AMOUNT	**79,800,000**	

25. *Basis of disbursements:* It was agreed that the project will start with the transaction based disbursements and may convert to Interim Unaudited Financial Reports (IUFRs) based disbursements when the project demonstrates the capacity to prepare a reliable and timely financial reports during the implementation of the project.

26. *Project Preparation Advance:* A project preparation advance in the amount of US$ 1.69 million has been requested by the GOB. It has been approved by the Bank and currently being processed. The advance has been requested to facilitate preparation and speed up the procurement processes for key consultancies for BMD and BWDB.

27. *Flow of Funds from Designated Account (DA):* Funds (in BDT) will be disbursed through three separate Designated Accounts (DA), to be established in a branch of a commercial bank acceptable to the Bank. The Commercial bank should have adequate experience, manpower, network and authority to process transactions on a fast track basis. The approved government procedures governing the establishments of DA in the form of CONTASA shall be followed in all respects and each PIU will be responsible for their own DA. Each agency will initiate to open their own DA through their Ministry.

28. No allowance (per diem, honoraria, sit-in allowance, travel allowance and others) shall be handed out as cash payment to the trainees/participants and trainers/resource speakers in BWCSRP training, knowledge transfer, or other capacity building activities (including workshops, seminars and others). Instead, all such allowances (except for sit in allowances, which are not eligible for IDA financing) should be paid via banking system; allowances should be paid at the official rates applied by GOB at the time of the event. Attendance Register for all local training must be maintained by all three PIUs and made available for future audit.

29. A total of no more than 15 percent of IDA financing will be used for paying taxes for the project.

Procurement

30. Out of the total project cost of US$ 128.7 million, IDA contribution is US$ 113 million equivalent. Procurement under this project will largely involve goods, consulting services and

non-consulting services, and a few works. Of the 49 goods contracts 14 are priced at 1 million dollars or more – mostly on the account of BWDB and comprising of technologically advanced equipment. Of the 51 service contracts 2 are priced at 1 million dollars or more – distributed among all three implementing agencies.

31. *Procurement Responsibility:* Each of the three PIUs will process all procurements for their respective implementing agencies – BMD, BWDB, and DAE – centrally. The PCU will not conduct any procurement.

32. *Procurement Capacity*: Both BWDB and DAE have experience and capacity in processing Bank financed procurement. BMD, however, did not implement any project financed by the Bank.

33. DAE has a permanent setup for monitoring and evaluation of contract performance, and a good number of its personnel received formal procurement related training. The existing procurement capacity of DAE should be adequate to process the contracts in its procurement plan.

34. BWDB is one of the four government organizations where the Bank-financed public procurement reform (PPRP and PPRP-II), and e-government procurement (eGP) were piloted. BWDB has a good number of staff with sound procurement training and there is a fair capacity for contract management. The procurement capacity of BWDB is adequate to process the contracts in its procurement plan.

35. BMD does not have any experience of processing donor financed procurements; and is currently implementing its first donor funded project – where the donor is processing all procurements. BMD is also in need of staff with formal training in procurement. The current capacity of BMD is therefore less than adequate to process the contracts in its procurement plan.

36. *Procurement risks.* The fiduciary assessment carried out for the agencies indicates "substantial" risk in procurement operations and contract management. The main drivers to the risks are associated to the acute capacity constraint of BMD, DAE, and Hydrology Division of BWDB in performing procurement related activities, delay in processing procurement activities, inadequate record management system, and vulnerability of the agencies with respect to fraudulent, collusive and coercive practices under taken by the bidders. Several measures to mitigate the risks would be put in place as described below.

37. *Managing Procurement Risks:* In order to minimize the procurement associated risks, the following measures have been agreed upon with the implementing agencies. Part of these measures are already in place, while the remaining will be implemented during implementation of the Project.

a. General

(i) *Bid/Proposal Evaluation Committee*: All implementing agencies shall ensure that the bid/proposal evaluation committees are formed in a manner acceptable to the Bank, and

Bank's no objection shall be required on the formation, as well as alteration in the composition or membership, of the bid/proposal evaluation committees. Procurement consultant(s) of the project will be mandatory member(s) of the bid/proposal evaluation committee;

(ii) *Introducing STEP system:* Systematic Tracking of Procurement Exchanges system (STEP) will be introduced to prepare and manage procurement plan and procurement transactions under the project;

(iii) *Identify procurement focal points (PFP) in all three agencies:* Each of the implementing agencies (PIU) shall nominate a procurement focal person for their part of the Project. The appointed focal person will take necessary training, both on PPR 2008 and Bank Procurement Guidelines, if required. The focal persons will help the respective agencies in day-to-day procurement follow-up and preparation of periodic procurement reporting.

(iv) *Recruit local procurement consultant in all three agencies:* BMD and BWDB will hire two local procurement consultants (one each) for the entire duration of the project preparation (i.e. using project preparation fund). Procurement consultant of BWDB will also support DAE during project preparation. DAE will hire a local procurement consultant for a duration of 36 months. The consultants so hired will be re-employed for the project implementation period on a single source basis – provided the respective implementing agency and the Bank agree that their performance have been satisfactory during the project preparation period. DAE will hire a local procurement consultant for the project implementation period.

(v) *Due-diligence Measures:* the following steps will be followed as part of procurement and implementation arrangements: (a) all bid evaluation reports will include verification of recommended bidders' post-qualification information; (b) make bidders generally aware about fraud and corruption issues; (c) preserve records and all documents regarding procurement (including correspondences with the potential bidders as well as complaints/clarification requests etc.), in accordance with the Bank Guidelines and PPA/PPR, to facilitate smooth procurement audit or post-review; and (e) publish contract award information on CPTU and the respective agencies website within two weeks of contract award (and in UNDB online for ICBs or international consultancies).

b. Special Measures for International Competitive Bid (ICB) Contracts

(i) *Service of international technical and procurement experts for BMD:* These two international individual consultants will be engaged to support BMD during bid/proposal evaluation for ICB contracts and international consultancy contracts. In addition, the technical expert may also be involved in post-award inspections for the ICB contracts at the discretion of BMD. There services will be staggered time based.

(ii) *Bid/Proposal Evaluation Committee.* At BMD, Bid/Proposal Evaluation Committee for ICB or international consultancy contracts will have five members including international procurement and international technical experts. Formation of such BEC/PEC shall be subject to Bank's acceptance. BMD will prepare in agreement with the Bank, detailed terms of reference of the BEC/PEC including time bound action plan for the bid evaluation committee to ensure strict confidentially of the bid evaluation process, and timely completion of the evaluation;

(iii) *Extra due diligence for the local agents:* All agencies will need to do extra due diligence on the local agents of the bidders. Bank bidding documents have explicit requirements for disclosure of the local agents, if any. As part of bid evaluation, the implementing agencies need to be carefully looking at who the proposed local agents are and what their roles are with respect to the particular bidding.

c. Special measures for National Competitive Bid (NCB) Contracts

(i) *Bid Evaluation Committee:* BEC for NCB contracts will be formed in accordance with Public Procurement Rules 2008. Formation of such BEC shall be subject to Bank's acceptance;

(ii) *Electronic Government Procurement (e-GP):* All NCB contracts under this project shall be processed using e-GP system of the country;

d. Other measures

Following procurement packages will be subject to advance actions so that the contracts can be awarded immediately after credit effectiveness. DAE Contract Packages C1 and C3 will be signed after approval of the project by ECNEC and immediately after effectiveness of the Credit:

- BMD Contract Package G1 - supply and installation of automatic weather stations (AWS) and automatic rain gauges (US$ 6.5 million), and Contract Package C1- meteorological systems and services integrator (US$ 2 million);
- BWDB Contract Package G1- ground water stations (US$ 5.5 million), BWDB Contract Package G2 – water level stations, AWS and ARGs (US$ 8.3 million) and BWDB Contract Package C2 - hydrological information services consultancy (US$ 0.2 million);
- DAE Contract Package C1 - BAMIS technical design consultancy (US$ 0.2 million) and Contract Package C3 agro-meteorology technical expert consultancy (US$ 0.215 million)

36. *Procurement Guidelines:* Procurement financed under the project shall 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 and Grants by World Bank Borrowers" published in January 2011 (revised July 2014), in the case of goods, works, and non-consulting services; and "Guidelines: Selection and Employment of Consultants under IBRD Loans and IDA Credits and Grants by World Bank Borrowers" published in January 2011 (revised July 2014) in the case of consultants' services, and the provisions stipulated in the Financing Agreement.

37. *Procurement Plan:* For each contract to be financed under the project, the different procurement methods or consultant selection methods, the need for pre-qualification, estimated costs, prior review requirements and time frame were agreed between the implementing agencies and the Bank in the Procurement Plan. All expected major procurements will be announced in the General Procurement Notice (GPN), published in the Bank external website and United Nations Development Business (UNDB). The procurement plan will be updated semi-annually (or as required) using STEP system of the Bank.

38. *Particular Methods of Procurement of Goods, Works and Non-consultancy services:* Except as otherwise agreed in the procurement plan, works and goods may be procured on the basis of International Competitive Bidding. Procurement of goods and works having estimated value less than the ceiling stipulated in the Procurement Plan may follow National Competitive Bidding (NCB), Framework Agreement, and Shopping (Request for Quotations) methods. Direct Contracting may be allowed under special circumstances with prior approval of the Bank. NCB would be carried out under Bank Procurement Guidelines following procedures for Open Tendering Method (OTM) of the People's Republic of Bangladesh (Public Procurement Act 2006 - PPA, 1st amendment to PPA (2009) and The Public Procurement Rules 2008, as amended in August 2009) using standard/model bidding documents satisfactory to the Bank. Shopping will be carried out based on a model document satisfactory to The Bank. For the purpose of NCB the following shall apply:

- Post bidding negotiations shall not be allowed with the lowest evaluated or any other bidder;
- Bids should be submitted and opened in public in one location immediately after the deadline for submission;
- Lottery in award of contracts shall not be allowed;
- Bidders' qualification/experience requirement shall be mandatory;
- Bids shall not be invited on the basis of percentage above or below the estimated cost and contract award shall be based on the lowest evaluated bid price of compliant bid from eligible and qualified bidder; and
- Single-stage two-envelope procurement system shall not be allowed.

39. *Methods of Procurement of Consultants' Services:* Selection of Consultants will follow the Bank's Consultant Guidelines and standard documents in all types of selection processes. The following methods will apply for selection of consultants: Quality and Cost based Selection (QCBS), Quality-based selection (QBS), Fixed Budget Selection (FBS), Consultants' Qualification (CQ), Least Cost Selection (LCS), and Single Source Selection (SSS). Single Source Selection may be allowed under special circumstances with prior approval of the Bank. Shortlist of consultants for services estimated to cost less than US$500,000 equivalent per contract may be composed entirely of national consultants. The Procurement Plan will specify the circumstances and threshold under which specific methods will be applicable, along with the Bank's review and implementation support requirements.

40. *Use of Standard Procurement Documents:* For procurement through International Competitive Bidding and for selection of consultants, the Bank's Standard Bidding Documents (SBDs) and Standard Request for Proposals (SRFPs) will be used, including the form of contract attached with SBDs and SRFPs. For all NCB, Shopping packages, and Framework Agreements, the implementing agencies will use model tender documents (MTD) agreed with the Bank.

41. *Prior review Thresholds:* The Procurement Plan shall set forth those contracts which shall be subject to the Bank's prior review. All other contracts shall be subject to Post Review by the Bank. Initial Procurement plan agreed with agencies indicate the following prior review thresholds which will be updated annually based on the review of the capacity and performance of the procuring entities and will be reflected in the updated procurement plan as appropriate:

Table 3. 2: Prior Review Thresholds

Expenditure Category	Contract Value (Threshold)	Procurement Method	Contracts Subject to Prior Review
Goods	**>=US$ 2,000,000**	ICB	All contracts
	<US$ 2,000,000	NCB	**All contracts valued US$ 1,000,000 or more**
	<US$ 2,000,000	Framework Agreement	All agreements
	<=US$ 6,000	DC	All contracts
		RFQ/ National Shopping	Post review
Works/Supply Installation	**>= US$10,000,000**	ICB	All contracts.
	<US$10,000,000	NCB	**All contracts valued US$10,000,000 or more**
	<=US$ 12,500	RFQ/ National Shopping	Post review
		DC	All contracts
Services	**>=US$500,000**	QCBS /QBS	**All contracts valued US$500,000 or more**
	<US$500,000	FBS	**All contracts valued US$500,000 or more**
	< US$300,000	LCS	Post review
	<US$300,000	CQ	Post review
		IC	All contracts valued **US$200,000** or more; and all contracts of procurement and FM consultants
		SSS	All Contracts

Note: In case of a contract package containing multiple lots, sub-packages, or slices the sum of estimated costs of all lots / sub-packages / slices in that procurement package will determine the procurement method and whether it will be prior- or post-reviewed, in accordance with the thresholds given above.

42. *Post Review/Integrated Fiduciary Review:* For compliance with the Bank's procurement procedures, the Bank will carry out sample post review of contracts that are below the prior review threshold. Such review (ex-post and procurement audit) of contracts below the threshold will constitute a sample of about 15 percent (fifteen percent) of the post-review contracts in the project. Procurement post-reviews will be done on annual basis depending on the number of post-review contracts.

Table 3.3 Major Procurement Packages

Serial Nr.	Procurement Category	Contract Description	Estimated Cost (US$)	Method
A. BMD				

Serial Nr.	Procurement Category	Contract Description	Estimated Cost (US$)	Method
1	Goods	Supply and Installation of Automatic Weather Stations (AWS) and Automatic Rain Gauges	6,500,000	ICB
2	Goods	Supply and Installation of Coastal Marine Automated Network (CMAN) including software	550,000	ICB
3	Goods	Supply and Installation of Portable Hydrogen Generators	1,100,000	ICB
4	Goods	Supply and Installation of X-Band Weather Radar including software and training	7,500,000	ICB
5	Goods	Procurement of High Performance Computer	2,927,000	ICB
6	Consultancy	Meteorological Systems and Services Integrator (MSSI)	2,000,000	QCBS
7	Consultancy	Multiple technical studies as part of regional collaboration	200,000	QCBS / IC
8	Non Consulting Service	Consultancy for Community based early warning for drought and extreme meteorological events in NW Bangladesh	3,000,000	QCBS
9	Consultancy	Consultancy for BMD Climate Services Product generation	400,000	QCBS
10	Non-Consulting Service	Survey of Bathymetry and coastal elevation monitoring for modeling tropical cyclone associated storm surge (in collaboration with BWDB)	2,800,000	QCBS

Serial Nr.	Procurement Category	Contract Description	Estimated Cost US$	Method
B. BWDB				
11	Goods	Upgrade existing groundwater stations and nests from manual to automatic and new stations including monitoring and maintenance	5,500,000	ICB
12	Goods	1) Automatic Water Level Stations (incl maintenance and stream gauging for project period) 2) Upgrade existing 3 climate stations and 257 rain gauges to automatic and real time	8,300,000	ICB
13	Goods	Systems for Morphological survey	1,500,000	ICB
14	Goods	ICT and communication hardware: including, computers, related systems, (communication systems for 13 locations)	1,700,000	NCB
15	Consultancy	1) Expand flood forecasting model (whole country); 2) Improve inundation model in coastal and hotspot areas (depth and area of inundation)	200,000	QCBS
16	Consultancy	Water Resources System Integrator (WRSI) Consultancy (design and implementation support)	1,000,000	QCBS

Serial Nr.	Procurement Category	Contract Description	Estimated Cost US$	Method
17	Consultancy	Risk analysis and Mitigation - Hazard, vulnerability and risk assessment and development of feasibility studies for mitigation measures of flood and disaster prone NE districts (in collaboration with DDM) - results to contribute to regional collaboration (dists. Netrakona and Sunamganj)	250,000	QCBS

Serial Nr.	Procurement Category	Contract Description	Estimated Cost US$	Method
C. DAE				
18	Consultancy	BAMIS technical design consultancy	200,000	QCBS
19	Consultancy	Senior Agromet Technical consultant	215,750	IC

Environmental and Social (including safeguards)

Environmental Safeguard

43. **Applicable Environmental Category and Safeguard Polices.** The project is classified as a Category B project and requires partial environmental assessment. The policy on environmental assessment (OP/BP 4.01) has been triggered to ensure that project design and implementation focus on reducing adverse impacts and enhancing positive impacts. The environmental safeguard policies Natural Habitats (OP/BP 4.04), Forests (OP/BP 4.36) and Physical Cultural Resources (OP/BP 4.11) have not been triggered since the physical work of the project is mainly limited to installation of weather and climate equipment and most of them will be located on DAE's office premises or in their current location.

44. **Approach to Address Environmental Safeguard Issues.** The BWCSRP will be implemented over a period of six years. The implementing agencies intend to ensure that the proposed investments take environmental concerns into account and also provide the opportunity to improve their institutional capacity on environmental management. Details of the sub-projects to be implemented under the project will be finalized during project implementation phase and therefore, the exact locations, size and extent of the sub-projects were unknown at the project appraisal stage. Therefore, an Environmental Management Framework (EMF) has been prepared for the project describing the procedure of environmental screening, assessment, management plan preparation and implementation, monitoring and reporting.

45. The EMF has been prepared based on the: (i) detailed review of the proposed activities; (ii) experience with similar kinds of projects in the region; (iii) stakeholder consultations during project preparation; and (iv) identification of the institutional barriers and capacity building needs for environmental management.

46. The EMF prepared for the project includes the requirements of the Department of Environment (DOE), Bangladesh and the World Bank's environmental safeguard policies. The EMF will be the guiding document for site-specific interventions: (i) environmental screening of each installation of equipment or physical interventions; (ii) partial assessment of proposed investments, if required; (iii) consultation and disclosure; (iv) preparation of environmental management plan (EMP) and application of Environmental Code of Practice (ECoP) with budgeting; (iv) implementation and supervision of EMP and ECoP; and (v) reporting and quality control, etc. The project will not finance any high risk physical interventions or any installation.

47. Further to EMF, the relevant Environmental, Health and Safety Guidelines of the World Bank Group will be applicable to the project.

48. All site-specific installation of equipment and physical interventions under the project will go through an environmental screening process, which will determine the nature and level of impacts, category of specific interventions, requirement of further assessment, application of Environmental Code of Practices (ECoPs) and needs of Environmental Management Plan (EMP).

49. **Borrower's capacity on environmental safeguard.** The Bangladesh Meteorological Department (BMD) has no prior experience implementing World Bank funded projects. Although the Bangladesh Water Development Board (BWDB) has long experience on implementing Bank funded projects, their capacity is also limited on environmental management and mostly depend on the consultants. Department of Agricultural Extension (DAE) has experience on Bank funded project, but has also limited capacity. The project will help to develop the institutional capacity of three implementing agencies on environmental management. The overall capacity on weather and climate services will also contribute the environmental improvement of the country.

50. **Environmental Safeguard Implementation, Supervision and Monitoring.** As mentioned earlier, BWDB Head Office will create a Project Coordination Unit (PCU) headed by a Project Coordinator (PC) who will be the Chief Planning of the BWDB. The PCU will appoint an Environmental Specialist who will be responsible for effective and timely implementation of safeguard activities, monitoring of the environmental impacts of components throughout the project period and environmental enhancement of project activities.

51. The Environmental Specialist will provide support to the PIUs throughout the EA process with advice, training, dissemination of good practice, and operational support. The Environmental Specialist will review all the screening report, EMFs, monitoring reports etc. prepared by implementing agencies.

52. During project implementation, each Project Implementation Unit (PIU) responsible for ensuring effective implementation of environmental safeguard measures in close consultation with local authorities and local communities. This means there will be three PIUs associated with each implementing agency. The PIU will assign at least one full time staff as the safeguard focal person to be responsible for forging effective implementation of safeguard activities in each of the project locations. PIU-BMD and PIU-DAE will assign one additional staff each for training

purposes and to ensure continuity in case of transfer of assigned focal person. The PIU will be responsible for incorporating environmental considerations in bidding and contractual documents. During implementation, the PIU will assign local officials to be responsible to supervision and monitoring of environmental issues. The results will be part of the component progress report and the safeguard focal point will be responsible for ensuring proper documentation of safeguard activities.

53. **Consultation and Disclosure.** The EMF was prepared in consultation with the key stakeholders including the implementing agencies officials both at central and field levels. A national consultation workshop on the EMF was organized by the implementing agencies on November 25, 2015 with all the stakeholders and feedback incorporated. Consultation with labors and nearby communities has been made mandatory for environmental screening/assessment of each site specific interventions. The EMF document with Bangla version was disclosed both in all three implementing website (www.bmd.org;http://www.bwdb.gov.bd/index.php/site/digital_archive; http://dae.portal.gov.bd/site/page/414d0961-fb21-44dd-af68-3c7f79ddb5ab) and the Bank's Infoshop. Hard copies of the document are also available in implementing agencies offices.

54. The cost of overall environmental management includes waste management, dissemination, and impact assessment, mitigation and evaluation and capacity building and is estimated to be USD 0.6 million over the project period.

Social Safeguard

55. **Applicable Social Safeguards Policies**: The scale of physical infrastructure related activities under the project will be relatively small in terms of land and space usage, and the activities will be mainly carried out within the existing premises of the implementing agencies. It is not anticipated that at this stage any land acquisition or related displacement will take place, and hence no land expenditures are considered. The option has however been kept open for future phases in case of the improbable situation where small amounts of land acquisition becomes absolutely necessary after exhausting other options such as willing buyer willing seller, voluntary donation etc. OP 4.12 Involuntary Resettlement is triggered for the project considering the very slim chance mentioned above. Since the exact locations and/or exact land requirements cannot be determined at this stage, a Resettlement Policy Framework has been prepared to provide guidance on site-specific Resettlement Action plans if required. The project will be implemented nationwide and although specific geographical locations have not been identified at this stage it is probable that it will be implemented in areas where indigenous/tribal/small ethnic minorities live. OP 4.10 Indigenous Peoples is also triggered for the project.

56. **Approach to Address Social Issues:** A Resettlement Policy Framework (RPF) and a Small Ethnic Communities and Vulnerable Peoples Development Framework (SECVDF) have been prepared for the project based on Bank safeguard policies and GOB regulatory/policy requirements. These two frameworks include social screening formats for the subcomponents; resettlement policies and process following the World Bank's policies (OP 4.12); consultation communication, information dissemination and feedback framework; grievance redress mechanisms, gender considerations; institutional arrangement and capacity building; and

framework for monitoring and mitigation of adverse impacts. The framework for small ethnic/tribal and vulnerable community development is a standalone document that includes guidance on consultation strategies and participatory processes to gather feedback effectively and efficiently in a culturally appropriate and gender sensitive manner so that appropriate mitigation measures can be designed. Grievance mechanism and institutional arrangements are also discussed.

57. The RPF and the SECVDF will be utilized to prepare site specific Resettlement Action Plans (RAPs) or abbreviated RAPs and/or Small, Ethnic Communities and Vulnerable Peoples Development Plans once the sites are identified, screened and assessed via the SIA and screening process, and if resettlement impacts are anticipated and/or indigenous people are identified as living there. The RPF and SECVDF will focus on consultation and communication strategies with a lens on gender, ethnic people and other vulnerable communities/households.

58. **Borrowers Capacity regarding Social Safeguards:** The RPF was prepared based on the detailed review of the proposed activities; stakeholder analysis and consultations during project preparation; and assessment of the institutional and implementation modality for the project including capacity for appropriate social safeguards management. The Bangladesh Metrological Department (BMD) has no prior experience on the World Bank funded project implementation. The Bangladesh Water Development Board (BWDB) has had a long experience on implementing Bank funded projects, but their capacity in terms of preparing for and implementing social safeguards is limited with heavy reliance on consultants Department of Agricultural Extension (DAE) has some experience implementing Bank funded projects (especially with a focus on CDD interventions and gender) and the Bank team has engaged in significant capacity building with them. However, here too there is heavy reliance on consultants. The project will help to develop the institutional capacity of three implementing agencies on social safeguards management.

59. **Consultation and Disclosure**: A combined (social and environment safeguards) national level workshop was held on November 25, 2015. The RPF and SEVCDF documents with Bangla versions were disclosed both in the implementing agencies website ((www.bmd.org; http://www.bwdb.gov.bd/index.php/site/digital_archive; http://dae.portal.gov.bd/site/page/414d0961-fb21-44dd-af68-3c7f79ddb5ab)) on December 23, 2015 and the Bank's Infoshop on January 9, 2016. Hard copies of the document are also available in implementing agencies. The disclosure notification was published in one Bangla and one English daily newspaper.

Other Safeguards Policies Triggered

61. OP/BP 7.50 on International Waterways has also been triggered because the project will support water resource surveys including bathymetric survey in the coastline of Bangladesh, installation of coastal storm surge stations, buoys in the ocean, and installation of hydro-meteorological and weather related monitoring system. While most of these project interventions will be in-land, some will take place in the Bay of Bengal, an international waterway to which the policy requirements are applicable. The Bank has determined that the project meets the criteria defined in paragraph 7(b) of OP 7.50 providing for an Exception to the Riparian Notification Requirement on the basis that: (a) the project is located in the lowest downstream riparian country from where the river drains into the Bay of Bengal, and (b) that the

limited scope of the physical interventions and expected negligible impacts will not adversely change the quality or quantity of water flow to other riparian countries, and will not be adversely affected by the other riparian's possible water use.

Monitoring and Evaluation

62. The responsibility of overseeing the coordinating all M& E activities under the project will be done by the M and E consultant in each of the three PIUs. The M and E consultants will work closely with the PIU team members and ensure that sufficient and accurate information and data on project outputs and outcomes are collected and submitted in a timely manner. Data analysis and findings on project performance will be shared with all stakeholders and will provide the basis for any corrective measures to improve project performance.

Annex 4: Implementation Support Plan

Bangladesh Weather and Climate Services Regional Project

Strategy and Approach for Implementation Support

1. The Implementation Support Plan (ISP) for the Bangladesh Weather and Climate Services Regional Project has been developed based on the specific nature of Project activities, lessons learned from past Bank projects, monitoring implementation of risk management measures, and to ensure compliance with Bank fiduciary and safeguards policies. The plan will be reviewed regularly and revised as needed.

Implementation Support Plan

2. The ISP includes frequent review of implementation performance and progress, especially given the involvement of three implementing agencies and the nationwide coverage of the project. The Bank team will monitor progress on several fronts including: (i) key performance indicators as defined in the Results Framework; (ii) agency specific project implementation plans; (iii) independent verification of project activities; (iv) proper fiduciary management of all activities carried out by each of the three PIUs; (v) reconciliation of payments with contracts; (vi) ongoing technical advice to PIUs and training; (vii) supervision of large number of procurement activities; (viii) monitoring of key legal covenants and (ix) facilitating regional level dialogue with other national hydrological and meteorological services.

3. Information from various sources will be used to monitor progress through the implementation period. In addition to formal implementation support missions each year, regular technical advice and support will be provided to the implementing agencies throughout the project period. Technical training will be provided to the PIUs on an ongoing basis. In order to ensure coordination between agencies, a team member from the Bank team will serve as an observer on the JTWG. Semi-annual Implementation Status Reports will be prepared to provide progress updates, tracking risk development and efficacy of mitigation measures. In addition to review of bidding documents, the procurement specialist will provide ongoing procurement advice and guidance depending on the procurement needs. The financial management specialist will review all financial management reports and audits and take necessary follow-up actions as per the Bank procedures. Team members will also help identify capacity building needs to strengthen procurement and financial management capacity. The monitoring and evaluation specialist will work closely with all implementing agencies to support design and implementation of the baseline survey, comprehensive impact evaluation with mid-term and end of project survey. Technical inputs from the environmental and social specialists will be required throughout the Project, and formal supervision missions and field visits will ensure compliance with all environmental and social frameworks. The project team will also coordinate with regional partners, national hydrological and meteorological services and the WMO to facilitate regional cooperation.

4. The following Implementation Support Plan reflects the preliminary estimates of the skill requirements, timing, and resource requirements over the life of the Project. Keeping in mind the need to maintain flexibility over project activities from year to year, the ISP will be reviewed annually to ensure that it continues to meet the implementation support needs of the Project.

Table: 4.1 Implementation Support Plan

Time/ Year	Focus	Primary Skills Needed	Missions	Resource Estimate	Comments
1.	• Project Launch • FM systems functioning effectively • Procurement practices following Bank norms • Environmental and Social frameworks are in place	• Team leads • FM and Procurement • Safeguards Specialist • Hydromet Specialist • Hydrologist • Agromet specialist • Monitoring and Evaluation Specialist	Sept 2016 Jan 2017 May 2017	US$ 120,000	• Project will likely become effective in July 2016. • Task team to support smooth startup following effectiveness • Techical support
2.	• Monitor implementation of project activities • FM, Procurement , Safeguards	• Team leads • FM and Procurement • Safeguards Specialist • Hydromet Specialist • ITC Spe. • Agromet specialist • M& E Specialist	Sept 2017 Jan 2018 May 2018	US$ 120,000	• Support all PIUs as necessary • Serve as observer on JTWG • Support regional dialogue • Provide technical and procurement support
3.	• Monitor implementation of project activities • FM, Procurement , Safeguards, M&E • Mid-Term Review	• Team leads • FM and Procurement • Safeguards Specialist • Hydromet Specialist • ITC Spe. • Agromet specialist • M&E Specialist	Sept 2018 Jan 2019 May 2019	US$ 120,000	• Support all PIUs as necessary • Serve as observer on JTWG • Facilitate regional dialogue

4.	• Monitor implementation of project activities • FM, Procurement , Safeguards, M&E • Scaling up service Delivery models	• Team leads • FM and Procurement • Safeguards Specialist • Hydromet Specialist • ITC Spe. • Agromet specialist • M& E Specialist	Sept 2019 Jan 2020 May 2020	US$ 120,000	• Oversight, ideas for improvement
5.	• Monitor implementation of project activities • FM, Procurement , Safeguards, M&E Scaling up service Delivery models	• Team leads • FM and Procurement • Safeguards Specialist • Hydromet Specialist • ICT Spe. • Agromet specialist • M& E Specialist	Sept 2020 Jan 2021 May 2021	US$ 120,000	• Oversight, ideas for improvement
6.	• Project withdrawal and closure • Scaling up service Delivery models	• Team leads • FM and Procurement • Safeguards Specialist • Hydromet Specialist • ICT Spe. • Agromet specialist • M & E Specialist	Sept 2021 Jan 2022 May 2022	US$ 120,000	• ICR mission

Annex 5: Governance and Accountability Action Plan (GAAP)

Bangladesh Weather and Climate Services Regional Project

Introduction

1. Improving governance and fighting corruption are part of the government's development agenda set forth in the Sixth Five Year Plan (SFYP) and the World Bank's mission of promoting sustainable growth and reducing poverty. The GAAP for Bangladesh Weather and Climate Services Regional Project contributes to these efforts by outlining a framework for actions, institutional arrangements, and additional measures to minimize governance and corruption risks in the project. This GAAP has been designed to reflect the responsibilities of the BMD, BWDB and the DAE (the three implementing agencies) and the World Bank to facilitate effective and appropriate use of the funds for the project.

2. The GAAP is a matrix jointly developed by the GOB and World Bank utilizing participatory consultation with stakeholders at all levels. The framework is a key risk management tool designed to be used by the PCU, PIUs, GOB and the World Bank. The main objectives of GAAP are to: (i) identify governance risks that may threaten the attainment of project objectives and implementation results; and (ii) ensure that planned risk mitigation measures are implemented and working. Since BWDB and DAE are already implementing World Bank supported projects, previously agreed GAAPs --for BWDB and DAE were used to inform this GAAP. Since BMD has no prior experience working with World Bank funded projects, an assessment of the governance risks, particularly fraud and corruption was undertaken to develop this plan.

3. The GAAP will be considered a live document and adjusted as necessary during implementation to reflect any governance issues that may emerge and/or to strengthen or add actions. It will be monitored regularly through indicators and reflected in monthly progress reports by the implementing agencies as well as in the World Bank's Implementation Supervision Reports and Aide Memoires.

4. Several risks and mitigation measures related to implementation arrangements, procurement, financial management, environment and social safeguards compliance have already been described in the relevant sections of the PAD. The GAAP complements and adds value to the risk mitigation measures already identified in the fiduciary and safeguard sections.

Country Context and Background in Governance

5. The GOB has introduced a National Integrity Strategy (NIS) and Bangladesh's Right to Information Act 2009 is under implementation. Though many steps to improve transparency and accountability have been taken, Bangladesh is still a high risk in terms of governance because of poor "conflict-of-interest" and public sector regulations, weak capacity, political uncertainties and weak legal framework for corporate governance.

6. Though BWDB and DAE have considerable experience in implementing Bank-financed projects, governance in the water and agriculture sectors have had challenges. Performance of projects implemented by both the institutions have been varied between moderately satisfactory and satisfactory. Because of this ongoing engagement, institutional weaknesses, governance and corruption risks for this project are mostly known. This has contributed to the detailed risk assessment and design of the mitigation measures in this GAAP. BMD will implement the World Bank funded project for the first time though it has experience implementing JICA funded grant projects. Both MOD and BMD are in the process of learning World Bank processes. The project is highly technical in nature which may expose it to institutional capacity risk.

Governance Risks

7. Major risks for BWCSRP relate to the following: (i) institutional capacity and technical complexity of the project; (ii) governance and accountability; (iii) delivery monitoring and sustainability; and (iv) inter-agency and regional coordination risk. Fiduciary risks have been highlighted extensively in Annex 3 and detailed mitigation measures elaborated.

8. **Institutional Capacity Risks**. The project is highly technical in nature which may expose the project to institutional capacity risk. Number of relevant technical experts are absent in the implementing agencies compatible with the modern technology to be introduced through this project. The local institutional capacity risk is also associated with a lack of understanding and / or limited experience of working within World Bank's guidelines, the multiplicity of institutions involved and the geographical scope of the project.

9. **Governance Risks.** There is a scope of improvement in the record keeping, maintaining greater transparency between the users and government officials and the use of right to information act to ensure that all processes and outcomes are transparent, fully disclosed and publicly available. There is also a possibility of too much bureaucratic influence on the technical aspects of the project. Internal within agency communication between ministry level officials and PIU needs to be improved in the case of MOD and BMD to facilitate implementation of project activities. Additional risk mitigation measures to address fiduciary risks have been addressed in detail in Annex 3.

10. **Delivery Monitoring and Sustainability Risks**. The project is service oriented which involves purchasing highly sensitive equipment which needs technical capacity and financial resources for operation and maintenance. The risks are associated with (i) adequate budget for long term operation, maintenance, and financial sustainability of the modernized hydro-meteorological network and services; and (ii) adequate staff capacity to manage the modernized and enhanced service delivery system after the project period. The particular challenge of this project is that many of the location of the sites are remote and difficult to access, so on site supervision of monitoring stations will remain a challenge.

11. **Inter-agency and Regional Cooperation Risks**. The need for multiple agencies and for increased cooperation vis-à-vis weather, climate and water data measurement and sharing data has resulted in a somewhat challenging project design. Slow decision making by multiple implementing agencies may delay project implementation. Some of the benefits of regional cooperation depend on open data sharing policy which will need to be put in place. It will also to

some extent depend on outcomes of regional cooperation activities involving multiple countries which are at this stage hard to predict.

Actions to Mitigate Governance and Corruption Risks

12. **Institutional Capacity Risks**. To mitigate Institutional Capacity Risks, the PIU has been strengthened with externally hired staff to manage the day-to-day implementation within the three PIUs. All three PIUs will have their own technical and fiduciary staff. BMD and BWDB will be supported by the MSSI and WRSI consultant teams to provide technical support to the PIUs. DAE will get technical support from an international agrometeorology specialist. Multiple oversight entities will scrutinize the three implementing agencies performance, particularly on governance and countering corruption. First, the IA's performance will be overseen by a PSC chaired by the secretary of the MoD or his/her designee. Second, an independent M&E consultant will be recruited to carry out M&E of project performance. Third, the PCU will oversee the performance of the each implementing agency's role closely.

13. **Governance Risks:** A number of actions will be undertaken to mitigate governance risks. According to the Right to Information Act, the PCU will designate a communications officer dedicated to the project for requests for information. The communications officer will be provided with sufficient training on the Right to Information guidelines and adequate staff and administrative support to carry out an expansive communications program of proactive disclosure. The communications officer will also develop a communication strategy to ensure broad access to information for civil society and media on all aspects of the project performance and data dissemination.

14. The project website and the monitoring report will state clearly how to file complaints through prominently displayed text. Each PIU will maintain a log of complaints that will track the status of response or follow up. Depending on the nature of complaint, the PIU will assign the review to internal auditors or third party auditors, or may transfer the investigation of the complaint to other appropriate investigative bodies. All complaints received shall be responded to within five days of the receipt, with a copy to the PCU and the Bank. Recording and appropriate referral of all incoming complaints will be undertaken by the PIU. The PCU will share a report every month including the status of the complaint unless it is resolved. Reports summarizing complaint cases that have been resolved will be published on the website. At all times and in all documents the anonymity of the complainant will be maintained. The project is highly technical in nature and may be hampered by the interference of bureaucratic procedures. The PIUs will require independent environment to take decision about the technical aspect of the project.

15. **Delivery Monitoring and Sustainability Risks**. The project's long term sustainability and effectiveness of the project interventions are largely dependent on the operational quality and availability of maintenance cost of highly technical equipment. To mitigate this risk measurement of ratio of Government O&M budget to O&M costs for delivery of weather and climate Services and number of training to the various level of staff have been incorporated as monitoring indicators in the Results Framework. The project will also have in-built enhanced complaint mechanism including information and communication technology.

16. **Inter-agency and Regional Cooperation Risks**. Coordination of three line ministries is a significant challenge in implementing this project. At the national level, the PCU will lead to coordinate among three implementing agencies. Further, a number of MOUs between agencies will be agreed and signed. Open data sharing policies by both BMD and BWDB will be implemented to support regional cooperation aspects. The project will also support consultations on regional collaboration, sub-regional twining arrangements and improvements in ICT and bandwidth to improve regional and global data access and flow.

Monitoring and Bank Supervision

17. The GAAP will be monitored regularly through indicators and reflected in progress reports by the implementing agencies as well as in the Bank's implementation supervision reports and aide memoires for supervision missions. The GAAP matrix will be used widely for monitoring purposes. Any 'early warning' indicators of governance and accountability risks will be monitored regularly so that corrective measures can be carried out promptly.

18. The project will require intensive, random, and unannounced supervision by Bank staff. Supervision arrangements for this project are extensive. Bank supervision missions will be more frequent at the start of the project and will involve qualified staff in all disciplines. The Bank will also conduct regular monitoring between supervision missions.

19. The GAAP will be adjusted as necessary during implementation to reflect governance issues which may emerge and/or to add actions.

Table 5.1: Matrix of Action

Issues/Risks/ Objective	Actions	Responsible Agency	Timeline	Early Warning Indicators to Trigger Additional Action
Institutional Capacity Risks				
Need to **strengthen capacity** to handle the highly technical equipment, management of critical consultancy and monitoring functions	Establish PMU with internally and externally hired technical and staff as per the agreed organogram	BWDB, BMD, DAE	Key staff recruited within first month after project's effectiveness	Delays in conduct of execution of contracts, processing of payments, and filing reports
	Carry out intensive third-party M&E functions	PCU/BWDB	Contracted in first six months	
	Increase frequency of Bank supervision missions to review operations, including more intensive supervision early in the project	World Bank	At least twice a year	
Need for proactive provision of **information**	Undertake regular reporting by the PIUs on implementation	BWDB, BMD, DAE	Ongoing	Lack of information
	Updating the three IA's website with the recent data obtained	BWDB, BMD, DAE	Website regularly updated.	Delays in publishing

and enhanced transparency	from the project			information
	Appoint a communications specialist as part of the PCU and at each PIU	PCU, BWDB, BMD, DAE	Three months after project effectiveness	Delays in implementation of communication strategy
	Adopt and implement a communications strategy	PCU/BWDB, BMD, DAE	Adopt 6 months after communications specialist is on board	
Governance Risks				
Reduce risk of corruption	Enhanced complaints mechanism with reporting established and follow-up guidelines.	BWDB, BMD, DAE	Ongoing	Nature and frequency of complaints
	Set up PSC; Empower PIUs and PCU to execute technical decision.	BWDB, BMD, DAE	Ongoing	Delay of project implementation
Delivery Monitoring and Sustainability Risks				
In adequate budget for long term monitoring and operation and skills to operate the highly sensitive equipment	Measure ratio of Government O&M budget to O&M costs for delivery of weather and climate Services as an indicator of the RF	BWDB, BMD, DAE, Bank	Ongoing	RF identify anomalies
	Provide training to professional staff, local level staff and community	BWDB, BMD, DAE, Bank	By project effectiveness	Lack of a good training plan
	Establish the response/feedback mechanism to address user satisfaction complaints. • Numerous levels of scrutiny: • Midterm and End term Project Evaluations, Regular Monitoring	BWDB, BMD, DAE, Bank PCU, BMD, BWDB, DAE		RF identify anomalies Lack of reporting
Inter-agency and Regional Cooperation Risks				
Need to improve collaboration and information flow between relevant authorities at the regional and national level	Improve ICT and bandwidth	BMD	By Midterm	Status of ICT improvements
	Establish data access broadband	PCU, BMD, BWDB, DAE	By Mid-term	Status of the connection with regional data center
	Establish sub-regional twinning arrangements	PCU, BMD, BWDB, DAE	Throughout implementation	Poor exchange of information over a long period.
	Coordination and cooperation among the relevant agencies at the national level.	PCU/ JTWG meetings convened once a month		
	Establish functional Joint Working Group on Weather,	BMD, BWDB, DAE		

	Water and Agriculture comprising of technical representatives of BMD, BWDB, DAE, BARI, BRRI, BJRI, BSRI and DDM			
	Hire a Project Coordination consultant to ensure the overall coordination	PCU		

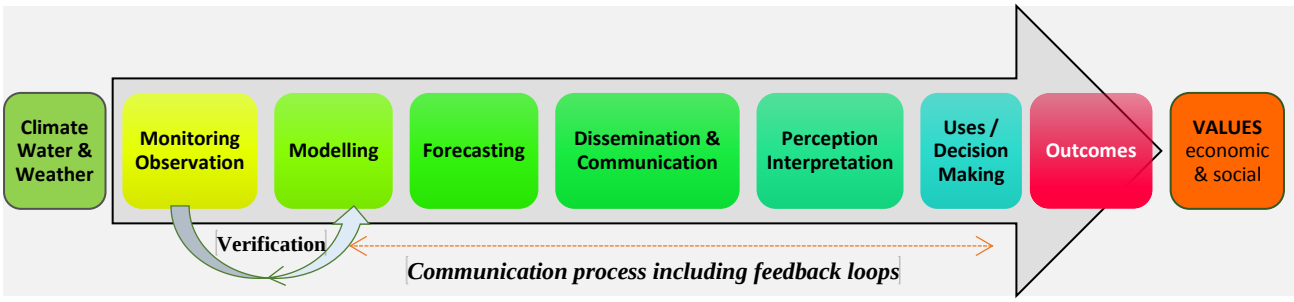
Annex 6: Economic Analysis

Bangladesh Weather and Climate Services Regional Project

1. **Background.** Not including earthquakes and epidemics, the EM—DAT database (http://www.emdat.be/database) records 251 major hydro-meteorological disasters in Bangladesh in the 35 year period 1980-2015. These include cold waves, heat waves, severe winter conditions, riverine floods, flash floods, coastal floods, landslides, tropical cyclones, and convective storms. These average 7.2 events a year with roughly 5,500 deaths, almost 10,000,000 people affected, and nearly US$ 500 million in damages each year. In terms of societal impacts these are in large part related to tropical cyclones averaging 1.4 events per year with nearly 5,000 deaths, 1,500,000 affected, and US$130 million in damages. These tropical cyclone impacts are likely related to a few specific events such as the April 1991 tropical cyclone that struck in the Chittagong region with 130 knot winds and 20 foot storm surge, killing over 138,000, leaving 10 million homeless, and causing over US$1.5 billion (1991 US$) in damages. This also understates the socio-economic impacts of hydro-meteorological events in Bangladesh as the EM-DAT only records major disasters and the vast majority of events are likely smaller lower impact events that could still cumulatively represent similar or even greater magnitudes of impacts.

2. **Economic Value of Improvements in Hydro-Meteorological Services.** A hydro-meteorological value chain shows that value, in economic and social terms, is ultimately at the end of the process that starts with observation of weather, water, and climate through to decision-making and outcomes. As such, the value of an accurate, timely and relevant forecast can only be realized if a beneficial value is achieved at the end of the process. Often, it is assumed that by merely improving observations - through improved technologies for example - an end economic value will be secured.

Figure 6.1: Hydro-meteorological information value chain



3. For the purposes of this analysis in assessing economic benefits of improved hydro-met information, products, and services we assume that these flow through as needed from product creation and dissemination to end-users decision making. As such, the economic and social values that can derive from this project will require not only investing in hard infrastructure but in the entire processes that ensures that outcomes are properly realized and measured.

4. **Economic Analysis**. To estimate the value of strengthening Bangladesh's hydro-

meteorological services, a Cost-Benefit Analysis (CBA) was undertaken. The objective of the analysis was to verify the economic justification for the project, guide the project's priorities and investments during implementation, position the value of Bangladesh's hydro-met services in a wider sociopolitical context, and create a baseline against which progress can be compared.

5. **At the time the economic analysis was undertaken, project costs were estimated at US$127.5 million.** Following an initial year investment of US$10.0 million, the balance of the total investment is allocated across a project implementation period of the remaining five years as shown in Table 6.1. In addition to the initial investment, factors for capital maintenance (e.g., to account for depreciation) and for operation and maintenance (O&M) are estimated to be 10 percent of total costs. This rate may overstate actual costs if not all investment is in depreciable capital (e.g., buildings, equipment) and there is a risk of double counting by including depreciation and O&M as separate items. Hence, this assumption is conservative and may be overestimating the costs. During and beyond implementation, costs will be incurred for capital maintenance (e.g., depreciation of capital) at an assumed 10 percent of total project investment to date (i.e., maximum of US$12.75 million/year) for the time period of the analysis. Costs will also be incurred for operation and maintenance (e.g., operational costs – ongoing labor, energy, maintenance, training, etc.) at an assumed rate of 10 percent of total project investment to date (i.e., maximum of US$12.75 million/year) for the time period of the analysis. As the GOB contribution during project implementation will cover O&M, we calculate additional ongoing O&M starting in 2023.

Table 6.1 shows estimated annual costs, cumulative costs, depreciation, assumed operation and maintenance flows over the first six years of the project in current values (i.e., not discounted to present values) as well as all future years (2023+ costs remain the same for all years of analysis).

Table 6.1: Baseline Cost, Depreciation. O&M Assumptions

Fiscal Year	Annual	Cumulative Cost	Depreciation 10%	O&M 10%	Total Invest, Depr, O&M
2017	10,000,000	10,000,000	1,000,000	0	11,000,000
2018	21,900,000	31,900,000	3,190,000	0	25,090,000
2019	26,900,000	58,800,000	5,880,000	0	32,780,000
2020	36,900,000	95,700,000	9,570,000	0	46,470,000
2021	21,900,000	117,600,000	11,760,000	0	33,660,000
2022	9,900,000	127,500,000	12,750,000	0	22,650,000
2023	0	127,500,000	12,750,000	12,750,000	25,500,000

6. **Benefits:** For the benefit estimates in this phase of the analysis, two estimation approaches were utilized: i) benchmarking approach, and ii) benefit transfer (BT) and value of statistical life (VSL).

7. In prior assessments of the value of hydro-met services the World Bank has used a **benchmarking approach** developed to estimate an order-of-magnitude benefits of reducing damages from weather-related events resulting from hydro-met services. Benchmarking is carried out by first using data and estimates from other countries and expert judgment to define and adjust two benchmarks for each country: a) the average annual direct economic losses caused by hydro-met hazards as a share of GDP; and b) the potential changes in annual losses

with modernization of hydro-met services as a percentage of the total level of losses. In a second step, these factors may be adjusted to account for country-specific estimates of weather and climate conditions, structure of the economy and other factors. These factors will be a function of the weather dependency of the economy (i.e., national economic structure and hydro-meteorological vulnerability) and the current and potentially improved quality of hydro-met products and services (i.e., the efficiency of hydro-met services with and without modernization). The benchmarking analysis is based on a series of exercises conducted in Eastern Europe and Central Asia Region which concluded that the mean annual losses from hydro-met hazards and events varies between 0.1 percent to 1.1 percent of GDP and that that the share of preventable or prevented losses with modernization ranges from 20 percent to 60 percent of total weather and climate-related losses.

8. Using the simplest top down benchmarking approach two different factors are estimated:

    1) *Vulnerability Factor*: Average annual direct economic losses caused by hydro-met hazards as a share of GDP. Bangladesh is one of the world's most hydro-met vulnerable countries and has experienced large scale natural disasters that have had significant impacts on gross domestic product. Based on the existing estimates for ECA countries, experts recommend that a 1 percent annual loss factor is used for Bangladesh.
    2) *Loss Reduction Factor*: Potential changes in annual losses with modernization as a percentage of the total level of losses. While the national hydro-meteorological services in Bangladesh are in need of improvement there has been considerable advancement in reducing the impacts of hydro-met events in the last 30 years in Bangladesh. For the purposes of this analysis, a conservative estimate of 20 percent is used as potential further loss reductions with modernization.
    3) Gross Domestic Product (GDB) of Bangladesh in 2014 was US$173.8 billion (http://www.worldbank.org/en/country/bangladesh)

9. A benchmark estimate of benefits is calculated as the product of these factors: **GDP x Vulnerability Factor x Loss Reduction Factor = Benchmarking Benefit Estimate**

10. As shown in Table 6.2, a top down benchmarking estimate indicates a potential annual value of improved hydro-met services of US$347.6 million/year in Bangladesh. Based on the chosen factors this represents 2/10ths of 1 percent of Bangladesh's GDP.

Table 6.2: Benchmarking Calculation

GDP	US$173.8 billion
Vulnerability Factor	1%
Loss Reduction Factor	20%
Benchmarking Benefit Estimate	US$ 347.6 million

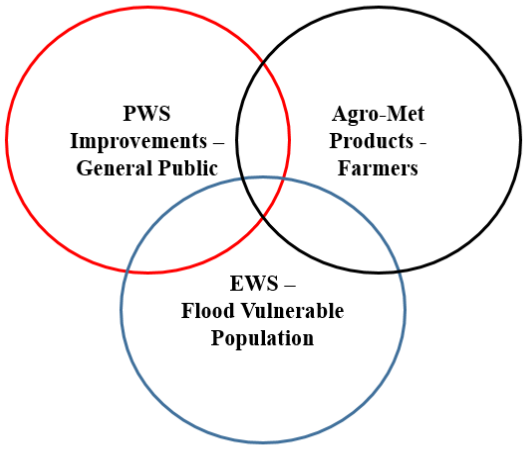
11. The second estimation approach combines benefits transfer and value of statistical life (VSL) estimates for the three components of the proposal hydro-met improvement program. In part this approach uses a common method for valuing nonmarket goods and services known as benefits transfer (BT) where the results of existing valuation studies are transferred from the study context (i.e., Mozambique or Zimbabwe) correcting and adjusting to the current context (i.e.,

Bangladesh). This is the best feasible valuation approach when there is not time and resources for primary data collection and analysis. A number of cautions are relevant when using BT particularly as there is a limited literature on economic values of improved weather forecasting in developing countries. Thus the approach can generate potentially inaccurate or misleading results if not appropriately framed. Obtaining valid and reliable benefit estimates using BT methods can be challenging when differences exist among the types of conditions studied in the primary empirical research (i.e., the study context for the published monetary estimate), and the NMHS context to which we are transferring the results. The approach implemented here is largely a unit-value approach (as opposed to a transfer function) using simplified adjustments based on differences in national income (thus also assuming WTP is linear in income). The assessment is conducted to provide some reference unit values but a targeted analysis is being conducted for this project.

12. The project identifies primary project benefits accruing to (1) members of the general public from improvements in public weather systems (PWS), (2) farmers from improvements in agro-meteorological (Agro-Met) information systems, and (3) vulnerable populations from improvements in community based flood and drought early warning systems (EWS). To derive baseline benefits estimates we used a different approach for each of these benefit areas. For Public Weather Service (PWS) benefits we undertook a benefits transfer (BT) to Bangladesh using value estimates from a study of willingness to pay (WTP) for improved weather services in Mozambique (Lazo 2015)[7]. For an agro-met decision support system (DSS) values we undertook a benefits transfer to Bangladesh using value estimates from Zimbabwe for improved seasonal forecasts (the source was a literature review of the value of climate and seasonal forecasts in Clements et al. 2013). For the value of early warning systems we undertook a benchmarking type evaluation using value of statistical lives saved (VSL) for reduction in hazardous hydro-met related fatalities. Figure 6.2 illustrates these three hydro-met information improvements and benefit areas.

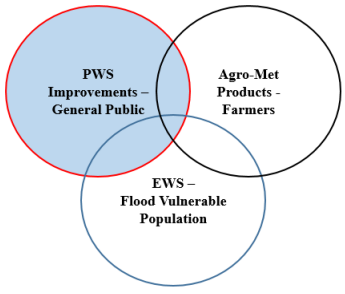
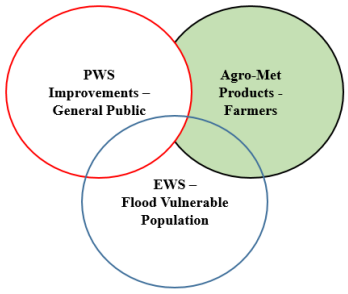
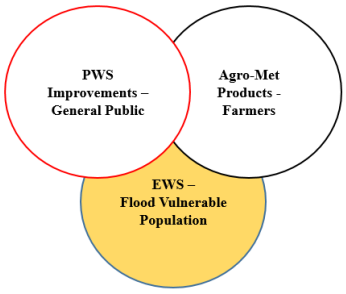
Figure 6.2: Primary hydro-met information improvements and benefit areas

[7] Lazo, J.K., 2015: Survey of Mozambique Public on Weather, Water, and Climate Information. NCAR Technical Note NCAR/TN-521+STR, 236 pp, DOI: 10.5065/D6B56GS4.



13. As suggested by Figure 6.2, there is likely some overlap in the benefits between the different valuation approaches. For instance, many members of the general public are also farmers and will benefit from improved hydromet information regardless of new agro-met products and services. And, members of the public will also be the primary beneficiaries of improved EWS for floods and droughts. And further, farmers will benefit from early warning on floods and droughts regardless of new agro-met products and services. While we currently do not have empirical indications of these potential overlaps, we assume a 20 percent overlap between pairs of benefits estimates and in aggregating benefits estimates we adjust downward as indicated in Figure 6.3. First we take 100 percent of the WTP values, then add 80 percent of the agro-met values (adjusting for the assumed 20 percent overlap with WTP), and then add 60 percent of the EWS values (adjusting for the assumed 40 percent overlap with WTP and agro-met values – ignoring the small area where all three benefit areas may overlap). Future empirical work could evaluate the degree to which such overlap may exist and adjust accordingly.

Figure 6.3: Primary hydro-met information improvements and benefit areas

		
100% of estimated PWS benefits from Mozambique WTP (willingness-to-pay) study (blue area)	80% of estimated agro-met benefits (green area = agro-met benefits minus overlap with PWS)	60% of hydro benefits (orange area = EWS benefits minus overlap with PWS and agro-met)

14. **Value to Households for Public Weather Services (PWS):** For an estimate of benefits from improvements in PWS products and services we identified two studies from which to transfer values to the current project. The first set of values transferred are from a recent survey conducted in Mozambique for a World Bank project with similar objectives as this one. The values were estimated for households' willingness to pay for improvements to national hydro-meteorological services. Using a contingent valuation method (CVM) question for a single program but with two different versions representing an intermediate improvement and a maximal improvement, total WTP was estimated for the maximal improvement program (not adjusting upward for potential scenario rejection) of 40.89 MT (metical) per year per respondent. This value is equal to US$1.16 (US$0.53-US$2.62, 95 percent confidence interval (CI)). An income ratio conversion from Mozambique to Bangladesh using 2013 per capita GDP estimates from the World Bank website was used to make the adjustment (Table 6.3). This yields a Bangladeshi WTP estimate for hydro-met forecast improvement equal to US$1.84 (US$0.84-US$4.15, 95 percent confidence interval). This is taken as a per-household estimate aggregated across all households in Bangladesh (32,288,660) to get a national benefit estimate of US$59,296,282.

Table 6.3: Conversion of Mozambique CVM Household WTP Based on Income Ratios

		Central Estimate	Lower CI	Upper CI
	WTP	1.16	0.53	2.62
GDP per capita (current US$)	Mozambique (2013)	605.00	605.00	605.00
	Bangladesh (2013)	957.80	957.80	957.80
Income Ratio: Bangladesh/Mozambique		1.58	1.58	1.58
	Adjusted Bangladesh WTP	1.84	0.84	4.15
Households		32,288,660	32,288,660	32,288,660
Bangladesh Aggregate National WTP (US$)		59,296,282	27,092,267	133,927,810

15. **Benefits of Agro-Met Decision Support System:** The project proposes to support the development of a decision support system (DSS) for agro-meteorological services at the Department of Agricultural Extension (DAE). A DSS would provide information for agricultural decision making at all time scales (e.g., days to annual) and thus generate benefits in a range of decision situations. For an estimate of benefits of an Agro-Met DSS we add a value estimate for seasonal forecasts (from Clements et al 2015) and scale that up based on literature suggesting that value of forecasts in agriculture are greater for short term decision making than for seasonal forecasts. As indicated in Clements et al.[8] (2013 – Exhibit 5) Makaudze (2005)[9] derives a per

[8] Clements, J., A. Ray, and G. Anderson. 2013. The Value of Climate Services Across Economic and Public Sectors: A Review of Relevant Literature. Prepared for: United States Agency for International Development.

household WTP of "[US$]$0.44 – 0.85 in willingness-to-pay by households in Zimbabwe for improved seasonal forecasts." Using a midpoint of USD$0.645 and converting to Bangladesh based on a Bangladesh/Zimbabwe income ratio of 1.058[10] yields a per household WTP of US$0.6823/year. In their review of literature of the benefits of climate services, Clements et al. find similar values for seasonal forecasts in other countries and contexts.

16. In a summary of the extant literature on the value of weather forecasts in agriculture, Katz[11] provides per hectare benefit estimates for a range of crops, forecasts, and decision contexts. A qualitative assessment of this literature indicates benefits from short term forecasts (days to weeks) in general at twice or more the value of seasonal forecasts (in large part forecasts of El Nino). Based on this assessment and a conservative approach we triple the per household WTP estimate from Makaudze to capture some of the short term benefits of an Agro-Met DSS as well (i.e., value of seasonal forecasts plus twice that as value of shorter-term forecasts). We thus use a per household WTP for the Agro-Met DSS of US$2.0468. With 32,288,660 households in Bangladesh, 60 percent of these in agriculture, and assuming that one-third (33.3 percent) of those households use the Agro-Met DSS yields annual benefits of US$13,204,223.

17. Agriculture and Forestry represented about 15.3 percent of Bangladesh's GDP between 2008 and 2013 or 569 billion taka. Based on current exchange rates this is over US$7 billion. The benefits from the Agro-Met DSS are thus about 0.180percent (i.e., less than 1 percent) of agricultural output. Given the vulnerability to weather variability of agriculture in Bangladesh and the potential for improved decision making, this represents a lower bound estimate.

18. **Benefits of EWS in Reducing Loss of Life:** A primary benefit of enhanced early warning systems (EWS) is for the protection of life in impending hazardous conditions such as typhoons, floods, tornadoes, and landslides. The EM-DAT database (http://www.emdat.be/) "contains essential core data on the occurrence and effects of over 18,000 mass disasters" by type, year, and country (including Bangladesh). EM-DAT only records major disasters (e.g., at least 10 fatalities or 100 or more people affected/injured/homeless) and so will not capture smaller events. Counting only meteorological, hydrological, and climatological events and not counting two years of exceptional natural disasters in Bangladesh (1970 and 1991), in the four decades from 1965 to 2014, an average of 2,618 individuals died in natural disasters in Bangladesh. Visual examination of the data indicates that the number of fatalities has been falling over time. This has occurred even with increased population and is likely due in part to prior advances in early warning systems, hazard mitigation, and response. In addition, regression analysis indicates that fatalities have been falling over time falling but at a decreasing rate (i.e., fatalities have

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[9] Makaudze, E.M. 2005. Do Seasonal Climate Forecasts and Crop Insurance Matter for Smallholder Farmers in Zimbabwe? Using Contingent Valuation Method and Remote Sensing Applications. PhD Dissertation. Ohio State University.

[10] Based on the ratio of Bangladesh to Zimbabwe per capita income in 2013 from http://data.worldbank.org/indicator/NY.GDP.PCAP.CD

[11] Katz, R. Economic Value of Weather and Climate Forecasts: Case Studies: Agriculture. http://www.isse.ucar.edu/staff/katz/agriculture.html (accessed March 23, 2016)

fallen but will not fall to zero).[12] In the decade 2005-2014 an average of 722 individuals died each year in major disasters (driven largely by Cyclone Sidr in 2007 for which EM-DAT indicates 4,275 fatalities). Not counting Cyclone Sidr, in the decade 2005-2014 an average of 295 individuals died each year in major disasters. (As smaller events that are not recorded in EM-DAT are likely more impactful in aggregate than major disasters this analysis is likely an underestimate of impacts and thus of benefits from impact reductions.) Assuming that 10 percent of these fatalities could be avoided with the improvements in project related EWS, this represents 29.5 fewer fatalities each year on average. Note that having excluded the major disasters (e.g., disasters in 1970, 1991, and Cyclone Sidr in 2007) from the fatality measures we are likely understating the potential value of improved EWS.

19. To adjust VSL estimates from the US to Bangladesh we use Eq. 1 from Hammitt and Robinson (2011)[13], where "elasticity" is the income elasticity of VSL meaning the per cent change in VSL estimates as income changes by one percent. In this case Bangladesh is indexed as Country B and the US is indexed as Country A. Eq. 1: $VSL_B = VSL_A * (Income_B / Income_A)^{elasticity}$

20. For VLS_A, we use a policy based recommended median point estimate of VSL of US$9.1 million[14]. We use a midpoint estimate of the income elasticity of VSL of 0.40 from Doucouliagos et al. 2014[15]. And we use median GDP per capita from the World Bank[16] for US and Bangladeshi income. This yields a Bangladeshi VSL of US$ 1,899,024. Applying this to the average fatality reduction of 29.5/years yields an annual expected benefit of US$ 56,021,195.

21. Table 6.4 shows the summation of the three benefits estimates qualitatively adjusted for potential double counting. An annual benefit upon full program implementation of US$103,472,378 is used in the subsequent benefit-cost analysis.

Table 6.4: Summary of Baseline Benefit Estimates

	Aggregate Annual Benefits	Adjustment for Double Counting	Adjusted Benefits for Aggregation
National WTP for PWS	59,296,282	100%	59,296,282
Annual WTP for Agro-Met DSS	13,204,223	80%	10,563,378

[12] In "Reduced death rates from cyclones in Bangladesh: what more needs to be done?" Ubydul Haque et al. analyze reductions in typhoon-related fatalities in Bangladesh (http://www.who.int/bulletin/volumes/90/2/11-088302/en/) noting the possibility of further reductions.

[13] Hammitt, J.K. and L.A. Robinson, 2011. "The Income Elasticity of the Value per Statistical Life: Transferring Estimates between High and Low Income Populations". *Journal of Benefit-Cost Analysis*. Vol. 2(1) Art 1.

[14] Rogoff, P. and K. Thomson.2014. Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in U.S. Department of Transportation Analyses – 2014 Adjustment. US DOT. https://www.transportation.gov/sites/dot.gov/files/docs/VSL_Guidance_2014.pdf.

[15] Doucouliagos, H. T.D. Stanley, and W.K. Viscusi. 2014. "Publication selection and the income elasticity of the value of a statistical life." Journal of Health Economics. 33:67–75.

[16] Source: http://data.worldbank.org/indicator/NY.GDP.PCAP.CD 2011-2015 average).

VSL from EWS	56,021,195	60%	33,612,717
Baseline Aggregate Benefits (PWS+DSS+EWS)			103,472,378

22. Another recent study, this in Vietnam, estimates the benefits to households of an improved cyclone warning service through the use of a discrete choice experiment survey with over 1,000 respondents. The analysis examines issues with respect to preference heterogeneity, variation in benefit estimates based on analysis approaches, potential bequest and altruistic values, and impacts of value elicitation on benefit estimates. The valuation focuses only on improvements in tropical cyclone information which is only a subset of likely improvement in Bangladesh and would only apply directly to cyclone prone areas in Bangladesh (approximately 40 percent of Bangladesh population). As such, and for the purpose of this preliminary analysis, it is assumed that non-cyclone vulnerable populations in Bangladesh have comparable values for the range of other hazards subject to improved forecasts (i.e., riverine, urban, and flash floods, landslides, drought, extreme winds, etc.). This may represent a lower bound estimate though as the Bangladesh program proposes a much wider range of information improvements including hydrological and climatological that are not considered in the analysis for Vietnam. The results for Vietnam for annual WTP are US$0.61 for a medium improvement and US$0.90 for maximal improvement. Values are expressed as thousands of Vietnamese Dong (VND) (as of July 17, 2015 1,000 VND = US$0.0459672). The value elicitation was for a one-time payment so the WTP estimates are converted to an annualized value using a 12 percent rate of discount (r) and dividing the one-time payment by 1/r.

23. Table 6.5 illustrates the conversion of per household WTP in Vietnam to Bangladesh using simple income ratios and then the aggregation to a national benefit estimate for the medium and maximal improvement programs. The results of this exercise indicate a range of point estimates of WTP for the medium and maximal improvement programs that when transferred to Bangladesh and aggregated indicate potential national WTP of US$9.9 million to US$14.6 million depending on program attributes.

Table 6.5: Conversion of Vietnam CVM Household WTP Based on Income Ratios

	Program	Medium Improvement	Maximal Improvement
	WTP	0.61 US$	0.90 US$
GDP per capita (current US$)[17]	Vietnam (2013)	1,908.6	1,908.6
	Bangladesh (2013)	957.80	957.80
Income Ratio: Bangladesh/Vietnam		0.50	0.50
Adjusted Bangladesh WTP		0.31	0.45
Households		32,288,660	32,288,660
Bangladesh Aggregate National WTP		9,884,160	14,583,187

24. **CBA Results.** Table 6.6 below summarizes the key variables for the benefit-cost analysis including timing of benefits and costs and the discount rate. For all calculations, real values were

[17] http://data.worldbank.org/indicator/NY.GDP.PCAP.CD accessed July 17, 2015.

applied that do not factor in inflation or potential changes in exchange rates. A discount rate of 12 percent was applied as a baseline discount rate as is required by the Bank's guidelines on economic analysis. However, the Team also looked at the discount rates that could be applicable for Bangladesh. Information on the website Trading Economics suggest private sector Bangladeshi interest rates range from a low of 4.50 to a high of 8.75 with an average of 7.25 percent during the period 2008 – 2015. Applying baseline rates of 10-12 percent is therefore a conservative estimate for comparing an Internal Rate of Return (IRR) to an Economic Rate of Return (ERR).

Table 6.6: Key Variables for Benefit Cost Calculations

Key Variables	**Value**
First year of costs	2017
First year cost of investment (millions US$)	10.0
Subsequent cost of investment (next five years) (millions US$)	See Table 6.1
Timeline of initial investment (Years)	6
Annual depreciation (% of initial investment)	10%
Annual maintenance and repair (% of initial investment)	10%
Project analysis period	100 years
Timeline of increasing O&M costs (starts with investment) (Years)	6
Households in Bangladesh [a]	32,288,660
Benefit Estimates (Annual US$)	
Top-Down Benchmarking	347,600,000
Sector Specific Benchmarking Calculation	347,252,400
Working Group Benchmarking Calculation – Step 1	750,168,418
Working Group Benchmarking Calculation – Step 2	724,924,912
Baseline Benefits	
Mozambique CVM Household WTP - Central Estimate (WTP for PWS)	59,296,282
WTP for Agro-Met DSS	10,563,378
VSL from EWS	33,612,717
Baseline Aggregate Benefits (PWS+DSS+EWS)	103,472,378
Mozambique CVM Household WTP - Lower CI	27,092,267
Mozambique CVM Household WTP – Upper CI	133,927,810
Vietnam CVM Household WTP – Medium Program	9,884,160
Vietnam CVM Household WTP – Maximal Program	14,583,187
Discount rate	
Discount rate – Base Case	12%
Discount rate – Lower value for sensitivity analysis	3%

[a] The World Bank (http://data.worldbank.org/country/bangladesh) indicates a population of 156,600,000 in Bangladesh and the Bangladesh Bureau of Statistics http://www.bbs.gov.bd/RptHIES_2_1.aspx?page=/PageReportLists.aspx?PARENTKEY=73 indicates an average 2005 household size of 4.85 thus we use 32,288,660 as the number of households.

25. Using the baseline analysis variables indicated previously and the Baseline Aggregate Benefits (PWS+DSS+EWS) a baseline was established (see Table 6.7).

Table 6.7: Baseline Variables for Baseline Benefit-Cost Calculations	
Key Variables	**Value**
First year of costs	0
First year cost of investment (millions US$)	10.0
Subsequent cost of investment (next four years) (millions US$)	See Table 6.1
Timeline of initial investment (Years)	6
Annual depreciation (% of initial investment)	10%
Annual maintenance and repair (% of initial investment)	10%
Project analysis period	100 years
Timeline of increasing O&M costs (starts with investment) (Years)	6
Baseline Aggregate Benefits (PWS+DSS+EWS)	103,472,378
Discount rate	12%

26. Table 6.8 shows the results from the baseline benefit-cost calculations. A net present value of US$414.3 million and a benefit-cost ration (BCR) of 2.67 indicate that the project is economically viable. The present value to households is US$661.7 million using a time horizon of 100 years for the project with basic assumptions and a 12 percent discount rate. A present value of total costs of US$247.4 million was estimated using the same assumptions and discount rate as for the benefits. The net present value (NPV) of the project is US$414.3 million. The Internal Rate of Return (IRR) is 75.07 percent. This IRR represents a significantly better return than a relevant comparison Economic Rate of Return (ERR) of private sector Bangladeshi interest rates averaging 7.25 percent.

Table 6.8: Results of Baseline Benefit Cost Calculations	
Total Present Value (PV) Benefits	661,748,359
Total PV Costs	247,429,343
Net Present Value (NPV)	414,319,016
Benefit-Cost Ratio (BCR)	2.67
Internal Rate of Return[18]	75.07

27. A **sensitivity analysis** was conducted using i) different benefits estimates; ii) a lower discount rate; iii) an analysis of no ongoing investment in program upkeep and operations and maintenance; and iv) a shortened analysis timeline. Using a lower bound benefit estimate from Vietnam and all other baseline CBA parameters generates a NPV of (US$184.2 million) and a

[18] The IRR was generated using an Excel spreadsheet data function that choose the variable value in one cell (parameter cell) to set a specific other cell (target cell) to a predetermined value. In this case, using the spreadsheet that calculates project benefit and cost flows and discounts these, the value of the Discount Rate (parameter cell) is found that equalizes the present value of costs and the present value of benefits (i.e., sets the NPV cell (i.e., the target cell) equal to zero).

BCR of 0.26 (Table 6.9). If it could be ascertained that this was a best estimate of benefits to be realized in Bangladesh this would bring the program into question with respect to standard CBA policy criteria.[19] On the other hand, using the largest benefit estimate from a benchmarking approach, a significant NPV of US$4.6B and BCR 19.4:1 are derived.

Table 6.9: Sensitivity Analysis with Alternate Benefit Estimates			
	Baseline	Lower Bound	Upper Bound
Annual Benefits	103,472,378 (PWS+DSS+EWS)	9,884,160 (Vietnam Medium Program)	750,168,418 (Benchmarking)
Total Present Value (PV) Benefits	661,748,359	63,213,263	4,797,635,170
Total PV Costs	247,429,343	247,429,343	247,429,343
Net Present Value (NPV)	414,319,016	-184,216,080	4,550,205,827
Benefit-Cost Ratio (BCR)	2.67	0.26	19.39

28. The choice of a 12 percent discount rate is based on a review of other BCAs in developing countries. The 12 percent rate is likely set higher than that used in developed in countries to attempt to control for project risk (e.g., possible failure of project to achieve projected benefits) and to avoid "crowding" out private sector capital which likely incurs a similarly high rate of interest. This rate (12 percent) may thus not reflect broader social rates of time preference. Table 6.10 illustrates the same baseline BCA but using a lower discount rate (3 percent) that may more closely reflect discount rates in developed countries. Using a 3 percent discount rate rather than 12 percent indicates a NPV of US$3,022.6 million and BCR of 3.57, as may be expected (given that benefits generally incur in future years compared to upfront investment costs) there is a higher NPV and BCR using a lower discount rate.

Table 6.10: Sensitivity Analysis with Alternate Discount Rate		
	Baseline	Alternate
Annual Benefits	12%	3%
Total Present Value (PV) Benefits	661,748,359	3,022,626,044
Total PV Costs	247,429,343	845,891,429
Net Present Value (NPV)	414,319,016	2,176,734,615
Benefit-Cost Ratio (BCR)	2.67	3.57

29. Operation and Maintenance is a critical issue with project implementation as it requires an internal commitment by the Government to support the ongoing, long-terms costs of the project.

[19] The Vietnam estimates are only for values of meteorological forecasts and warnings for tropical cyclones and this would not represent potential total benefits of the program in Bangladesh to improve hydrological, meteorological, and climate information across all phenomenon and areas. In other words the Vietnam estimates are likely a significant understatement of potential benefits to Bangladesh.

Given the likely increase in costs necessary to maintain capital and equipment as well as increased ongoing operations and maintenance in the baseline analysis, the assessment assumes a 10 percent costs for depreciation (e.g., to maintain initial project equipment at adequate levels) and 10 percent costs for operations and maintenance. As an alternative analysis, it is assumed that after the first five years there is no ongoing O&M or investment to counter depreciation. In Alternate 1 it assumed that benefits end immediately after the sixth year and in Alternate 2 there is an assumption that these benefits diminish to zero over five years. As shown in Table 10, the NPV and BCR is reduced considerably and the BCR less than 2.0. This indicates that if there is not a commitment to ongoing support of the initial investment the policy decision may question the initial investment.

Table 6.11: Sensitivity Analysis with No Ongoing O&M or Depreciation			
	Baseline	Alternate 1 – Benefits End After Yr 6	Alternate 2 – Benefits Diminish After Yr 6
Total Present Value (PV) Benefits	661,748,359	172,484,871	250,985,029
Total PV Costs	247,429,343	126,853,986	126,853,986
Net Present Value (NPV)	414,319,016	45,630,885	124,131,043
Benefit-Cost Ratio (BCR)	2.67	1.36	1.98

30. For the baseline analysis benefits and costs are projected over 100 years as this is clearly a long lived investment. To assess the impact of the length of the analysis timeline a sensitivity test was conducting using a 15 year project analysis rather than the 100-year baseline approach. As shown in Table 6.12 the basic policy conclusion does not change although the NPV and BCR fall.

Table 6.12: Project Analysis Over 15 Years rather than 100 years)	
Total Present Value (PV) Benefits	485,322,433
Total PV Costs	203,950,483
Net Present Value (NPV)	281,371,951
Benefit-Cost Ratio (BCR)	2.38

31. Due to the nature of the program (to support an ongoing modernization program), alternative designs were not evaluated. The analysis is based on the assumption that a particular investment has been identified as least cost.