CGIAR Challenge Program on WATER & FOOD

Revised Proposal

Project: G4. Assessment of the impact of anticipated external drivers of change on water resources of the coastal zone

Ganges Basin Development Challenges of the CPWF

April 2011

INSTITUTE OF WATER MODELLING
IWM

PART A: SUMMARY

1. Project Data

BDC: Ganges Basin Development Challenge
Project Title: Assessment of the impact of anticipated external drivers of change on water resources of the coastal zone
Project Lead Organization: Institute of Water Modelling, Dhaka, Bangladesh
Consortium partners (who receive budget): 1. International Water Management Institute, Colombo, Sri Lanka; 2. Institute of Water and Flood Management, BUET, Dhaka, Bangladesh; 3. Bangladesh Water Development Board, Dhaka, Bangladesh **Project Leader (name and contact details):**
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Duration: 36 months
Target start date: 30 April 2011
Finish date (not later than 30 April 2014): 30 April 2014
Maximum budget requested from CPWF (in US$): 1,000,000 (one million)
Any matching funds offered (provide brief explanation): 100,000 UD$ (Contribution shall be in kind from the lead and partner institutions in terms office space, data, and available software)

2. Project Summary

Rationale: This project will address the important external drivers that influence water resources of the coastal zone and to assess the anticipated changes in flooding, drainage congestions, salinity intrusion, water availability, sedimentation and risk of inundation of cyclone induced storm surge as a consequence of these drivers. The water resources in the coastal zone of the Ganges basin are vital for crop production, ecosystem sustenance and livelihoods. These resources are largely shaped by tidal dynamics and upstream flows, and are affected by changes in the natural, socio-economic and institutional systems. It is important to identify and prioritize these drivers, and assess their effects on water resources towards building resilient water governance and management to cope with the projected future conditions.

Key activities of the project are: review of the existing model studies, literature, available data and collection of data; identification and ranking of external drivers; adaptation, calibration and validation of Soil Water Assessment Tool (SWAT) and Water Evaluation And Planning System (WEAP) models for assessing baseline hydrological conditions; setup, calibration and validation of Ganga-Brahmaputra-Meghna (GBM) basin model, South West Regional Model (SWRM), and Bay of Bengal (BoB) model; assessment of water flow pattern, salinity distribution, storm surge risk, sedimentation pattern in baseline and projected conditions; assessment of adaptation strategies to changes caused by key drivers; and exploration of policy implications for adaptation strategies and water governance.

Key outputs of the project include: list of key external drivers; climate change projections for the study region; projection of scenarios for land-use and climate change; flow availability; salinity zoning map of the coastal Ganges; flood depth-duration map; water storage volume inside polders; storm surge risk map; sedimentation rate in peripheral rivers; plan for improvement of khal system, sluices and embankments; operation rules for sluices.

Methodology: This project will develop a comprehensive list of external drivers based on past researches, global literature review, interaction with the major stakeholders and peers. This list will then be put under a well designed priority and ranking criteria for identification of the key drivers contributing to about 85-90% of the anticipated changes. On the basis of performance and field validation, appropriate models will be selected for studying the baseline conditions and effects of external drivers on salinity intrusion, water availability, drainage congestions and risk of inundation due to storm surges. The models available with IWM and partner organizations will be utilized to simulate the baseline and changed conditions in 2020, 2030 and 2050. The study will be conducted at two scales: regional level for the coastal regions of Bangladesh and at local level for the selected polders. On the basis of the anticipated impacts different adaptation strategies will be devised such as improvement of the land-use patterns, drainage canals, operation of sluices, strengthening of embankments, dredging, restoration of dry season freshwater flow for flushing salinity as well as restoration of the ecosystem. Specific adaptation strategies for choice and selection of the crops/aquaculture during different seasons and their salinity and submergence tolerance will be developed in consultation with G2 and G3 projects. Policy implications on these strategies and a required governance structure will be also explored in a participatory way. The implications of major national policies in the realm of national water policies, agricultural policy, environment policy, disaster management policy, and climate change adaptation strategy and action plan (BCCSAP) will be particularly emphasized.

Likely Impacts: The output of this project is expected to be reflected in water use of local farmers and fishermen, water management by water control system managers and planning of the policymakers.

PART B: PROJECT DESCRIPTION

3. BDC Goals to which the project will contribute

The BDC goal is to reduce poverty and improve food security through improved water governance and management, and more productive and diversified agricultural-aquaculture systems for more resilient communities in the fresh-brackish water coastal zones of the Ganges delta. The present and future agriculture-aquaculture systems in these regions depend, to a large extent, on the availability of fresh water which in turn is governed by a number of external drivers. These interactions are likely to be more pronounced in future. The existing knowledge of the anticipated role of these external drivers on water availability and health of the coastal zones is limited. Through an improved understanding, this project shall help in development of appropriate agricultural systems, design suitable water infrastructure and its operating practices leading to climate resilient communities in the vulnerable coastal zones of the Ganges delta.

4. Research questions and methodologies

In the first instance this project shall identify and prioritise the key external drivers of change in hydrology, water resources and soil and water quality in the coastal zone of Bangladesh. Furthermore, through rigorous data collection and state-of-the art modelling, the project shall assess the impact of these key external drivers for the selected study polders. The project shall also develop scenarios for the near long term future projections to facilitate physical, governance and policy interventions and targeted investments.

For ease of understanding, we have disaggregated this complex research and development problem into four research questions. The following paragraphs describe these questions along with the proposed research methodology to achieve the desired outputs and outcomes:

1. What are the key drivers of change in the hydrology and performance of the system?

The hydrologic system in the coastal regions of Bangladesh is very vulnerable to impact of external drivers. The performance of the system varies seasonally, annually and especially during the occurrence of extreme events. The project will develop a comprehensive list of external drivers based on past researches, literature review, and interaction with the peers and major stakeholders. This list will then be put under a well designed priority and ranking criteria for identification of the key drivers contributing to about 85-90% of the anticipated changes. We shall also consult with TWG on global drivers in selecting and prioritizing the key drives. We shall organize a workshop of the major professionals and stakeholders (including the project leaders of G1, G2, G3 and G5) to seek their inputs, advise and finalization of the priority ranking and final selection of the drivers. Only the selected drivers will be considered in this study.

We will visit the Indian part of the Ganges to gain knowledge about the situations in the upstream and experience of the people in the unpoldered regions of coastal Ganges.

Based on previous studies the likely external drivers can be divided in two broad categories: (1) biophysical drivers such as land-use change, change in water use and water management practices, climate change impacts (change in temperature and precipitation, sea level rise), urbanization, industrialization, change in transboundary flow; and (2) socio-economic drivers including demographic change, change in water governance, shift in political economy of water, change in water/coastal zone policies and so on. There are interdependences among

the biophysical and socioeconomic drivers. The future scenarios simulated in this study will be devised considering combination of various drivers.

2. What are the effects of anticipated changes on flooding, submergence, sedimentation, salinity intrusion and water availability in the different polders of the coastal zone?

The project will review and evaluate models available in-house, with the partner organizations and globally. Based on the performance and suitability appropriate models will be selected for studying the effects of the drivers of changes. For flood, submergence, sedimentation and salinity intrusion the study will use the GBM basin model, regional models, the Bay of Bengal and RCM models based on MIKE basin, MIKE 11, and MIKE 21FM. (Details are available in Annex-I). Soil Water Assessment Tool (SWAT) and Water Evaluation And Planning Process (WEAP) models will be used for assessing the impacts of land-use changes on flow. The effect of storm surges of varying intensities and frequencies on polder overtopping and inundation will be assessed using the Bay of Bengal model based on MIKE 21. These models will be utilized to simulate the baseline and projected conditions in 2020, 2030 and 2050. The study will be conducted at the regional level for the coastal regions of Bangladesh as well as in three selected polders (Polder No.3, 31 & 43/2f, see Figure 1: Study area map of G4). The projection years and the polders have been selected during the proposal development workshop through communication among the projects. Water flow, salinity, sediment and storm surge model results will be calibrated with respect to measured data and verified in consultation with the local communities. The preliminary findings will be discussed with G1, G2 and G3 (through G5) to obtain their feedbacks which will be incorporated in G4 research for further refinement of the model results.

3. What are the implications of adaptation strategies for different anticipated changes?

It is now well recognised that the existing adaptation strategies are inadequate to cope up with the enhanced magnitude and increased frequency of the impacts of the anticipated changes. The project shall employ a resilience framework to study the future impacts and devise appropriate short, medium and long-term adaptation strategies. In the beginning, the resilience of different agro-hydrological system for the southwest region and indentified polders will be analyzed. Based on the resilience and the anticipated impacts different adaptation strategies will be devised such as improvement of drainage canals, operation of sluices, strengthening of embankments, dredging, and restoration of dry season freshwater flow for flushing salinity as well as restoration of the ecosystem. Specific adaptation strategies for choice and selection of the crops/aquaculture during different seasons and their salinity and submergence tolerance will be developed in consultation with G2. Collaboration shall be developed with G3 and G5 projects for information on community/ institutional management of the resources and the operation of the water infrastructure and its governance at the polder level. Implications of these adaptation strategies will be determined using the models and stakeholder consultation. Polder-specific impacts and economic implications will be also analyzed. These upscaling and downscaling will be conducted through G5. Moreover, linkage with TWG on resilience will be established through G5 in order to devise resilience strategies.

4. What are the implications of policy changes and its applications to cope with anticipated changes? What strategies can be put in place to influence policy makers and stakeholders to adapt to anticipated changes?

The implications of major national policies including the national water policies, agricultural policy, environment policy, disaster management policy, climate change adaptation strategy and action plan (BCCSAP), and water sharing agreements will be reviewed to identified their specific relevance to the present context and to determine what changes may be effective in coping with the anticipated changes. Specific development programs like IPSWAM, WAMIP, and CEIP, and those being conducted by LGED, Department of Fisheries and other organizations will be also analyzed to identify possible policy changes.

The project shall then endeavour to develop potential strategies for consideration of the policymakers and major stakeholders involving G5. These strategies, both short and long term, shall be specific to the identified polders, for the south west region as a whole and Bangladesh. The project shall conduct a number of well-designed and targeted policy dialogues, round tables, one-to-one meetings with the key change agents and polder level meetings with the key stakeholders for familiarising them with the external drivers of change and their potential future impacts on water resources. These upscaling and downscaling will be conducted through G5. The project shall also develop high quality policy and media briefs, and electronic and published communication material for facilitating the informed decisions on policy changes. Extensive field visits and interaction meetings of the water control agencies and policymakers will be conducted to influence policymakers and stakeholders to adapt to anticipated changes. National stakeholder workshops and local training sessions will be conducted to disseminate the effects of anticipated changes on water resources and importance of changing the policies to cope with anticipated changes.

5. Links to previous and ongoing work

A number of studies were carried out in the Ganges basin and study results are available. However, these studies did not address the availability of flow and storage capacity for crop planning and management. There is a lack of continuity of assessing implications of external drivers on water availability and salinity intrusion. Assessment of implication of recent projection of climate change on water resources has not been addressed in the Ganges basin.
The IPCC 4th Assessment predicted seasonal percentage precipitation change occurring over a period of three decades for South-East Asia which can be very useful in developing climate change scenarios in the present study (Cruz et al., 2007). However, this prediction is for entire South-East Asia and not specifically for Bangladesh. The projections are summarized in the following table.

Table 1: 4th IPCC Predicted precipitation for the next 100 years (the values represent change of precipitation in percentage)

Sub- regions	**Season**	**2010 - 2039**		**2040 - 2069**		**2070 - 2099**	
		A1FI	**B1**	**A1FI**	**B1**	**A1FI**	**B1**
South Asia	DJF	-3	4	0	0	-16	-6
	MAM	7	8	26	24	31	20
	JJA	5	7	13	11	26	15
	SON	1	3	8	6	26	10

Note1: DJF: December January February, MAM: March April May, JJA: June July August and SON: September October November

Note2: A1 Scenario – based on homogeneous world of very rapid economic growth, high global population that peaks in mid-century and the rapid introduction of new and more efficient technologies. Based on emission it is divided into three categories such as A1Fl, A1T and A1B. A1Fl – Based on fossil fuel intensive – represent very high emission

B1 Scenario: based on convergent world with the same global populations as in A1 but with rapid change in economic structures and the introduction of clean and resource-efficient technologies. Special emphasis is given on global solution to economic, social and environmental sustainability including improved equity. It represents very low emission.

Key lessons learned:

- According to IPCC estimates the winter precipitation is likely to decrease while summer and monsoon precipitation increasing significantly.
- The temperature has an overall increasing trend throughout.

CEH et. al (2007) completed a study titled "Impact of CLimate And Sea Level Change in part of the Indian Sub-Continent (CLASIC)", in which they used a number of RCMs (PRECIS and HadRM2) together with a number of GCMs (CGCM2, CCSRNIES, GFDL, HadCM3 and CCCma) to assess impacts of climate change in the Ganges, Brahmaputra and Meghna (GBM) basins.

Key lessons learned:

- When simulated in the GBM region, the GCMs results had some uncertainties and inconsistencies among them; whereas the RCMs could consistently simulate the effects in the Himalayas.
- The PRECIS and HadRM2 models were simulated for different climate change scenarios and predicted precipitation for future dry and wet season precipitations. The PRECIS model under SRES A2 scenario showed a 14.8% decrease in dry season precipitation and a 16.1% increase in wet season precipitation in 2050s. The HadRM2 model with a scenario of 1%/year increase in CO2 from 1990 onwards showed a 17.3% decrease in dry season precipitation and a 10.1% increase in wet season precipitation for the same projection period.

World Bank completed a research project titled "Bangladesh Economics of adaptations to climate change" (World Bank, 2010). This project aimed at assessing the effects of climate change on flooding, water-logging, salinity intrusion and storm surge level in the coastal area of Bangladesh. In this project different adaptation strategies were devised and their effectiveness was assessed using available Ganges-Brahmaputra-Meghna Basin, Southwest regional (Ganges delta) and Bay of Bengal models.

Key Lessons Learned:

- Cyclone induced storm surge overtops a large number of coastal polders with and without climate change and sea level rise conditions.
- Salinity front moves landward considerably due to sea level rise and freshwater pockets in the coastal area are likely to be lost.
- A good number of coastal polders are likely to experience drainage congestions.

Asian Development Bank (ADB) conducted a study on "Bangladesh: Strengthening the Resilience of the Water Sector in Khulna to climate change" (IWM and Alterra, 2010). The project was aimed at assessing the impacts of climate change on drainage, water availability, and the salinity situation in Khulna City; providing adaptation options based on social, economic, public health and urban planning aspects; and conducting workshops and trainings to develop capacity of relevant stakeholders/agencies to combat the impacts of climate change scenarios. The study considered A2 and B1 scenarios of IPCC to simulate the models for 2030 and 2050 conditions.

Key Lessons Learned:

- The dependable river flow decreased significantly for the scenarios at the study locations.

- In climate change conditions, the maximum salinity exceeds the 1.0 ppt (Chloride limit for water supply) in Khulna and Gopalganj districts throughout a significant period of the year.
- The water logging in the Khulna city area increases significantly in climate change condition.

Bangladesh Water Development Board (BWDB) has completed the project titled "Feasibility study and detailed engineering design for long term solution of drainage problems in the Bhabodah area (Jessore and Khulna districts)",(IWM and DDC, 2010). Main activities of this study are in line with our present project and the study area is also in the coastal zone of the Ganges River. The study addressed the following issues: drainage congestion, sedimentation, excavation and dredging of khals, tidal river management and salinity.
Key Lessons Learned:
- Salinity level remains below 2ppt during the month of December, January and February of dry season, i.e. during the cultivation period of Boro.
- Drainage congestion occurs due to spill of river flow and sedimentation of peripheral rivers.
- The drainage improvement measures are excavation of internal khal system and construction of sluices at the outfall of khals.

Bangladesh Water Development Board (BWDB) has completed "Integrated planning for sustainable water management (IPSWAM) programme" which assessed of present and future sediment deposition rate in the peripheral rivers and drainage performance of the selected coastal polders considering climate change and sea level rise (IWM, 2008). It also addressed Spatial and temporal variation of salinity level in the rivers with and without sea level rise.
Key Lessons Learned:
- Sedimentation rate in the peripheral rivers of the selected polders.
- Availability of freshwater in the peripheral rivers.
- Water storage capacity of internal khal systems in the polders.
IWM is conducting a study is carrying out a project titled "Forecasting of salinity and assessment of sea level rise on salinity in the southwest area" under DANIDA funding. This study is being carried out to forecast seasonal variation of salinity in the coastal region of Bangladesh. The findings of this study may help to assess the salinity variation in the coastal region of Bangladesh.

International Water Management Institute (IWMI) has completed a number of projects in the region including Global Irrigated Area Mapping (GIAM), Groundwater Governance in the Indo-Gangetic Basin and most recently the Basin Focal Project for the Indus-Ganges basin. These projects have helped in better understanding of the availability of water resources, water productivity of the crops and fisheries in the basin and linkages of water-land-poverty and the interventions for improved productivity (Sharma et al., 2011). The project has also assessed the impact of rise in temperature on the glacier melt and runoff on the Ganges flow regime. The database developed during the implementation of these projects shall also be highly useful and available for early implementation of this project.

Previously, CPWF undertook IGB Phase 1 projects (PN 7, PN 10, PN 48 and so on) to enhance agriculture in the region. PN 7 (Ismail, 2009) focused on enhancing land and water productivity of rice-based cropping systems in salt-affected areas by integrating genetic improvement and management strategies that are environmentally sustainable and socially acceptable. This project carried out socioeconomic and biophysical characterization of target areas for baseline and socioeconomic surveys. At the same time both primary and secondary data were analyzed

for this purpose. The following important recommendations were made in the report: (1) Make greater efforts to establish accurate databases on the extent and severity of salt-affected lands, crop losses, and coping mechanisms. This information is needed in defining recommendation domains for technology targeting. (2) Build on indigenous knowledge in traditionally salt-affected areas and understand the interface between the biophysical and socioeconomic circumstances of targeted communities for effective development and dissemination of technology options and policy formation. In this project the effects of external drivers on water resources and agriculture were not focussed in details .

PN 10 (Tuong and Hoanh, 2009) focussed on water and land resources management for improving agriculture, aquaculture and fisheries in coastal zones of Bangladesh and enhance livelihoods of poor people in the region. The project assessed the positive impact of coastal polders for salinity and flood control, recommended water management and cropping patterns for better agricultural productions. To ensure and use of these research findings, our assessment of the impacts of anticipated external drivers of change on water resources in the region is needed.

One of the major objectives of PN 48 (Amarasinghe, 2009) was to assess the most plausible scenarios and issues of water futures (for India) given the present trends of key drivers of water demand. These may be useful to generate the basin-wide scenarios for the present project, and determine how the local and regional contexts are affected under these scenarios. Exogenous or endogenous drivers that affect the water system were identified in the project. The exogenous drivers are mainly the primary drivers while the endogenous or secondary drivers are influenced by the exogenous drivers.

6. Links to other BDC projects

Research outputs	**Dependencies on other BDC projects to produce it**	**Use of research output by other BDC projects**	**Risks and assumptions**
List of key external drivers	Feedback for ranking of the drivers from G1,G2,G3 and G5	G1,G2 and G3	• Timely and meaningful participation of research groups for finalizing the external drivers • Proper and timely input from the partner organizations
Flood inundation depth-duration map for polders 3, 31 and 43/2F (present and future conditions)	G1: Digital Elevation Model G5: Communication with G1	G1,G2 and G3	• Availability of reliable data in time
Detailed water resources availability map and scenarios for land -use and climate change	G1: Existing land-use map G5: Communication with G1	G1,G2 and G3	• Availability of reliable data in time

Salinity zoning map (present and future conditions)	G1 and G2: Soil salinity G5: Communication with G1 & G2	G1,G2 and G3	• Availability of reliable data in time
Flow availability (present and future), weekly and seasonal (3monthly)	G2: Crop planning and water requirement G5: Communication with G2	G1,G2 and G3	• Availability of reliable data in time
Water storage volume inside polders 3, 31 and 43/2F (present and future)	G2 and G3: present and future water requirement G5: Communication with G2 and G3	G1,G2 and G3	• Availability of reliable data in time
Sedimentation in peripheral rivers of polders 3, 31 and 43/2F (present and future)		G3	• Availability of reliable data in time
Storm surge risk map (present and future)		G1 and G3	• Availability of reliable data in time
Plan for improvement of khal system, sluices and embankments	G3: Water requirement of local community and farmers G5: Communication with G3	G5	• Proper and timely upscaling and downscaling • Availability of field information in time.

7. Suggested sites

The study area of G4 includes the coastal zone of Ganges river in Bangladesh part for analysis of flooding, storm surge and salinity. The detailed analysis on salinity, water availability, storage capacity of drainage khals in the polders, storm surge and drainage congestion will be carried out for specific polders (3, 31 & 43/2F). Flow, salinity and storm surge risk will also be assessed for polders 30, 34/2 and 43/1 to support research works of G3. The study area is shown in following map.

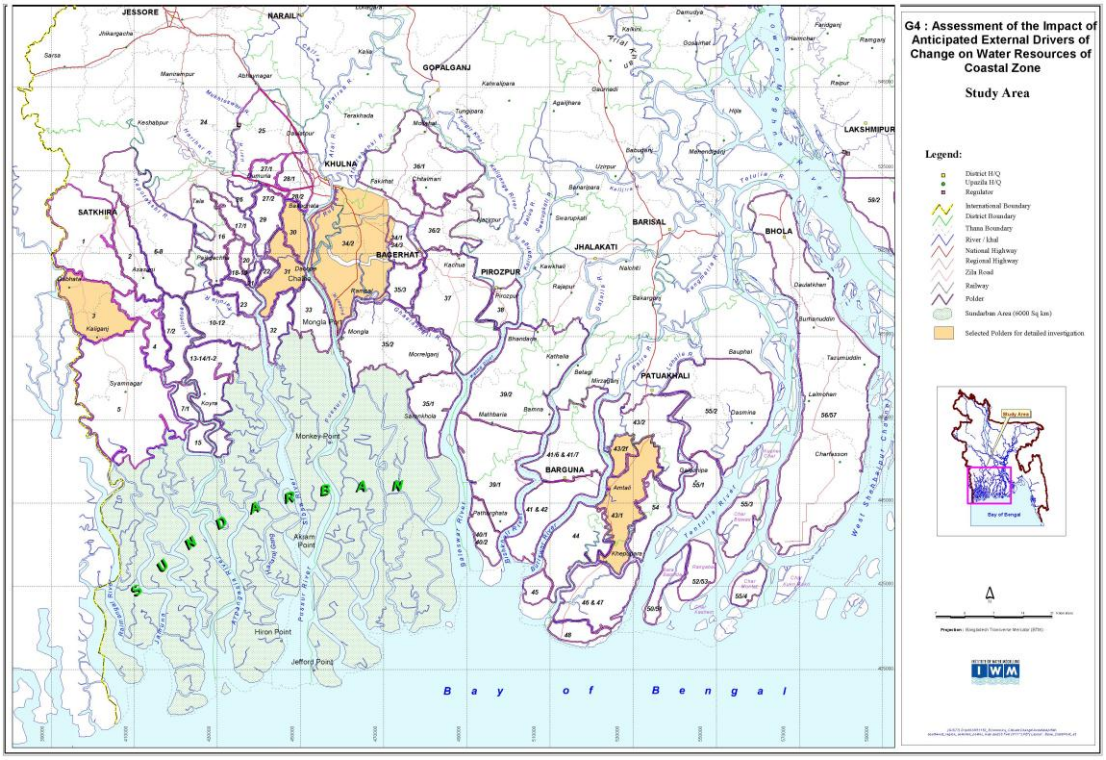

Figure 1: Study area map of G4

8. Project Outcome Pathways

Annex A Project workbook, worksheet G4-OLM

9. Activities and Implementation Plan

Annex A Project workbook, worksheet G4-Gantt Chart

10. Communications

Actor/ Practice change	Change in KAS	Approach to communication	Products/ process used	Channels for dissemination
Farmers and fishermen inside the polders	- K: Understanding of the key external drivers of change and their effects - A: motivated to use new knowledge and information - S: Farmers will change and improve their crop planning by knowing changed flooding and salinity variation.	- G4 will directly communicate with local stakeholders (facilitated by G5) - Training will be provided to local communities for awareness building - Interaction meetings - Presentation	- Maps, graphs, flip charts and tables - Posters - Powerpoint presentation	- Field visits - Training - Workshops

	They will start storing water inside the khals and use the stored water for irrigation during dry season. The knowledge of brackish water zone will help the fishermen in aquaculture.			
Researchers of G1, G2, G3, G5 and other institutions	- K: Understanding of the key external drivers of change - A: Motivated to use new knowledge and information	- G4 will directly communicate with other projects (facilitated by G5) - Networking/ partnerships - Regular interaction meetings (facilitated by G5)	- Technical sheets - Maps, tables and charts - Time-series data - Hydrograph	- Group to group approach - Study visits - G5
BWDB, LGED, DAE, DMB, DOE	- K: Acquiring new knowledge and benefits - A: Encouraged to adopt - S: Skill to manage water in changed condition	- Networking - Partnerships - Training - Workshops, round table meetings and seminars	- Animations - Maps, tables and charts - Manual/ guidelines - Policy brief	- Training - Study tour/ field visits - Reports - G5
MoWR, MoEF, MoA, C.C. Cell	- K: Understanding of effects of external drivers on water resources - A: Motivated and encouraged	- Policy dialogue(facilitated by G5) - Workshops (facilitated by G5) - Persuasion	- Policy brief - Animations - Presentations	- Workshops - Study visits - Personal & project discussions & interaction - G5

PART C: CONSORTIUM DETAILS, INDICATIVE BUDGET AND REFERENCES (Section 11-13)

11. Consortium Details

The quality and experience of your project team will help ensure the delivery of quality outputs. Please use **Annex A Project workbook, worksheet G4-Contacts** to describe the project team members. Indicate in particular who has responsibility for communications, M&E, knowledge sharing and gender analysis. Remember to attach a full C.V. for the project leader and a one page C.V. for each team member in Annex B. These will be people who will normally be funded at least partly by the project. You will be requested to enter into a Memorandum of Understanding with their institutions if successful. Please provide below a brief text statement on the lead institution and partners institution, their qualification to lead the group and carry out the proposed research.

Lead Institution

Provide a brief text statement on why the lead institution is well-placed to lead the group.

Institute of Water Modelling (IWM) provides world–class services in the field of Water Modelling, Computational Hydraulics & Allied Sciences for improved Integrated Water Resources Management. It is a unique organization in the region having sustainable technological capability in developing mathematical models and decision support systems .The applications of IWM modelling tolls cover a wide range of water related aspects such as : *irrigation and drainage management, water resources management, salinity intrusion, tidal river management, coast and estuary management, environmental impact assessment, Impact Assessment of Climate Change and Sea Level Rise on coastal environment and coastal infrastructure development, flooding, water-logging.*

IWM has gained knowledge and experiences over the years in home and abroad on water resources management and assessment of effects of any natural and manmade changes on water resources in devising adaptation measures for improved water governance and water management to increase the productivity of water. The institute carries out various projects and research works to estimate river flow and flooding, drainage congestion, water availability, coastal and offshore hydraulics, marine environment, storm surge risk assessment, coastal protection, salinity intrusion and biodiversity conservation. In developing the models, IWM undertakes its own data campaign and has earned a high reputation for fast and cost effective river surveys using state-of-the-art techniques. IWM has been maintaining models for Bay of Bengal, regional models and Ganges, Brahmaputra and Meghna basin model since 1986 to assess the effect of external drivers on water resources and devising improvement measures and adaptation plan.

Project Partners

Provide brief text statements on why the proposed partner institutions are qualified to carry out the proposed research.

Institution 1: International Water Management Institute (IWMI)
The International Water Management Institute (IWMI) has been a lead actor and a major player in water management research in the Indus-Ganges Basin, with the objective of improving water and land management for food, livelihoods and nature and with the goal of contributing to the vision of 'A Food Secure World for All'. IWMI's research is organized around four themes: Water Availability and Access; Productive Water Use; Water Quality, Health and

Environment; and Water and Society. IWMI has developed and implemented/implementing over 10 projects in the basin pertinent to its thematic priorities. Through its India office based in New Delhi, it addresses this challenge through an integrated program, of which the Water Availability and Access theme is in key partnership with a host of relevant organisations.By creating strong partnerships with a large number of strategic partners, IWMI has implemented and contributed to successful projects such as the Comprehensive Assessment of Water in Agriculture, as well as CPWF phase 1 projects such as

I. Strategic Analysis of National River Linking Project (of India),
II. Groundwater Governance in Asia (PN 42) and
III. Basin Focal Project for the Indus-Gangetic Basin (PN 60)

IWMI has an established partnership with the relevant universities and research and policy institutions and government departments in Bangladesh and a valuable database for an early implementation of the research project and impact creation.

Institution 2: Institute of Water and Flood Management (IWFM)
The Institute of Flood Control and Drainage Research was established in 1974 in BUET and later renamed as the Institute of Water and Flood Management (IWFM) in 2002. IWFM is a premier institute for the advancement of knowledge and development of human resources in water and flood management. The Institute offers postgraduate degrees for the professional and fresh graduates in water resources development with the objectives of training and enhancing the knowledge and skills of professionals in planning and management of land and water resources, and widening their perspectives on Integrated Water Resources Management (IWRM). Since IWRM is a multi-disciplinary process, requiring a holistic understanding of the system with a good blend of engineering, agricultural, socio-economic and environmental analyses, a multi-disciplinary course curriculum is pursued. The multi-disciplinary programmes are aimed at engineers, planners, hydrologists, agriculturists, and physical and social scientists. Research activities of the Institute focus on priority areas in water management with major emphases on water resources management in floodplain environment, river and coastal hydraulics, wetland hydrology, hazard management, urban water management, irrigation and water management, environmental impact of water development, water resources policy, and climate change. A Climate Change Study Cell has been established at IWFM.

Institution 3: Bangladesh Water Development Board (BWDB)
BWDB is a Government institution under the Ministry of Water Resources. This institution is a major stakeholder for water management and governance in Bangladesh. BWDB has Knowledge on agriculture, water governance water and crop management, policies and strategies. This institution is capable of identifying proper outputs required for improvements of polder and crop management, providing policies, strategies for devising scenarios to assess impacts and adaptive measures for improved water and crop management, reviewing proposal, research outputs, reports and participation in the workshops. Moreover, this institution has vast field knowledge, field experience and linkage with other organizations. BWDB is well accepted as a major stakeholder in water management in Bangladesh.

12. Indicative breakdown of budget

Following preparation of your budget in the excel table, provide a % calculation and $ value that each institutional partner will be allocated for their outputs using the table(s) below. Please complete and submit the budget spreadsheets using Please use **Annex A Project workbook, worksheets G4 $ Summary, G4 $ Comments, G4 $ Time Allocation, G4 $ By Outputs, and G4 $ By Institution** to this submission.

13. Bibliography

Please list up to 10 references and key documents

Amarasinghe, Upali (2009). Strategic Analysis of India's River Linking Project, CPWF Project Report, PN #48, August 2009, 78 pages.

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Annexes to your proposal submission

A: Project Workbook
B: Team leader and team member's C.V.s.