Economics of CC Adaptation – case of Khulna city water sector projects

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Understanding CC impact pathways

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- GHG emission → Global warming → Temperature change → changes in the climate
- Events
- rapid climate events
  - Cyclone, major flood, flash flood, GLOF
- Slow onset events
  - Salinity, SLR, flood, storm surges, seasonal change, seasonal temperature fluctuations, etc.

Impact pathways

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- Events → impacts
  - Exposure
  - Intensity
  - Vulnerability
- Introduces Risks
- Development Projects should be planned to be robust enough to withstand these risks
  - Need adaptation

Strategies to deal with CC

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- Mitigation – to reduce emission of GHGs
- Adaptation – to build capacity to deal with climate events
  - Developing resilience among
    - People
    - Nature

Analysis of Adaptations

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- Public expenditures at risk due to climate change related events
  - How to select the best set of adaptation strategies?
  - How to separate cost of adaptation from other project costs?
  - How to claim ‘additional costs’ from climate funds/climate resilient fund/climate adaptation funds/climate trust fund?

The Issue of Water sector

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- Khulna is a south-western metropolitan city with a population of about a million
- It is a major city of the country
- Salinity in water is rising
- Water-logging is increasing
- City is planning to upgrade its water infrastructure – Water supply and Drainage system
- This study is designed to understand the CC impact on this plan.

Khulna City

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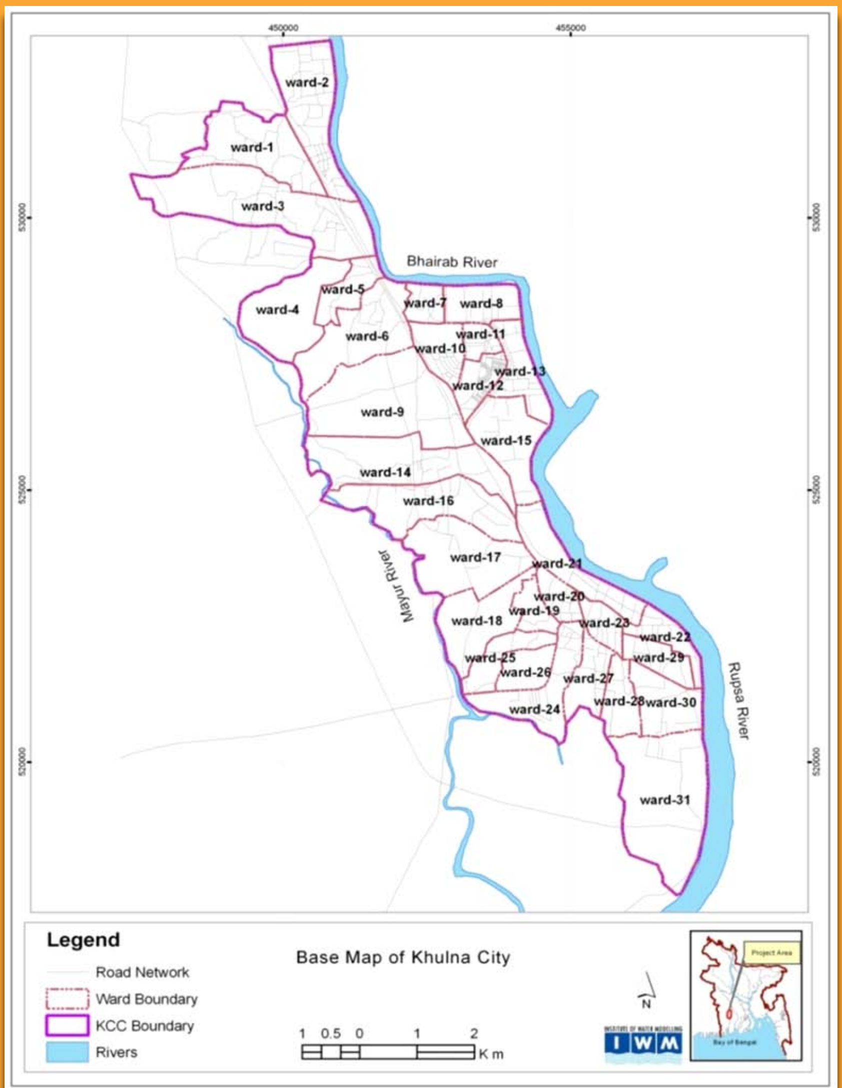

31 Wards
1,000,000 Population (approx.)

Rivers
East – Rupsha and Bhairab
West – Mayur

Drainage through Mayur

Land elevation 2.5m from the mean sea level

Climate Induced Threats
-Water logging
-Salinity Intrusion
-Cyclone/Storms

Study team

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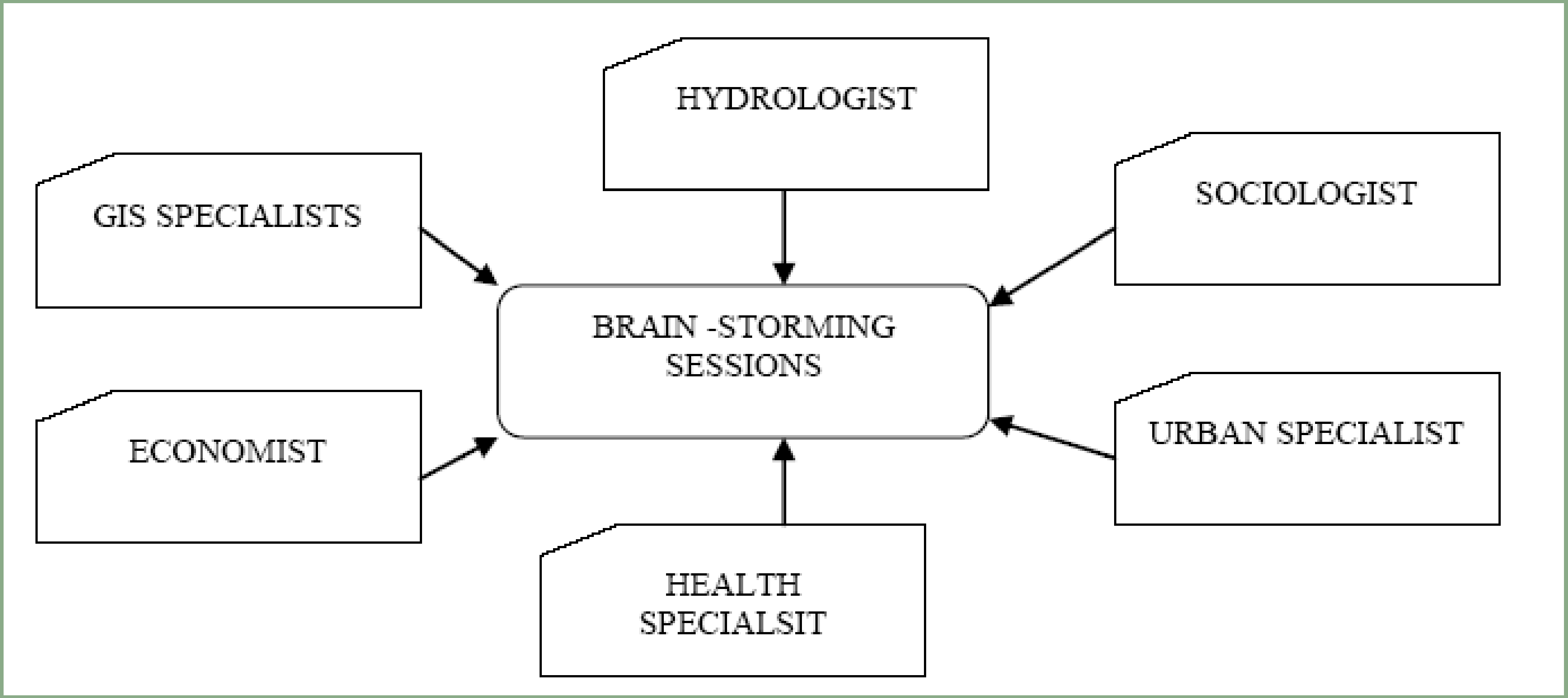

Study Method

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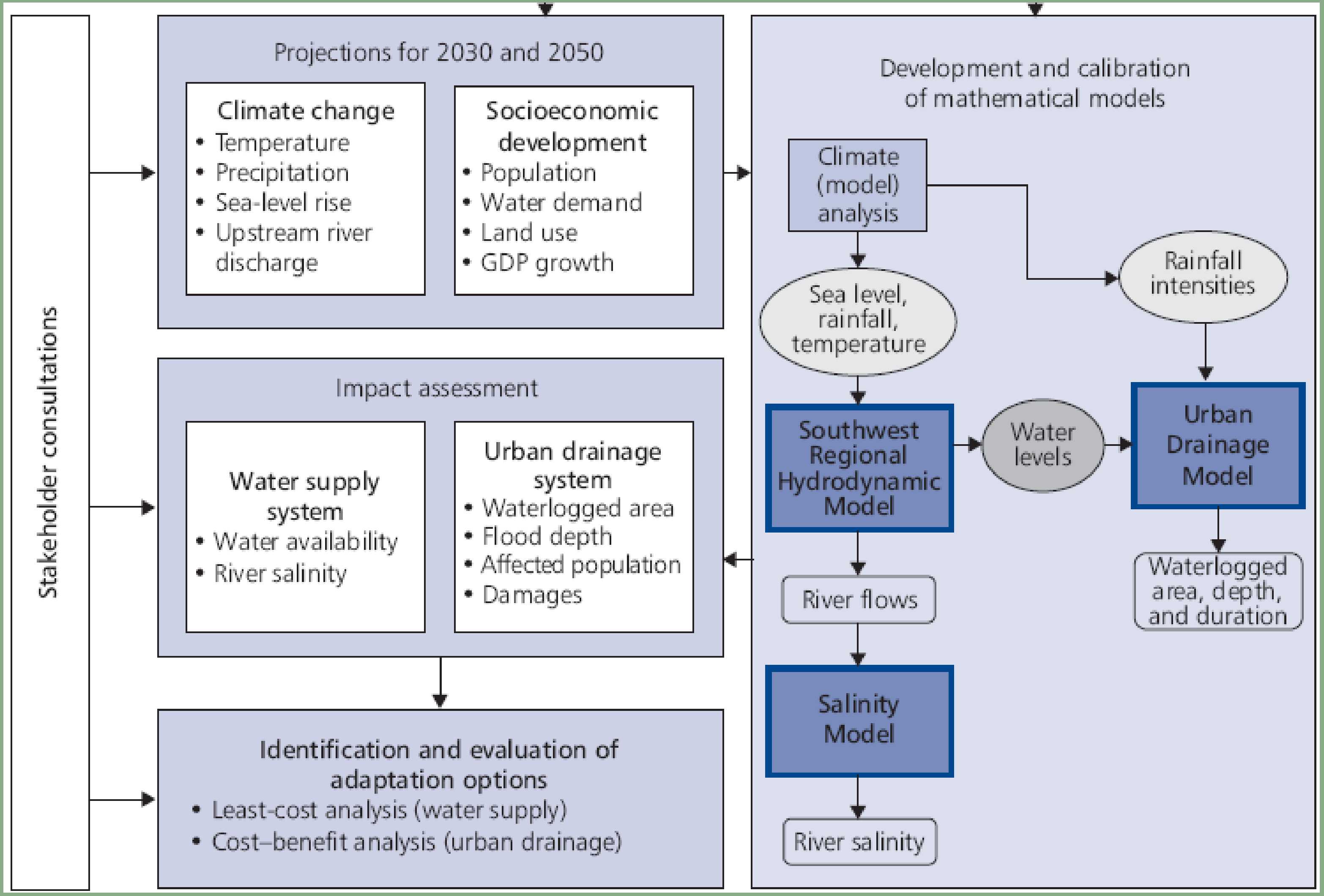

Climate Scenarios

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Scenario	A2	B1
Temperature	The average monthly temperature rise by 2050 varies from +0.5°C in October to +1.7°C in January and February.	The average monthly temperature rise by 2050 varies from +0.5°C in June, July, and August to +1.5°C in February and April.
Rainfall	The annual rainfall increases by about 5.0% by 2050 (1,860 mm per year) from the reference period.[a]	The annual rainfall increases by about 9.3% by 2050 (1,739 mm per year) from the reference period.[b]
Seasonal rainfall	Increase in July–September by 4.6% and a decrease in December–February by 26.3%	Increase in July–September by 10.5% and a decrease in December–February by 46.2%.[c]
Rainfall intensity	50 mm or more rainfall in 6 hours increases from 4.20 times per year to 5.90 times per year in 2050.	50 mm or more rainfall in 6 hours marginally increases from 4.20 times per year to 4.25 times per year in 2050.

Changes in socio-economic variables

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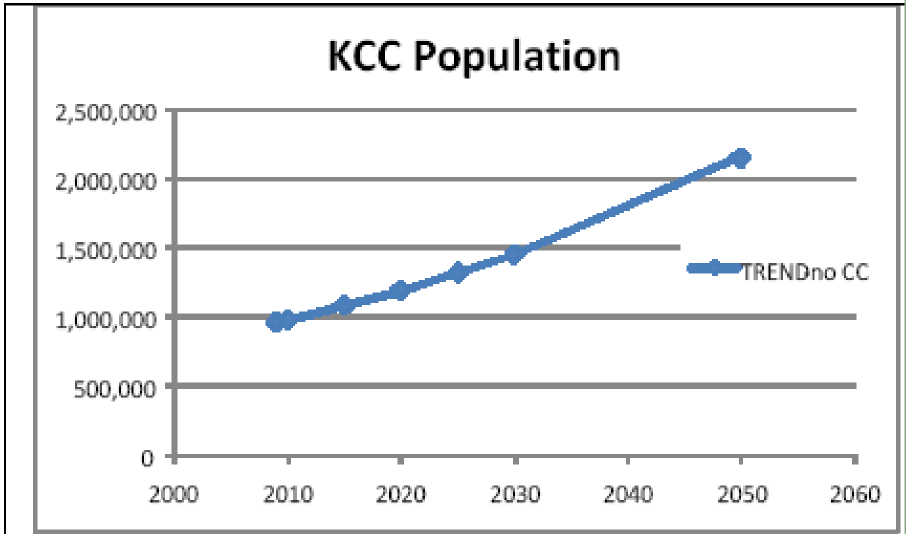

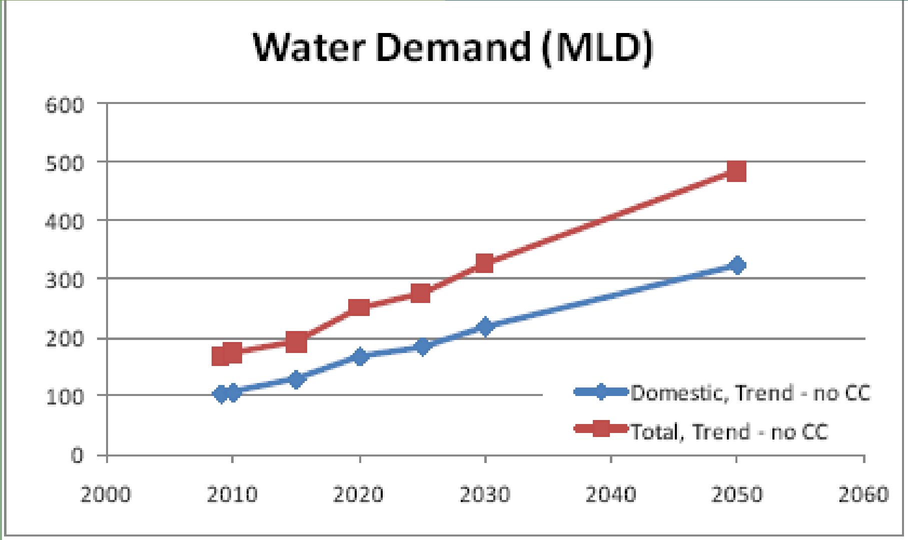

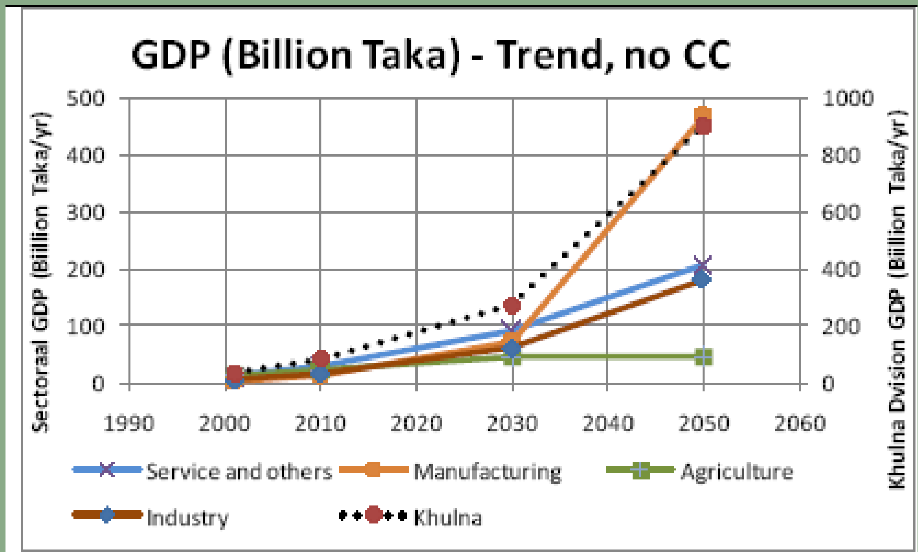

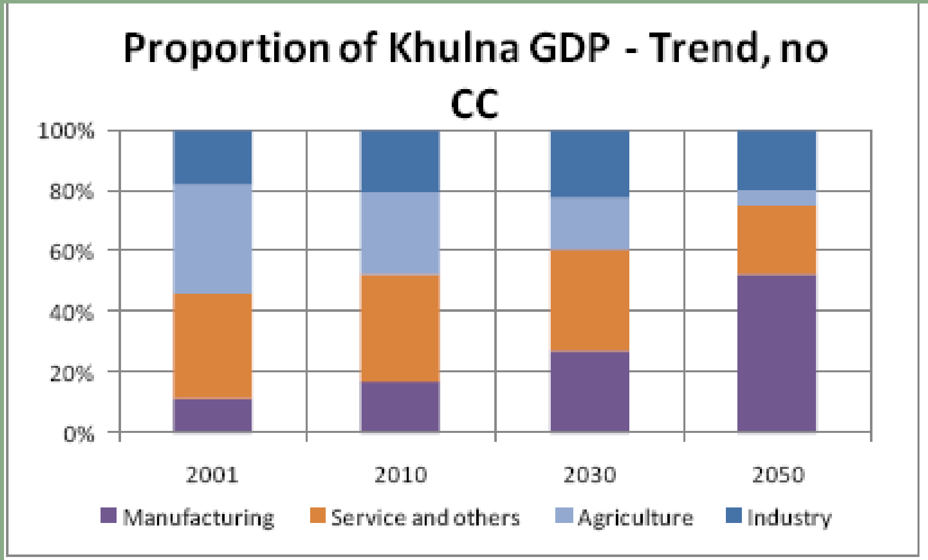

Changes in land use-2030 and 2050

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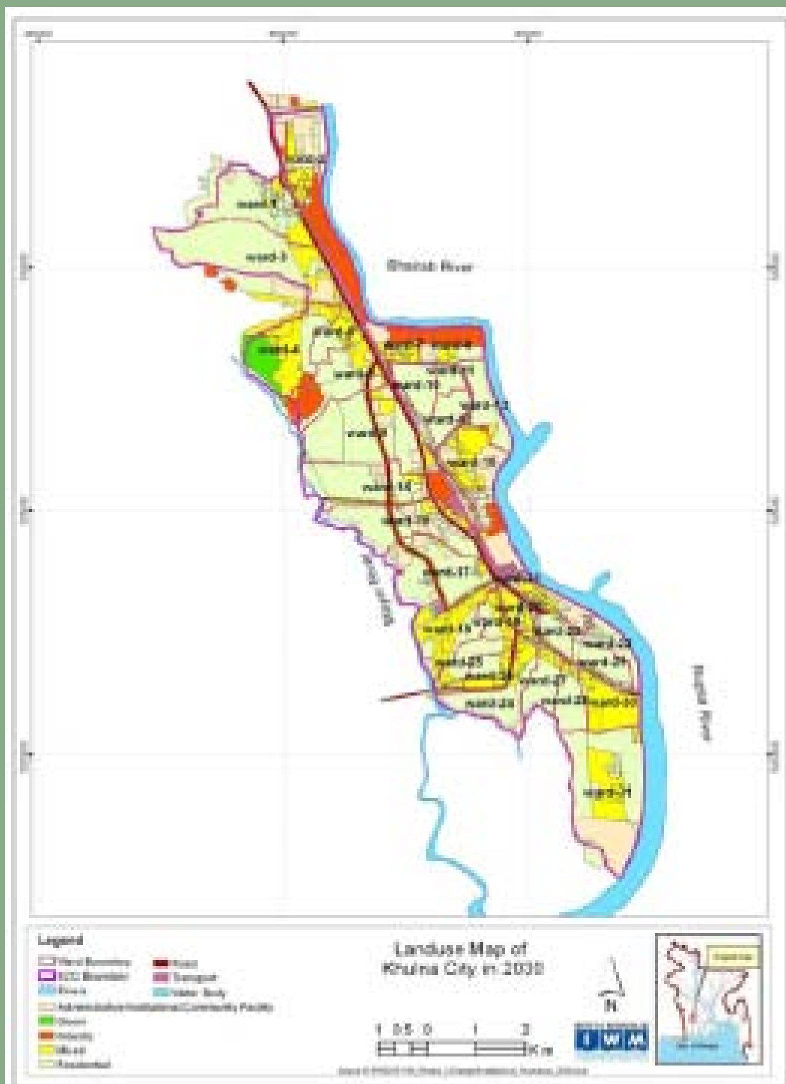
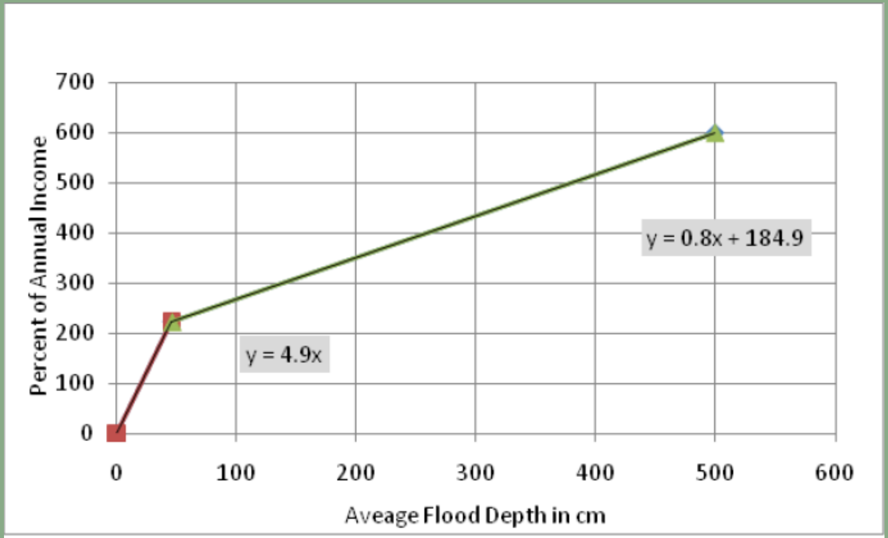
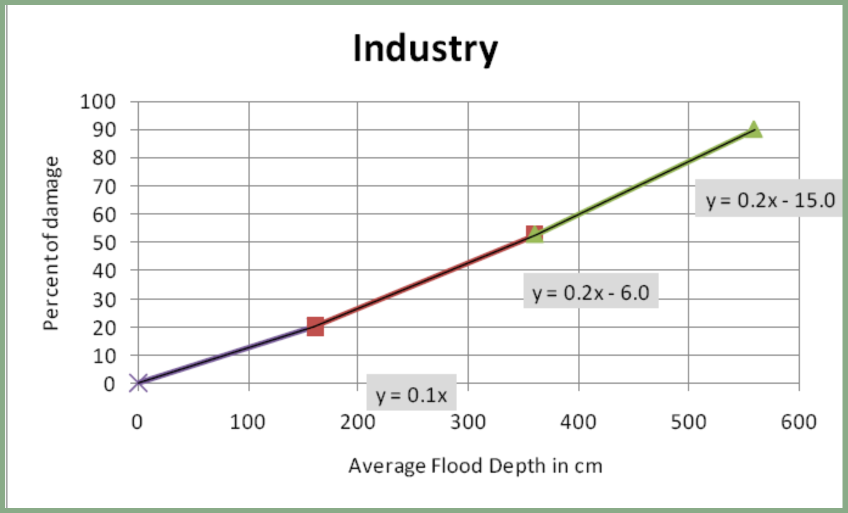
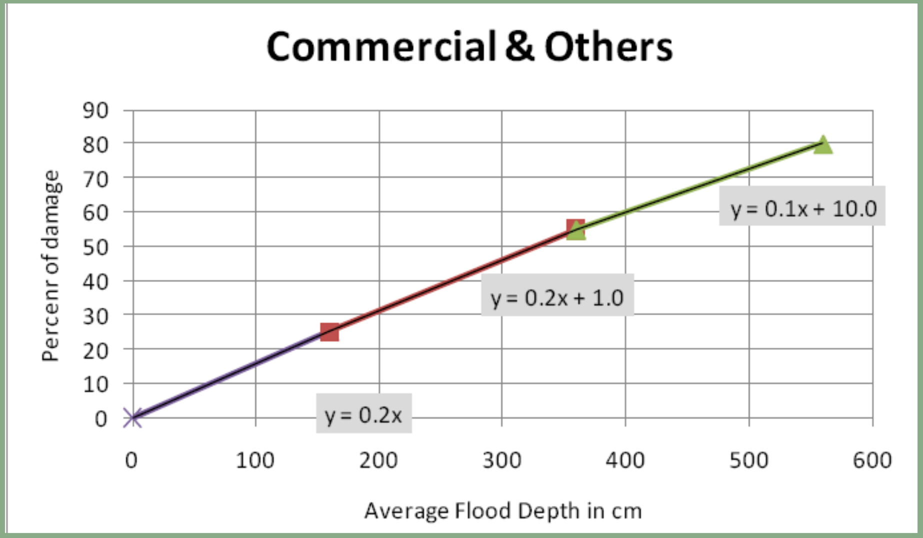
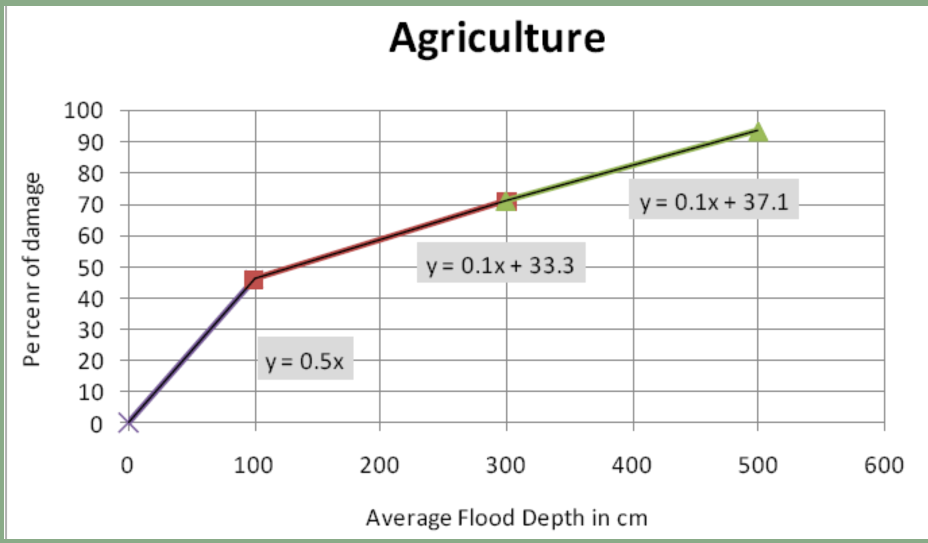


Damage function









Adaptation options

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Construction of new roads
Construction of culvert/bridge
Construction of new surface drains
Redesign of building
Raise the plinth of land/earth filling
Sluice gates improvement and clean up the siltation from outlets
Re-excavation of drain with lining
Re-excavation of Moyur river
Re-excavation of canals/drainage channel
Widen the canals
Widen the drains
Repair of prevailing dam/embankment/bridge
Temporary embankment construction
Repair of culvert
Resettlement of affected people
Preserve rain water
Keeping valuables away
Migrate during disaster
Proper solid waste management
Arrange campaign/education program to create awareness among people
Inform to people before disaster

2050 water logging

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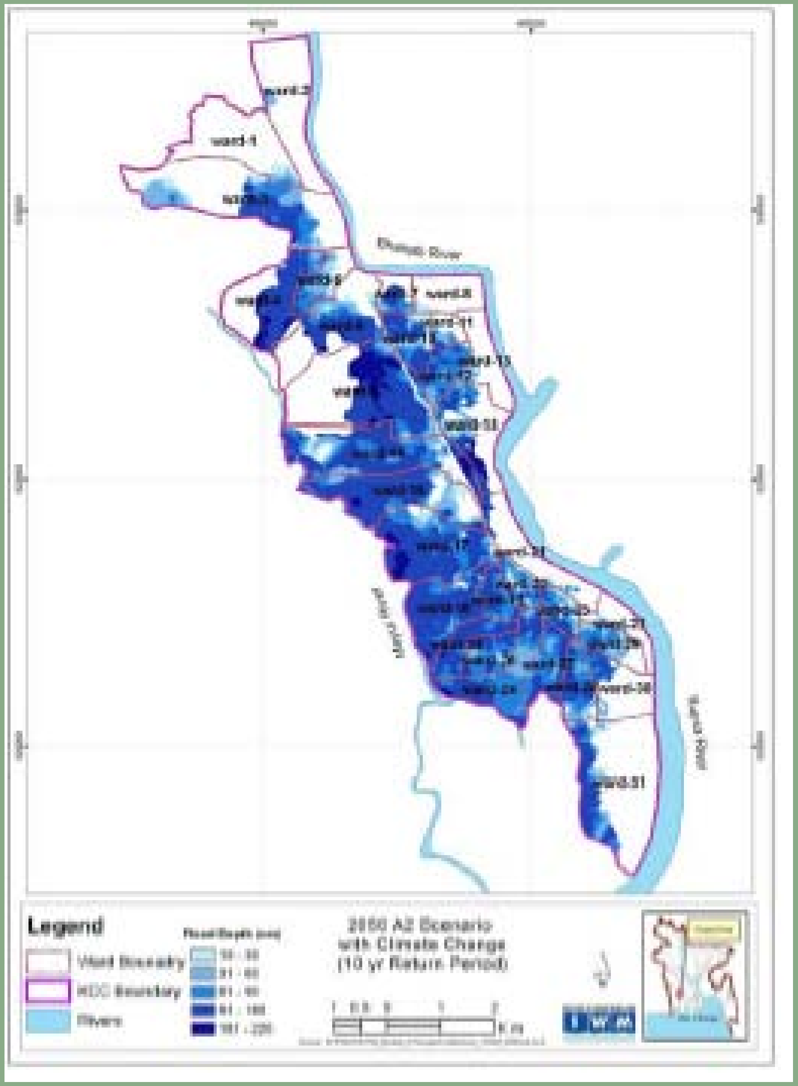

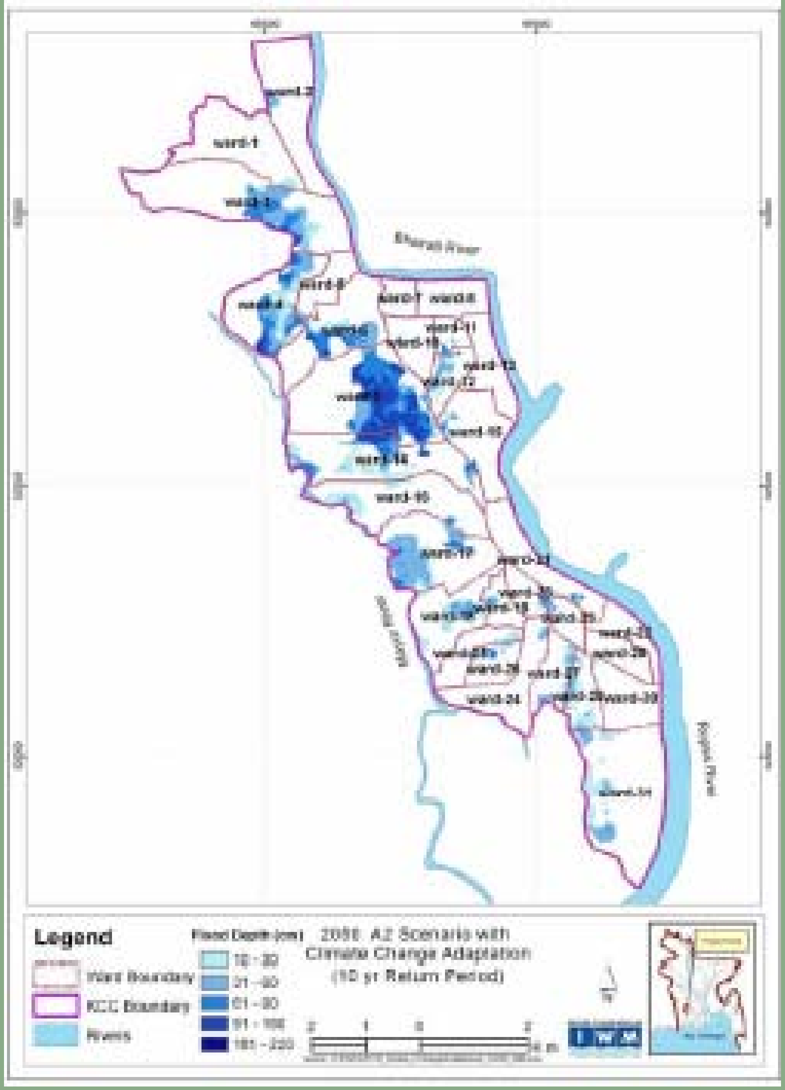

Impact of Adaptation

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KCC Area	Average water logging depth (cm)	% Household income lost	% of capital loss in Industry	% of capital loss in Manufacturing	% of capital loss in Commercial & social institutions	% of yield loss in Agriculture	% of Roads damaged	% Population affected
Base Case before project	41	195	5	6	6	19	12	24
Base Case with improved drainage system (IDS)	33	159	4.1	4.7	5.2	15.2	9.3	6
2050 Base Case with Socio-Economic (SE) changes and IDS. (No Climate change)	33	159	4.1	4.7	5.2	15.2	9.3	6
2050 Case with SE changes and with climate change (CC)	63	236	7.8	8.8	9.8	28.7	17.6	58
2050 Case with SE changes, with CC and with IDS	47	217	6	7	7	22	13	30
2050 Case with SE changes, with CC with IDS and with Adaptation Strategies	40	191	5	6	6	19	11	13

Damage costs

1 in 10 year Water Logging Event	logging depth (cm)	Household	Industry	Manufacturing	Commercial & Others	Agriculture	Roads	**Total (mTk)**
Base Case	41	5	33	14	564	3	535	1,155
Base Case with improved drainage system (IDS)	33	1	6	3	109	1	165	285
2050 Base Case with Socio-Economic (SE) changes and IDS. (No Climate change)	33	5	761	1,699	3,299	1	258	6,023
2050 Case with SE changes and with climate change (CC)	63	48	13,745	30,665	59,548	21	4,651	108,679
2050 Case with SE changes, with CC and with IDS	47	25	4,964	11,075	21,507	7	1,680	39,259
2050 Case with SE changes, with CC with IDS and with Adaptation Strategies	40	10	2,157	4,813	9,345	3	730	17,059

Benefit cost ratio

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	Pessimistic scenario	Realistic scenario	Optimistic scenario
Benefit-Cost Ratio	*15*	*5*	*n/a*
Parameter			
Discount Rate	10	10	10
GDP Growth Rate	6.2	6.2	6.2
Population Growth Rate	0.04	0.02	0.015
KCC Factor	0.33	0.33	0.33
% Manufacturing in 2010 hotspot areas	2	0.3	0.1
% Industry in 2010 hotspot areas	2	1.1	0.5
% Commercial in 2010 hotspot areas	20	17.3	14
Fraction of Commercial in 2010 mixed area in hotspot areas	0.7	0.6	0.4

Learning

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- CC adaptation study
  - Requires multi-disciplinary team
  - Needs to understand climate events, climate risks
  - Use future climate scenarios
  - Needs to develop socio-economic scenarios for the future
  - Identify additional costs in project
  - Justify which adaptation measures make sense.
  - Access international finance mechanism to pay for climate related adaptation costs.