Testing of an IWRM DSS for Assessing Climate Adaptation Options in an Urban Area of Bangladesh

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Theme: Decision support instruments for climate adaptation policy
Session DD 7.1: DSS – improving their communicative power

Dr. Asif M. Zaman, Mr. S.M. Mahbubur Rahman
Water Resources Planning Division, Institute of Water Modelling, Dhaka Bangladesh

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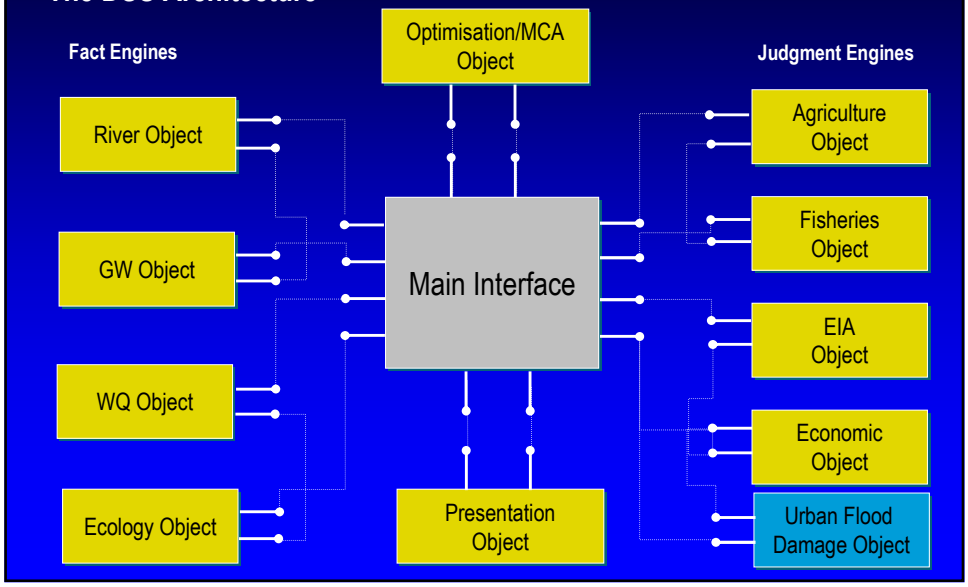
Presentation Outline

- Background
- Scenarios
- Urban Drainage Analyses
- Conclusions

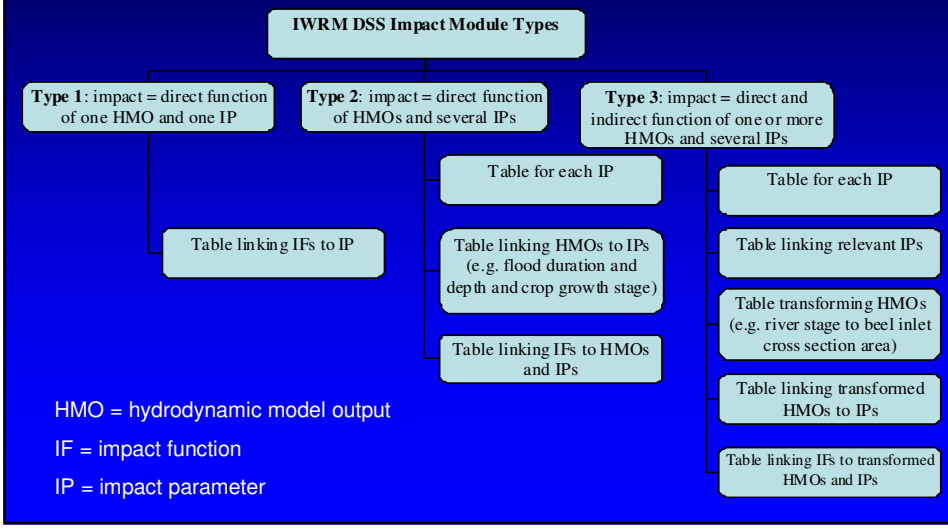
Background

The DSS Architecture



Background

Response Modules Conceptual Approach

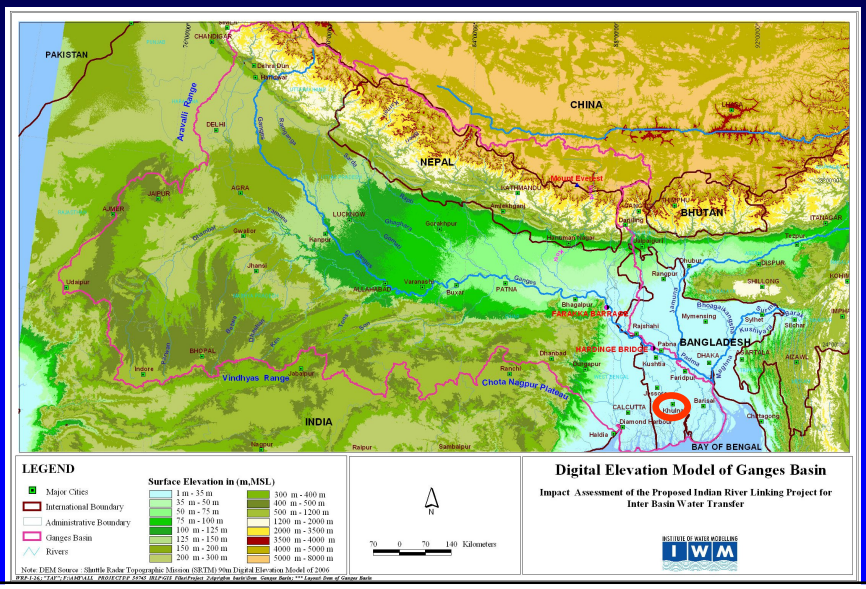


HMO = hydrodynamic model output

IF = impact function

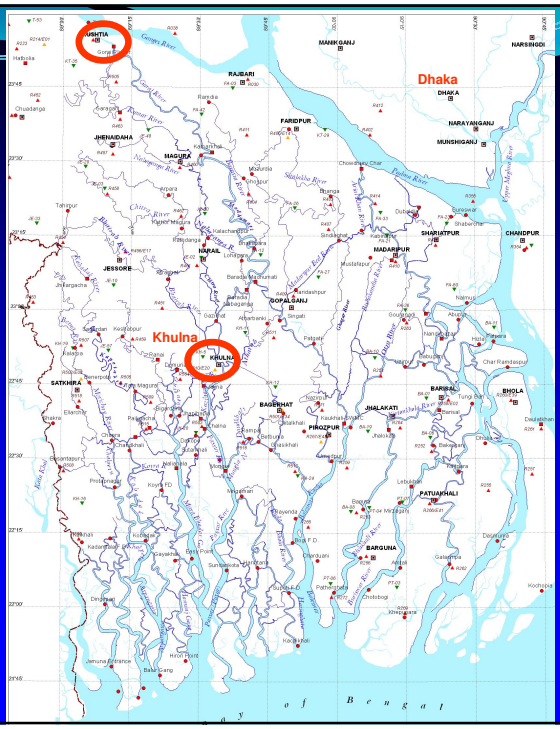
IP = impact parameter

Hydrologic Setting



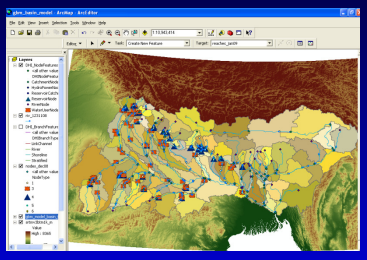
Hydrologic

- Southwest region of Bangladesh

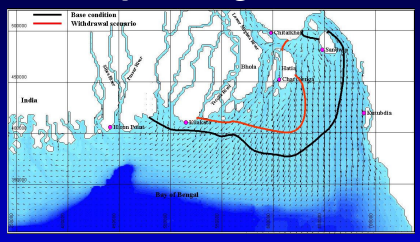


Modelling Tools (Fact Engines)

Basin Model

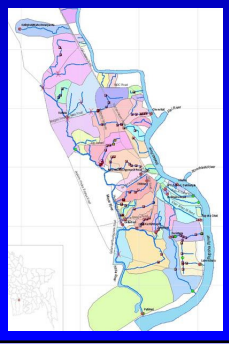


Bay of Bengal Model



Southwest Region Hydrodynamic and Salinity Model

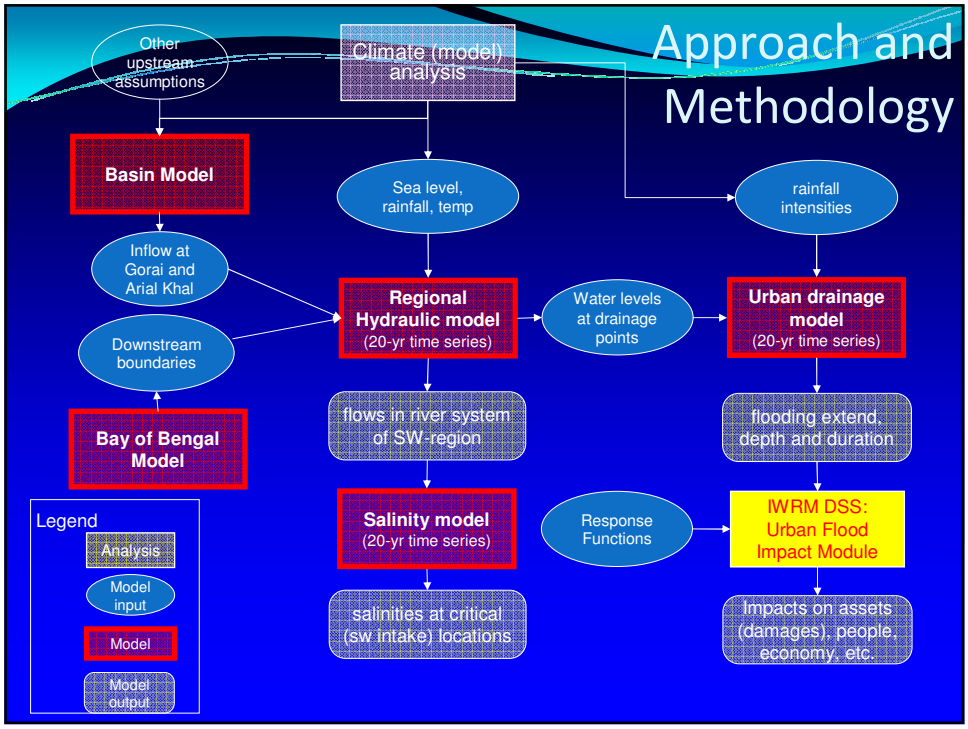
Urban Drainage Model



Study Area

- Area: ~ 46 km²
- 31 Wards
- Population:
  - 2010 = 0.98m
  - 2030 = 1.45m
  - 2050 = 2.12m
- Objectives:
- Identify impacts of climate change on flooding, drainage, salinity and water availability aspects
- Develop and assess adaptation options based on social, economic, public health and urban planning aspects

Approach and Methodology



Scenario Development

Climate / Socio-economic	2010	2030			2050		
	Present	No climate change	A2	B1	No climate change	A2	B1
Trend/Realistic	√	√	√		√	√	

Base cases

Reference cases

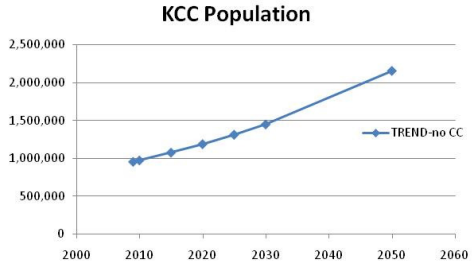
Difference = impact of CC in 2030

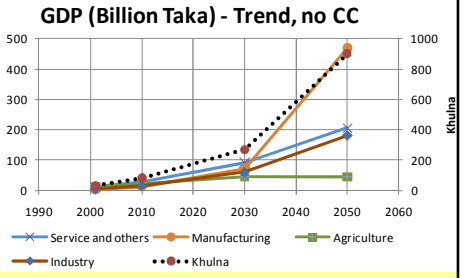
Difference = impact of CC in 2050

ADAPTATION MEASURES
REDUCE / REMOVE CC IMPACTS

	2030	2050
SLR (Low):	10 cm	20 cm
SLR (High):	25 cm	40 cm

Socio-economic Scenarios





- 2% annual growth rate
- Internal spatial distribution remains same

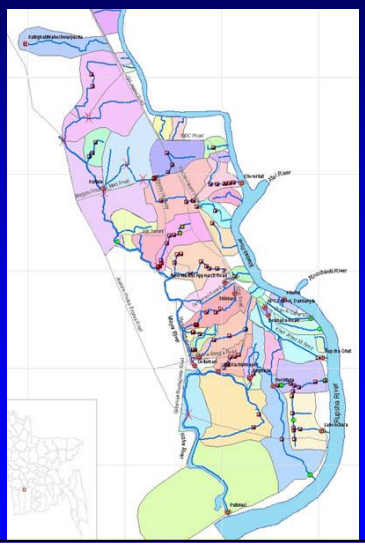
- Bangladesh Economic Survey Data from 1997-2007
- Khulna GDP from BBS data quoted in Khulna Master Plan

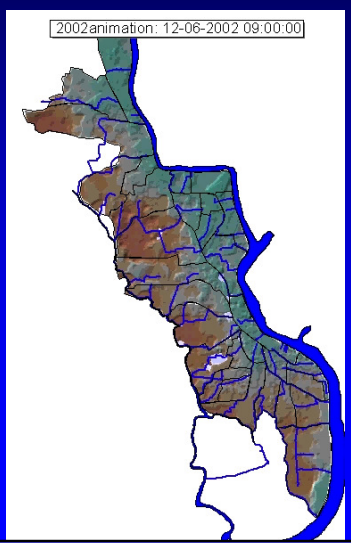
category (manufacturing, agricul

9. Paved road area (sq km)
10. Diarrhoea incidence in 2030 and 2050 (% of population)
11. Proportion of urban poor people below upper and lower poverty lines in 2030 and 2050 (% of population)
12. Urban Development patterns for 2030 and 2050

Climate change impacts

- Increased rainfall intensity
- Increased outfall water level due to SLR



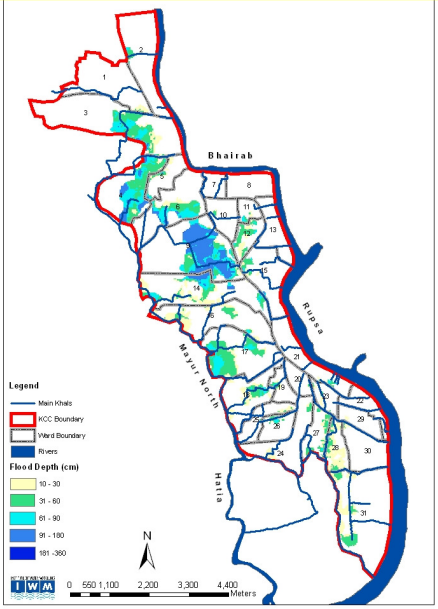


Adaptation Options

- Khulna urban drainage
  - Core options
    - Widen/deepen drains
    - Lay new drains
    - River dredging
    - Sluice gate
  - Add-on options
    - Good solid waste management
    - Awareness and education campaigns
    - Introduce drainage tax
    - Strict implementation of fines and planning measures
    - Improved prediction and early warning system

- Avge Flood depths
  - Base = 33 cm
  - 2050 CC = 47 cm
  - 2050 CC + Adaptation = 40cm

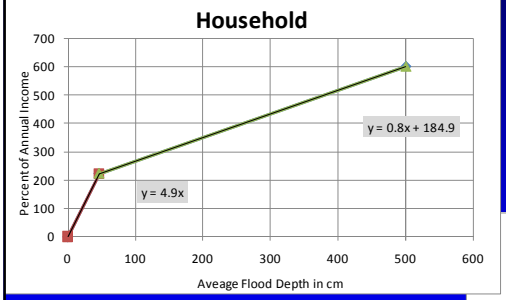
2050: with CC, adaptation options

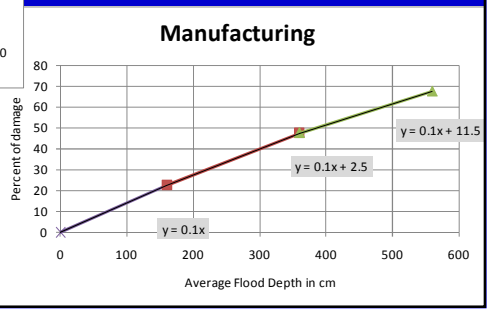


Impact Module (Judgment Engine) Damage Estimate

- Household related damages
  - Loss of income
  - Loss of assets /property
  - Health costs
  - Other damages
- Industry damages – asset loss
- Manufacturing damages – asset loss
- Services damages – asset loss
- Agricultural damages – yield loss
- Road damages – repair costs

Impact Module
Sectoral Damage Functions





Impact Module
Damage Cost Estimate

Sector Damage (mTk) =

x damage factor (f (flood depth in cm))

- Survey and FGD
- Drainage Model
- SE Scenario

x Khulna Division Sector GDP (mTaka)

- GIS (land use)

x % of Khulna sector affected

- Assumption based on Electricity power allocation

x KCC factor

Impact Module

1-in-10 year event, Realistic Scenario

KCC Area % Damage	Average flood depth (cm)	% Asset of Household	% of Capital Industry	% of Capital in Manufacturing	% of Capital Commercial & Others	% of Agriculture Yield	% of damage to Roads	% of affected Population
2050+SE+noCC+Imprvd DS	33	13	12	14	15	15	12	6
2050+SE+CC + Imprvd DS	47	18	17	20	21	22	17	30
2050+SE+Imprvd DS+CC+AS1	40	16	15	17	18	19	15	13

Impact Module

Economic Analyses

- Costs of adaptation in terms of
  - Investment costs
  - Operation and maintenance costs
- Costs of climate change in terms of damage
- Benefits of adaptation (damage avoided)
- Benefit-Cost ratio
- Sensitivity analyses (optimistic and pessimistic scenarios)

Impact Module

Economic Analyses

- Costs of adaptation

Design Event	*5 Year Return Period*				*10 Year Return Period*			
	Investment Cost		O&M Cost		Investment Cost		O&M Cost	
	Tk (Mil)	USD (Mil)	Tk (Mil)/yr	USD (Mil)/yr	Tk (Mil)	USD (Mil)	Tk (Mil)/yr	USD (Mil)/yr
2030 Adaptation	64	0.9	24	0.4	39	0.6	15	0.2
2050 Adaptation	1,312	19	101	1.4	1,167	17	89	1.3

Note:
Adaptation investment cost for climate change is on top of drainage system improvement cost. Similarly, adaptation O&M cost is on top of annual costs without climate change.

Impact Module

- CC damage costs and Adaptation Benefits (Realistic Scenario, 1-in-10 year event)

KCC Area Damages in m USD	Average flood depth (cm)	Household	Industry	Manufacturing	Commercial & Others	Agriculture Yield	Damage to Roads	Total (m USD)
2030+CC+Imprvd DS	40	0.1	8.9	9.2	51.3	0.0	5.8	75
2030+CC + Imprvd DS + Adaptation	39	0.0	6.2	6.4	35.8	0.0	4.0	52
2030 Adaptation Benefit	-1	0.0	2.7	2.8	15.5	0.0	1.7	23
2050+CC+Imprvd DS	47	0.4	70.9	158.2	307.2	0.1	24.0	561
2050+CC+Imprvd + Adaptation	40	0.1	30.8	68.8	133.5	0.0	10.4	244
2050 Adaptation Benefit	-7	0.2	40.1	89.5	173.7	0.1	13.6	317

Impact Module

Economic Analyses

- Benefit-Cost ratio
  - 40 years cash flow and 10% discount rate

Design Event	NPV (m USD)	
	5 Yr return period	10 Yr return Period
Benefits	24.5	31.6
Costs	8.0	6.1
B-C RATIO	3.1	5.2

- Sensitivity analyses of Adaptation for 10yr return period:
  - Optimistic (B1 CC + low SLR): no adaptation required
  - Pessimistic (A2 CC + high SLR): B-C ratio = 15

Conclusions

- Mathematical models as part of an IWRM DSS are vital for
  - Quantifying CC impacts and
  - Assessing different CC adaptation options
- Socio-economic scenarios can be included in DSS framework
- Climate change adaptations for urban drainage
  - Increase conveyance capacity of primary drains
  - Increase outfall capacities of several outlet structures
- Considerable uncertainties in future scenarios
  - Condition of secondary drainage system
  - Base case (2030 and 2050) improvements to drainage system
  - Operation of control structures and level of maintenance
  - Future land use pattern
  - Damage functions


Thank You