Application of Bangladesh Metamodel

Model Simulation and Result Visualization

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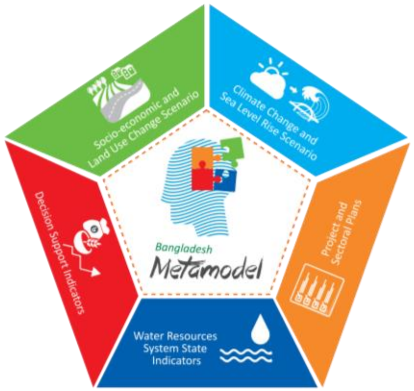
Joint Cooperation Programme
Bangladesh Netherlands
Knowledge development for a prosperous delta

Contents

- Brief of Metamodel engine
- Formulation of strategies/ interventions
- Workflow to run Metamodel
- Output result analysis
- Group exercise
- Live simulation



Developing the partnership for applied research by

Deltares

CEGIS
Center for Environmental and Geographic Information Services

WAGENINGEN
UNIVERSITY & RESEARCH

IWM
Water Environment & Climate

Kingdom of the Netherlands

Metamodel: In short

- used for decision making
- Simplified simulation
- Based on results of detailed sectoral models
- Integrations of sectoral models
- Wide scope
- Short calculation time
- Less detail and accuracy in results
- No replacement for detailed models
- At planning level

Metamodel Indicators

State Indicators	Decision Support Indicators
Environmental flow (m^3/s)*	Annual rainfall damage (Taka)
Dry season river flow (m^3/s)	River navigability (km/class)*
Annual flood extent (km^2)	Rural access to safe drinking water (%)*
Annual flood duration (month)	Habitat area suitable for protective species (km^2)*
Extreme flood extent (km^2)	
Waterlogged area (km^2)	
GWL at end of dry season (m)	
Flood damage (Taka)	Poor households affected by droughts, floods and salinity (%)*
	Displaced people due to disasters (%)*
	Rice production (Ton)
	Food security for the poor (%)
Area affected by salinity (km2)*	Cost of project implementation (Taka)

* Under development

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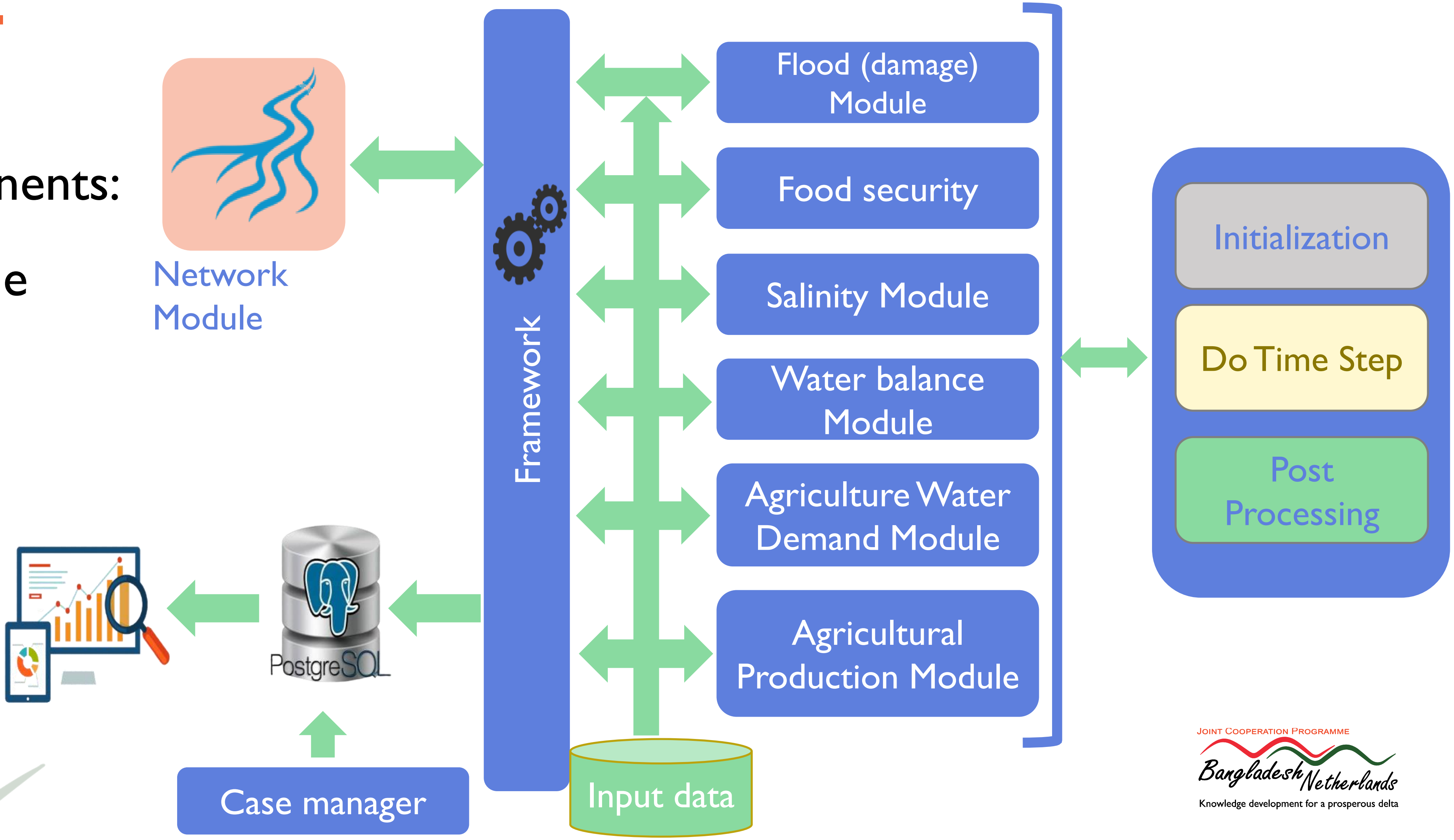
Metamodel components

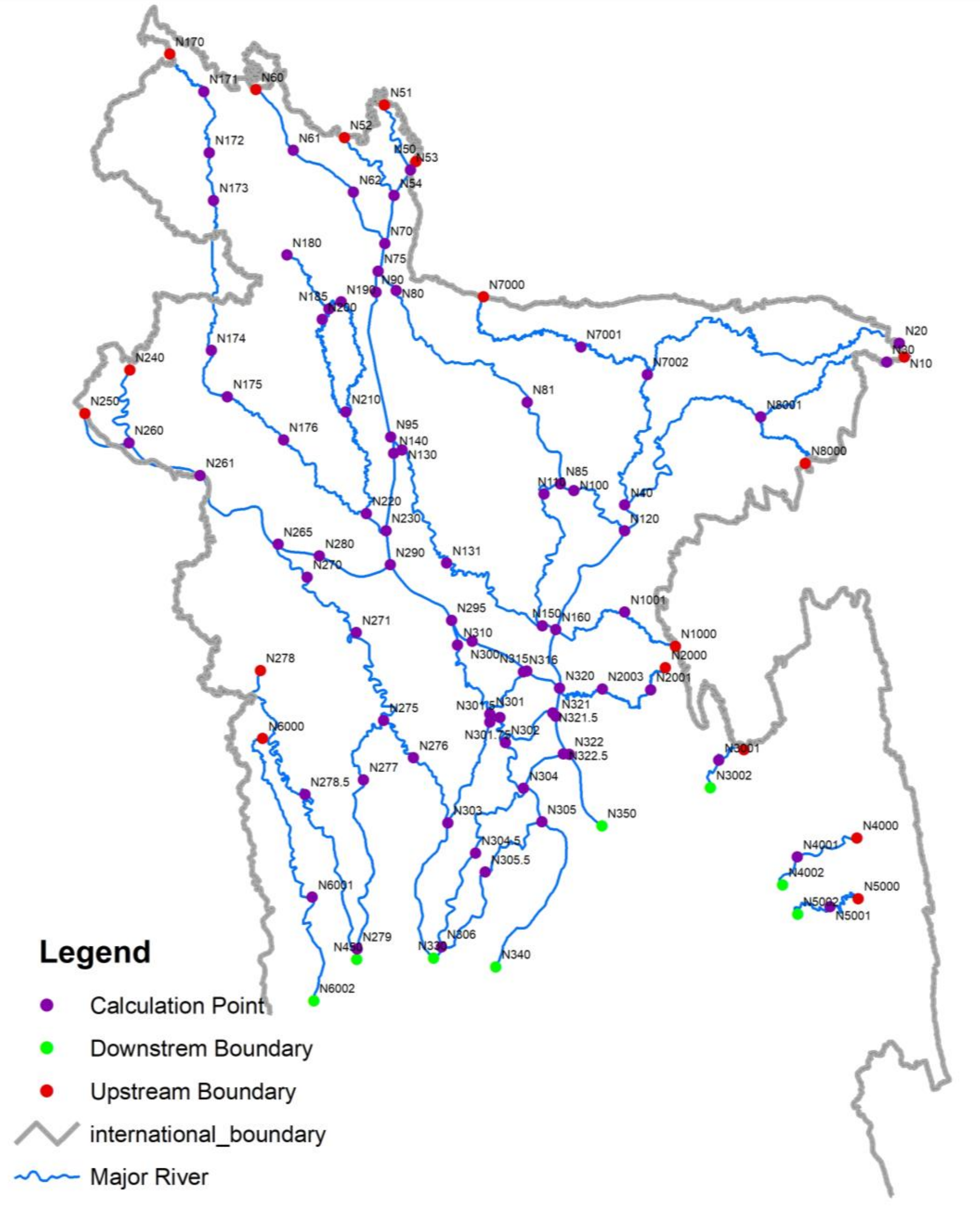
Three major components:

- Metamodel engine
- Database
- Dashboard



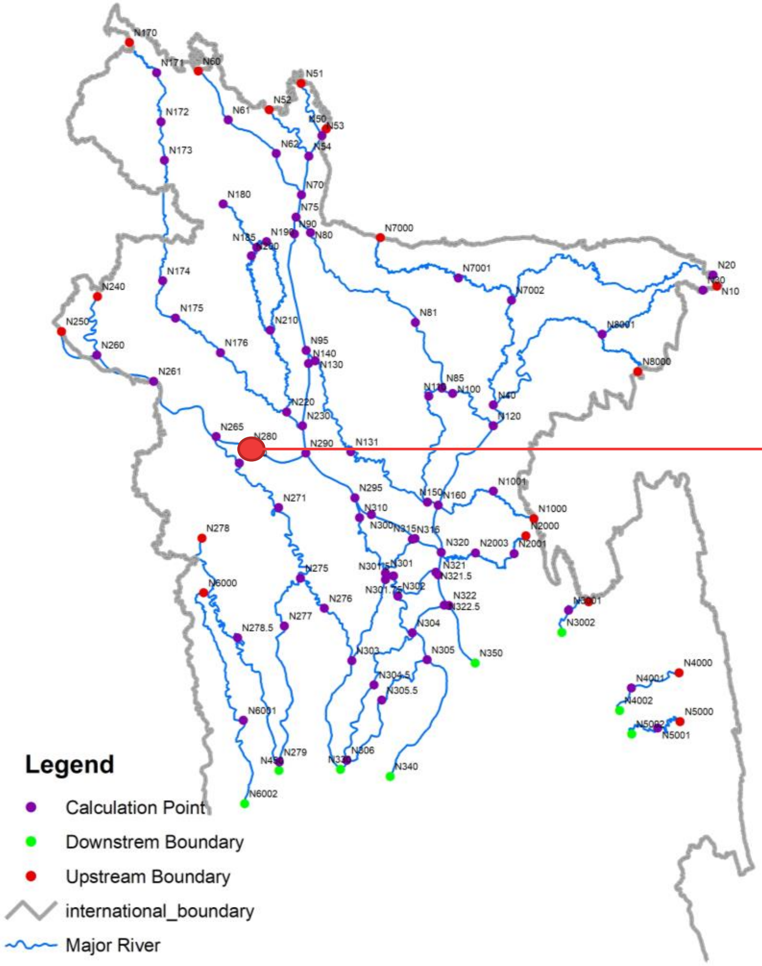
Network Module

- To generate necessary output for Water Balance module and parameter which gives inputs to Agricultural Production module & Flood Damage Module
- To describe transport of water through the major rivers of Bangladesh;
- To calculate decadal discharge, water level, tidal range and salinity (based on detailed IWM MIKE-11 models)

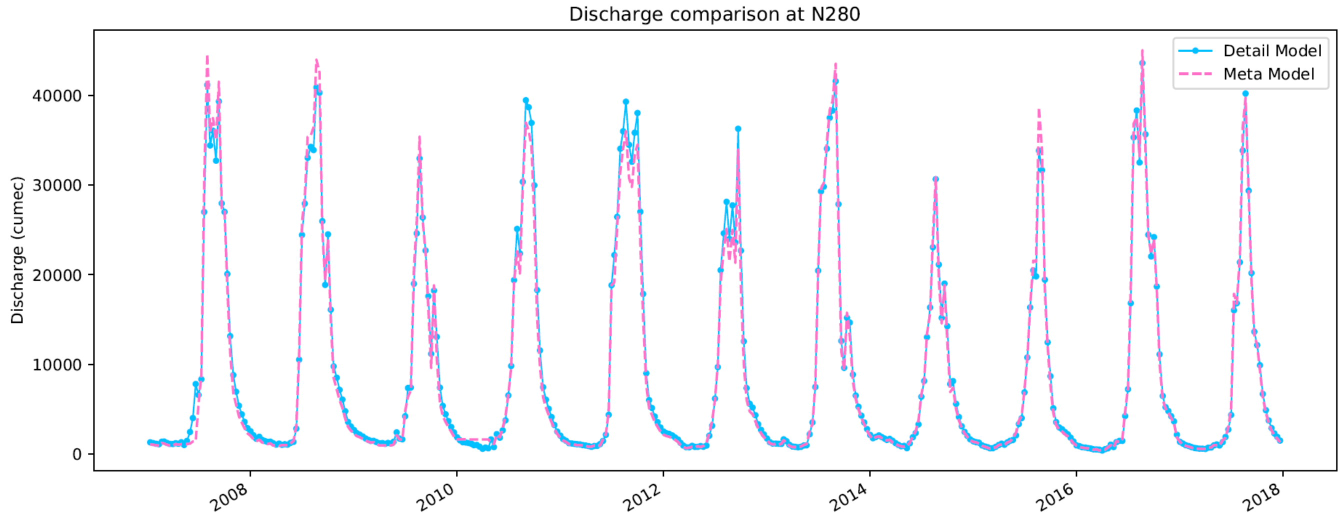


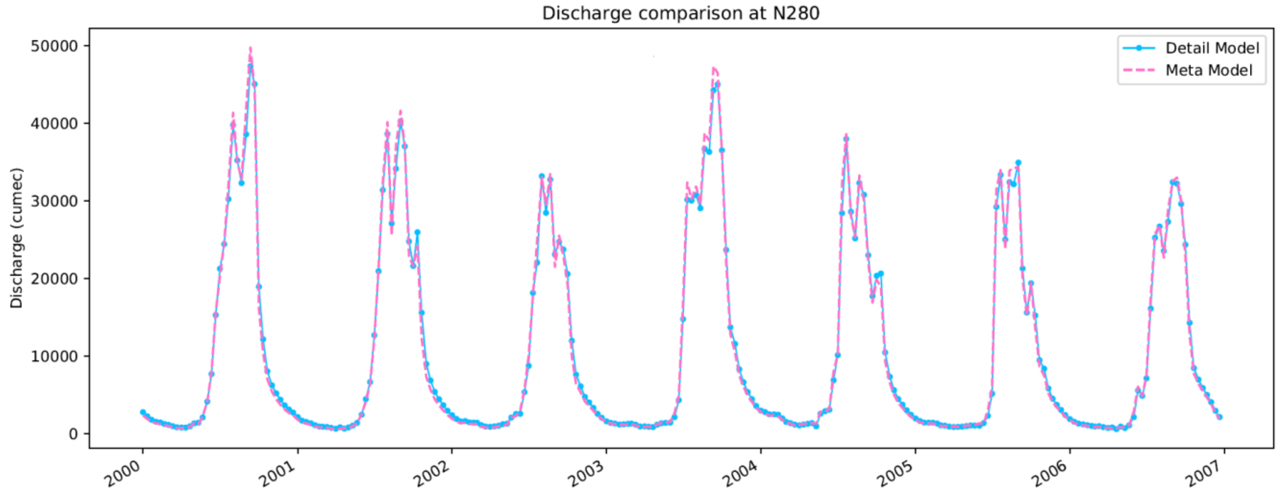
Extent of Network Module

Calibration and Validation



Ganges River, Sujanagar





Node	NSE	PBAIS	R_square	.peakError	Log_NSE	Season	Categoty
N280	0.99	1.83	0.99	-1443.89	0.98	Monsoon	Calibration
N280	0.94	10.82	0.98	1364.86	0.93	Dry	Calibration
N280	0.99	-0.82	0.99	-2424.77	0.99	Monsoon	Validation
N280	0.96	10.79	1.00	1161.84	0.97	Dry	Validation

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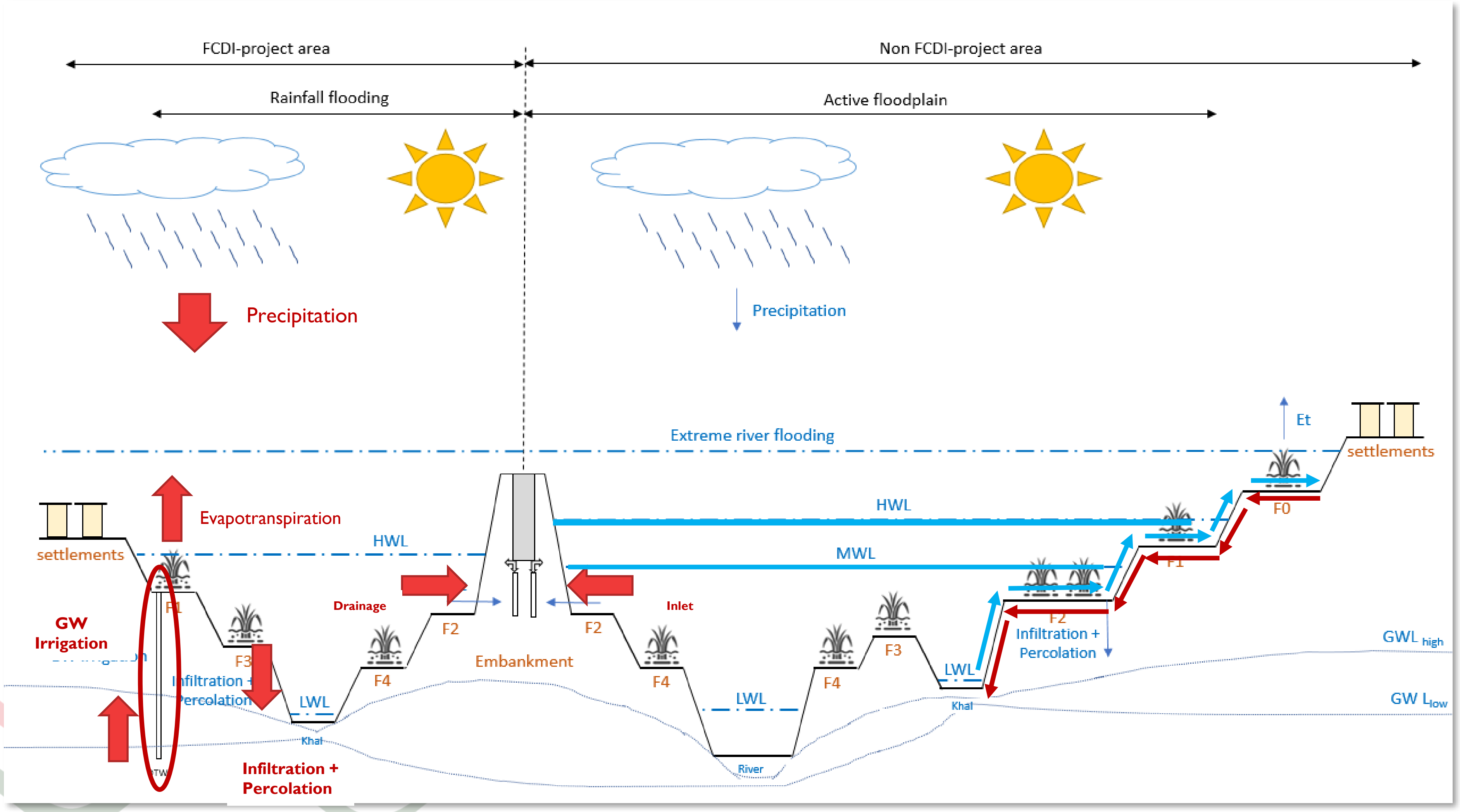
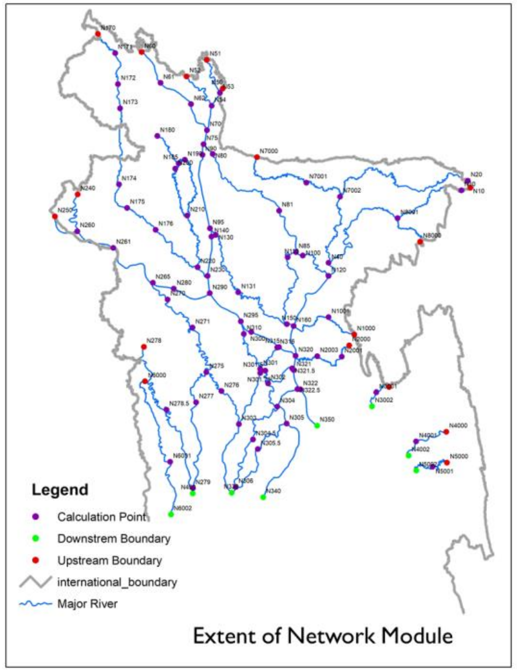
Water Distribution





1) **Vertical distribution of water;**
2) **Horizontal Distribution of Water**
3) **Shortage of Excess of Water at Field Level**

provides flood extents, flood duration, GWL at end of dry season and waterlogged area

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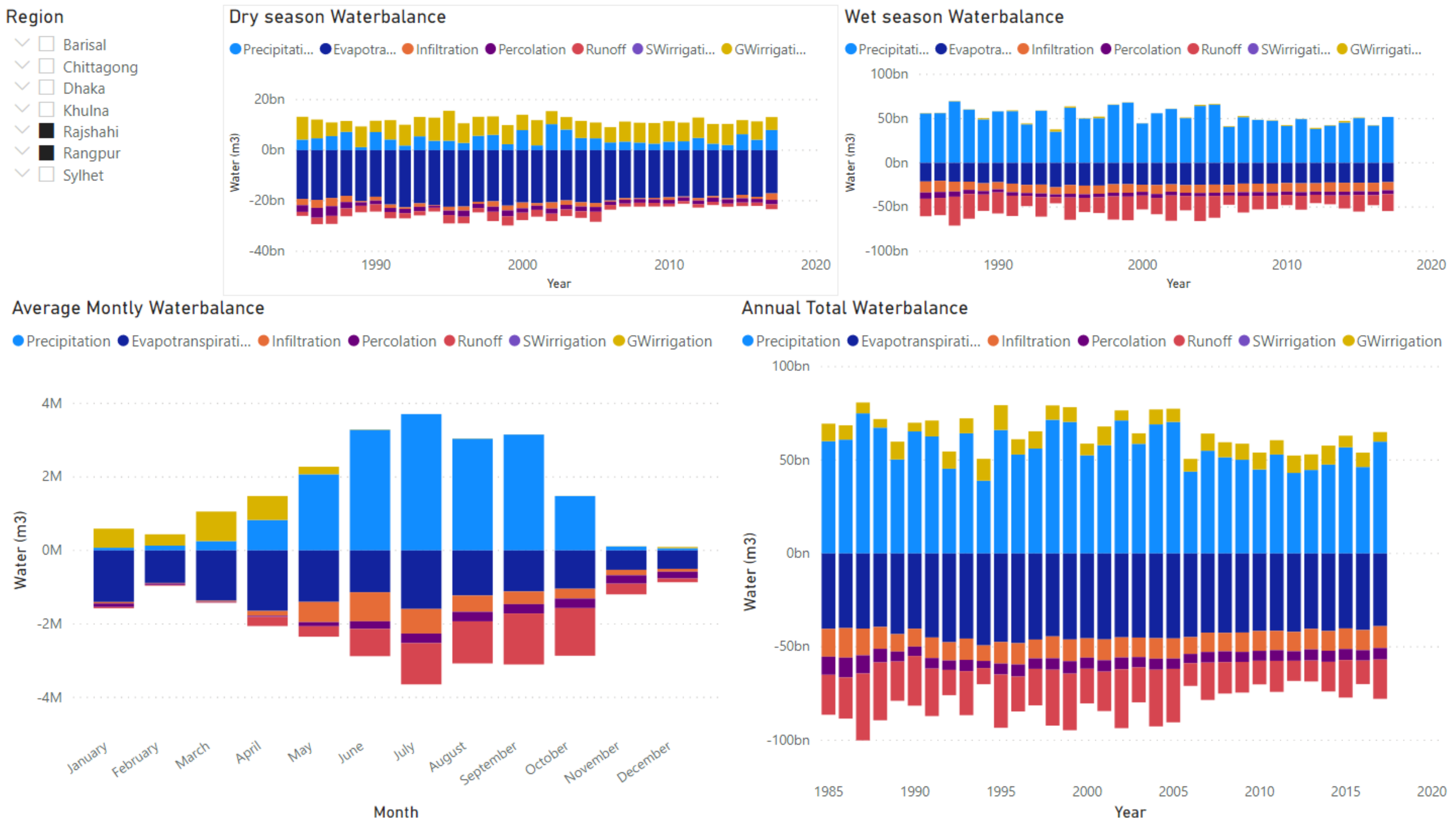
Water Balance Module output for NW-region (base run)



<u>Observations:</u>

I. Clear seasonal diff
II. Large annual variation
III. Residual moisture supplemented by GW irrigation in beginning of dry season

Available for every district in Bangladesh (currently calibrated for NW-region)

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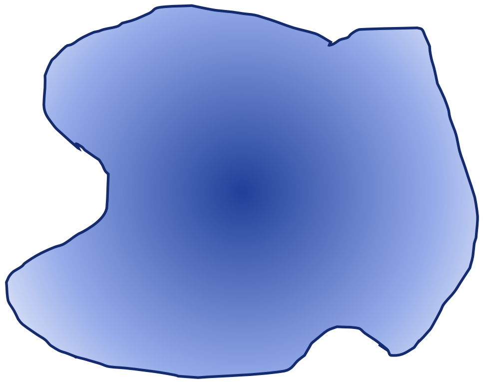
Flood damage and losses module

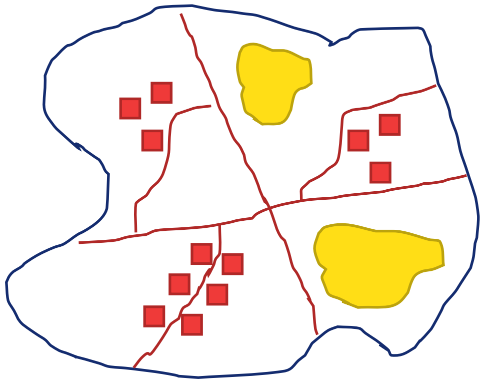
- Estimates flood impacts to population, road infrastructure, buildings, agriculture and embankments
- Based on well established unit-loss method and data from scientific literature

Max. water depth
(hazard)



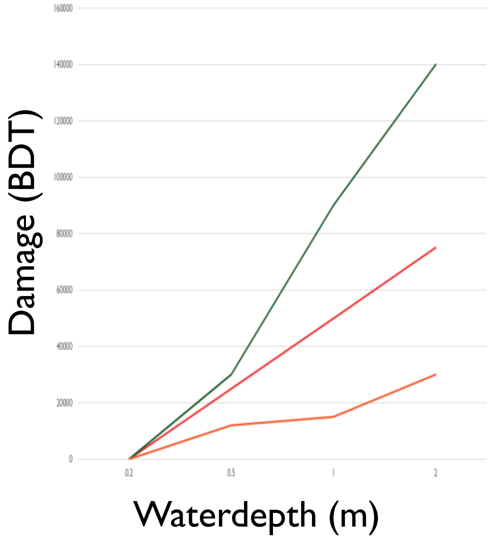
Waterbalance
result

Exposure (value)



BBS, RHD, LGED,
BARC, BWDB

Vulnerability
(damage factor)



Literature
(N. Islam, BIDS)

Damage in BDT
Persons affected

Water Demand

Objective

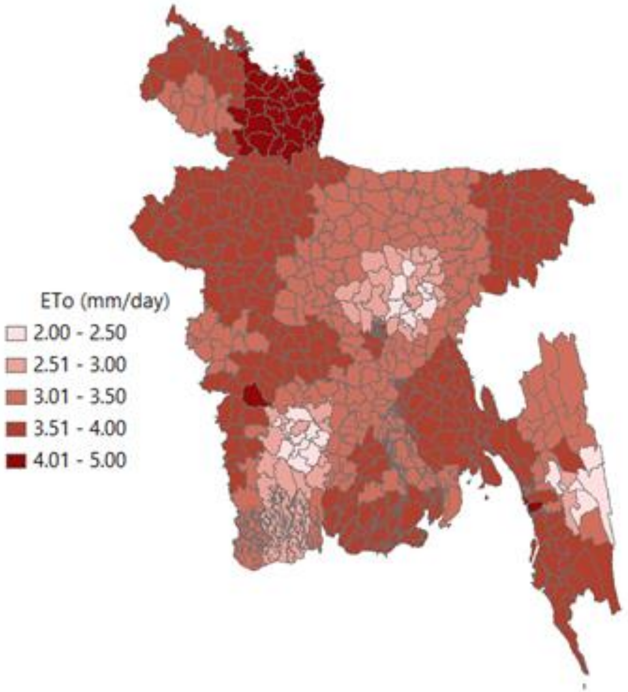
To estimate amount of water needed to meet water loss through evapotranspiration from crop land, forest land, fallow land, settlements and waterbodies.

Specific objectives :

1. crop water demand per crop per upazila on decadal basis.
2. loss of water through evapotranspiration from forest land, fallow land, settlement and waterbodies by upazila on decadal basis.

Crop water demand (m³/decade)

1. Crop Water Demand (CWD) = (10*EToi * Kci)/1000 *Acrop*10000 = EToi*Kci*Acrop*100
2. *Penman-Monteith (FAO, 1988):* Estimation of Decadal ETo (36 BMD station) and station data interpolated to Upazila by IDW (*Inverse Distance Weighting) method.*
3. BARI, 2018, MPO,1987: Crop coefficient (Kc)
4. Crop data (district) from Yearbook of Agricultural Statistics-2018



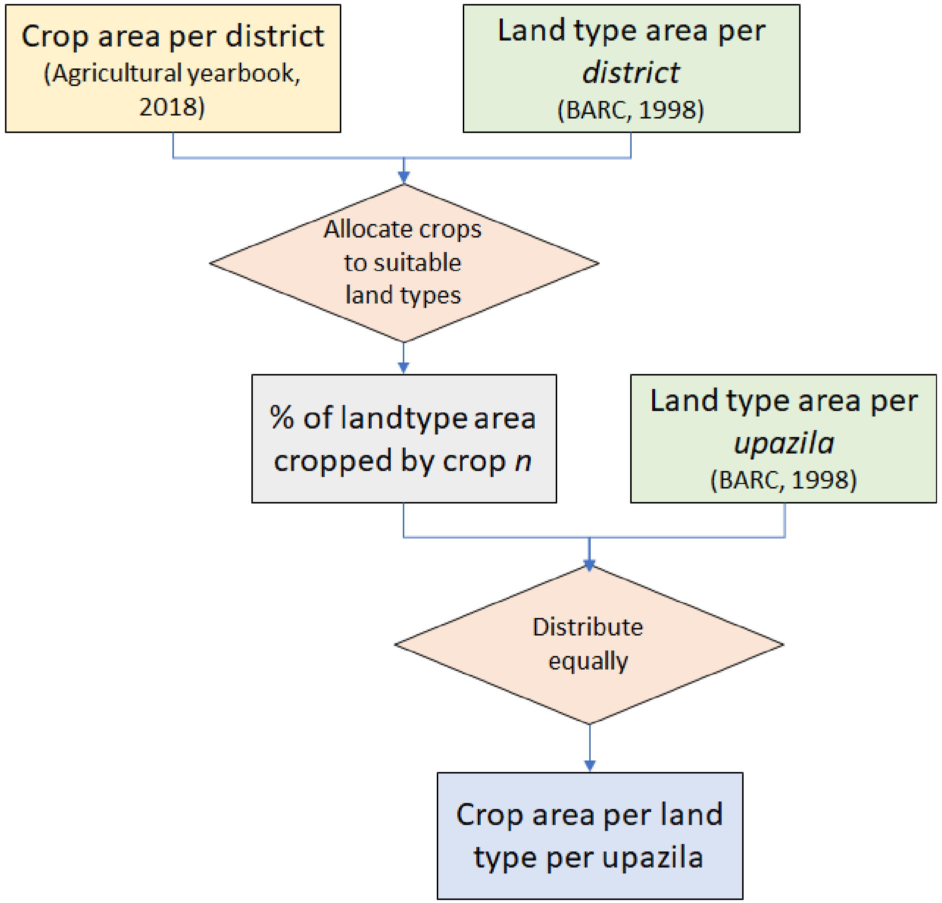
Crop coefficient
(BARI, 2018, MPO,1987)

Land type (F)
BARC, 1998

Per season:
Area per crop per landtype in an upazila → Total water demand

Documentation available: http://jcpbd.nl/bdpMetaModelDocs.php

Results: Crop distribution (District to Upazila)



Crop Name	Land Type F0	F1	F2	F3	F4	Season	Implemented Suitability
Aus	2	1	3			2	1,0,2,3,4
T Aman	2	1	3			3	1,0,2,3,4
B Aman		2	1	3		3	2,1,3,0,4
Boro	5	3	2	1	4	1	*
Wheat	1	2	3	4		1	0,1,2,3,4
Pulses	1	2	3	4		1	0,1,2,3,4
Maize_Rabi	1	2	3	4		1	0,1,2,3,4
Maize_Kharif	1	2				2	0,1,2,3,4
Jute	1	2	3			2	0,1,2,3,4
Spices	1	2	3			1	0,1,2,3,4
OilSeeds	1	2	3	4		1	0,1,2,3,4
Potato	1	2	3	4		1	0,1,2,3,4
Sugarcane	1	2				4	0,1,2,3,4
Vegetables_S	1	2				2	0,1,2,3,4
Vegetables_W	1	2	3			1	0,1,2,3,4

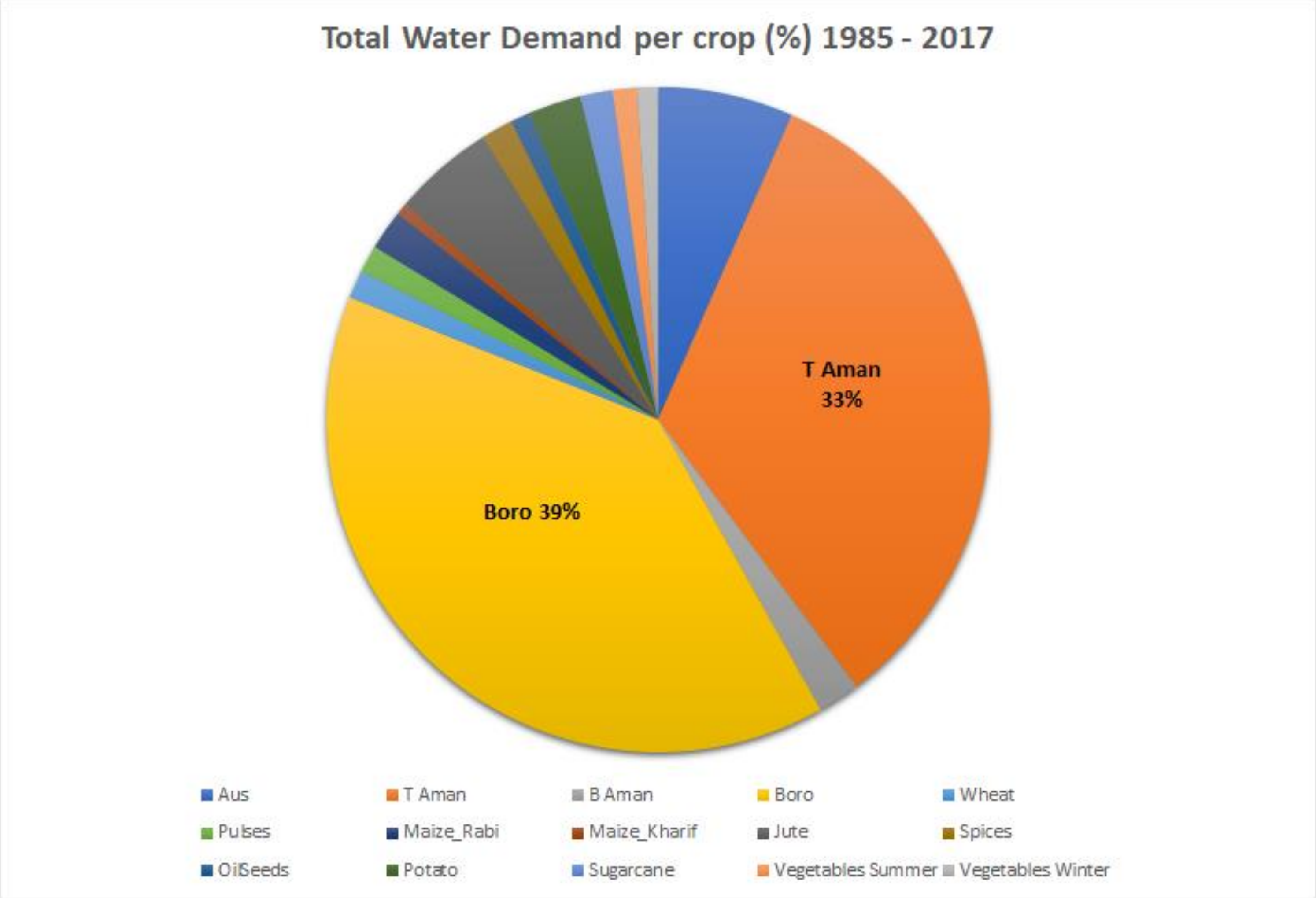
*Upazila data from Satellite Images

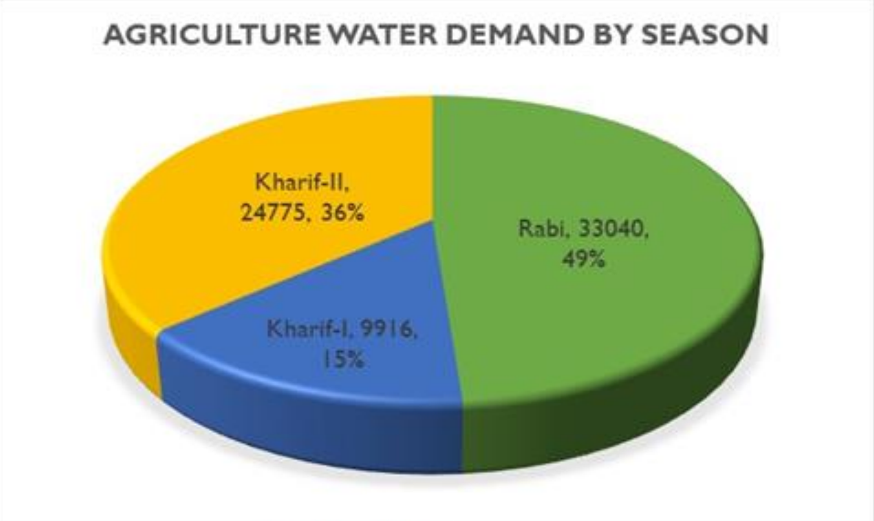
Suitable	(green)
Moderately Suitable	(yellow)
Not Suitable	(red)

Input for the Metamodel (Colomn Suitability 1 = highest and 4 lowest)

Results: Water Demand

from meta-model engine





SL	Crop Name	Water Demand (Million Cubic Meter)
1	Aus	4,477
2	T Aman	23,626
3	B Aman	1,520
4	Boro	26,746
5	Wheat	781
6	Pulses	717
7	Maize_Rabi	1,210
8	Maize_Kharif	342
9	Jute	3,217
10	Spices	788
11	OilSeeds	523
12	Potato	1,406
13	Sugarcane	1,167
14	Vegetables_S	731

Agricultural production

Goal

Actual crop yield of 15 crops

Agricultural production (Important considerations)

1. Input from other modules water demand (water demand, cropping area) and water balance (water supply, flooding depth)
2. The potential yield is reduced by flooding and drought damage (FAO, 2012)
3. Calibration: Crop yield (district) from Yearbook of Agricultural Statistics-2011 – 2018 (include damage from flood events)

Maximum yield (Agricultural book 2011-2018)

↓

Drought damage (total deficit water during growing period)

↓

Flood damage (flood occurrences, % submerged and duration)

↓

Actual yield (tonnes, per crop, upazila)

Agricultural production

Data

Agricultural yearbook:

- Chapter 3. Potential yield (63 districts, 7 years, 10 crops) ~4000 data inputs
- Chapter 4. Crop damage due to events ~300 data inputs

Drought damage

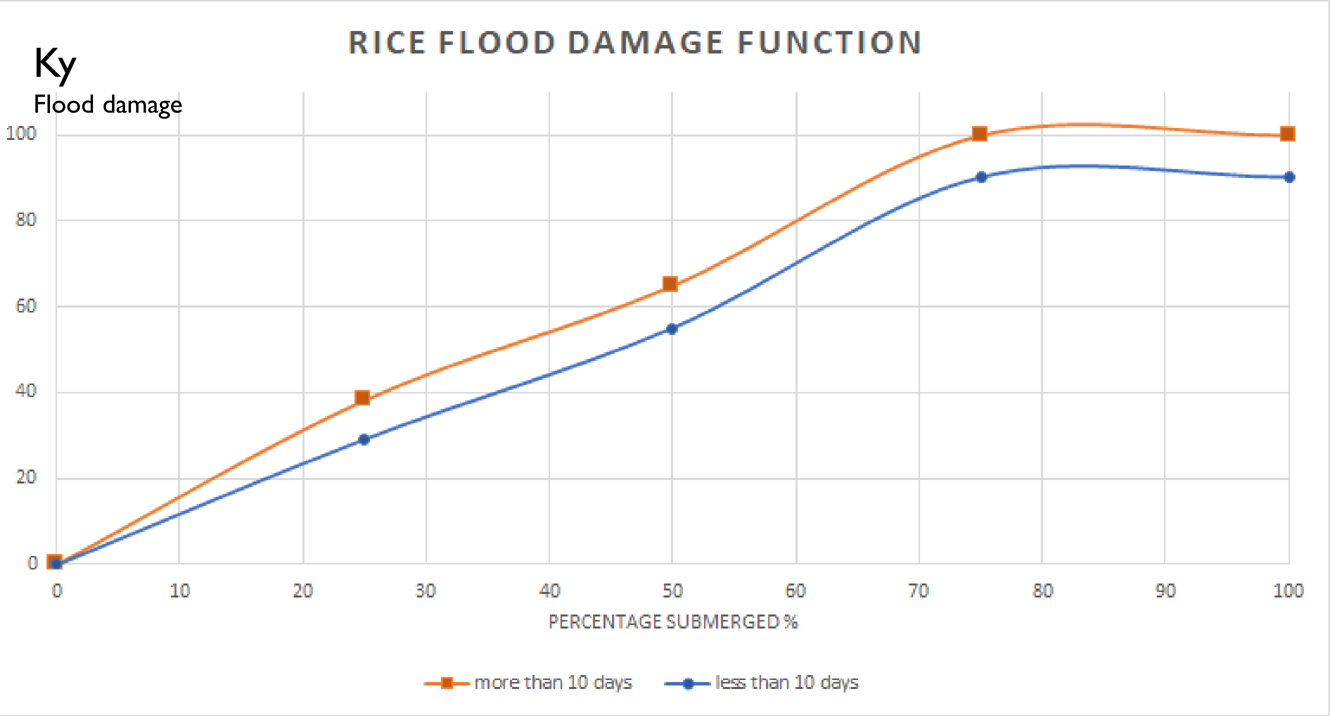
Coefficient Kd = Total deficit / Total demand

Flood damage

Coefficient Kf, damage function. This depends on days of submerged and % submerged

Rice plants height ~1.2 m

(developed from: Hussain, 1995)



Food Security: our approach

Goal

Average Dietary Energy Supply Adequacy (ADESA) for the lowest income (lowest 20% income quantile)

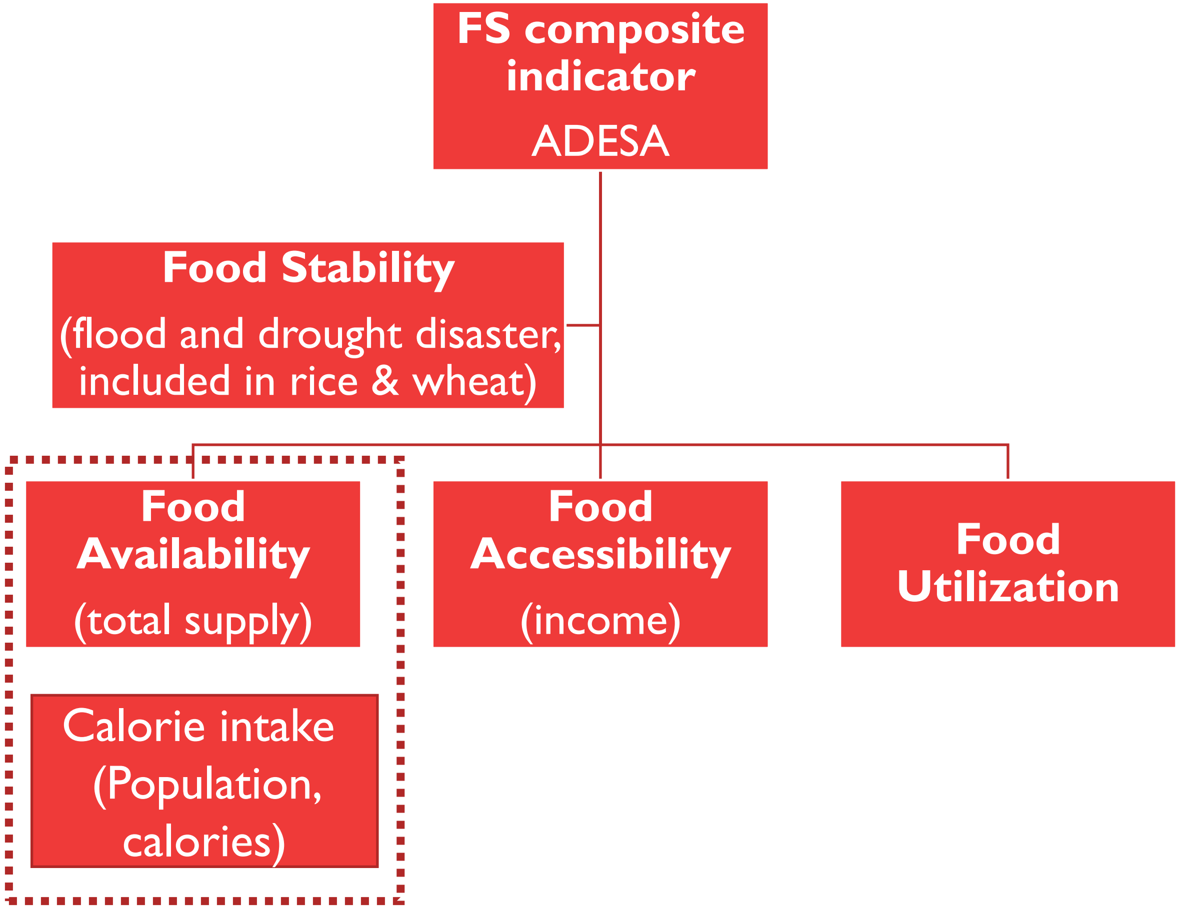
Pillars of food security

- *Availability* Total supply (import & production, rice and wheat from modules, others (meat, milk, and others from data) translated to calorie intake per capita per day
- *Accessibility* Income
- *Stability* Reduced wheat and rice production due to disasters

ADESA: expected calorie intake for lowest income quantile combining all the above pillars

Developments

- Income & production at district level?
- Scenario projections: population, income, food import, other agricultural productions?



Documentation available: http://jcpbd.nl/bdpMetaModelDocs.php

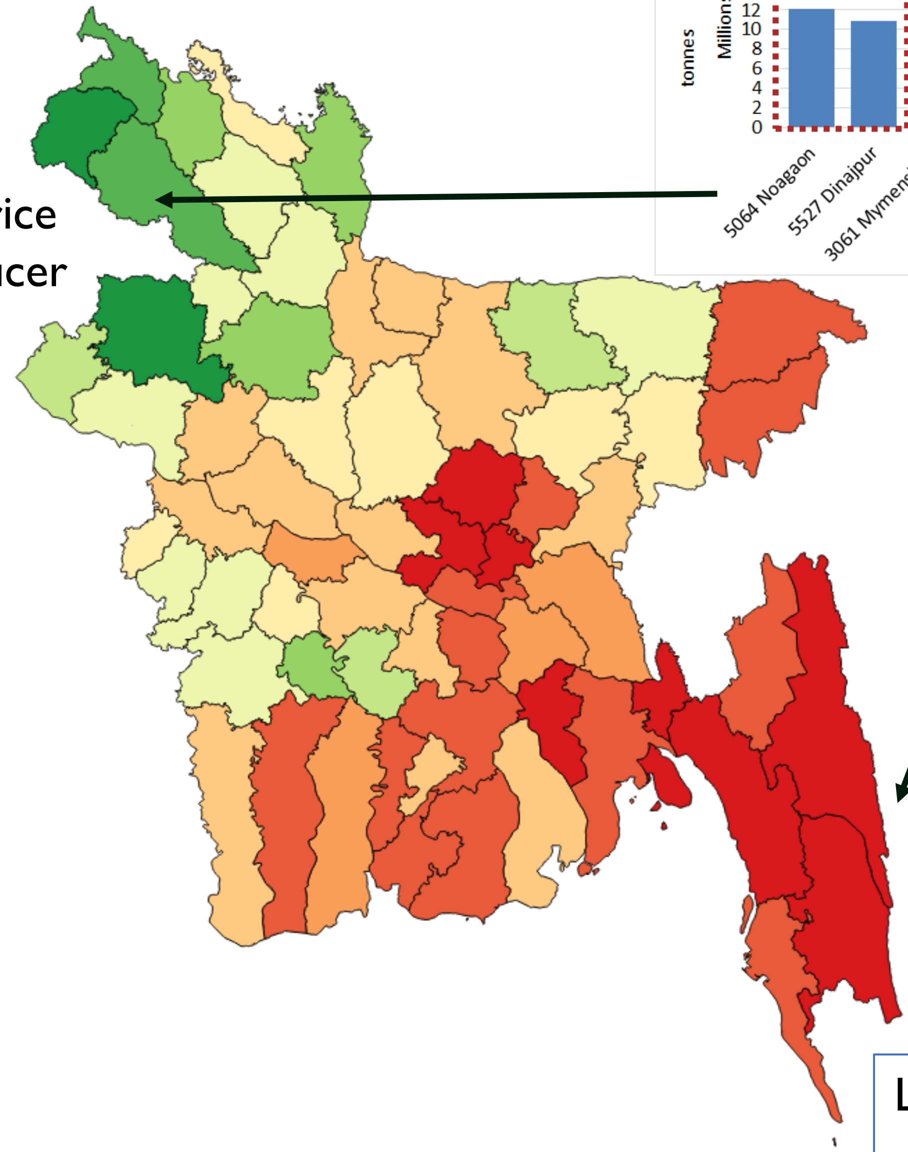
Results: Food security

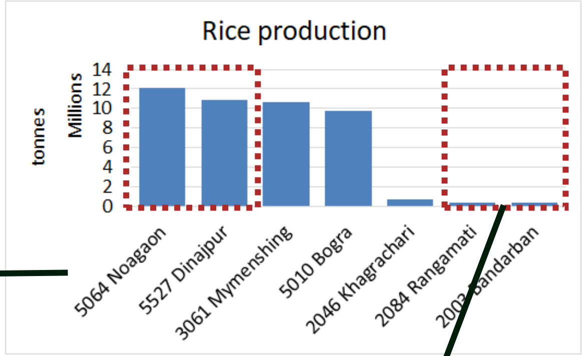
Food security composite indicator (ADESA) for the 20% lowest income quantile

Red = Lower food security
Green = Higher food security

Low food security is an impact of
low rice production in combination with
lower income per capita
(e.g. Chattogram)

Top rice producer





Chattogram

Low rice production
Lower income/capita for the poor

Data used in Metamodel

- Administrative boundary (BBS, 2011)
- Landuse (CEGIS, 2010)
- Land types and Soil (BARC, 1999)
- Crop Suitability, BARC
- Meteorological (BMD, 2018 and BWDB)
- FCDI-projects (BWDB, 2018)
- DEM (WARPO, 2017)
- Exposure data, BBS
- Infrastructure owners (RHD, LGED, BWDB)
- Yearbook of Agricultural Statistics-2018,BBS
- MIKE11Region Model's Output
- BDP2100 Scenario

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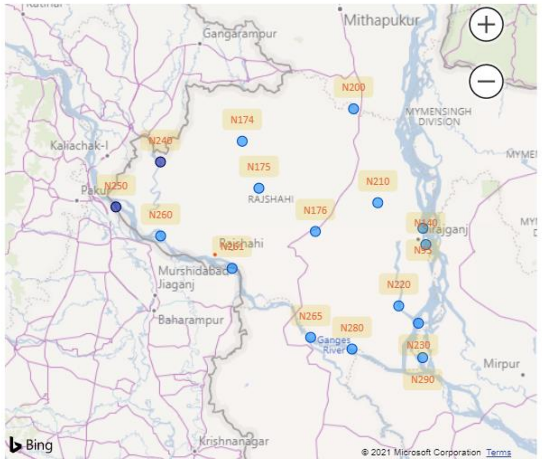
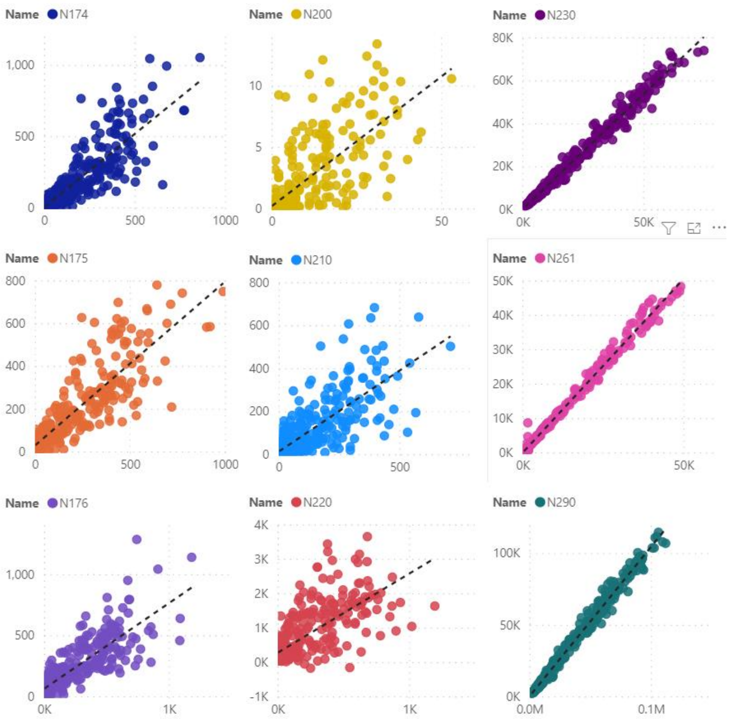
Present Status of Metamodel

- Calibration has been done for NW-Region
- Salinity, Fisheries and E-flow modules development ongoing
- Whole country will be calibrated end of 2021
- Application within SIBDP to select projects for the Basin Implementation Programs

wet_or_dry	dry				wet			
Name	nse_q	pbias_q	riv_q_avg	q_obs_avg	nse_q	pbias_q	riv_q_avg	q_obs_avg
N174	0.09	0.09	41	45	0.49	0.06	304	324
N175	-0.20	0.42	26	45	0.36	-0.13	334	297
N176	-0.60	0.76	17	72	0.20	-0.11	403	363
N200	-29.06	-8.18	1	0	-18.73	-2.92	15	4
N210	0.12	0.26	13	18	0.20	-0.14	217	190
N220	-1.58	0.86	36	265	-1.33	0.71	379	1,317
N230	0.92	0.10	6882	7,673	0.91	0.08	36258	39,402
N261	0.97	0.06	1942	2,068	0.99	0.02	19763	20,177
N290	0.90	0.11	8703	9,749	0.95	0.06	54545	57,947

Network nodes





Workflow to run Metamodel cases

Step 1: Selection of Projects

Step 2: Formulation of Strategies/Interventions

Step 3: Selection of River location/Districts

Step 4 : Selection of Parameters to be Changed

Step 5 : Change in Parameters in "strategydefinition.csv"

DP12_cegis_2	PrivateData	NetworkModule	WaterLeve	Node	N174	AdjustWat	-
DP12_cegis_2	PrivateData	NetworkModule	WaterLeve	Node	N261	AdjustWat	+
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Rajshahi#	Drainage_	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Naogaon#	Drainage_	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Natore#	Drainage_	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Pabna#	Drainage_	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Sirajganj#	Drainage_	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Bogra#	Drainage_	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Rajshahi	Reg_open	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Naogaon	Reg_open	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Natore	Reg_open	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Pabna	Reg_open	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Sirajganj	Reg_open	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Bogra	Reg_open	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Rajshahi	Reg_close	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Naogaon	Reg_close	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Natore	Reg_close	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Pabna	Reg_close	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Sirajganj	Reg_close	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Bogra	Reg_close	=
DP12_cegis_2	PrivateData	WaterBalanceMod	init_wbupz	DISTNAME	Rajshahi	Irripump_o	=

Step 6 : Change in "run.bat" file

```
REM python Framework.py --r DP12_cegis_3 --s C0_E0_20 --i 101
REM python Framework.py --r DP12_cegis_3 --s CH_EH_30 --i 102
REM python Framework.py --r DP12_cegis_3 --s CH_EH_50 --i 103
REM python Framework.py --r DP12_cegis_3 --s CH_EL_30 --i 104
REM python Framework.py --r DP12_cegis_3 --s CH_EL_50 --i 105
REM python Framework.py --r DP12_cegis_3 --s CL_EH_30 --i 106
REM python Framework.py --r DP12_cegis_3 --s CL_EH_50 --i 107
REM python Framework.py --r DP12_cegis_3 --s CL_EL_30 --i 108
REM python Framework.py --r DP12_cegis_3 --s CL_EL_50 --i 109

python Framework.py --r DP12_cegis_2 --s C0_E0_20 --i 111
python Framework.py --r DP12_cegis_2 --s CH_EH_30 --i 112
python Framework.py --r DP12_cegis_2 --s CH_EH_50 --i 113
python Framework.py --r DP12_cegis_2 --s CH_EL_30 --i 114
python Framework.py --r DP12_cegis_2 --s CH_EL_50 --i 115
python Framework.py --r DP12_cegis_2 --s CL_EH_30 --i 116
python Framework.py --r DP12_cegis_2 --s CL_EH_50 --i 117
python Framework.py --r DP12_cegis_2 --s CL_EL_30 --i 118
python Framework.py --r DP12_cegis_2 --s CL_EL_50 --i 119
```

Step 7 : Simulation of Model – "run.bat" file

Step 8 : Case wise Result in the "Case" Folder

Step 9 : Combining the outputs using "CombineIndicators.py"

Step 10 : Preparing the "PowerBI" file

Step 11 :Visualization of Result

Project Impact Analysis

Revitalization and Restoration of Chalan Beel

Options -1,2 & 3

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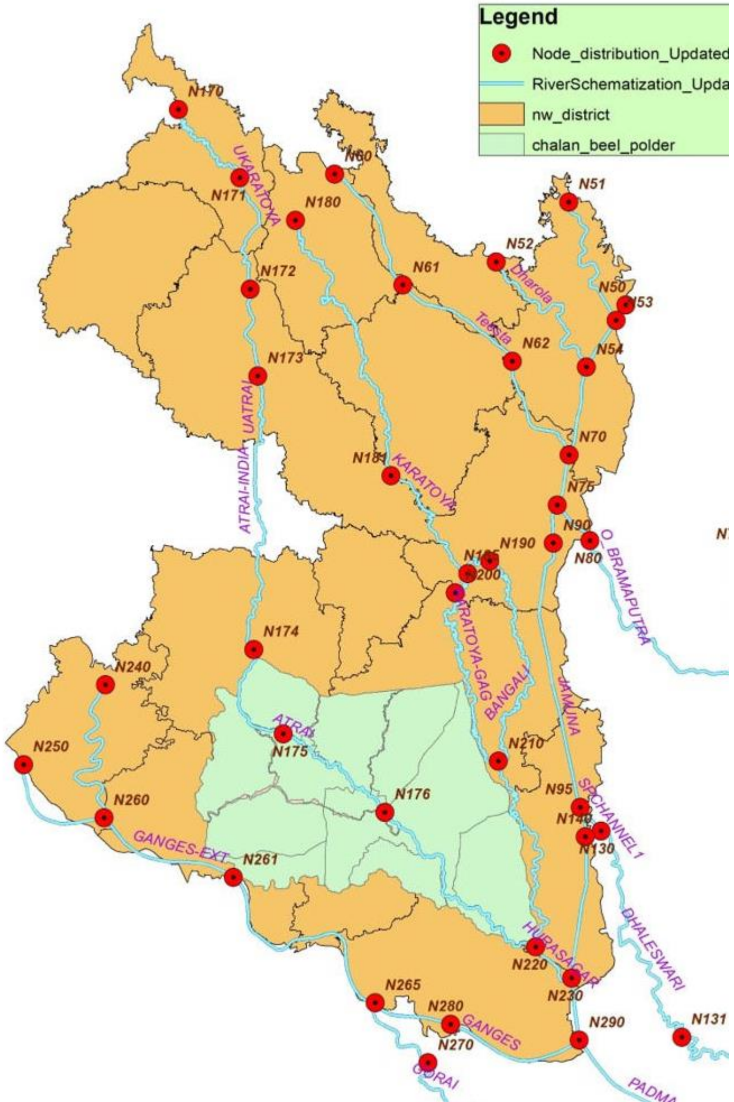
Revitalization and Restoration of Chalan Beel



- Location: Pabna, Bogra, Naogaon, Natore, Rajshahi, Sirajganj
- 11 Polders
- FCD-project
- The gross area about 5,66,000 ha

Problem

- Cuts and braches in embankments
- Habitat and breeding grounds for the traditional fish species severely affected
- Loss of flood plains and bio-diversity
- Road Network vulnerable to Climate Change impacts

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Options Considered

Option 1: Protect the lands from flood and to extend the irrigation coverage

Option 2: Green Beel

Option 3: Climate Resilient Roads

Option 1

Strategic

- No breaches and no spilling over the existing embankments
- Main public cuts provided with structures or weirs
- Dredging in Sib river

Changed parameters in Metamodel:

- *Node 174, decreased water level by 1m (dredging in Sib River)*
- *Node 261, increased water level by 0.05 m (effect of Rubber Dam)*
- *In districts- Rajshahi, Naogaon, Natore, Pabna, Sirajganj, Bogra*
  - *Increased drainage efficiency to 0.75*
  - *Regulator opened on Decade 1, closed on Decade 36.*
  - *Both SW and GW irrigation enabled*
  - *Irrigation pumping turned on Decade 1, off Decade 36*
  - *SW irrigation efficiency = 0.45, GW irrigation efficiency = 0.6*
  - *SW irrigation capacity= 3m^3/s*

Option 1

Expected Outputs:

- Increase in drainage capacity of the beel area
- Water is allowed inside the polders
- Allowing migration of fishes and uninterrupted navigation
- Decrease in Ground water depletion

Option2: Green Beels

Strategic Interventions:

- Realigning polder boundary/embankment
- Flood proofing some portions of settlement so that flood damage gets reduced

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Option2: Green Beels

Changed parameters in Metamodel:

- Selecting parcels of land containing beels/permanent waterbodies to be left outside the polder areas
- Transferring calculated amount of area from "Project" to "Non-Project" Upazila-wise
- Changing values in the 'Flood Damage Function' files

Expected Outputs:

- Increase in ecosystem values and services in the beels (not computable in the MetaModel)
- Reduced damage due to river floods

Option3: Climate Resilient Roads

- Strategic Interventions
  - Elevating Roads at strategic segments
  - Using culverts, slope protection measures and pavement materials to facilitate GW infiltration and percolation
  - Using Polder embankments as roads (Upazila Paved Roads only)

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Option3: Climate Resilient Roads

Changed parameters in Metamodel:

- Updating data-
  - Length of Roads Upazila-wise
  - Relative height of aforementioned type of roads
- Changing the values in Flood Damage Function to imitate effects of climate resilient roads
- Increasing Drainage efficiency to 0.75

Expected Outputs:

- Decrease in damage to river floods
- Decrease in Flood Extent
- Decrease in dry season river flow (increased drainage efficiency leading to more GW infiltration)

Meta Model Outputs: Option I,II and III

Step 1. Select region: Multiple selections

Step 2. Select project(s): Multiple selections

Step 3. Change scenario: 2020: No CC and No EC

Name	Base 2020		ChalanBeel_Option1 2020		ChalanBeel_Option2 2020		ChalanBeel_Option3 2020	
Indicator_combi	Value	% diff	Value	% diff	Value	% diff	Value	% diff
Agricultural damage due to river and rainfall floods (BDT/year)	9,856,873,995	0.0	7,694,457,676	-21.9	9,856,873,995	0.0	9,856,873,995	0.0
Damage due to river and rainfall floods (BDT/year)	3,731,990,444	0.0	3,909,922,561	4.8	839,593,118	-77.5	839,593,118	-77.5
Damage due to river floods (BDT/year)	752,133,496	0.0	723,028,290	-3.9	387,997,895	-48.4	387,997,895	-48.4
Damaging rainfall and river flood extent (ha/year)	145,111	0.0	117,227	-19.2	145,111	0.0	145,111	0.0
Population affected due to river and rainfall floods (Persons/year)	542,042	0.0	521,669	-3.8	542,042	-2.1E-14	542,042	0.0
Rainfall and river flood extent (ha/year)	627,234	0.0	606,145	-3.4	627,234	0.0	627,234	0.0
Rice production (tonnes/year)	4,284,852	0.0	4,453,558	3.9	4,284,852	0.0	4,284,852	0.0
River flood extent (ha/year)	63,335	0.0	64,757	2.2	63,335	0.0	63,335	0.0
Sustainable groundwater use (cm/year)	-8	0.0	8	-193.0	-8	0.0	-8	0.0
Waterlogged area (ha/year)	115,199	0.0	81,277	-29.4	115,199	0.0	115,199	0.0

The results presented here are draft results from Bangladesh Metamodel runs v1.0 and are subject to change according latest insights and continuous improvements. For more information about the BangladeMetamodel contact IWM or CEGIS or visit icpbd.nl

Meta Model Outputs: Option1 and Scenario 2050

Step 1. Select region: Multiple selections

Step 2. Select project(s): Multiple selections

Step 3. Change scenario: Multiple selections

Name	Base 2020		Base Productive 2050		ChalanBeel_Option1 2020		ChalanBeel_Option1 Productive 2050	
Indicator_combi	Value	% diff	Value	% diff	Value	% diff	Value	% diff
Agricultural damage due to river and rainfall floods (BDT/year)	9,856,873,995	0.0	16,869,749,316	71.1	7,694,457,676	-21.9	10,551,016,942	7.0
Damage due to river and rainfall floods (BDT/year)	3,731,990,444	0.0	49,547,867,151	1227.7	3,909,922,561	4.8	50,833,852,329	1262.1
Damage due to river floods (BDT/year)	752,133,496	0.0	26,933,281,670	3480.9	723,028,290	-3.9	20,998,870,853	2691.9
Damaging rainfall and river flood extent (ha/year)	145,111	0.0	321,601	121.6	117,227	-19.2	183,521	26.5
Population affected due to river and rainfall floods (Persons/year)	542,042	0.0	2,816,149	419.5	521,669	-3.8	1,297,614	139.4
Rainfall and river flood extent (ha/year)	627,234	0.0	777,029	23.9	606,145	-3.4	694,461	10.7
Rice production (tonnes/year)	4,284,852	0.0	3,754,298	-12.4	4,453,558	3.9	4,238,390	-1.1
River flood extent (ha/year)	63,335	0.0	206,054	225.3	64,757	2.2	126,216	99.3
Sustainable groundwater use (cm/year)	-8	0.0	-3	-67.6	8	-193.0	10	-221.4
Waterlogged area (ha/year)	115,199	0.0	247,035	114.4	81,277	-29.4	125,674	9.1

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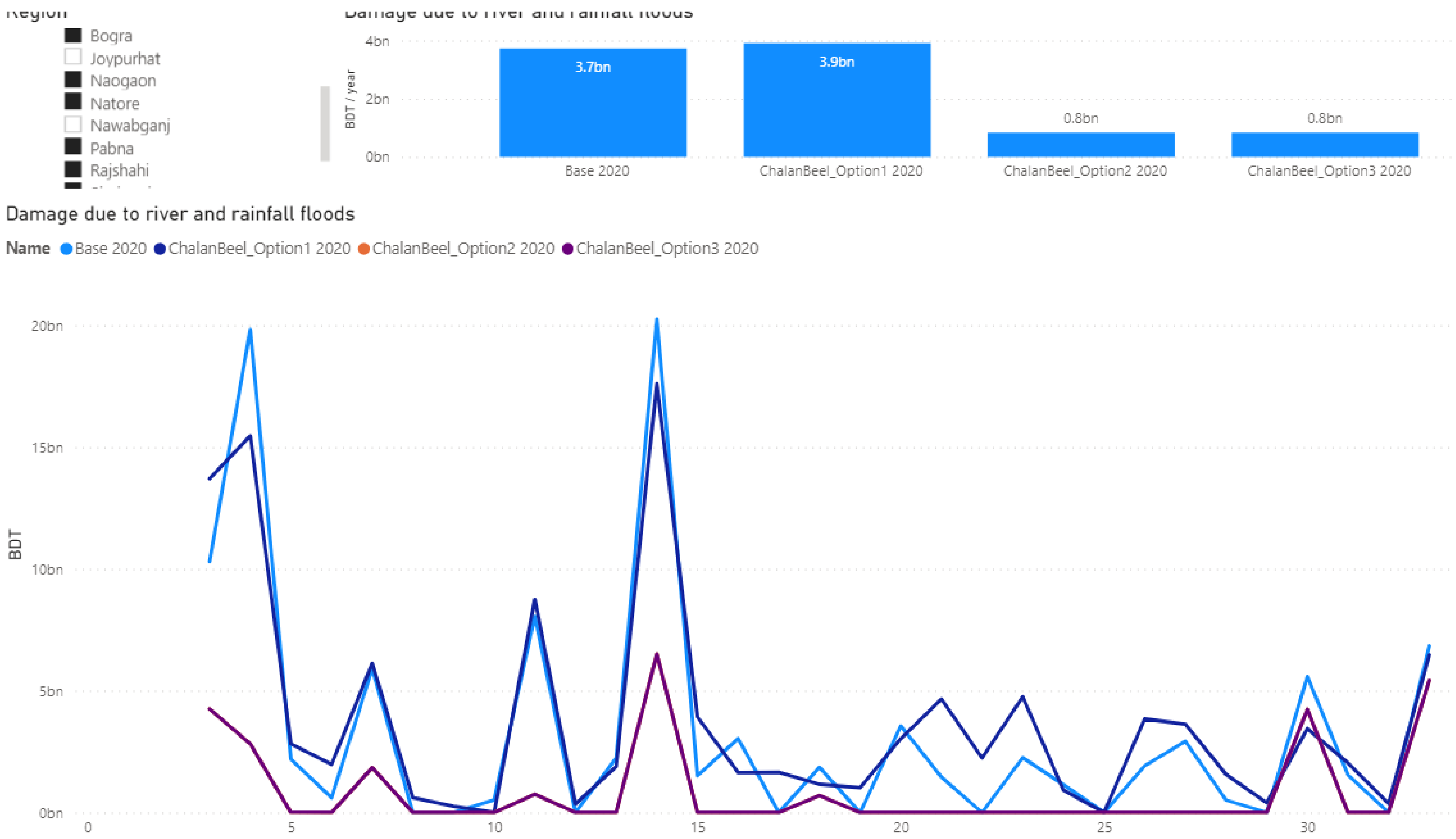
Meta Model Outputs: Option I,II and III

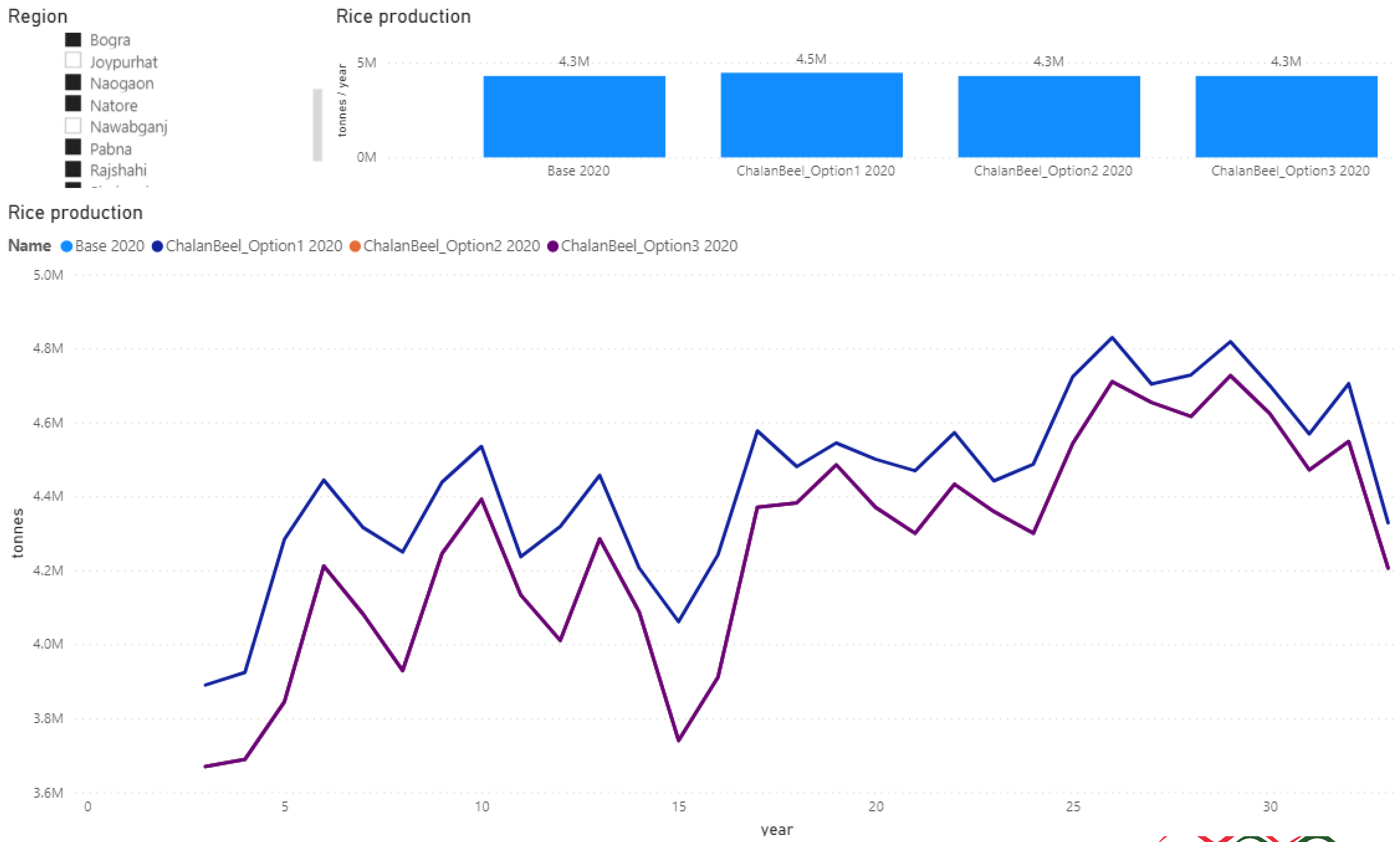
Indicator: Flood Damage due to River and Rainfall

Scenarios:

- Base 2020 and
- Base 2020 with project



Meta Model Outputs: Option I,II and III



Indicator: Rice Crop Production

Scenarios:

- Base 2020 and
- Base 2020 with project

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Metamodel Dashboard

- Present model results for future decision-making
- Evaluate and compare impacts of projects and programs
- Indicator values for selected combination of
  - Project / program
  - Scenario
  - Time horizon
- Information present in table, chart and map format

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Group Exercise

Implementation of Rationalized Water Related Interventions in Hurasagar Basin

Strategies/interventions selection

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Implementation of Rationalized Water Related Interventions in Hurasagar Basin

- Erosion along the river banks
- Flood and drainage problem in the project area due to siltation
- Depletion of GWT due to excessive use of GW irrigation
- Drought and low flow
- Vulnerability to climate change
- Navigation problem due to siltation and human intervention
- Lack of proper water use and management
- Loss of habitat and species

Implementation of Rationalized Water Related Interventions in Hurasagar Basin

Interventions

- Excavation of Karotoa, Atrai River and Ganges
- Encouraging surface water irrigation at Dinajpur, Kurigram, Lalmonirhat, Nawabganj, Rajshahi, Naogaon specially in drought prone area
- Reducing ground water irrigation at Dinajpur, Kurigram, Lalmonirhat, Nawabganj, Rajshahi, Naogaon specially in drought prone area.
- Stregthening embankment at flood prone zone.

Expected Outputs

- Decrease in flood extent and flood damage
- Increase Surface water Irrigation
- Decrease groundwater abstraction
- Increasing agricultural production
- Increasing fisheries production
- Increasing livestock production
- Increasing fresh water supply
- Reducing Poverty
- Flood proofing of houses in flood plains

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Measures Parameters

	Intervention type	File(s)	Parameter	Unit	Range	Note
A	Systemic measures					@Shahadat
4	Dredging of regional rivers (new in schema)					Requires updates of networkfiles + related
B	Flood control, drainage and irrigation					
1	New or extend FCDI project	init_wbupz.csv	Project_Area, pw, shr, F4, F3, F2, F1, F0, forest, settl, riv	ha	0 to max(Total_area)	Area of landtypes adapted: to what level? Impact on crop distribution?
2	Embankment heightening (en lowering)	init_wbupz.csv	Embankment_height	mm	-1000 to 10000	Higher or lower relative to current max. wl of related node (DetailWL.csv); filter on 'Project' under parameter Area
3	Embankment strengtening	init_wbupz.csv	Embankment_height	mm	0 to 10000	Stronger = higher
4	New or improve regulator - efficiency or dimensions	init_wbupz.csv	MaxDrainagerate	m3/s	0 to 100	default max. 10 m3/s per regulator (5 regs.)
5	New or improve regulator - operation	init_wbupz.csv	Reg_open, Reg_close	decade	1 to 36	default 10 (open), 30 (close)
6	Increase local SW storage or runoff - drainage_eff per THAID	init_wbupz.csv	Drainage_eff	fraction	0 to 1	Increase/decrease water retention for all landtypes within THAID; accept higher wls
7	Increase local SW storage or runoff - drainage_eff per landtype	ll_drainagerates.csv	DR_rate	fraction	0 to 1	Increase/decrease water retention for all THAIDS per landtype and per project area; accept higher wls
8	Pumped drainage - status	init_wbupz.csv	MaxPump_drainage	m3/s	0 to 5	
9	Pumped drainage - operation	init_wbupz.csv	Pump_on, Pump_off	decade	1 to 36	default 10 (on), 28 (off)
11	SW irrigation schemes - status	init_wbupz.csv	SW_irrigation	binary	0 or 1	potentially combined with reservoir
10	SW irrigation schemes - capacity	init_wbupz.csv	MaxSWIrripump	m3/s	0 to 5	
12	SW irrigation schemes - operation	init_wbupz.csv	Irripump_on, Irripump_off	decade	1 to 36	
13	SW irrigation schemes - efficiency	init_wbupz.csv	SW_irri_eff	fraction	0 to 1	default: 0.25
14	GW irrigation schemes - status	init_wbupz.csv	GW_irrigation	binary	0 to 1	can also be interpreted as fraction, impacting capacity
15	GW irrigation schemes - capacity	init_wbupz.csv	MaxGWIrri	m3/s	0 to 10	
16	GW irrigation schemes - efficiency	init_wbupz.csv	GW_irri_eff	fraction	0 to 1	default: 0.45
17	Settl sewerage storage	init_wbupz.csv	Urbanstore	mm	0 -300	
18	Settl sewerage drainage capacity	init_wbupz.csv	Maxurbandrain_rate	m3/s	0 - 10	
C	Land management					
1	Flood-proofing of infrastructure or housing	DamageFunctions.csv				test needed
2	Adapting cropping patterns or rotations (via subsidiaries)	District.csv	Area pe crop per district	ha	> 0	This only changes the areas per crop

Thank You

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