



DELTA IN TIMES OF CLIMATE CHANGE II

ROTTERDAM, THE NETHERLANDS 24 - 26 SEPTEMBER 2014

DD 4.6 Ecosystem values and the coupling of human and natural dynamics

Spatial variation in soil salinity in relation to hydro-climatic factors in southwest coastal Bangladesh

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Chowdhury¹, Sara Nowreen¹

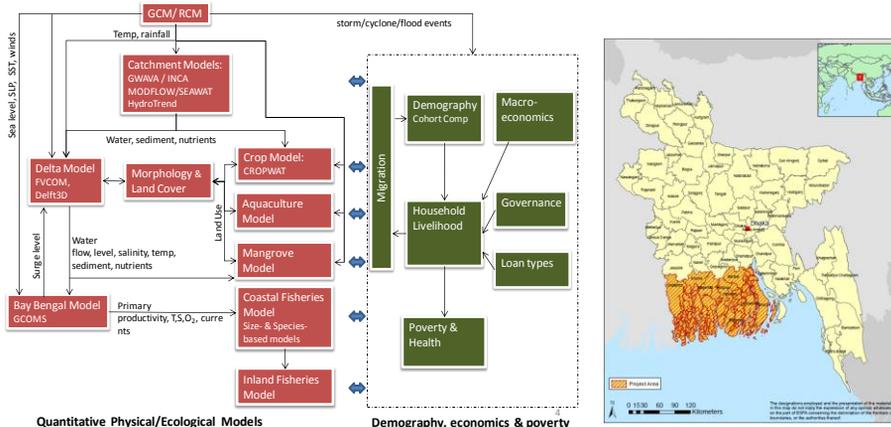
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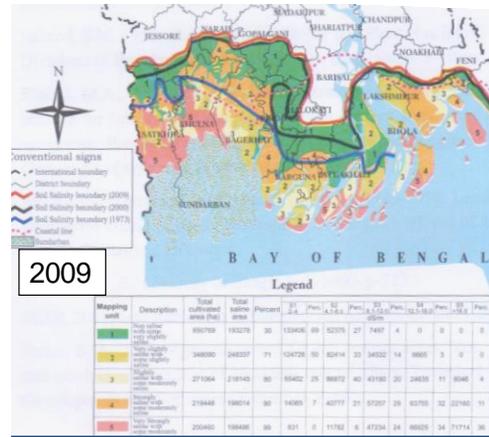
Coupling of human and natural dynamics in ESPA Deltas Project

- Relationship between ES and associated poverty?
- How ES and poverty would evolve in different scenarios (population/ social/ economic change, climate change/ SLR; regional catchment change, freshwater availability and quality, **soil quality**, agricultural and fisheries productivity)?
- Options for management strategies and governance arrangements?



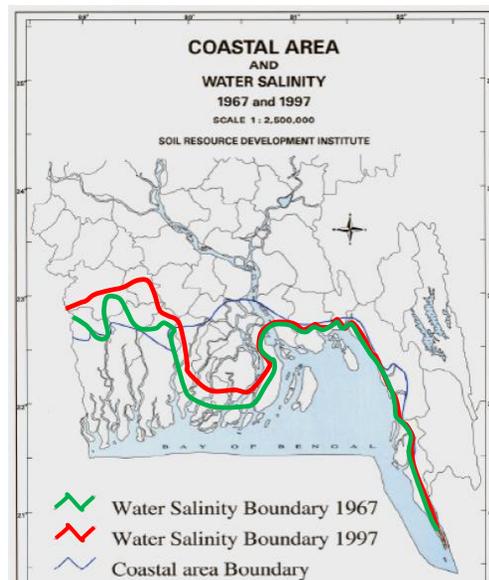
Soil Salinity in southwest coastal Bangladesh

- ❑ 1.65 Mha (70%) affected by soil salinity within Khulna and Barisal divisions
- ❑ Soil salinity limits cultivation dry season crops and delays planting of wet season crops until rainfall reduces soil salinity
- ❑ River & groundwater salinity – a major constraint on irrigation water quality.
- ❑ Lower agricultural productivity compared to national average – main reason for high incidence of poverty.



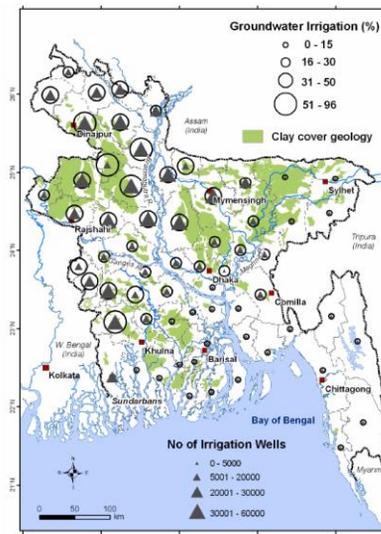
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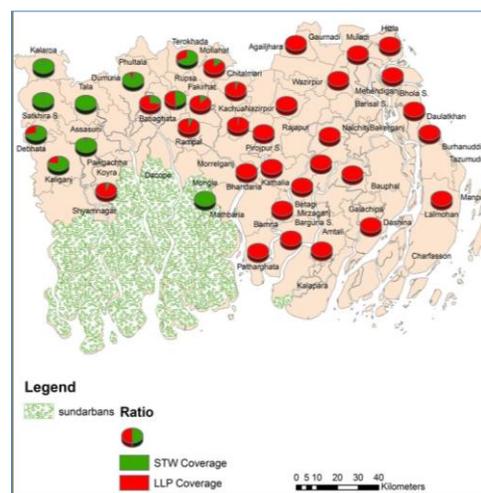
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[Shamsudduha et al., 2009]

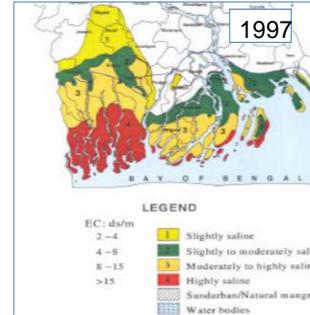
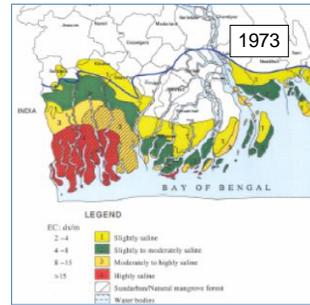
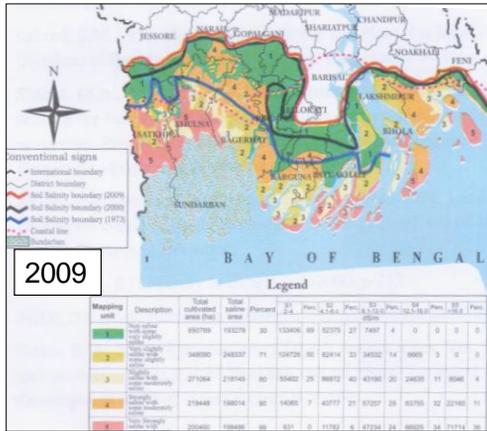
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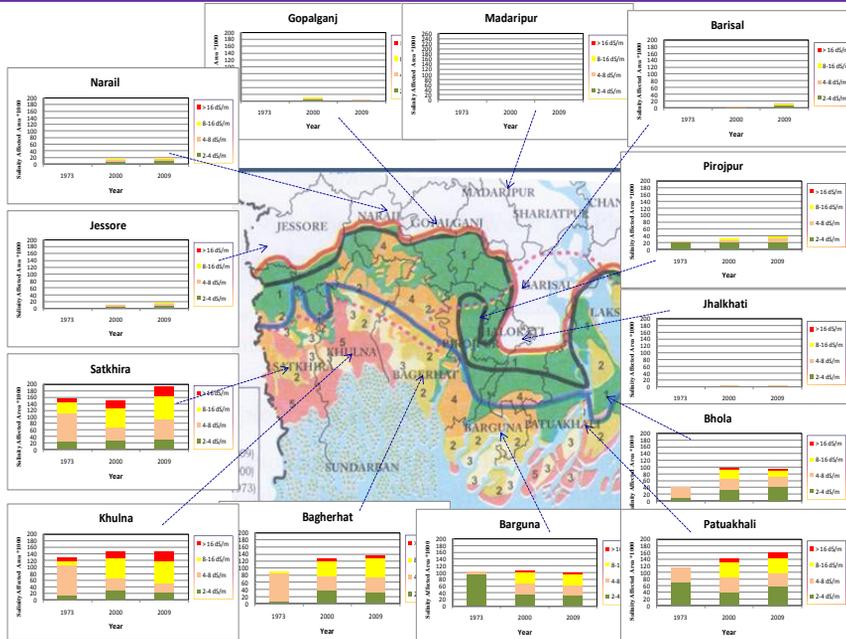


Soil Salinity in southwest coastal Bangladesh

☐ Soil salinity has increased manifolds since early 70's



Soil Salinity in southwest coastal Bangladesh



We want to understand:

- ❑ What are the different hydro-climatic factors that affect soil salinity in coastal Bangladesh?
- ❑ Are their relationships that can be used to explain soil salinity?
 - e.g. - Soil Salinity and River Salinity
 - Soil salinity and Depth to Groundwater table
 - Soil salinity and groundwater salinity?
 - Combination?
- ❑ Future projections of soil salinity under different hydro-climatic and anthropogenic scenarios?

A number of factors affect soil salinity

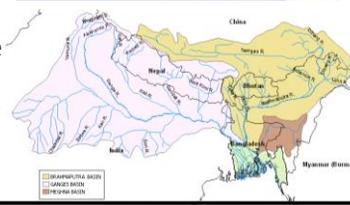
relative effects are spatially variable and complex

(1) River water salinity

- Process:
- saline tidal inundation in unprotected area
 - seepage
 - saline tidal inundation in protected area (faulty management)

Changes in long-term:

- less dry season flow due to climate change, upstream damming/diversions, increased upstream dry season water use
- sea level rise



(2) Depth to groundwater table

- Process: - capillary rise leading to increased evaporation

Changes in long-term:

- Irrigation water withdrawal
- sea level rise

A number of factors affect soil salinity relative effects are spatially variable and complex

(3) Groundwater salinity

- Process: - capillary rise of soluble salts
- Irrigation with saline groundwater

Changes in long-term:

- Increased irrigation water withdrawal
- sea level rise

(4) Rainfall and Evaporation

Process: Irregular rainfall

Changes in long-term:

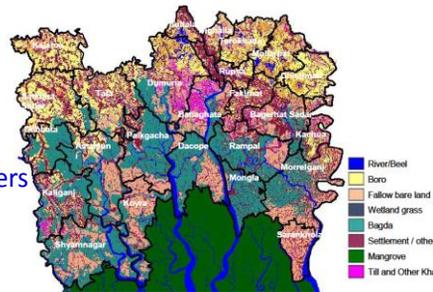
- Climate change

(5) Shrimp (Bagda) cultivation

Process:- Saltwater brought into shrimp gher

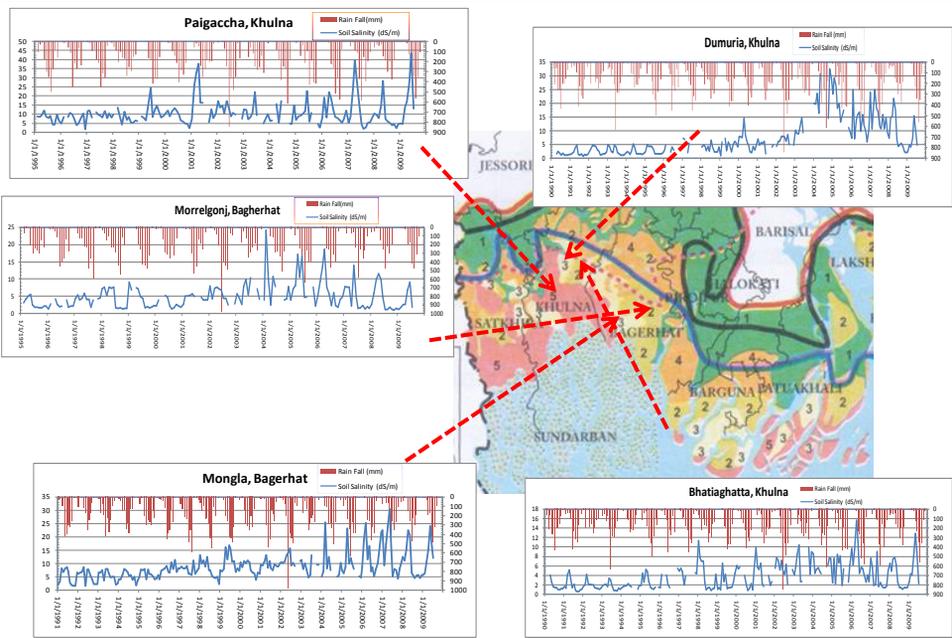
Changes in long-term: ????

(6) Storm surge flooding

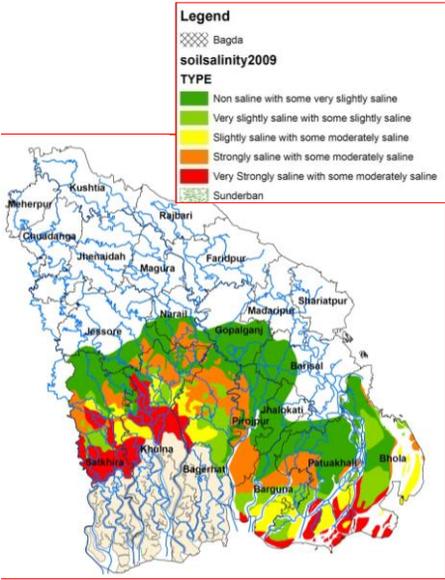


Source: CEGIS, 2006

Soil salinity: seasonal variation



Data used in analysis

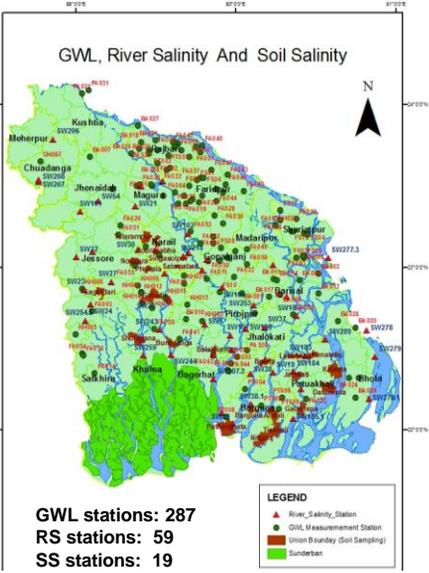


Legend

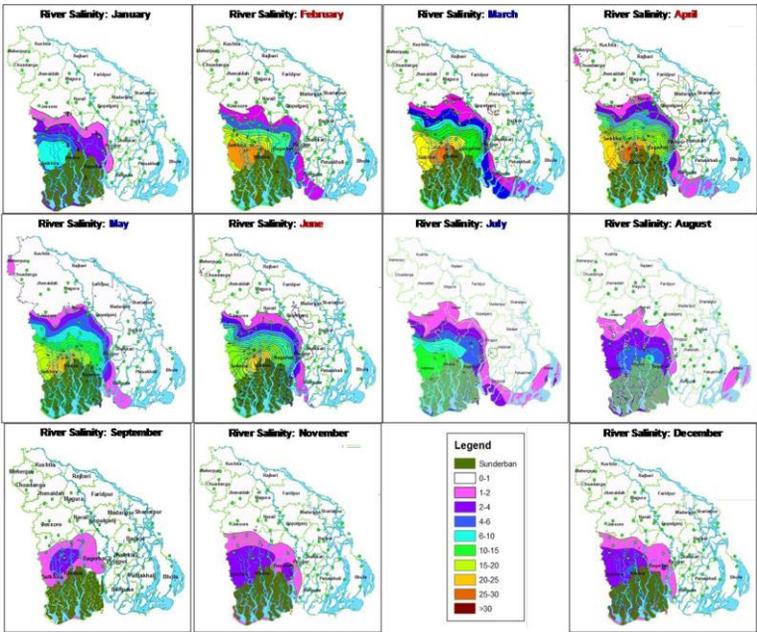
Soilsalinity2009

TYPE

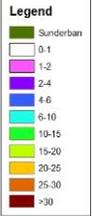
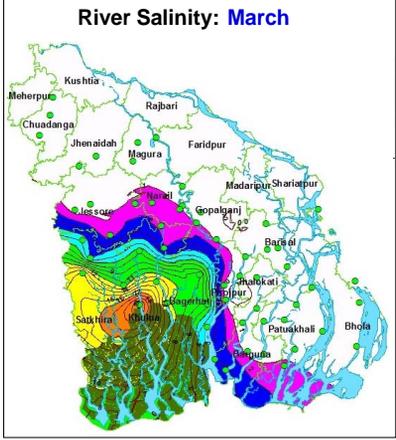
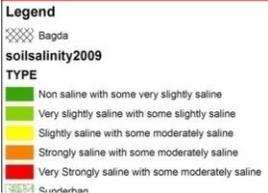
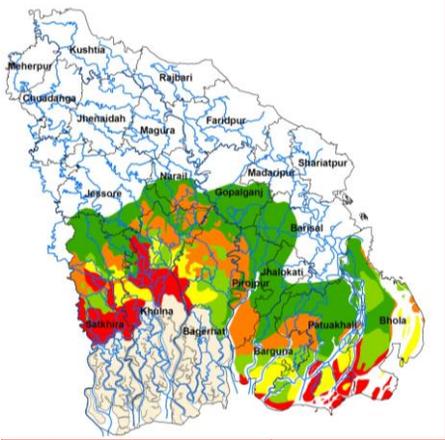
- Non saline with some very slightly saline
- Very slightly saline with some slightly saline
- Slightly saline with some moderately saline
- Strongly saline with some moderately saline
- Very Strongly saline with some moderately saline
- Sunderban



Soil salinity: related to river salinity?

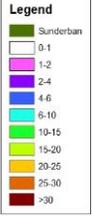
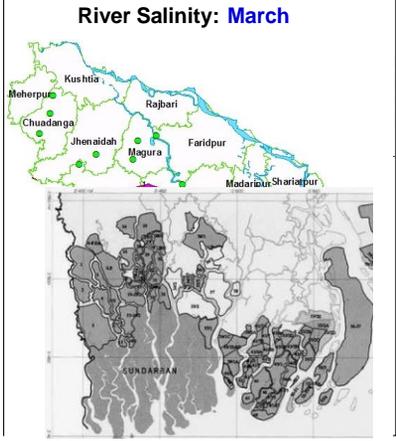
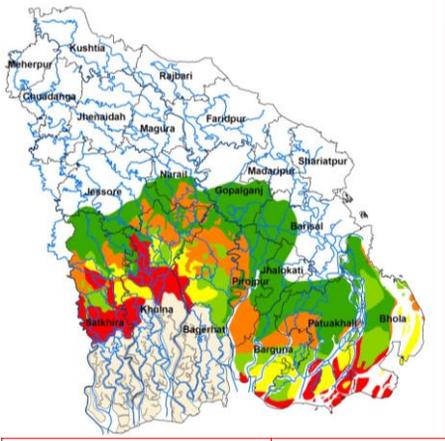


Soil salinity: related to river salinity?

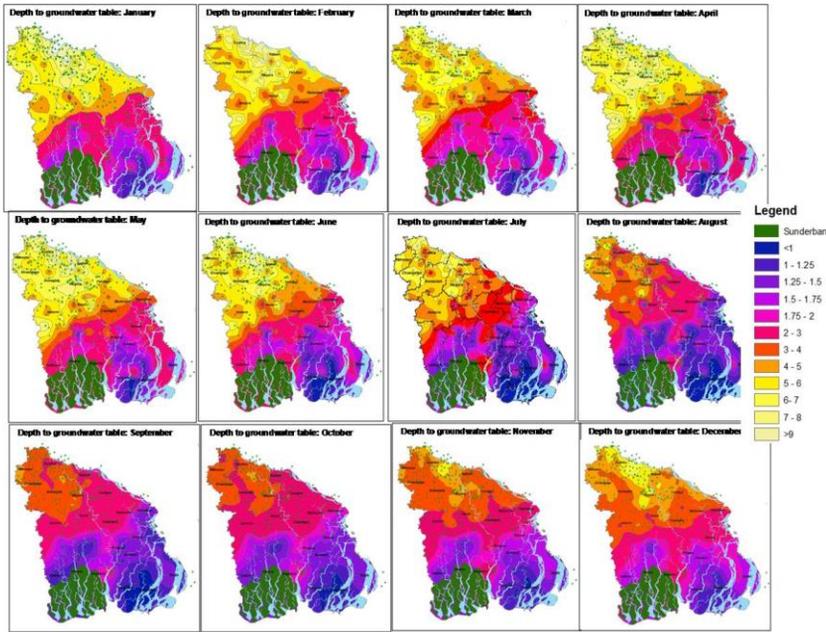


- River salinity seems to have impact in the western part
- River salinity seems to have less impact in the eastern part except in the extreme south

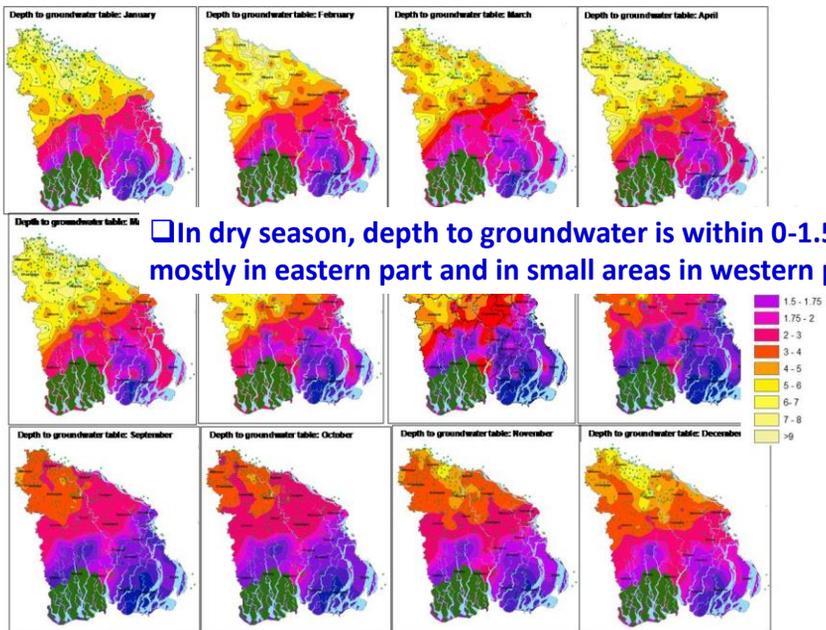
Soil salinity: related to river salinity?



Soil salinity: related to depth to groundwater table?

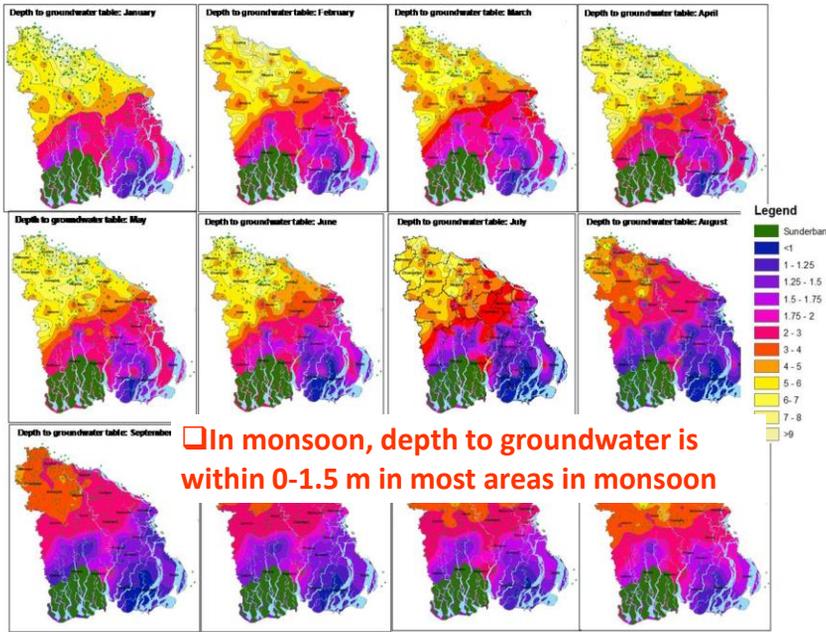


Soil salinity: related to depth to groundwater table?

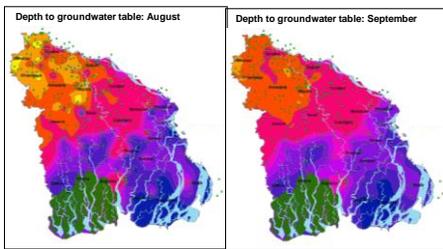


In dry season, depth to groundwater is within 0-1.5 m mostly in eastern part and in small areas in western part

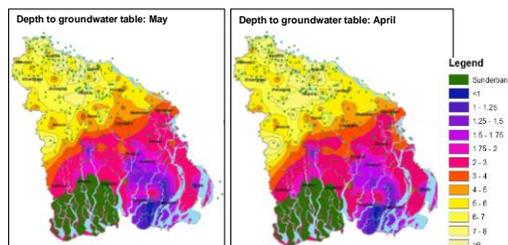
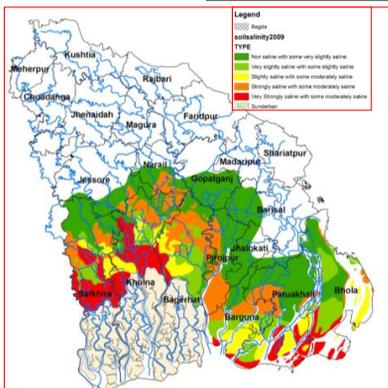
Soil salinity: related to depth to groundwater table?



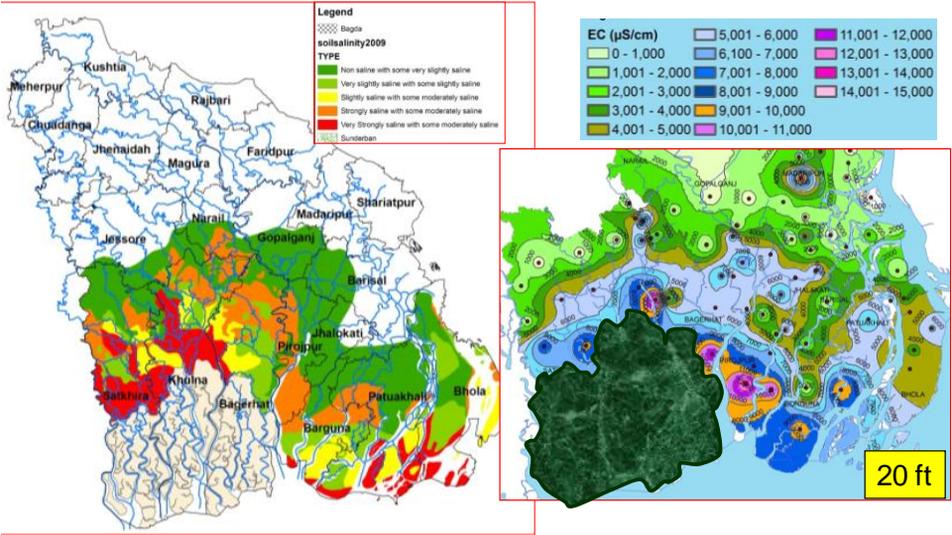
Soil salinity: related to depth to groundwater table?



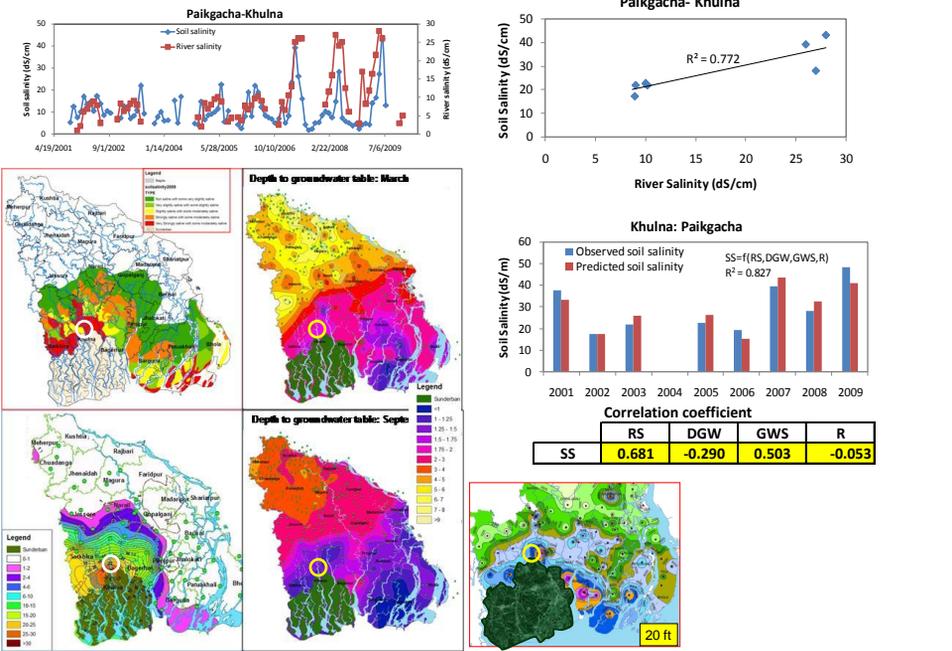
- Depth to groundwater will have influence, more so in the eastern part
- In the eastern part, influence of seepage from river will be more in dry season.



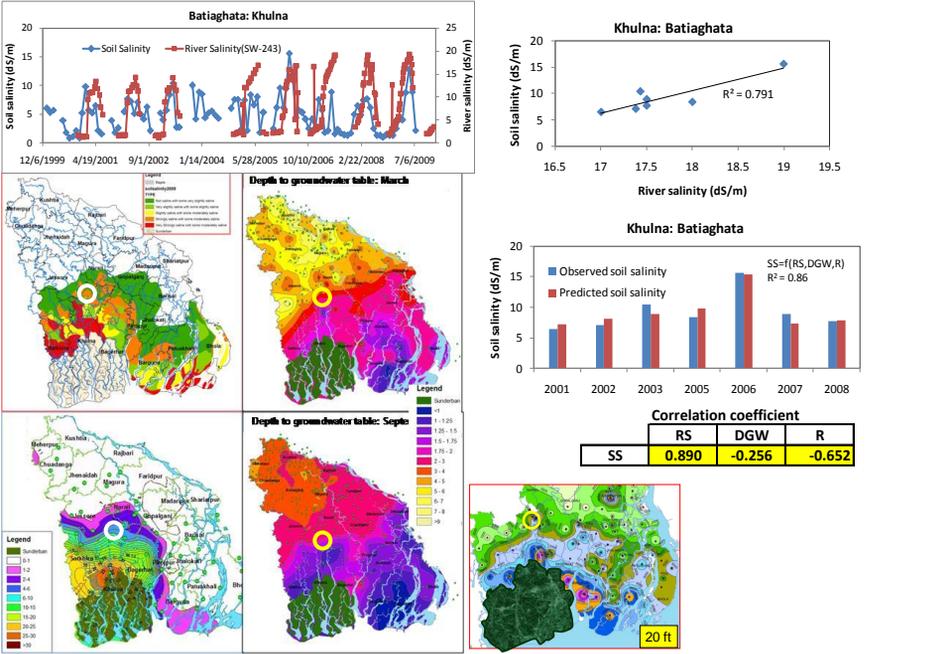
Soil salinity: how is related to groundwater salinity?



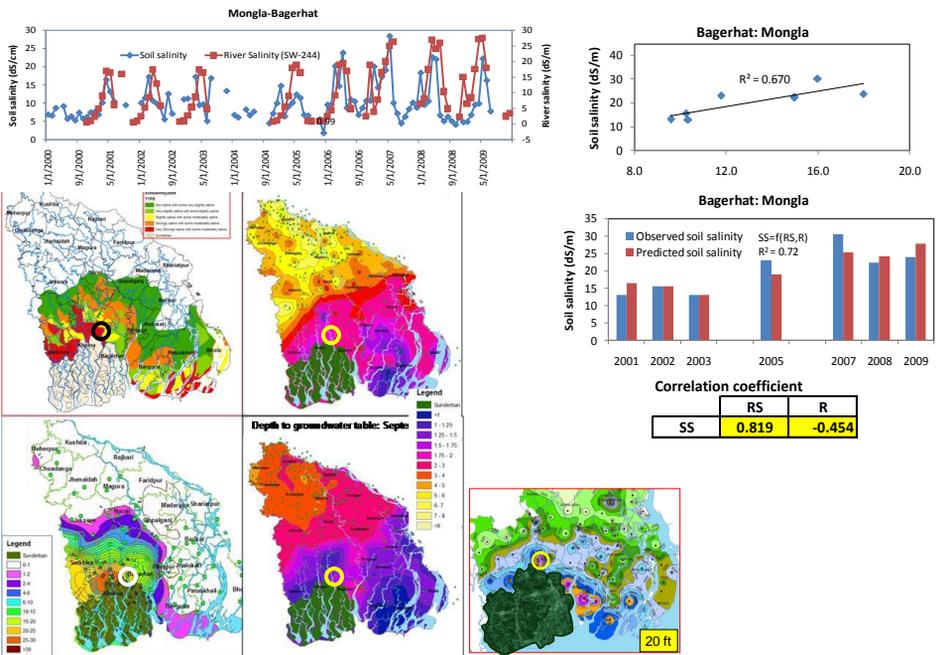
Soil salinity ?? f(RS, DGW, R, GWS, ??)



Soil salinity ?? f(RS, DGW, R, GWS,??)



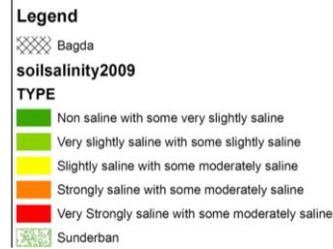
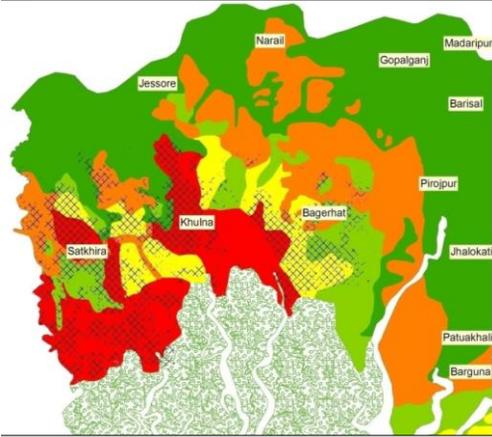
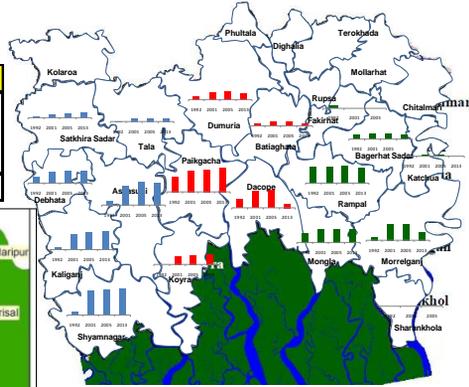
Soil salinity ?? f(RS, DGW, R, GWS,??)



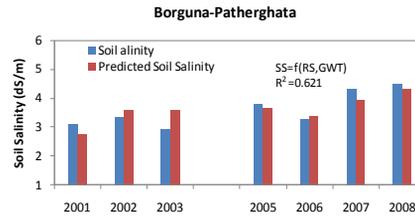
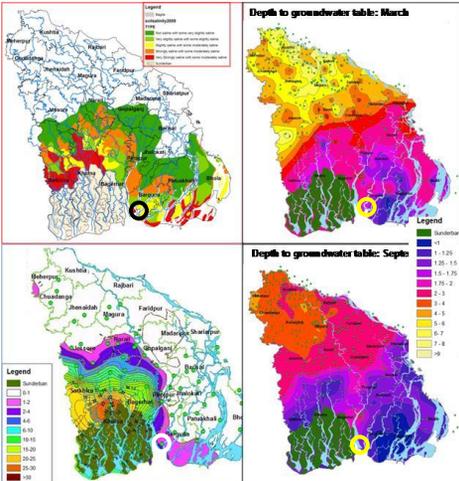
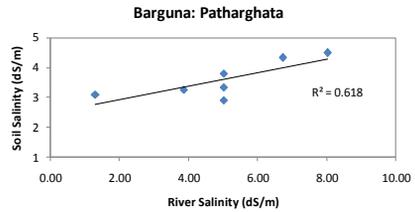
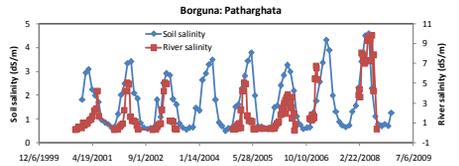
Role of Bagda Shrimp cultivation?

BAGDA Shrimp cultivation

	1992	2001	2005	2013
Bagerhat	34,736	49,621	50,142	39,400
Khulna	27,280	53,675	57,138	43,545
Satkhira	17,997	72,036	80,363	81,478
Total	80,013	175,332	187,643	164,424

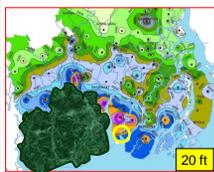


Soil salinity ?? f(RS, DGW, R, GWS,??)

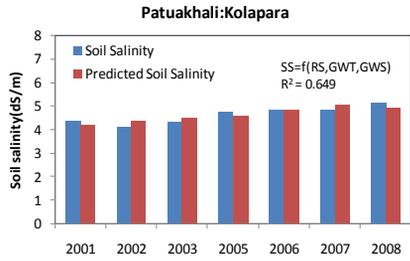
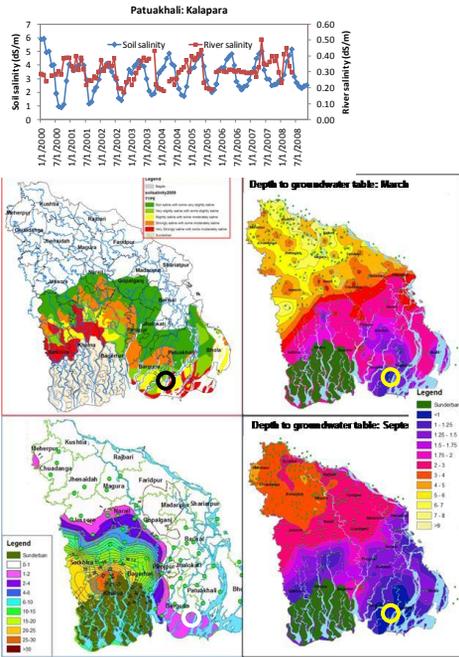


Correlation coefficient

	RS	DGW
SS	0.787	-0.154

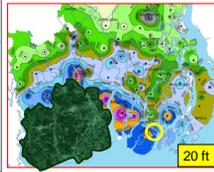


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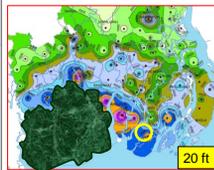
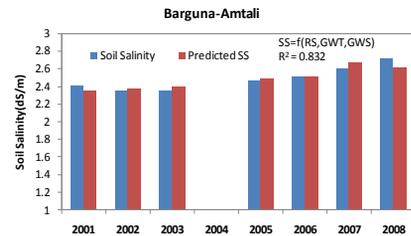
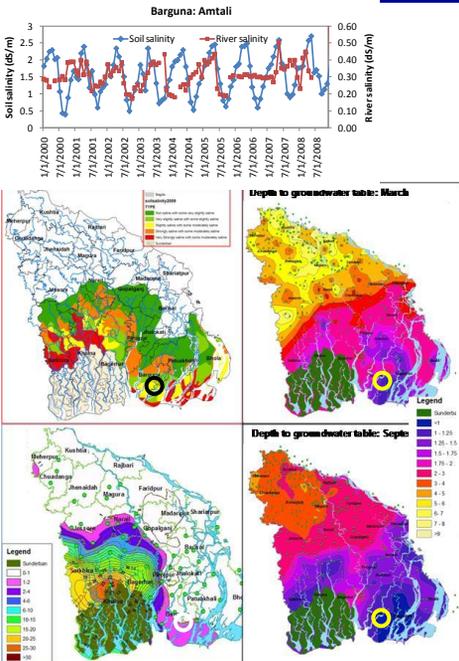


Correlation coefficient

	RS	DGW	GWS
SS	0.650	-0.600	0.134

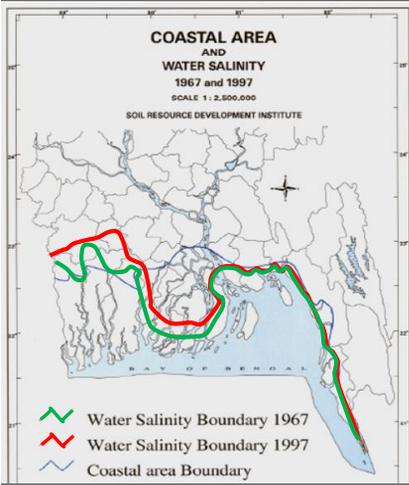


Soil salinity ?? f (RS, DGW, R, GWS,??)

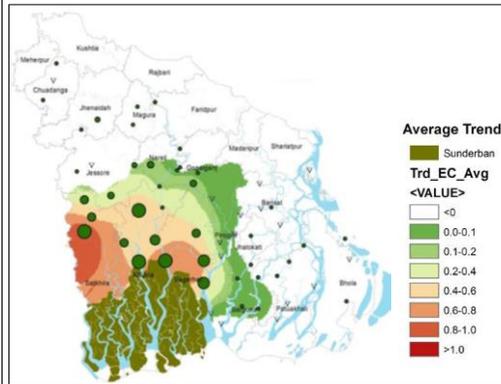


River salinity trend

1967-1997



2000-2010



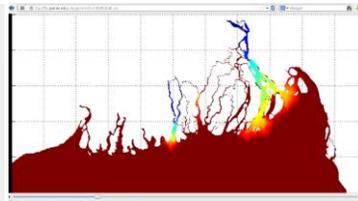
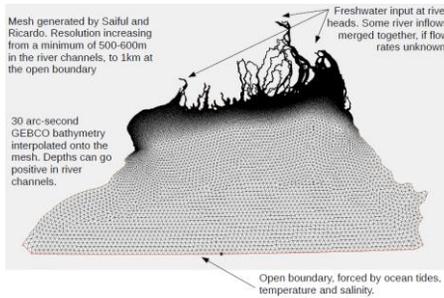
River salinity trend

Delta Model (FVCOM)

How does saline intrusion change with changing river flows and sea level rise?

Forced by:

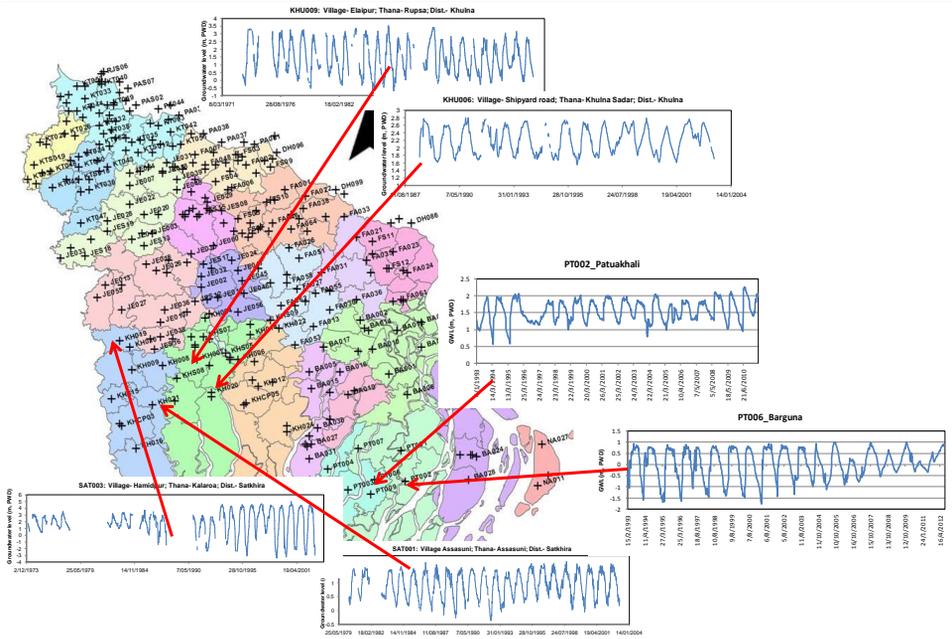
- Climate model at the surface
- Bay of Bengal (GCOMS) model at the seaward boundary
- Catchment model at the landward edge



Evolution of sea surface salinity over time, initialised from a constant value, with freshwater input at 3 river heads.

**Major output:
simulated SW salinity**

Groundwater level trend

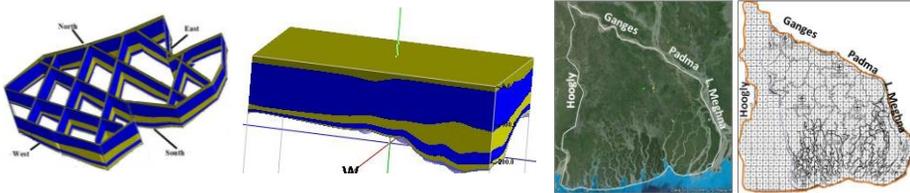


Groundwater level/ salinity trend

- ❖ How are groundwater levels and salinity impacted by increasing agricultural extraction?
- ❖ What is the impact of sea level rise, changing river flow/salinity, recharge?

GW modeling

Groundwater model **MODFLOW** is set-up as the main model for simulating groundwater flow. For saline water intrusion modeling, **SEAWAT** is used



THANK YOU