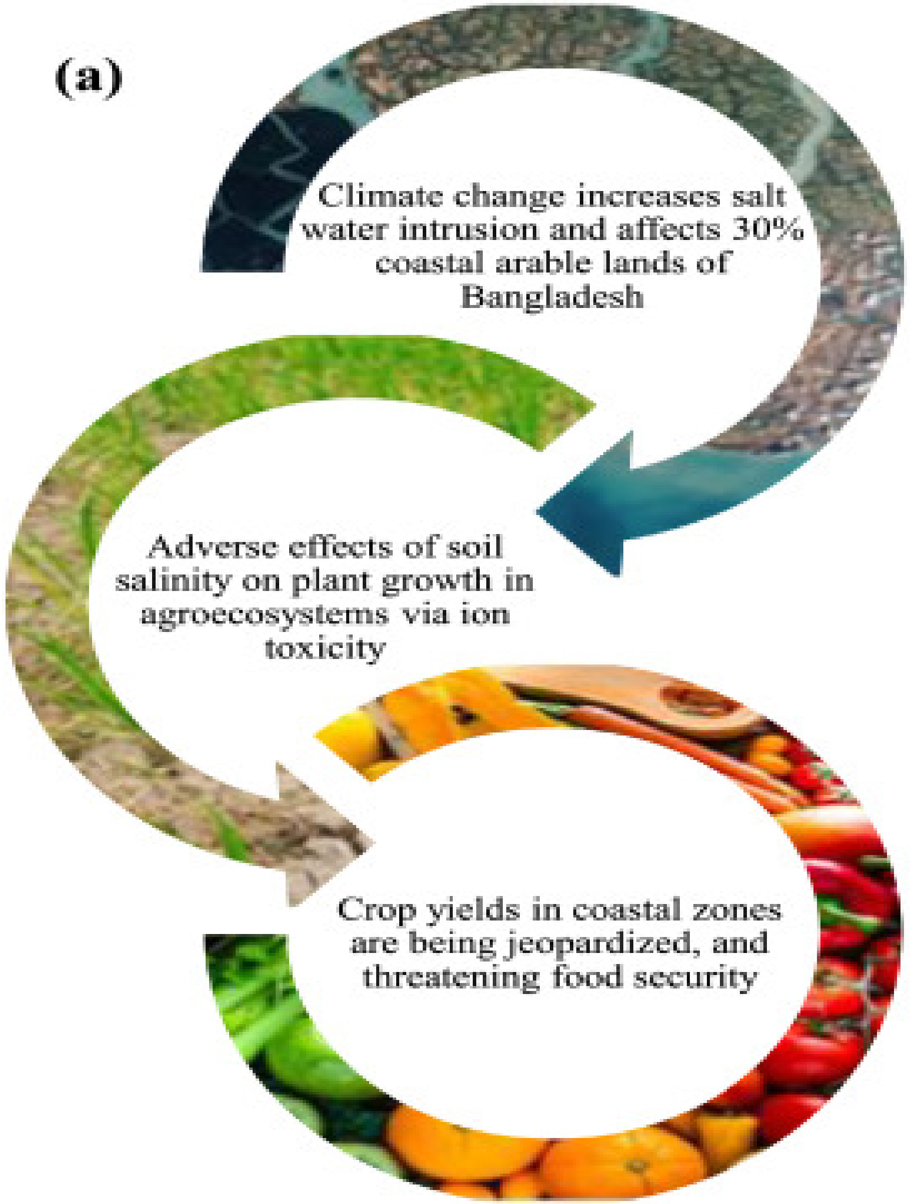
Presentation
on

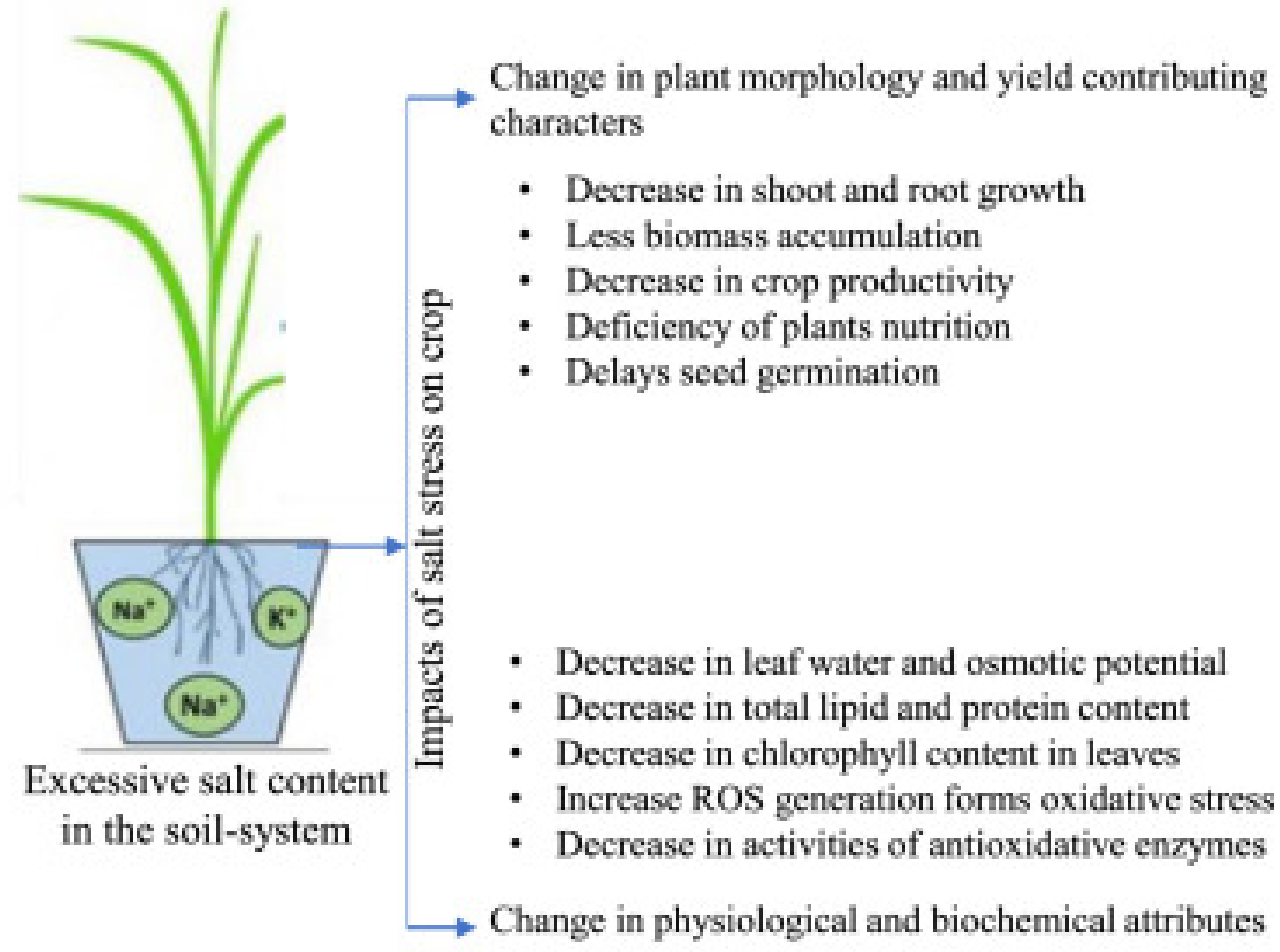
State of Salinity and its impact in Bangladesh

Md. Motaleb Hossain Sarker
Deputy Executive Director
Center for Geographic Information Services (CEGIS)
Dhaka, Bangladesh

Email: mhsarker@cegisbd.com

Background





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Background (Global Context)

- ***Projected Global Impact:*** By 2050, an estimated 1.5 billion people living in coastal areas globally will be at risk of increased soil and water salinity, threatening agriculture, food security, and freshwater availability.
- ***Salinity and Global Agriculture:*** Around 20% of the world's irrigated land (about 45 million hectares) is affected by salinity, causing annual economic losses of approximately $27 billion due to decreased crop yields.
- ***Sea-Level Rise and Bangladesh:*** Global sea-level rise is expected to increase by 0.26 to 0.98 meters by 2100, significantly affecting Bangladesh’s low-lying coastal areas, which sit at an average elevation of only 1-1.5 meters above sea level.
- ***Transboundary Salinity Issues:*** Salinity in Bangladesh is also influenced by upstream river management in India, where dam construction and water diversion reduce freshwater flow, exacerbating saltwater intrusion from the Bay of Bengal.
- ***Comparative Vulnerability:*** While salinity is a growing problem in regions like the Mekong Delta (Vietnam), Nile Delta (Egypt), and Indus Basin (Pakistan), Bangladesh faces disproportionate risks due to its dense population, reliance on freshwater for agriculture, and high cyclone frequency.

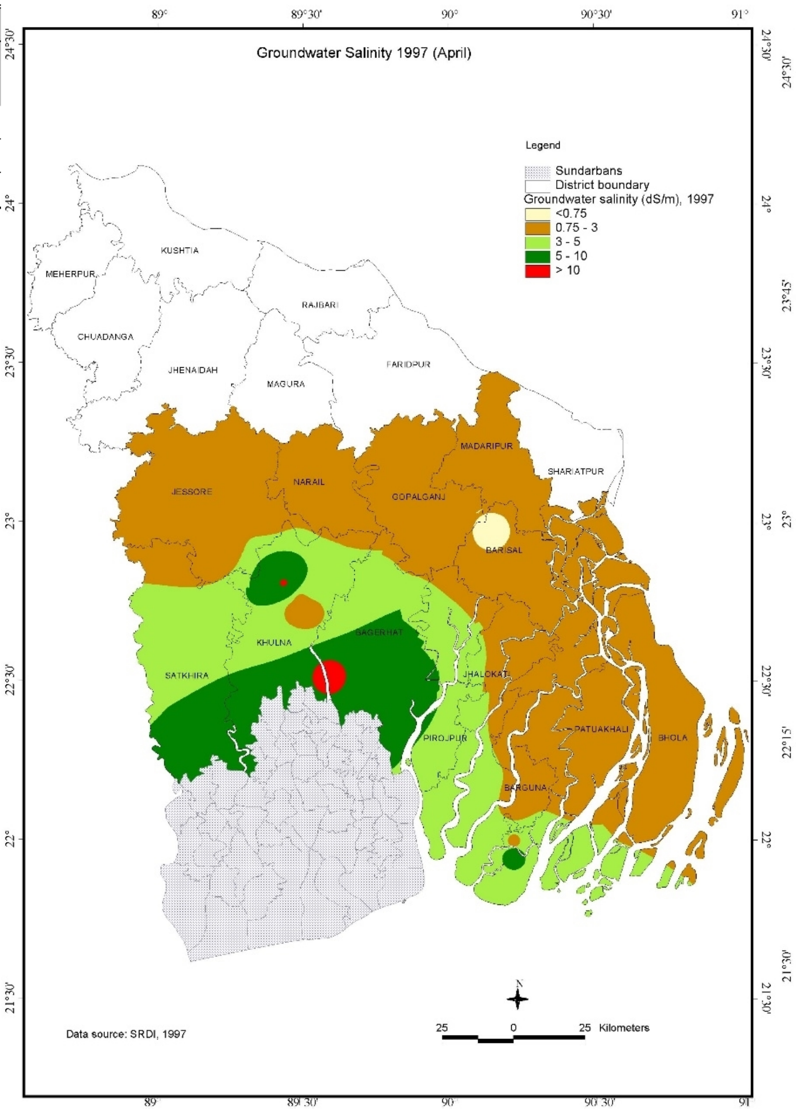
Background

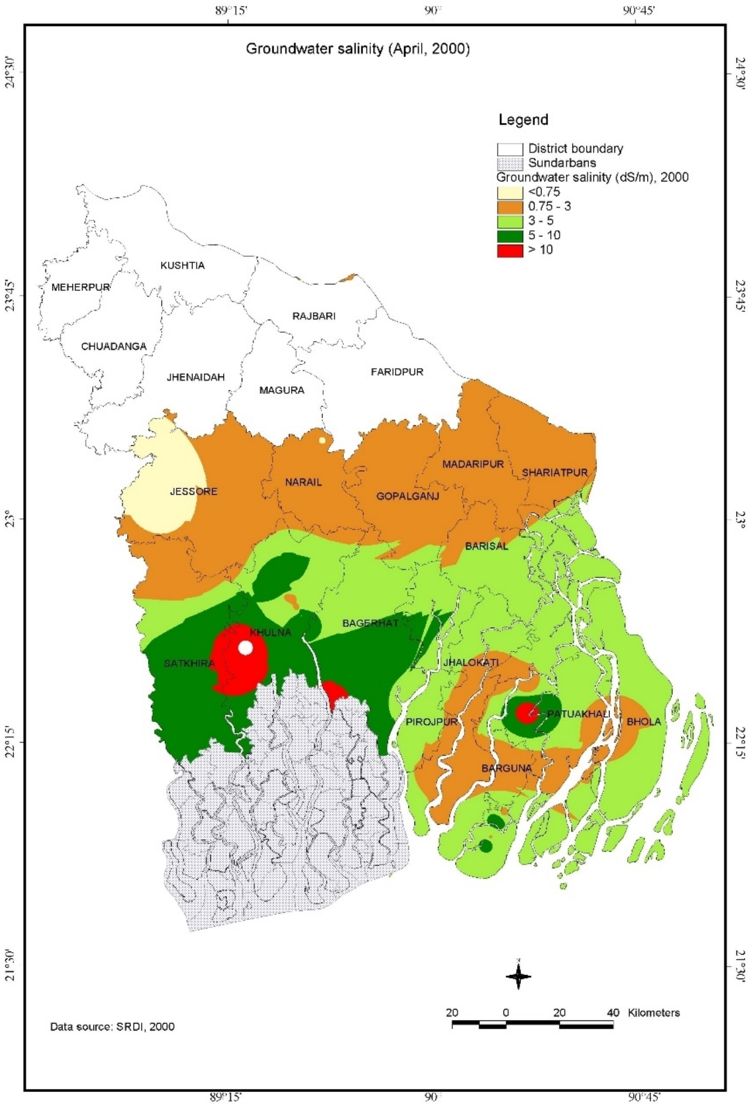
- Approximately 30% of Bangladesh's arable land is situated in coastal areas, where salinity is influenced by factors such as coastal flooding, storm surges, and the influx of saltwater etc
- Sea level rise induced soil salinity pollution, could impact 170 million globally and 35 million of them residing in the coastal areas of Bangladesh alone.
- Saltwater intrusions in the southwestern coastal region of Bangladesh are having devastating consequences on water resources, agriculture, and human health.
- Bangladesh was hit by 154 cyclones between the years 1877 and 1995, many of them included storm surges that went more than 7 meters inland.
- Approximately 20 million people in Bangladesh are at high risk of hypertension due to the intrusion of saline water caused by climate change.
- Most of Bangladesh's coastal towns are located on the banks of low tidal areas at an average elevation of 1.0–1.5 meters from the sea level.
- Dasgupta et al. (2015) predicted that soil salinity will increase by 39.2% across 41 monitoring stations in Bangladesh by 2050, causing significant challenges for agriculture and livelihoods.

Increasing trend of groundwater salinity – short time (3 years)

Groundwater salinity class	EC (dS/m) class for crops	EC (dS/m) class limit for drinking purposes	
		Bangladesh standard	WHO guideline values
Safe	< 0.75	0.5 – 1.5	0.25 – 0.45
Harmful	0.75 – 3.0	> 1.5	> 0.45
Very harmful	> 3.0		

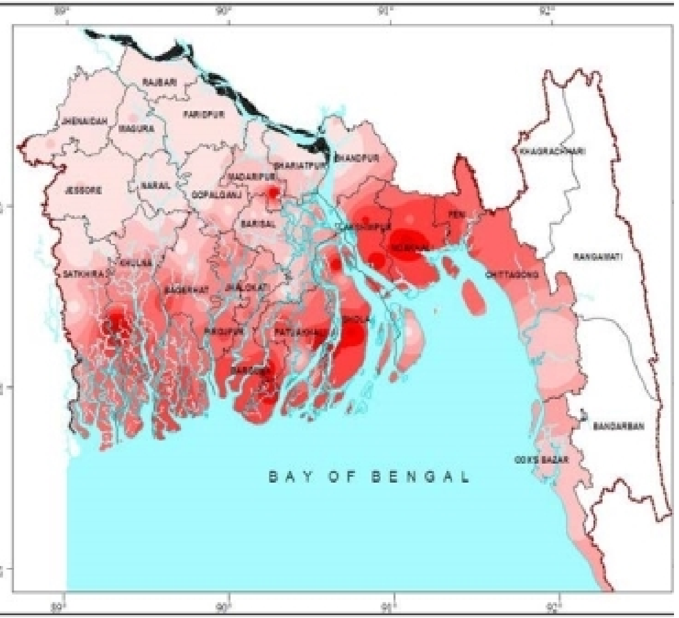
Salinity class (dS/m)	GW salinity area (ha) April 1997	GW salinity area (ha) April 2000	GW salinity area (ha) (increased)
(< 0.75)	12519	87391	74872
(0.75–3)	1320046	911680	-408366
(3–5)	593828	905210	311382
(5–10)	287987	368012	80025
(> 10)	10343	56551	46208
Total Area	2224723	2328844	104121
% Total			4.68%



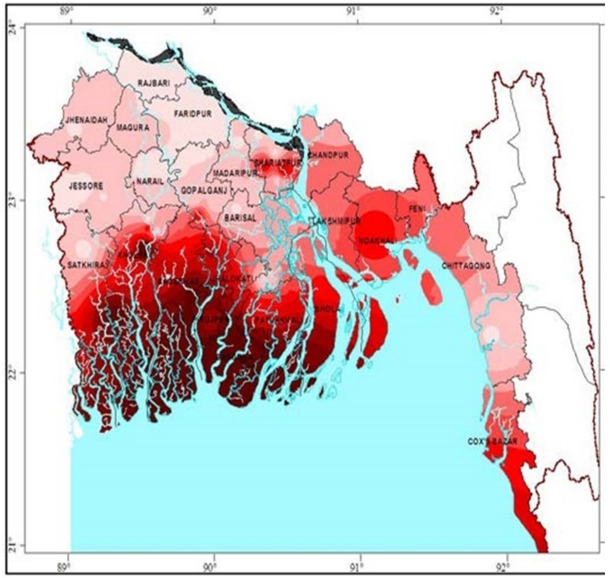


Groundwater Contamination GW Salinity 2010-12

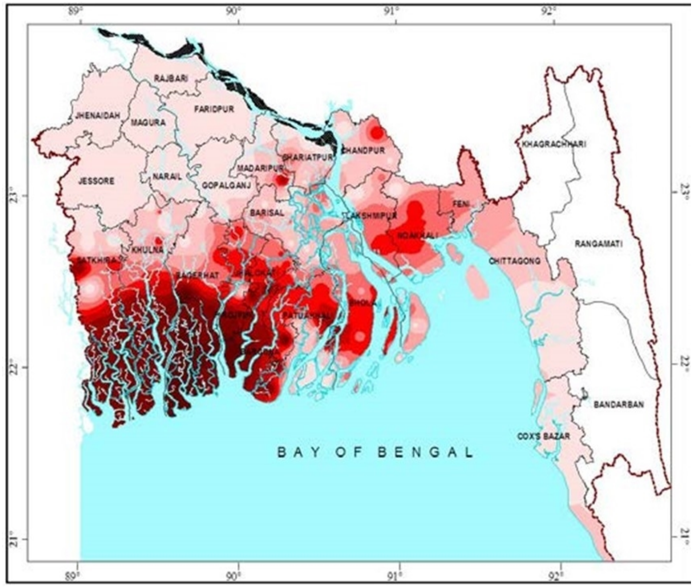
2010



2011



2012



- GW salinity is relatively high near the coast and low away from the coast.
- GW salinity gradually increased from 2010-2012

Source: BADC

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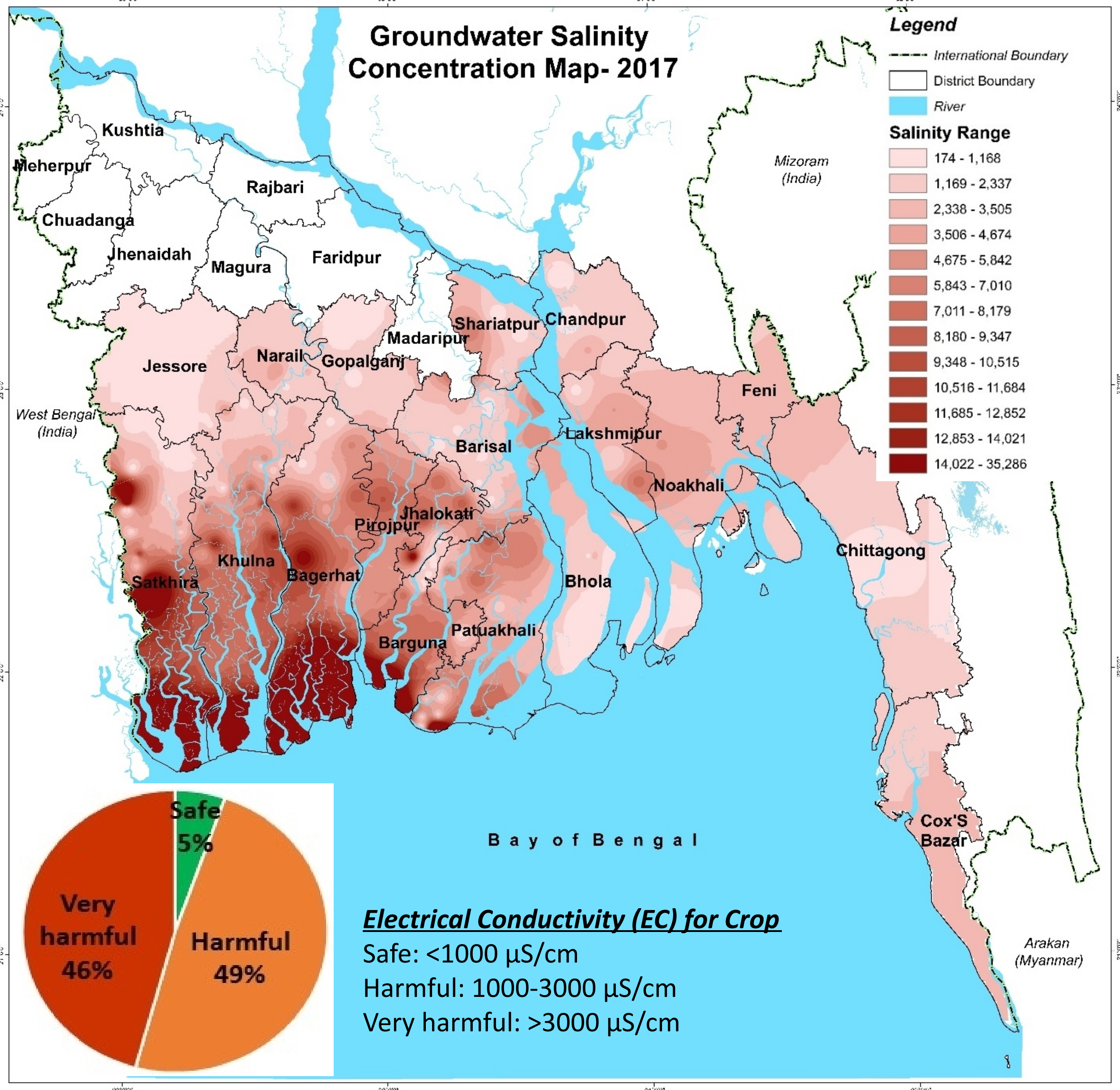
Groundwater Salinity Monitoring 2017

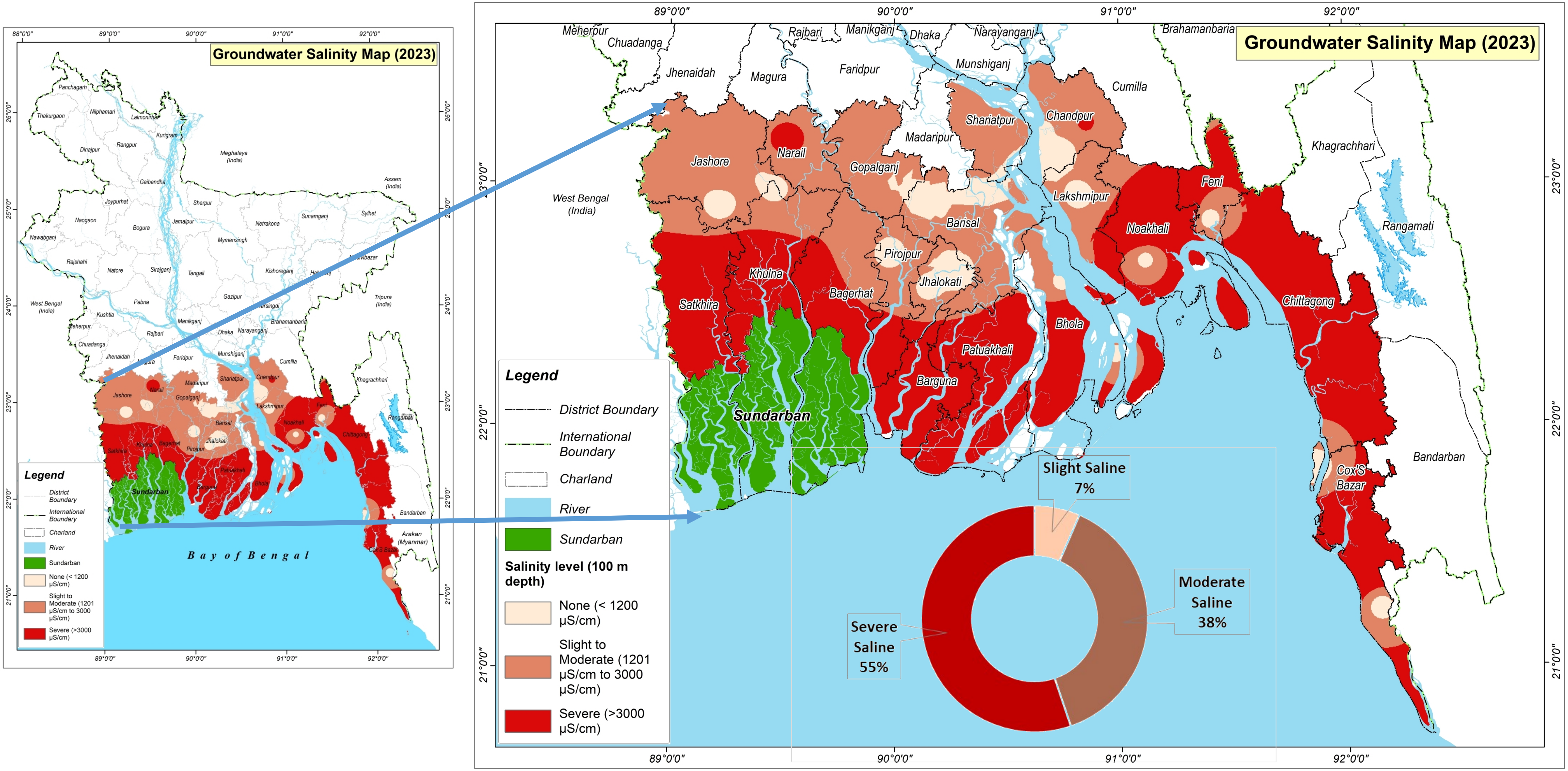


Groundwater salinity monitoring is essential for protecting human health, preserving ecosystems, ensuring agricultural productivity, and managing water resources effectively. It provides crucial information for decision-making related to water treatment, land management, and sustainable development.

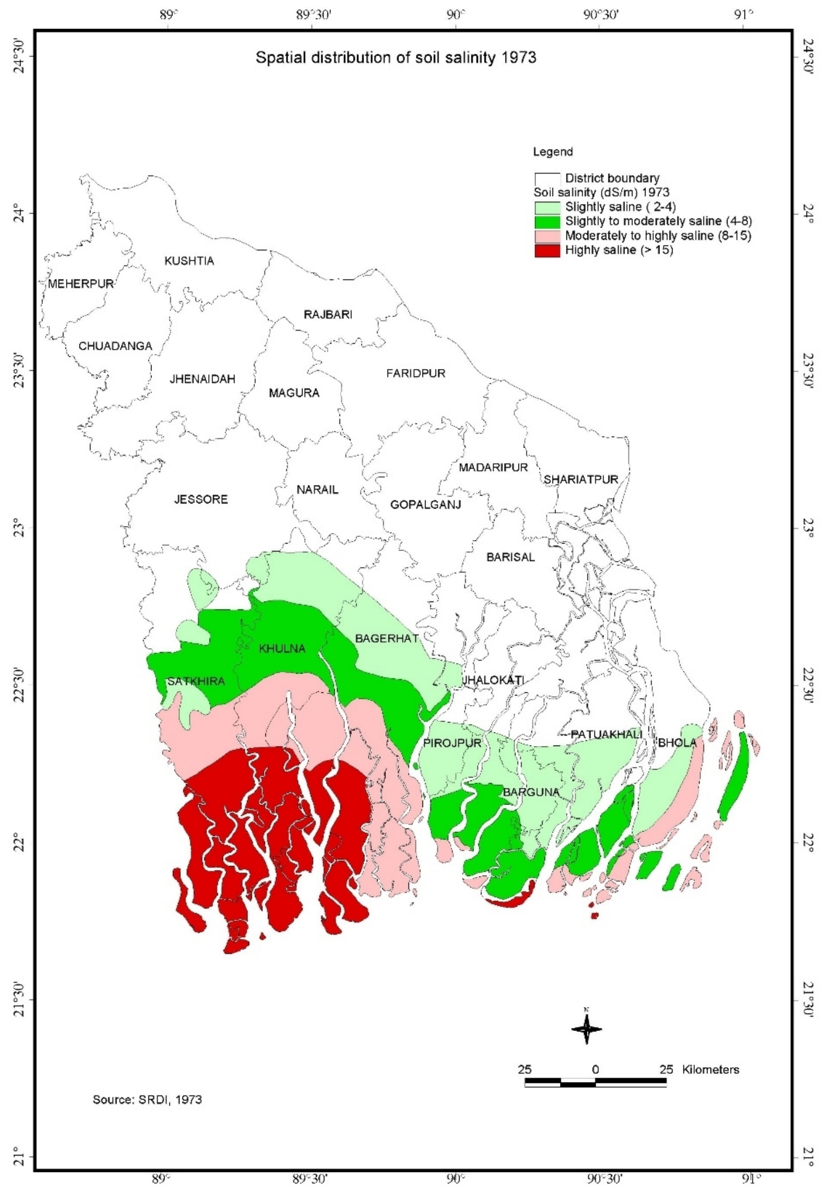
Causes of Salinity:

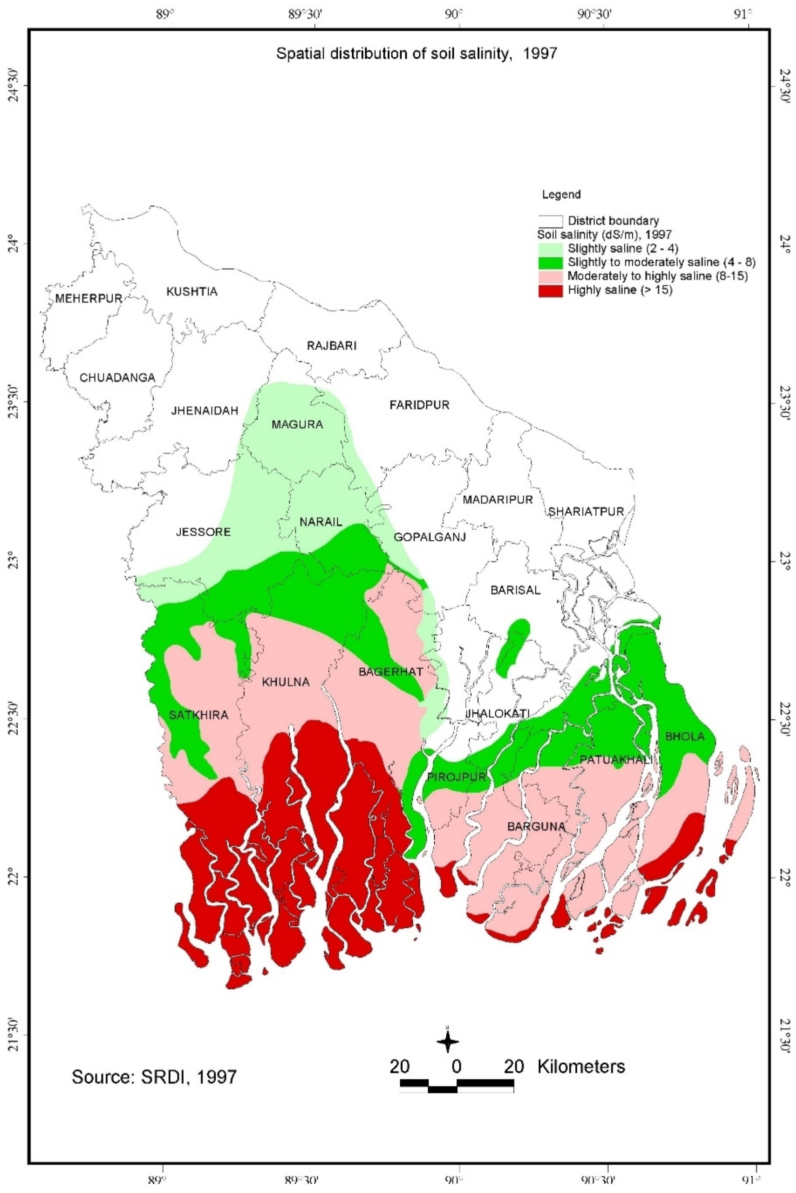
- Climate change and sea-level rise
- Decrease of upstream surface water flow
- Horizontal expansion of shrimp farming
- Upward or lateral movement of saline groundwater during dry season
- Direct inundation by saline water
- Tidal flooding during wet season

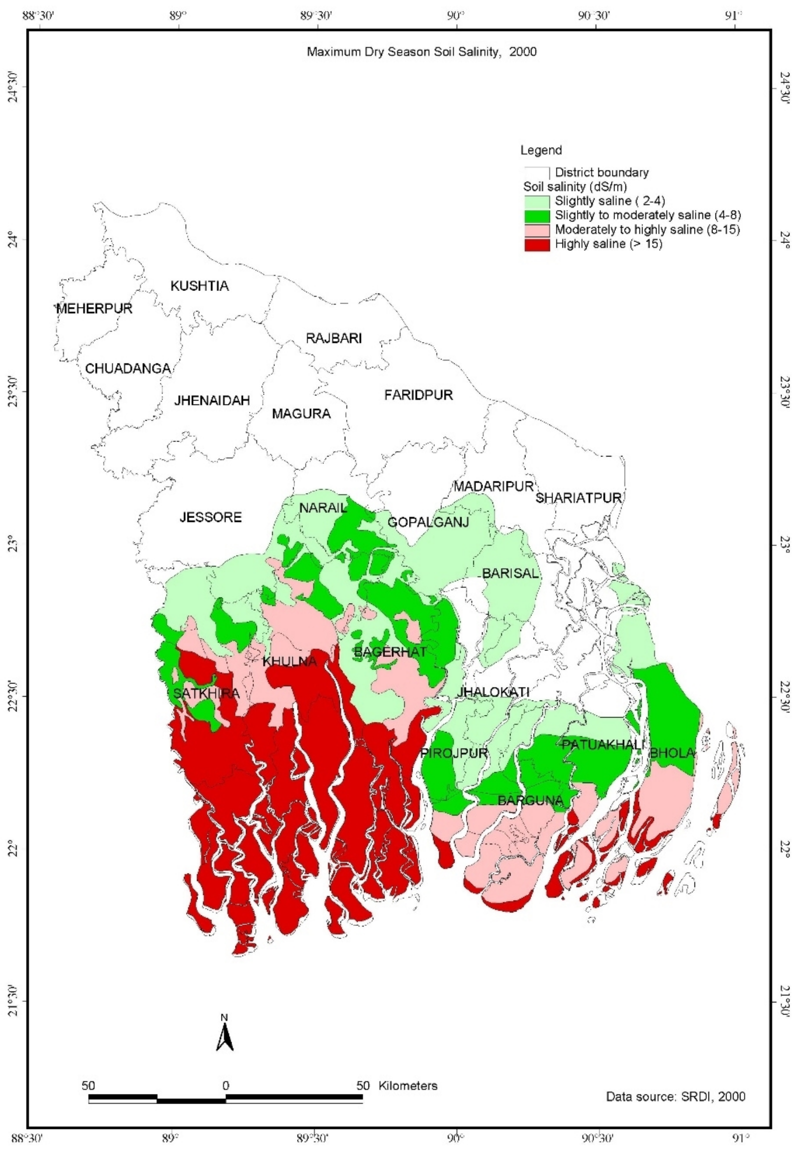
Ground Water Salinity Map 2023



Increasing trend of soil salinity 1979, 1997 & 2000







Increasing trend of soil salinity 1979-2000

Table 5.7: Different classes of soil salinity areas, 1973

Soil salinity class (EC, dS/m)	Salinity affected area (ha)
Highly saline (> 15)	20700
Moderately to highly saline (8-15)	49100
Slightly to moderately saline (4-8)	341730
Slightly saline (2-4)	242120
Total saline area	**653650**

Note: S1 = 2-4 dS/m, S2 = 4-8 dS/m, S3 = 8-15 dS/m, S4 = > 15 dS/m

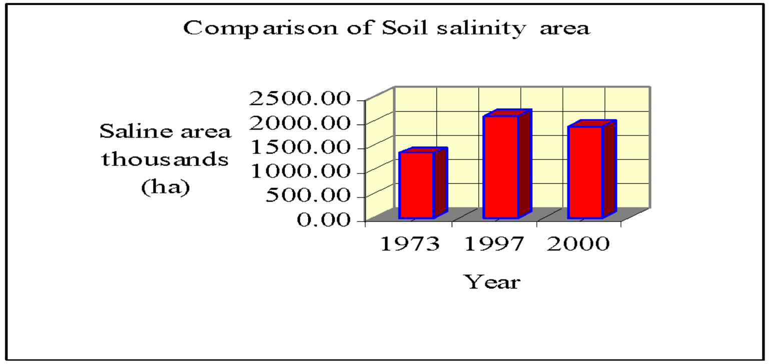
Table 5.8: Different classes of soil salinity areas, 1997

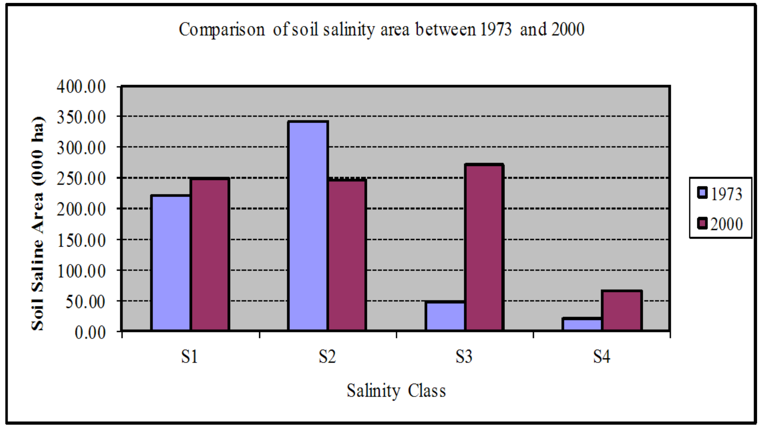
Soil salinity class (EC, dS/m)	Salinity affected area (ha)
Highly saline (> 15)	253738
Moderately to highly saline (8-15)	371827
Slightly to moderately saline (4-8)	259291
Slightly saline (2-4)	168880
Total saline area	**1053736**

Table 5.9: Different classes of soil salinity areas, 2000

Soil salinity class (EC, dS/m)	Salinity affected area (ha)
Highly saline (>15)	66920
Moderately to highly saline (8-15)	272420
Slightly to moderately saline (4-8)	246290
Slightly Saline (2-4)	250330
Total saline area	**835960**

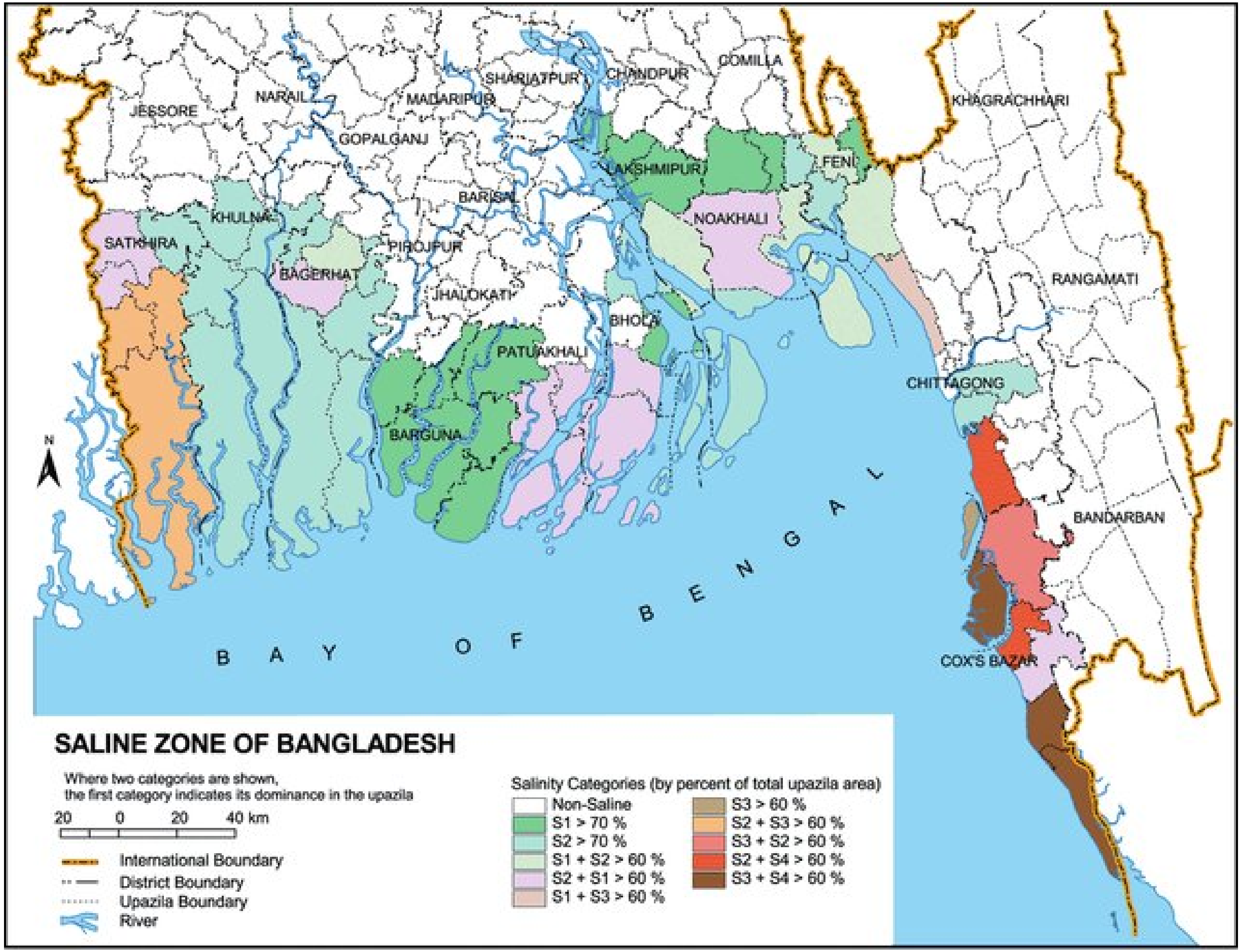
Increasing trend of soil salinity 1979-2000





District	Salt affected area (000'ha)		Salinity class (dS/m)								Salinity increase over 3 decades	
			S1 (2.0-4.0)		S2(4-8.0)		S3 (8-15.0)		S4 >15.0		Area (000'ha)	%
	1973	**2000**	**1973**	**2000**	**1973**	**2000**	**1973**	**2000**	**1973**	**2000**		
Khulna	120.04	145.25	3.9	28.8	92.54	37.32	13	59.49	9.8	19.61	25.21	21
Bagerhat	107.98	125.13	8.3	35.7	77.08	41.5	2.6	41.23	0	6.74	17.15	15.9
Satkhira	146.35	147.08	16.5	27	85.6	38.01	33.5	60.03	10.9	22.01	0.73	0.5
Jessore	0	10.86	0	7.21	0	3.06	0	0.59	0	0	10.86	100
Narail	0	16.05	0	10.7	0	4.3	0	1.08	0	0	16.05	100
Pirojpur	20.3	28.64	18.4	19.2	1.9	6.05	0	2.43	0	0	8.34	41.08
Jhalakhati	0	3.52	0	2.35	0	1.17	0	0	0	0	3.52	100
Barisal	0	10.82	0	8.12	0	2.7	0	0.55	0	0	10.82	100
Bhola	40.33	93.64	9.52	28.4	30.81	33.7	0	26.13	0	5.27	53.31	132.2
Patuakhali	115.1	139.35	68.5	40.1	46.6	43.62	0	46.1	0	9.52	24.25	21.07
Borguna	103.55	104.23	96.39	36.2	7.2	30.77	0	33.47	0	3.77	0.67	0.65
Gopalganj	0	10.2	0	5.76	0	3.12	0	1.32	0	0	10.2	100
Madaripur	0	1.19	0	0.79	0	0.4	0	0	0	0	1.19	100
Total	**653.65**	**835.96**	**221.51**	**250.33**	**341.73**	**245.72**	**49.1**	**272.42**	**20.7**	**66.92**	**182.3**	

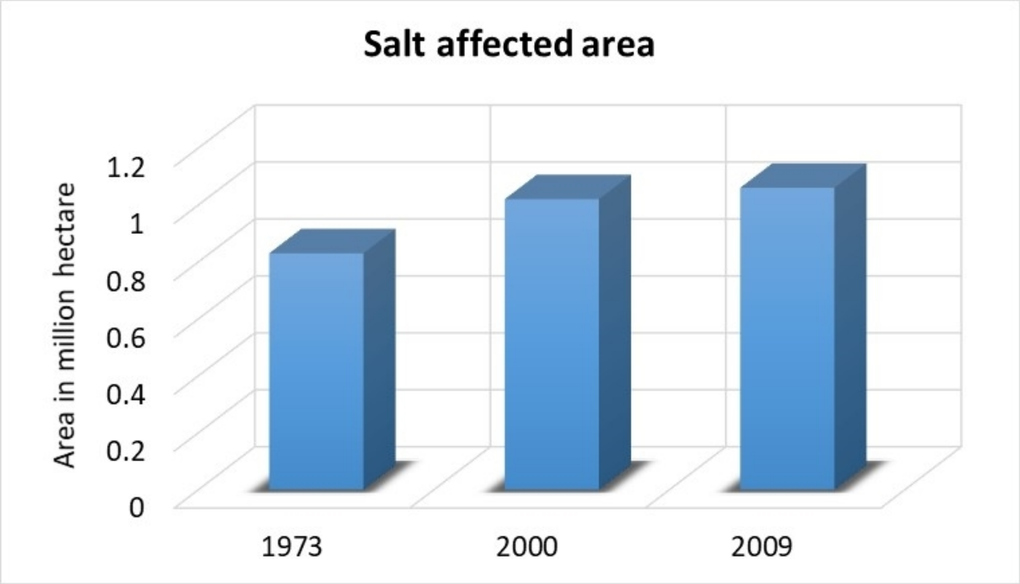
Soil Salinity 2009



Soil Salinity

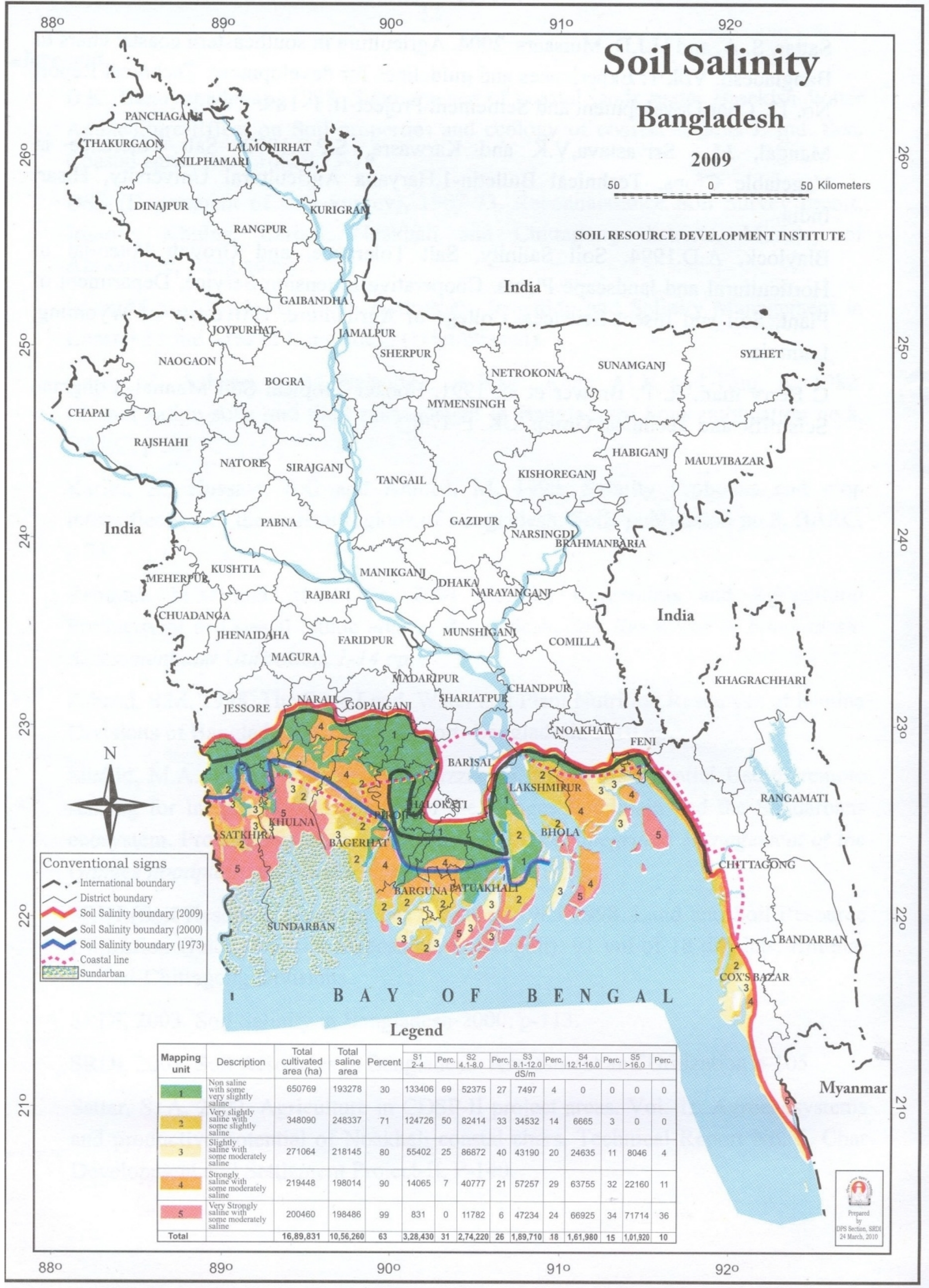
Salt affected area

- **1973: 0.83 Mha**
- **2000: 1.02 Mha**
- **2009: 1.06 Mha**

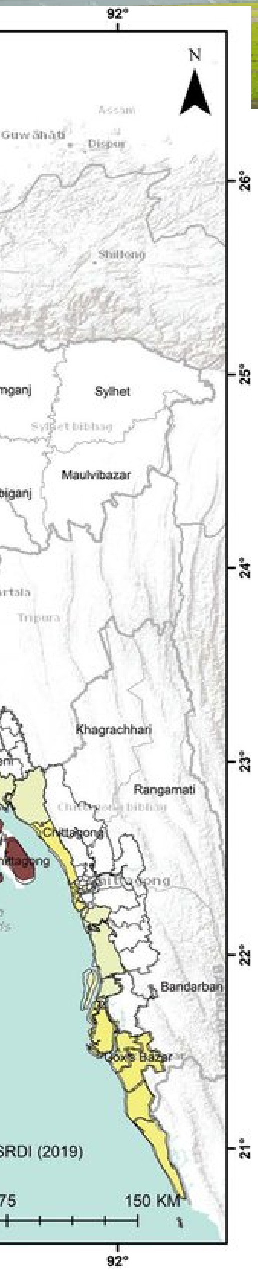


Salt affected area increased during last 9 years (2000-2009): **3.5%**

Salt affected area increased during last 36years (1973-2009): **26.7%**



Soil Salinity 2019



Impact of Salinity (Rice Crop)

Yield Reduction in Rice Due to Salinity (Coastal Bangladesh)

Salinity (EC in dS/m)	Expected Yield (ton/ha)	Yield Reduction (%)	Notes
0–3	4.5–5.5	0%	Normal conditions (non-saline soils).
3–4	3.6–4.5	10–20%	Sensitive stages (e.g., seedling) show stress.
4–6	2.7–3.6	20–40%	Moderate salinity; significant losses in non-tolerant varieties.
6–8	1.8–2.7	40–60%	Severe salinity; only salt-tolerant varieties survive.
>8	<1.8	60–100%	Crop failure likely in non-tolerant varieties; extreme stress.

Salt-Tolerant Varieties (e.g., BRRI dhan47, BRRI dhan61)

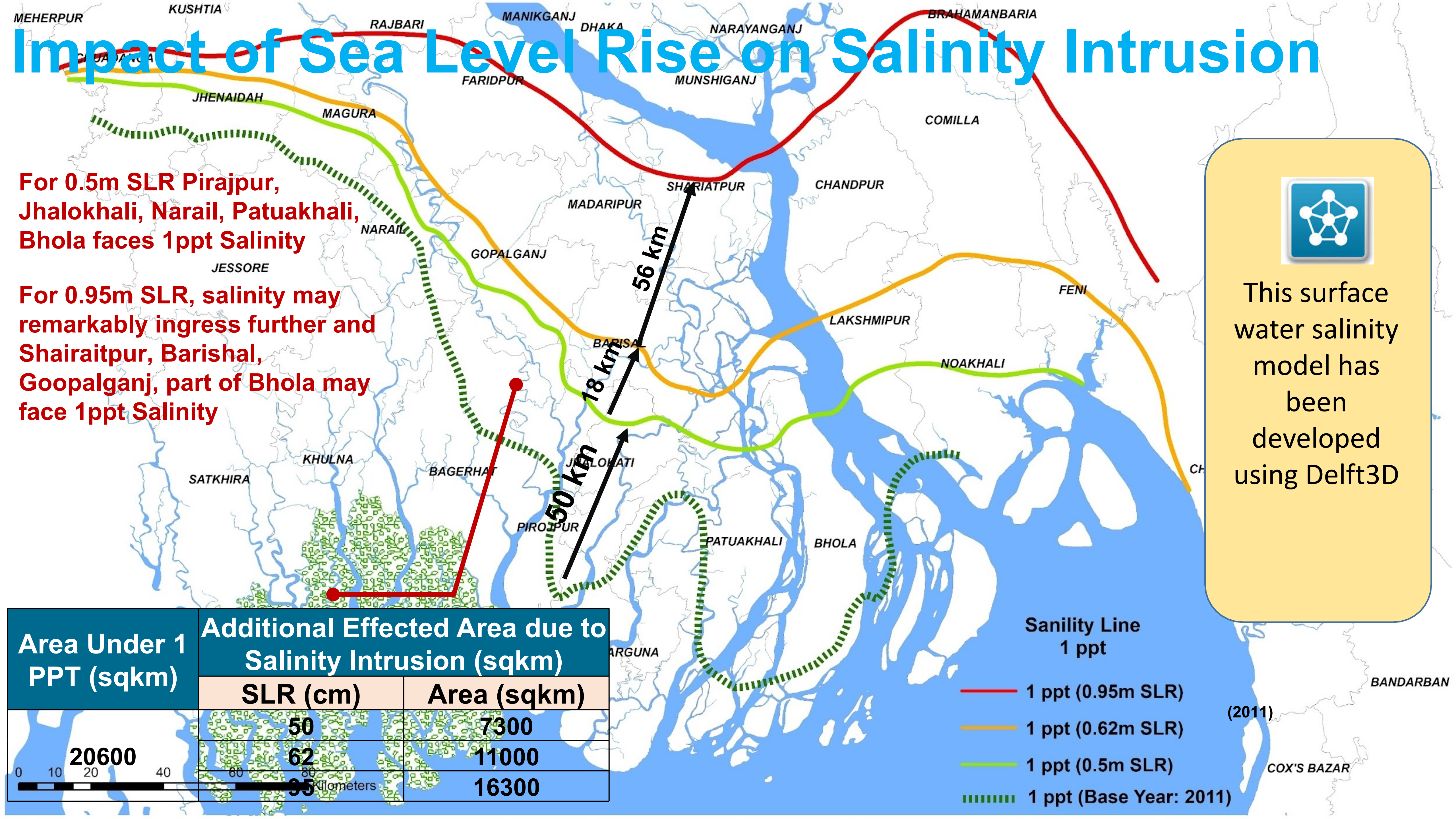
Salinity (EC in dS/m)	Expected Yield (ton/ha)	Yield Reduction (%)	Notes
0–4	4.0–5.0	0%	Optimal performance in mild salinity.
4–6	3.5–4.0	10–20%	Minimal impact due to tolerance traits.
6–8	3.0–3.5	20–30%	Manageable losses with proper irrigation/management.
8–10	2.0–3.0	30–50%	Severe but survivable; requires adaptive practices.
>10	<2.0	50–100%	Extreme salinity; crop failure possible even in tolerant varieties.

Impact of Salinity (Non Rice Crop)

Yield performance of non-rice crops irrigated by saline water in the coastal area

Name of crops	Maximum yield (t/ha)	Electrical conductivity (dS/m)		Yield loss, %
		Irrigation water	Soil	
Wheat	2.45	1.55-1.80	4.00-4.85	25
Burly	2.17	1.55-1.80	4.00-4.85	29
Millet (Kaon)	1.07	1.50-1.80	4.00-4.75	12
Cheena (Bogai Kanchi)	1.46	1.50-2.00	4.85-4.90	22
Maize (Shavra)	3.95	1.50-2.00	5.80-6.20	45
Chick pea	0.78	1.50-2.00	3.75-4.95	-

Impact of Sea Level Rise on Salinity Intrusion



For 0.5m SLR Pirajpur, Jhalokhali, Narail, Patuakhali, Bhola faces 1ppt Salinity

For 0.95m SLR, salinity may remarkably ingress further and Shairaitpur, Barishal, Goopalganj, part of Bhola may face 1ppt Salinity

Area Under 1 PPT (sqkm)	Additional Effected Area due to Salinity Intrusion (sqkm)	
	SLR (cm)	Area (sqkm)
20600	50	7300
	62	11000
	95	16300

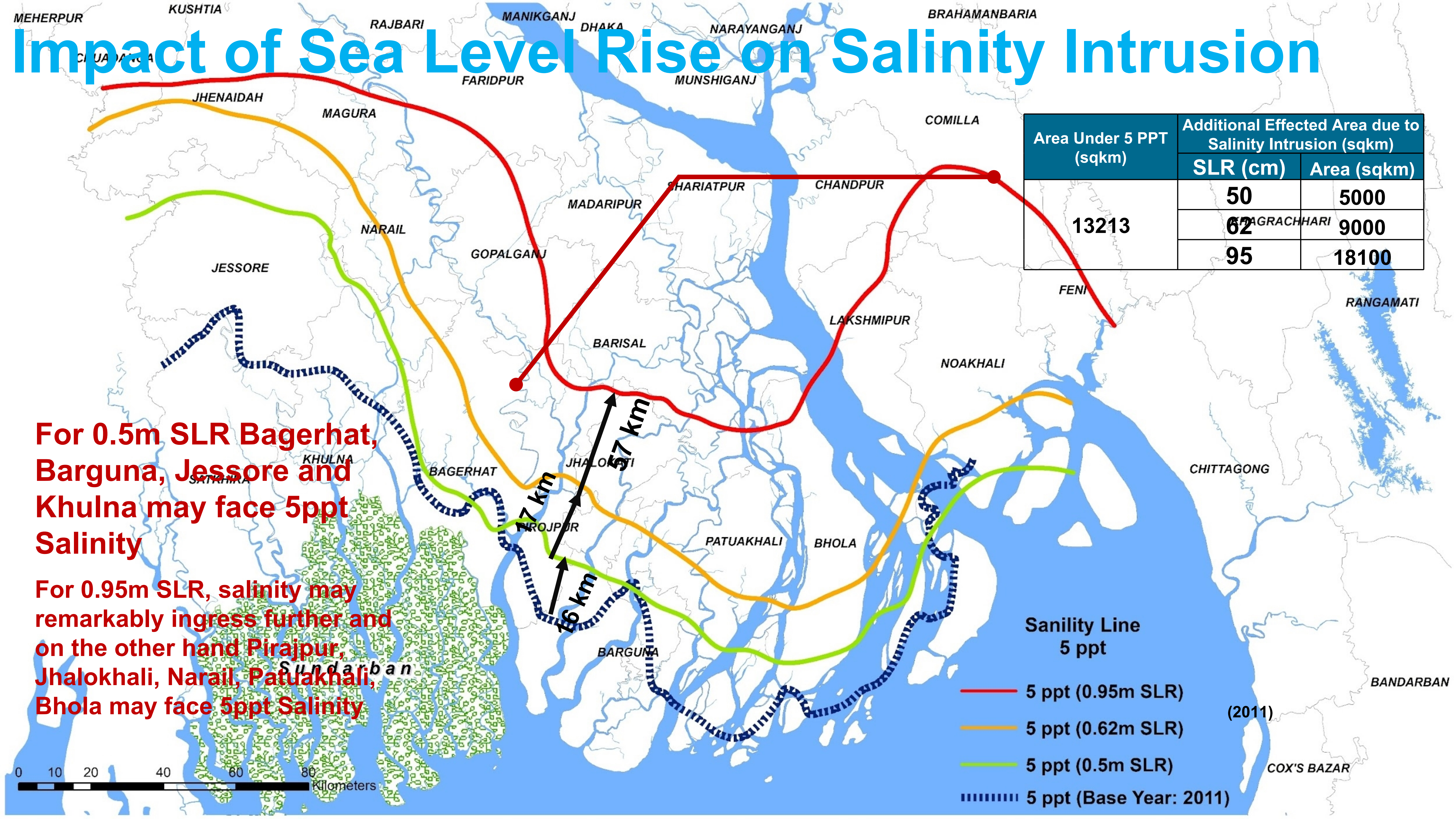
This surface water salinity model has been developed using Delft3D

Impact of Sea Level Rise on Salinity Intrusion

Area Under 5 PPT (sqkm)	Additional Effected Area due to Salinity Intrusion (sqkm)	
	SLR (cm)	Area (sqkm)
13213	50	5000
	62	9000
	95	18100

For 0.5m SLR Bagerhat, Barguna, Jessore and Khulna may face 5ppt Salinity

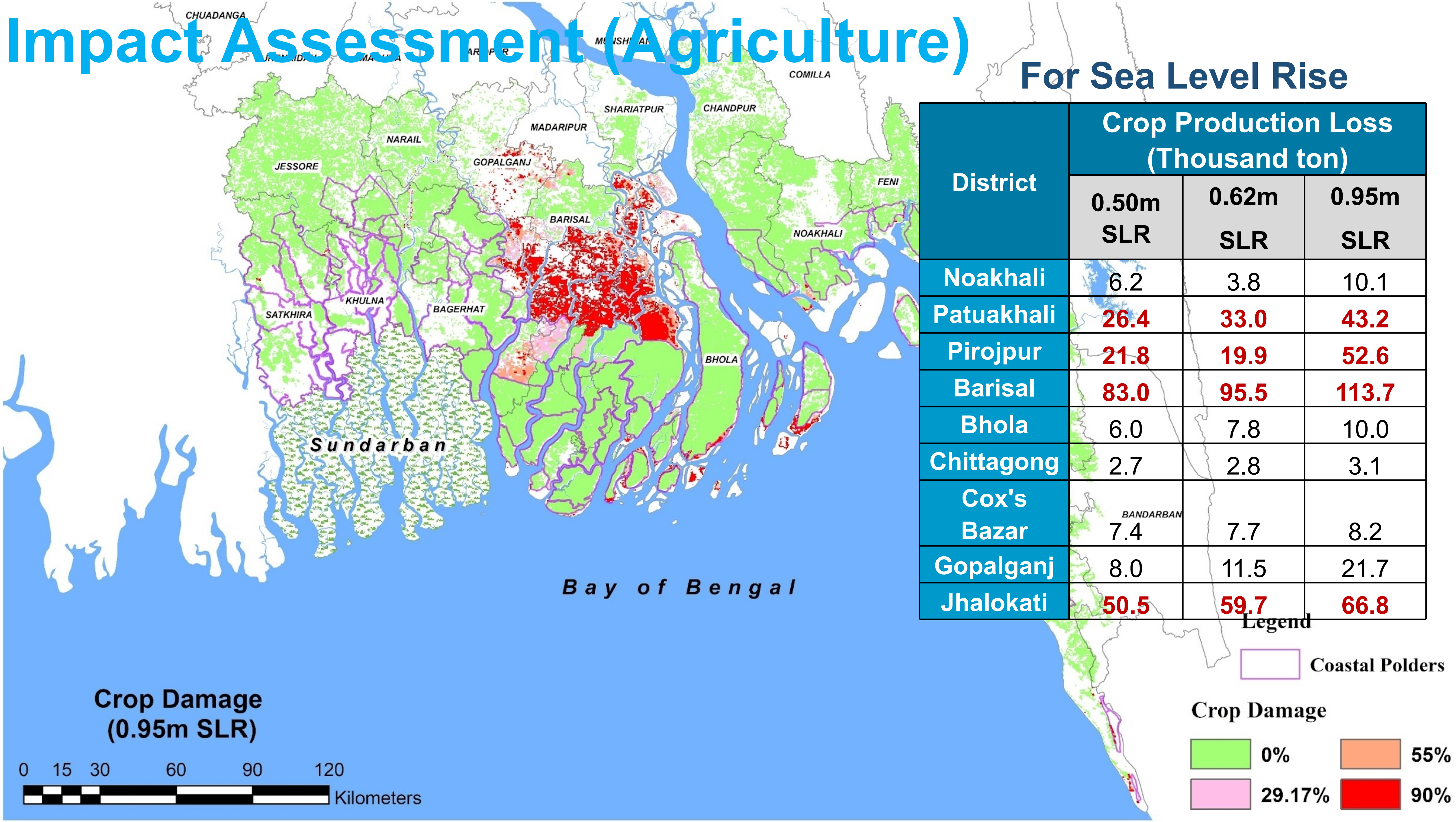
For 0.95m SLR, salinity may remarkably ingress further and on the other hand Pirajpur, Jhalokhali, Narail, Patuakhali, Bhola may face 5ppt Salinity



Impact Assessment (Agriculture)

For Sea Level Rise

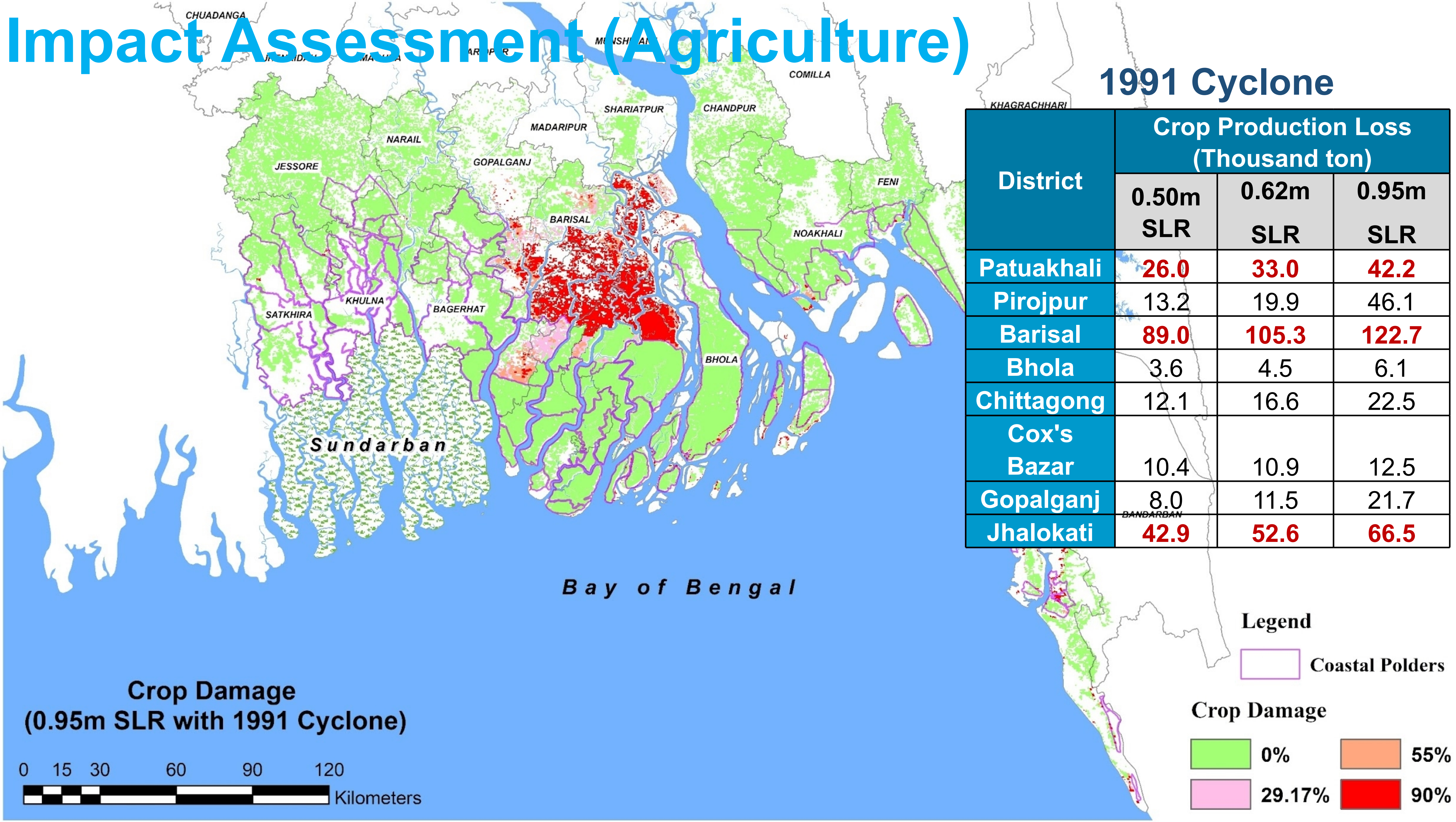
District	Crop Production Loss (Thousand ton)		
	0.50m SLR	0.62m SLR	0.95m SLR
Noakhali	6.2	3.8	10.1
Patuakhali	**26.4**	**33.0**	**43.2**
Pirojpur	**21.8**	**19.9**	**52.6**
Barisal	**83.0**	**95.5**	**113.7**
Bhola	6.0	7.8	10.0
Chittagong	2.7	2.8	3.1
Cox's Bazar	7.4	7.7	8.2
Gopalganj	8.0	11.5	21.7
Jhalokati	**50.5**	**59.7**	**66.8**



Impact Assessment (Agriculture)

1991 Cyclone

District	Crop Production Loss (Thousand ton)		
	0.50m SLR	0.62m SLR	0.95m SLR
Patuakhali	26.0	33.0	42.2
Pirojpur	13.2	19.9	46.1
Barisal	89.0	105.3	122.7
Bhola	3.6	4.5	6.1
Chittagong	12.1	16.6	22.5
Cox's Bazar	10.4	10.9	12.5
Gopalganj	8.0	11.5	21.7
Jhalokati	42.9	52.6	66.5

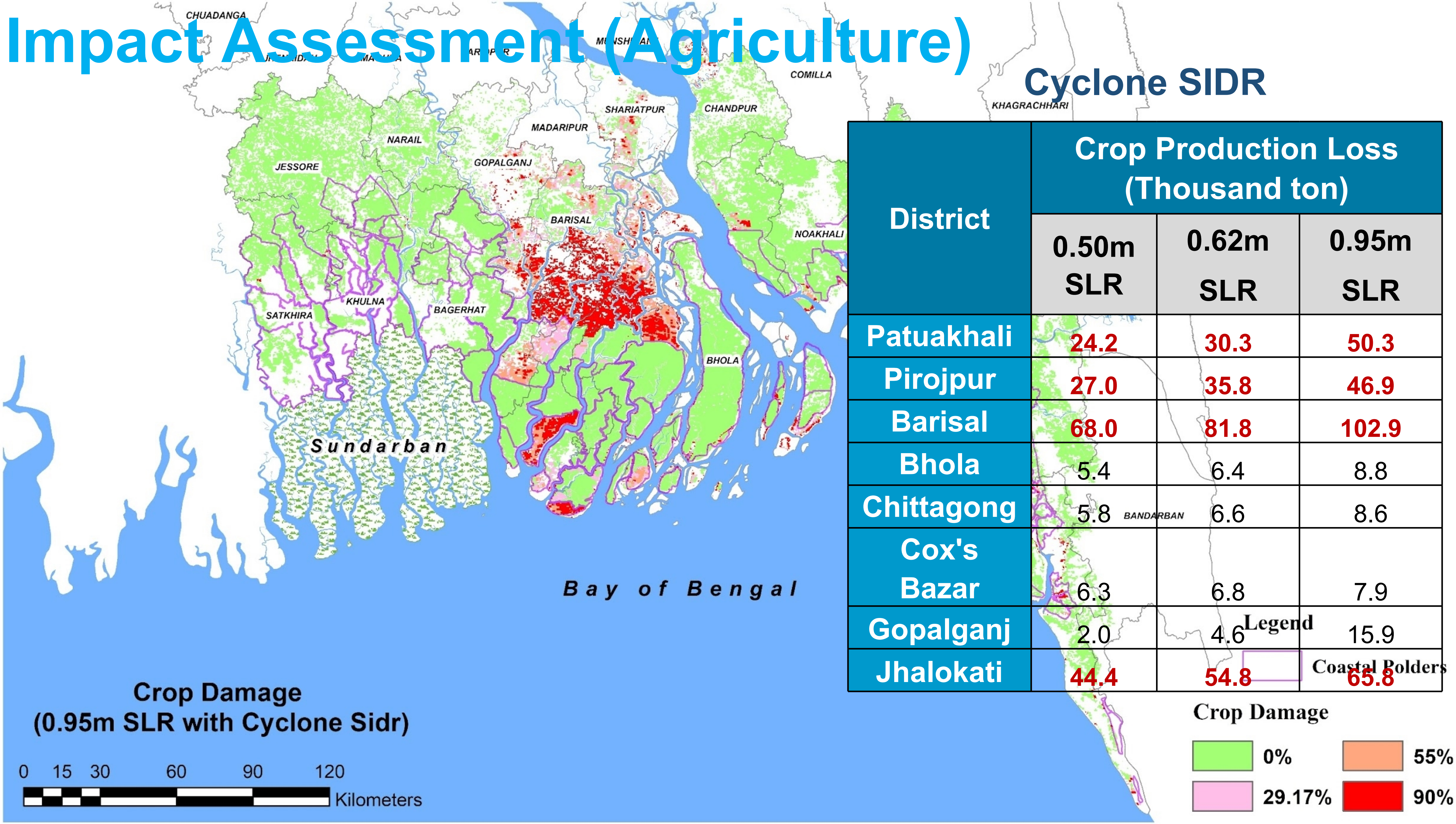


Crop Damage
(0.95m SLR with 1991 Cyclone)

Impact Assessment (Agriculture)

Cyclone SIDR

District	Crop Production Loss (Thousand ton)		
	0.50m SLR	0.62m SLR	0.95m SLR
Patuakhali	24.2	30.3	50.3
Pirojpur	27.0	35.8	46.9
Barisal	68.0	81.8	102.9
Bhola	5.4	6.4	8.8
Chittagong	5.8	6.6	8.6
Cox's Bazar	6.3	6.8	7.9
Gopalganj	2.0	4.6	15.9
Jhalokati	44.4	54.8	65.8

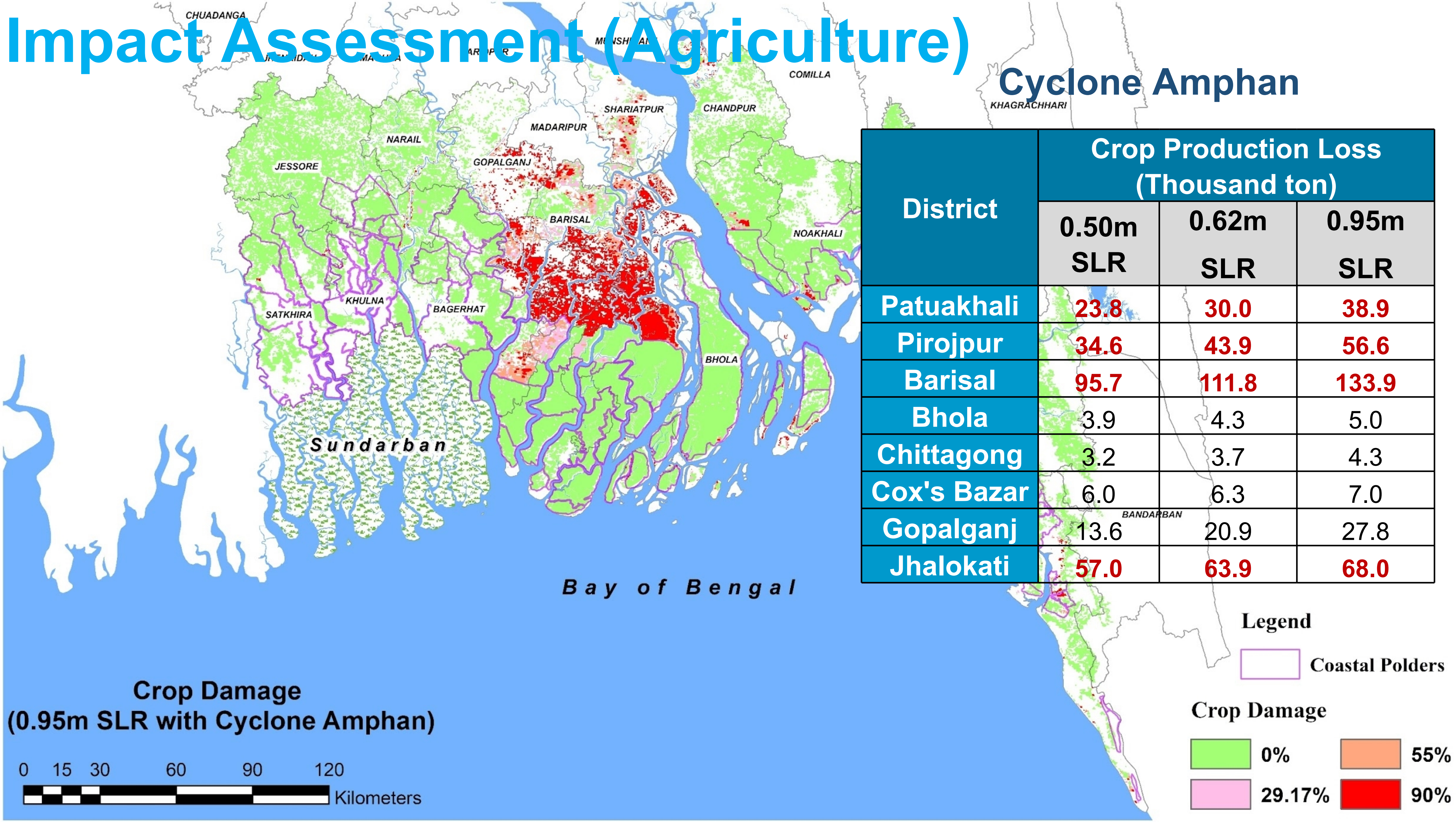


Crop Damage
(0.95m SLR with Cyclone Sidr)

Impact Assessment (Agriculture)

Cyclone Amphan

District	Crop Production Loss (Thousand ton)		
	0.50m SLR	0.62m SLR	0.95m SLR
Patuakhali	23.8	30.0	38.9
Pirojpur	34.6	43.9	56.6
Barisal	95.7	111.8	133.9
Bhola	3.9	4.3	5.0
Chittagong	3.2	3.7	4.3
Cox's Bazar	6.0	6.3	7.0
Gopalganj	13.6	20.9	27.8
Jhalokati	57.0	63.9	68.0



Crop Damage
(0.95m SLR with Cyclone Amphan)

Way Forward

- Need more action research on Salinity Management and Monitoring
- Introduce of satellite-based salinity monitoring system
- Action research on Salinity management and adaptation
- Improvement of soil health
- Identification of indigenous salinity management mitigation technology