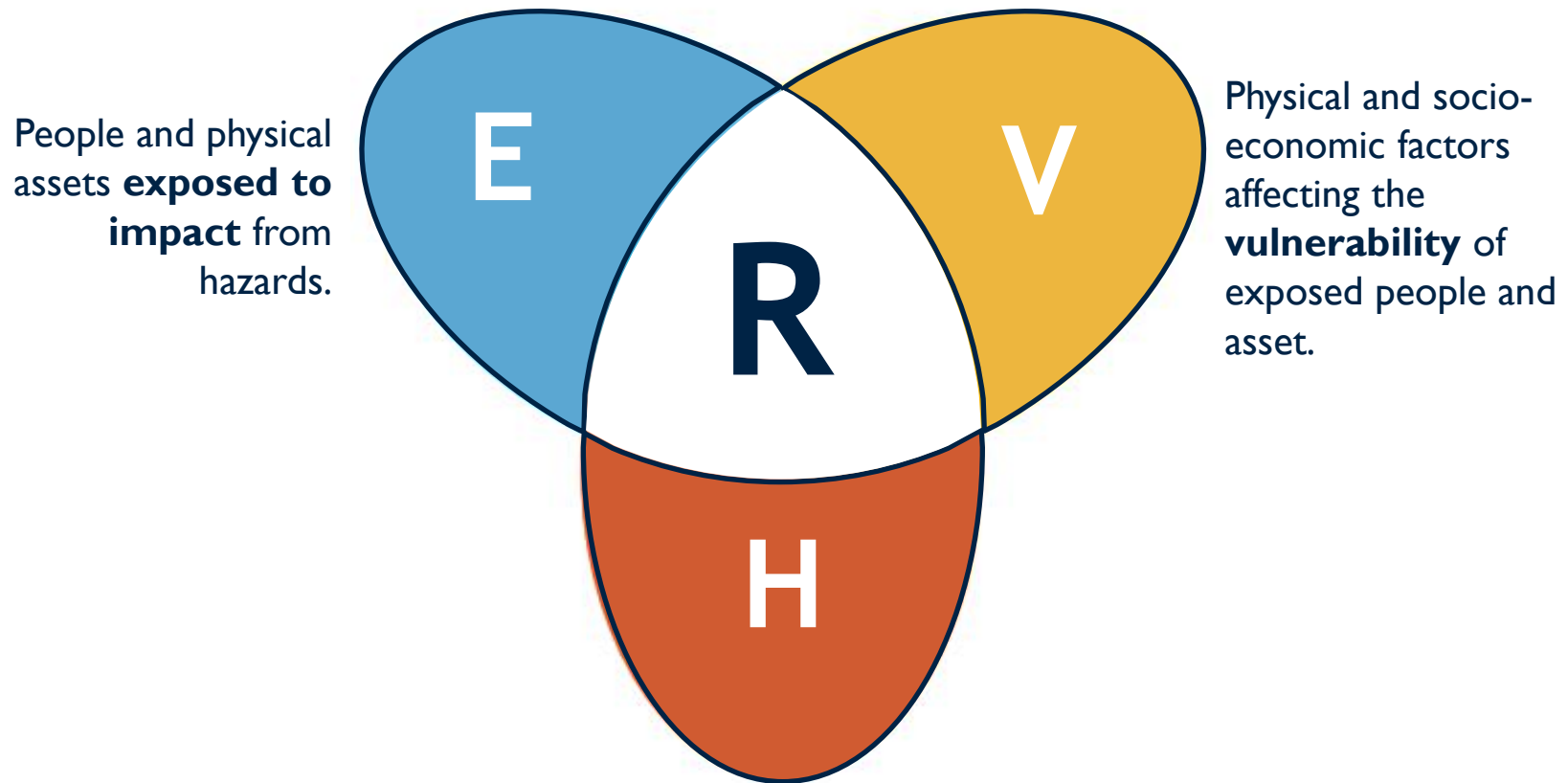


Present and Future Climate Risk Across Bangladesh: Integrated Findings on Hazard Exposures & Poverty Vulnerability

Dhaka, December 3, 2022

I. Components of Risk

Risk is defined as probability of damage, and it is calculated as a function of:

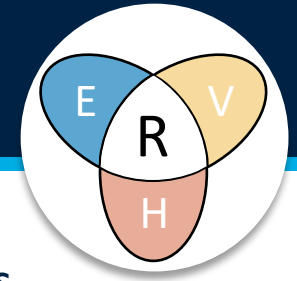


People and physical assets **exposed to impact** from hazards.

Physical and socio-economic factors affecting the **vulnerability** of exposed people and asset.

Hazard occurrence probability and physical intensity.

2. Exposure categories



Hazard types are combined with three main **exposure** categories.



Population

- Potential impacts on health and mortality



Built-up environment

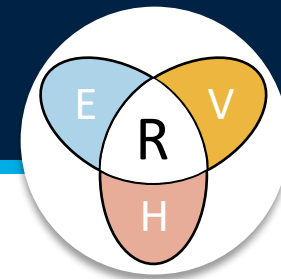
- Physical damage to buildings and infrastructural assets



Agriculture and natural environment

- Affected cropland and pastures
- Crop production and livestock numbers

3. Vulnerability



Two main components typically accounted for in vulnerability assessments:

Impact model

Relationship between the intensity of hazard and the degree of damage suffered by exposed categories

Quantitative (impact function)

→ Expected Annual Impact (EAI)

Qualitative (exposure classification)

→ Expected Annual Exposure (EAE)

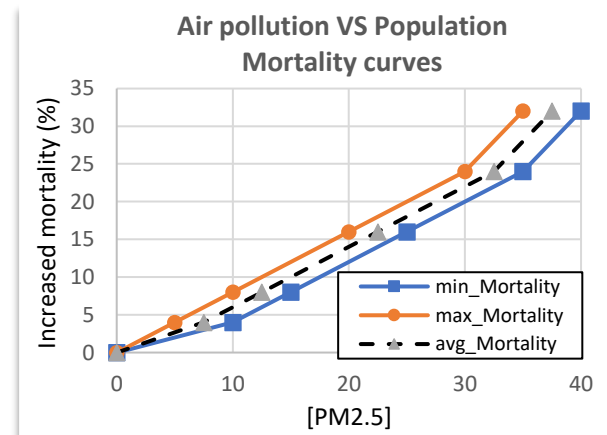
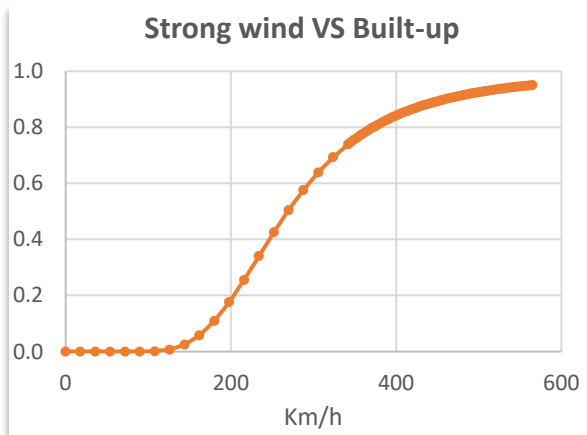
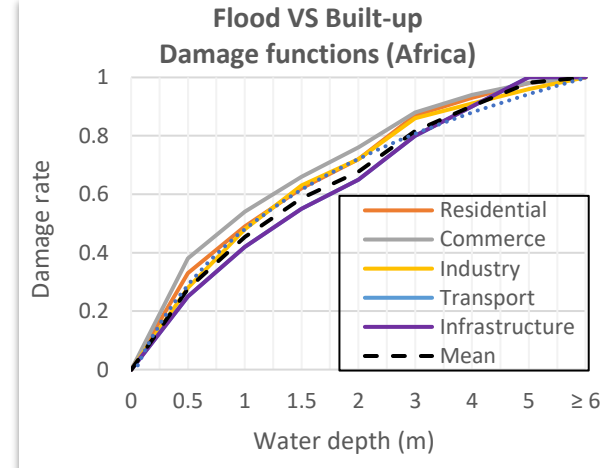
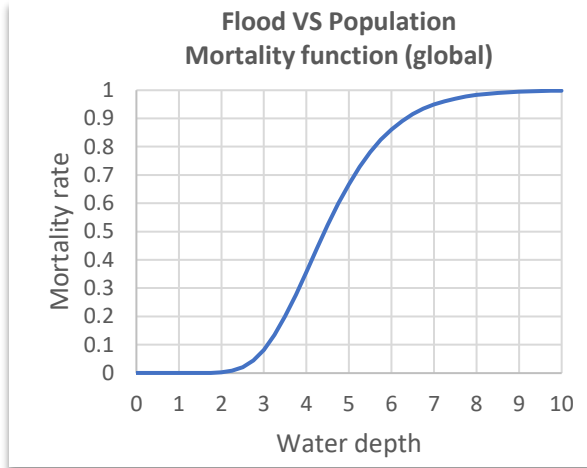
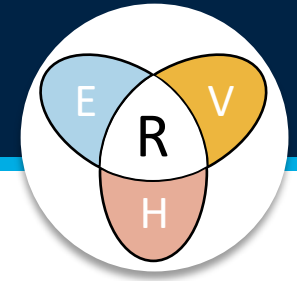
Socio-economic conditions

Differential susceptibility of exposed categories to suffer damage

Measured using quantitative spatial indices based on demographics and socioeconomic statistics (RWI)

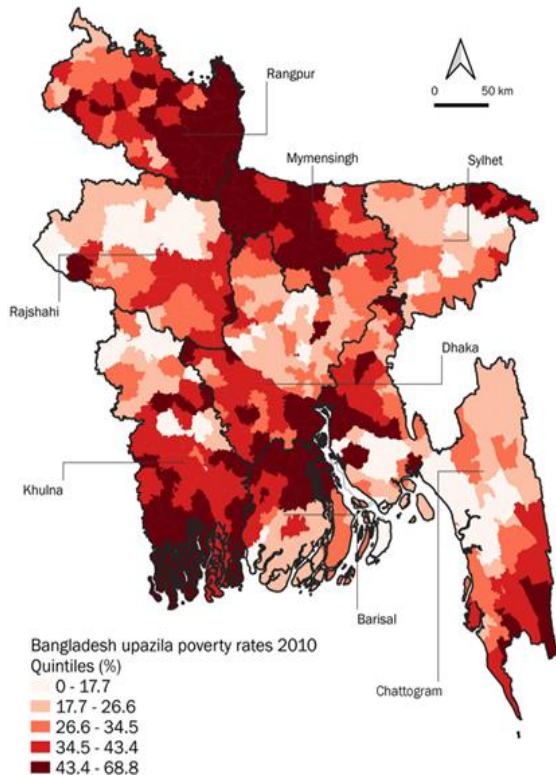
When no vulnerability information is available, a simple exposure estimate in relation to hazard intensity classes is performed.

4. Impact models

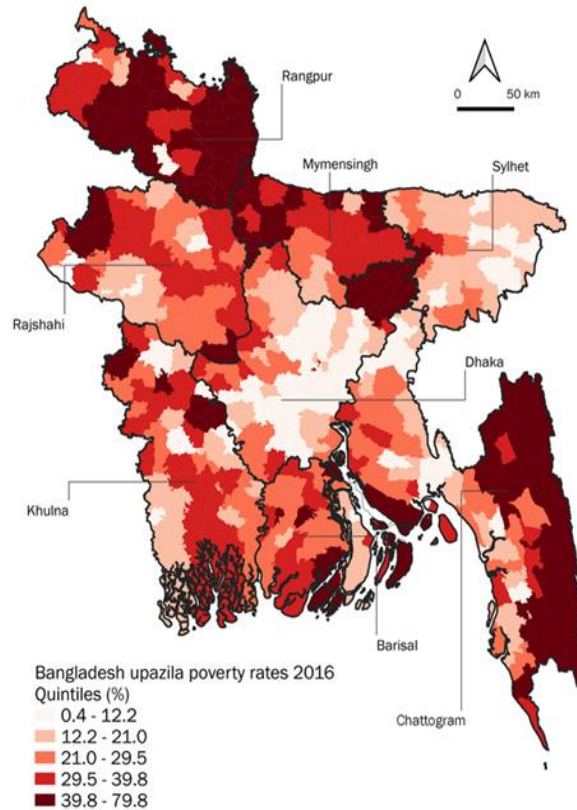


5. Socio-economic index

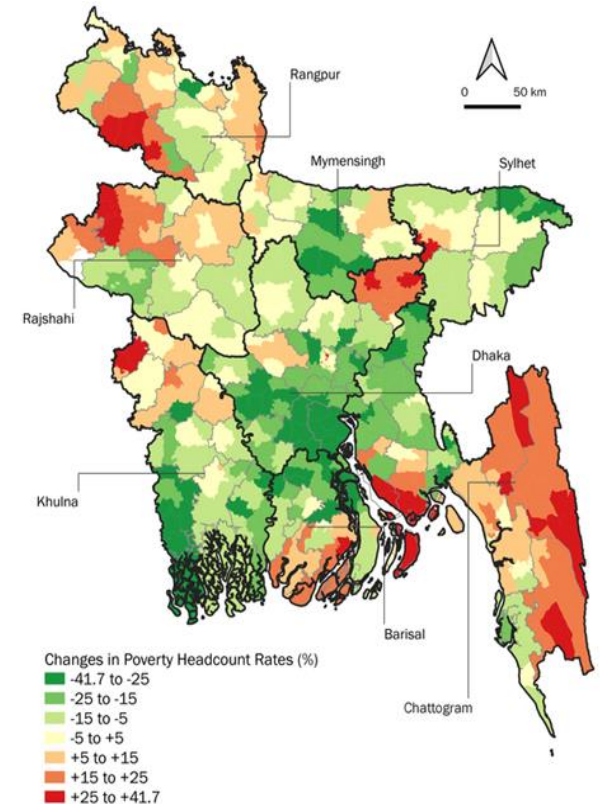
Up to two-thirds of the population lived in poverty in 2010: Upazilas in the north Divisions (Rangpur and Mymensingh), southwest (Khulna, northern Barisal, and southern Dhaka) and southeast (Chattogram).



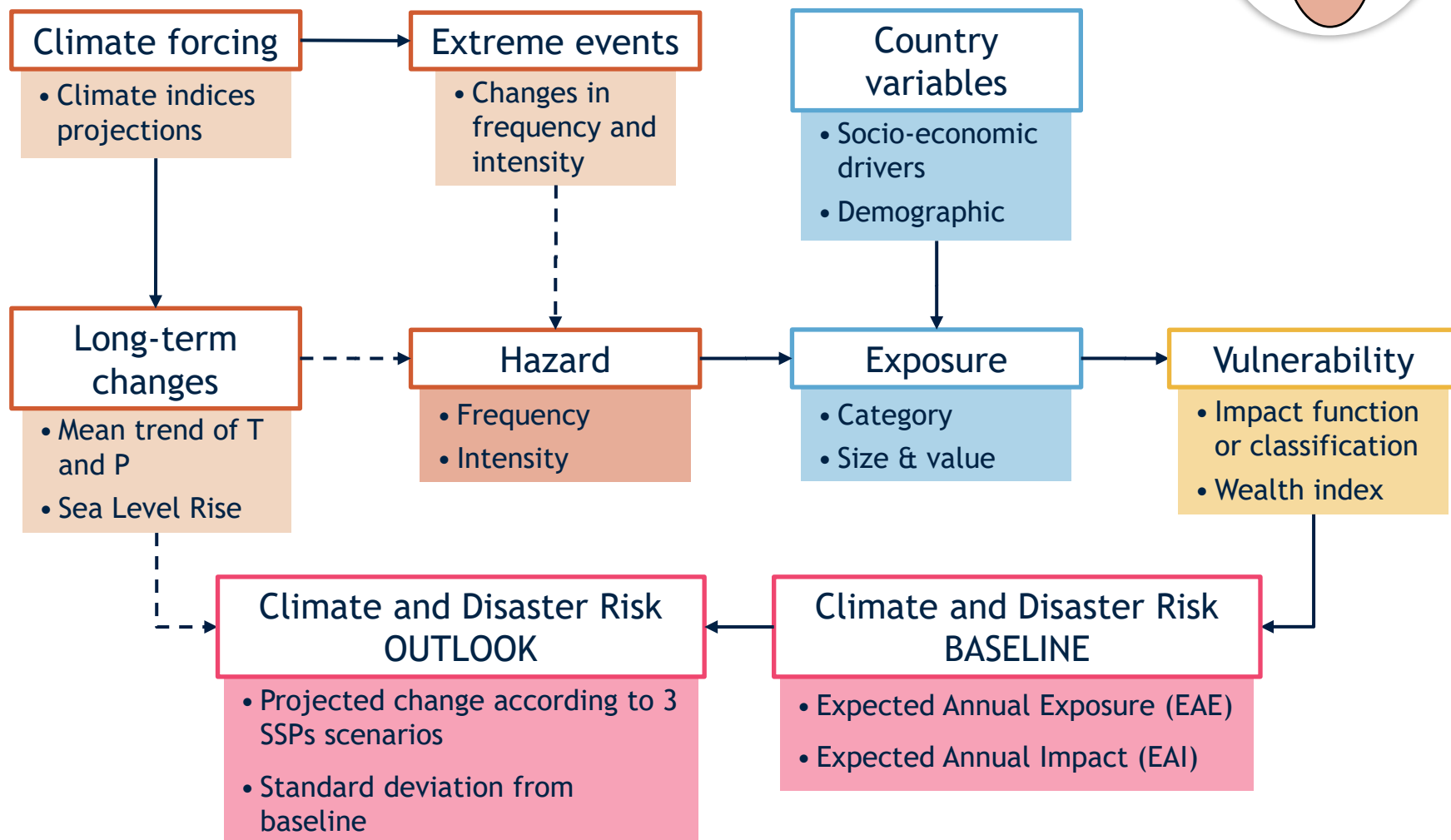
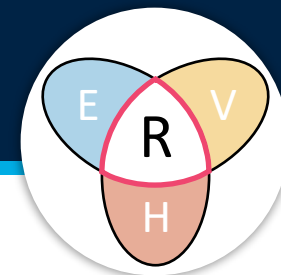
Upazila poverty rates 2016/17: Northern Chattogram, central Dhaka, Sylhet, and Rajshahi Divisions still performed better, comparatively.



Change in poverty: 2010 and 2016: Poverty was stagnant or even increased in northwest Divisions and in Southeast



6. Approach workflow



EXAMPLE: FLOOD IMPACT

An aerial photograph of a rural area with a grid of fields. The map is overlaid with semi-transparent colored polygons representing different flood impact zones. The colors include orange, pink, light blue, and yellow. Four black-bordered boxes with white text are connected to specific areas on the map by thin black lines. The top-left box points to a pink area, the top-right to a light blue area, the bottom-left to a pink area, and the bottom-right to a yellow area. The background map shows a mix of agricultural fields, some with water bodies, and a few buildings.

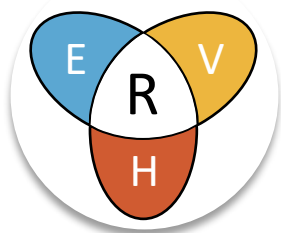
- Population: 145 #
- Water depth (RP100): 0.53 m
- Mortality factor: 0.002
- Expected impact (mortality): 0.3 #

- Population: 0 #
- Water depth (RP100): 1.30 m
- Mortality factor: 0.1
- Expected impact (mortality): 0 #

- Population: 201 #
- Water depth (RP100): 0
- Mortality factor: none
- Expected impact (mortality): 0 #

- Built-up: 0.6 ha
- Water depth (RP100): 0.7 m
- Damage factor: 0.30
- Expected impact (damage): 0.18 ha

7. Expected results



Hazard	Exposure		
	Population (health, mortality)	Built-up (physical damage)	Agriculture (production loss)
River flood	Impact function	Impact function	Exposure classification
Coastal flood	Impact function	Impact function	Exposure classification
Agricultural drought			Exposure classification
Landslide	Exposure classification	Exposure classification	
Heat stress	Exposure classification		
Tropical cyclone		Impact function	
Air pollution	Impact function		

- ✓ Country screening report – Context, past disasters, modelled impacts and future outlook
- ✓ Table summary – Modelled impacts
- ✓ Open Analytical Notebooks on GFDRR GitHub



RESULTS

Disaster Risk Baseline

Riverine and coastal flood risk

Hazard

- RP 10, 100, 1000 years

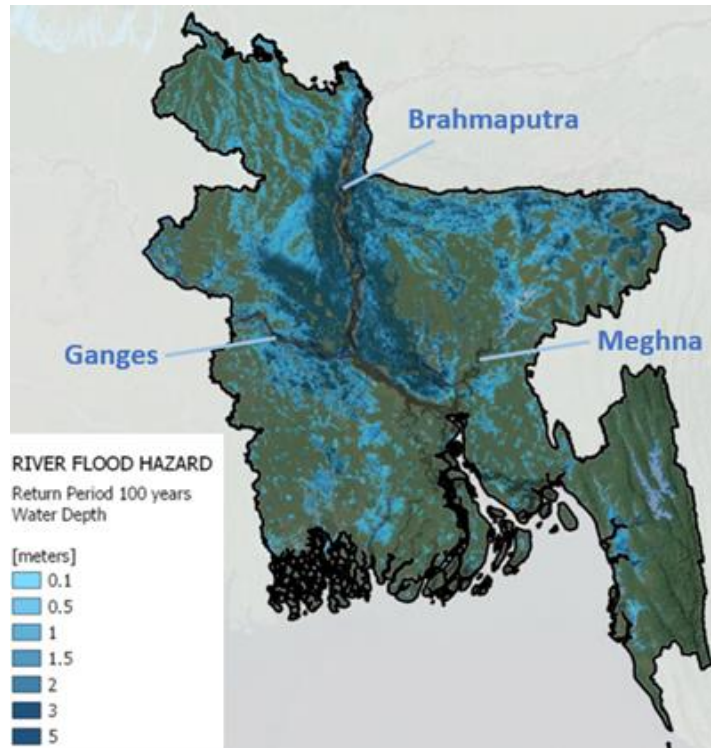
Exposure

- Population
- Built-up mask
- Agri land

Vulnerability

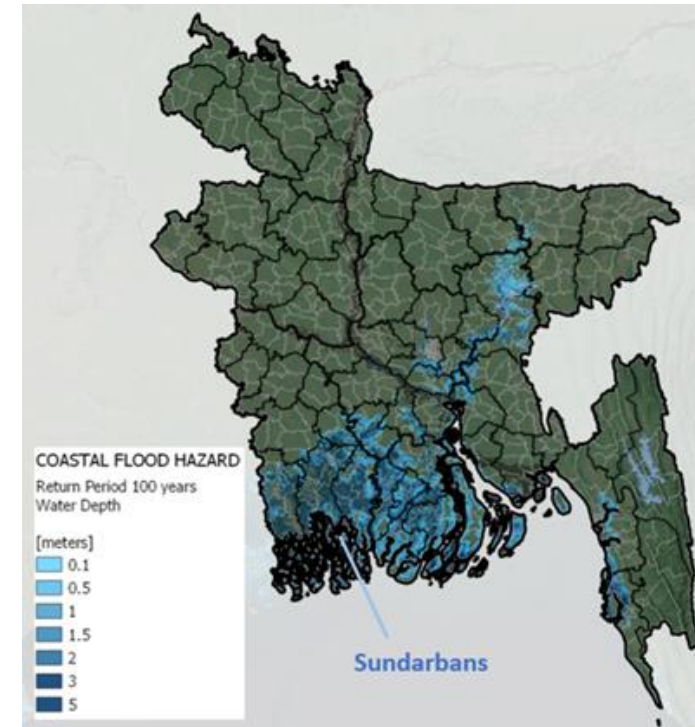
- Structural damage
- Mortality

Riverine flood risks: Floods experienced along major rivers



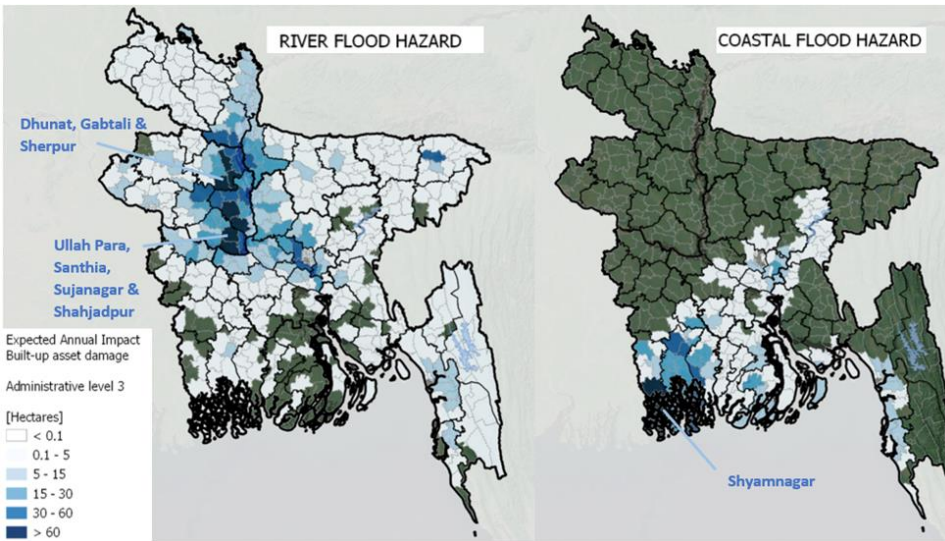
Coastal flood risk:

Floods experienced along the coastal areas

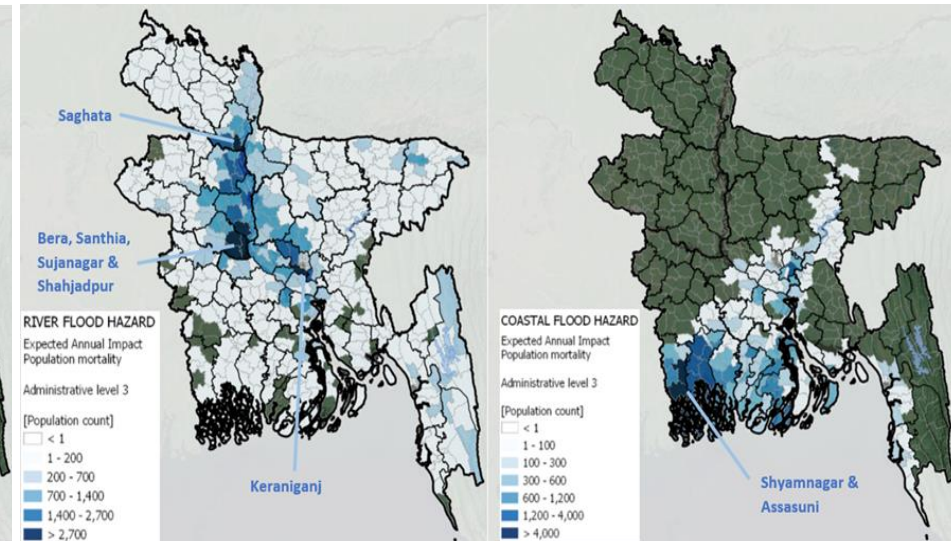


Expected annual exposure and damages

Expected Annual Damage to Built-Up Assets of Riverine and Coastal Floods



Expected Annual Population Impact of Riverine and Coastal Floods – Mortality and Morbidity



Landslides

Hazard

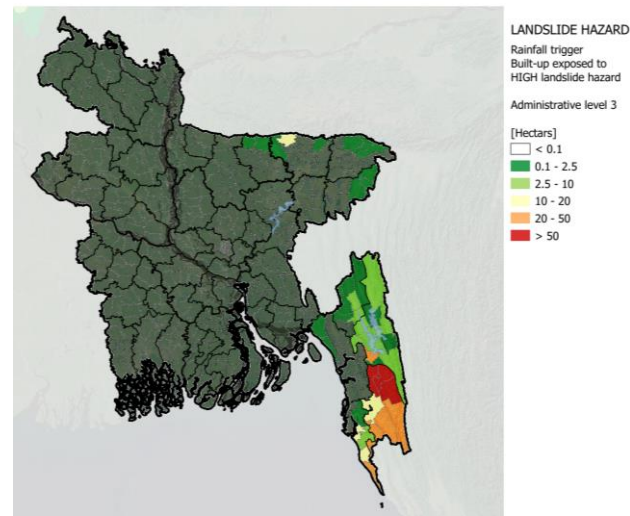
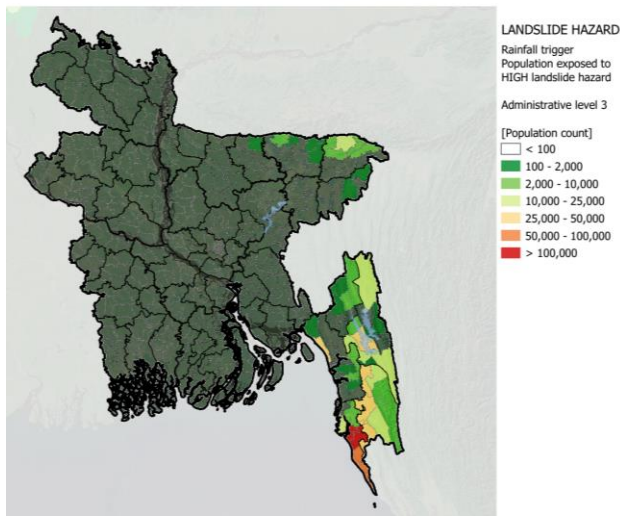
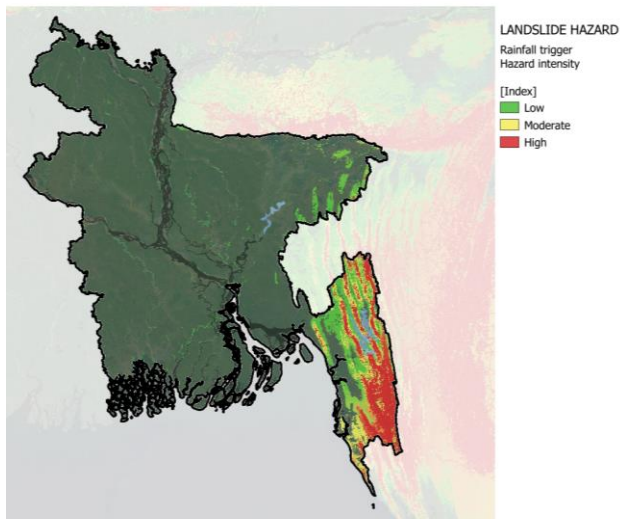
- Landslide hazard index

Exposure

- Population
- Built-up

Vulnerability

- Intensity index



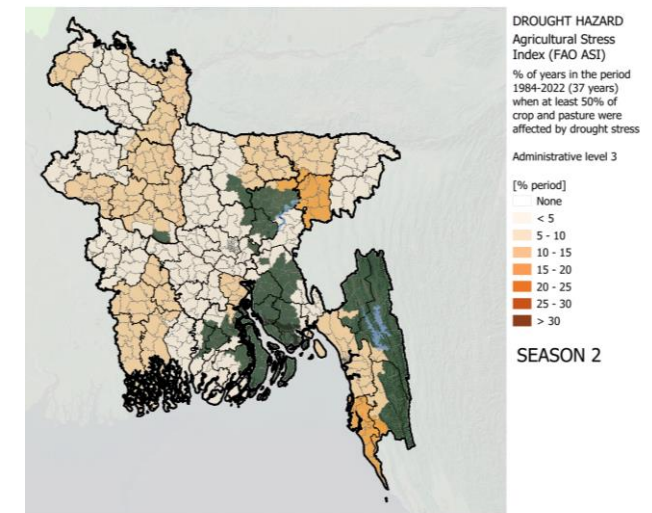
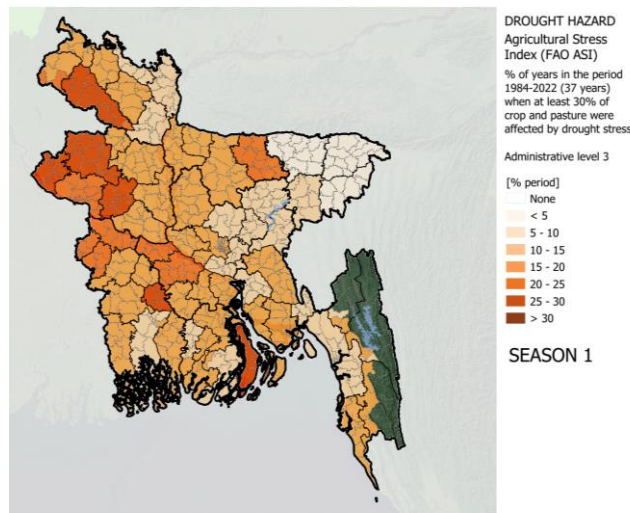
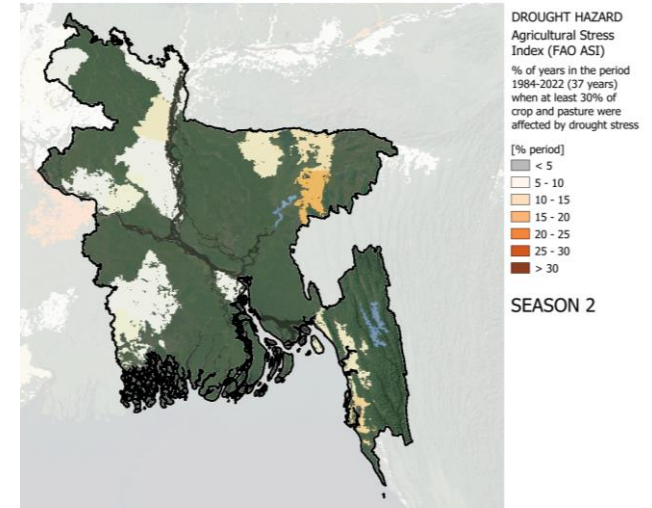
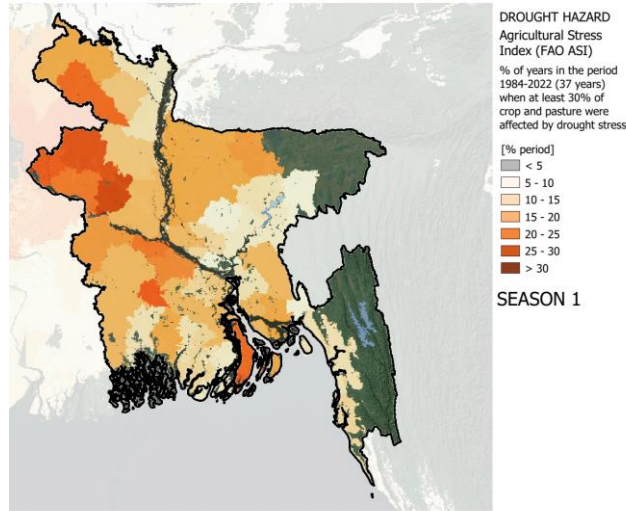
Agricultural drought

Hazard

- % of agricultural land affected
- Frequency of drought stress over 37 years

Exposure

- Cropland and pastures (frequency/intensity classes)



Heat stress

Hazard

- RP 5
- RP 20
- RP 100

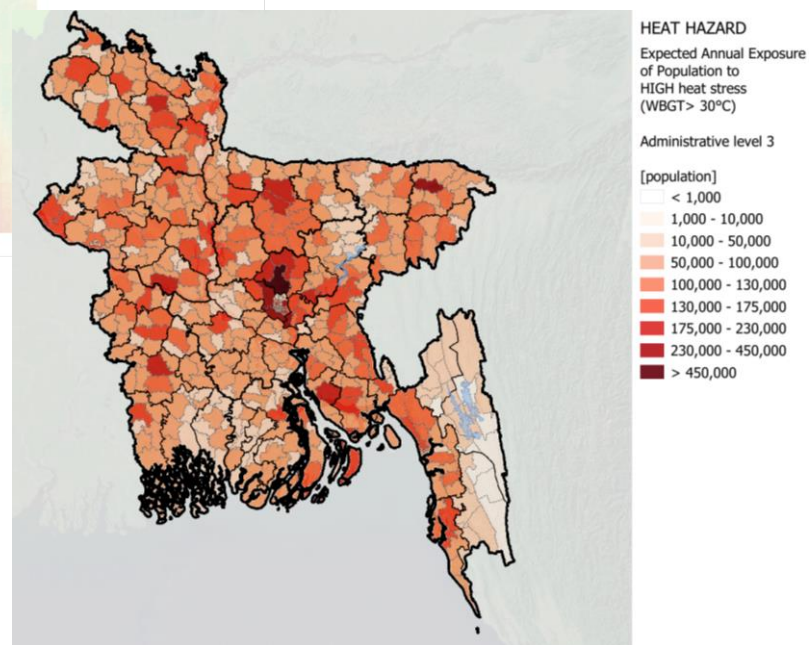
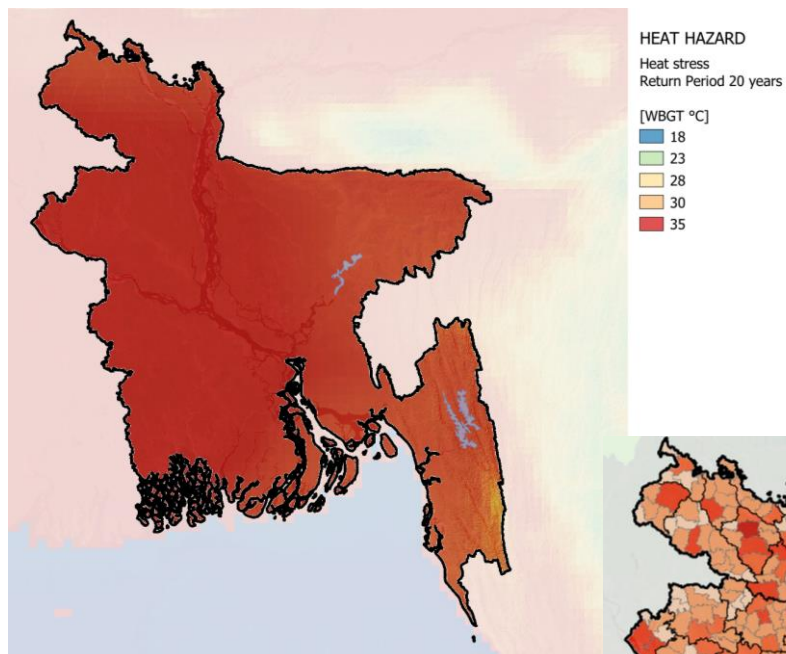
Exposure

- Population

Vulnerability

- Intensity classes

WBGT (°C)	Heat Stress
> 30	extreme
28 to 30	very strong
23 to 28	strong
18 to 23	moderate
<18	none



Air pollution

Hazard

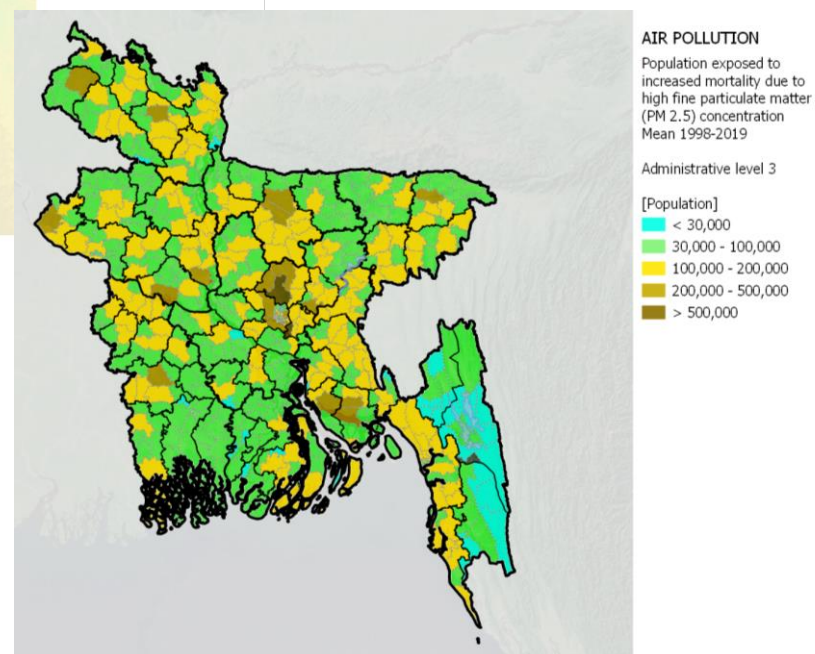
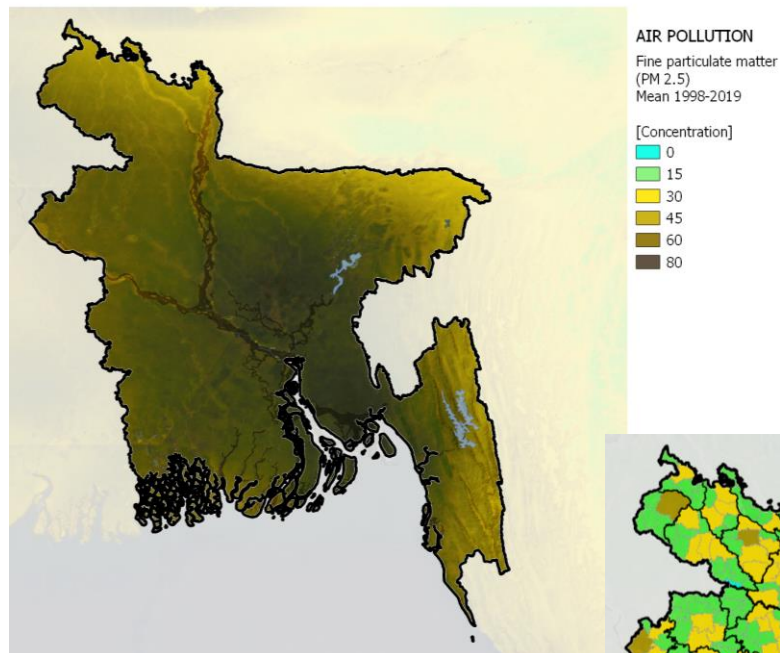
- Mean PM 2.5 concentration

Exposure

- Population

Vulnerability

- Health impact

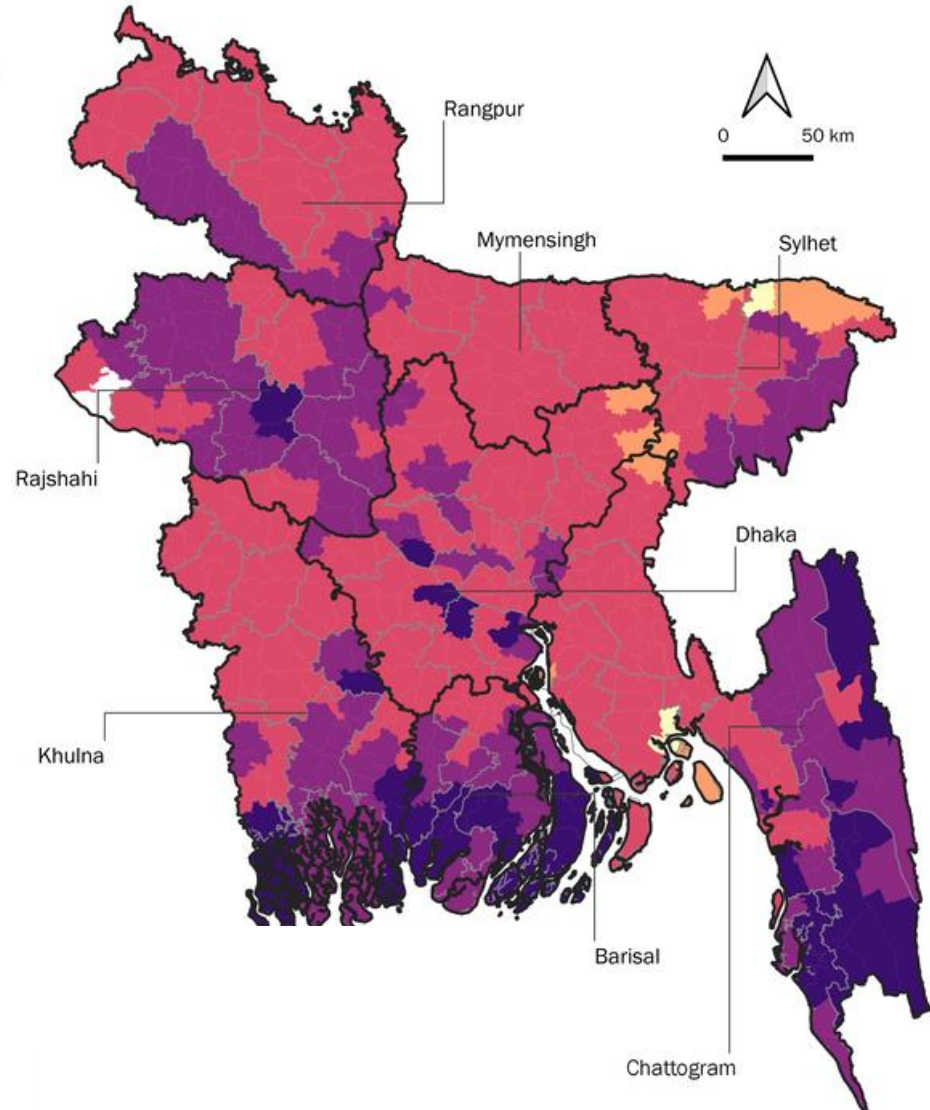


The compounding effect of risk

Number of Natural Hazards for Which Upazila Falls in Top Decile



- Each upazila falls into the highest decile of relative population or built-up asset exposure.
- Seven hazards considered: riverine floods, coastal floods, heat stress, drought, tropical cyclones, landslides, and air pollution

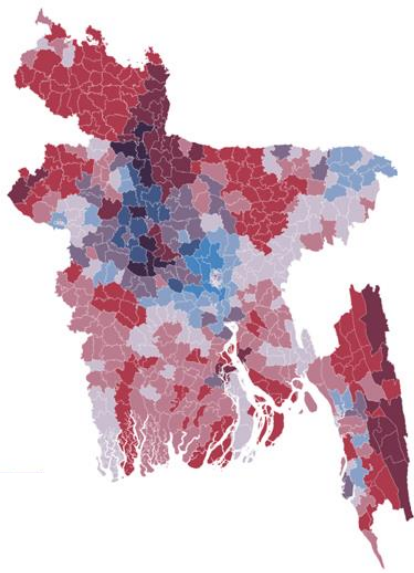


RESULTS

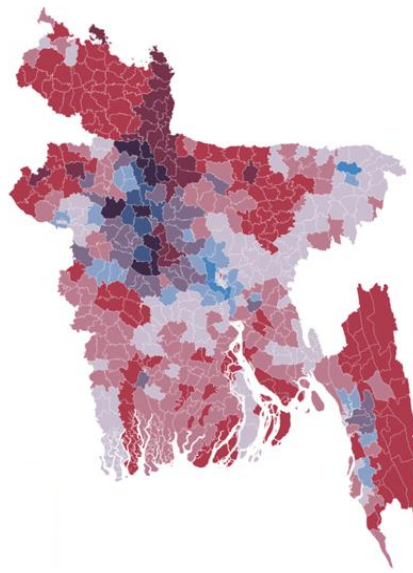
Climate Risks & Poverty vulnerability

Risk and Poverty matrices – River floods

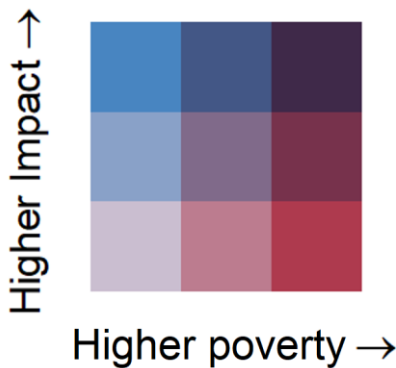
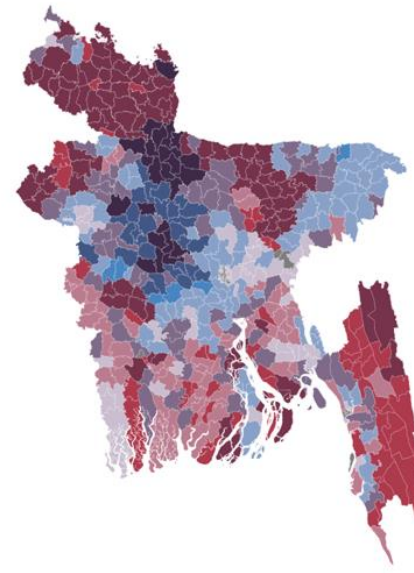
River Flooding: Impact on Population and Poverty
EAI classes: <100 people, 100-1,000 people, >1,000 people



River Flooding: Impact on Built-Up Assets and Poverty
EAI classes: <5ha, 5-30ha, >30ha

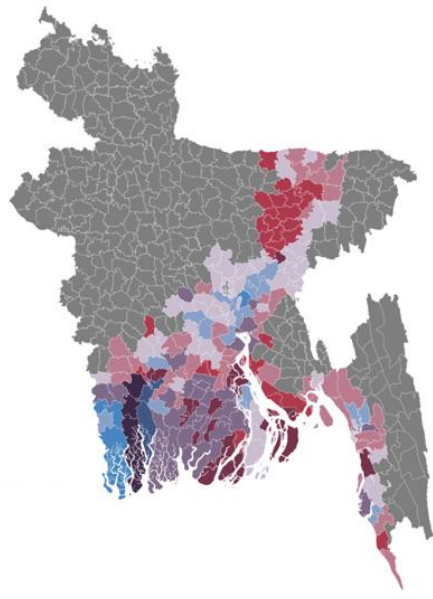


River Flooding: Impact on Agricultural Land and Poverty
EAI classes: <100ha, 100-1,000ha, >1,000ha

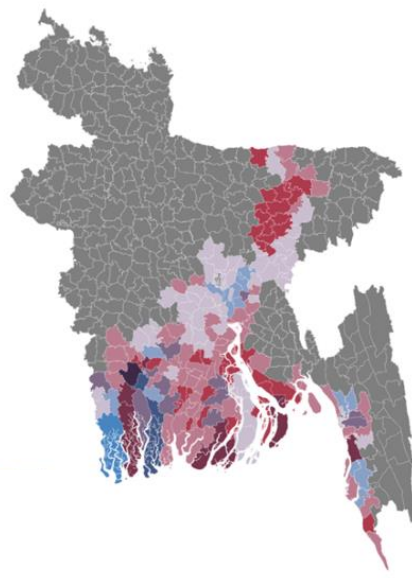


Risk and Poverty matrices – Coastal floods

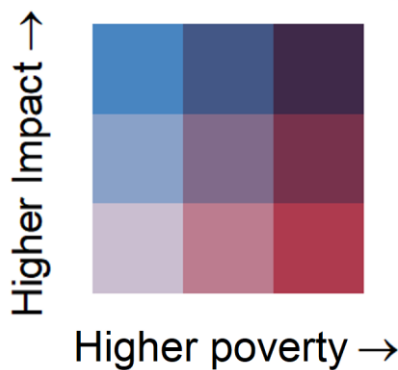
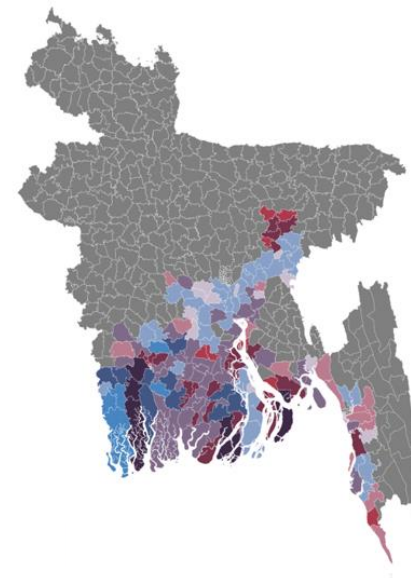
Coastal Flooding: Impact on Population and Poverty
EAI classes: <100 people, 100-1,000 people, >1,000 people



Coastal Flooding: Impact on Built-Up Assets and Poverty
EAI classes: <5ha, 5-30ha, >30ha

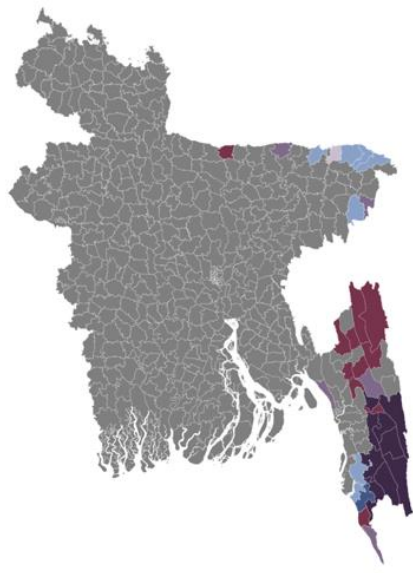


Coastal Flooding: Impact on Agricultural Land and Poverty
EAI classes: <100ha, 100-1,000ha, >1,000ha

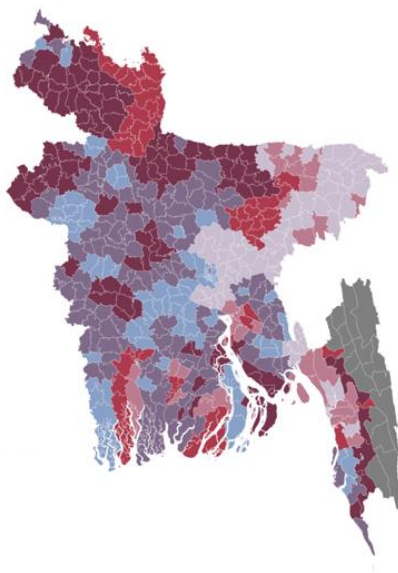


Risk and Poverty matrices

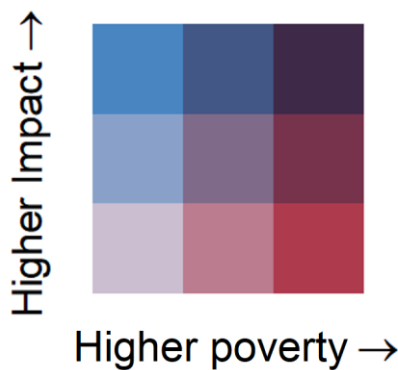
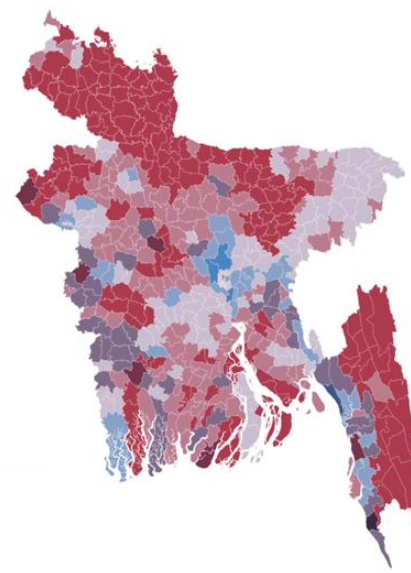
Landslides: Exposure of Population and Poverty
EAE classes: <100 people, 100-10,000 people, >10,000 people



Drought: Frequency of Agricultural Land Exposure and Poverty
Exposure classes: <10% of years, 10-25% of years, >25% of years

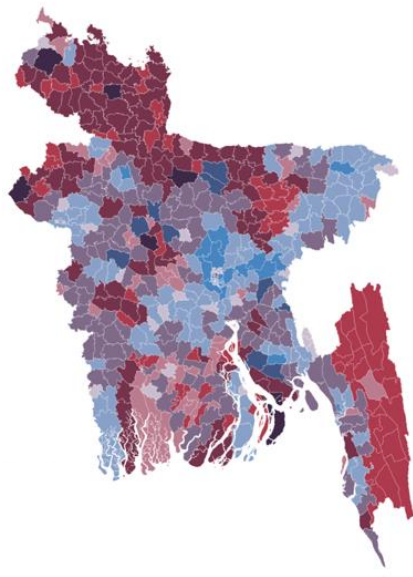


Tropical Cyclone: Exposure of Built-Up Assets and Poverty
EAE classes: <0.5ha, 0.5-2ha, >2ha

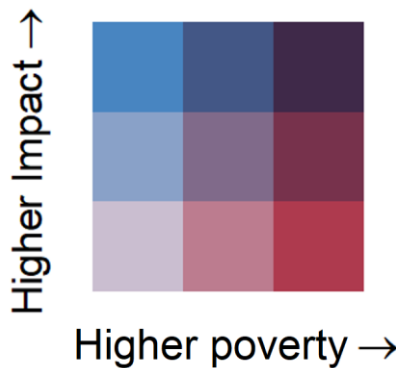
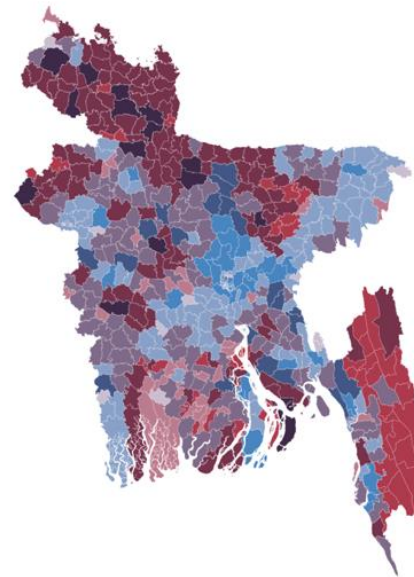


Risk and Poverty matrices

Heat Stress: Exposure of Population and Poverty
EAE classes: <50,000 people, 50,000-150,000 people, >150,000 people

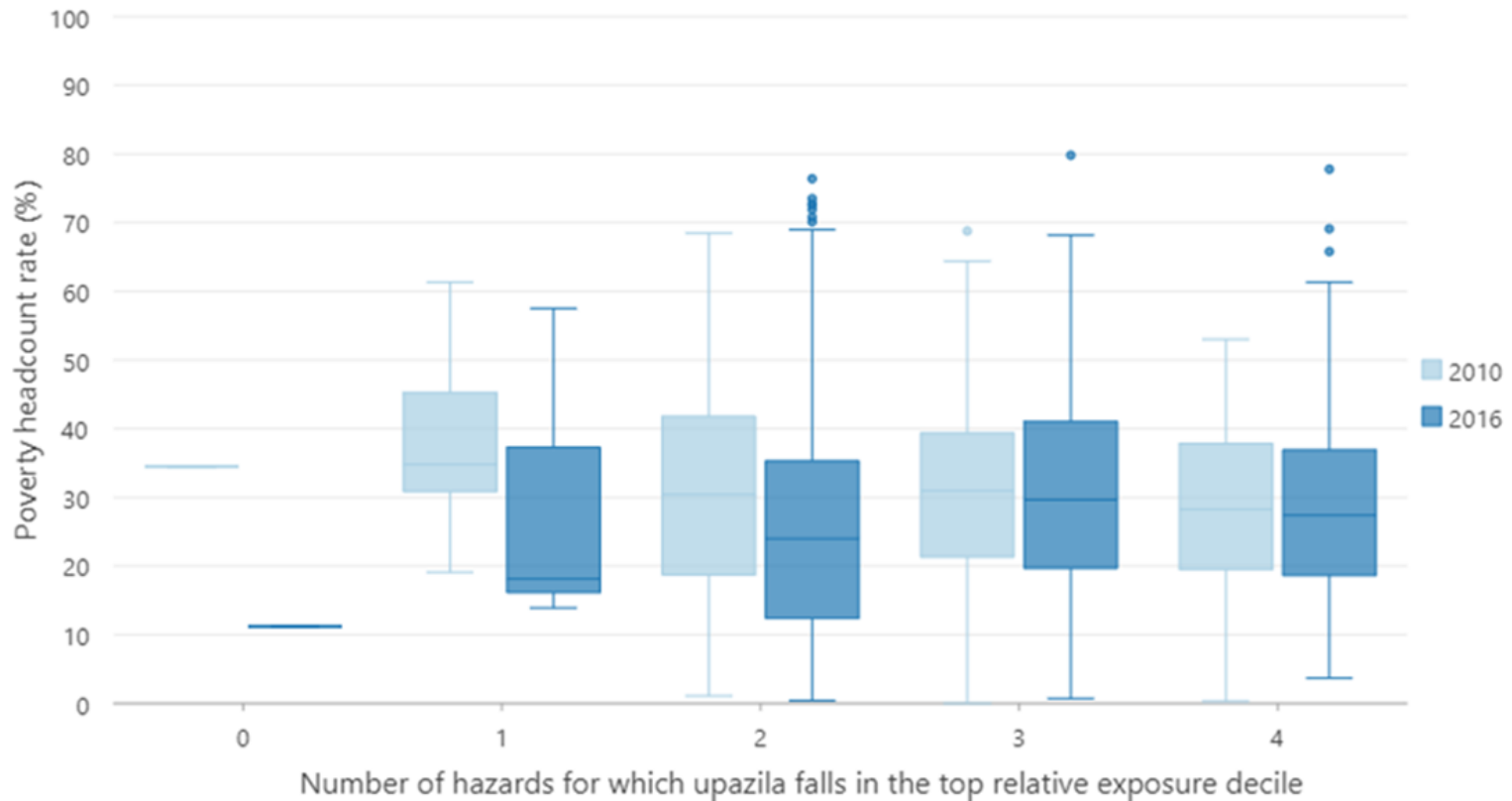


Air Pollution: Exposure of Population and Poverty
EAE classes: <50,000 people, 50,000-150,000 people, >150,000 people



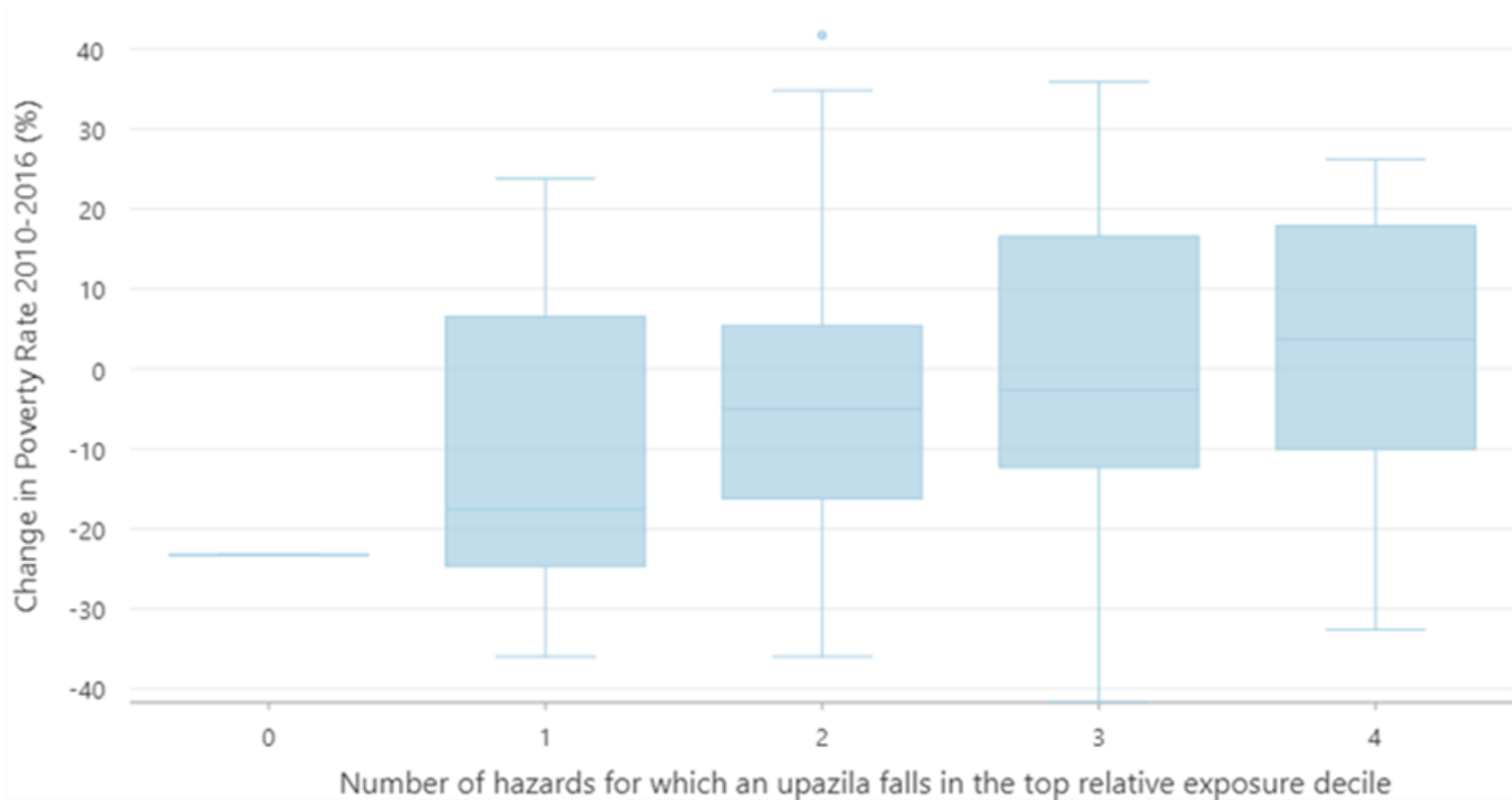
Poverty rates and hazard exposure

2010 and 2016 Poverty Rates and Co-Occurring Hazards for Hazard-Exposed Upazilas



Poverty rates and hazard exposure

Change in Poverty Rates and Co-Occurring Natural Hazards for Hazard-Exposed Upazilas



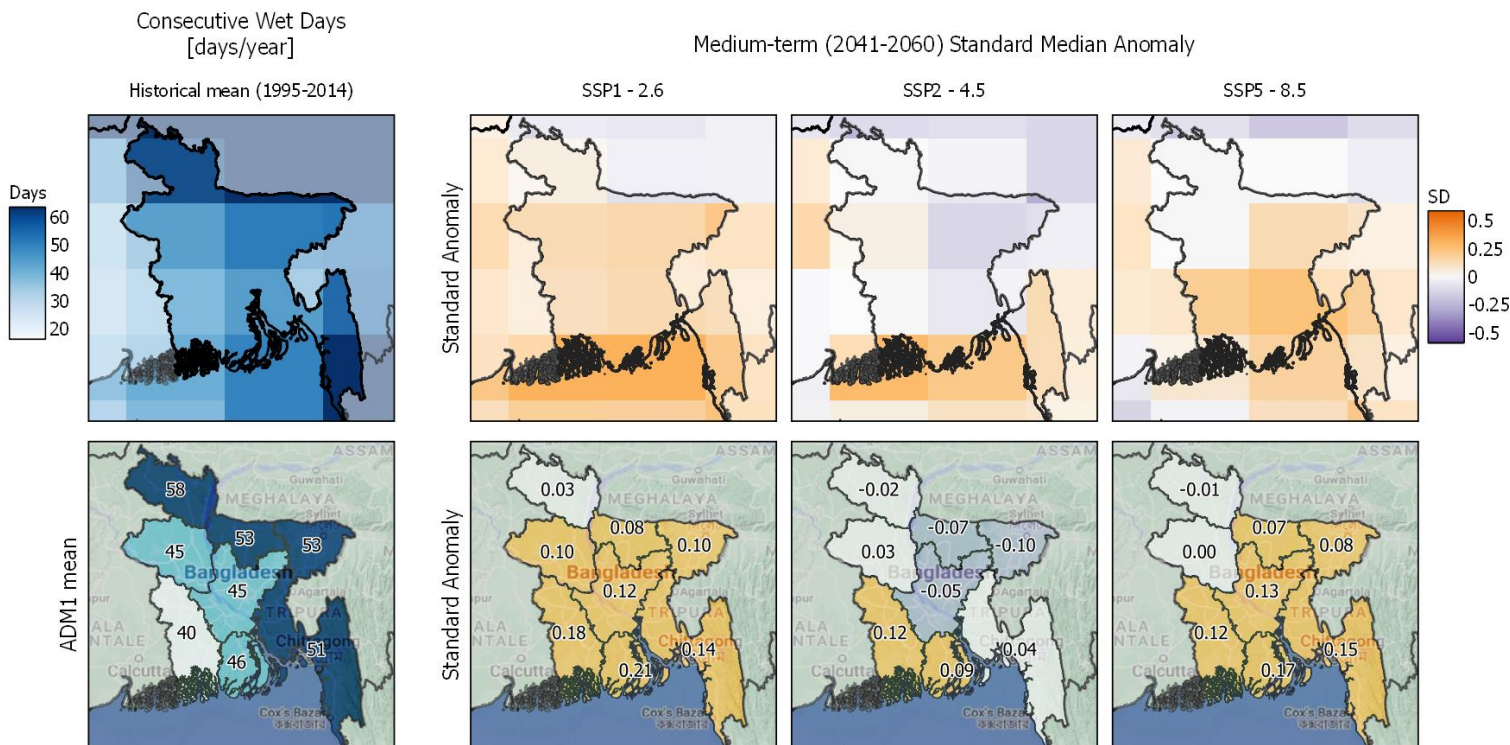
RESULTS

Climate indices – Outlook

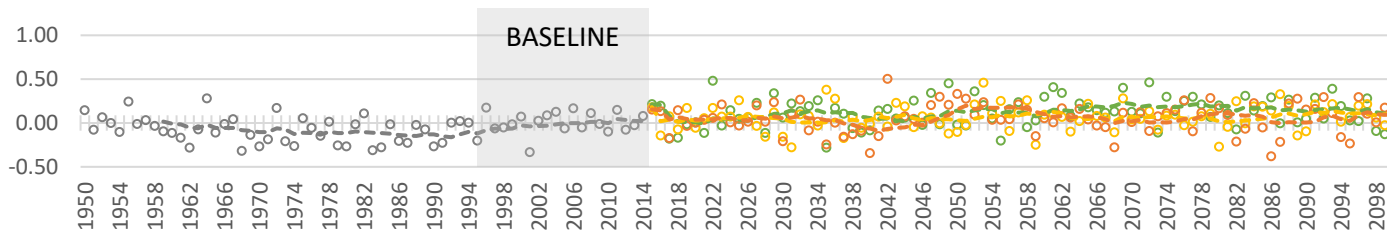
Projections shows worrisome picture: heat stress, riverine and coastal flooding, and landslides for the period 2041-2060

Climate indices – Rainfall and floods

➤ Consecutive Wet Days

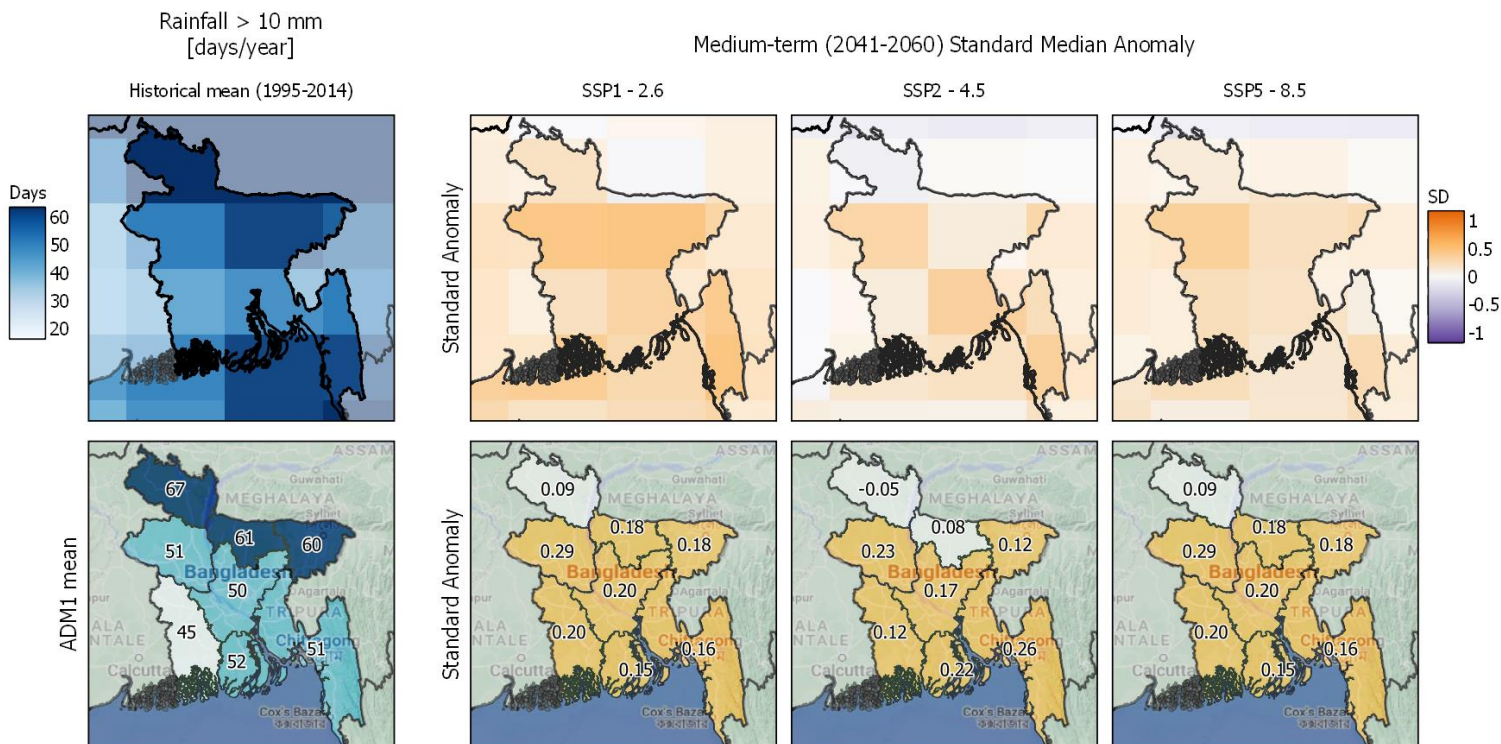


- Historical
- SSP1 2.6
- SSP2 4.5
- SSP5 8.5

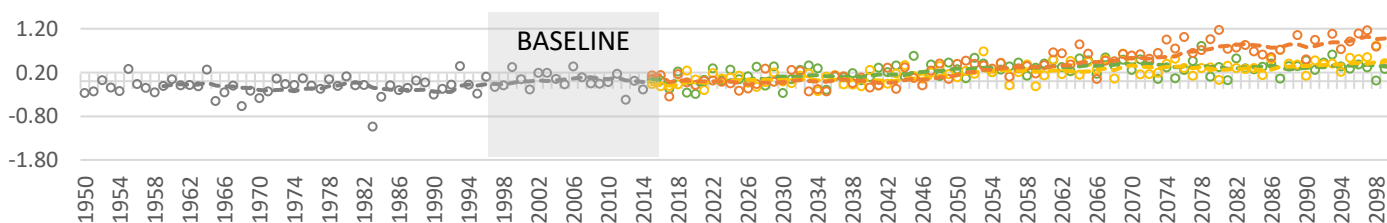


Climate indices – Rainfall and floods

➤ Rainfall > 10 mm days



- Historical
- SSP1 2.6
- SSP2 4.5
- SSP5 8.5

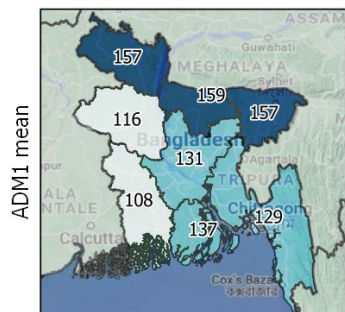
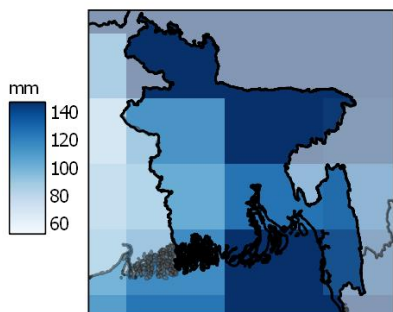


Climate indices – Rainfall and floods

➤ Extremely wet days

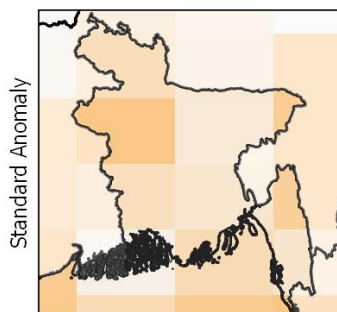
Extremely wet day precipitation [mm]

Historical mean (1995-2014)

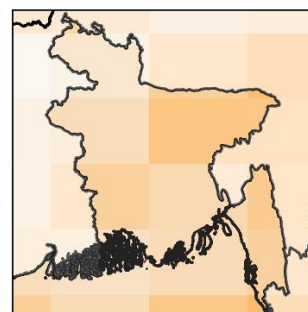


Medium-term (2041-2060) Standard Median Anomaly

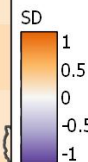
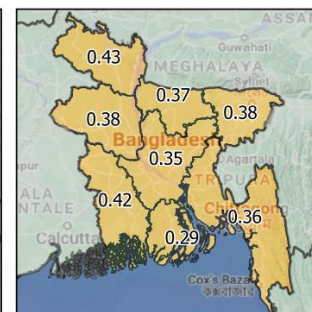
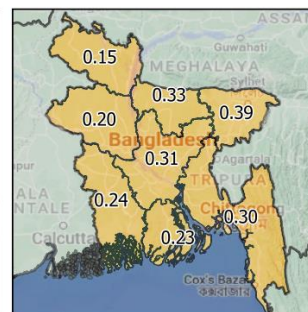
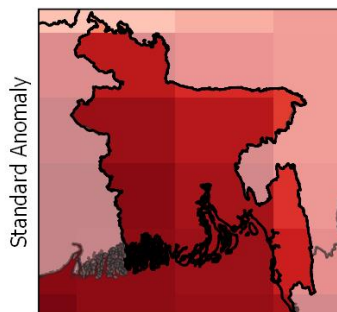
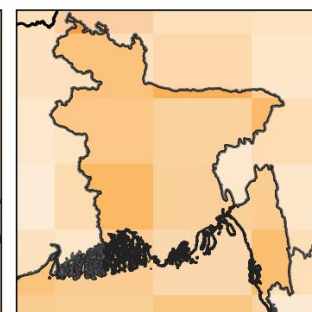
SSP1 - 2.6



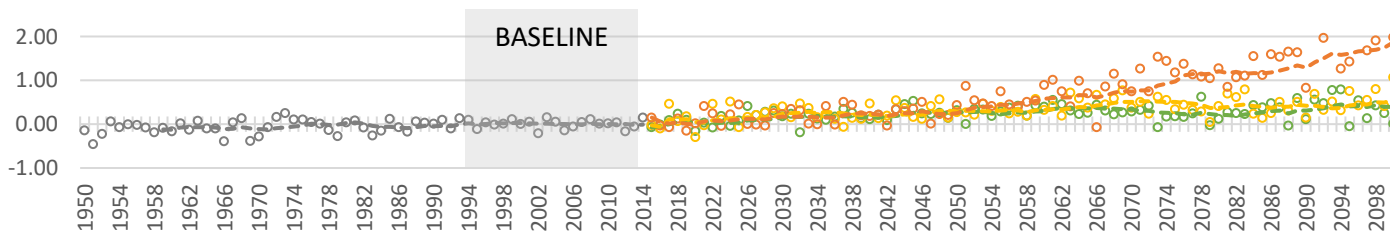
SSP2 - 4.5



SSP5 - 8.5

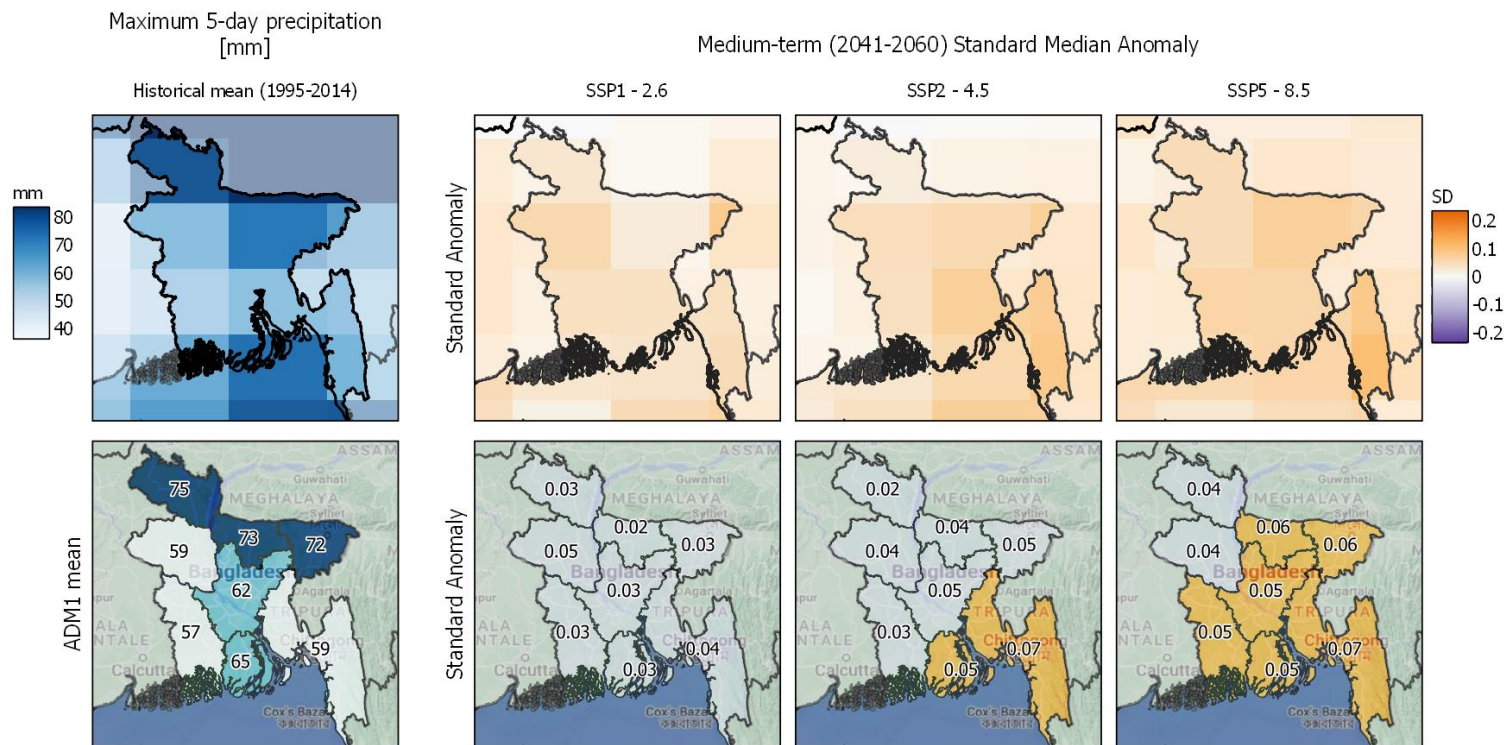


- Historical
- SSP1 2.6
- SSP2 4.5
- SSP5 8.5

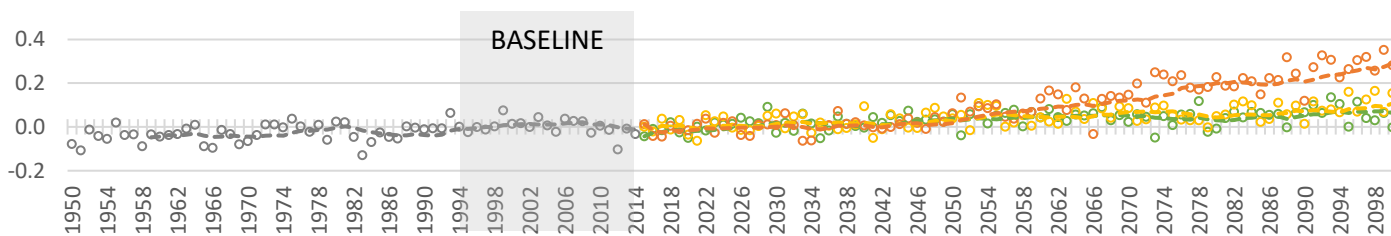


Climate indices – Rainfall and floods

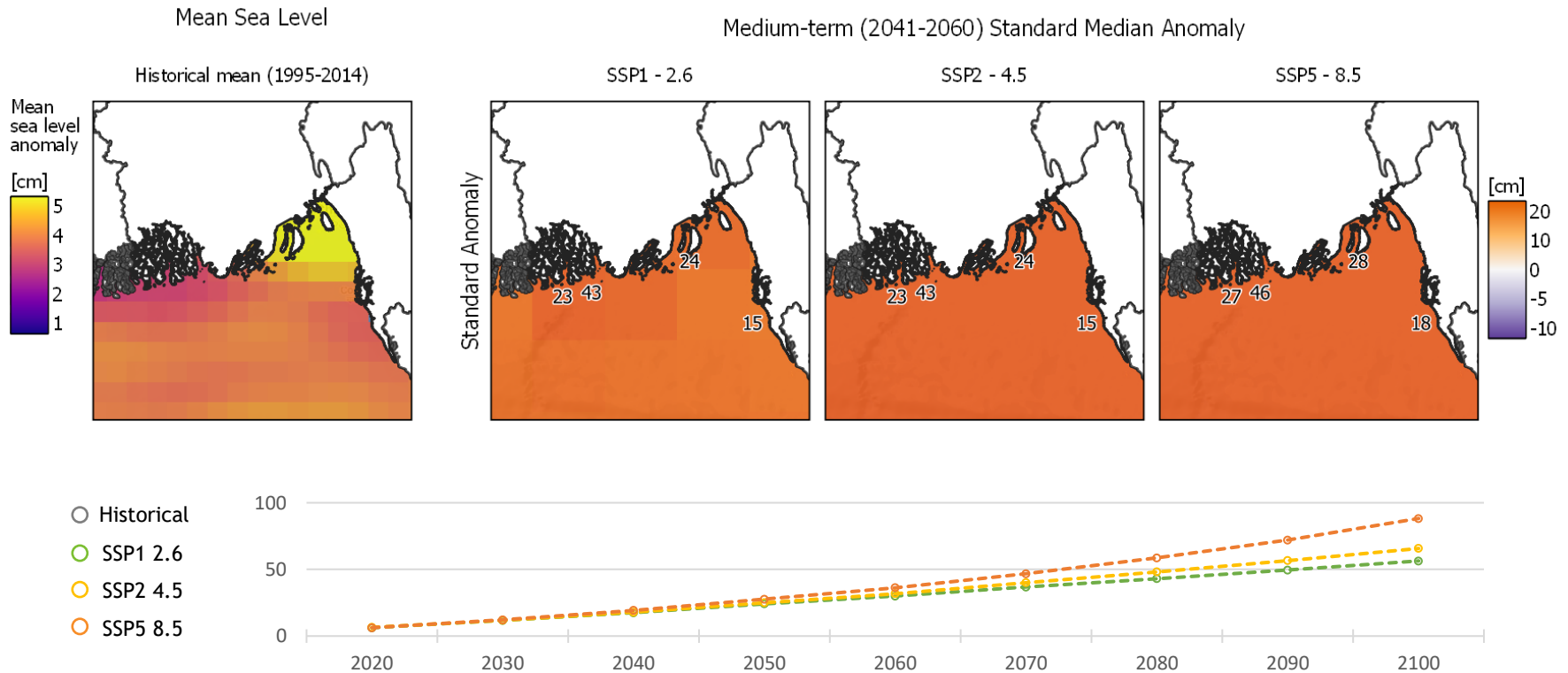
➤ Max 5-day rainfall



- Historical
- SSP1 2.6
- SSP2 4.5
- SSP5 8.5

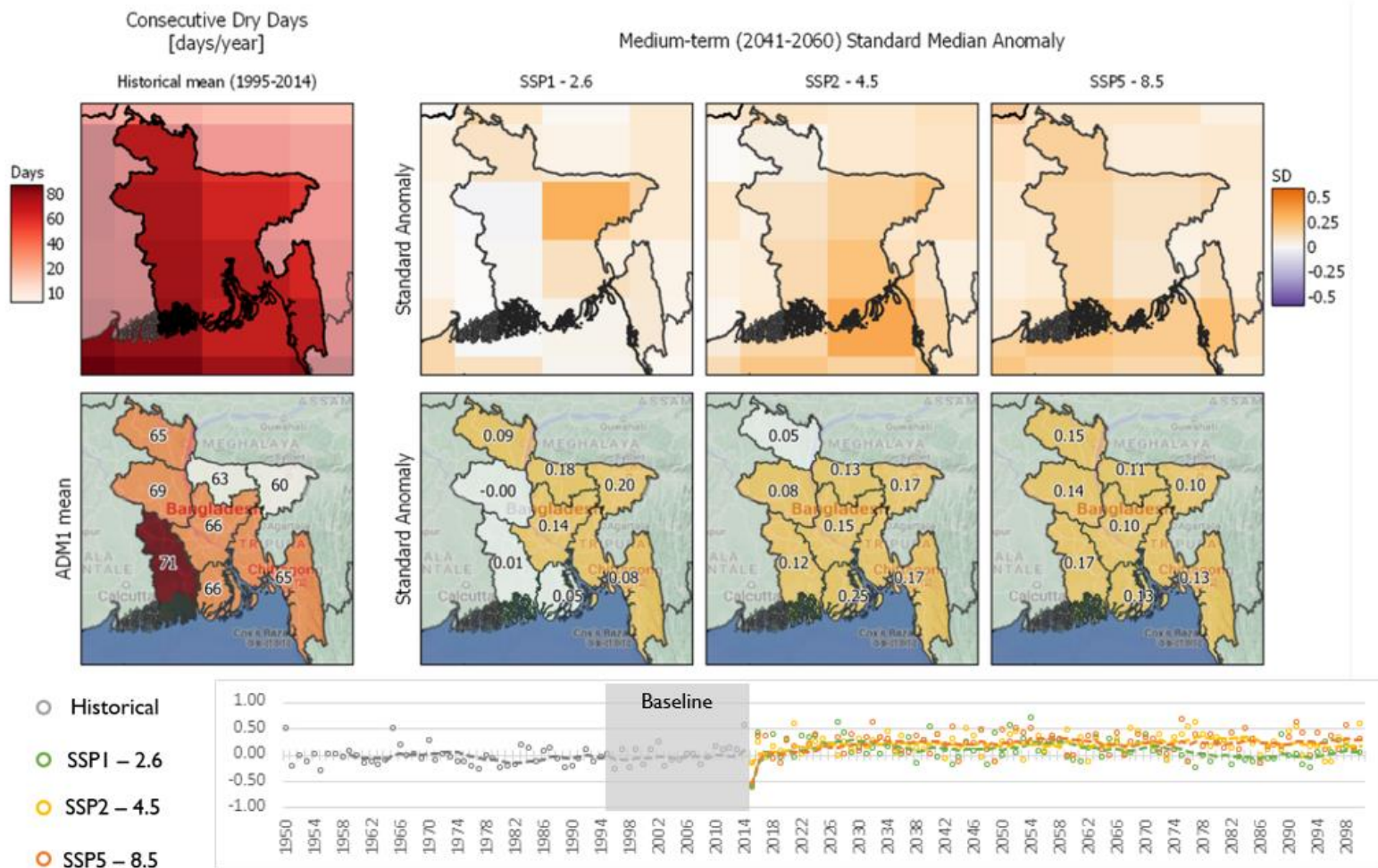


Climate indices – Sea level rise & coastal floods



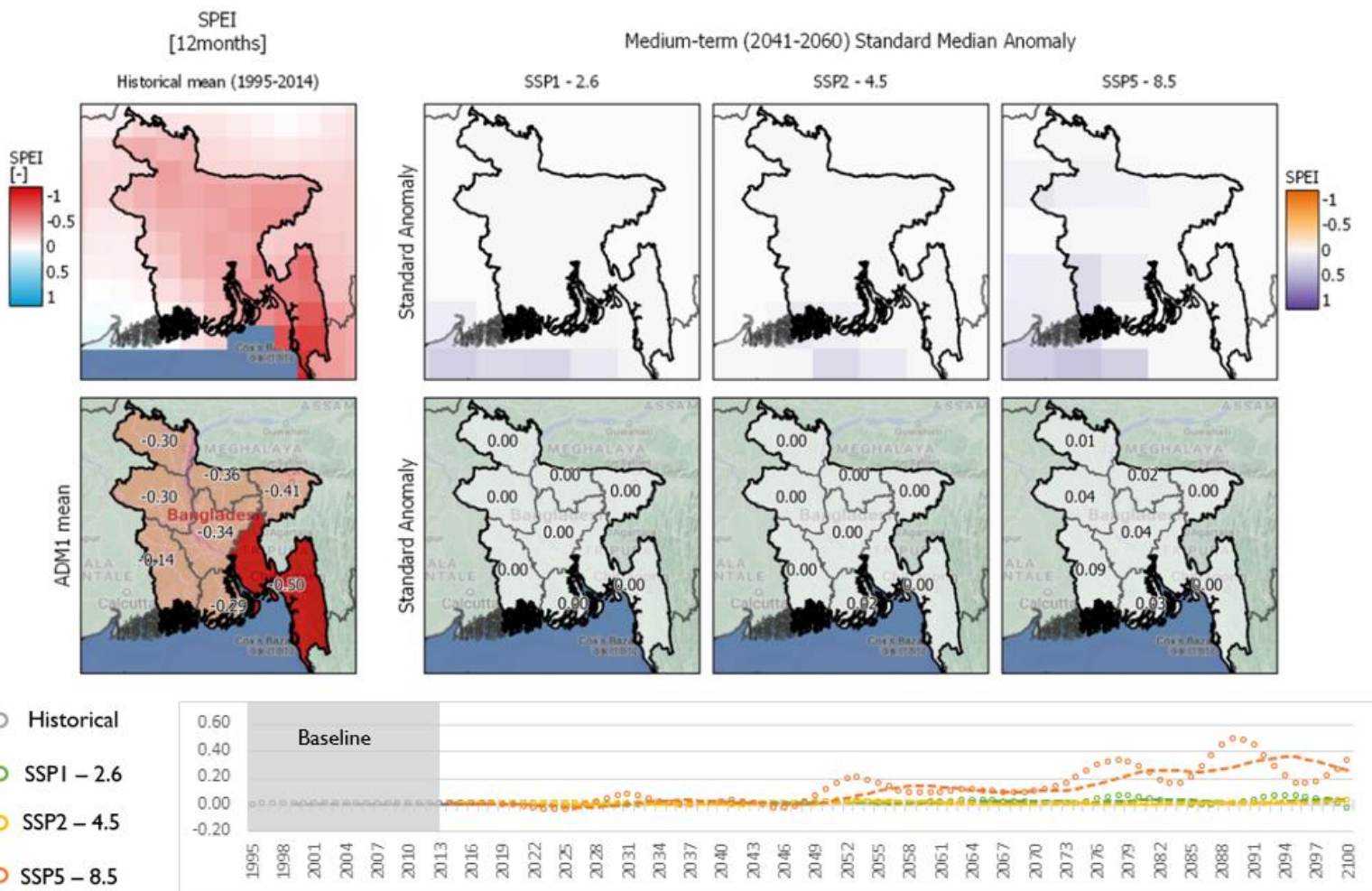
Climate indices - Drought & Water scarcity

➤ Consecutive Dry Days



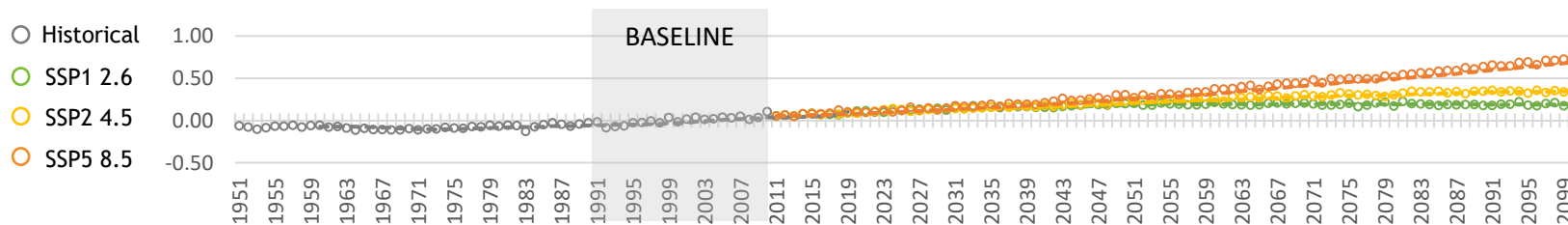
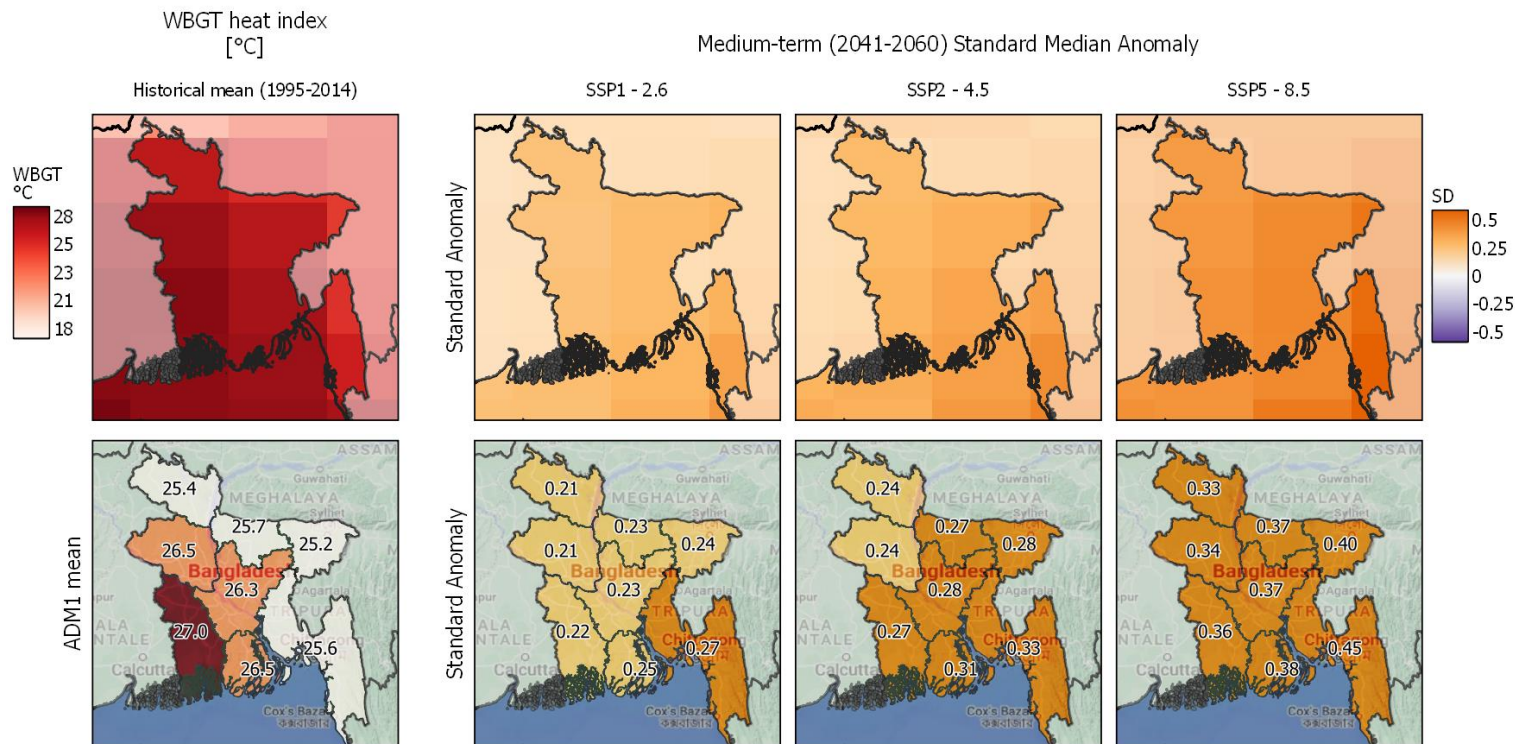
Climate indices - Drought & Water scarcity

➤ SPEI



Climate indices - Heat stress

➤ **Wet Bulb Globe Temperature (WBGT ° C)**





End

