Climate change baseline study for the Bangladesh Delta Plan: methodology and initial findings

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Presentation overview

1. Bangladesh Delta Plan – Vision based planning
2. Current climate
3. Climate change (temperature, precipitation, SLR, cyclones)
4. Future climate change future
5. Interactive map
6. Next steps / knowledge agenda
1. BDP: Vision based planning

Instead of current planning in 5 year cycles:

1. Create a longer term vision for e.g. 100 years (1).
2. ‘Translate’ it back to the present (2).
3. Integrate it in regular (short and medium term) planning (3).

Key elements Bangladesh Delta Plan

- Institutional setting
- Scenarios
- Delta issues
- Delta Plan Vision Indicating: Delta priorities Delta challenges
- Broad stakeholder involvement
- Link with policy and implementation cycles
- Solid financial underpinning

Source: Choudhury et al, 2012
2. Current climate

Current climate in Bangladesh

Temperature: Maximum - peak in April (33.5°C) secondary peak in Sep (31.6°C) Minimum - in January (12.5°C).

Rainfall: Annual 2425 mm; high variation - standard deviation 286 mm.

Distribution of the rainfall (% of annual)
- Monsoon: 1750 mm (72%)
- Pre-monsoon (17%)
- Post-monsoon (9%)
- Winter, relatively dry (1.5%)
3. Climate change: Temperature

### Annual Trend of Minimum Temperature

- Formula: $y = 0.014x - 7.249$
- $R^2 = 0.177$

### Annual Trend of Mean Temperature

- Formula: $y = 0.0103x + 4.9261$
- $R^2 = 0.3582$

### Annual Trend of Maximum Temperature

- Formula: $y = 0.008x + 14.47$
- $R^2 = 0.524$

### Seasonal Trend of Temperature

<table>
<thead>
<tr>
<th>Season</th>
<th>Trend (°C/year)</th>
<th>p</th>
<th>Trend (°C/year)</th>
<th>p</th>
<th>Trend (°C/year)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tmin</td>
<td></td>
<td>Tmax</td>
<td></td>
<td>Tmean</td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>0.014</td>
<td>&lt;0.001</td>
<td>0.008</td>
<td>&lt;0.001</td>
<td>0.010</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Winter</td>
<td>0.021</td>
<td>&lt;0.001</td>
<td>0.000</td>
<td>n.s.</td>
<td>0.013</td>
<td>&lt;0.002</td>
</tr>
<tr>
<td>Pre-monsoon</td>
<td>0.014</td>
<td>&lt;0.002</td>
<td>-0.004</td>
<td>n.s.</td>
<td>-0.001</td>
<td>n.s.</td>
</tr>
<tr>
<td>Monsoon</td>
<td>0.008</td>
<td>&lt;0.001</td>
<td>0.015</td>
<td>&lt;0.001</td>
<td>0.011</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Post-monsoon</td>
<td>0.016</td>
<td>&lt;0.001</td>
<td>0.024</td>
<td>0.528</td>
<td>0.016</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
3. Climate change: Precipitation (Country average)

<table>
<thead>
<tr>
<th>Season</th>
<th>Trend value (mm/year)</th>
<th>% of Seasonal rainfall in 50 year</th>
<th>Probability p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>0.181</td>
<td>25</td>
<td>n.s.</td>
</tr>
<tr>
<td>Pre-monsoon</td>
<td>1.719</td>
<td>20.5</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Monsoon</td>
<td>3.082</td>
<td>8.5</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Post-monsoon</td>
<td>0.279</td>
<td>3.4</td>
<td>n.s.</td>
</tr>
<tr>
<td>Annual</td>
<td>5.207</td>
<td>10.7</td>
<td>&lt;0.02</td>
</tr>
</tbody>
</table>

Note: In Brammer, 2014, Kolkata annual rainfall 1829-2012 – shows upward trend for last 50 years, which could be part of cycle (1830-1870 also showing upward trend)
### 3. Climate Change: Observed RSLR

(1978-1998) based on tidal data

<table>
<thead>
<tr>
<th>Stations</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Sea Level Rise (mm/year)</th>
<th>IPCC (AR5) observed 1981-2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Sundarban Coast (Hazra, 2002)</td>
<td>-</td>
<td>-</td>
<td>3.24</td>
<td>2.0 mm/year</td>
</tr>
<tr>
<td>Hiron Point</td>
<td>21°48’ N</td>
<td>89°28’E</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Char Changa</td>
<td>22°08’ N</td>
<td>91°06’E</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Cox’s Bazar</td>
<td>21°26’ N</td>
<td>91°59’E</td>
<td>7.8</td>
<td></td>
</tr>
<tr>
<td>CEGIS (2011)</td>
<td></td>
<td></td>
<td>1991-2010</td>
<td></td>
</tr>
<tr>
<td>Sandwip</td>
<td></td>
<td></td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>Moheshkhali</td>
<td></td>
<td></td>
<td>7.5</td>
<td></td>
</tr>
</tbody>
</table>

RSLR = Relative Sea Level Rise (including subsidence)
3. Climate change: Tropical Cyclones

**All tropical Cyclones**

- Equation: $y = 0.017x + 5.218$
- $R^2 = 0.1280$

**Cyclonic Storms**

- Equation: $y = -0.024x + 3.746$
- $R^2 = 0.199$

**Severe Cyclonic Storms**

- Equation: $y = 0.007x - 1.437$
- $R^2 = 0.038$

- $V_{max} = 62 - 118$ km/hour

- $V_{max} > 152$ km/hour

- 5 year moving average

- Equation: $y = 0.0162x + 0.4789$
- $R^2 = 0.1280$
4. Future climate change

IPCC Climate Model results for south Asia using 5 GCMS

GCMs used: 
MPI-ESM-LR
IPSL-CM5A-LR
HADGEM2-ES
ECEARTH
CNRM-CM5

- Interpolated to 0.5x0.5 deg lat/lon for Bangladesh
  - Future scenarios of temperature
  - Future scenarios of rainfall
  - Runoff scenarios
  - Future Sea Level Rise (IPCC)
  - Future Tropical cyclone frequency and intensity
  - Meteorological indicator analysis

Meteorological indicators

1. Average maximum temperature (Tmax)
2. Average minimum temperature (Tmin)
3. Difference Tmax-Tmin
4. Heatwaves (>5 days above normal)
5. Number of days Tmax above threshold
6. Average precipitation
7. Duration and length of dry spells
8. Duration and length of wet spells
9. Average rain intensity
10. Average highest one day prec. amount
11. Average highest 5 day prec. amount
12. Number of wet days
4. Future climate change: Some results

Average change in the rainfall (mm) at the end of the century (2070-2099 compared to 1970-1999) for rcp4.5 and rcp8.5.

Changes in the average length of the largest period of consecutive dry days (cdd) at the end of the century (2070-2099 compared to 1970-1999) for respectively the rcp4.5 and the rcp8.5 scenario. A cdd period is counted when more than 5 consecutive dry days occur.
5. Interactive climate map

Bangladesh Delta Plan – baseline study climate change in collaboration with Climate Atlas Service (Touch table team)

http://www.climateadaptationservices.com/nl/interactieve-klimaatatlas-bangladesh

Visualising the data – for discussion, verification, planning

6. Conclusion: future steps and knowledge agenda

- **We need to collect facts**: Provide daily data and meteorological indicators – more meteorological stations especially in rural area.
- **We need to use facts**: Provide climate change information for adaptation – We’ll make factsheets. Need for further research and ‘translation’ of research.
- Climate change trends are a combination of global warming and local changes (e.g. land use).
- Quantification of climate change impacts for indicators, sectors or issues relevant for the Bangladesh Delta Plan.
- Quantitative values on climate aspects of delta scenarios – Determine future water demand in agriculture under climate change (modelling).
- **We need to work on deepening our understanding (parallel)**: Dynamic downscaling of GCM results for GBM region and Bangladesh territory.
- Thank you -

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