Climate Change Impact Assessment on Indian Water Resources

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Objectives of the Study

• To quantify the impact of the climate change on the water resources of the country
• Identify Hotspots
• Identify Adaptation & Coping strategies
Data Used for Modeling

- DEM: 1km grid, generated using contours from 1:250000 topographic data
- Land use: 1:2M USGS
- Soil: 1:5M FAO
- Weather: Data generated by the “Hadley Centre for Climate Prediction” U.K. at a resolution of $0.44^\circ \times 0.44^\circ$ latitude by longitude (HadRM2) from IITM, Pune
River Basins Modeled
Assumptions

- The land use has been assumed to remain same
- Water bodies including reservoirs could not be incorporated at this stage due to lack of data - capacities and the operation rules
Drought Prone Basin-Krishna River Basin
Annual water balance components

Krishna

Control Scenario

GHG Scenario
Monthly water balance components for Krishna river basin
Change in Monthly water balance components for Krishna river basin

Change in monthly water balance for Control and GHG climate

- Precipitation
- ET
- Water Yield
Sub-basin Water Balance components for Krishna Basin

Current Scenario

GHG Scenario
Change in Sub-basin Water Balance components for Krishna

Change in Water Balance Components

% Change in Water Balance Components

Subbasin

Subbasin
Current to GHG - Krishna Sub-basins

- Reduction in precipitation by about 20% of the current value
- Corresponding decrease in water yield over the sub-basins is varying between 30% to 50%
- Actual evapotranspiration reduced by about 5% over most of the sub-basins
Vulnerability Assessment Procedure

• Palmer Drought Severity Index (PDSI) widely used index
  – incorporates information on rainfall, land-use, and soil properties in a lumped manner

• PDSI value
  – below 0.0 indicates the beginning of drought situation
  – A value below -3.0 as sever drought condition

• Soil Moisture Index to monitor drought severity
  – Narasiman, B., and Srinivasan, R., 2002
Number of drought weeks in Sub-basins of Krishna for Current to GHG scenarios
Krishna Sub-basins with maximum Monsoon & Non monsoon events
Krishna River - Flow Duration Curve

<table>
<thead>
<tr>
<th>% of time Q equal or exceeded</th>
<th>Flow (Cumecs)</th>
<th>Present</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>90%</td>
<td>664.8</td>
<td>4261</td>
<td></td>
</tr>
<tr>
<td>75%</td>
<td>25%</td>
<td>4867</td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td>1046</td>
<td>1046</td>
<td></td>
</tr>
<tr>
<td>25%</td>
<td>0.5784</td>
<td>0.2969</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>0.05251</td>
<td>0.03422</td>
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</table>
## Flood Prone Basin - Mahanadi River Basin

### Annual water balance components

<table>
<thead>
<tr>
<th>Year</th>
<th>Value (mm)</th>
<th>Precipitation</th>
<th>ET</th>
<th>Water Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>1200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>1300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>1500</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Control Scenario**

**GHG Scenario**
Monthly water balance components for Mahanadi river basin

![Graph showing water balance components for Mahanadi river basin under Control and GHG scenarios.](image-url)
Change in Monthly water balance components for Mahanadi river basin

Change in monthly water balance for Control and GHG climate scenarios

Change (%) in monthly water balance for Control and GHG climate scenarios
Sub-basin Water Balance components for Mahanadi River Basin

- An increase in precipitation, water yield and evapotranspiration has been predicted in all the sub-basins of Mahanadi.
Flood Analysis - Mahanadi Basin

**Current Scenario**
Subbasin 15

**GHG Scenario**
Subbasin 15

**Control Scenario**
Subbasin 21
Events exceeding arbitrary thresholds in Mahanadi River Basin

<table>
<thead>
<tr>
<th>Discharge (cumecs)</th>
<th>Control</th>
<th>GHG</th>
<th>Control</th>
<th>GHG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahanadi Subbasins</td>
<td>Sub15</td>
<td>Sub15</td>
<td>Sub21</td>
<td>Sub21</td>
</tr>
<tr>
<td>Discharge&gt;20000</td>
<td>2</td>
<td>4</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Discharge&gt;30000</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>
Flow Duration Curve for Mahanadi River for Control and GHG scenarios

The flow for all the dependable levels has increased for the GHG scenario over the corresponding Current flow magnitude.

For the 50% level of dependability, the flow has marginally reduced.

<table>
<thead>
<tr>
<th>Dependable Flow (cumecs)</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRESENT</td>
<td>4716</td>
<td>1206</td>
<td>15.9</td>
<td>1.468</td>
</tr>
<tr>
<td>FUTURE</td>
<td>6103</td>
<td>1168</td>
<td>43.39</td>
<td>3.182</td>
</tr>
</tbody>
</table>
Annual mean water balance for Control and GHG climate scenarios in different river basins

Trends in Waterbalance Components (Control and GHG Climate Scenarios)
Percent change in mean annual water balance for Control and GHG climate scenarios
Conclusions

• The study is the first step towards getting the realistic estimates of the possible climate change impacts across the country

• It has provided a framework to be used for integrated river basin planning and management which was missing so far

• There is lot of improvement that is desirable and is under process