Adaptation mechanisms for extreme events in the Capibaribe River Basin

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INTRODUCTION

Increase in the frequency and magnitude of extreme events

Human, economic and ecological impacts

The necessity to investigate these events, the risk, and the possible adaptation strategies
The evaluation of areas exposed to different events contributes to identify the level of relationship between technology, community, and extreme phenomena.
OBJECTIVES

- To characterize the climate spatial variability and the mechanisms used to deal with extreme events in the Capibaribe River Basin (CRB) – Brazil.

- To contribute with discussions around strategies of adaptation and their availability in the region.
STUDY AREA

- Drainage area: approx. 7454 km²
- 3 different geographic areas
- Historical and touristic importance
- Significant Socioeconomic influence
- Specific policies required
STUDY AREA

- Shallow soils
- Caatinga vegetation (thornscrub, cactus, and bunch grasses)
- Semiarid Climate
  - 550 mm yr\(^{-1}\)
  - Average air temperatures 20 – 22°C

- Deeper soils
- Atlantic Forest vegetation
- Humid/Sub-humid climate
  - 2400 mm yr\(^{-1}\)
  - Average air temperatures 25 – 26°C
<table>
<thead>
<tr>
<th>Century</th>
<th>Drought events (years with records)</th>
<th>Flood events (years with records)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17th</td>
<td>1603-1606; 1614-1615; 1652; 1692</td>
<td>1632; 1638</td>
</tr>
<tr>
<td>18th</td>
<td>1709-1711; 1720-1724; 1736-1737; 1744-1746; 1748; 1754; 1760; 1772; 1776-1777; 1782; 1784; 1790-1794</td>
<td>No records</td>
</tr>
<tr>
<td>19th</td>
<td>1804; 1808-1810; 1816-1817; 1824-1825; 1830-1833; 1844-1845; 1888-1889; 1891; 1898</td>
<td>1824; 1842; 1854; 1862; 1869; 1870; 1884; 1894; 1899</td>
</tr>
</tbody>
</table>

ADOPTED INFRASTRUCTURE AND NON-STRUCTURAL POLICIES

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Drainage Area (km²)</th>
<th>Total volume (x10⁶ m³)</th>
<th>Useful volume (x10⁶ m³)</th>
<th>Average inflow (m³/s)</th>
<th>Inauguration</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tapacurá</td>
<td>360</td>
<td>98.7</td>
<td>98.7</td>
<td>2.25</td>
<td>1973</td>
<td>Flood control and supply</td>
</tr>
<tr>
<td>Goitá</td>
<td>450</td>
<td>52.0</td>
<td>15.6</td>
<td>2.00</td>
<td>1976</td>
<td>Flood control and supply</td>
</tr>
<tr>
<td>Carpina</td>
<td>5999</td>
<td>270.0</td>
<td>81.0</td>
<td>6.92</td>
<td>1978</td>
<td>Flood control, supply and fishery</td>
</tr>
<tr>
<td>Poço Fundo</td>
<td>854</td>
<td>27.75</td>
<td>27.75</td>
<td>1.47</td>
<td>1986</td>
<td>Supply and irrigation</td>
</tr>
<tr>
<td>Jucazinho</td>
<td>4171</td>
<td>327.0</td>
<td>227.0</td>
<td>6.34</td>
<td>1999</td>
<td>Supply and pisciculture</td>
</tr>
</tbody>
</table>

![Map of reservoirs and drainage areas](image)
ADOPTED INFRASTRUCTURE AND NON-STRUCTURAL POLICIES

- Construction of dams
ADOPTED INFRASTRUCTURE AND NON-STRUCTURAL POLICIES

- **Management of dams**
  
  Total volume: 270 million m$^3$
  
  Volume (wet season): 50 million m$^3$
  
  Opening dam floodgates: 100 million m$^3$

  Total volume: 327 million m$^3$
  
  Volume (wet season): 40 million m$^3$
ADOPTED INFRASTRUCTURE AND NON-STRUCTURAL POLICIES

Governmental Programs developed to deal with natural and social hazards that enhance population resilience:

- "Bolsa Família"
  Income distribution to poor and extremely poor families
  More than 13.9 million recipient families so far in Brazil

- "Garantia-Safra"
  Support to rural households in municipalities that are susceptible to suffer loss of crops due to shortage or excess of water
  From 2010 to 2014 this program registered more than 3.6 million farmers

- "Chapéu de Palha"
  A Program of the Pernambuco State Government
  Support to unemployed rural workers due to offseason dynamics or natural disasters
  Attending 54 municipalities in the state
ADOPTED INFRASTRUCTURE AND NON-STRUCTURAL POLICIES

- **Water trucks**
  - Advantages: Fast response
  - Disadvantages: Temporary solution

- **Small reservoirs**
  - Advantages: Irrigation, human supply and fish-farming
  - Disadvantages: High evaporation rates, indiscriminate dissemination

- **Rural cisterns**
  - Capacity: 7-15 m³
  - Availability: 50 L of water per day during 140 – 300 days
ADOPTED INFRASTRUCTURE AND NON-STRUCTURAL POLICIES

- **Groundwater**
  
  Advantages: Human and animal water supply, protection from high evaporation rates
  
  Disadvantages: Deficiencies in the management and the lack of public incentives
  
  Availability: 50 L of water per day during 140 – 300 days

- **Underground dams**
  
  Advantages: Promotion of infiltration and storage of rainwater in alluvial deposits, protection from evaporation and salinization, low cost.
  
  Availability: Estimated 2,240 units throughout the northeastern semiarid.
EXAMPLES IN OTHER COUNTRIES OF HOW TO COPE WITH HYDROLOGICAL EXTREMES

- Use of different cropping techniques and types of crops for each season (Zimbabwe)
- Construction of dams (China)
- Rainwater Harvesting and Managed Aquifer Recharge (Thailand)
- Early warning systems
- Monitoring techniques
- Development of conservancy projects
- Forecast modeling
DISCUSSION

- The level of climate variability in the study area is coherent with other regions worldwide, especially places that face both flood and drought events.

- Vulnerability is not only related to natural aspects, but it is also part of political, economic and social processes.

- The CRB is not an exception; the solutions observed in the region resemble others displayed by the literature, especially in agricultural based communities.

- Aside from all the alternative adaptation strategies, reservoirs play an important role, being the largest most popular structures used to face both drought and flood events.
FINAL REMARKS

- The reservoirs are the main option chosen to face drought and flood events in CRB.

- For small communities in the rural zone alternative techniques are more suitable, such as cisterns, groundwater, and underground dams.

- The assistance programs originally created for income transfer for poor families can currently also be considered as an adaptation measure in Northeast semiarid.

- The idea is that technologies applied to cope with hardening climate conditions can corroborate to an effective risk management and sustainable development, in short and long terms.
ACKNOWLEDGEMENTS

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