Hydropower and Water Management Practices and Challenges

NSF - PIRE Kickoff Conference

Bahir Dar
11 July 2016

Paul Block
University of Wisconsin - Madison
Ethiopia - Disaster Statistics

Data related to human and economic losses from disasters that have occurred between 1980 and 2010.

Natural Disasters from 1980 - 2010

Overview

- No of events: 86
- No of people killed: 313,486
- Average killed per year: 10,112
- No of people affected: 57,382,354
- Average affected per year: 1,851,044
- Economic Damage (US$ X 1,000): 31,700
- Economic Damage per year (US$ X 1,000): 1,023

Top 10 Natural Disasters Reported

<table>
<thead>
<tr>
<th>Disaster</th>
<th>Date</th>
<th>Affected (no. of people)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought</td>
<td>2003</td>
<td>12,600,000</td>
</tr>
<tr>
<td>Drought</td>
<td>1983</td>
<td>7,750,000</td>
</tr>
<tr>
<td>Drought</td>
<td>1987</td>
<td>7,000,000</td>
</tr>
<tr>
<td>Drought</td>
<td>1989</td>
<td>6,500,000</td>
</tr>
<tr>
<td>Drought</td>
<td>2008</td>
<td>6,400,000</td>
</tr>
<tr>
<td>Drought</td>
<td>2009</td>
<td>6,200,000</td>
</tr>
<tr>
<td>Drought</td>
<td>1999</td>
<td>4,900,000</td>
</tr>
<tr>
<td>Drought</td>
<td>2005</td>
<td>2,600,000</td>
</tr>
<tr>
<td>Drought</td>
<td>1997</td>
<td>986,200</td>
</tr>
<tr>
<td>Flood</td>
<td>2006</td>
<td>361,600</td>
</tr>
</tbody>
</table>

Natural Disaster Occurrence Reported

- Drought: 10
- Epidemic: 21
- Flood: 45

Economic Damages

<table>
<thead>
<tr>
<th>Disaster</th>
<th>Date</th>
<th>Cost (US$ X 1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought</td>
<td>1998</td>
<td>15,600</td>
</tr>
<tr>
<td>Flood</td>
<td>2005</td>
<td>5,000</td>
</tr>
<tr>
<td>Flood</td>
<td>1994</td>
<td>3,500</td>
</tr>
<tr>
<td>Flood</td>
<td>2006</td>
<td>3,200</td>
</tr>
<tr>
<td>Flood</td>
<td>1999</td>
<td>2,700</td>
</tr>
<tr>
<td>Flood</td>
<td>2005</td>
<td>1,200</td>
</tr>
<tr>
<td>Flood</td>
<td>1995</td>
<td>500</td>
</tr>
<tr>
<td>Epidemic</td>
<td>1980</td>
<td>0</td>
</tr>
<tr>
<td>Epidemic</td>
<td>1981</td>
<td>0</td>
</tr>
<tr>
<td>Flood</td>
<td>1981</td>
<td>0</td>
</tr>
</tbody>
</table>

Credit: Prevention Web
Weather vs Climate

Time scales of interest:

“Weather”
- 1-10 days
- 2-3 months
- 6 months – 1 year
- Decades

Atmosphere-Land conditions

“Climate Variability”
- Several decades

Ocean-atmosphere-land conditions; conditions vary at slower rates – leads to predictability

“Climate Change”
- Centuries

Climate change: in addition to physical processes, assumptions about human behavior

Credit: S. Someshwar
From a WRM perspective, this provides prospects for predicting and managing water system risks (design, operation, allocation...)

Credit: L. Goddard, IRI
Climate Prediction for WRM

Goal
• Prepare not React
• Reduce risks
• Exploit opportunities

Why is implementation lacking?

Need Better Risk Management Practice
Seasonal Climate Variability

Ethiopia: Rainfall, GDP and Agric. GDP

- Rainfall variation around the mean
- GDP growth
- Ag GDP growth

Source: World Bank 2005
Climate Factors: ENSO

Correlation of Nino3.4 and *Kiremt* Precipitation (CHIRPS); 1981-2015
Climate Forecast Products

Advanced information that can systematically be used in decision-making
Climate Forecast Products

NMA – 2015 *Kiremt* Prediction; categorical. Shift toward drought
Cluster Analysis

Homogeneous Precipitation Regions (Zhang, Moges, Block)
Four large-scale dams proposed (one started)
Could a seasonal forecast improve benefits?
Does the prediction technique have any influence?
Does increased prediction skill translate to greater benefits?
Cross-validated forecast ensembles

Linked Model System
Hydropower Benefits

Median = marginal improvement; reduction in probability of low decades
Forecast Value, Reliability, Threshold

Trade-off between reliability and benefits
Water Management

Water

Climate

Agriculture

Energy

Health

Human Activity
The Challenge

How can we better inform seasonal decision-making for agriculture and water resources / hydropower management?

• Technology development
• Social – Human understanding
• Institutional cooperation
• Year-to-year variability in supply; changing demands
• Extremes

National or Local Issue?
Focus on Today (security) or the Future (sustainability and resilience)?
World’s Water