Climate Change

- Climate change presents an urgent challenge to the well-being of all countries...
- ....and particularly to the poorest countries and the poorest people (especially women and children) in vulnerable regions.
- Addressing climate change is central to the development and poverty reduction agenda.
- Tackling climate change is feasible...
- …but who bears how much of the costs remains the key issue [UNFCCC estimates $100b for mitigation + ~$40b for adaptation in addition to ODA]
Projected Change in Frequency of Extreme Events in next 20 years


Myanmar: May, 2008
Cyclone Tracks 2006-07 Season

Courtesy: Dartmouth Flood Observatory
Adaptation to Climate Variability & Change

Zambezi Floods, Jan-Feb, 2007

Mozambique:
Impact of 2000 floods on the economy

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Projection</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Real GDP (ann. Growth rate)</td>
<td>12.0</td>
<td>9.0</td>
<td>7.0</td>
<td>7.2</td>
</tr>
<tr>
<td>Inflation (ann. average, %)</td>
<td>0.6</td>
<td>2.0</td>
<td>6.6</td>
<td>5.0</td>
</tr>
<tr>
<td>External current account:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before grants</td>
<td>-20.5</td>
<td>-31.7</td>
<td>-23.0</td>
<td>-15.7</td>
</tr>
<tr>
<td>After grants</td>
<td>-12.4</td>
<td>-21.5</td>
<td>-16.3</td>
<td>-9.1</td>
</tr>
<tr>
<td>Fiscal Balance:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before grants</td>
<td>-10.7</td>
<td>-12.1</td>
<td>-12.1</td>
<td>-10.7</td>
</tr>
<tr>
<td>After grants</td>
<td>-2.4</td>
<td>-1.2</td>
<td>-5.2</td>
<td>-4.4</td>
</tr>
<tr>
<td>Memorandum:</td>
<td>GDP (Mt billion)</td>
<td>46,134</td>
<td>52,913</td>
<td>60,177</td>
</tr>
</tbody>
</table>

Source: Staff estimates, IMF and Government of Mozambique
Many of the major “food-bowls” of the world are projected to become significantly drier.
Globally there will be more precipitation.
Higher temperatures will tend to reduce run off.
A few important areas drier (Mediterranean, southern South America, northern Brazil, west and south Africa).

Climate – Landsurface – Water Cycle (1)

\[ Q \text{ (river flow)} = P \text{ (rainfall)} - ET \text{ (evapotranspiration)} + \Delta SM \text{ (soil moisture)} \]
Climate – Landsurface – Water Cycle (2)

Climate and landscape structure

- Precipitation distribution
- Precip. Open Sky
- Terrain shadowing
- Vegetation Types
- Soil Types
- Soil Depth
- Basin mask
- Elevations

Water and “stuff” movement

- Basin Cell
- Ground surface
- Quickflow from Impervious Surfaces
- Subsurface Flow
- Channel Segment Flow
- Surface Flow

Bring it to life: geospatially-explicit, process-based Landscape-Hydrology Models

Large Scale
- e.g. VIC (Variable Infiltration Capacity) Meso/Macroscale Landscape/Hydrologic Model. (moderate to large-scale resolution)

Small-Scale
- e.g., DHSVM (Distributed Hydrology Soil Vegetation Model) Micro/Mesoscale Landscape/Hydrologic Model (high to moderate resolution)
System/Terrain Analysis method

Wetness index:

\[ \omega = \ln\left(\frac{A_s}{\tan\beta}\right) \]

Sediment transport index:

\[ \tau = \left(\frac{A_s}{22}\right)^{0.6} \left(\frac{\sin\beta}{0.09}\right)^{1.3} \]

\( A_s = \) contributing area
\( \beta = \) slope

Moore et al. 1991, 1992

Example map of contributing area

Water Use – Plantation Forests v Grasslands

(Source: Zhang et al., 2001)
User-Friendly Decision Support Systems

Effects of landuse change on the hydrologic regime of The Mae Chaem river basin, NW Thailand

Thanapakpawin et al (in press) J. of Hydrology*

4000 km²/Sparse Data

*NSF, BNPP Functional Value of Biodiversity
### Landcover Scenarios

<table>
<thead>
<tr>
<th>Landcover Scenarios</th>
<th>Annual yield, mm (m³/s)</th>
<th>High flow, m³/s</th>
<th>Low flow, m³/s</th>
<th>Annual evapotranspiration, mm</th>
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</thead>
<tbody>
<tr>
<td>Veg 2000</td>
<td>I 215 (26.2)</td>
<td>54.7</td>
<td>7.6</td>
<td>762</td>
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<tr>
<td></td>
<td>NI 249 (30.5)</td>
<td>58.6</td>
<td>12.0</td>
<td>727</td>
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<tr>
<td>Scenario I</td>
<td>NI 223 (27.2)</td>
<td>53.3</td>
<td>11.1</td>
<td>752</td>
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<td>Scenario II</td>
<td>I 202 (24.7)</td>
<td>53.6</td>
<td>5.8</td>
<td>781</td>
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<tr>
<td></td>
<td>NI 261 (31.8)</td>
<td>61.2</td>
<td>12.5</td>
<td>715</td>
</tr>
<tr>
<td>Scenario III</td>
<td>I 220 (25.6)</td>
<td>56.8</td>
<td>7.0</td>
<td>759</td>
</tr>
<tr>
<td></td>
<td>NI 269 (32.8)</td>
<td>63.1</td>
<td>12.7</td>
<td>707</td>
</tr>
<tr>
<td>Scenario IV</td>
<td>I 193 (23.6)</td>
<td>51.6</td>
<td>5.6</td>
<td>786</td>
</tr>
<tr>
<td></td>
<td>NI 251 (30.7)</td>
<td>59.1</td>
<td>12.2</td>
<td>724</td>
</tr>
</tbody>
</table>
Pro-Poor Instruments

- Integrated Land & Water Management (Soil carbon, avoided deforestation, Rehabilitation of degraded lands)
- Capacity strengthening (regional, national, local)
- Methodologies and transaction costs
  - New science and new technologies
  - Improved temporal and spatial resolution
  - Better handle on assessing tradeoffs
  - Empowering communities with knowledge and access to technologies (early warning, decision support, relocation, infrastructure…)
Analyses & Actions

• Optimal spatial scales for conducting analysis of spatially variable economic and bio-physical processes.
• Clean Energy Investment Framework (CEIF)
• Economics of Adaptation
• Strategic Framework on Climate Change (SFCC)
NEXT STEPS IN WBG Investments

Empowering local institutions and communities with geospatial and time referenced tools and incentives for:
- Conserving, better understanding, and using traditional and cultural knowledge
- Improved NRM approaches
- Adaptation to Climate Change
- Preparation for climate variability and extreme events
- Objective monitoring of progress based on quantitative indicators, and
- Better and more resilient livelihoods.

Towards a Strategic Framework on Climate Change (SFCC)

Climate change “is a development, economic, and investment challenge. It offers an opportunity for economic and social transformation that can lead to an inclusive and sustainable globalization. That is why addressing climate change is a critical pillar of the development agenda.”


www.worldbank.org/climateconsult