Managing Water at the Urban-Rural Interface: The key to climate change resilient cities

Urban water balance modeling in VENSIM and findings from the PhD research

Daniel Van Rooijen (IWMI)

5th August 2010, ILRI Campus, Addis Ababa
Contents

• Project objectives for research working package
• Addis Ababa urban water system
• Impacts climate change on urban water balance
• Scenarios in relation to the working of the model
• Model properties and preliminary outputs
• PhD findings
• Data needs for model refinement
• Planning of WP2 activities
Objectives

• To generate needed knowledge and deeper understanding of urban water system and vulnerability
• To process demographic and water supply and demand scenarios
• To rationalize the discussion on climate change risks
• To provide decision support
Addis Ababa Urban Water System.
What water are we talking about?

Water supply
- river
- groundwater
- reservoir
- rainfall

Urban use
- water distribution
- sanitation
- wastewater treatment

Wastewater disposal
- receiving water bodies
- use in irrigated agriculture

Locations:
- Akosombo
- Weija
- Drain
- Communal shower
- Wastewater Disposal
- Urban agriculture
Water Supply to Addis
Urban water demand vs supply

Water Demand
- High scenario
- Medium scenario
- Low scenario

Urban water demand and supply (10^6 m^3 yr^-1)

Impacts Climate Change on Urban Water Balance

Addis urban catchment

Addis urban water balance
Fraction urban water use of run-off generated in the basin

<table>
<thead>
<tr>
<th>Basin</th>
<th>Annual basin run-off $10^6\text{m}^3\text{yr}^{-1}$</th>
<th>Urban use $10^6\text{m}^3\text{yr}^{-1}$</th>
<th>% of Run-off</th>
<th>Irrigation potential ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awash</td>
<td>4,900</td>
<td>90</td>
<td>1.84</td>
<td>134,121</td>
</tr>
<tr>
<td>Abbay</td>
<td>54,800</td>
<td>250 (planned)</td>
<td>0.46</td>
<td>815,581</td>
</tr>
</tbody>
</table>
CC impact scenarios in relation to the working of the model

**CC Scenario: Rainfall events becoming more intense and frequent (city level)**

**Impact:** More severe and frequent flooding in urban areas. Increased health risk due to mixing with untreated domestic wastewater.

**Modeling results that can help develop adaptation strategies:**

- Improving drainage system will reduce flood volume by \(X\%\) (government)
- \(X\%\) potential flood reduction through rooftop water harvesting (households)
- \(X\%\) storm water reduction by increasing fraction green areas in the city, to improving infiltration (government)
**CC Scenario:** Dry periods becoming more severe (drier) and recurring more often (catchment level)

**Impact:** Low water availability for all water use sectors. Reduced urban water supply.

**Modeling results that can help developing adaptation strategies:**

- Potentially X% of rainwater saved through rooftop rainwater harvesting (household)
- Shift X% of water use to more reliance on groundwater (city)
- Reduce physical losses by X% (utility)
Model properties

- System Dynamics
- No feedback loops applied – this is ‘one flow through’
- Time series data input (ET, Rainfall, water supply etc)
- Outputs as xls format or VENSIM graphs
Outputs for the project

- Urban Water Database
- Scenarios
- Impact assessment (through modeling)
- Urban Water model (part of decision support)

Preliminary model outputs for:
- City level wastewater generation
- Stormwater runoff
PhD findings 1/2

City:
• Urban water stress: low per capita use and supply driven water supply
• City authorities constrained in their daily and structural operations: constrained financial and institutional capacities

Upstream:
• Source expansion of water supply: inter-basin transfer from Abay Basin, groundwater
• Siltation of reservoirs, threat to water availability
• Catchment development: agricultural and domestic water demands
PhD findings 2/2

Downstream of city:

• Re-use in irrigated agriculture - vegetables
• Pollution of Great and Little Akaki River with industrial effluent and domestic wastewater
• Health concerns for humans and environment
Data needs for model refinement

- Informal water use (from groundwater)
- Urban expansion (historic and projected)
- Land use maps for Addis and Oromia region (built-up vs green and water)
- Historical development of sanitation facilities (breakdown by type of facility)
- Plans for urban water supply expansion
Planning of WP2 Activities

- **Inventory of available climatic and hydrologic models (properties and usefulness)** *(completed)*
- **Define main scenario types** *(ongoing)*
- **Data collection: climatic data generated from downscaled climate scenario results**
- **Data collection: demographic data and urban water system** *(ongoing)*
- **VENSIM model set-up** *(ongoing)*
- **Data analysis and modelling of scenarios** *(planned)*
- **Generating and incorporating input and feedback from platform** *(planned)*
- **Finalize scenarios and modelling in collaboration with stakeholders** *(planned)*
Thank you!