IMPACT OF LAND USE/COVER CHANGES ON STREAMFLOW:
THE CASE OF HARE RIVER WATERSHED, ETHIOPIA

Kassa Tadele and Gerd Foerch
University of Siegen

July 06, 2007
Presentation outline

1. Introduction
   - Study area
   - Objective

2. Methodology
   - Model setup
   - Existing watershed practices

3. Results
   - Land use dynamics
   - Model evaluation
   - Seasonal Streamflow variability
   - Downstream impacts

4. Conclusions
1. Introduction

1.1 Study area

Abaya-Chamo Basin

Hare Watershed

Major River basins in Ethiopia
1.2 Objectives of the study

- Examine the extent of past and present land use/cover dynamics and analyse their implications on streamflow at a watershed and sub-watershed levels.

- Analyse the seasonal streamflow variability and understand the upstream-downstream linkages with respect to irrigation water use.
2. Methodology

2.1) Model setup

I) DEM and stream network

- A DEM was derived from digital contour lines
- A stream network was digitized from top map
- 15 sub-watersheds and 92 HRUs were created
II) Meteorological Data

- To establish elevation-rainfall relation, 15 weather stations,

- Elevation bands were developed in SWAT to account for orographic effect of PCP
III) Soil data

- Sample locations identified (random sampling)
  - Sample were taken to determine physical & chemical parameters
  - Soil polygons were developed for the point location samples
Soil sampling and analysis

Texture distribution

Introduction- Materials and Methods- Results- Conclusions
IV) Land use/cover mapping

- Spatial databases were developed using aerial photographs (1967 & 1975), satellite image (2004) and intensive on field land use mapping (2005)

- Hybrid of automated classification (supervised classification based on maximum livelihood approach) and visual interpretation (based on tone, texture, proximity) was adopted

- post-classification comparison method
V) Streamflow data

- Observed daily streamflow (1980 – 2005) at the outlet of the watershed
2.2 Existing watershed practices
   a) Downstream practices

- 3 diversions to irrigate 2224 ha (depend on daily streamflow)
b) Upstream practices
3. Results
3.1 Land use dynamics

Legend
- Subbasins
- Land use/cover
- Farmlands and settlement
- Grazing/pasture land
- Wood/Bush land
- Forest land
- Riverine tree/Bamboo

Introduction- Materials and Methods- Results-Conclusions
Farmlands increased mostly associated with a decrease in forest cover.

Sub-watersheds adjacent to villages more affected.

Introduction- Materials and Methods- Results-Conclusions
I) Sensitivity Analysis (SA)

- 8 most crucial parameters
  - Curve number (CN), Soil Available Water Capacity (SOL_AWC), Soil depth (SOL_Z), Soil Evaporation Compensation factor (ESCO), Saturated hydraulic conductivity (SOL_K), Slope (SLOPE), Groundwater “revap” coefficient (GW_REVAP) and Groundwater recession factor (ALPHA_BF)

Introduction- Materials and Methods- Results- Conclusions
II) Calibration and validation

<table>
<thead>
<tr>
<th>Index</th>
<th>1975 land use/cover map</th>
<th>2004 land use/cover map</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Calibration (1980-85)</td>
<td>Validation (1986-91)</td>
</tr>
<tr>
<td>Coef. dete($R^2$)</td>
<td>0.63</td>
<td>0.72</td>
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<tr>
<td>N-S coeff. (E)</td>
<td>0.52</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Introduction- Materials and Methods- Results- Conclusions
3.3 Seasonal streamflow variability (1992-2004)

<table>
<thead>
<tr>
<th>sub-watersheds</th>
<th>Farmland &amp; settlement class change (%)</th>
<th>Mean monthly flow change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Wet season (Mar.-May)</td>
</tr>
<tr>
<td>11</td>
<td>+ 5.1</td>
<td>+ 7.1</td>
</tr>
<tr>
<td>13</td>
<td>+ 12.8</td>
<td>+ 8.1</td>
</tr>
<tr>
<td>4</td>
<td>+ 18.2</td>
<td>+ 11.6</td>
</tr>
<tr>
<td>2</td>
<td>+ 18.8</td>
<td>+ 13.3</td>
</tr>
<tr>
<td>15</td>
<td>+ 18.9</td>
<td>+ 11.7</td>
</tr>
<tr>
<td>Entire WS</td>
<td>+ 10.4</td>
<td>+ 12.5</td>
</tr>
</tbody>
</table>
3.4 Downstream impacts on irrigation project

- Irrigation water demand at the intakes was computed

- Water deficit & surplus periods for irrigation were determined
4. Conclusions

- Hare watershed had experienced land use/cover dynamics during the past four decades.

- Model performance assessment verified that the model simulation results are dependable and SWAT can be utilized in similar watersheds.

- Simulation results illustrated that land use/cover dynamics has had significant impacts on streamflow.

  - At present Hare River only satisfies 15.75% of downstream irrigation water demand.
Thank you for your attention