Water-Food-Energy Nexus: with the perspective of watershed management

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The presentation is based on the results from the graduate program of PhD in Integrated Water Management.

Outlines

- Blue Nile Basin-erosion
- Hydrology and landscape change
- Soil loss and Nutrient
- Landscape interventions: Successes and Challenges
- Nexus Development
• Blue Nile contributes 60% of the Nile flow and sediment

(Gani et al., 2007)
Since 2007 with international partner Cornell University
Soil’s infiltration rate has exceeded the rainfall intensity

Mechanism:
- Hortonian (Horton, 1933)
- Dunnean

Infiltration capacity, Rainfall Intensity (cm/hr)

Probability of Exceedance
Landscape is changing

- Cultivated land is increasing at the cost of forests and shrub land.

- Flow paths become shallower due to land degradation
Stream flows with time in the highland

- Low flows during dry period is decreasing
- Flows during the rainy period is increasing
  - 5% approximate surface runoff increase at Sudan border

\[ y = -0.0716x + 144.36 \]
\[ R^2 = 0.68 \]

Low flows at Gilgel Abbay (Enku et al., 2014)
Soil loss by runoff from agricultural plots

(Tilahun et al., 2015)
Soil loss from Gullies

Upstream (Inlet)

400 ton ha\(^{-1}\) year\(^{-1}\)

Down stream (Outlet)
Sediment concentration vs Dissolved phosphorus (DP)

Moges et al., (2016) at Mizewa watershed
Dissolved phosphorus (DP) at shallow wells

(Moges et al., 2016)
Landscape interventions
Success and Challenges
Water was conserved with infiltration in furrows due to interventions 2012.
Sediment load decreased with infiltration furrows.
Debra Mawi sediment concentrations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2010-2011</th>
<th>2011-2012</th>
<th>2012-2013</th>
<th>2013-2014</th>
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</thead>
<tbody>
<tr>
<td>Mean</td>
<td>21.6</td>
<td>22.6</td>
<td>14.0</td>
<td>19.9</td>
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<tr>
<td>Std. deviation</td>
<td>10.5</td>
<td>10.3</td>
<td>7.6</td>
<td>13.5</td>
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<tr>
<td>Minimum</td>
<td>0.0</td>
<td>0.2</td>
<td>0.8</td>
<td>0.1</td>
</tr>
<tr>
<td>Maximum</td>
<td>93.4</td>
<td>62.6</td>
<td>42.1</td>
<td>57.8</td>
</tr>
</tbody>
</table>
What do we need to do to reverse land degradation?

Nexus Development: balancing demands for water, food and energy
Changing gullies to feed livestock

The case of Bir watershed

(Aylele et al., 2015)
One gully selected by the community and Participatory gully rehabilitation was conducted before (2013) and after rehabilitation (2015).

Marginal Rate of Return was 10 based on the value of increased forage production and trapped soil nutrient values.
Built dams for hydropower and irrigation
CROP PRODUCTIVITY
at household level by managing water & other resources

- Fresh yield variability influenced by water lifting, water management & gender
- Large variability in vegetable production without significant increases in yield
- Oats & Vetch and Desho promising irrigated crops (annual vs. perennial)

(Source data: M. Tesema, T. Ewnetie, H. Mulugeta and D. Tegegne, 2015)
Improve household level energy use
Conclusions

• Erosion is a natural processes controlled by geology but its rate is currently increasing exponentially

• Part of the infiltrated water at hillslope will be interflow down the slope to saturate the valley bottoms—expand gullies

• Bottom lands (gullies and DP sources) are the hydrologic sensitive areas
Conclusions

“Our research has really to produce a cost effective way of producing food and alternative energy to reverse degradation in the Ethiopian highland.”