Surface water harvesting using small-scale dams in northern Ethiopia: Challenges and opportunities

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Outline of the Presentation

1. Background and Objective of the study
3. Distribution and capacity of small-scale dams constructed in Tigray, Northern Ethiopia
4. Problems/Challenges in surface water harvesting using dams
5. Advantages/opportunities of small-scale dam construction
6. Conclusion and recommendations
1. Background and Objective of the study

**Background**
The government of Ethiopia has been involved in the construction of different surface water harvesting schemes such as dams, diversion weirs, ponds, and other structures for water supply and small-scale irrigation purposes.

In the last 15 years alone, more than 65 small-scale dams have been constructed in different areas of Tigray, northern Ethiopia for small-scale irrigation.

**Objective of this study**
- Assess the efficiency of 65 small-scale dams;
- Identify the challenges/problems with the construction of the dams;
- Assess the advantages/opportunities with construction of the dams.
Ethiopia

Population:
39.9M in 1984
73.9 M in 2007
80M in 2010
(Projected from 2007)
Growth rate – 2.6%

Area:
1.1 M sq km
2. Overview: Water Resources Potential of Ethiopia

The country has four Major Drainage Systems:

(a) The Nile basin (including Abbay or Blue Nile, Baro-Akobo, Setit-Tekeze/Atbara and Mereb) covers 33 percent of the country and drains the northern and central parts westwards;

(b) The Rift Valley (including Awash, Denakil, Omo-Gibe and Central Lakes) covers 28 percent of the country;

(c) The Shebelli-Juba basin (including Wabi-Shebelle and Genale-Dawa) covers 33 percent of the country and drains the southeastern mountains towards Somalia and the Indian Ocean;

(d) The North-East Coast (including the Ogaden and Gulf of Aden basins) covers 6 percent of the country.
Map of basins and sub-basins (MoWR, 2006)

9 wet, 3 dry
<table>
<thead>
<tr>
<th>Basin Name</th>
<th>Source</th>
<th>Area (km²)</th>
<th>Direction of Flow</th>
<th>Annual runoff (BM3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wabi shebelle</td>
<td>Bale Highland</td>
<td>202220</td>
<td>East</td>
<td>4.6</td>
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<tr>
<td>Abbay</td>
<td>West, Southwest HL</td>
<td>199912</td>
<td>West (Nile)</td>
<td>52.6</td>
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<td>Genale Dawa</td>
<td>Bale Highland</td>
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<td>East</td>
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<td>Awash</td>
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<td>North-east</td>
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<td>Tekeze</td>
<td>North Wollo Highland</td>
<td>82350</td>
<td>West Nile()</td>
<td>7.6</td>
</tr>
<tr>
<td>Denakil</td>
<td>North Wollo Highland</td>
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<td>NF</td>
<td>0.86</td>
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<td>Ogaden</td>
<td>NF</td>
<td>77120</td>
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<td>Omo-Ghibe</td>
<td>Central, Western HL</td>
<td>79000</td>
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<td>Baro-Akobo</td>
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<td>Rift Valley Lakes</td>
<td>Arsi and Central HL</td>
<td>52000</td>
<td>South</td>
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<td>Mereb</td>
<td>Adigrat HL</td>
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<td>Aysha</td>
<td>NF</td>
<td>2223</td>
<td>NF</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: MoWR Respective Basin Master Plan Studies
Surface Water Resources Potential of Ethiopia
(MoWR, 2005)

• Annual runoff from the 9 river basins is estimated at 122BM$^3$.

• Abbay, Baro-Akobo and Omo-Ghibe contribute 76% of the total runoff.

Groundwater Resources Potential of Ethiopia
(MoWR, 2005)

• Total safe yield of groundwater: 26.1 BM$^3$.

• Recent studies by MoWR indicate a higher estimate.
3. Distribution and capacity of small-scale dams constructed in Tigray, Northern Ethiopia
Locations of the small-scale dam sites in Tigray, Northern Ethiopia

Height of the dams: 9m-22m
…. Continued; Distribution and capacity of small-scale dams in Tigray

(i) Diversion weir (i) that feeds water to a small scale dam (ii) for irrigation (iii).
4. Problems/Challenges in surface water harvesting using dams

(a) Geological, geotechnical, and construction problems:
- Seepage/leakage problems;
- Foundation problems;
- Construction problems: poor compaction.
Effects of surface water harvesting on stream discharge: (a) Seepage/leakage water from Korir dam, (b) Seepage/leakage water from Hizaet Wedi Cheber dam (Photo: Woldearegay, 2002).
…. Continued; Problems/Challenges in water harvesting

Cracks on earth dams
(b) Hydrological problems:
• Many dams failed to store adequate water due to high variability of rainfall (spatially and temporally).

(c) Sedimentation problems:
• High degree of sedimentation remains a major challenge to the sustainability of the reservoirs.

(d) Irrigation water management problems:
• Water loss through canal seepage;
• Evaporation from open canals;
• Water logging problems at downstream of dams.

(e) Health problems:
• Malaria in areas with elevations below 2000m a.m.s.l.; recent trends shown some Malaria incidence even in higher altitudes (up to 2400m a.m.s.l) Climate change?
.... Continued; Problems/Challenges in water harvesting
5. Advantages/opportunities of small-scale dam construction

(a) Socio-economic benefits through small-scale irrigation

- Production: increased by 3 fold;
- Cropping seasons: double.
(b) Hydrological benefits: enhancement of groundwater (recharge, and quality), and improvements in spring discharge.

Gumselasa dam and a groundwater well serving water supply for Adi Gudom town.
After the construction of dams:

- Water level in wells increased due to recharge;
- Water quality improved (mainly TDS values), especially in areas with carbonate environments;
- New springs emerged and discharge of existing ones increased.
(c) Environmental benefits:
• Improvements in the ecology and micro-climate of the areas around dam sites (i);
• Control/reduce soil erosion (ii).
Despite technical, financial and environmental constraints, the construction of small-scale dams and other surface water harvesting schemes is giving several benefits:

- **Economical**;
- **Hydrological**;
- **Environmental**.
Recommendations

- Further capacity building (technical and institutional) is required for safe and economic design and construction of dams and other water harvesting schemes;
- Options for conjunctive use of surface water and groundwater is highly required in order to:
  - Reduce water-logging and salinity problems;
  - Address the shortage of water through harvesting seepage/leakage water.
- Since many of the dams constructed in Tigray are in the Tekeze river basin (which contribute to the Nile river), further research on the effects of dam construction on downstream users is advisable;
- Further research on environmental problems (e.g. like sedimentation) and health issues (e.g. malaria) is required;
- Integrated approach of water resources management need to be introduced in Ethiopia.
- Further study on the possible scenarios of climate change on water and related health issues is needed.
Queen of Sheba Palace, Aksum, Ethiopia