Small Scale Irrigation Project at Abba Samuel River Watershed, Ethiopia

UCONN - Engineers Without Borders Ethiopia Program
& Civil and Environmental Engineering Design Project

Kelsey Reeves, Yamil Roman, Lori Fomenko, Alexander Curry

Partners


ETHIOPIAN INSTITUTE OF
WATER RESOURCES


UNIVERSITY OF CONNECTICUT
1881

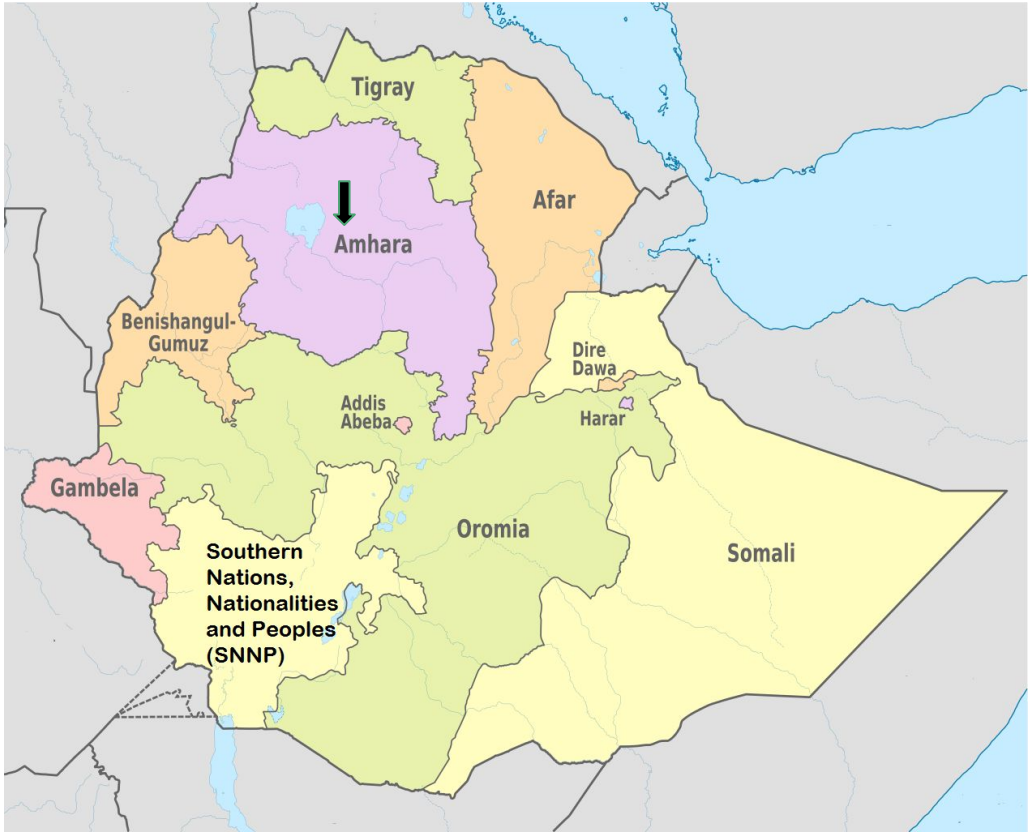

ADDIS ABABA UNIVERSITY


BAHIR DAR UNIVERSITY


ENGINEERS
WITHOUT
BORDERS
USA

Location

Picture taken in January 2016 showing a receding river.



Community is located in the Amhara region near to Woreta.

Agriculture in Ethiopia

- More than 80% of the population relies on agriculture for sustenance and income
- 10.2 million people in need of emergency food assistance
  - Possibly 15 million by the end of this year

The Community

Irrigation System in Place

Project Goal

- Reduce poverty for the community by irrigation
  - Greater crop yields
  - More employment
  - Reduce risk to irregular rainfall
  - Improve nutrition levels

Design Overview

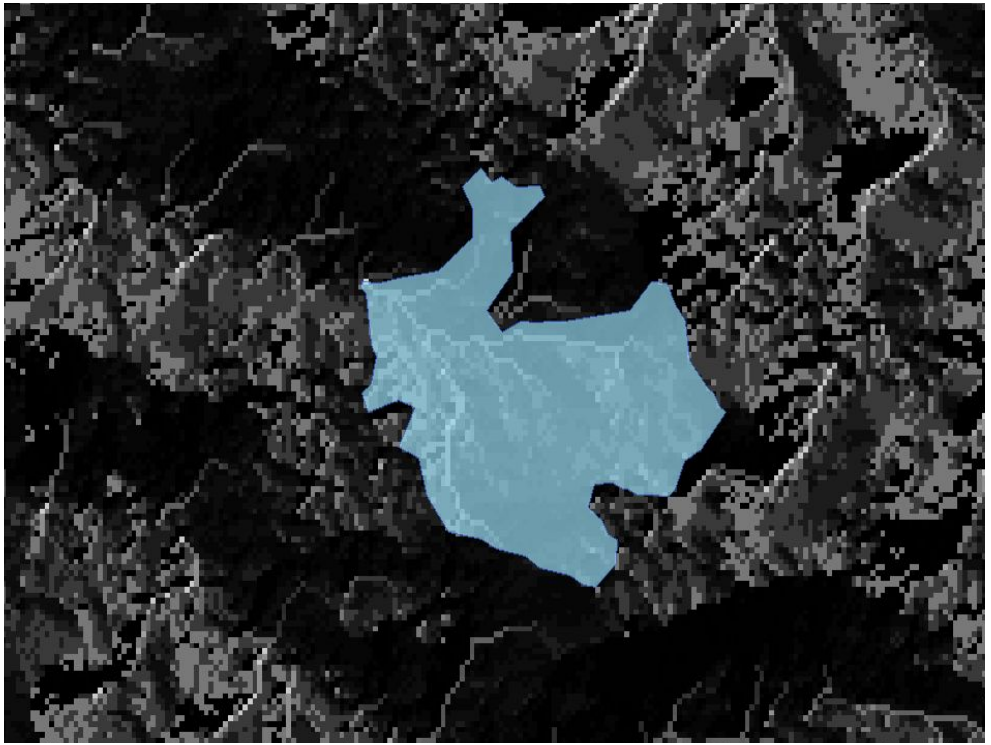
- Watershed model
- Storage of Wet Season River Flow
- Distribution
- Irrigation Method

Watershed Overview

- Local scale watershed for Woreta within Abba Samuel River in Nile River Basin
- Visual development done in ArcMap
- Estimated precipitation determined by observed rainfall data provided by Ethiopian Institute for Water Resources (EIWR) and the National Climatic Data Center (NCDC) / National Oceanic and Atmospheric Administration (NOAA)
- Soil type and estimated infiltration rates from field testing and various classification processes

Modeling

- Solely topography based
- Shuttle Radar Topography Mission (SRTM) - 30 m resolution, void-filled data used as base for digital elevation modeling, and compared to collected elevation data from assessment trip
- Flow direction and accumulation grids were derived from these elevations
- Estimated watershed size ~2.75 km^2



Precipitation Data Analysis

- Data taken from two stations
  - Bahar Dar - from NCDC/NOAA up to 1988
  - Woreta - from EIWR with reasonably reliable data from 2001-2011
- Comparison of Average Annual Precipitation amounts, as well as 10th, 50th and 90th percentiles

NCDC
AvgAnnual (1961-1988)
1.4343

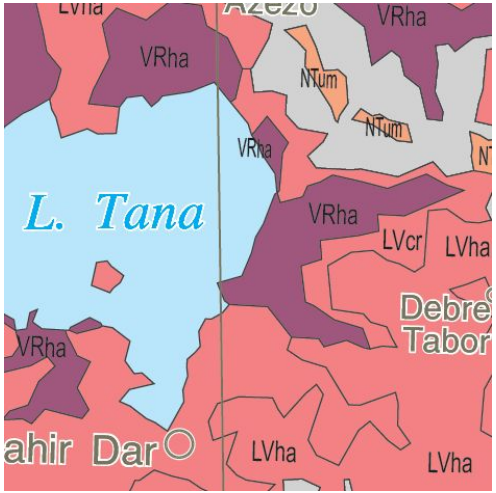
EIWR
AvgAnnual (2001-2011)
1.1324

	NCDC	
10th	50th	90th
1.1182	1.4539	1.7455

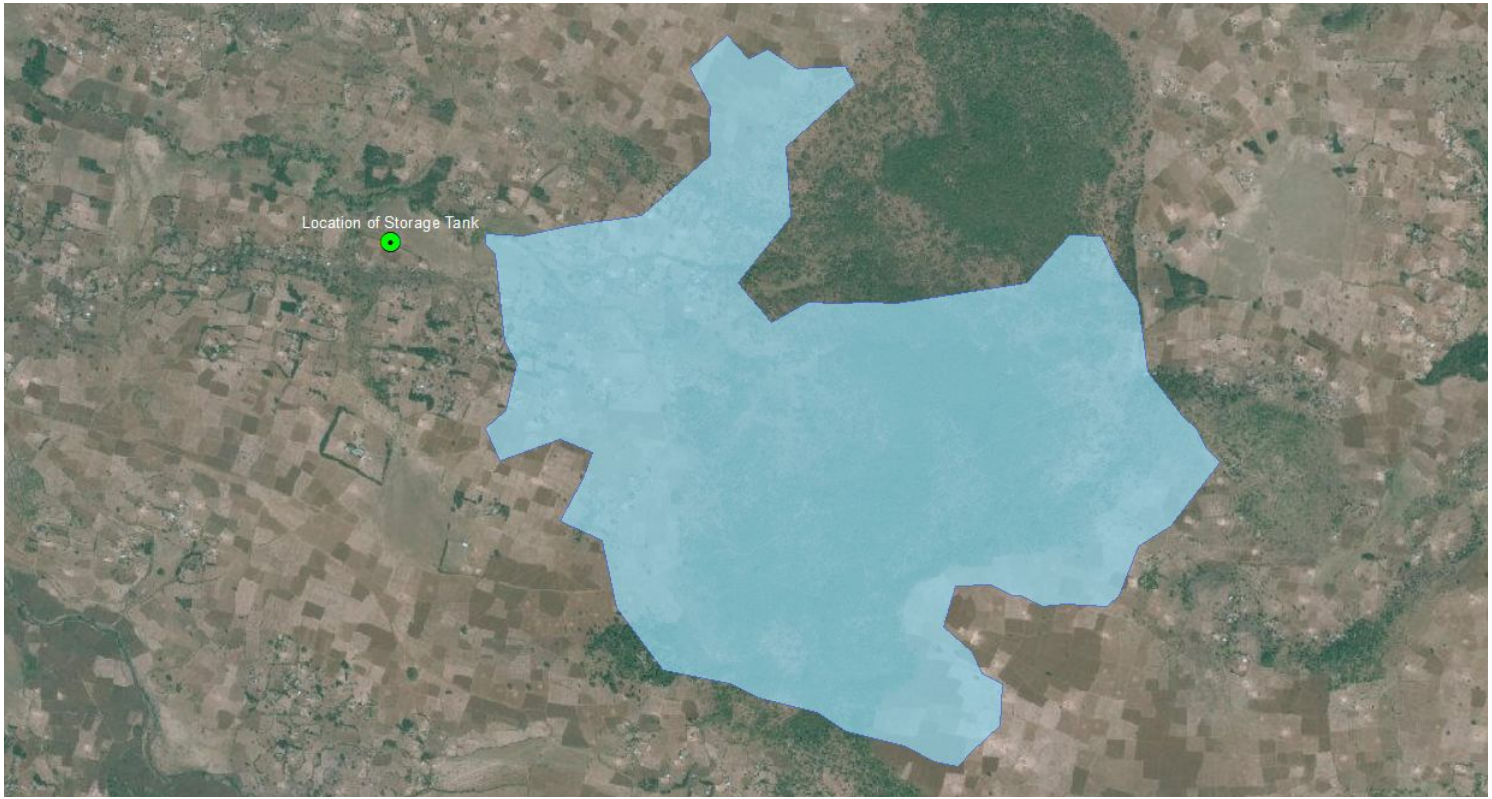
	EIWR	
10th	50th	90th
0.7624	1.1454	1.3098

Soil Type and Infiltration Rate

- Soil classification had two parts:
  - Sieve Analysis and Hydrometer testing done at Bahir Dar University (BDU) Soils Lab
    - Results: LL = 60.45, PL = 33.31, PI = 27.14
    - USGS Classification: CH, fat clay with high plasticity
    - FAO infiltration rates: 1-5 mm/hr
  - Further Research into typical soils of the area
    - Two soil reports (Gumara sub basin, and Abbay River Basin) and African Soil Atlas
      - Results: VRha classification: Haplic Vertisol, tendency to shrink and swell



Placement of the Storage Tank



Ferrocement Tanks

What is a Ferrocement Tank?

- Water storage tank built by hand trowelling a cement rich mortar onto a mesh of wire reinforcement.
- The walls typically vary in thickness from 3 to 10 cm depending on the size of the tank.
- The steel reinforcement usually consists of straight fencing wire wrapped during construction around a cylindrical framework or woven wire mesh tied to a supporting framework of weld mesh or heavier reinforcing rod

Why a ferrocement tank?

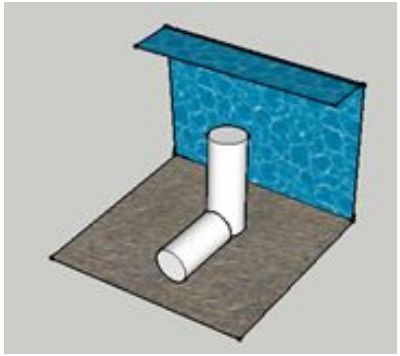
- A very dense mesh of woven or welded reinforcing wire is required to have a minimum value of wire volume for each unit volume of material.
- The minimum strength design approach can be used and will provide an ample amount of strength for the purpose.
- Straight wire reinforcement was chosen for cost reasons and its ability to simply wrap around a small diameter cylindrical form.
- The use of the ferrocement tanks in this area is suitable for the following reasons: commonly available materials, simple skills needed self help contribution, simple equipment and shared cost of formwork.
- The advantage of the ferrocement is its ability to resist corrosion and its cheapness in comparison to other materials.
- Cheaper to build, require less skilled labour, safer than a dam

Distribution

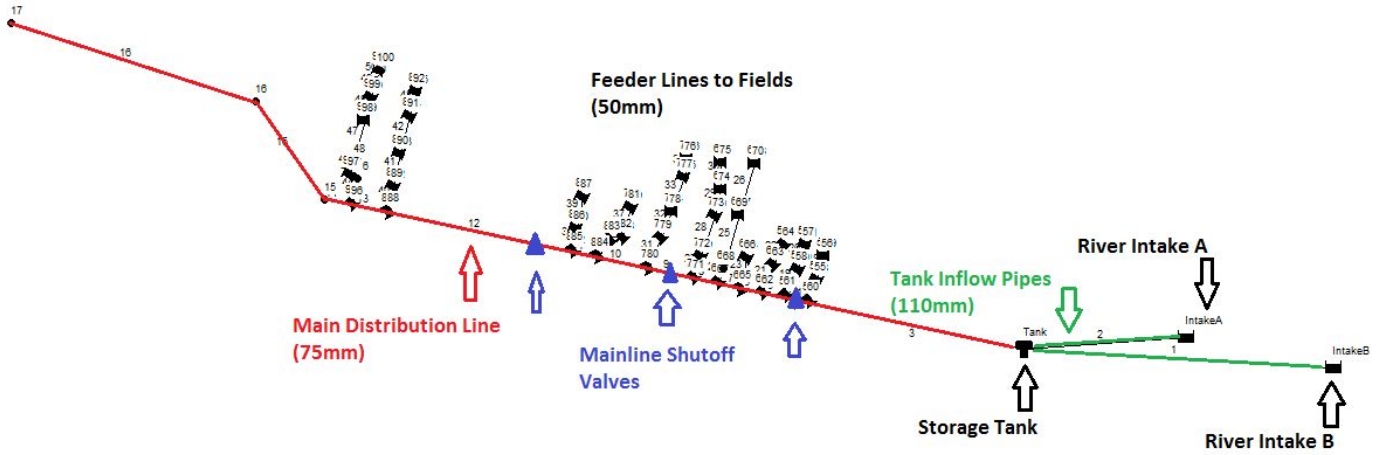

Tank
Inflow A
Inflow B

Inflows

- Inflow A to tank
  - 7 ft elevation drop
  - 57 stands
- Inflow B to tank
  - 22 ft elevation drop
  - 32 stands



EPANET: Distribution Modeling Software



Pipes VS Open Channels

Installation and O&M

- Installation
  - No major equipment or machinery
  - In-kind labor
  - Skilled irrigation engineer from Ethiopia
- Operation
  - Manage flows
- Maintenance
  - Clean screens

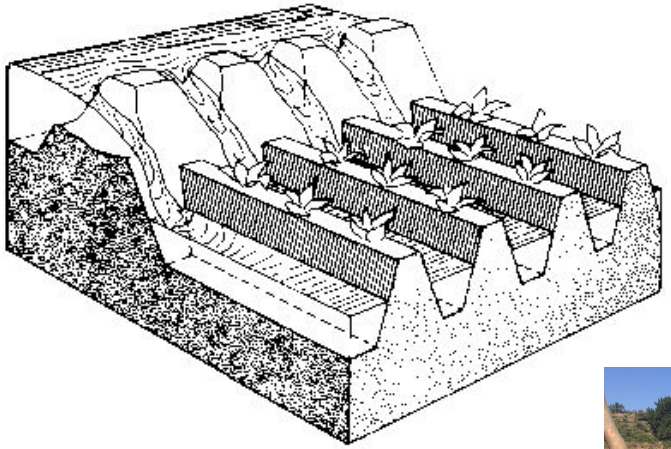
Capital Costs

Location	Birr	USD
Inflow Lines	71741	3416.24
Main Lines	67582	3219.19
Branches	49692.6	2366.31
Total Cost:	189,015.60	9,001.74

Operations & Maintenance Costs

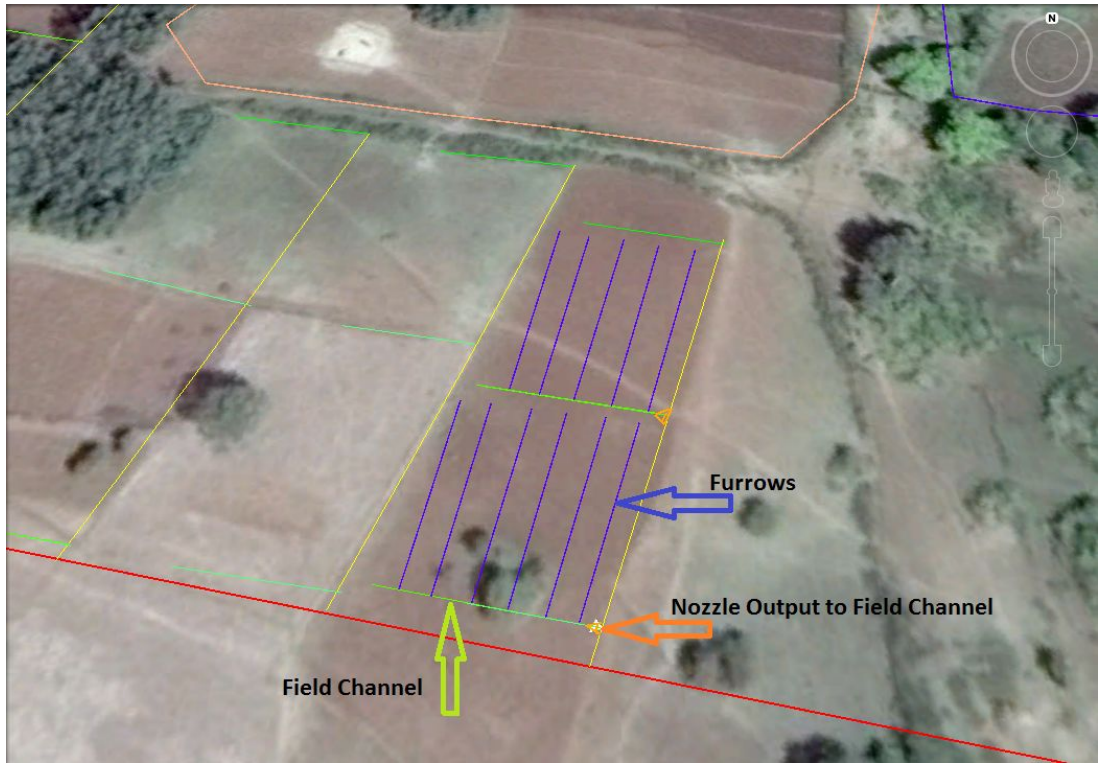
- No operation costs
- Limited amount of maintenance required

Irrigation



Irrigation Layout

- Water enters each field through a nozzle discharging into the field channel (eastern side of feeder pipe)
- Field channel runs along top of field and flows into furrows



Additional Data Collection

- Distribution: surveying
- Watershed model: precipitation, soil, and evaporation data, wet season conditions (flooding, height of water, runoff, etc.)
- Storage design: soil testing for foundation




Acknowledgements

Partners

- Mamo Kassegn, EIWR
- Shimelis Abebe, EIWR
- Dr. Geremew Sahilu, EIWR
- Dr. Seifu Tilahun, BDU
- Dr. Habtamu Tsegaye, BDU
- Dr. Maria Chrysochoou, UCONN

UCONN Engineers Without Borders Members

Local Community Government Leader

Professional Mentors

- Dr. Jonathan Mellor, UCONN
- Yigrem Dingo, UCONN
- Joe Thompson

Engineers Without Borders Travel Team

- Kristin Burnham
- Kelsey Reeves
- Ryan Cordier

Joy Larson, UCONN

Thank You!