Citizen Science at the Source of the Blue Nile: Promoting Public Participation in Science for Ensuring Food and Water Security in Ethiopia

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1. MOTIVATION

The main source of water for Ethiopia is the Blue Nile Basin where inter-annual variability of precipitation has caused droughts and floods leading to economic and food insecurity. Our NSF-PIRE project focuses on the Blue Nile Basin as the study domain, and aims to develop novel forecast technologies to mitigate the stresses to local communities.

To overcome data scarcity challenges in the region, a Citizen Science Initiative (PIRE CSI) was established, a project that trains high school students and local farmers in hydrologic data collection in four watersheds of interest, located south of Lake Tana, Ethiopia.

Kick-off meeting of the Citizen Science Initiative in Bahir Dar

Discussions with local high school director and teachers

2. QUICK FACTS

When was the PIRE CSI established?
June 2017
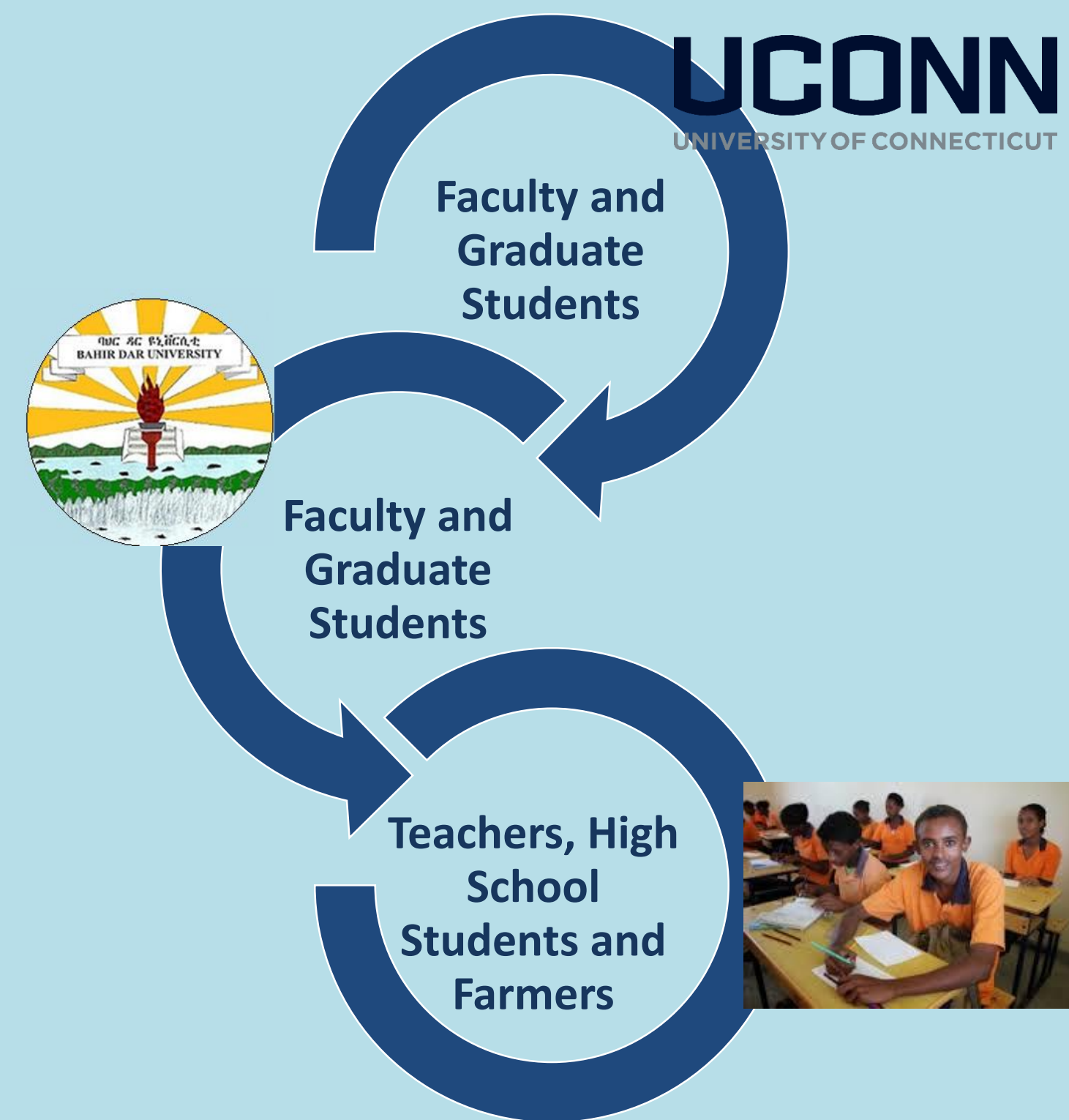
Who is involved from Ethiopia?
- 4 high schools
- 10 high school students
- 4 high school teachers
- 4 graduate students and
- 3 faculty from Bahir Dar University
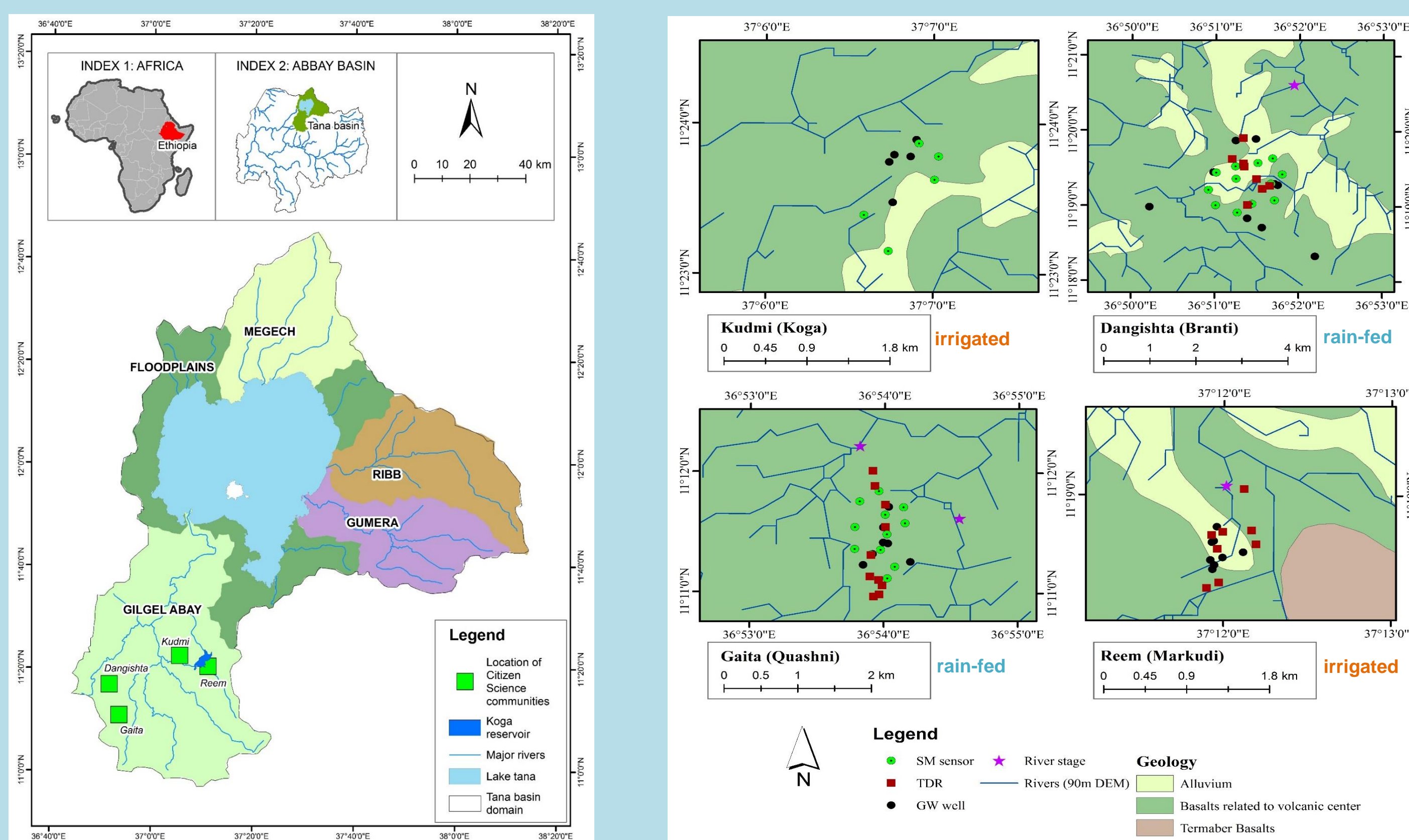- Farmers from 4 local communities, south of Lake Tana

What are they doing?
Collecting hydrological data on:
- river stage,
- soil moisture and
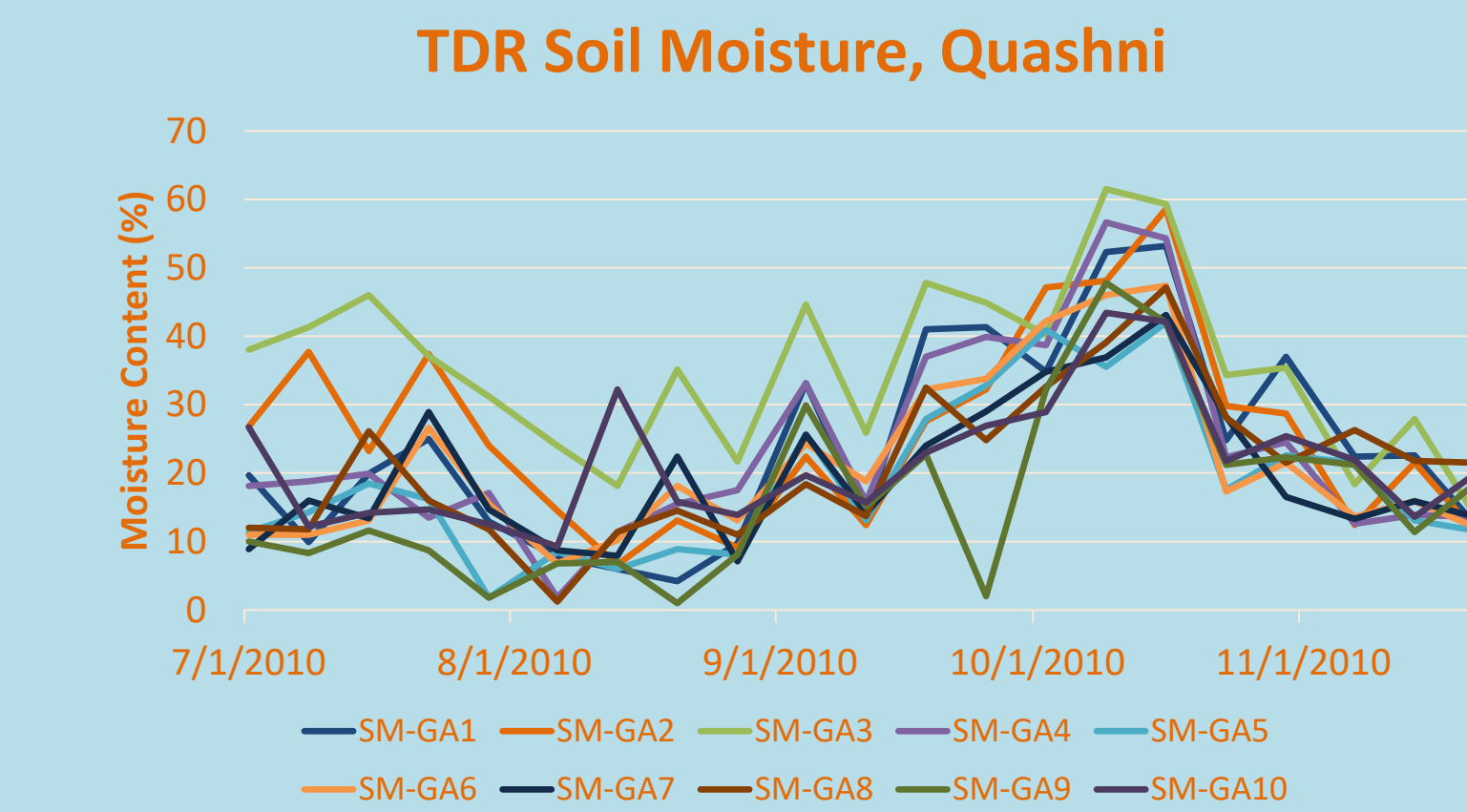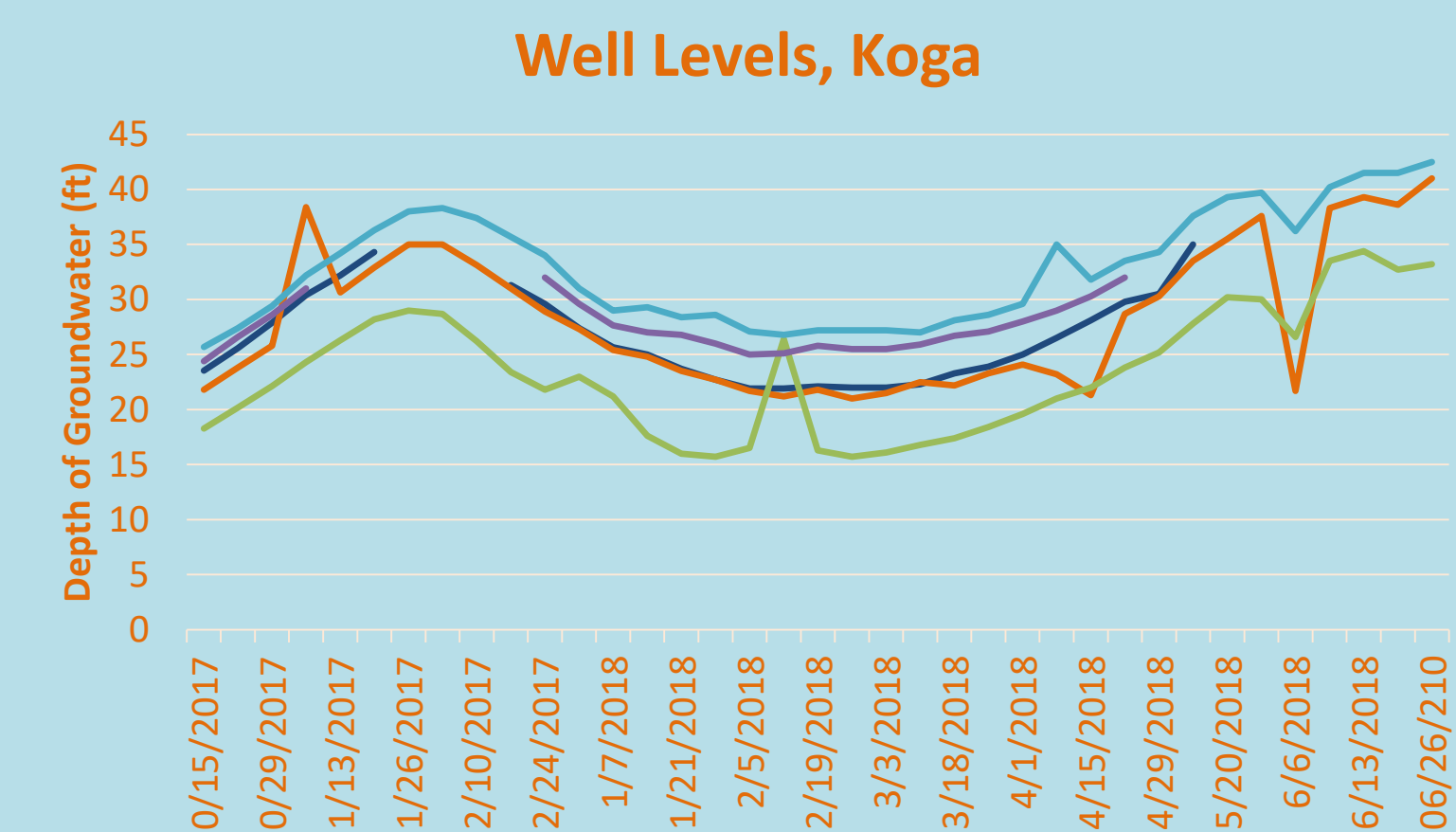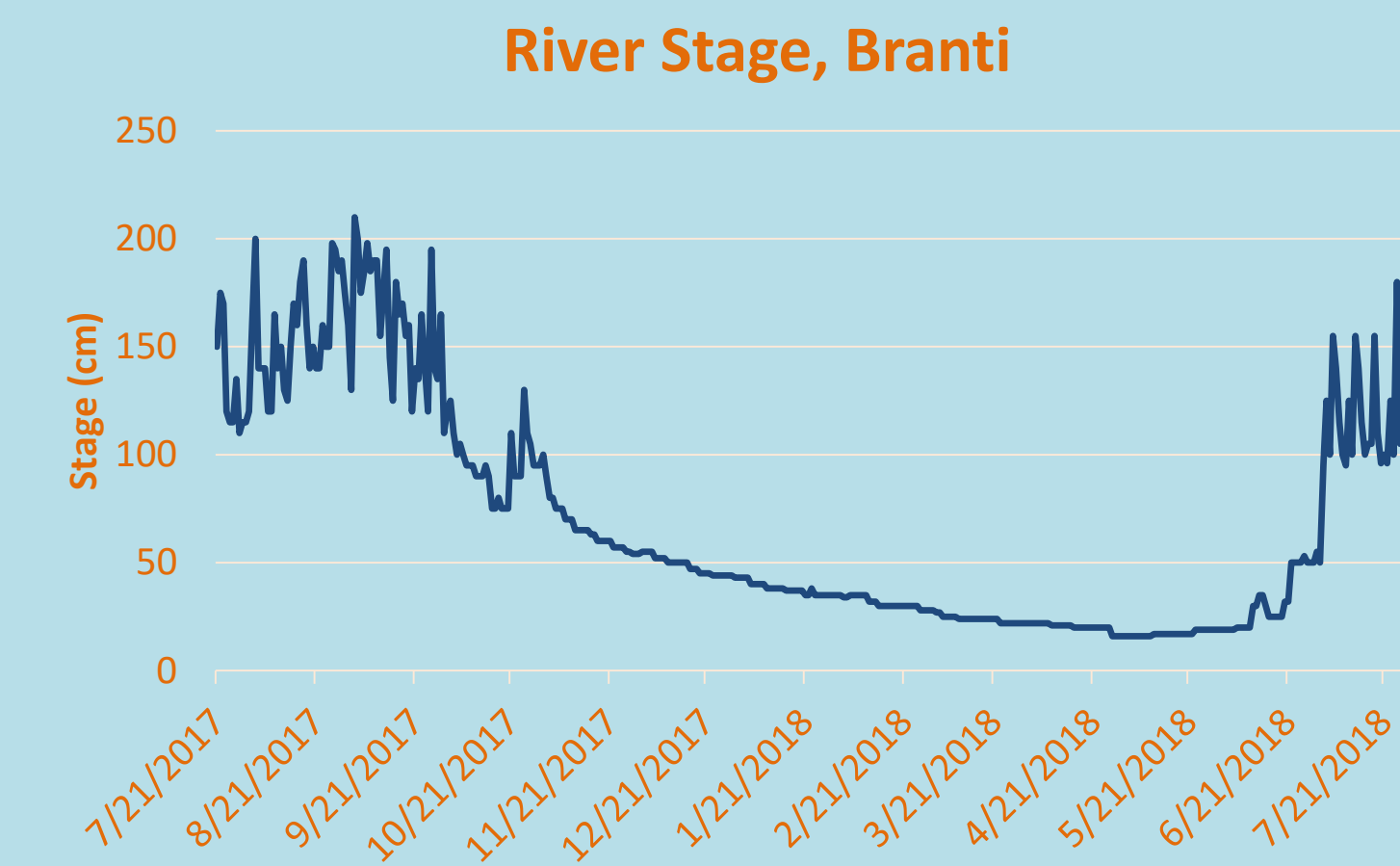- groundwater levels

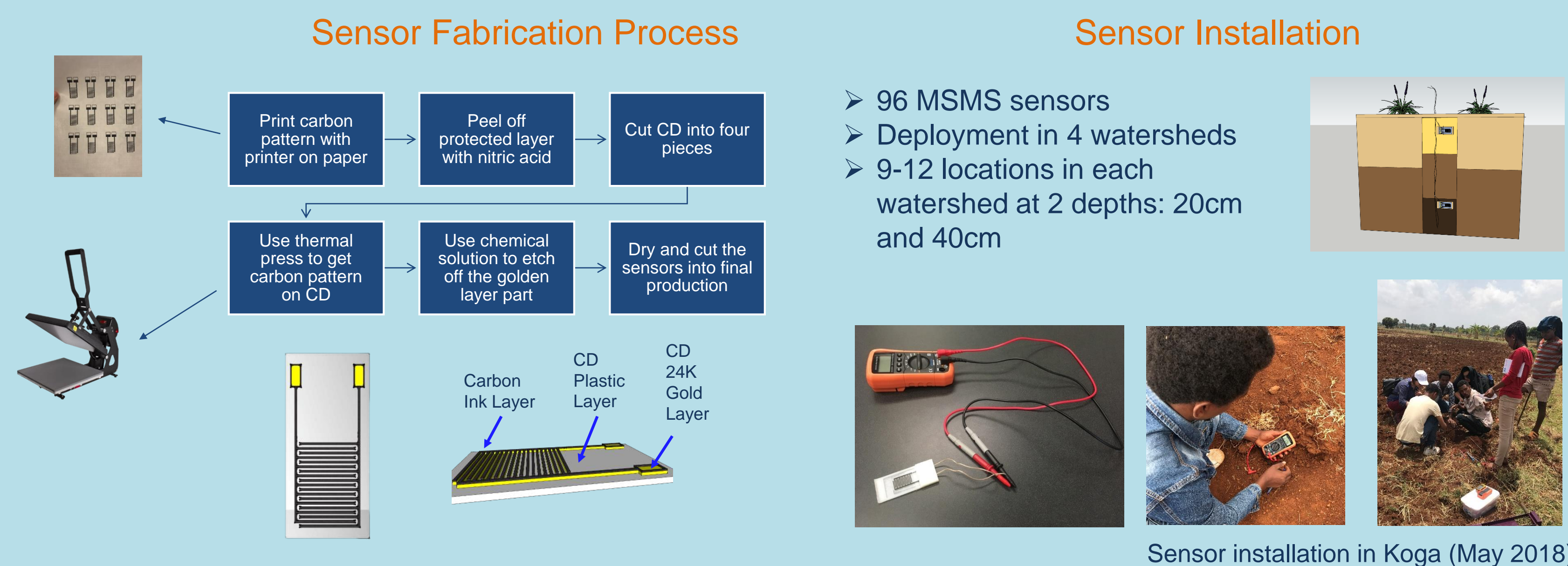Participating in college-ready activities

3. LOCAL COMMUNITIES

- Two rain-fed (Quashni and Branti) and
- Two irrigated communities (Koga and Markudi)
All sites are located in the Gilgel Abay sub-basin

4. DATA COLLECTION

High school students trained in data collection by Bahir Dar University graduate students under faculty supervision

River stage (daily)

Groundwater levels (weekly)

Soil moisture (weekly)

River Stage, Branti

Well Levels, Koga

TDR Soil Moisture, Quashni

Equipment

Optical Level for River Stage

Groundwater Well Level Meter

TDR Soil Moisture

New Soil Moisture Sensor Development (MSMS)

Sensor Fabrication Process

Print carbon pattern with printer on paper → Peel off protected layer with nitric acid → Cut CD into four pieces

Use thermal press to get carbon pattern on CD → Use chemical solution to etch off the golden layer part → Dry and cut the sensors into final production

Carbon Ink Layer / CD Plastic Layer / CD 24K Gold Layer

Sensor Installation

- 96 MSMS sensors
- Deployment in 4 watersheds
- 9-12 locations in each watershed at 2 depths: 20cm and 40cm
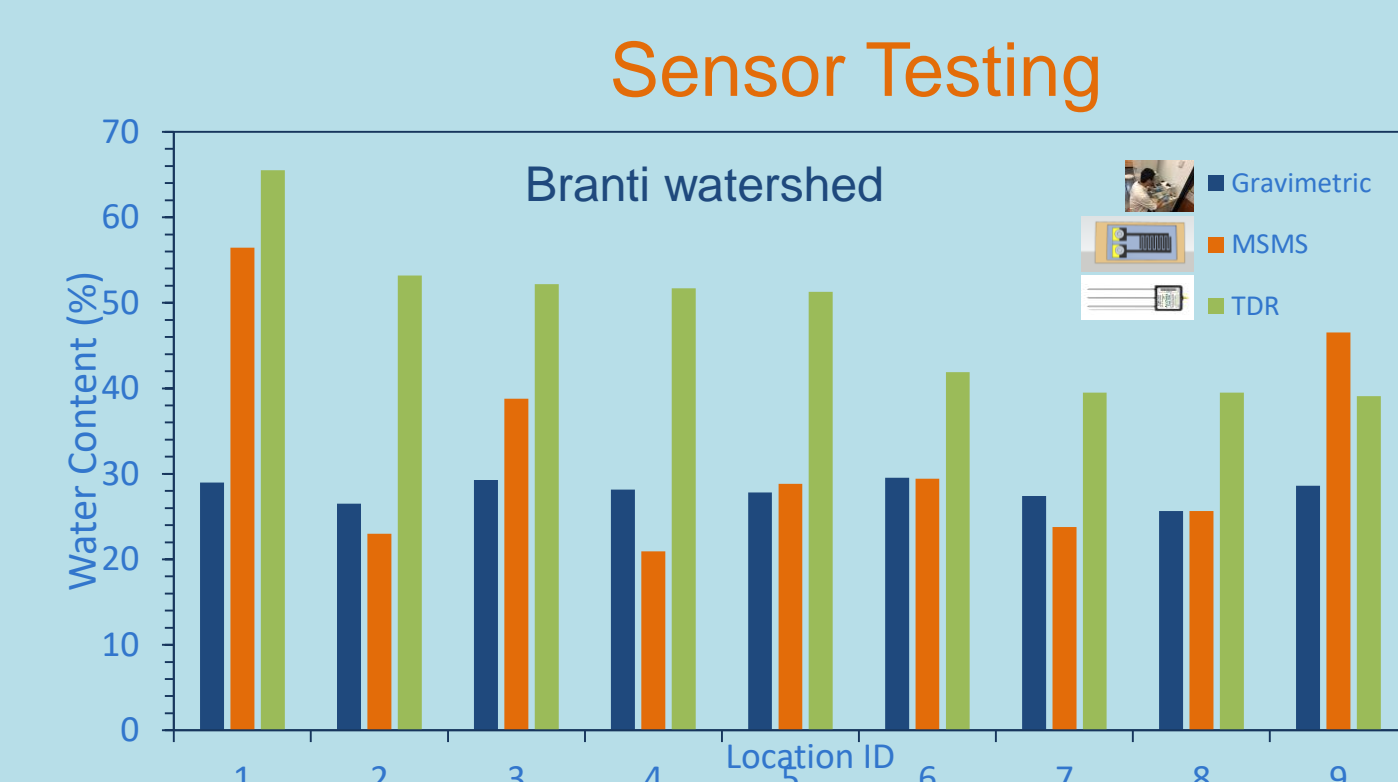

Sensor installation in Koga (May 2018)

Advantages
- Low cost (<$1 per sensor)
- High resolution profiling at low cost
- Long-term stability (over a year)
- Multiple depth measurements

Challenges
- Resistivity values may be affected by other soil parameters (e.g. nutrients, salt)
- Soil-sensor contact could be further improved

Sensor Testing
Branti watershed

5. DATA TRANSMISSION

BWING app – Blue Nile Weather Identification Near the Ground


- iOS app
- Loaded onto iPads for use in the field
- Queues reports until wifi is available and then sends
- Translated into Amharic for easier use in the field
- Graphs last 10 reports for easy comparison of current observation vs historic
- Will integrate model predictions with in-situ data in a single graph

App tested in the field with soil moisture measurements on March 9th, 2018

Trained first group of high school students on the usage of the app

6. DATA INTEGRATION

PIRE Researchers (Engineers) are integrated the data into their modeling for:
- Initialization of the hydrological models for the dry season
- Validation of model predictions (soil moisture, streamflows and groundwater levels) made each wet season 2018 through 2022

PIRE Project Modeling Framework
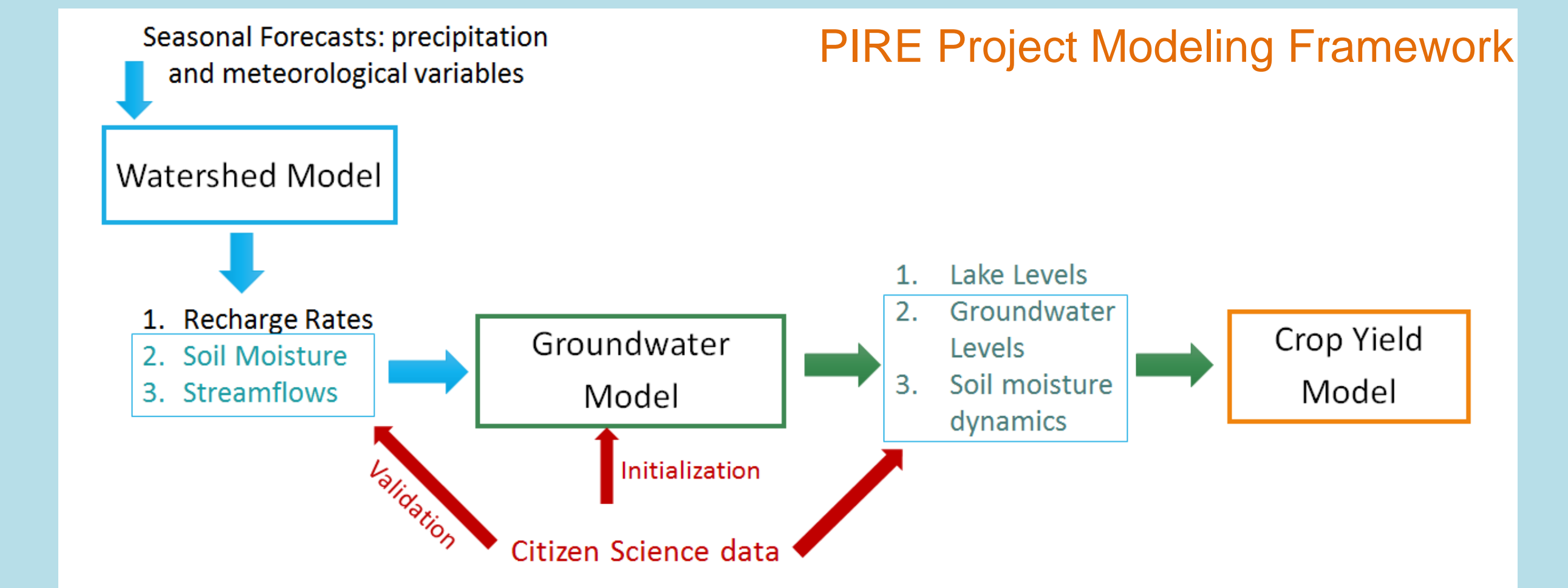
Bahir Dar graduate students (Engineers) are using the data as the basis of their Master thesis work

PIRE Researchers (Social scientists) will participate and observe the project in 2019 and 2020

7. IMPACT

- Citizen participation in science can:
  - promote empowerment of local communities
  - establish long-lasting partnerships between scientists and local communities
  - Citizens learn about science and the scientific method
- Co-generation of knowledge with farmers and students may:
  - Contribute to higher rates of forecast adaption by the local farmers
  - Trigger student's interest in STEM
  - Encourage student's uptake of scientific careers

8. FUTURE STEPS

- Following the high school students in a longitudinal study to see the impact of their participation in the citizen science initiative and STEM activities on their future careers
- Focus on gender studies and self-efficacy, specifically studying how high school female students perceive their participation in citizen science data collection and how they are perceived by their social network
- Moving from data co-generation to data application to guide water management decisions in the field
- A prototype nitrogen sensor is currently being developed to monitor nitrogen in the fields

ACKNOWLEDGMENTS