

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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Abstract

The Blue Nile Basin, Ethiopia, whose inter-annual variability in local precipitation has resulted in droughts and floods that lead to economic and food insecurity, is the area of interest for our NSF-PIRE project, which aims to develop novel forecast technologies to mitigate the stresses to local communities. As part of the PIRE project, a Citizen Science Initiative (PIRE CSI) was established in June 2017, a project that trains high school students in hydrologic data collection under the guidance of classroom teachers and graduate students and professors from Bahir Dar University in four watersheds of interest, located south of Lake Tana, Ethiopia. Four MSc graduate students were selected from Bahir Dar University and trained nine high school students who were nominated taking into account gender and the proximity of their schools to the watersheds. High school students are currently collecting soil moisture data using TDR, river stage measurements using optical levels and groundwater levels using shallow water level meters. The data collection is supported by an app (B-WING), developed specifically for the needs of the project. College-ready activities are being planned for the high school students, i.e. inviting them to Bahir Dar University to analyze some of the data, present their work at a workshop, and familiarize themselves with the university experience. Recently, the PIRE CSI was extended to involve local farmers as “citizen scientists”, collecting soil moisture data using low-cost, soil moisture sensors developed in-house at the University of Connecticut, that have been installed in 12 locations and two soil depths (20 cm and 40 cm). The collected data will be used for the initialization and validation of the hydrological models developed in the region. The PIRE CSI promotes the empowerment of local communities and establishes long-lasting partnerships between scientists and stakeholders. It is believed that the co-generation of knowledge may contribute to higher rates of forecast adaption by the local farmers and may trigger the student’s interest in STEM and encourage their uptake of scientific careers. Acknowledgment: This material is based upon work supported by the National Science Foundation under Grant No. 1545874.

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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

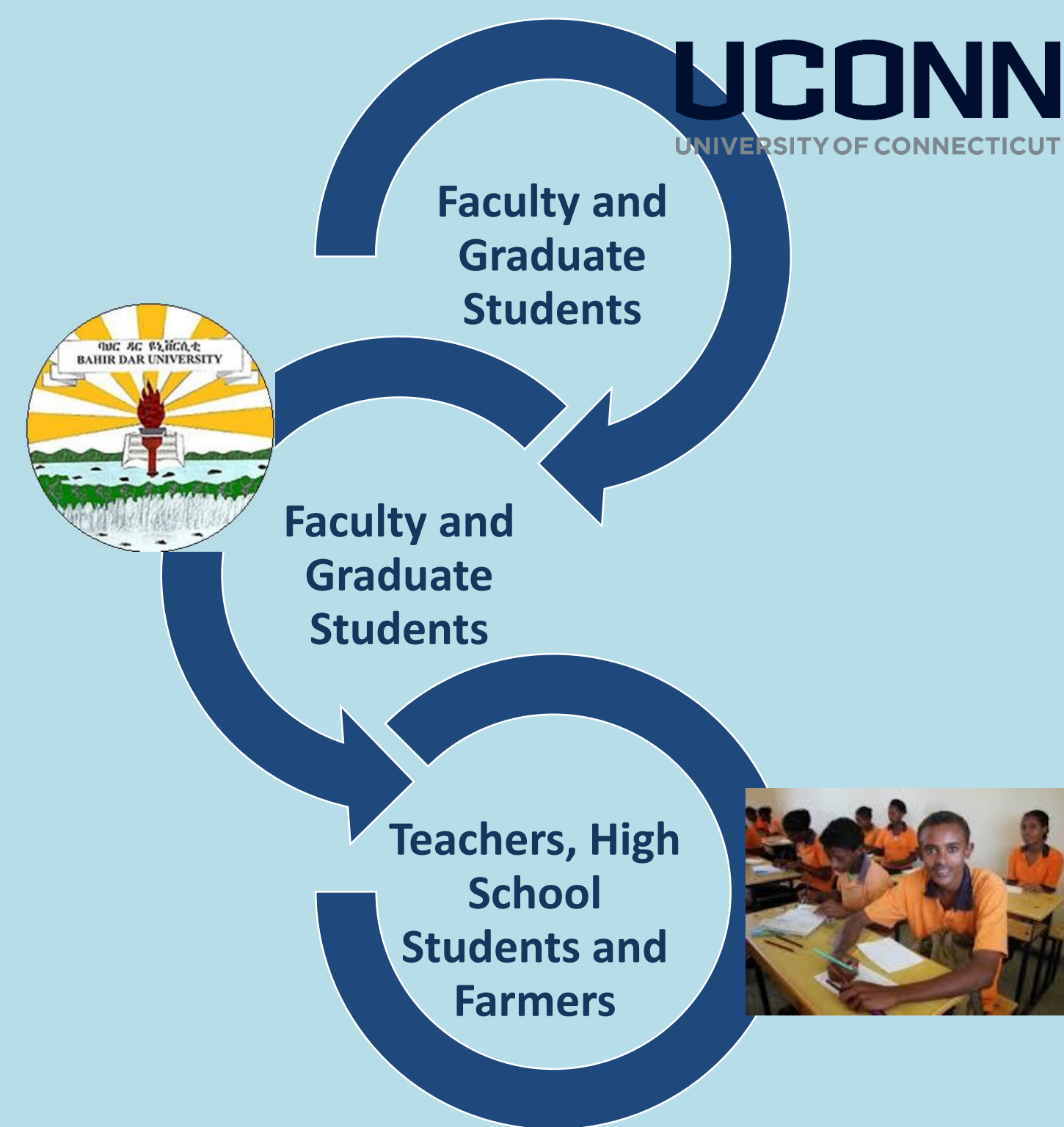
Who is involved from Ethiopia?

- 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

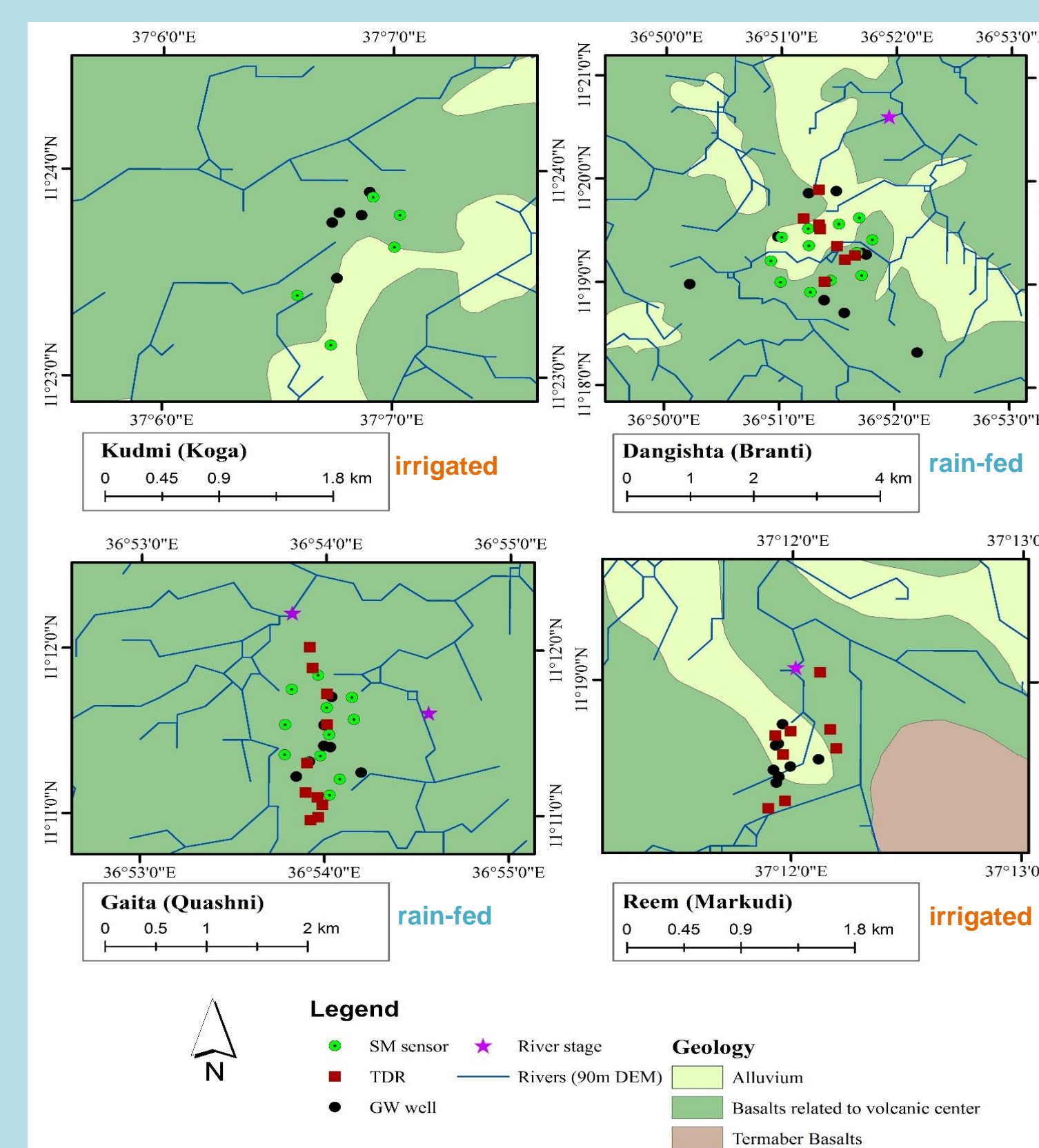
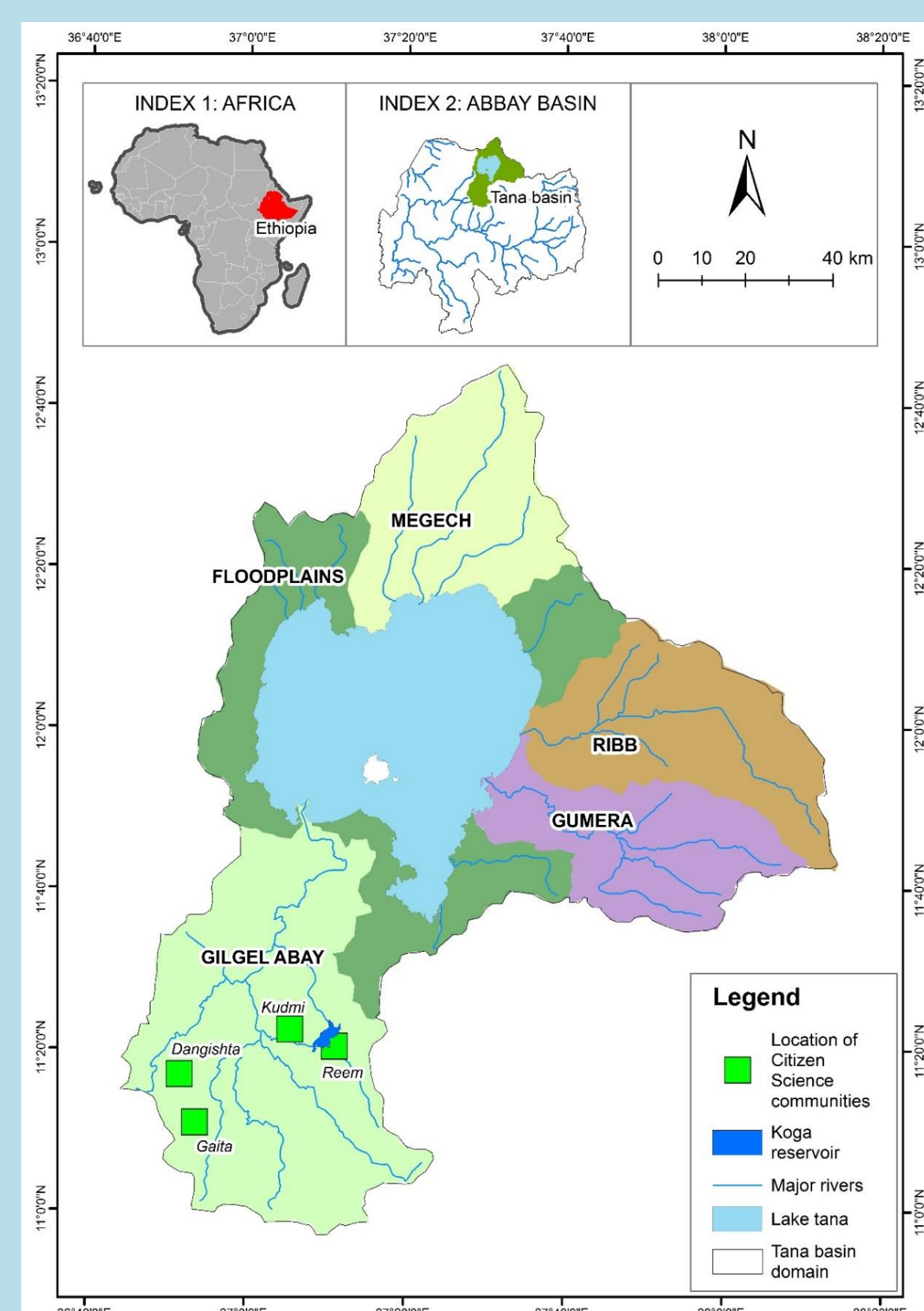
What are they doing?

- 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



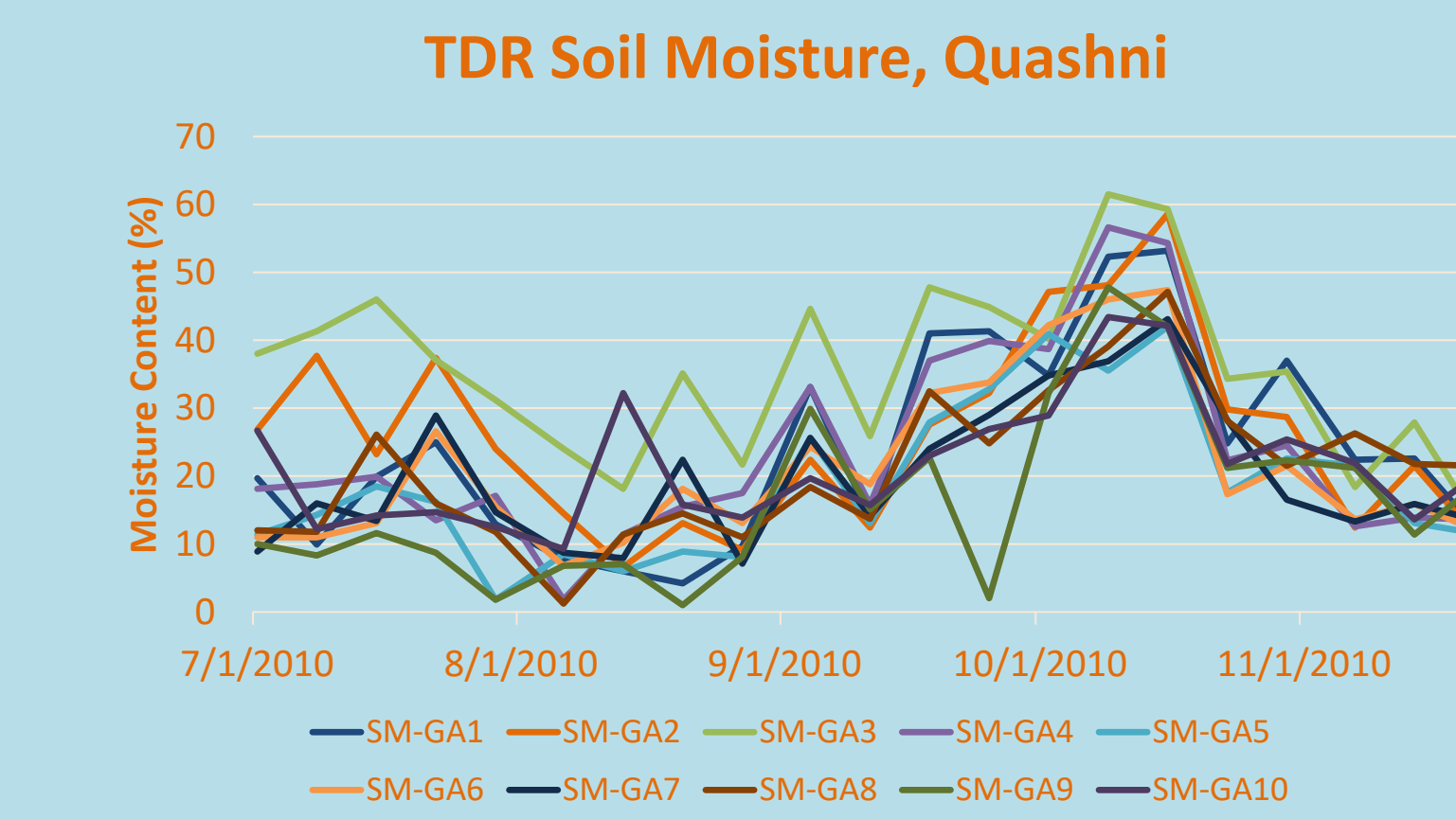
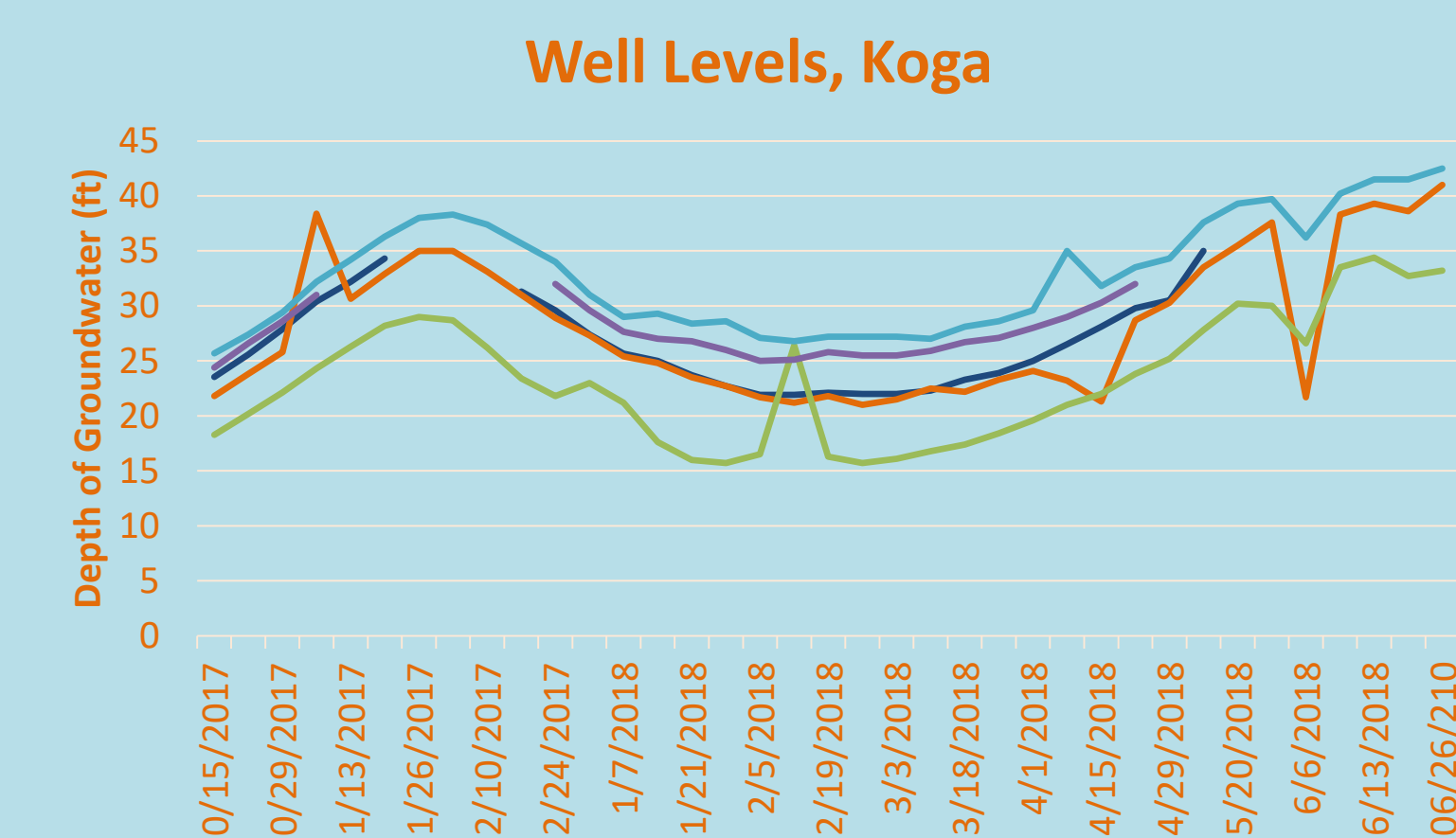
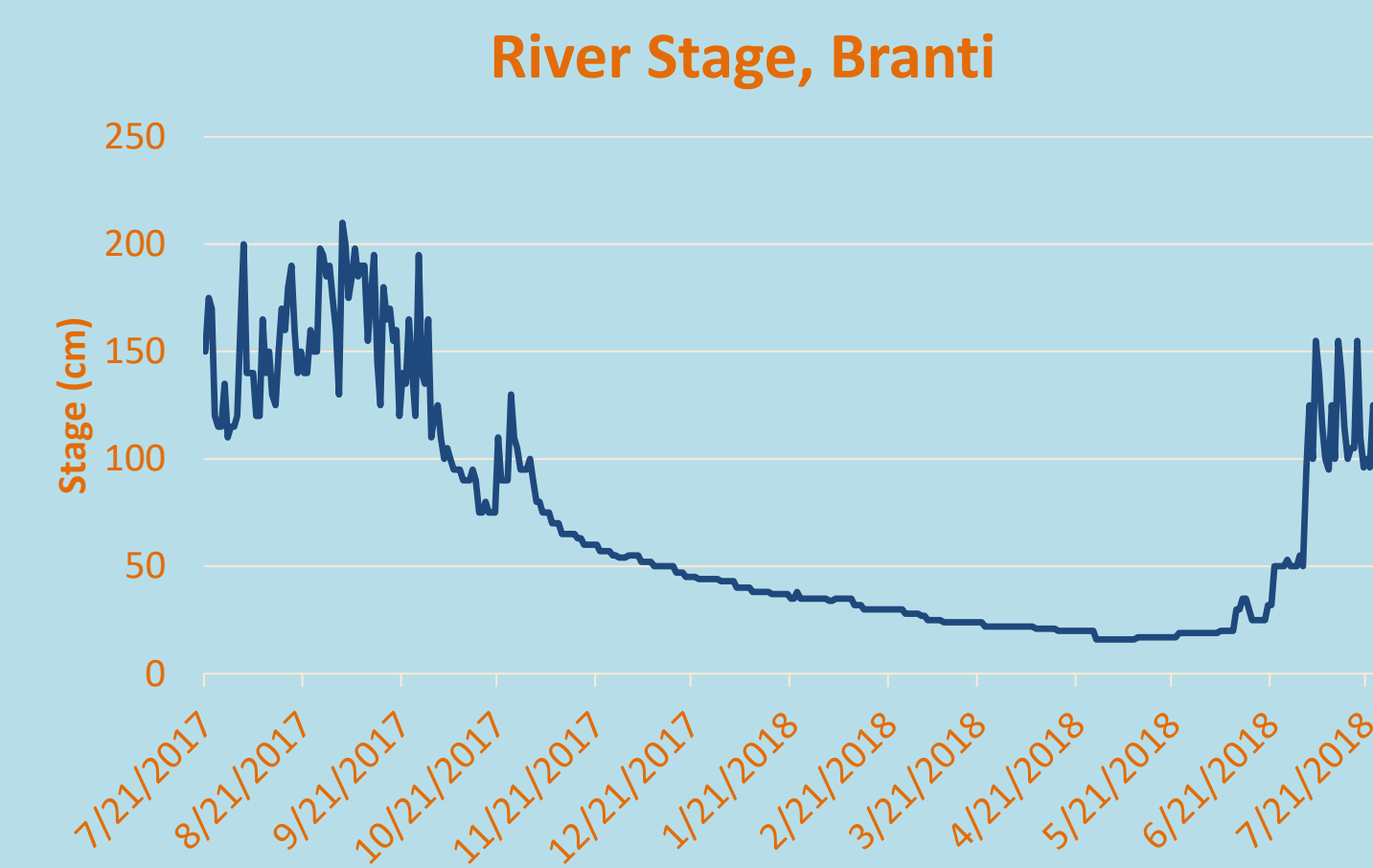
Groundwater levels (weekly)



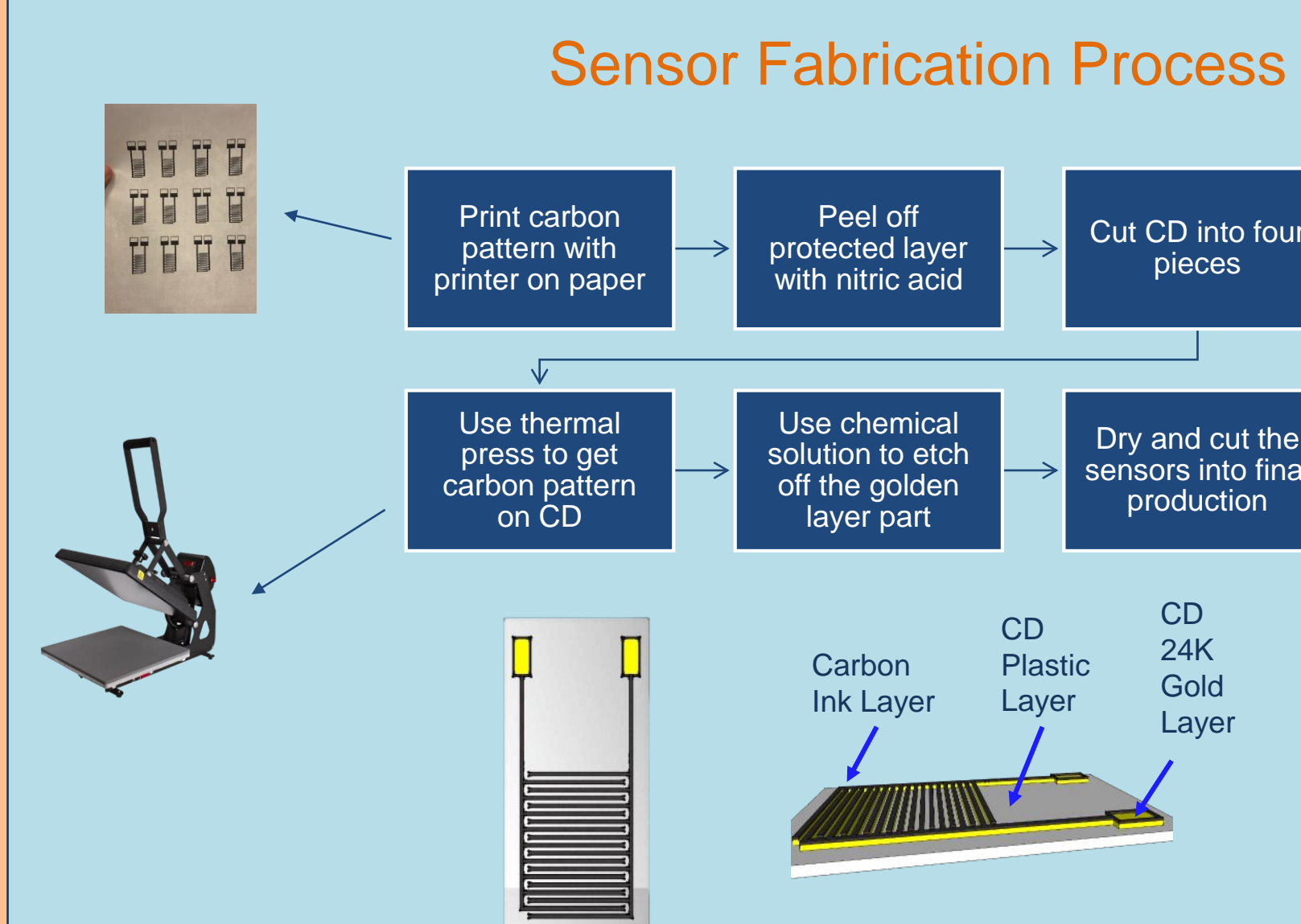
River stage (daily)



Soil moisture (weekly)



New Soil Moisture Sensor Development (MSMS)



Advantages

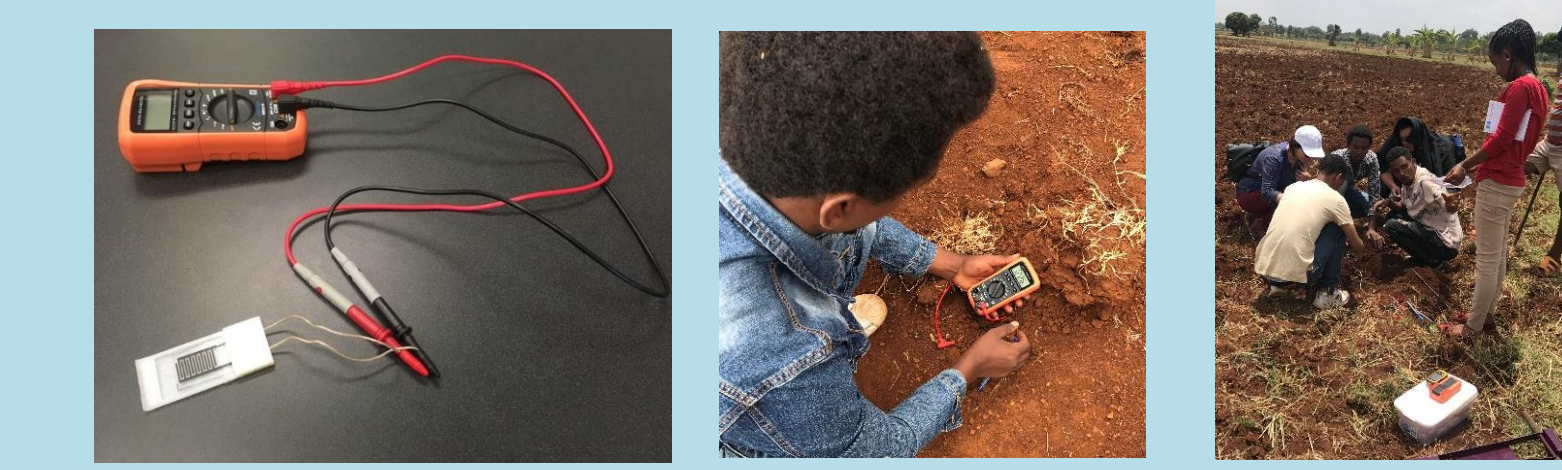
- Low cost (<\$1 per sensor)
- High resolution profiling at low cost
- Long-term stability (over a year)
- Multiple depth measurements

Challenges

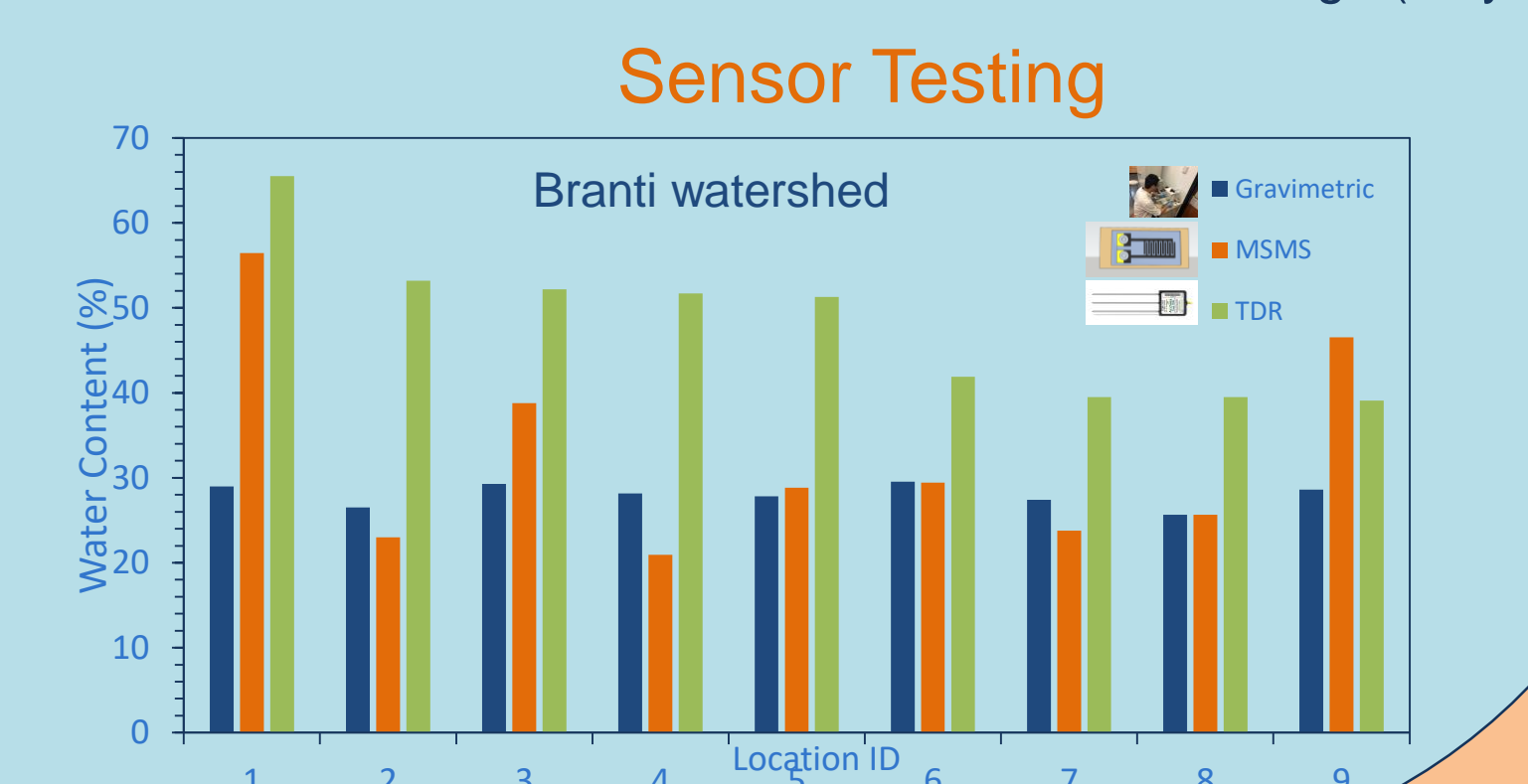
- Resistivity values may be affected by other soil parameters (e.g. nutrients, salt)
- Soil-sensor contact could be further improved

Sensor 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)



5. DATA TRANSMISSION

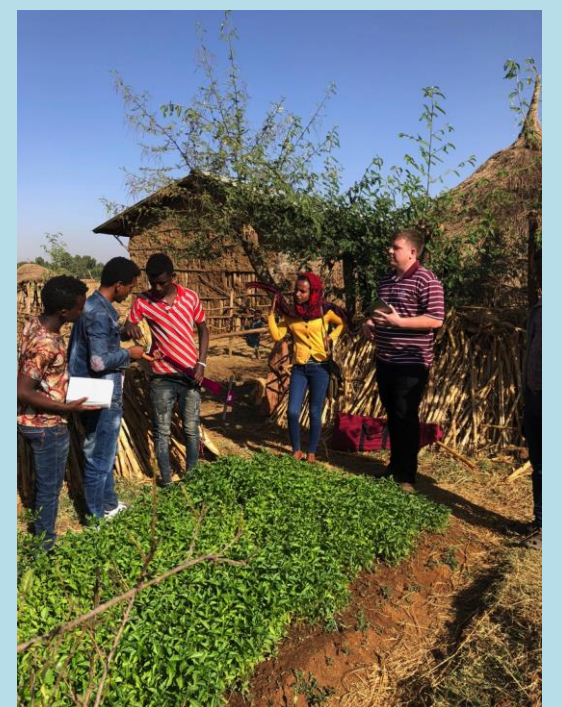
BWING app – Blue Nile Weather Identification Near the Ground



- 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

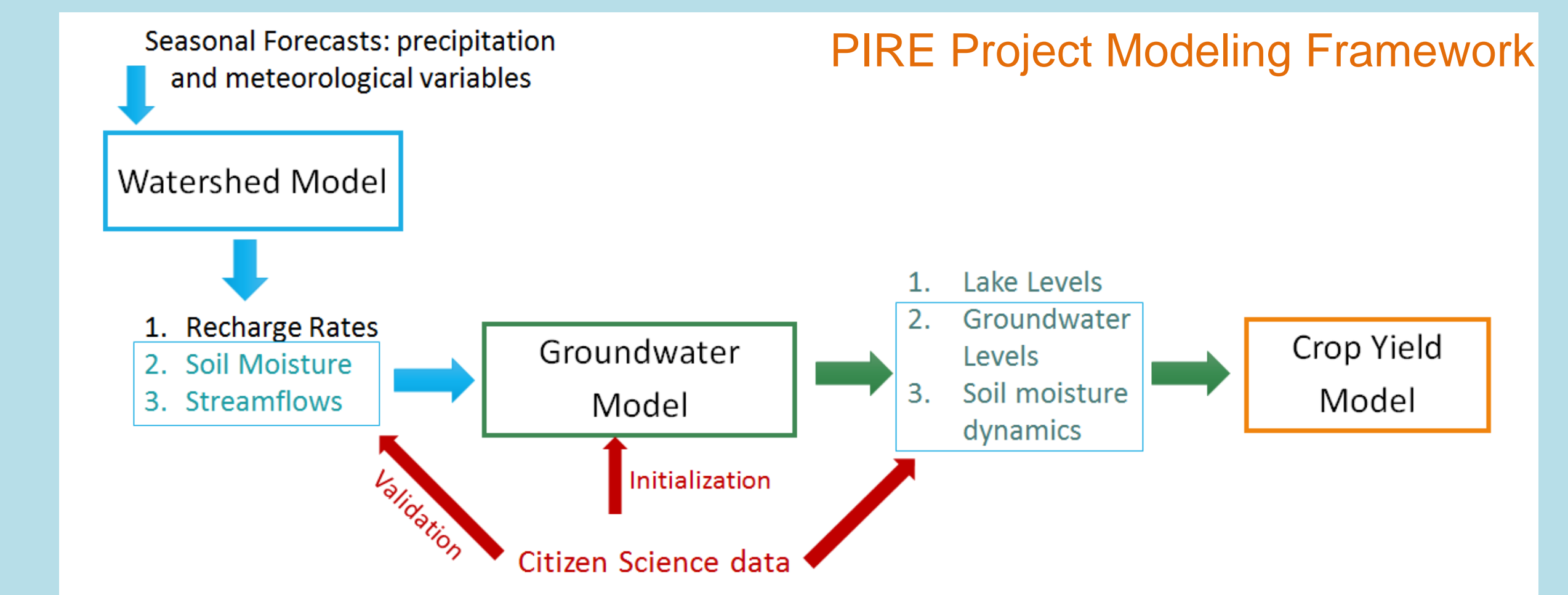


Trained first group of high school students on the usage of the app

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



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

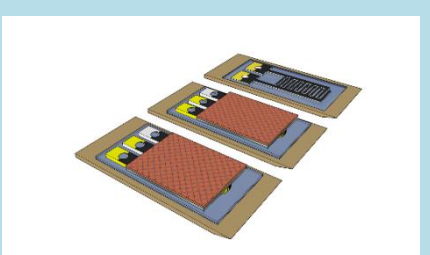
PIRE Researchers (Social scientists) will participate and observe the project in 2019 and 2020

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 adaptation 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



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