WellMapr© IS TO HELP SMALL FARMERS drinking water, irrigation and food supply

A project for the small famers of Ethiopia

WellMapr© is a unique AI system, giving a shallow groundwater map of Ethiopia, to decision makers

The system supports planning decisions to drill shallow wells

Outcomes are:

+clean drinking water
+irrigation
+double/triple crop yields
+better food security
+more youth jobs
+reduced hours for women lugging water cans each day
+safer access to water for women

Ethiopian scientists are leading the development

MapAid

Outcomes: WellMapr©

- **An AI system that puts a groundwater map on to a mobile app**
  - ***Guiding donors and development agencies*, replacing guesswork**
  - Providing more **accurate placement of shallow wells**, and
  - **Reducing costs, and risks** of shallow well programmes,
  - Enabling **more clean drinking water**, (60% - 80% of Ethiopians have gut infections)
  - **Liberating women & children from daily lugging of heavy water cans** (which also saves them from potential danger from vagabonds)
  - **Enabling irrigation, which doubles or triples food supply**
- Benefitting up to 47 million small farmers in Ethiopia living under the poverty line, **and in line with the Seqota Declaration**

Introduction: Project Background (1/4) WellMapr©

- **Collaboration group** between
  - George Mason University Center for Resilient and Sustainable Communities, USA
  - Arba Minch University, Water Technology Institute, Ethiopia
  - Global MapAid, a non-profit organization
- With *deep gratitude* for support from both the Czech Geological Survey and from Henley Business School, Reading University

Map Aid

Henley Business School

Awarded a humanitarian scholarship for an Executive MBA for R. Douglas-Bate

CZECH GEOLOGICAL SURVEY 1919

In negotiations for field collaboration

ARBA MINCH UNIVERSITY

GEORGE MASON UNIVERSITY

Center for Resilient and Sustainable Communities

Introduction: Project Background (2/4) WellMapr©

- **Project steering group** consists of:
  - Ministry of Water and Energy - confirmed
  - Ministry of Agriculture – in process
  - Collaboration group

In process

GEORGE MASON UNIVERSITY

Center for Resilient and Sustainable Communities

Map Aid

Introduction: Project Background (3/4) WellMapr©

- We have to collaborate; the days of competition are over:
  - Climate change respects no man or woman, and
  - The worst effects of climate change in recorded history are today, meaning
  - 23 million people in Horn of Africa are without food and water, but
  - Ethiopia has c.120,000 Km square of land suitable for shallow irrigation, and
  - Irrigation can double food supply**, but where should wells be drilled ?**
  - Better accuracy saves money & time for donors, drillers and diggers

Introduction: Project Background (4/4) WellMapr©

- In Ethiopia, small farmers comprise 95% of all farmers, which comprises about 80% of the population
  - Employment, food, health, and national success relies on small agriculture
- Ethiopian farmers could take micro-loans to construct wells for irrigation
  - Affordable borehole depth: less than 30 meters
  - Affordable pump: hand pumps

Objectives and Goals WellMapr©

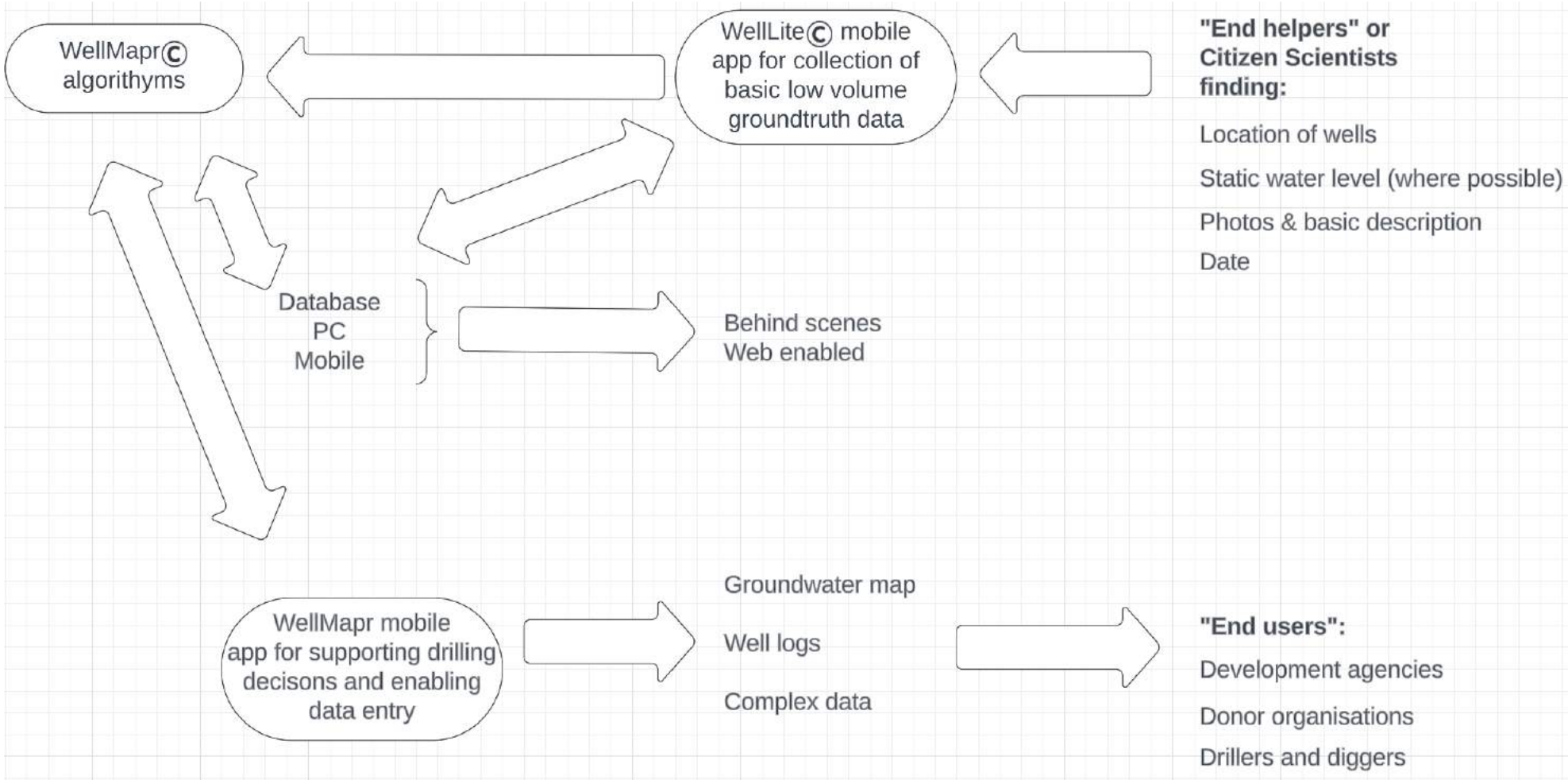
- Overall Objectives
  - Support better decision making for where to drill shallow boreholes for sustainable irrigation (<30 meters), by subsistence small farmers
  - Help save time and money, by increasing the rate of successful boreholes drilled
- Goals
  - 1) Estimate the depth to water table by using machine learning models
  - 2) Estimate the groundwater recharge
  - 3) Construct optimization models for identifying optimal drilling locations
  - 4) GROW the data inputs and refine accuracy
- Final Objective
  - Incorporate these results into a tool that can help guide drilling missions

Current Status (1/4) WellMapr©

- The “**WellMapr System”** is at the prototype stage
- The system includes a **database** and **algorithm backend** and two **smartphone apps**
- The main app, also called **“WellMapr”:**
  - Provides a map of suitable locations for drilling shallow wells for irrigation. The map is generated by an algorithm that uses openly available data to estimate the groundwater depth
  - Enables recording of well logs for new wells and updating of data on existing wells;
  - Supports management of data on wells within the covered region
- A **“WellLite”** version of the app is designed for data collection by citizen scientists
- The overall system is being designed to help predict groundwater levels, to accept data as new boreholes are drilled, and to support verification of existing well logs

Current Status (2/4) WellMapr©

WellMapr schematic

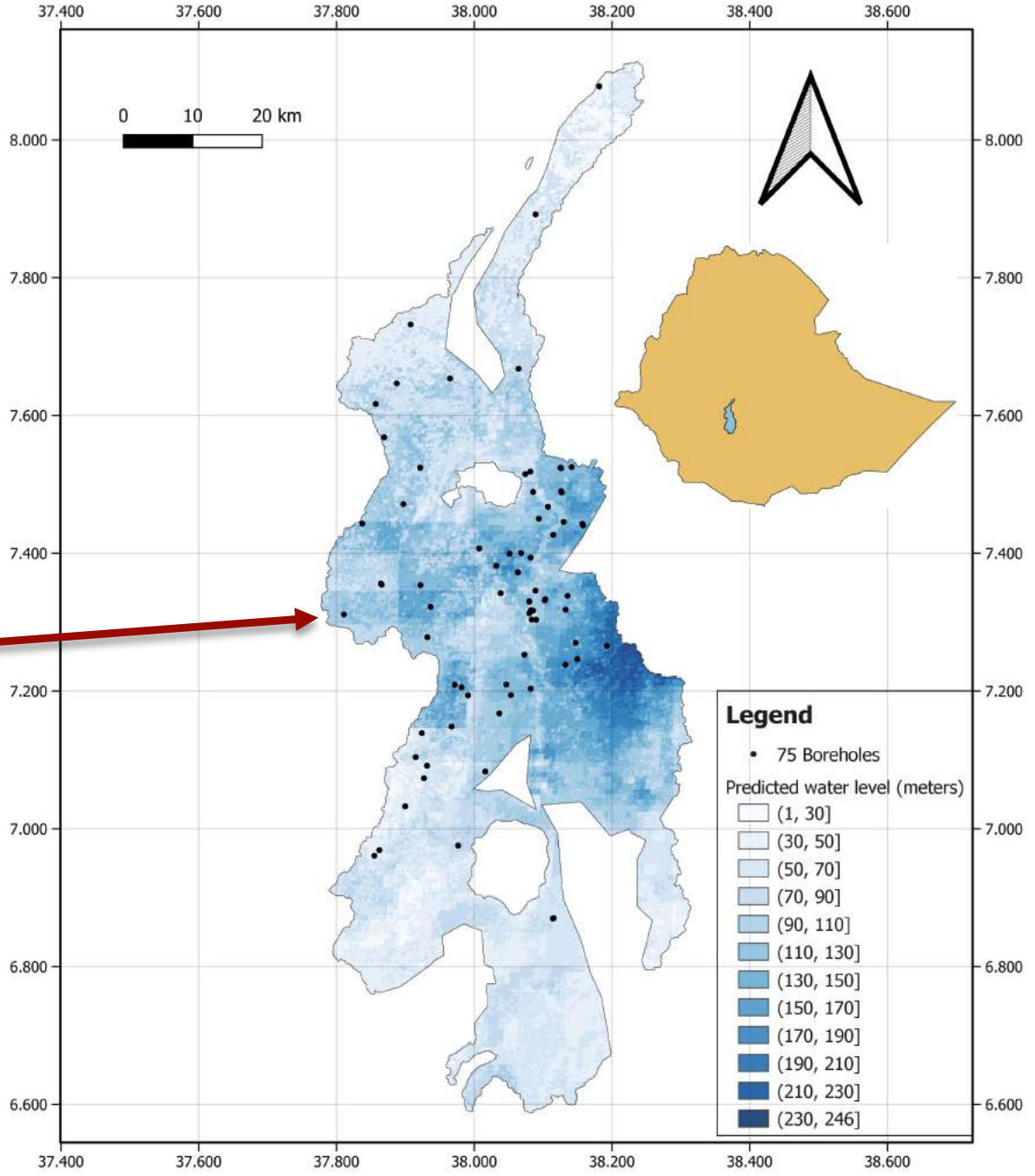


Current Status (3/4) WellMapr©

- **Groundwater level prediction**
  - Machine learning algorithms were constructed to predict the groundwater level
  - The models are trained using zero cost,
    - publicly available data on climate and geology
    - combined with data from existing shallow wells
  - Gradient boosting regression (GBR) outperforms the other models with a 19 m median absolute error (Table 1)
  - A map of the predicted groundwater level was created based on the best model
    - Prototype focuses on Bilate sub catchment

Table 1. Average model performance score based on multiple experiments did for each model

Dataset	Model	RMSE	MAE	R Squared
Training	MLR	42.49	29.92	0.43
	MARS	40.56	28.46	0.47
	ANN	7.58	2.10	0.96
	RFR	19.92	12.83	0.88
	GBR	12.74	7.58	0.95
Testing	MLR	46.81	26.14	0.31
	MARS	49.63	34.39	0.23
	ANN	36.45	23.74	0.49
	RFR	29.46	18.77	0.68
	GBR	24.55	18.92	0.77



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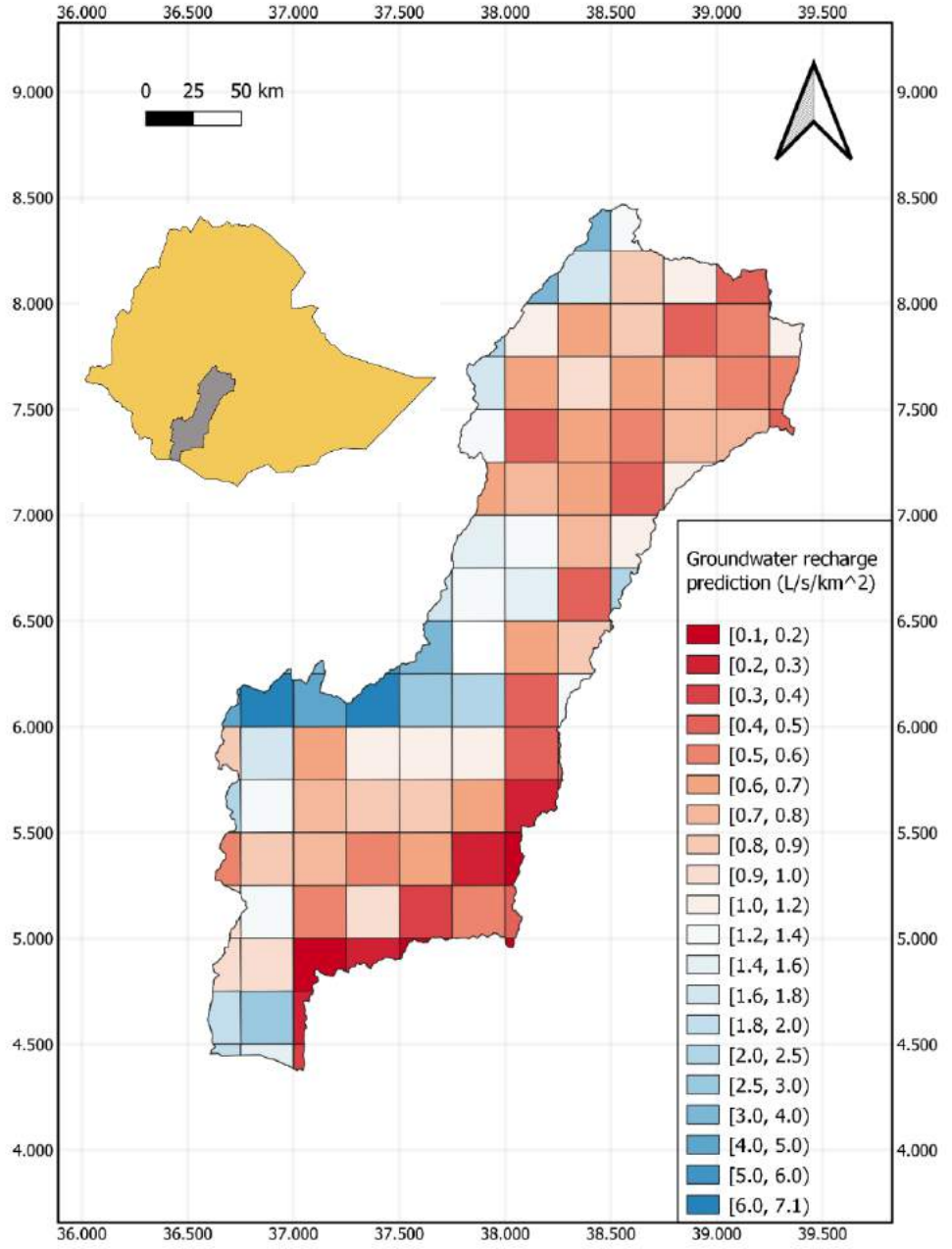
Current Status (4/4) WellMapr©

- **Groundwater recharge estimation**
  - Estimated the groundwater recharge using surface and subsurface runoff
    - Prototype focuses on **Rift Valley**
  - Compared estimated recharge with precipitation
  - Performed auto-correlation and trend analysis on estimated recharge and precipitation



Next Steps for Collaboration (1/2) WellMapr©

- **Estimate groundwater recharge**
  - Include other variables, such as NDVI and soil moisture, to complete the recharge analysis
  - Evaluate the groundwater recharge estimation by comparing to the GRACE data
  - Examine the correlation between the relevant variables and estimated recharge
- **Identify optimal drilling locations**
  - Formulate the model for identifying the optimal drilling locations
  - Increase data, the accuracy and the coverage areas in Ethiopia
- **In partnership with drillers, select locations for new boreholes, drill boreholes, create well log and add well data to model**
  - Use app to record well log data
  - Collect data on water level for newly drilled wells
  - Use data for evaluation of algorithm

Next Steps for Collaboration (2/2) WellMapr©

- **Evaluate prototype app in 2024**
  - Roll out beta version of app to **470,000 people, southern Ethiopia**
  - Provide app to donors, drillers, government hydrogeologists, engineers, agricultural extension workers
  - Perform usability testing of app for decision support and well log data collection
  - Evaluate quality of predictions and drilling decisions
- **Develop and pilot course at Arba Minch University on sustainable irrigation for small farmers**
  - Train students on app
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