Slide 1: Project title

“Enhancing AI for Predictive Modeling of Shallow Well Locations in Ethiopia" is the title of my proposed research project. The goal of this project is to create WellMapr, an AI-powered tool that will assist small-scale Ethiopian farmers by locating sustainable wells. In order to improve water access and solve climatic issues that impact nearby communities, the model will combine GIS and machine learning.

Slide 2: Project overview

The project's main goal is to create WellMapr, an AI-powered application for end users that will help Ethiopian farmers find appropriate well locations for irrigation. Chronic water scarcity, made worse by climate change and unpredictable rainfall, is a major problem for Ethiopia's rural agriculture. These factors restrict crop yields for communities who depend on subsistence farming, which has a direct effect on food security. WellMapr aims to predict the most suitable places for wells by leveraging a machine learning model called Gradient Boosting Regression (GBR), which has been trained on an initial set of well locations in Bilate region,s as well as environmental data such as land temperature, rainfall, soil composition, and humidity.

Nowadays, well siting in rural Ethiopia frequently depends on expensive technologies or informed guessing, both of which smallholder farmers cannot afford. With the help of inexpensive open-source data, our model demonstrated encouraging accuracy in the first trial findings, which this study aims to improve upon.

With the help of local specialists and the Czech Geological Survey, WellMapr will be expanded to the Sidama, Gamo, and Gofa (and later on further) regions of Ethiopia, making it more versatile in a variety of settings. WellMapr's ultimate goal is to provide a scalable and easily accessible solution to enhance agricultural resilience and water access.

Slide 3: Project Impact

Reliable groundwater data in rural Ethiopia is desperately needed, and this project addresses that requirement. Public access is restricted by the majority of current data being either out-of-date or under government control. This project uses AI-driven water mapping to enhance food and water security, which helps manage water resources. The Czech Geological Survey (CGS), George Mason University, and MapAid (UK) have partnered up to build sustainable, easily accessible water solutions.

Slide 4: Research question

The challenge of cross-disciplinary integration, incorporating geological and hydrological expertise into machine learning, is highlighted by our main research question, which asks: "How can machine learning, specifically an enhanced Gradient Boosting Regression model, be used to predict shallow well locations in varied Ethiopian regions accurately?" We further refine this question by investigating how additional environmental and geographical features can improve prediction accuracy.

Slide 5: Aims and objectives

By increasing and improving the WellMapr AI model's data inputs, we hope to improve the model's predicted accuracy for well sites in Ethiopia. To do this, further datasets from the Sidama, Gamo, and Gofa regions must be integrated. These datasets offer a variety of environmental features that can strengthen the model's resilience in various geographies. In order to improve the model's ability to forecast groundwater availability, we will add new characteristics such as soil composition and seasonal weather patterns, which have a significant impact on groundwater recharge and accessibility in semi-arid areas.

By working closely with geological and hydrological specialists from Ethiopia and the Czech Geological Survey, we can ensure that the model is relevant to local environmental circumstances and validate it scientifically. Expert feedback on feature selection and result interpretation is made possible by this collaboration, which helps to match our model with practical uses and community demands. All of these initiatives are working toward creating a dependable, flexible tool that offers useful information and gives communities the ability to make well-informed decisions about well-placement which promotes predictable well planning and water management.

Slide 6: Key literature and existing research

Literature research and review thus far revealed that applications of AI in hydrogeology are comparatively scarce and are furthermore mostly concentrated on high-resource industries like petroleum exploration (Morooka et al., 2001). The approaches of these AI-driven energy industry technologies are unsuitable for low-resource environments, such as rural Ethiopia, because they frequently rely on large and expensive datasets. Traditional well-siting techniques in these regions frequently depend on skilled specialists' on-site assessments or costly equipment like ground-penetrating radar. Small-scale farmers typically lack access to such resources, and they would substantially profit from a more straightforward and economical method of well siting (Pandey et al., 2020).

The WellMapr project seeks to fill this crucial gap by estimating groundwater availability using machine learning based on publicly available data. Focusing on readily accessible data sources (from NASA, Sentinel and Copernicus), like landcover characteristics and climate data, WellMapr provides a low-cost, scalable solution that can be tailored to other areas dealing with comparable issues. This initiative is significant because it supports agricultural resilience to climatic variability and supports sustainable development goals for food and water security in high-need, low-resource areas (Berhanu et al., 2014). Furthermore, the WellMapr methodology advances methods that enable underprivileged groups to utilize AI, promoting sustainable water management techniques where they are most needed.

Slide 8: Methodology overview

Our approach blends qualitative and quantitative methods:

.) Quantitative Methods: We will gather information from public sources and historical well records on soil composition, rainfall, land temperature, and other topics. Gradient Boosting Regression (GBR), our primary model, performs well on structured data and will be compared to alternative models, such as Random Forests. Metrics like MAE and RMSE will be used to assess the model's performance. In order to comprehend the environmental elements that affect groundwater depth, we will also perform correlation analysis.

.) Qualitative Methods: The applicability of our model will be guaranteed by discussions with geologists from Ethiopia and the Czech Geological Survey. In order to ensure that the model is in line with user needs and local conditions, we will perform field testing and collect qualitative input from local users, including farmers and non-governmental organizations.

Slide 9: Model deployment

In order to give Ethiopian farmers and non-governmental organizations easy access to well location recommendations, our finished model will be made available as the open-source smartphone application WellMapr. The following will be important features:

.) A map that can be used to illustrate suggested well locations.

.) An input system for coordinates that enables users to explore particular areas.

.) Cost estimation for water transportation to support resource planning. Local stakeholders will be empowered by this deployment's practical insights that promote sustainable water availability.

Slide 10: Ethical considerations and risk assessment

Several potential ethical issues are brought forward and will be considered during this project:

.) User privacy will be given top priority in accordance with data protection laws, especially when it comes to location data.

.) Transparency: To prevent over-reliance, the limitations of the model will be made widely known.

.) Equity and Accessibility: By collaborating closely with Ethiopian stakeholders, it will be possible to guarantee that the tool is usable by a variety of populations, thereby mitigating socioeconomic prejudices.

.) Risk of Misuse: Inappropriate tool use could result in well placements that are not sustainable, thus controls and user instructions will be in place to prevent this. The ethical foundation guarantees that our AI model does not inadvertently hurt communities.

Slide 11: Artefact (outcome)

The main output of this project is WellMapr, an AI-powered application tailored for Ethiopian consumers. The following are important features:

.) An interactive map with environmental data superimposed on suggested well locations to improve comprehension.

.) Users can provide high-quality data through user input and feedback features, adhering to a citizen science methodology that gradually enhances the model.

.) Tools for cost assessment aid in the logistical planning of water transportation and are particularly helpful when making decisions in rural areas. Targeting local farmers, NGOs, and Ethiopian government organizations, the application offers them a flexible and scalable tool for managing water resources.

Slide 12: Timeline

Our schedule is set up to guarantee that the project will be finished by June 2025:

Phase 1: (November–December 2024): Extend data collection to the regions of Sidama, Gamo, and Gofa, adding new characteristics such seasonal trends and soil composition.

Phase 2: (January–February 2025): Use fresh data to improve and evaluate the GBR model.

Phase 3: (March 2025): Test the model in new Ethiopian zones and make necessary modifications in light of early findings.

Phase 4: (April 2025): Improve forecast accuracy and model refinement by optimizing feature weighting.

Phase 5: (May 2025): Finish the last validation and get input from experts and stakeholders in Ethiopia.

Phase 6: (Jun 2025): Finish the documentation, conduct the last analysis, and turn in the project report. This schedule guarantees a methodical approach, starting with the preliminary data