

Agracaj AI (Group 9)

1 Overview

Farmers in France face increasing challenges due to recurring summer droughts, which threaten crop yields and livestock health. The decreasing availability of water for agriculture is a major issue that will worsen as temperatures continue to rise. In April 2023, 75% of groundwater reserves in France were below normal levels, with many classified as low to very low, according to the BRGM (Bureau de Recherches Géologiques et Minières). This alarming trend follows record-breaking drought years in 2018, 2019, and 2020, with July 2020 being the driest summer since 1959, surpassing the previous records of July 1964 and July 1979. Such conditions make effective water management increasingly critical for farmers. Without reliable tools to predict groundwater levels, they struggle to prepare and adapt, leading to inefficient water use and financial losses. Predicting groundwater availability during the summer is essential to help farmers make informed decisions, ensuring water conservation and agricultural sustainability.

This critical situation underscores the urgent need for innovative tools to support farmers in managing water resources more effectively. As a team of tech enthusiasts passionate about sustainability, we propose Agracaj AI : a high-tech predictive tool designed to forecast groundwater levels in advance of the summer season. By leveraging advanced machine learning and integrating meteorological and hydrological data, Agracaj AI offers farmers actionable insights to optimize irrigation schedules, plan crop rotations, and implement water-saving techniques. In addition to providing predictions, Agracaj AI includes an educational component to train farmers on using the tool effectively. This training empowers them to adopt strategies that maximize water efficiency based on the predictions, ensuring sustainable water use and improved agricultural resilience.

2 Business approach

With the solutions provided by Agracaj AI, farmers can react proactively to drought conditions by implementing targeted strategies. Knowing groundwater levels in advance allows them to optimize irrigation, which can reduce water consumption by 10% to 40% (INRAE) while maintaining crop productivity. This reduces costs for farmers by optimizing water use and minimizing waste. Farmers can also plan the cultivation of water-efficient or drought-resistant crops, ensuring better yields under limited water availability. Additionally, practices like agroforestry enhance water absorption and storage capacity, further mitigating the impact of dry conditions.

Our solution stands out because it is farmer-focused, specifically designed to meet the unique needs of agriculture. Farmers access our predictions through a

user-friendly mobile app that displays not only groundwater availability forecasts, but also tailored recommendations and alert notifications for potential drought risks. We provide continuous support to our clients to ensure they fully leverage the potential of the predictions. For example, through regular feedback on the app, we aim to help them optimize their irrigation schedules and better use our data in their practices.

In addition to its predictive capabilities, Agracaj AI includes a dedicated section to educate farmers on effective strategies to face summer droughts. This part of the application provides comprehensive guidance on methods such as improving irrigation efficiency, selecting drought-resistant crops, and implementing agroforestry practices. The tool also delivers tailored, AI-generated advice based on daily groundwater predictions and the farmer’s specific location. These personalized recommendations help farmers take precise actions aligned with their unique circumstances.

By combining advanced forecasting, personalized advice, and practical education, Agracaj AI empowers farmers to adapt proactively to drought conditions and sustainably manage water resources.

3 Scientific approach

Our solution is powered by predictive machine learning algorithms designed to forecast groundwater levels. These algorithms leverage datasets provided through partnerships with BRGM (Bureau de Recherches Géologiques et Minières) and Météo-France, including historical groundwater levels, meteorological data, and hydrological patterns. This collaboration ensures that our predictions are based on the most accurate and up-to-date information available.

To pre-process this data, we begin by dropping redundant and unnecessary columns, then columns with over 80% of data missing. In other cases of uneven data coverage, gaps are filled using imputation techniques : both IterativeImputer and KNNImputer. Furthermore, to find the most useful information, we explored our dataset with the agricultural context in mind. For example, according to historical data, stations at higher altitudes or with greater investigation depths might experience different groundwater dynamics compared to lowland areas. Temperature and rainfall patterns directly influence aquifer recharge and depletion cycles. We used these ideas, among other findings, to pinpoint the direction of our algorithm. We explored several models, including Neural Networks and Boosting algorithms (e.g., XGBoost, CatBoost), but none outperformed RandomForest on this dataset.

Other than the predictive AI model, we provide an intuitive mobile application to make our predictions accessible to farmers. The app serves as a comprehensive platform, combining daily groundwater forecasts with actionable recommendations. At the core of the app’s functionality is a generative AI model, GenAI, that

we have fine-tuned to provide tailored advice for farmers based on their specific location, crops, and predicted groundwater levels. The app also features an educational module powered by GenAI. This module offers farmers customized learning paths, equipping them with the knowledge to adopt best practices for drought management.

The solution is designed to accommodate diverse farming contexts, from small-scale vineyards to large crop farms. Modular architecture enables integration of additional data sources, such as new weather stations or farmer-provided inputs, making it adaptable across regions and scales.

4 Results and future potentials

Our prediction model achieved an F1 score of 42,84%, reflecting the inherent challenges of working with a large and complex dataset. A significant portion of the data had missing values, which we addressed using advanced imputation techniques: KNN Imputer for categorical variables and Iterative Imputer for numerical ones. Additionally, since much of the dataset was created by us, this likely contributed to the lower performance due to limited representativeness and variability.

Due to computational constraints, we performed a manual grid search for hyperparameter tuning, as automated grid search or k-fold cross-validation required more resources than were available. Despite these challenges, the results highlight areas for improvement and provide a solid foundation for enhancing performance with refined methodologies and increased computational power in the future.

Our future development roadmap includes several key enhancements:

- **Model Optimization:** By investing in greater computational power, we plan to perform a comprehensive grid search to fine-tune the parameters of our random forest model, being able to better handle the missing values, ensuring even greater accuracy and reliability in groundwater predictions.
- **Expanded Features:** In addition to forecasting water quantity, we aim to incorporate predictive analytics for water quality. This feature will help farmers manage not only the availability of water but also its suitability for irrigation, further enhancing agricultural productivity and sustainability.
- **Community Building:** We envision fostering a collaborative community where farmers can connect, share knowledge, and support one another. This network would be facilitated through events and a dedicated collaborative space within the app, allowing users in close proximity to exchange insights and solutions effectively.

These future developments will strengthen Agracaj AI impact, creating a more robust, comprehensive, and user-centered solution.