IOCAG 2022

The 1st International Online Conference on Agriculture:
ADVANCES IN AGRICULTURAL SCIENCE AND TECHNOLOGY

10–25 FEBRUARY 2022 | ONLINE

MOHAMMED VI POLYTECHNIC UNIVERSITY

CRSA Center for Remote Sensing Applications

Chaired by **PROF. BIN GAO**

agriculture

MDPI

# Towards smart big weather data management

Presented by: EL HACHIMI Chouaib, PhD candidate at CRSA, UM6P, Benguerir, Morocco

Supervisors:

Mrs. BELAQZIZ Salwa, LabSIV Laboratory, Department of Computer Science, Faculty of Science, UIZ University, Morocco.
Mr. KHABBA Saïd, LMFE, Department of Physics, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakesh 40000 , Morocco.
Mr. CHEHBOUNI Abdelghani, Center for Remote Sensing Applications (CRSA), Mohammed VI Polytechnic University (UM6P), Benguerir, Morocco

# Plan

- Problem statement
- Study area and data
- Methods and Results
  - Platform overview
  - Forecasting service
  - Data analysis and machine learning modeling service
- Conclusion

# Problem statement


Earth is facing real challenges related to climate change [1]

+

High rate of population growth [2]

Food security issues

Optimization of agricultural management practices

Optimizing irrigation water resources usage

Accurate estimation of the evapotranspiration

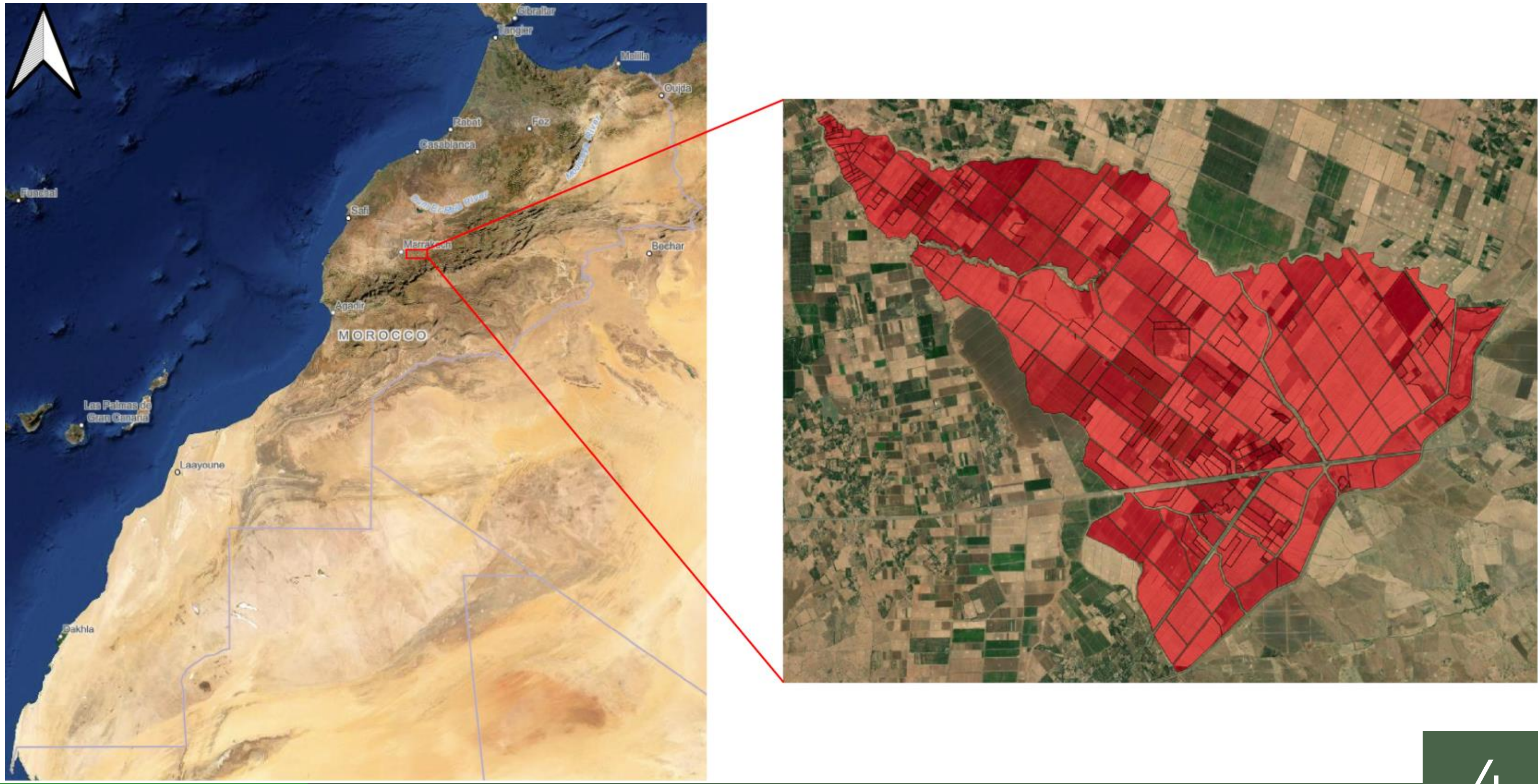
Weather monitoring

Lead to

Require

# Study area

- The experimental site is located  40 km east of Marrakesh city in Morocco.
- It is an irrigated area of about 2800 ha, which is almost flat.
- It has a Mediterranean semiarid climate: with around 250 mm of average annual rainfall[] and average annual evapotranspiration ($ET_0$) of 1600 mm [3, 4].
- Managed by : Office Régional de Mise en Valeur Agricole du Haouz (ORMVAH) & les associations des usagers des eaux agricoles (WUA).



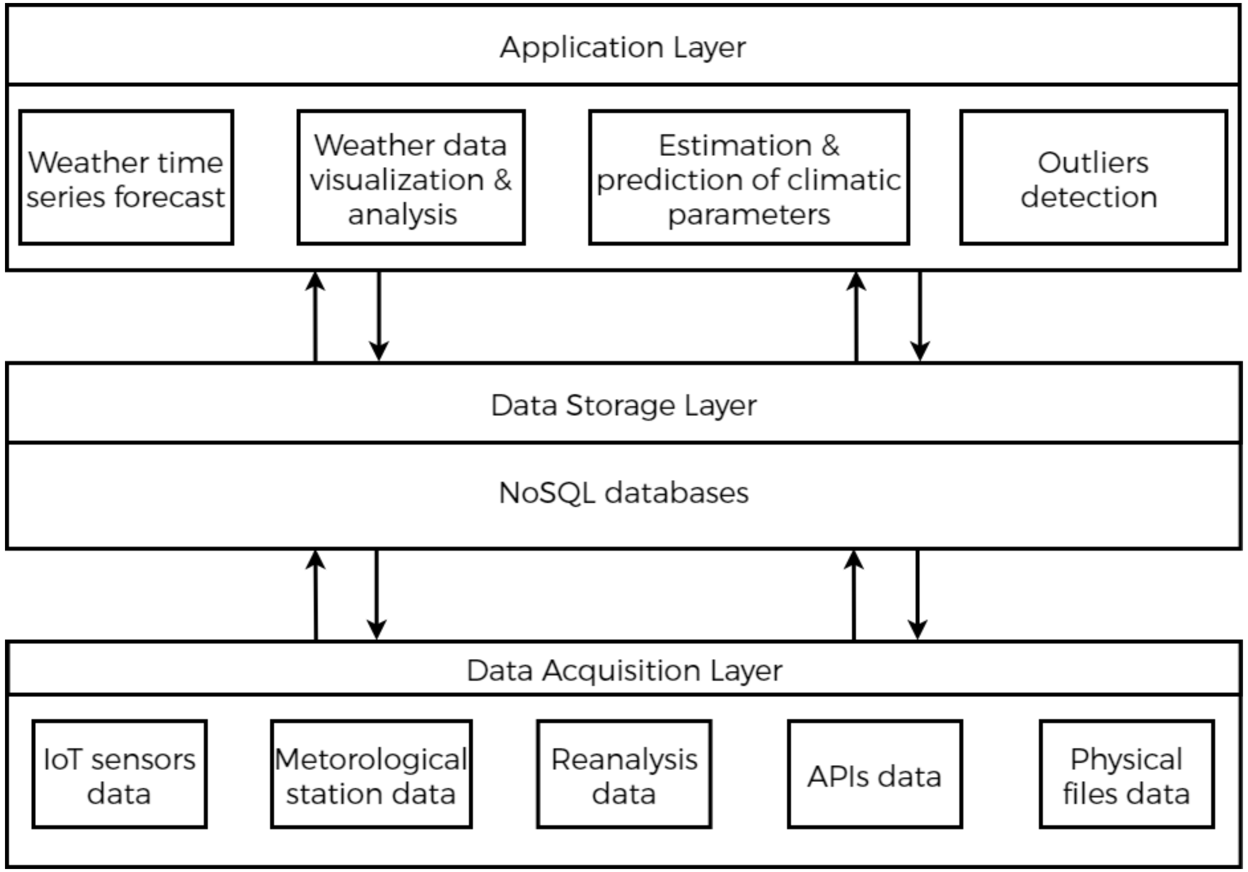
# Automatic Weather Station (AWS) data description

Weather data was collected from January 3, 2013, to December 31, 2020 at half-hour scale.

| Variables | Description | Unit |
|---|---|---|
| R3_Dv | Wind direction | Degree |
| R3_Hr | Relative humidity | No unit |
| R3_Rg | Global solar radiation | $W\ m^{-2}$ |
| R3_Tair | Air temperature | °C |
| R3_Vv | Wind speed | $m\ s^{-1}$ |
| R3_P30m | Rainfall | mm |

# Platform overview

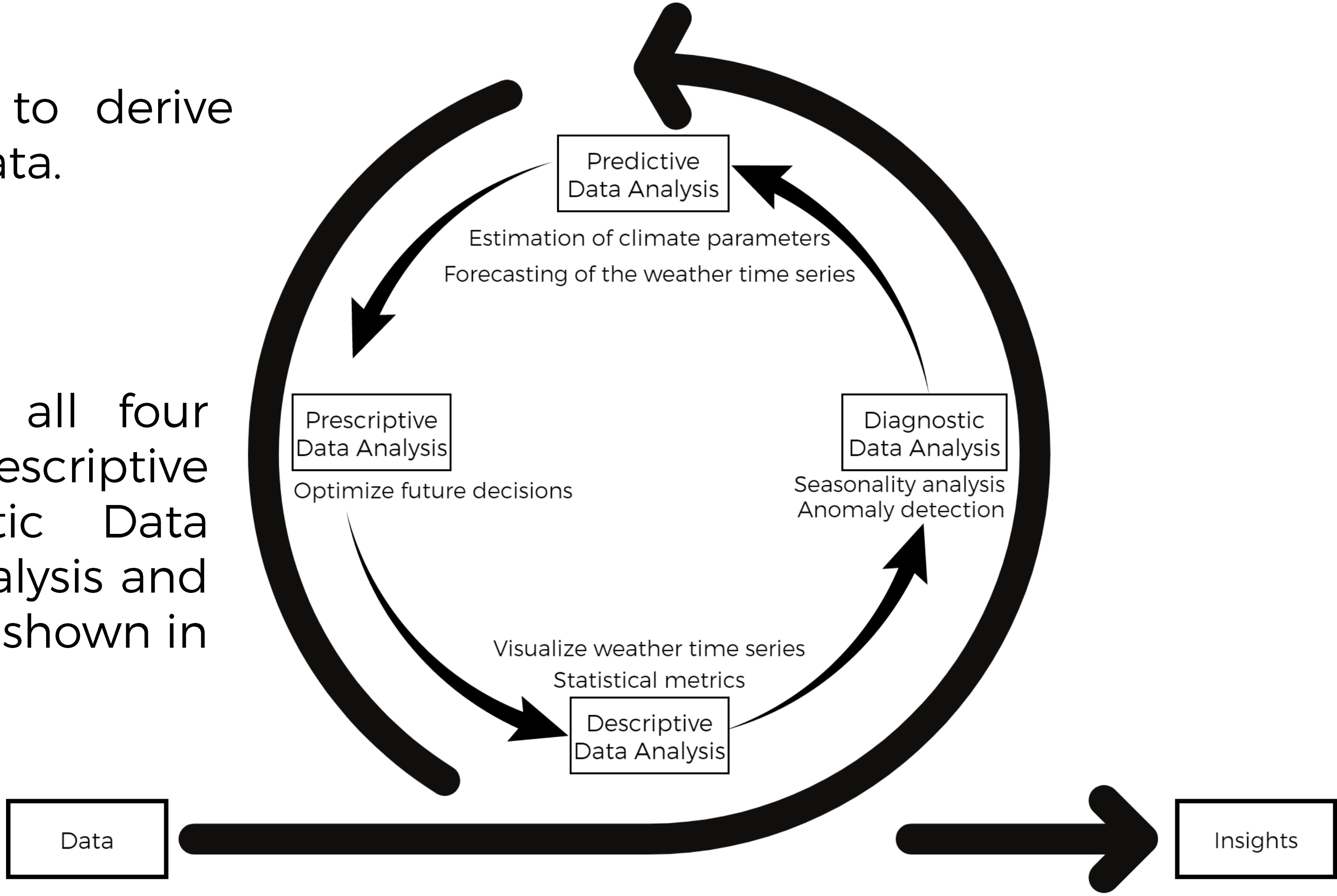
- The platform adopts a service-oriented architecture providing various services contained in the application layer.
- The data acquisition layer is responsible for collecting data from heterogeneous sources.
- The data is checked and preprocessed to handle missing values, before being stored using the MongoDB NoSQL database in the data storage layer.



# Platform overview

The platform enables users to derive actionable insights from raw data.

The platform services cover all four types of data analytics: 1) Descriptive Data Analysis, 2) Diagnostic Data Analysis, 3) Predictive Data Analysis and 4) Prescriptive Data Analysis as shown in the right figure.



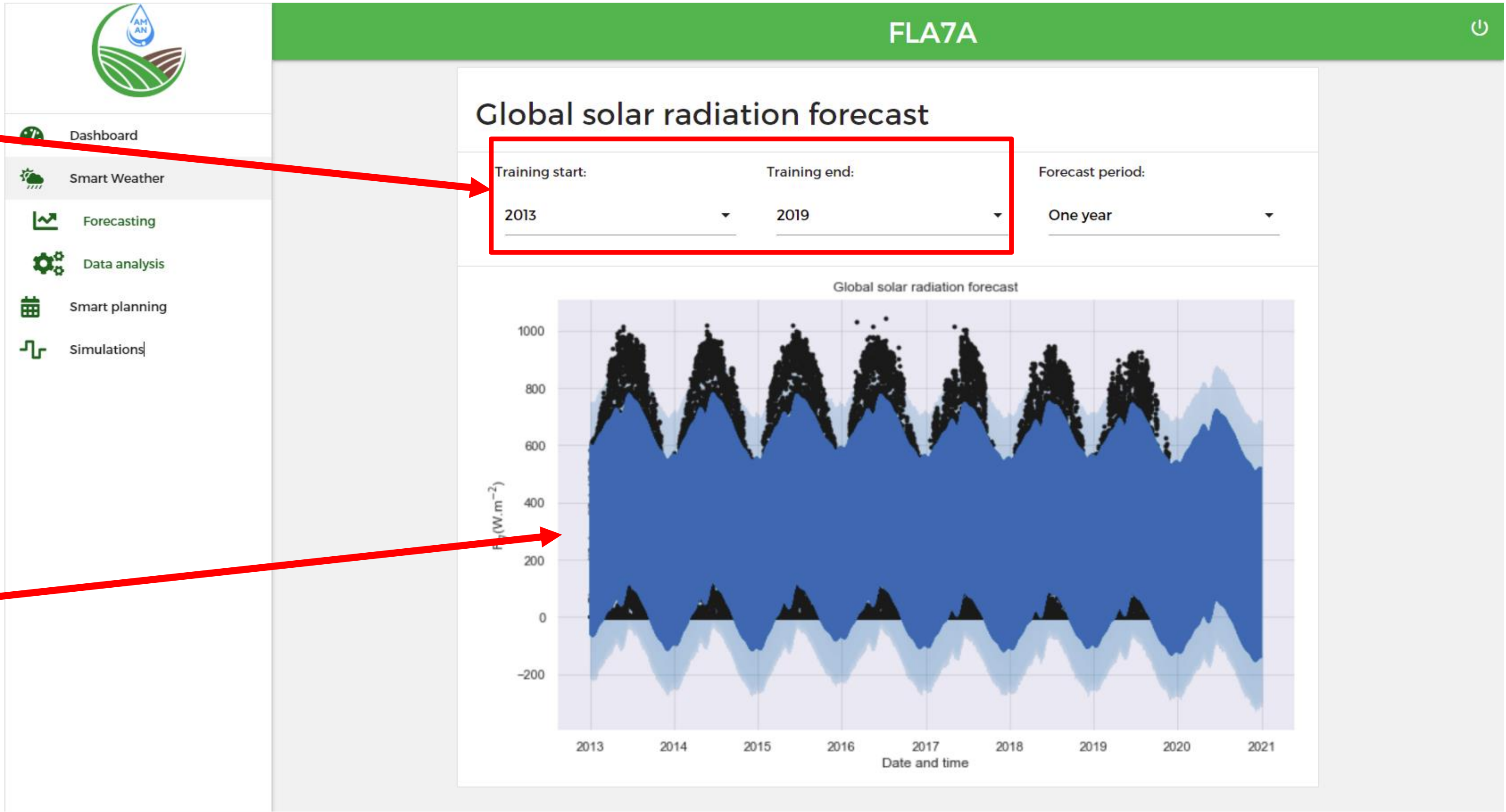
# Testing of weather time series forecasting service (2/2)

Steps of forecasting service

Generate training and testing sets based on years

Run the model

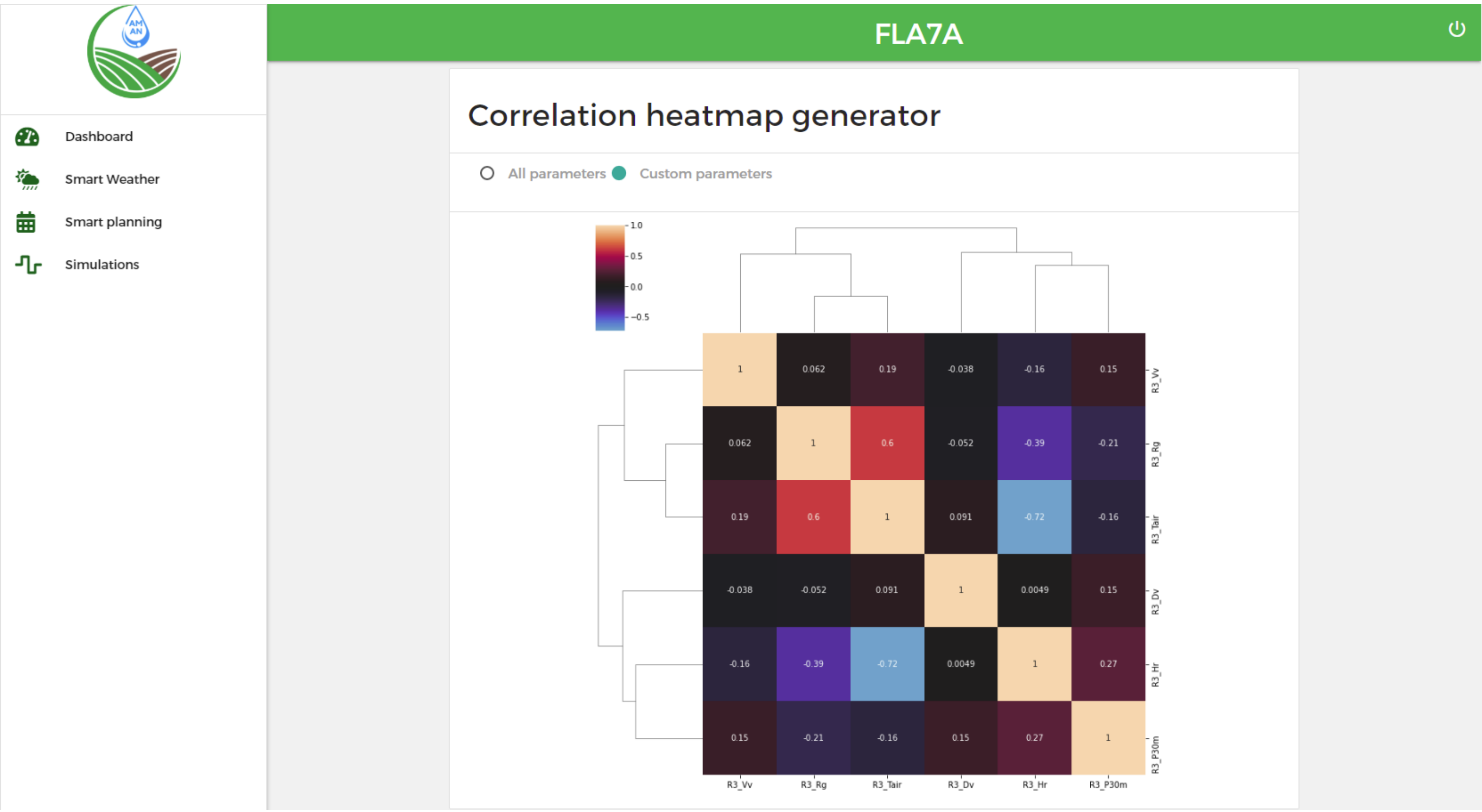
Visualize next year forecasts



# Correlation matrix generation for available weather data (1/3)

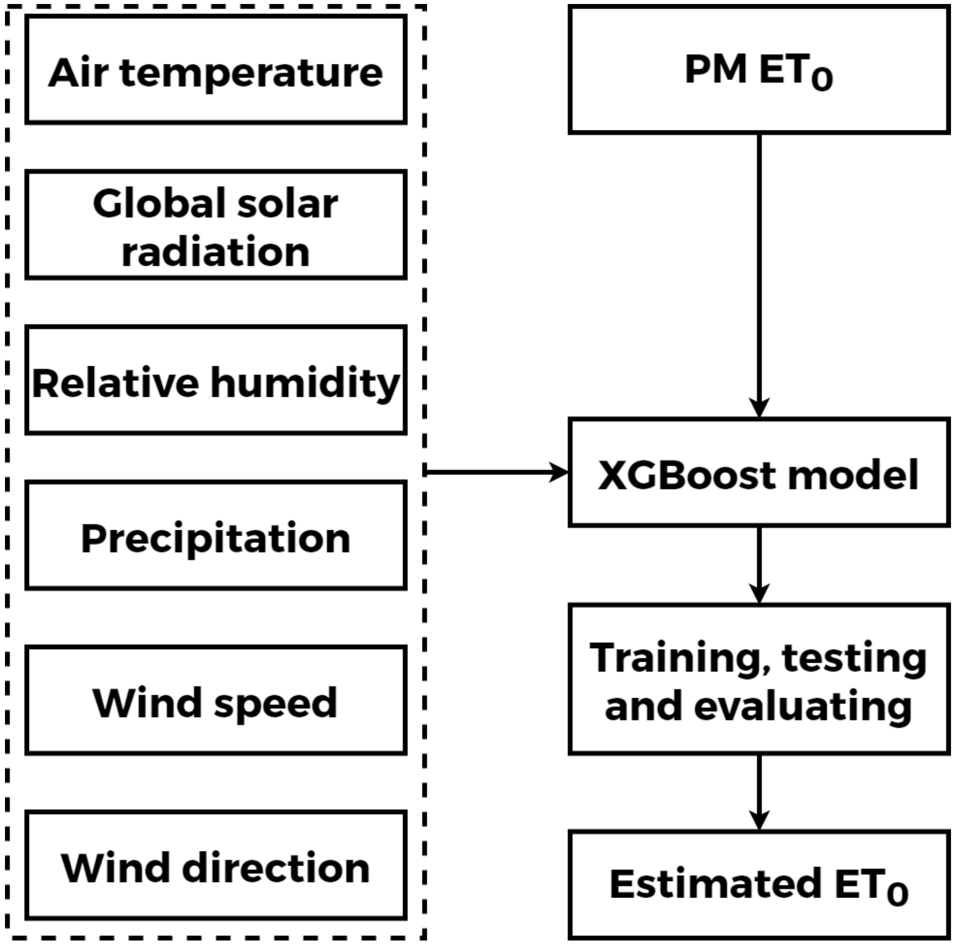
This service provides data analysis of stored data such as the generation of the Pearson correlation coefficient matrix calculated using the following equation:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$



# Modeling the reference evapotranspiration using machine learning (2/3)

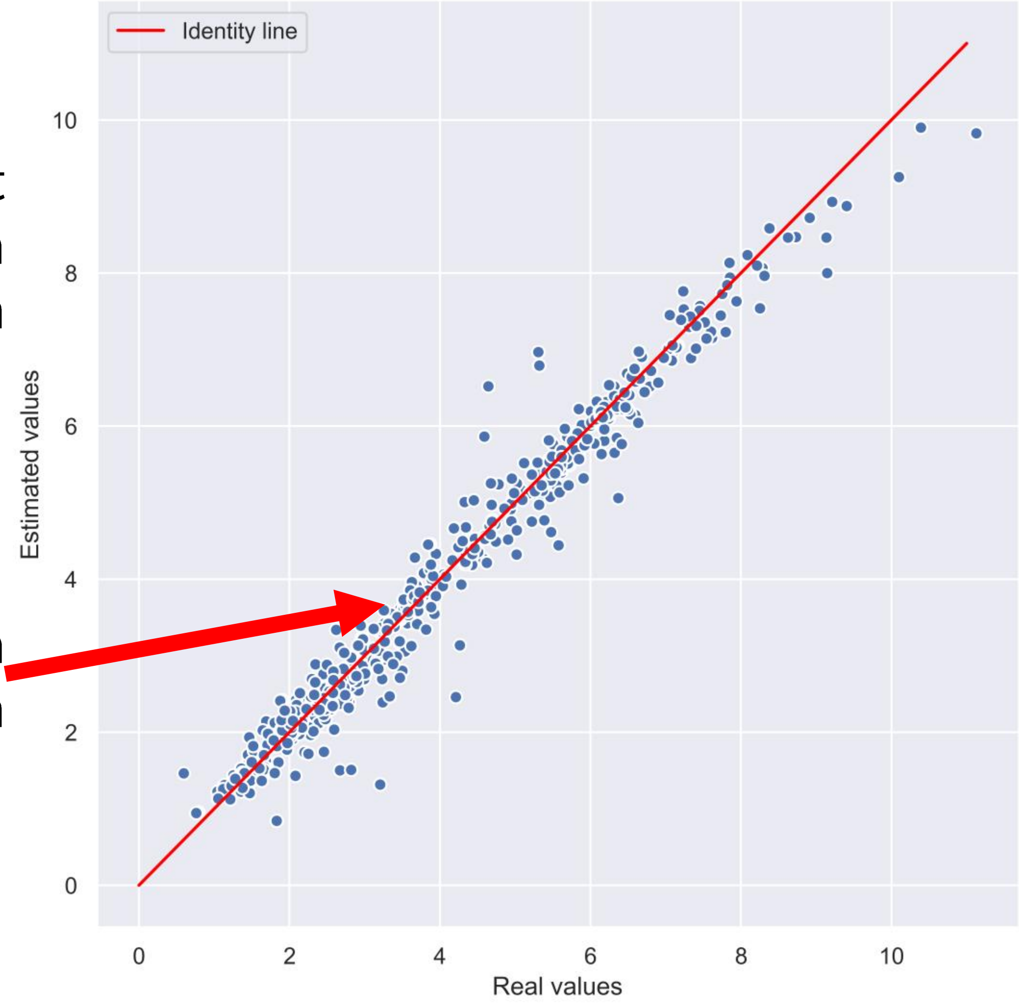
- The platform uses machine learning for modeling and estimation of important parameters used in agriculture such as the evapotranspiration.
- The evapotranspiration enables estimation of the quantity of water lost and in turn compensates for this loss through irrigation.
- The proposed approach uses the FAO Penman-Monteith $ET_0$[5] as a reference method for the estimation of the reference evapotranspiration from raw station metrological data.
- In the platform, the data is split into training and testing sets and then fed to the XGBoost[6] machine learning model.



# Modeling the reference evapotranspiration using machine learning (3/3)

Performance evaluation of the XGBoost machine learning model gives a high coefficient of determination $R^2$ (0.96) and a Root Mean Squared Error of 0.39

The positive linear scatter between estimated and real values of $ET_0$ indicates a good fit for the model.



# Conclusion

- In this work, we proposed a platform to assist decision-making in agriculture.
- It is based on artificial intelligence and big data analytics and offers various services related to weather data:
  - Storing and visualization;
  - Analysis and estimation of climatic parameters using machine learning;
  - Forecasting.
- As future work, the platform will be enriched with other services related to implementing smart agricultural practices.

# References

[1] Wade, M., Hoelle, J., Patnaik, R., 2018. Impact of Industrialization on Environment and Sustainable Solutions – Reflections from a South Indian Region. IOP Conf. Ser. Earth Environ. Sci. 120, 012016. https://doi.org/10.1088/1755-1315/120/1/012016

[2] Bongaarts, J., 2009. Human population growth and the demographic transition. Philos. Trans. R. Soc. B Biol. Sci. 364, 2985. https://doi.org/10.1098/RSTB.2009.0137

[3] Er-Raki, S., Chehbouni, A., Duchemin, B., 2010. Combining Satellite Remote Sensing Data with the FAO-56 Dual Approach for Water Use Mapping In Irrigated Wheat Fields of a Semi-Arid Region. Remote Sens. 2010, Vol. 2, Pages 375-387 2, 375–387. https://doi.org/10.3390/RS2010375

[4] Belaqziz, S., Khabba, S., Kharrou, M.H., Bouras, E.H., Er-Raki, S., Chehbouni, A., 2021. Optimizing the Sowing Date to Improve Water Management and Wheat Yield in a Large Irrigation Scheme, through a Remote Sensing and an Evolution Strategy-Based Approach. Remote Sens. 2021, Vol. 13, Page 3789 13, 3789. https://doi.org/10.3390/RS13183789

[5] PENMAN, H.L., 1948. Natural evaporation from open water, hare soil and grass. Proc. R. Soc. Lond. A. Math. Phys. Sci. 193, 120–145. https://doi.org/10.1098/RSPA.1948.0037

[6] Chen, T., Guestrin, C., 2016. XGBoost: A scalable tree boosting system. Proc. ACM SIGKDD Int. Conf. Knowl. Discov. Data Min. 13-17-August-2016, 785–794. https://doi.org/10.1145/2939672.2939785


# Thank you