



**Pole for Doctoral Studies**  
**Center for Doctoral Studies Sciences, Technologies, and Medical Sciences**

## **ANNOUNCEMENT OF DOCTORAL THESIS DEFENSE**



**Ms. NACIRI Hafssa**

**Will present their research work with the aim of earning a  
Doctorate**

**Doctoral program: Science and Technique Engineering**  
**Discipline: New Information and Communication Technologies**  
**Specialty: Informatics and Environment**

**On 07/02/2026 at 15H00 at the New Conference Hall, the National  
School of Applied Sciences of Tangier, UAE  
Under the Theme**

**Deep Learning and Remote Sensing Approaches for  
Environmental Monitoring: Forecasting Mediterranean Basin  
Vegetation and Climate Change**

**Front of the jury composed of :**

<b>First Name &amp; Last Name</b>	<b>Establishment</b>	<b>Designation</b>
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*Host Research Structure: Mathematics and Intelligent Systems (MASI)*

## Abstract



Climate change is intensifying global environmental pressures, altering temperature regimes, precipitation patterns, land conditions, and ecosystem functioning. These effects are especially severe in the Mediterranean, a major climate hotspot facing rapid warming, rising aridity, recurrent droughts, and widespread ecosystem degradation, all of which pose serious environmental and socio-economic risks. Remote sensing has become essential for monitoring and anticipating these changes thanks to its wide spatial coverage, temporal continuity, and consistency. Satellite missions such as MODIS, Landsat, and Sentinel provide long-term observations of vegetation dynamics, land and sea surface temperature, and land-cover change.

As these satellite time series grow, robust forecasting frameworks are increasingly needed for early-warning systems, resource management, and climate adaptation. Time series learning, using statistical, Machine Learning (ML), and Deep Learning (DL) models, offers strong capabilities for modeling environmental processes and capturing complex spatiotemporal patterns. However, forecasting remains difficult due to the variability of ecological processes, gaps and inconsistencies in satellite products, and the challenge of designing models that generalize across diverse climates, land-cover types, and multi-satellite datasets. Overcoming these issues requires systematic evaluation of forecasting methods and a deeper understanding of how environmental and data characteristics affect model performance.

This thesis improves environmental time series forecasting in the Mediterranean by integrating satellite-derived data with DL models. Forecasting performance of 29 vegetation indices across eight regions with diverse climates was evaluated using 624 multispectral seasonal images (2016–2022) from Sentinel-2, Landsat-8, and MODIS. Time series were analyzed with a traditional ARIMA model and two DL architectures (LSTM, Conv-LSTM) to assess the influence of climate, land cover, and satellite characteristics on accuracy. The thesis also presents AIRS, a QGIS plugin that enables DL-based forecasting, supporting data preparation, training of five architectures (FFNN, single-LSTM, stacked-LSTM, BiLSTM, Conv-LSTM) with hyperparameter tuning, and full performance evaluation. AIRS was applied to forecast 2023 Mediterranean Sea SST, where BiLSTM achieved the highest R2 and lowest RMSE, and to predict LST (2000–2024) across northern Morocco's land-cover types, highlighting the role of hyperparameter tuning in regional adaptability.

Overall, the study demonstrates that combining long-term satellite time series with advanced DL methods enhances forecasting, with performance shaped by environmental context, sensor characteristics, and model choice.

**Keywords:** Mediterranean, Climate change, Forecasting, Deep learning, LSTM, Satellites, Vegetation indices, LST, QGIS, AIRS