جامعة عبد المالك السعدي
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Université Abdelmalek Essaadi

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

ANNOUNCEMENT OF DOCTORAL THESIS DEFENSE

Ms. EZZAHER Fatima Ezahrae

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 10H00 at the New Conference Hall of the National School of Applied Sciences of Tangier, UAE
Under the Theme

Assessing Climate Change Impacts in the Mediterranean Region Using Remote Sensing and Deep Learning Techniques

Front of the jury composed of :

First Name & Last Name	Establishment	Designation
Pr. TABYAOUI Hassan	FP of Taza, USMBA	President
Pr. LAHRAOUA Mohammed	FSJES of Tangier, UAE	Reviewer
Pr. EL HAMMICHI Fatima	FP of Taza, USMBA	Reviewer
Pr. EL ADIB Samir	ENSA of Tetouan, UAE	Reviewer
Pr. AZYAT Abdelilah	ENSA of Tangier, UAE	Examiner
Pr. BOLAJRAF Mohamed	ENSA of Tetouan, UAE	Examiner
Pr. RAISSOUNI Naoufal	ENSA of Tetouan, UAE	Co-Supervisor
Pr. BEN ACHHAB Nizar	ENSA of Tangier, UAE	Supervisor

Host Research Structure: Mathematics and Intelligent Systems (MASI)

Abstract

Environmental monitoring is a key priority in the Mediterranean region due to climate change, rapid urbanisation, and growing pressure on natural resources. These dynamics affect vegetation, water bodies, urban expansion, thermal patterns, and fire-prone zones, threatening ecosystems and human well-being. With its large-scale and multi-spectral capabilities, remote sensing offers a powerful tool for monitoring such changes. Additionally, advanced tools like deep learning have increasingly been integrated into this field, providing influential pattern recognition and automated image analysis capabilities.

However, challenges remain: remote sensing data can suffer from distortions like cloud cover or atmospheric interference, which reduce image clarity and complicate the interpretation of environmental indicators. At the same time, deep learning demands large annotated datasets and computational resources. These limitations call for domain-specific solutions that are both precise and scalable.

In response, many efforts have been made to overcome these challenges through developing specialised software, improved algorithms, and integrating multi-source data. Contributing to this ongoing pursuit, this thesis proposes a multi-component framework based on satellite data to monitor environmental changes across spatial and thematic scales. It integrates: i) satellite-derived biophysical indices (e.g., NDVI, NDWI, NDBI, NBR, LST, etc.); ii) time series and spatial analyses to track surface dynamics and environmental trends; and iii) deep learning-based semantic segmentation (e.g., U-Net, LinkNet, etc.) for land cover mapping. Notably, over 100 indices were computed using Sentinel-2, Landsat-8/9, MODIS, and AVHRR data for Mediterranean study areas.

The comparative analysis showed strong inter-satellite consistency, particularly between Sentinel-2 and Landsat-8/9, and highlighted the impact of spatial resolution, land cover type, and time series quality on the analysis. To support such long-term monitoring and facilitate consistent data processing, the Remote Sensing Toolkit (RST) plugin was developed in QGIS, enabling automated computation and time-series generation of these indices.

The thesis also presents NDVI-UNet, a deep learning approach for improved vegetation mapping in cases where traditional NDVI thresholding fails, such as with blue roofs. This model enhances segmentation accuracy and eliminates reliance on manual annotations.

The approach was applied to a forest fire case in Bou Jedyane, Morocco, using multi-temporal Sentinel-2 and Landsat-8/9 data. NDVI, NBR, and LST time series revealed summer 2022 anomalies and vegetation loss, while NDVI-UNet provided precise pre- and post-fire vegetation maps and robust burned area detection consistent with the EFFIS product.

Overall, this work demonstrates the value of combining satellite images and multi-biophysical indices with deep learning techniques for scalable and accurate environmental monitoring. It also offers a strong and adaptable approach to tackle environmental challenges in rapidly changing areas, such as the Mediterranean basin.

Keywords : *Environmental Monitoring; Climate change; Remote Sensing; Deep Learning; Biophysical Indices; Time Series Analysis; Semantic Segmentation.*