Chapter 2
Shrinkage of the Lake Dayet Er-Roumi, Morocco: A Decadal Remote Sensing Analysis

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ABSTRACT

Freshwater lakes in semi-arid regions are critically vulnerable to climate change and anthropogenic pressures. Lake Dayet Er-Roumi, a permanent natural lake in Morocco recognized as a Site of Biological and Ecological Interest (SIBE), exemplifies such threats. This study quantifies the spatiotemporal dynamics of its water surface area from 2015 to 2025. Using Google Earth Engine, we analyzed Landsat 8/9 TOA imagery. The NDWI and MNDWI were applied to derive water masks. Seasonal water areas were computed by averaging cloud-filtered (5%) images per year. The lake underwent a 50% surface area reduction over the decade. Critical declines occurred in 2016–2017, 2019–2020, and most severely in 2023–2024 (-0.137 km^2), with recoveries too brief to reverse the trend.

I. INTRODUCTION

Freshwater lakes are among the most vulnerable ecosystems to impacts climate change and increasing anthropogenic pressures (Bouazzati et al. 2025 ; Meinam et al. 2025 ; Moumane et al. 2024 ; Mukherjee et al. 2023 ; Zhang et al. 2024). In semi-

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arid and Mediterranean environments, they act as critical reservoirs of biodiversity, provide water regulation services, and sustain local livelihoods. However, they are undergoing rapid transformations due to rising temperatures, and decreasing precepitation, and intensified human exploitation of water resources. Globally, numerous studies have reported shrinking lake areas, declining water quality, and reduced ecological resilience, highlighting an urgent need for monitoring and adaptive management strategies (Bucak et al. 2017; Moumane et al. 2025; Sahbani et al. 2022).

In Morocco, freshwater ecosystems are particularly scarce and fragile (Chrif El Idrissi et al. 2025; El Orfi et al. 2025). While significant number of researches have focused on large reservoirs and wetlands, comparatively little attention has been given to small ones, which face equally pressing hydrological and ecological threats. This knowledge gap is especially concerning given their dual role in preserving biodiversity and development. Recent studies show that Moroccan lakes and ponds are under threat from reduced precipitation, increasing evapotranspiration, groundwater overuse, and pollution (Addou et al. 2025; Grillas et al. 2021).

Lake Dayet Er-Roumi (33.744379°N, 6.192217°W) provides a critical case study for understanding wetland dynamics in semi-arid North Africa. Situated in Morocco's Khémisset Province within the Rabat-Salé-Kénitra region, this ecosystem represents the only permanent natural continental lake of low altitude, the lake supports unique biodiversity and provides essential ecosystem services.

Previous research has documented severe environmental degradation, including physicochemical pollution exceeding multiple regulatory thresholds (Ougrad et al. 2024), declining ichthyofauna diversity (Baladia et al. 2025), and intensifying anthropogenic pressures from agricultural expansion, groundwater extraction, and domestic wastewater inputs (El Ghizi et al. 2021). These compounding stressors have accelerated the lake's ecological deterioration, threatening its functional integrity and conservation status.

Our study addresses quantifying the spatiotemporal dynamics of Lake Dayet Er-Roumi's water surface area between 2015 and 2025 using multi-temporal remote sensing analysis. This research not only documents the alarming hydrological trajectory of a nationally significant ecosystem but also contributes to the broader understanding of freshwater vulnerability in semi-arid North African contexts, where climate change and human activities increasingly threaten wetland sustainability.

II. STUDY AREA: LAKE DAYET ER-ROUMI

Lake Dayet Er-Roumi is a unique natural feature in Morocco (Figure 1 and 2), recognized as a Site of Biological and Ecological Interest (SIBE*)* due to its ecological importance and biodiversity (El Ghizi et al. 2023; Sadki et al. 2022), making it