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Optimizing Water Resources in Coastal Areas using Artificial Intelligence:

TUNISIA

27/04/2026

Ras Jebel Case study overview

Dr. Fatma TRABELSI
ESIM

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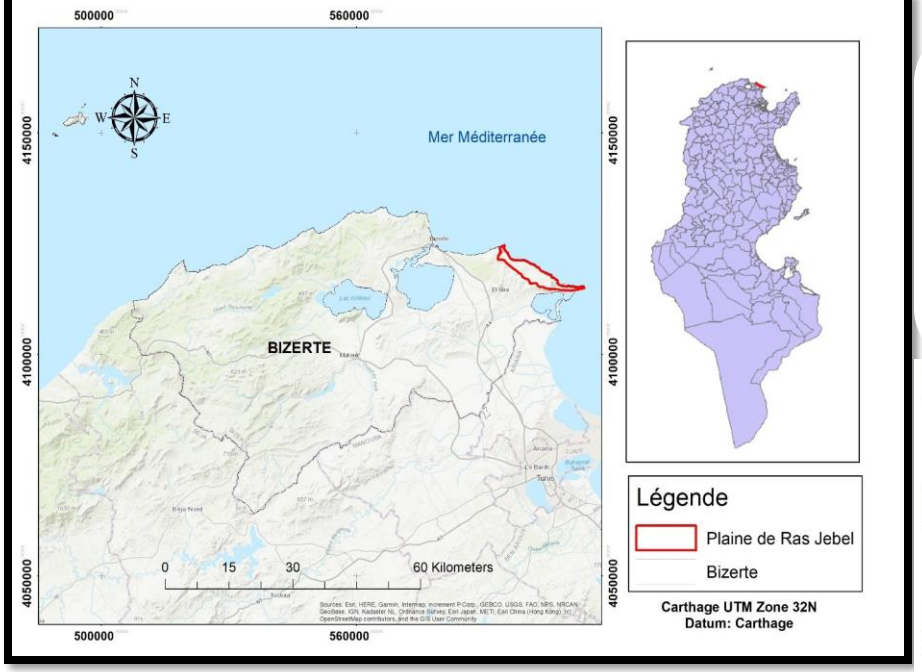
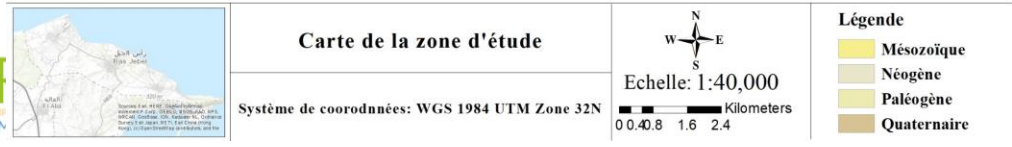
Geographical Context

- ✓ The Ras Jebel coastal aquifer is situated in the northeastern of Tunisia of Bizerte gouvernorate. It stretches along the Mediterranean shoreline between Cap Zebib and Raf Raf.
- ✓ The hydrogeological basin encompasses an area of 50 km² while the phreatic alluvial aquifer occupies approximately 35 km².





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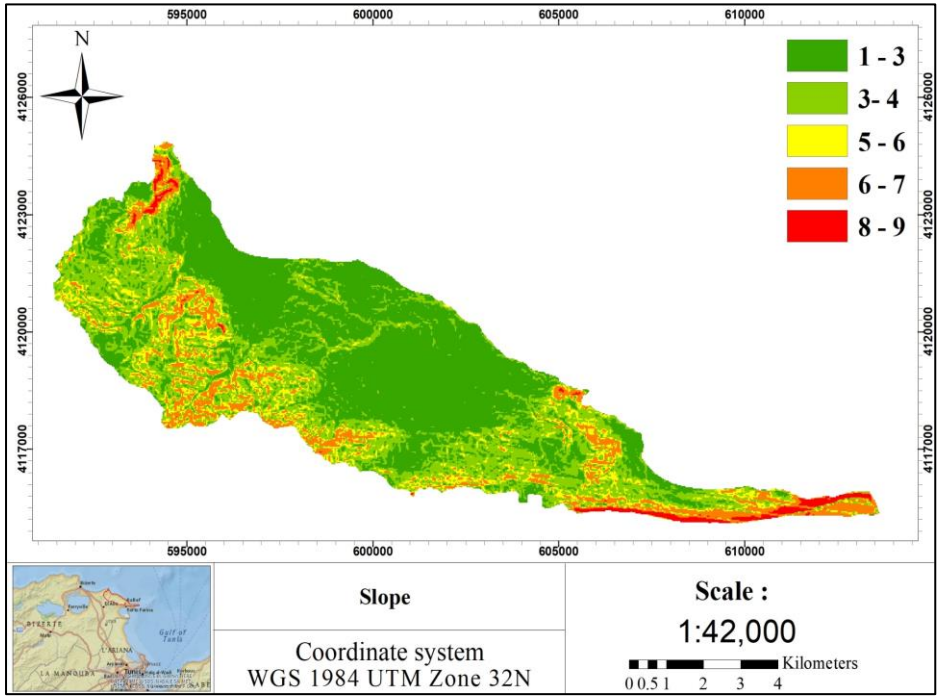
Topographic Context

- ✓ Ras Jebel has contrasting topography, marked by an abrupt passage of hilly reliefs in the southwest, culminating at 318 meters, towards a vast coastal or alluvial plain in the northeast located at an altitude close to sea level (0 - 36 m).
- ✓ The combined analysis of relief and slopes reveals a clear morphological asymmetry: the rugged peripheral areas (slopes from 6 to 9) promote rapid runoff and erosion, while the central area, mostly flat (slopes from 1 to 3), constitutes a natural receptacle favored for the accumulation of waters and sediments.
- ✓ This configuration suggests a hydrographic unit where flows converge towards the central depression, characterizing an environment conducive to agricultural activities and potentially to significant underground recharge in low-lying areas.



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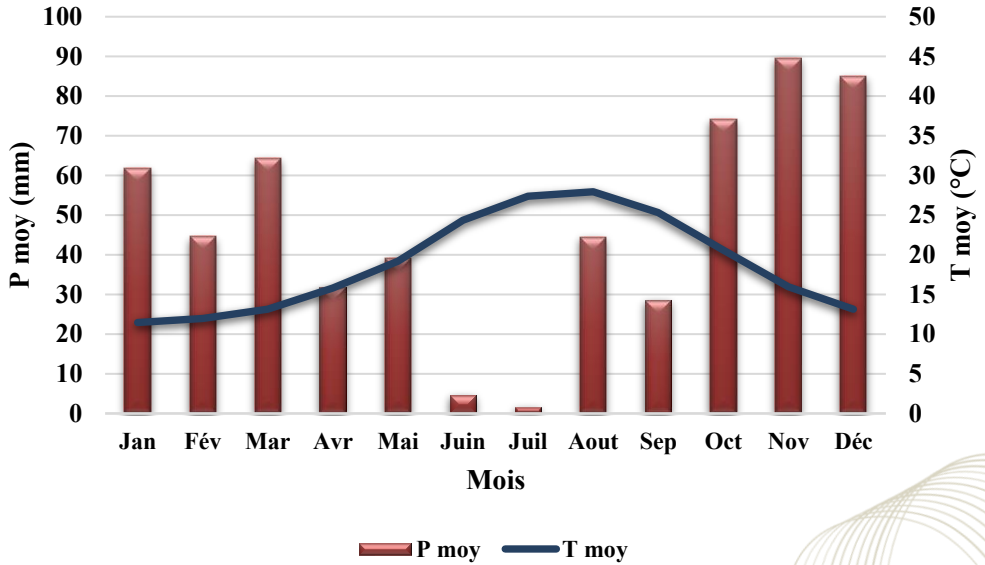
Climate Context

Rainfall

Average annual rainfall is estimated at 471 mm, with the highest levels recorded in winter and the lowest during the summer

Temperature

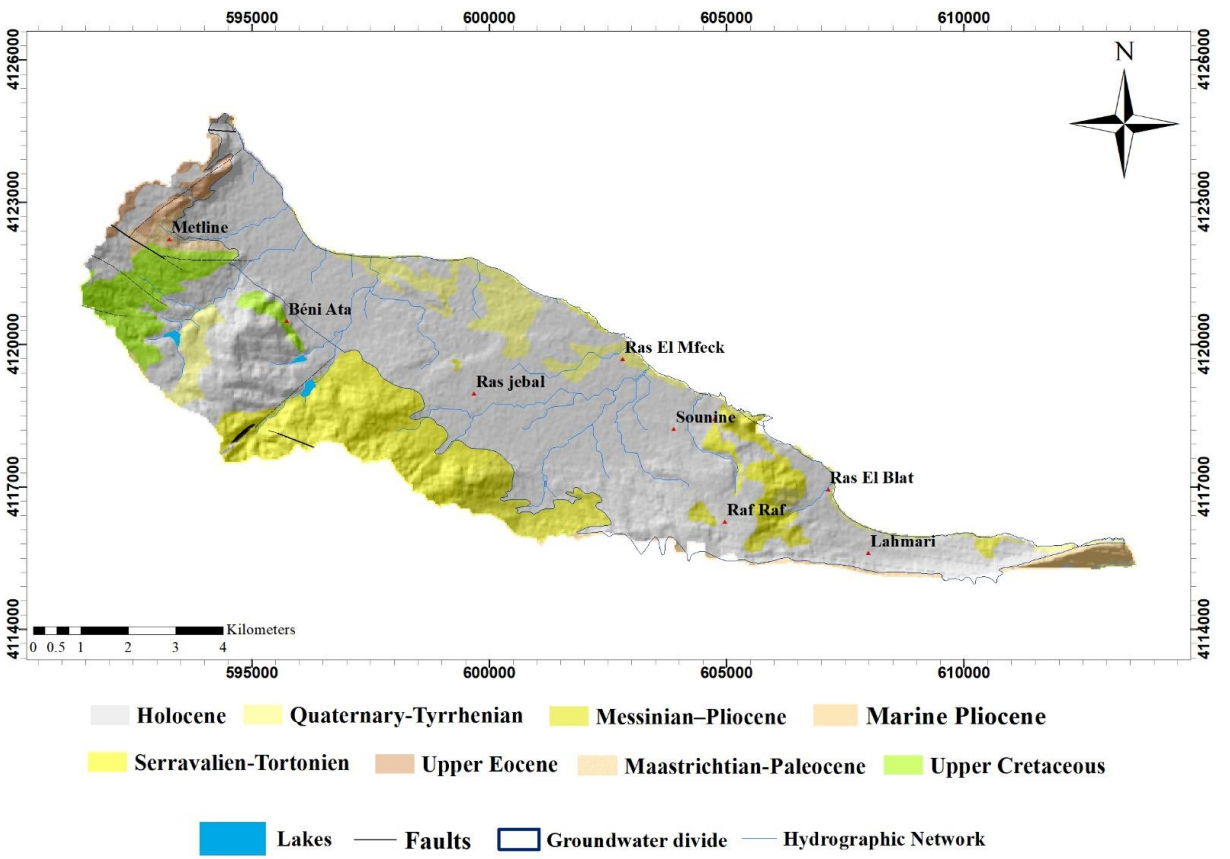
The average annual temperature is around 13°C, with summer highs reaching 28°C and winter lows around 10°C.



Geological context

The Ras Jebel aquifer is situated within a complex geological setting, shaped by natural processes over time. The Cap Zebib–Ras Jebel–RafRaf basin corresponds to an ancient collapse basin filled with recent alluvial deposits.

The region is dominated by Miocene-Pliocene formations and dunes, with a Quaternary coastline. The Pliocene is characterized by the yellow sandstones of Porto Farina (≈260 m), while the aquifer substrate consists of RafRaf marls.



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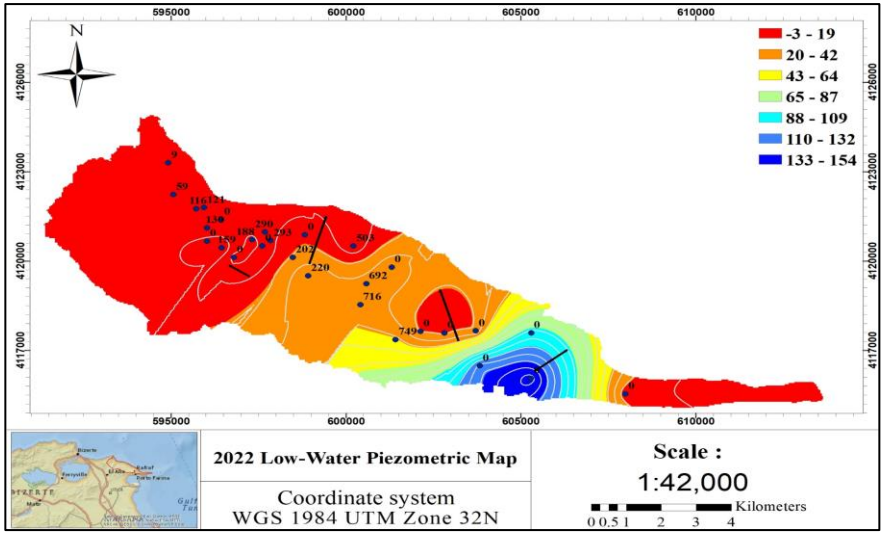
Hydrogeological Context

The Ras Jebel aquifer is a predominantly unconfined (phreatic) multi-layered coastal aquifer. It consists mainly of sandy and sandy-clay formations from the Miocene-Pliocene and Quaternary periods, which give it good permeability.

Locally, the presence of marl layers (notably the RafRaf marls) acts as an impermeable substrate and can create semi-confined conditions in some areas.

The piezometric maps show a decrease in groundwater levels below the static water level (SWL), which enhances the progress of seawater intrusion and the salinization of the groundwater



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Main Hydrological & Agriculture Challenges

For several years, the RJ aquifer is pumped intensively to meet water needs, especially for irrigation.

Overexploitation of groundwater has caused a piezometric dropdown near the sea and a groundwater quality deterioration.

Indeed, for groundwater remediation, the General Direction of Water Resources (DGRE) and local water authority (CRDA, Bizerte) adopted artificial groundwater recharge by surface water through the irrigation network in 1992,

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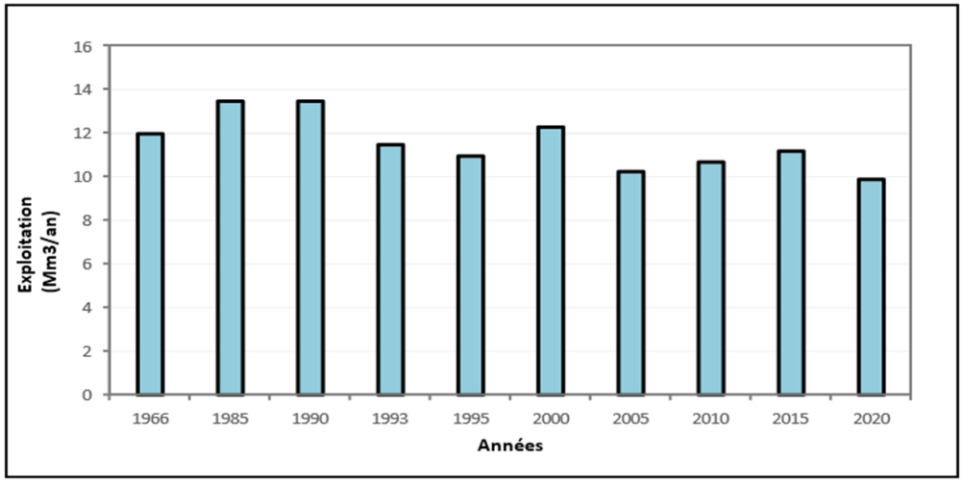
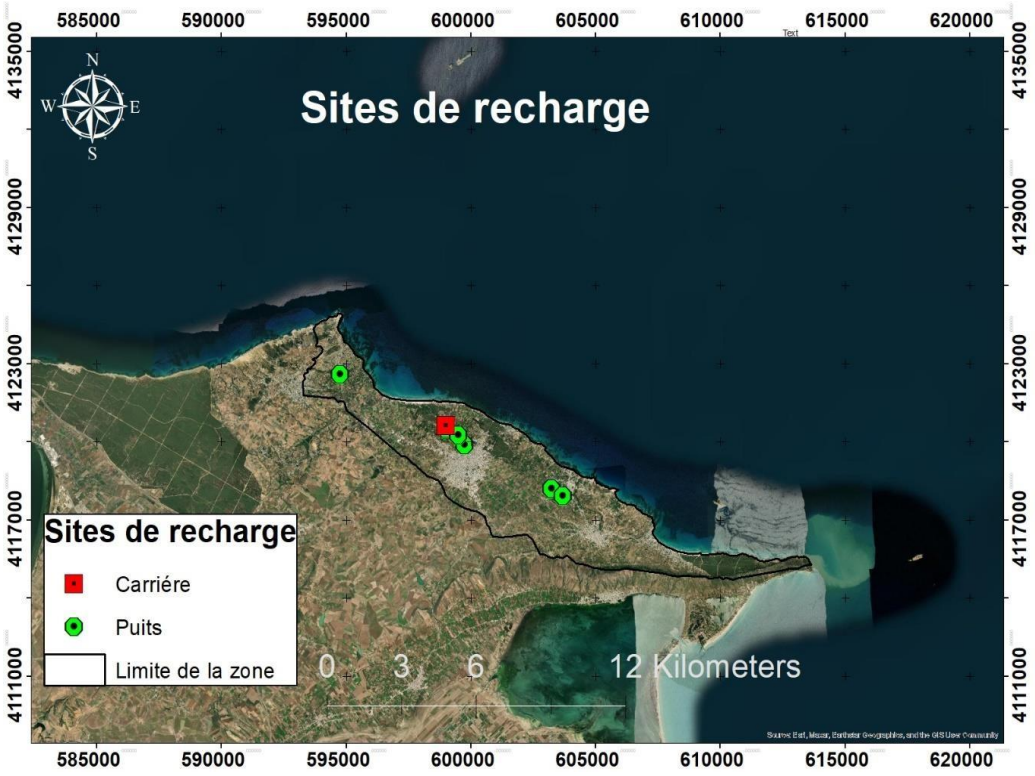
Groundwater Overexploitation

Evolution of groundwater withdrawal (1966-2020)



The groundwater exploitation rate remains high over 117%

Status of the artificial recharge of the Ras Jebel aquifer



The artificial recharge of the Ras Jebel aquifer was established in 1992 through the creation of a recharge system located north of the town of Ras Jebel, specifically at a site known as ‘Sidi El Gabbari’

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Available data

Data required for Groundwater modeling (MODFLOW) & Prediction (AI)

Geological data	Pumping wells (flow rates)
	Soil and rock types
	Aquifer geometry
Hydraulic properties	Hydraulic conductivity
	Porosity
	Storage coefficient / specific yield
Boundary conditions	Rivers, lakes, seas
	Impermeable limits (no-flow boundaries)
	Constant head zones
Recharge data	Rainfall
	Infiltration rates
	Evapotranspiration
	Land use (urban, agricultural, etc.)
Water abstraction	Aquifer layers (number, thickness)
	Irrigation or injection wells
	Aquifer geometry
Initial conditions	Starting groundwater levels (piezometric heads)
Observation data (for calibration)	Piezometric levels
	River flows or groundwater discharge points

Current research activities

Year	Level	Topic	Name of student	Supervisor
2026-2029	PhD Thesis	Groundwater Management Using Remote Sensing, Hydraulic Models and Artificial Intelligence: Case Study: Ras Jebel Aquifer (Northern Tunisia)	Abir Garouachi	Fatma Trabelsi
2026-2029	PhD Thesis	Smart Irrigation Management using Multiscale Hydraulic Modeling, Remote Sensing, and AI-Driven Decision Support System (DSS)	Mohamed Dhia Slim	Fatma Trabelsi
2026	Final-year engineering project	Monitoring and analysing trends in drought and land use in the Ras Jbel region using remote sensing	Kais Ganoun	Fatma Trabelsi
2025-2026	Research Master	Estimation of Evapotranspiration and Precipitation Using Remote Sensing: Impact on the Water Reserves of the Ras Jebel Aquifer (Bizerte)	Abir Garouachi	Fatma Trabelsi
2025	Final-year engineering project	Assessment of the impact of land use on the recharge of the Ras Jebel aquifer: Application of Remote sensing and Modelling	Mohamed Dhia Slim	Fatma Trabelsi

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Current research activities

Installation of Groundwater Sensors

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Expected outputs

-Hydrogeological Characterisation

-Groundwater Modeling of flow and salinity

-Groundwater level prediction

-Groundwater salinity prediction

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Thank you for your attention!!

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