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National Water and Energy Center

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United Arab Emirates University

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ندوة مشكلة ارتفاع منسوب المياه الأرضية في المناطق الحضرية في دول مجلس التعاون

The problem of Shallow Water Table Rise (SWTR) in urban areas in the GCC countries

Groundwater level fluctuation and environmental impact: A case study from Shiab Al Ashkhar district, Al Ain, UAE

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Outline:

- Introduction.
- Objectives
- Problem statement
- Aquifer characterization.
- Measurement and analysis.
- Results
- Practical solutions

Introduction

- Intensive urban, agricultural, industrial as well as the touristic development in Al Ain city has been growing massively
- These activities were accompanied by **uncontrolled pumping** and dumping of water during the different uses.
- The **complex nature of the subsurface soil** contributed to groundwater level rise.
- Changing quality and fluctuations in water level may **affect** engineering structures such buildings foundations and tunnels.
- These feature was obviously detected among many urban districts in al Ain city.
- This work focuses on one of those recent urban provinces in Al Ain city.

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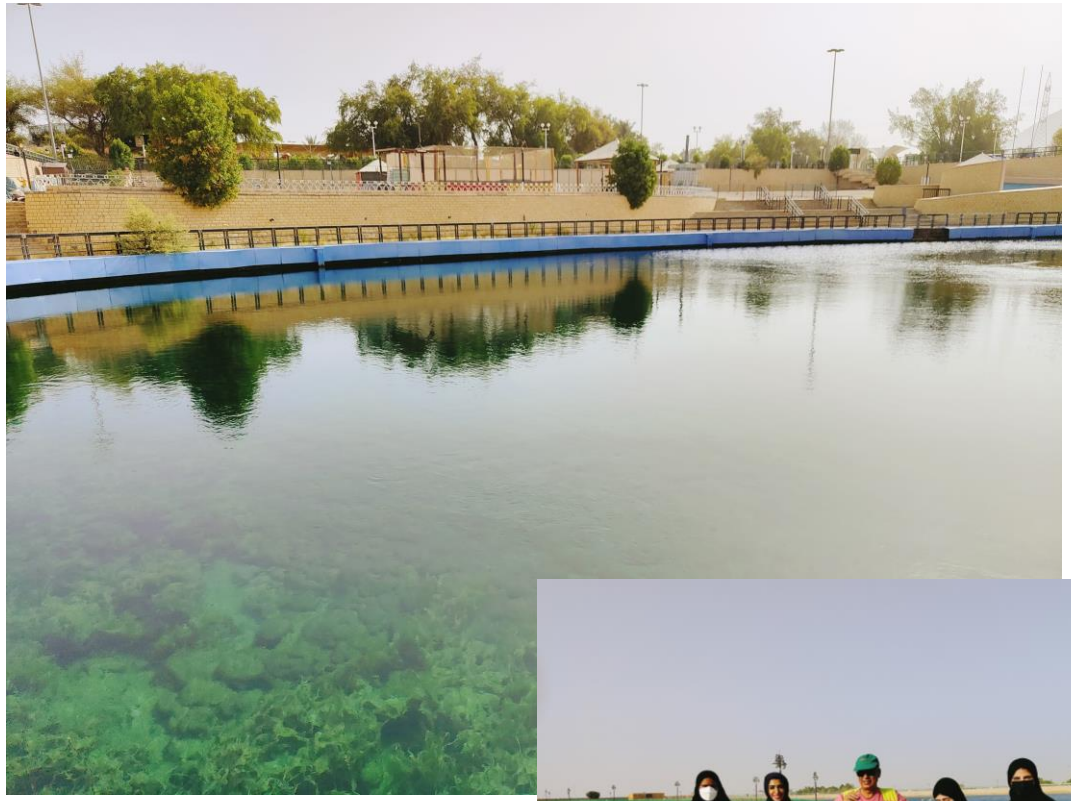
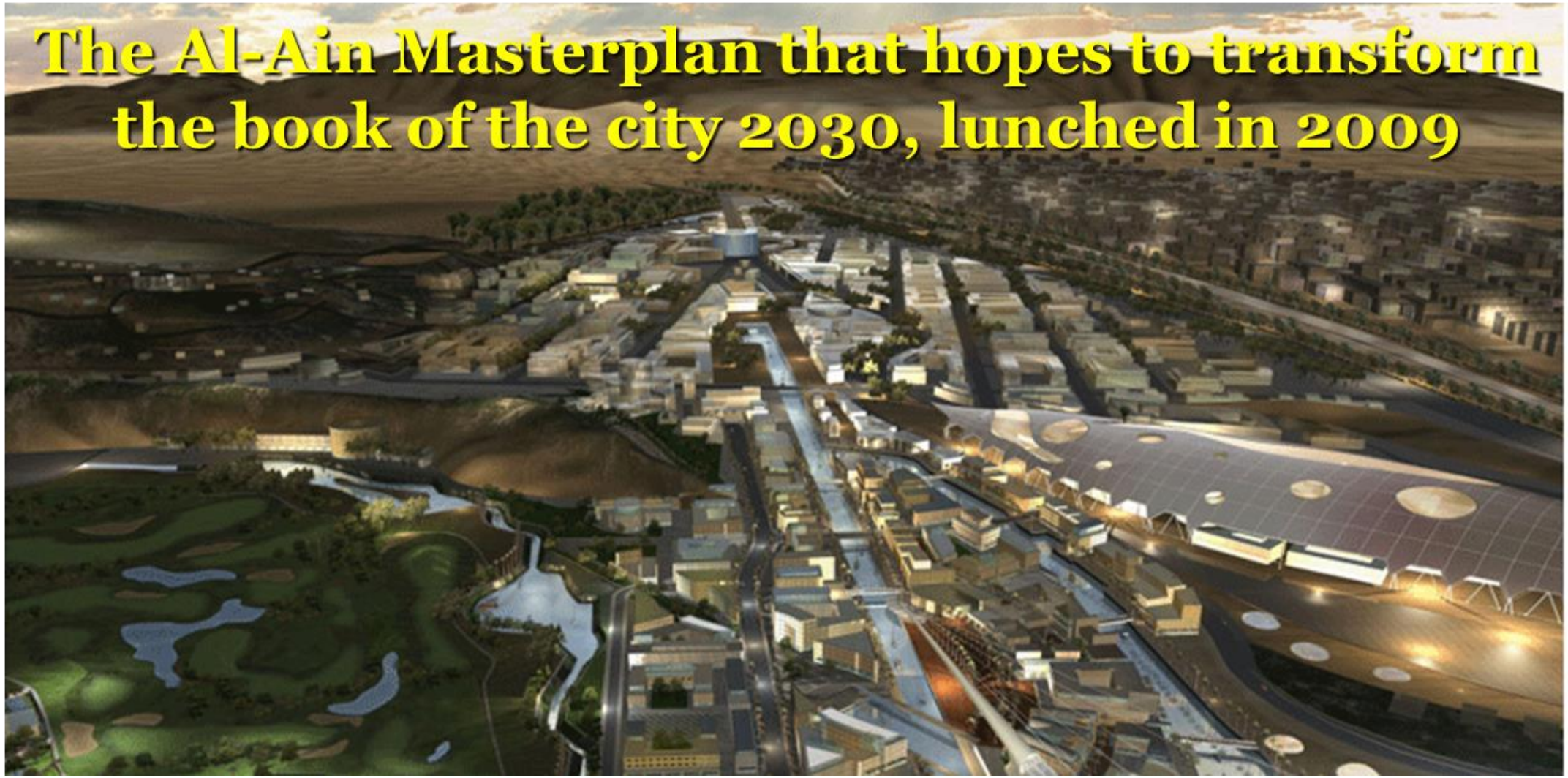
Thermal groundwater

Surface water lake



Green Mubazzarah in Hafeet Mountain

New urban districts

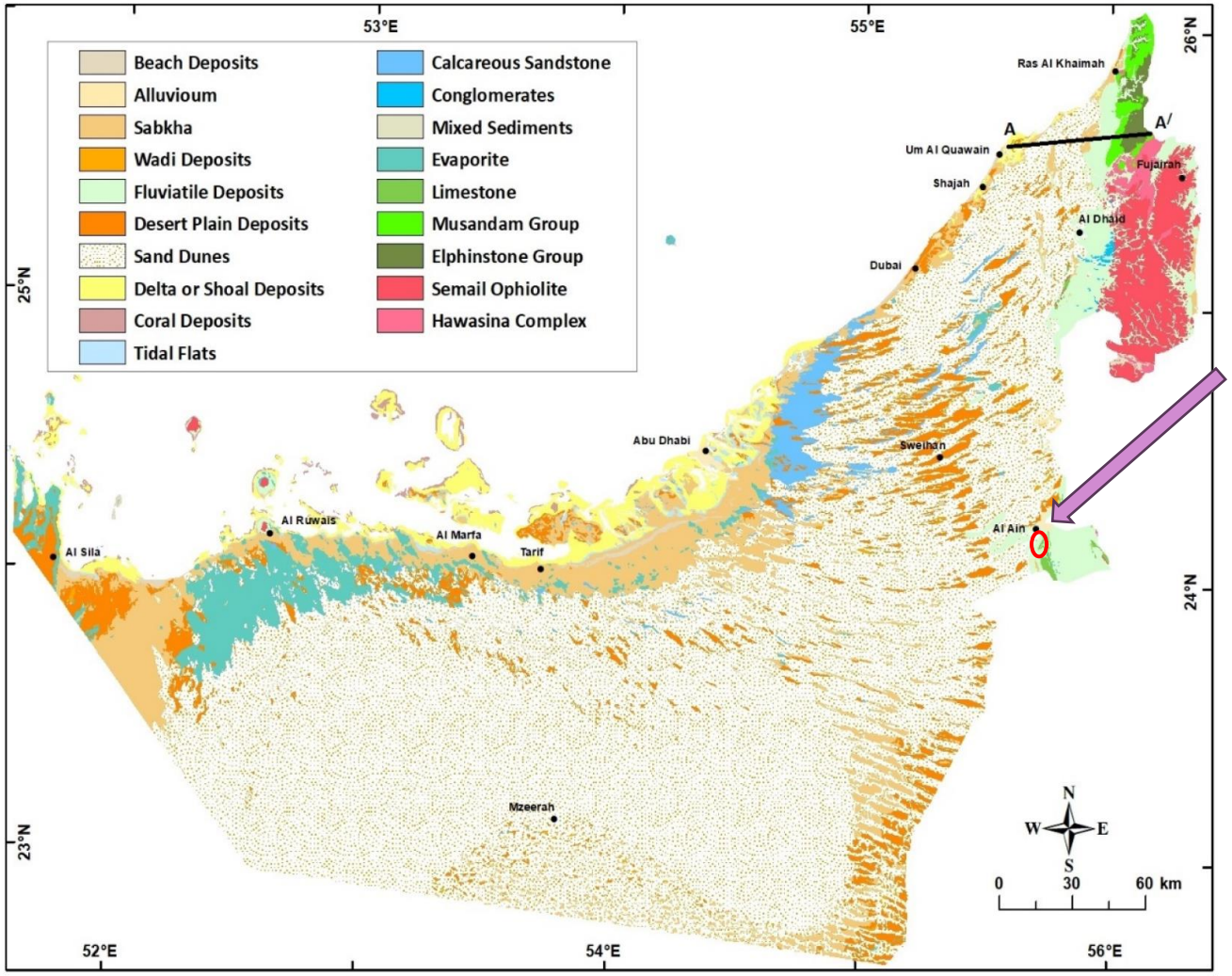

The Al-Ain Masterplan that hopes to transform
the book of the city 2030, lunched in 2009

Objectives

- Investigating the temporal and spatial behavior of groundwater fluctuations through consequent time periods in the study area.
- Studying the reasons behind the instability of water table and its possible effects on the civil constructions.
- Establishing an early warning strategy for preservation and protection of the foundations of the constructions

Problem statement

- ❖ The area represents one of the recent **residential projects** that are surrounded by many sources of dumped and pumped groundwater.
- ❖ The results of time series data have indicated that the **fluctuations are not systematic** and are controlled by rather complex effect of human caused and natural geological aspects.
- ❖ These groundwater fluctuations characterize a future threat to the **construction foundations** through corrosion, salinization, fracturing and plantation due to imbalance in the groundwater system.

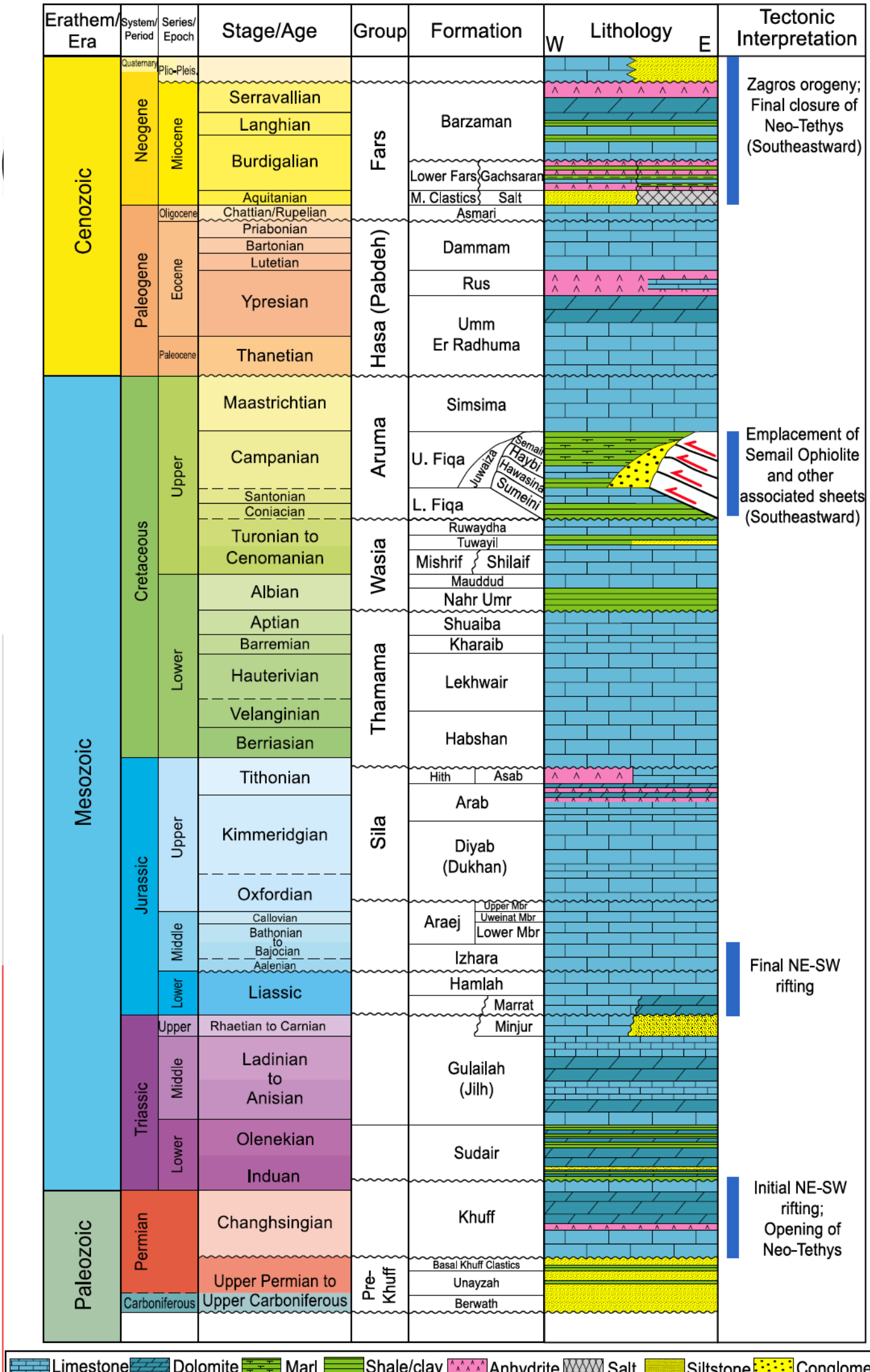


Sampling location map.
The map is modified after:

1. An et al., 2000
2. Sherif et al, 2021

9/17/2023

Reference: Abdelmaksoud et al., 2022;
Summarized stratigraphic column of the fold-and-thrust belt (FTB) and foreland basin of the UAE-Oman Mountains (modified after Ali et al. (2013), Alsharhan (1989), and Hu et al. (2016)).



❖**Anthropogenic activities** included the:

- **Uncontrolled pumping** and dumping of water.
- **Urbanization** and constructing new residential compounds.

❖**Natural conditions:**

- Groundwater aquifers in the study area are mainly **Quaternary sediments and carbonate rocks**. It is composed of sand, gravel, silt as well as intercalated clay and shale layers.

Aquifers characterization

- The **carbonates aquifer** is characterized by variable composition and texture, different degrees of fracturing and **interbedded with shales and evaporite**.
- The **Quaternary sediments** are composed of gravel, sand and silt layers **partly cemented** with evaporates, calcite and dolomite.
- Miocene **gypsum and clay layers** occur through thin Quaternary loose sediments.

- The complex nature of the subsurface soil **caused water table rise in some districts.**
- The **Quaternary aquifer** may develop **impermeable beds cemented by evaporites and carbonates due to evaporation:**
  - These beds might prohibit the surface water from deep penetration and **create perched water** groundwater accumulation which contribute to the rising water table.
  - Thickness of the Quaternary deposits varies a lot in the area, but may reach a depth of 15 m.

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Impact on the foundations of buildings

Basement Foundations salinization

9/17/2023

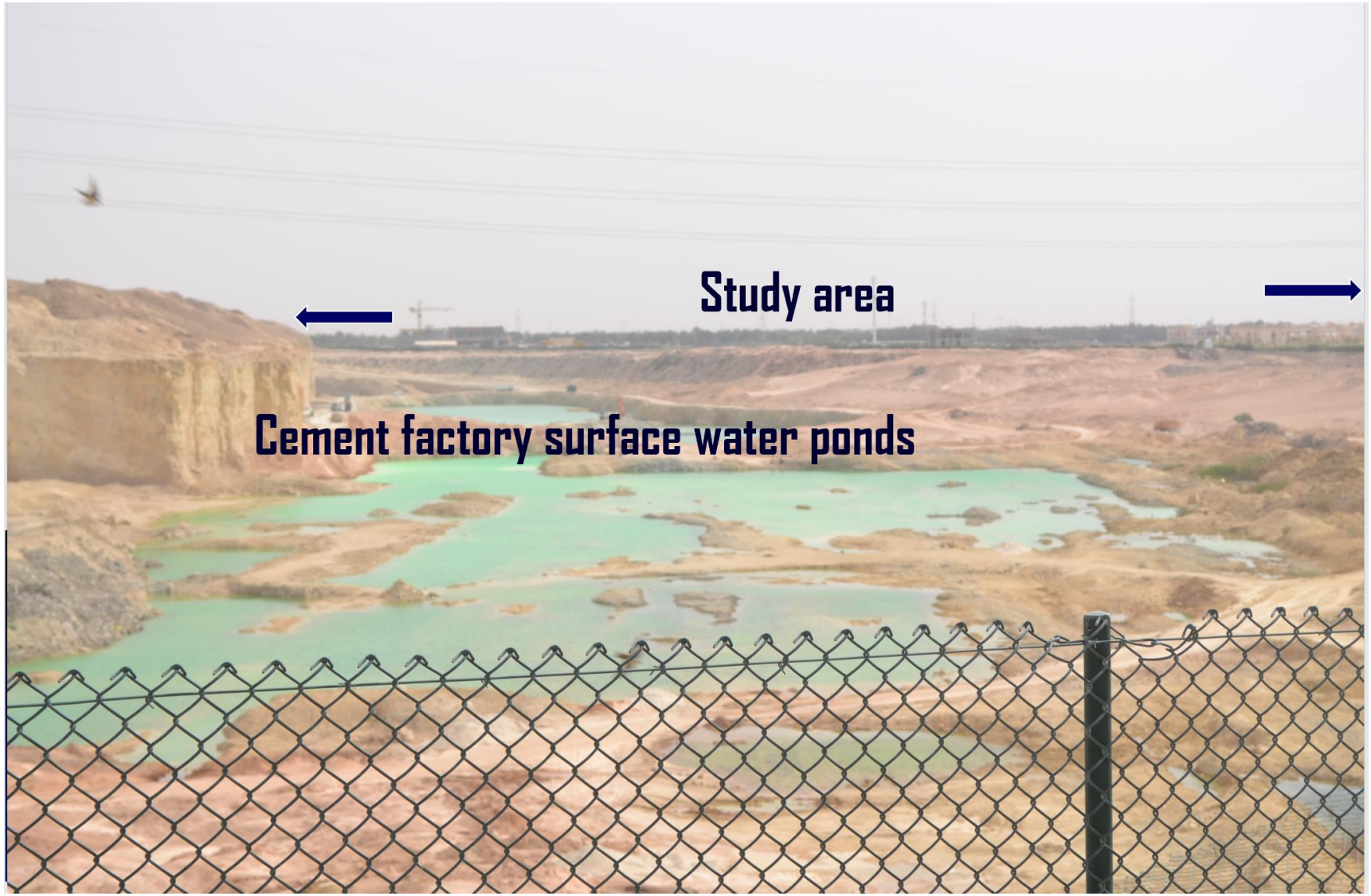
Forms of GWL rise impact

Impact on the mechanical and chemical properties of soil

Measurement and analysis

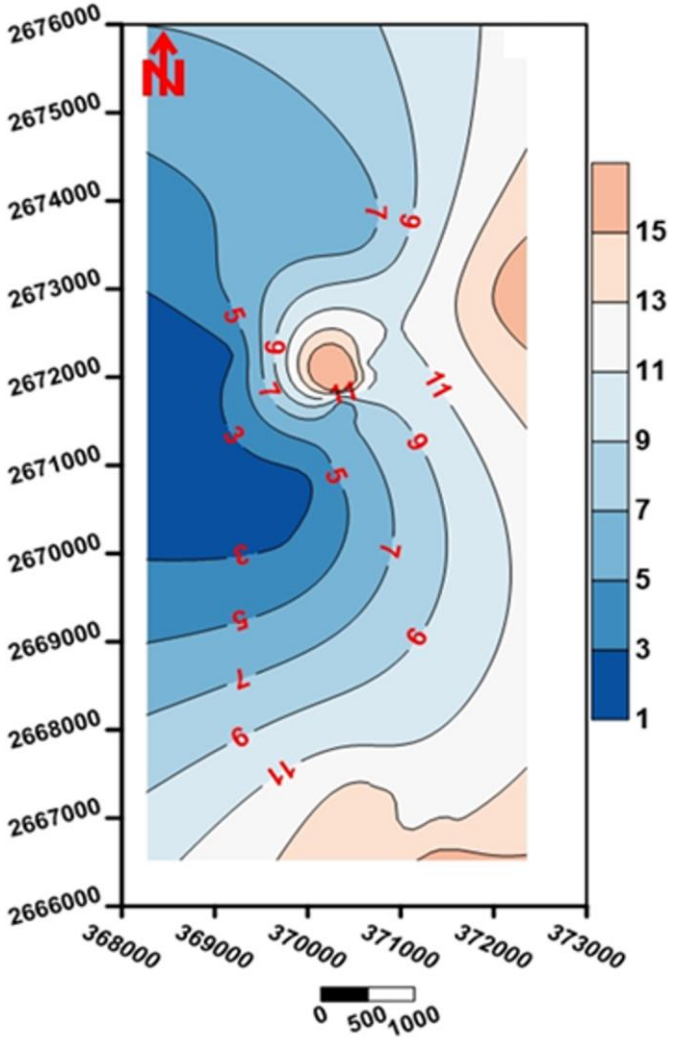



37 active well have ben monitored through water table measurements


Study area
Cement factory surface water ponds

Results

Despite the climatic change conditions, the GWL persisted < 3 m in some areas that may be attributed to geologic conditions which developed impermeable beds cemented by evaporites due to evaporation and is prohibit the surface water from deep penetration and contribute the water level rising.



Results

- These variations in water levels can affect the building foundations through *corrosion*, *salinization and cacking*.
- Farming can also be impacted through building up of *perched water level* resulting in *flooding* of water in the shallow root zone and *drought* in the deep root zone.
- At the same time, the relatively extensive exploitation in some parts of the study area can lead to *draining of groundwater in neighboring areas* and thus creation of draught conditions

Practical solutions:

- ✓ Implementing a **monitoring network** for groundwater levels for the purposes of continuous measurement of changes in water level and quality with an early warning system. This system would help decision makers allocate appropriate solutions for sustainable development.
- ✓ Using **geophysical** techniques available in universities to analyze temporal ans spatial trends in changing water levels and develop accurate forecasts, while including smart programming languages in the dynamics of water systems.
- ✓ Directing **graduate students' research** to develop appropriate solutions that mitigate the impact of rising water levels on urban areas.

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Thank You

ANY QUESTIONS?