Ministry of Higher Education and Scientific Research

Professional Diploma In Remote Sensing And Geographical Information Systems

Satellite-Based Assessment Of The Human-Induced Impacts On Environmental Sustainability In Damietta Governorate, Egypt

تقييم الآثار الناتجة عن الأنشطة البشرية على الاستدامة البيئية في محافظة دمياط بإستخدام بيانات الأقمار الصناعية

2023

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Outlines

- Introduction
- Objectives
- Methodology
- Results
- Conclusion & Recommendations
- Acknowledgement

Introduction

- **Anthropogenic activities** have significant impacts on **environmental sustainability**, human health, ecosystems, and climate change.
- Land-based and ocean-based **human activities** vary in their intensity of impact on environmental sustainability according to their spatial distribution.
- These impacts include **air pollution** and releasing greenhouse gases as a result of burning fossil fuels, industrial processes, and transportation
- Activities such as industrial processes, agriculture, and domestic sewage disposal contribute to **water pollution**, which can harm aquatic life, impact human health, and affect the availability of clean water.
- Human activities lead to different forms of **Land degradation** such as deforestation, mining, and urbanization, which can result in biodiversity loss, soil erosion, and desertification.
- **Coastal area** has great socioeconomic importance worldwide and is considered one of the most complex and dynamic ecosystems for non-living and living resources.

- Sustainable Development Goals (SDGs) aim to transform our world, eliminate poverty and inequality, protect the planet, and ensure that all people enjoy health, justice, and prosperity.
- Among the 17 Goals and 169 targets of the SDGs, indicators of **Goals 3, 6, 11, 13, 14, and 15** were investigated in this research to ensure take urgent action to eliminate human activities and their

SUSTAINABLE DEVELOPMENT GOALS

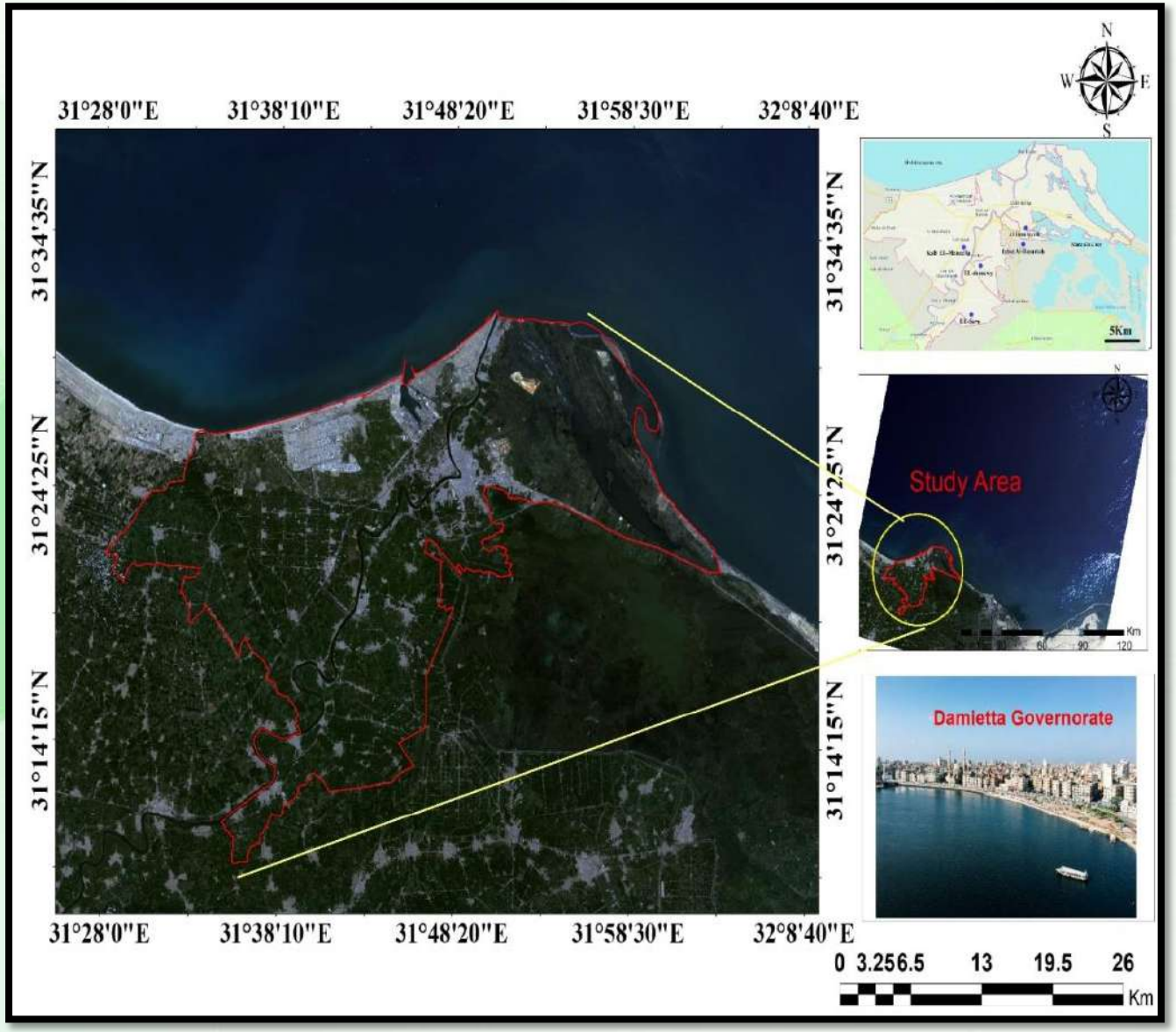
Objectives

The main objective of this research is to **assess the environmental quality in Damietta Governorate and evaluate the impacts of anthropogenic activities on environmental sustainability in the region.**

1. Define and Map **the land cover and land use changes** in Damietta.
2. Examine how **urbanization** and related human activities affect local environments.
3. Detect the **shoreline changes** along Damietta coastal area using **remote sensing, GIS, and DSAS**.
4. Predict the shoreline change **in the future.**
5. Explore **the changes in land surface temperature.**
6. Assess **the air quality** in the region in correlation with **human activities**.
7. Detect the areas most vulnerable to human activities' impacts
8. Develop **a web portal** for data dissemination.
9. Support decision makers with useful information about this important **coastal zone**

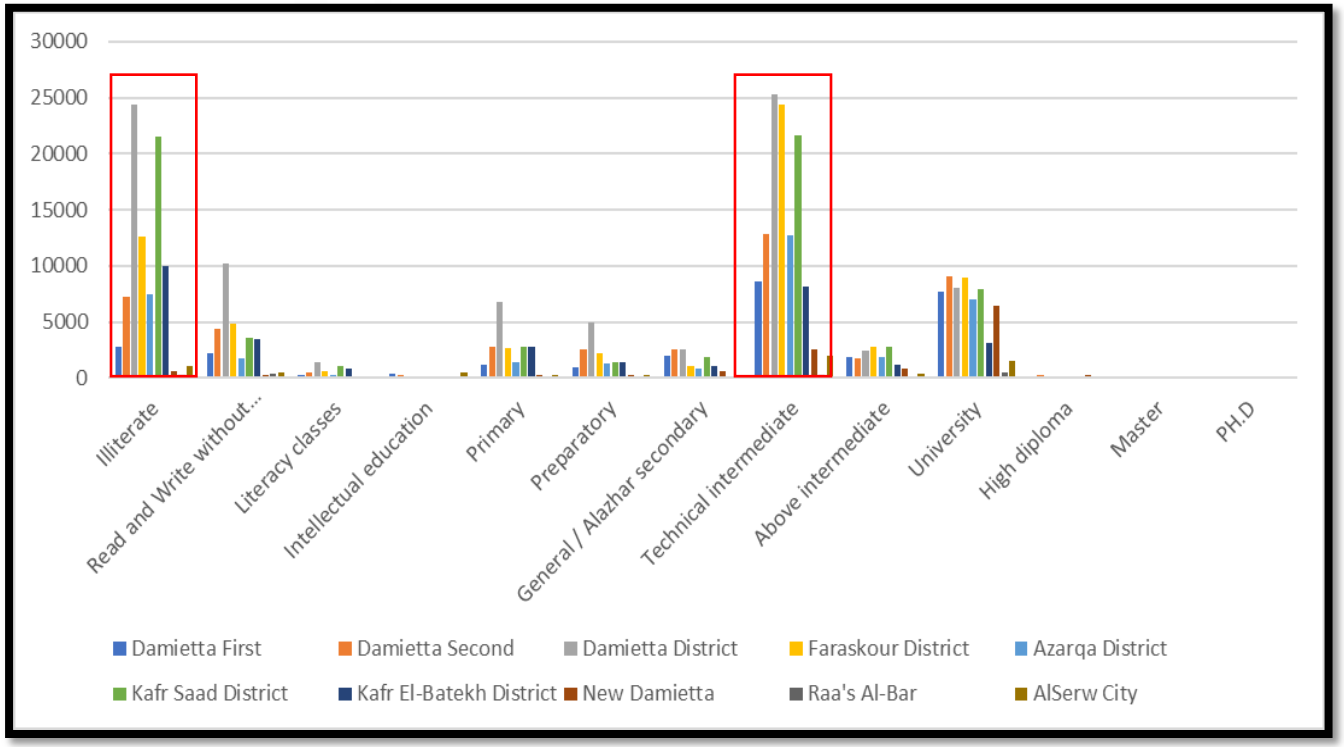
Study Area

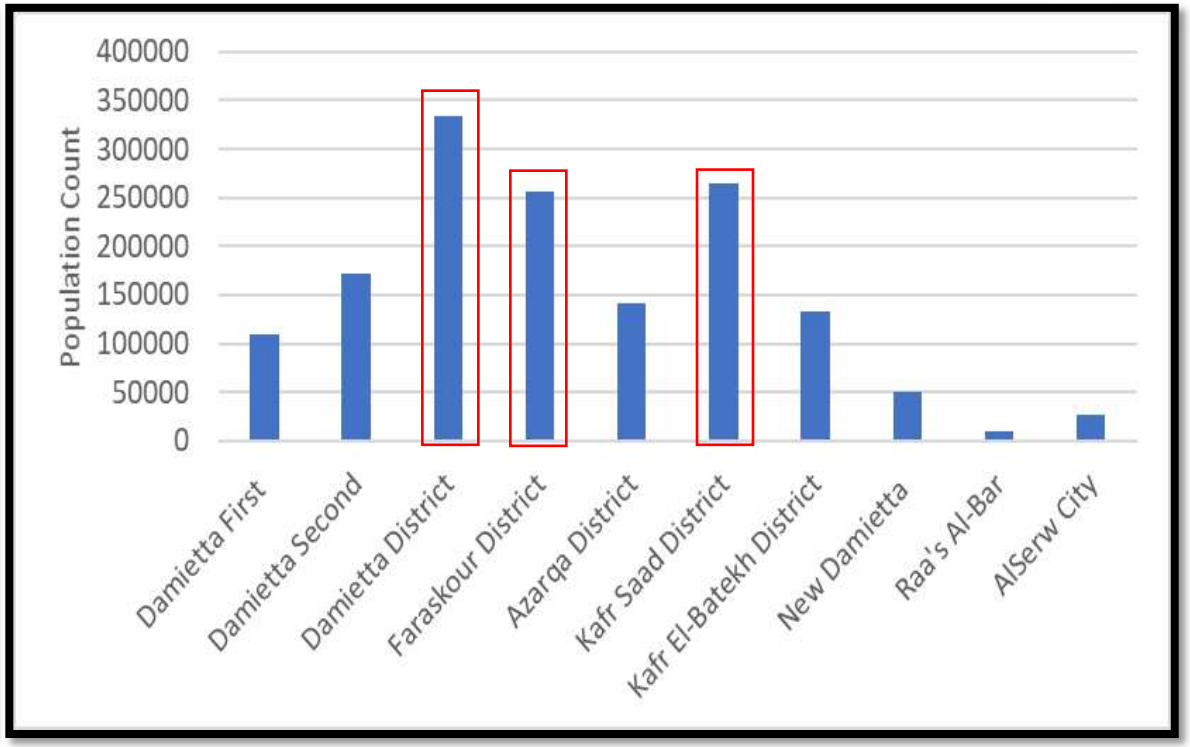
- **Damietta Governorate** lies in the northeastern part of the Nile delta and stretches from Ras El-Barr in the east to Gamasa in the west.
- It consists of four districts (i.e., **Kafr Saad, Damietta, Faraskour and Al-zarqa**).
- The coastal zone of Damietta is a promising area for energy resources and industrial activities.
- Different activities are practiced in the governorate such as:
  - **Fishing at Manzala Lagoon,**
  - **Recreation activities**
  - **Industrial activities**
  - **Navigation in Damietta Harbor,**
  - **Commercial activities.**
  - **Agricultural activities**



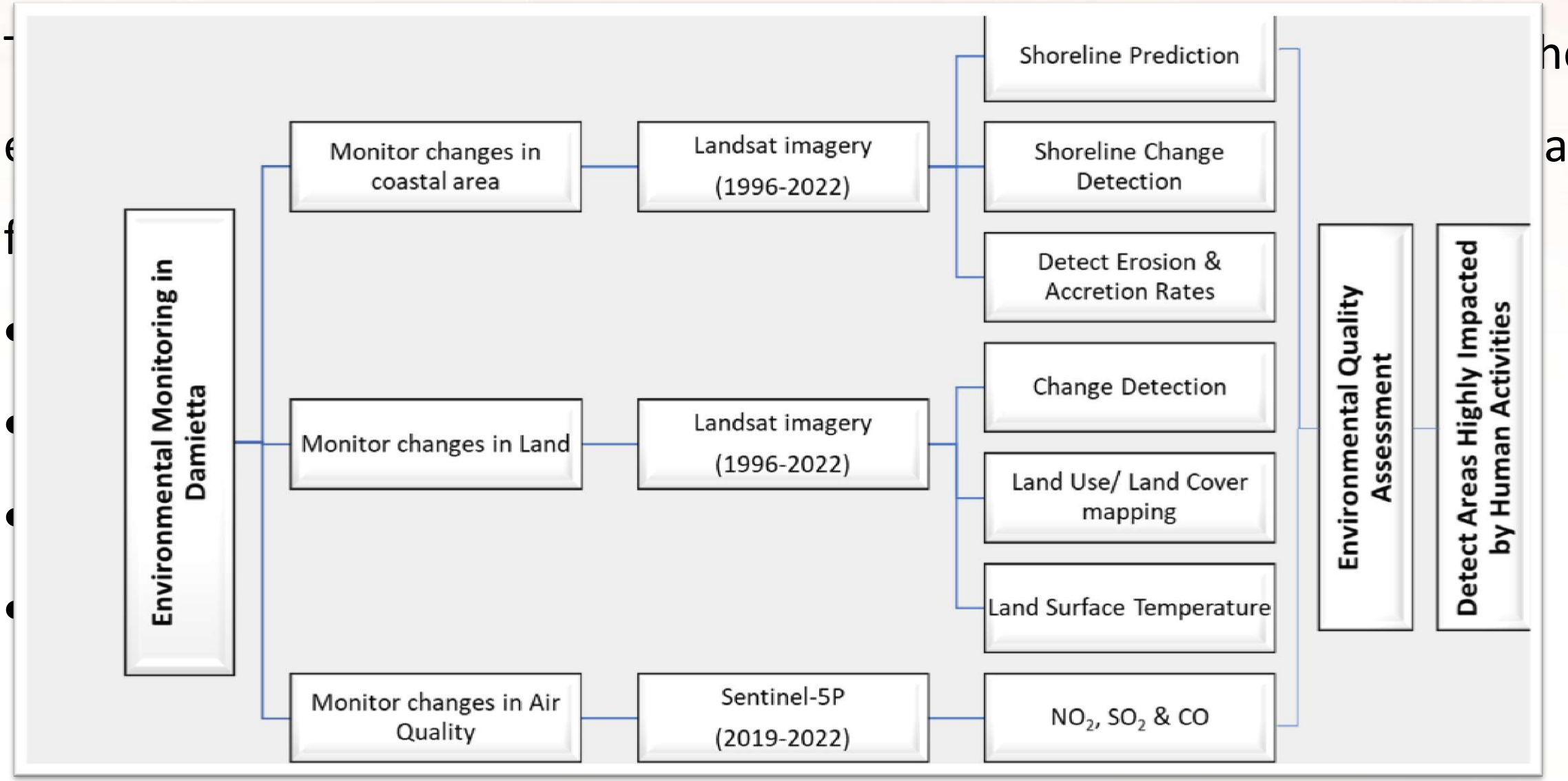
Study Area

- Damietta has a population count of **1.4m in 2017**, which increased to **1.6m in 2023** according to CAPMAS statistical records.
- Records showed that most of the population is concentrated in **Damietta, Kafr Saad, and Faraskour districts.**
- Most of the population in Damietta is **moderately educated** (technical education) and there is rate of **illiteracy.**





Data Set and analysis methods



Methods

ArcGIS

Google Earth Engine

MATLAB®

Excel

Python

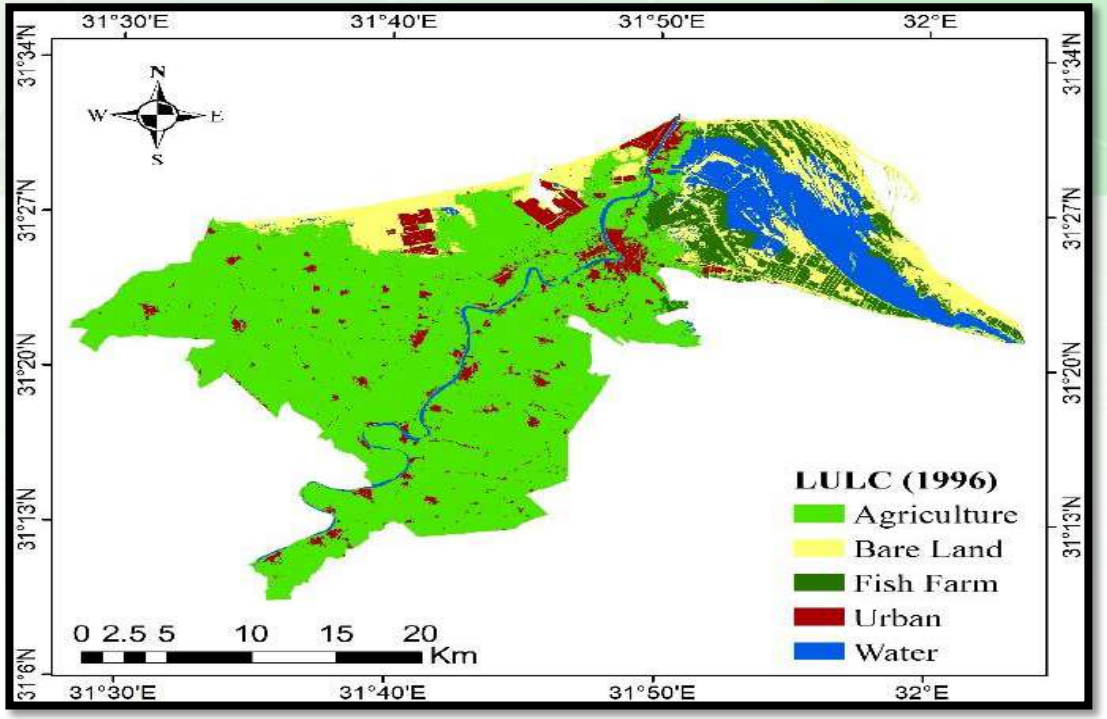
HTML CSS JS

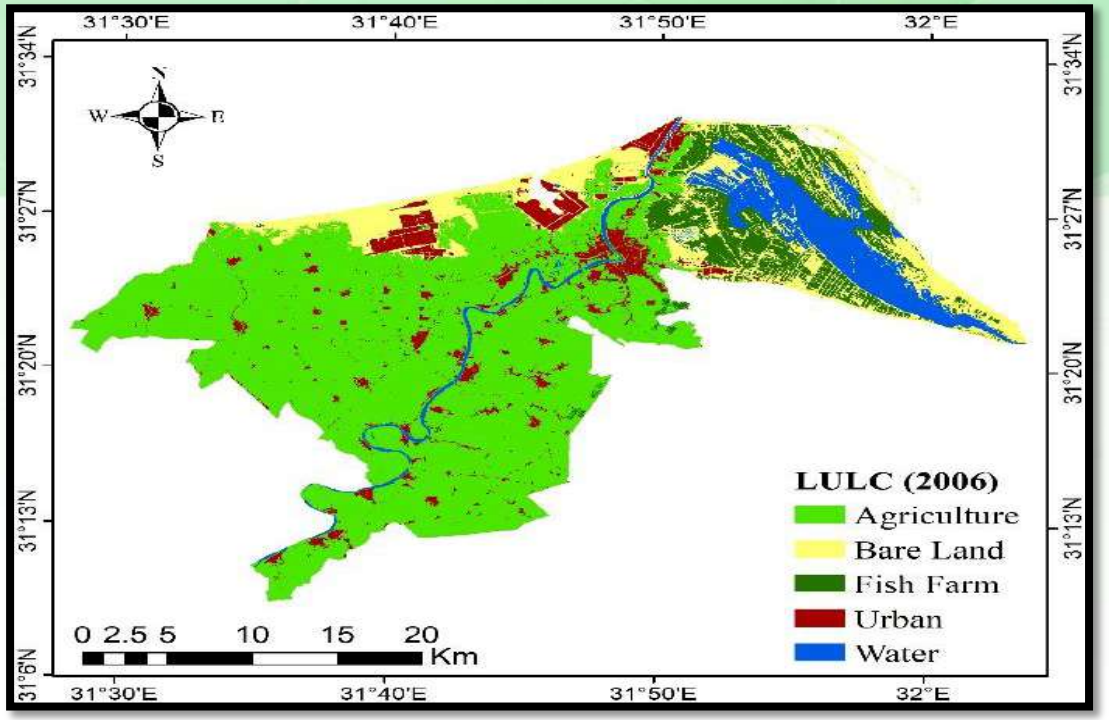
GeoAI

Land Cover mapping

- Multispectral Landsat imagery was used to classify the study area based on the supervised classification technique "***Support Vector Machine classifier***" to obtain land cover maps for the years **1996, 2006, 2017, and 2022**.
- The area of study was classified into five major classes including **water, vegetation, fish farms, urban, and bare land**.

Acquired Date	Spacecraft ID/Sensor	Path/Row	Pixel Size (m)	Coordinate System/Datum	Zone
03/07/1996	Landsat_5/TM	176/38	30	UTM/WG84	36
31/07/2006	Landsat_5/TM				
13/07/2017	Landsat_8/ OLI_TIRS				
29/07/2022	Landsat_8/ OLI_TIRS				


31°30'E
31°40'E
31°50'E
32°E
31°34'N
31°27'N
31°20'N
31°13'N
31°6'N
N
W
E
S
LULC (1996)
Agriculture
Bare Land
Fish Farm
Urban
Water
0 2.5 5 10 15 20
Km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32°E
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31°27'N
31°20'N
31°13'N
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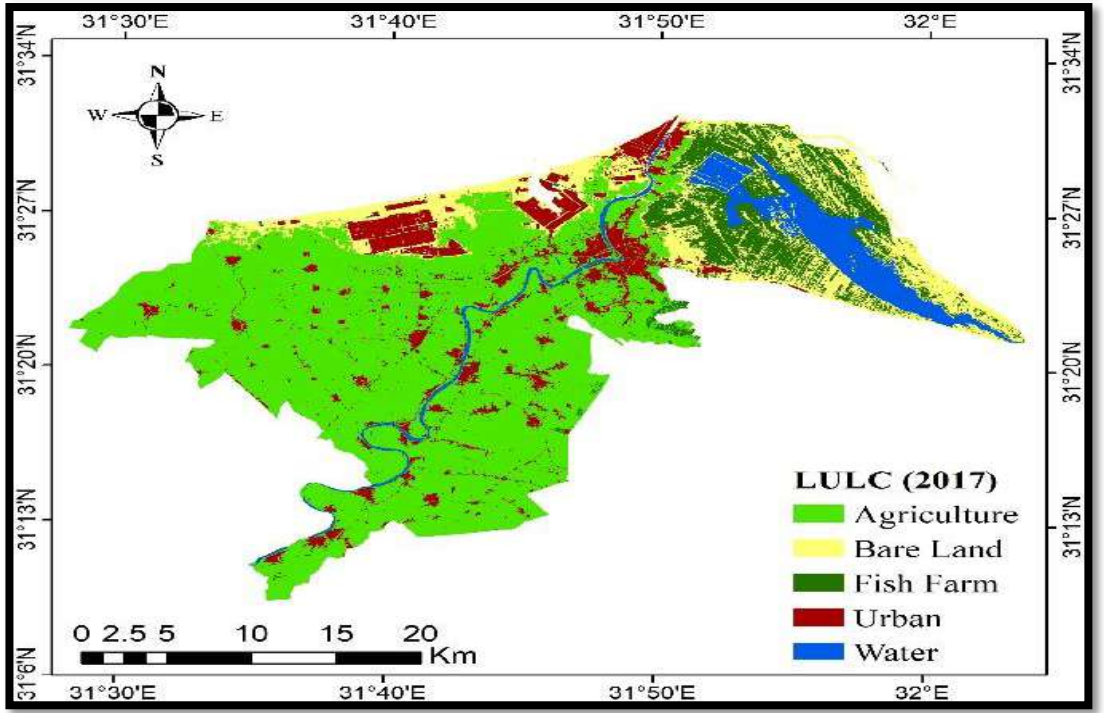
LULC (2006)
Agriculture
Bare Land
Fish Farm
Urban
Water
0 2.5 5 10 15 20
Km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32°E
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31°27'N
31°20'N
31°13'N
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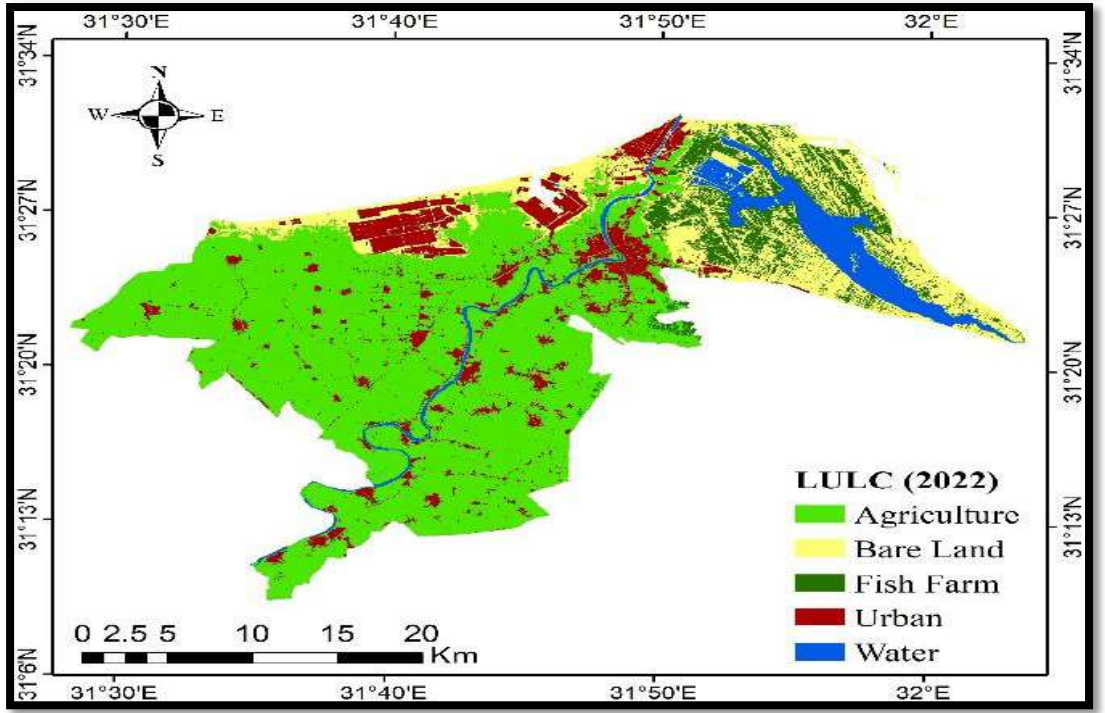
LULC (2017)
Agriculture
Bare Land
Fish Farm
Urban
Water
0 2.5 5 10 15 20
Km


31°30'E
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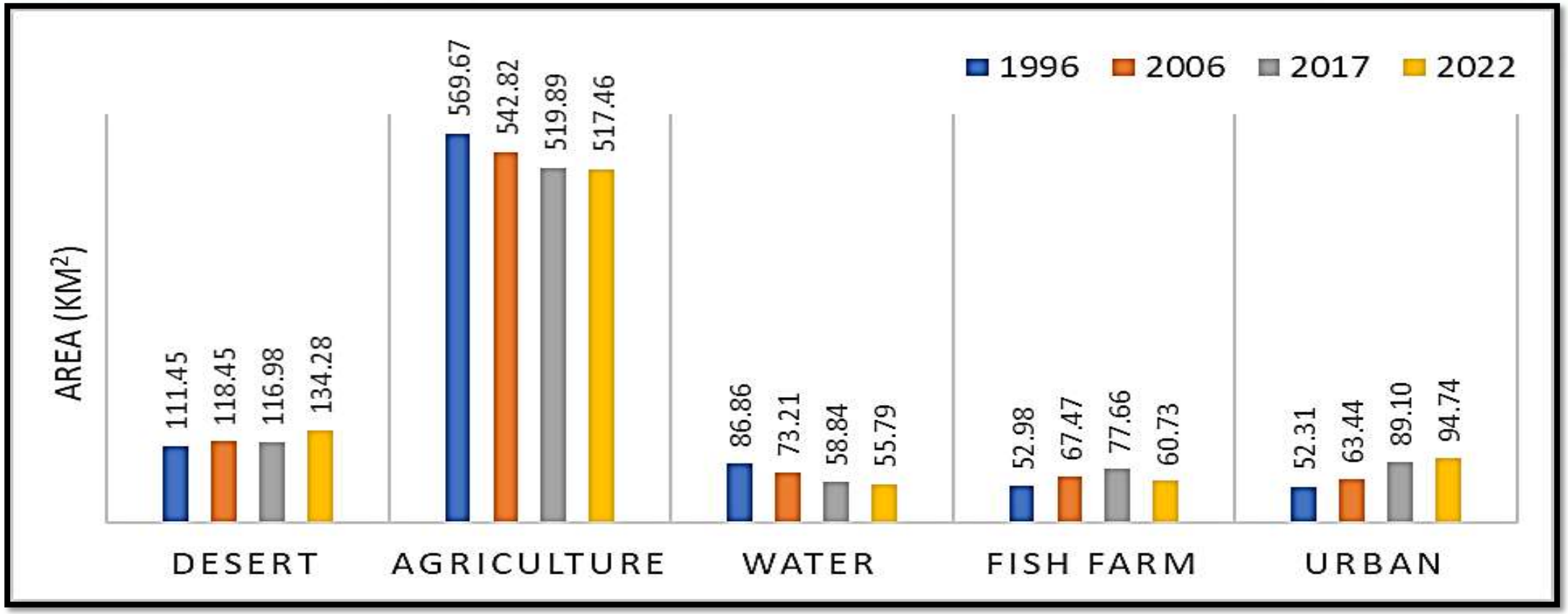
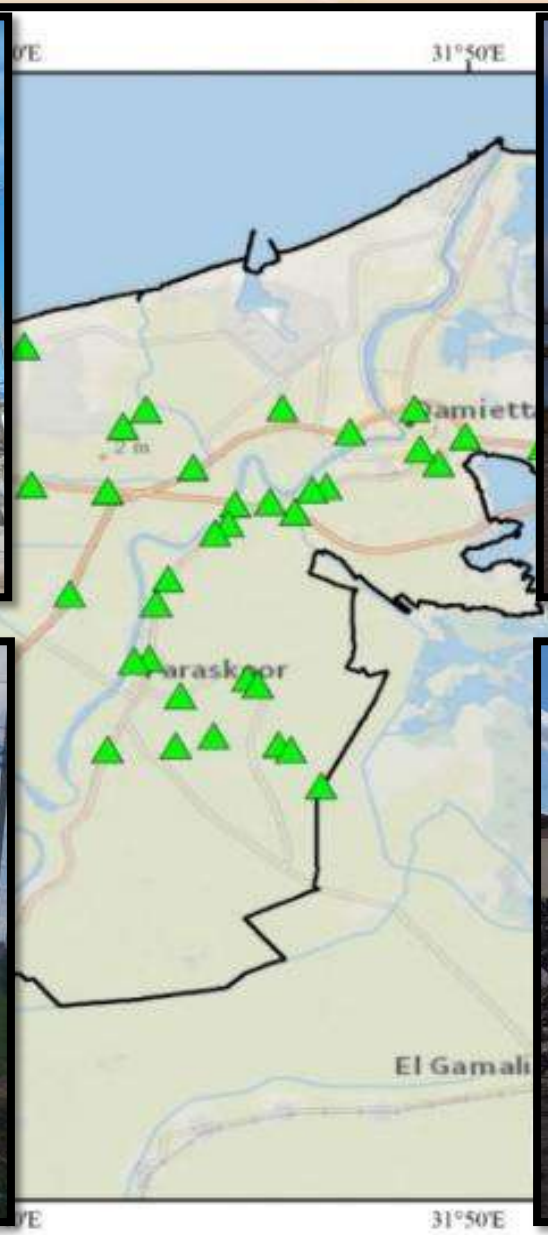
32°E
31°34'N
31°27'N
31°20'N
31°13'N
31°6'N
N
W
E
S
LULC (2022)
Agriculture
Bare Land
Fish Farm
Urban
Water
0 2.5 5 10 15 20
Km

Land Cover mapping

- From 1996 to 2022, the urban area increased from about 52.31 Km^2 to 94.74 Km^2,
- The bare land increased from 111.45 Km^2 in 1996 to reach 134.28 Km^2 in 2022.
- Vegetation cover decreased from 569.67 Km^2 to 517.46 km^2.
- Surface water area decreased from 86.86 Km^2 to 55.79 Km^2 in the years 1996 and 2022,



Field Survey




ترحب بكم

Land Surface Temperature

- The thermal bands of Landsat imagery were used to estimate LST to understand how much change occurred in Damietta as a result of human activities.
- LST was calculated for the years **1996, 2006, 2017, and 2022** using **Google Earth Engine**.

(Derivation of at-sensor brightness temperature)

$$L_\lambda = L_{min} + \frac{(L_{max} - L_{min})}{(Q_{calmax} - Q_{calmin})}(Q_{calDN} - Q_{calmin})$$

$$T_b = \frac{K_2}{Ln(\frac{K_1}{L_\lambda} + 1)}$$

(Derivation of land surface emissivity)

$$\varepsilon = \varepsilon_v F_v + \varepsilon_u (1 - F_v) + d\varepsilon$$

$$F_v = (\frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}})^2$$

$$d\varepsilon = (1 - \varepsilon_u)(1 - F_v) F \varepsilon_v$$

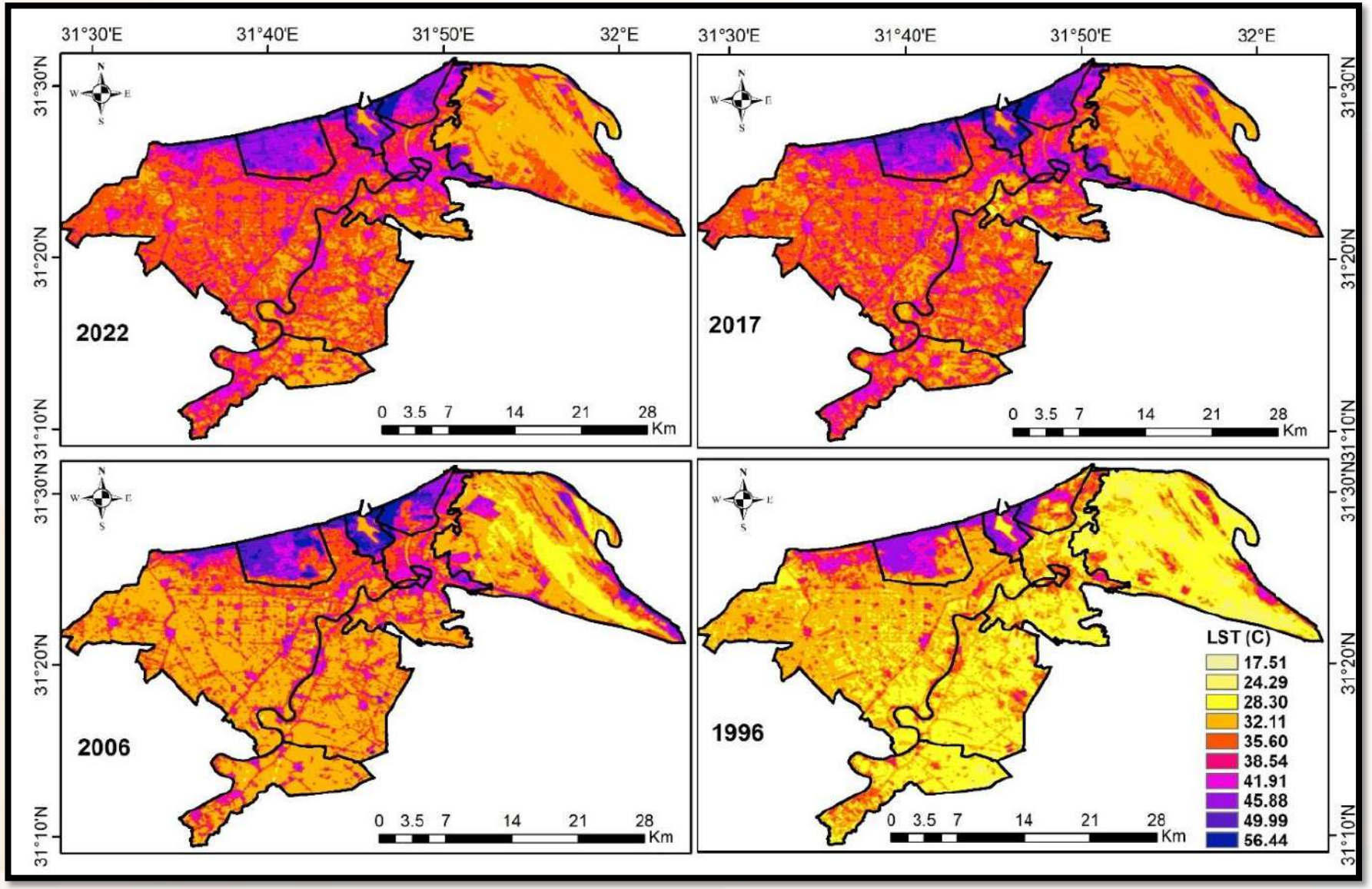
Retrieval of land surface temperature

$$T_s = \frac{T_b}{1 + (\lambda \times T_b / \alpha) ln\varepsilon}$$

$$T(°C) = T(°C) - 273.15$$

- LST increased in 2022 than 1996, by about 5.61°C.
- LST ranged between 17.51-48.69 °C in 1996, 19.02-56.44 °C in 2006, 20.93-54.96 °C in 2017, and 26.08-54.59 °C in 2022

LST (°C) / Year	MIN	MAX	MEAN	STD
1996	17.51	48.69	**29.57**	4.43
2006	19.02	56.44	**33.77**	5.24
2017	20.93	54.96	**35.29**	4.61
2022	26.08	54.59	**35.18**	4.52



Air Quality

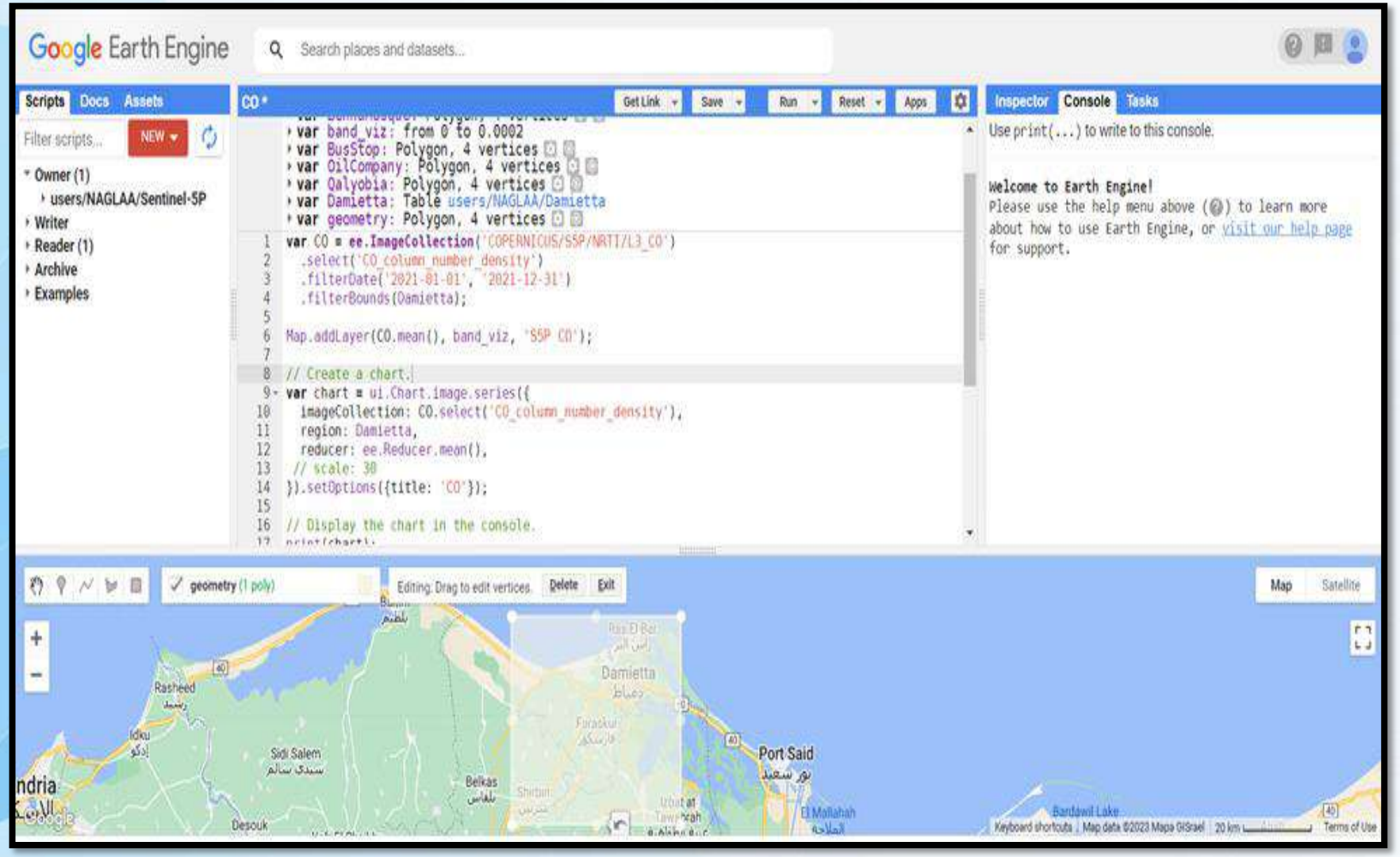
- Air quality data including:

Nitrogen Dioxide (NO_2),

Sulfur Dioxide (SO_2),

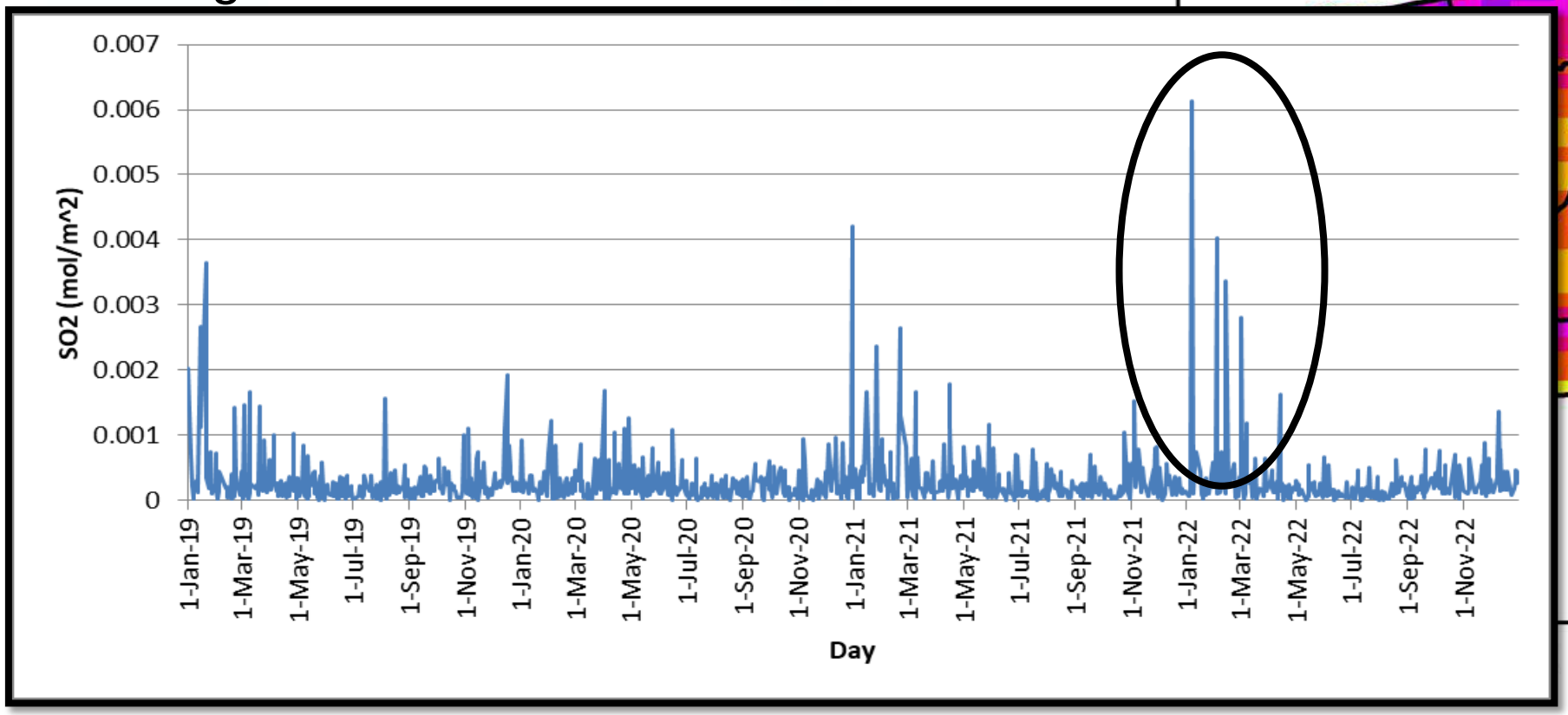
Carbon Monoxide (CO)

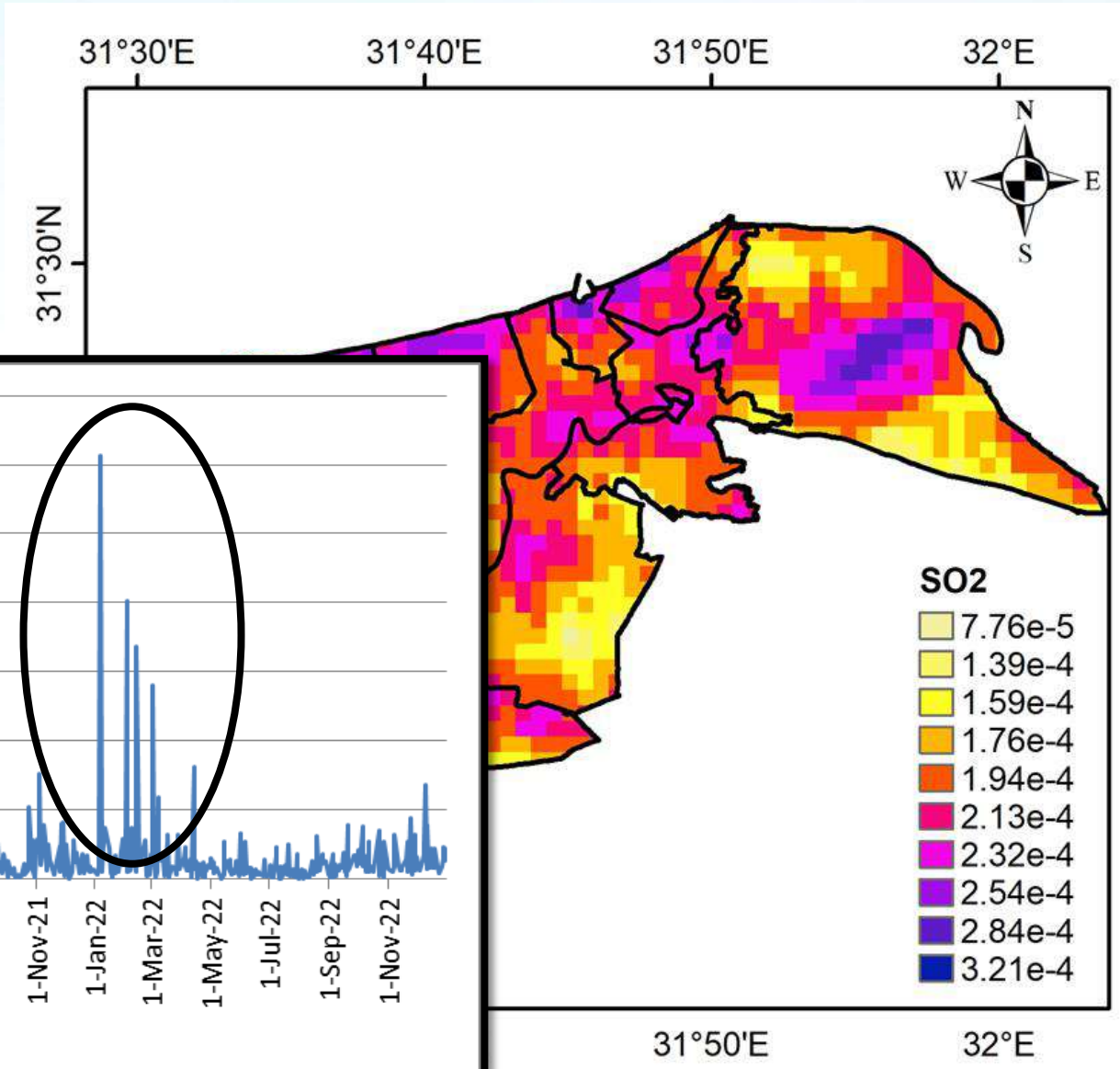
were obtained from the Sentinel-5p satellite for the period 2019-2022 on daily bases using Google Earth Engine.



Sulfur Dioxide

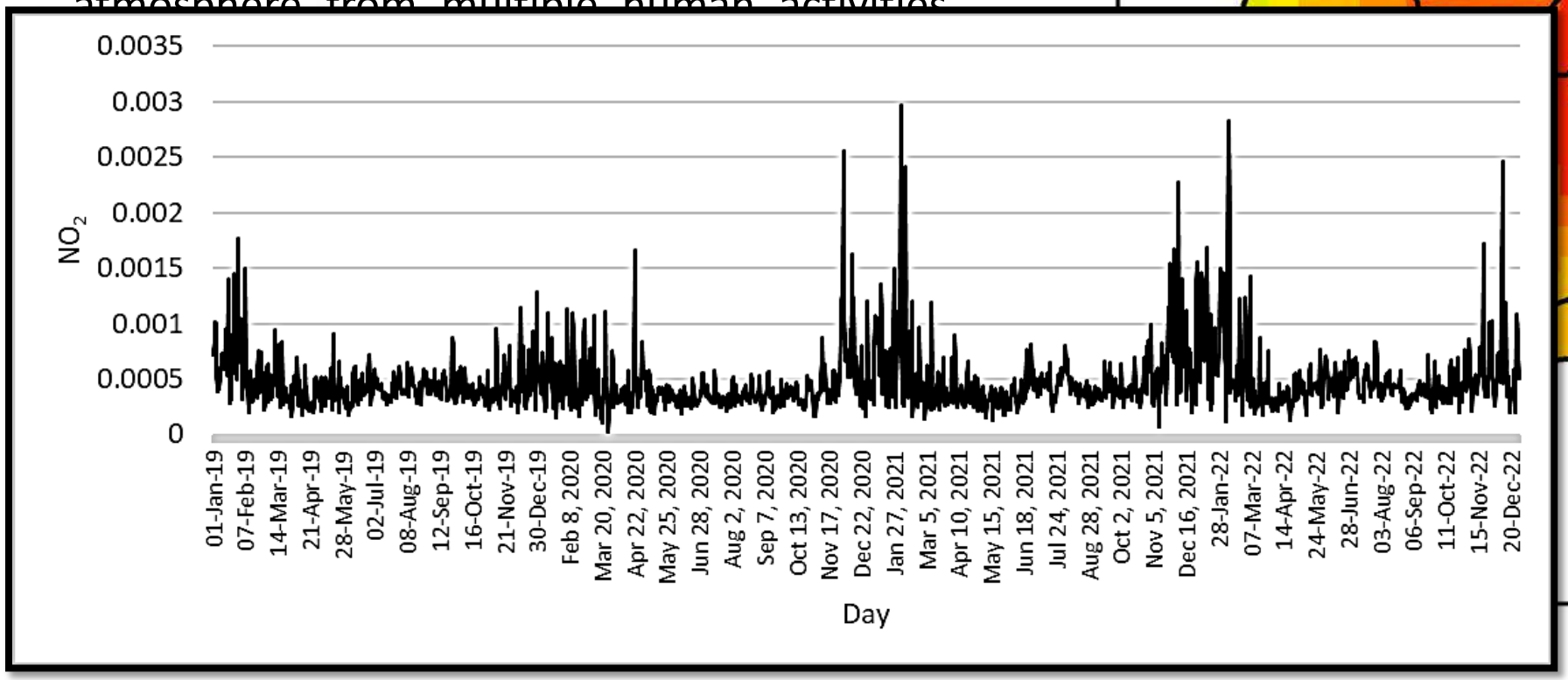
- SO_2 ranged between 0 and 0.006 mol/m^2 with a mean of 0.00027 mol/m^2 during the period 1st Jan 2019-31st Dec. 2022.
- The highest concentration was observed

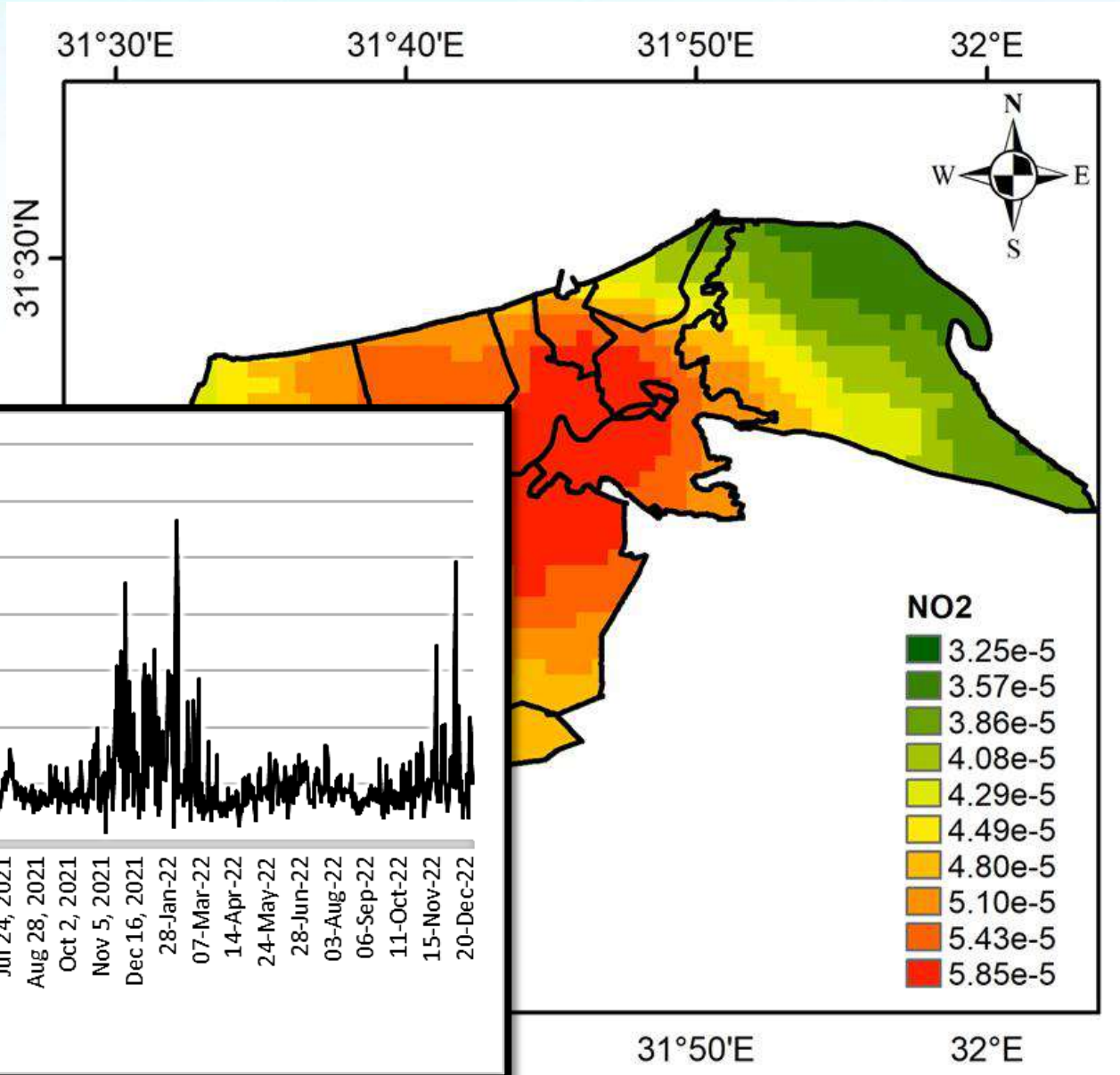




Nitrogen Dioxide

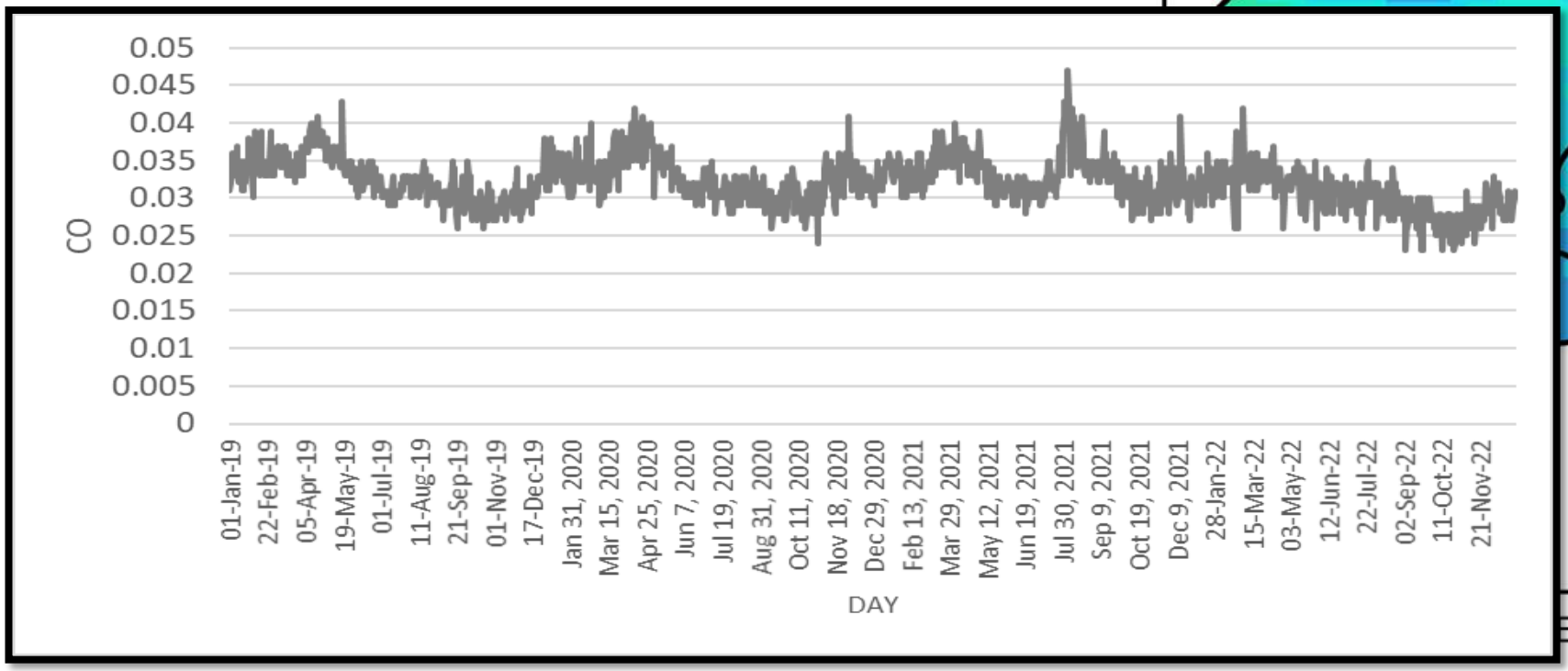
- The mean concentration in the area during the period 2019-2022 was 0.00047, with a minimum of 0.000031 and a maximum of 0.00297. NO_2 can also be released into the

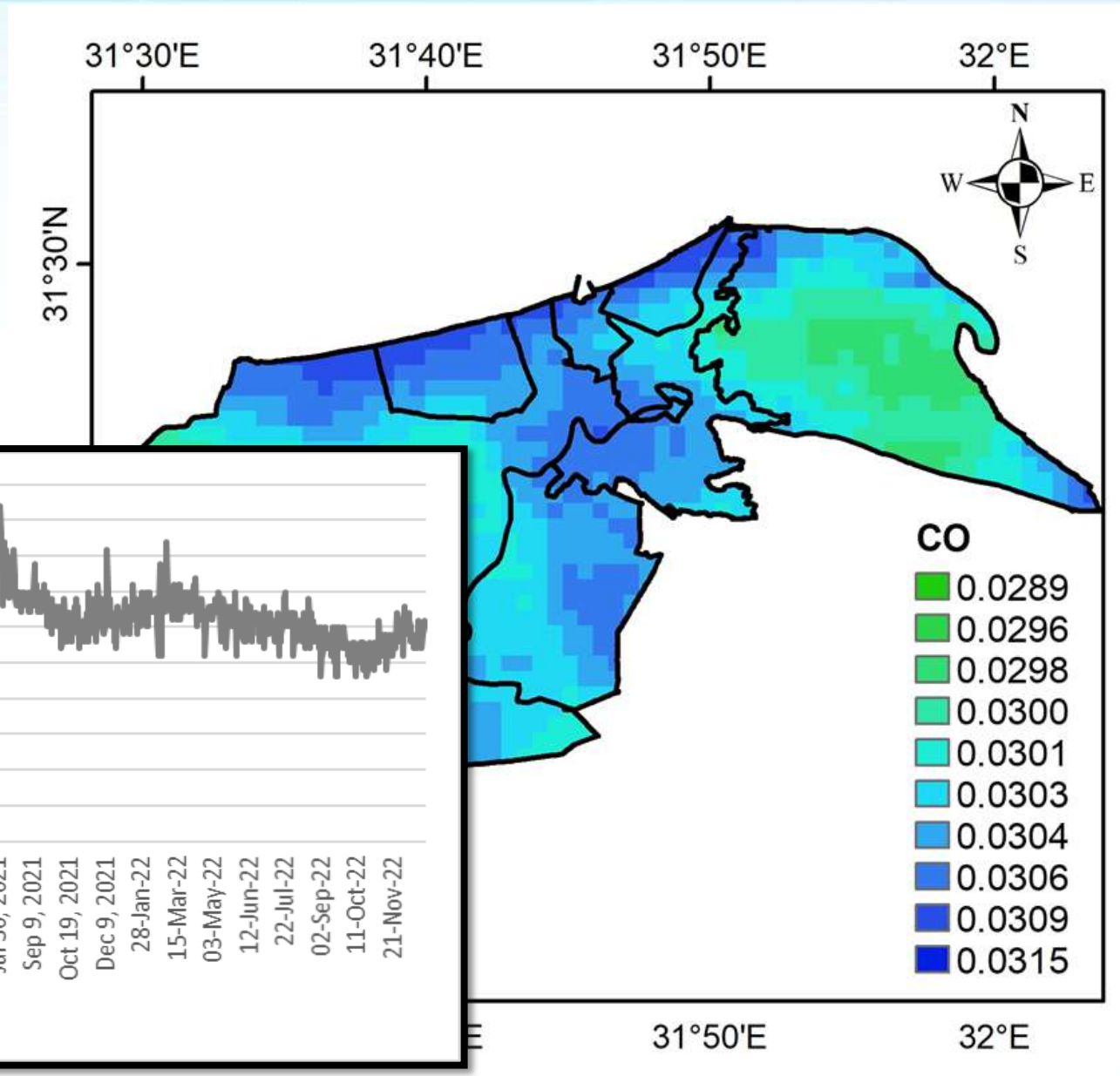




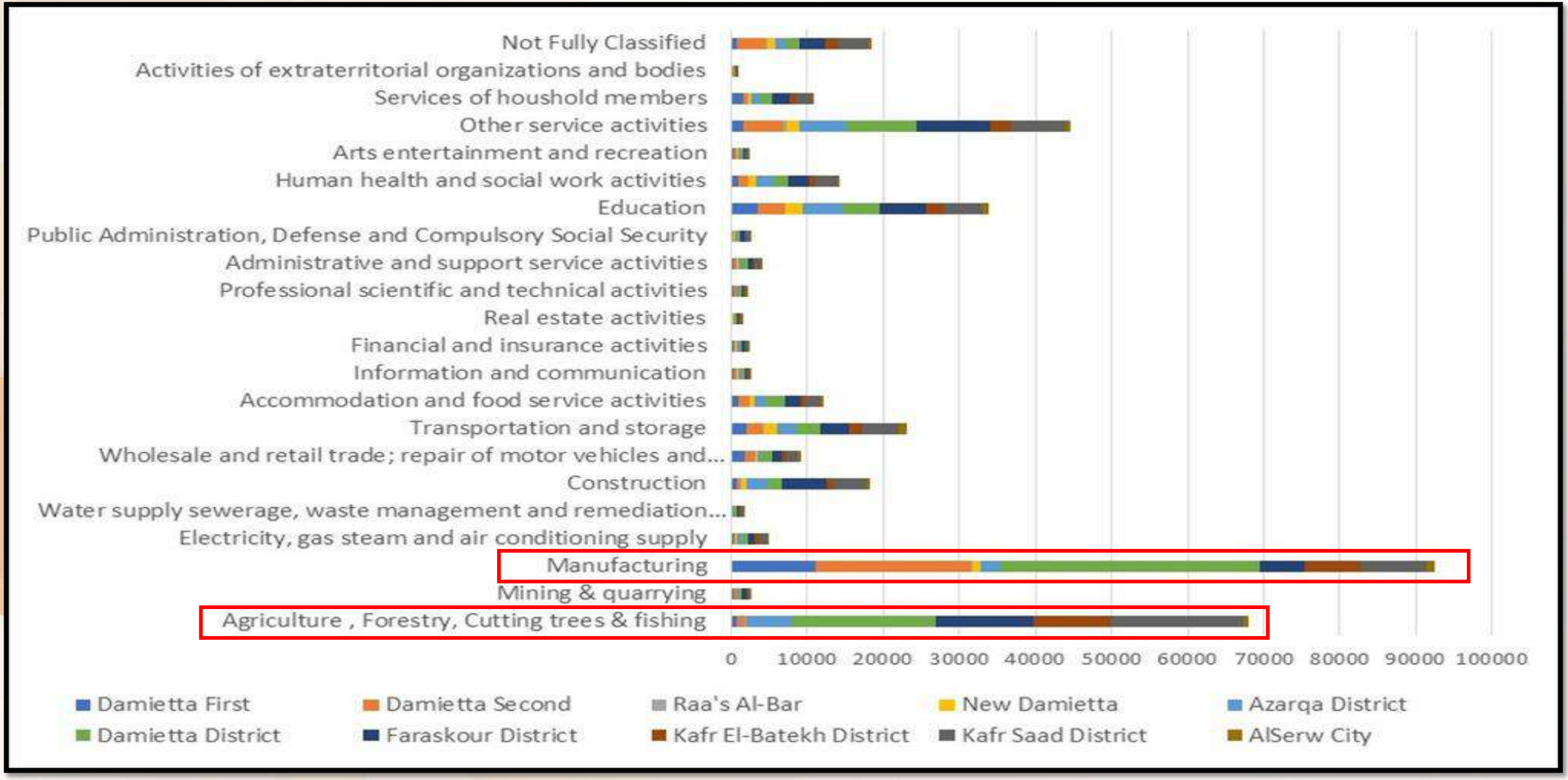
Carbon Monoxide

- CO concentration ranged between 0.023 mol/m^2 and 0.047 mol/m^2 with a mean of 0.032 mol/m^2 during 2019-2022.
- CO can be emitted from the incomplete



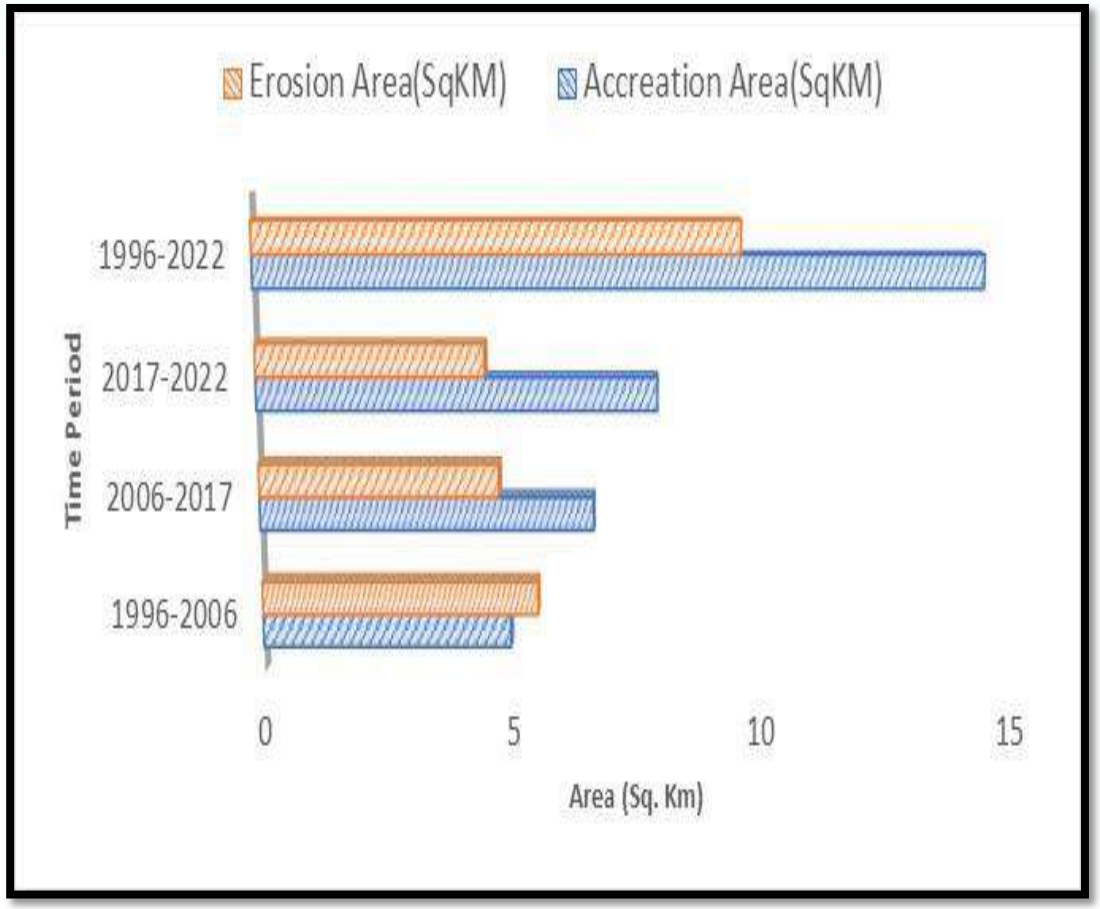


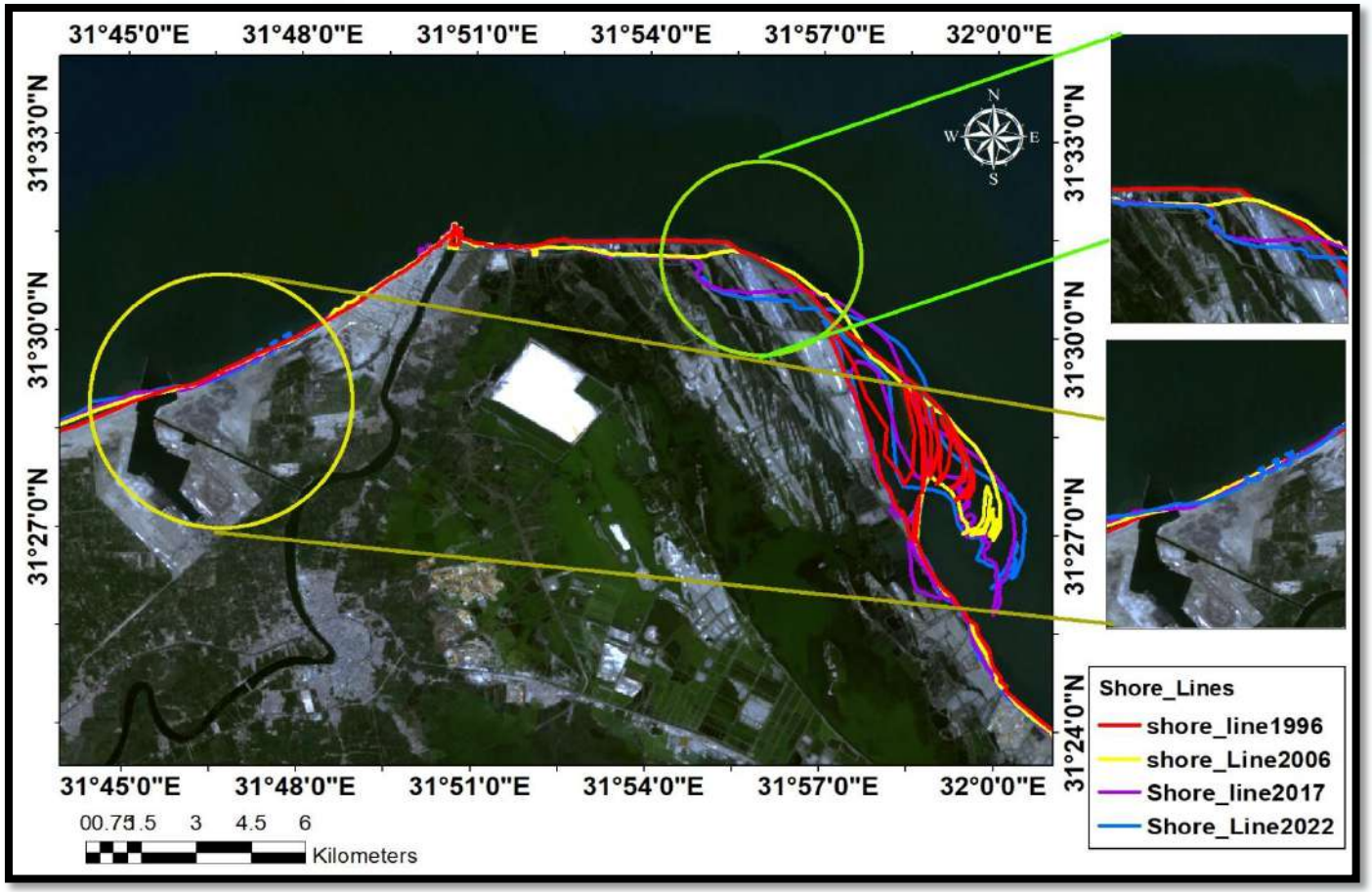
Industrial Activities



Coastal changes and Shoreline extraction & prediction

- The shoreline was extracted by the on-screen digitizing method on Landsat images, in the years of investigation (1996, 2006, 2017, and 2022).
- shoreline change rates are determined using DSAS software, End Point Rate (EPR), and Linear Regression Rate (LRR) techniques.





Shoreline changes

- 204 transects were defined to detect the changes along Damietta shoreline during the period from 1996 to 2022.
- Erosion appeared in 98 transects while accretion was observed in 106 transects.
- The average rate of shoreline accretion was about 20.12 m/yr with a distance accreted of about 513.56 m, while the average erosion rate was estimated at 11.96 m/yr, with an average distance eroded of approximately 311.72 m.
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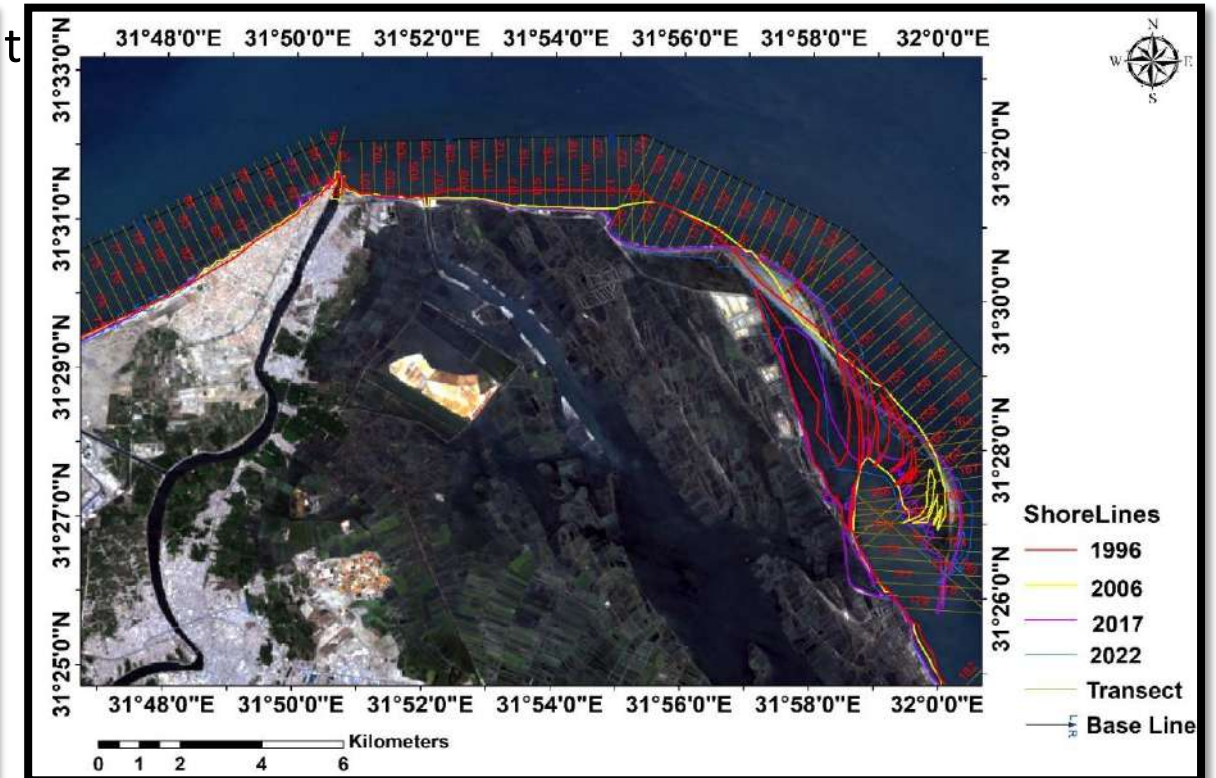
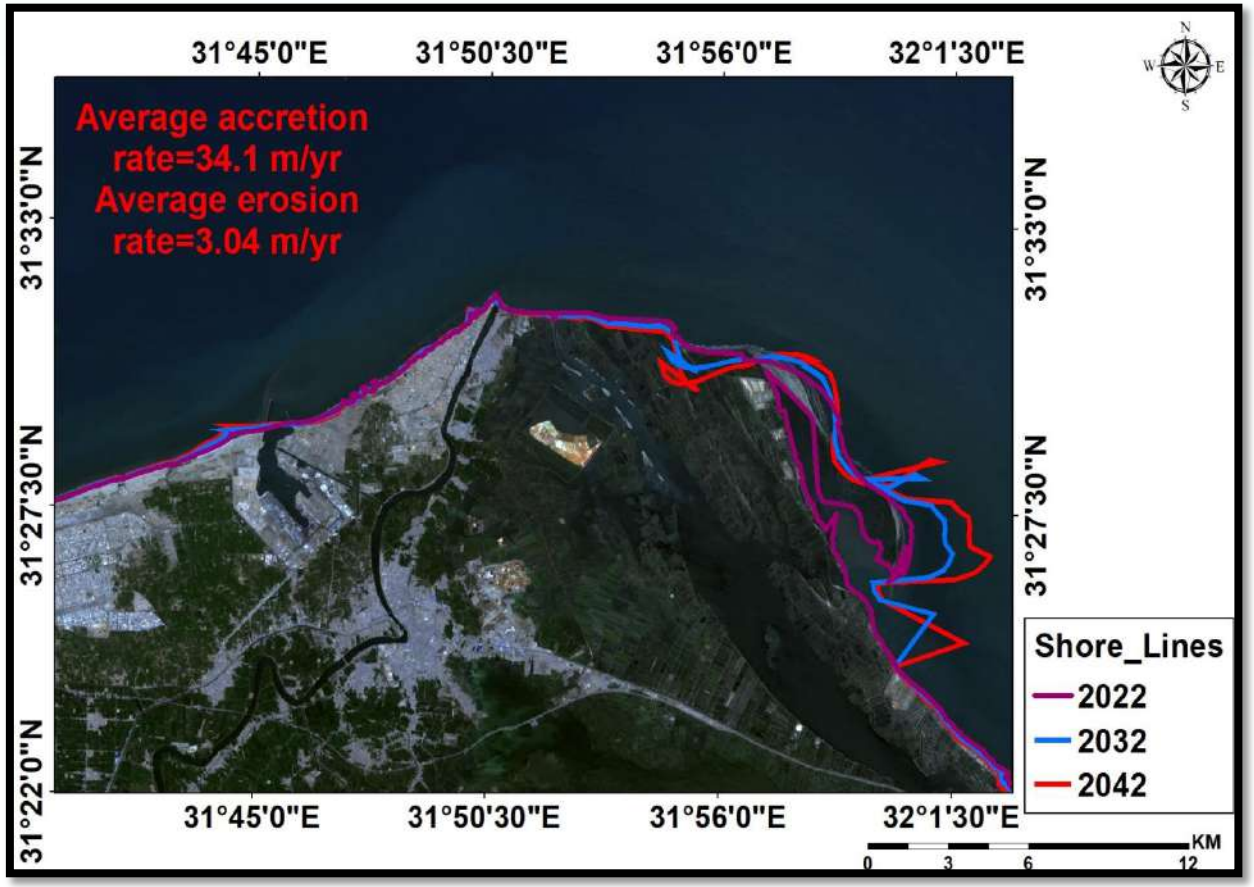
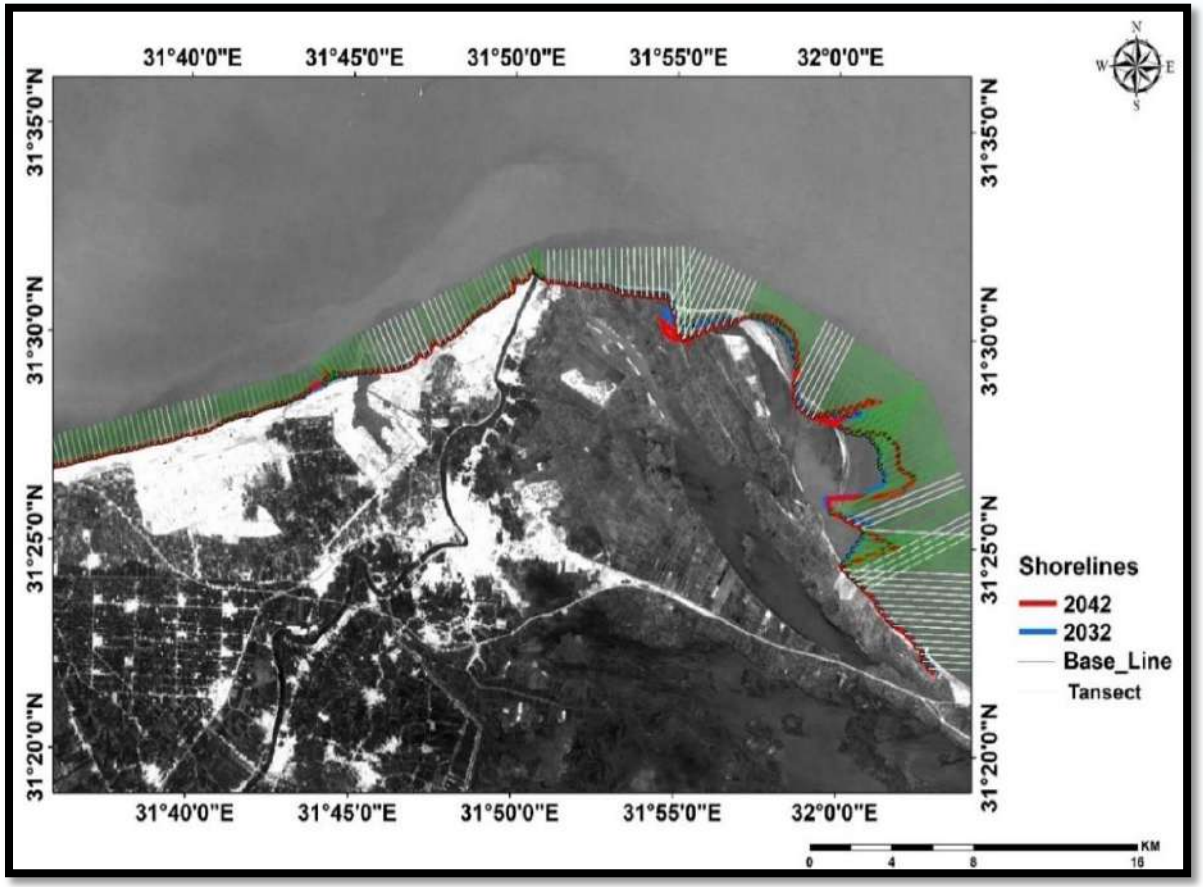


Shoreline prediction

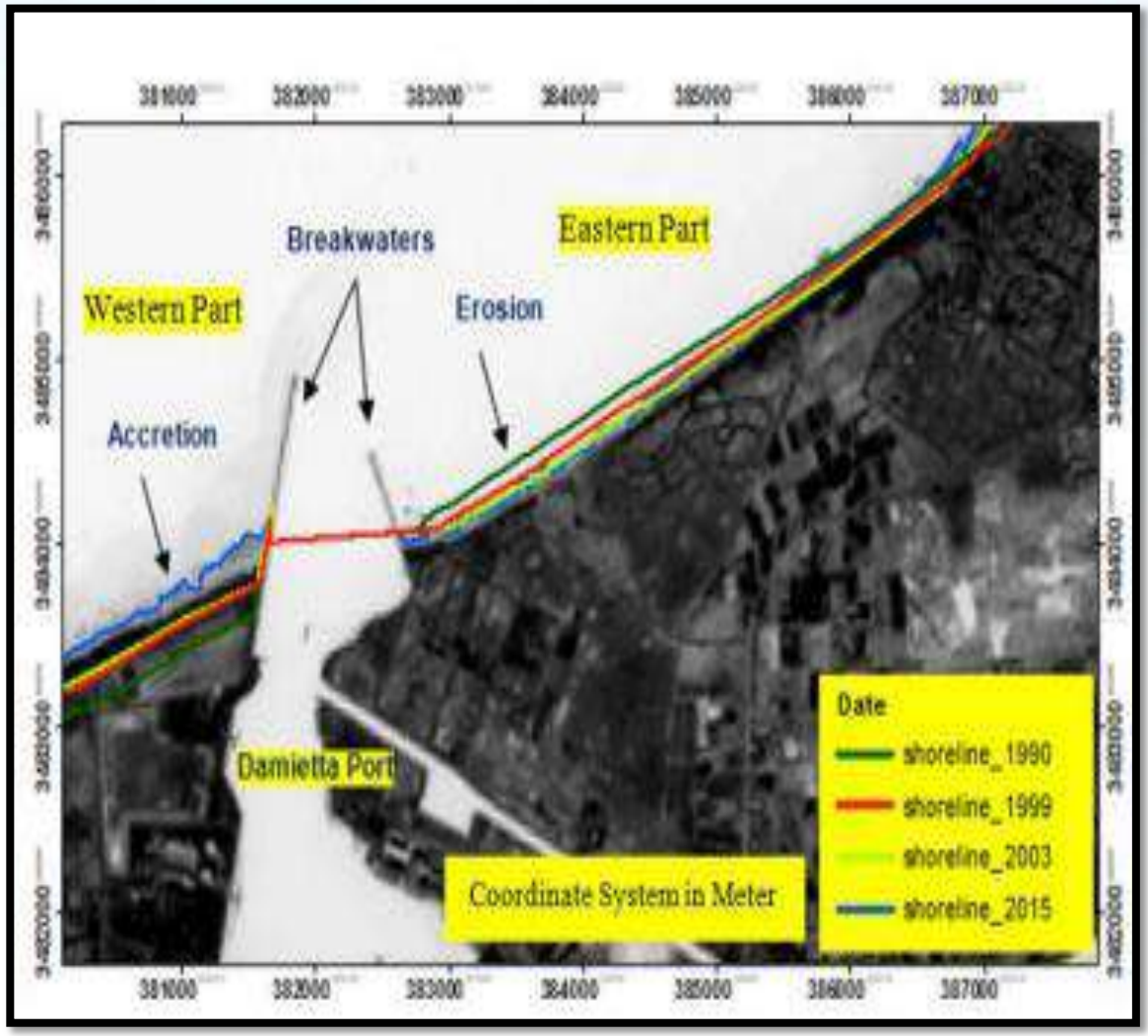
- Using the EPR method for estimation the shoreline change rates in 2032 and 2042.
- The average rate of accretion is expected to reach 34.1 m/yr. with an average rate of erosion of about 13.04 m/yr.





Coastal management

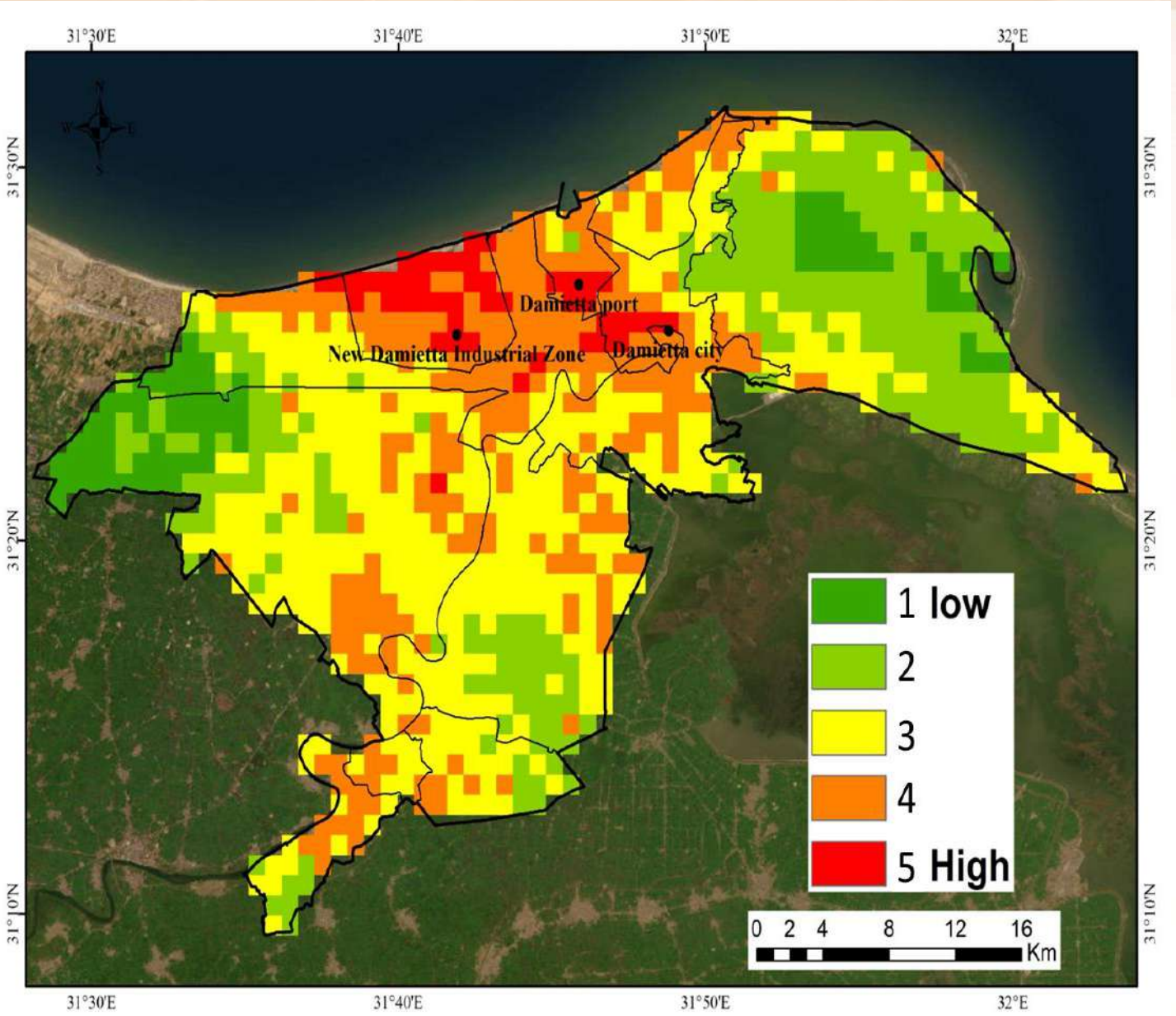
- Various protection efforts have been reinforced along the coast of Damietta to resist coastal erosion, to prevent waves from attacking the coast by intervening in protective structures.
- In 1980, two breakwaters were constructed to protect the navigation channel for Damietta port.
- The west one is 1500m in length and the east one is 800m.
- The effect of the two breakwaters is strongly apparent in accretion at the western side of the port and erosion on the other side in all years.
- In the period from 1990 to 1999, the effect of Damietta port breakwaters appears in shorelines behavior, in which accretion occurs western the port by 14.0 m/year, and erosion process occurs at the eastern part of the port by a rate of 10.0 m/year.
- The accretion still advanced at the same rate till 2015 but the erosion rate decreased to 5.0 m/year. The shoreline changes on the west and east sides of the port represent the danger to the port navigation channel and the land on the east of the port.



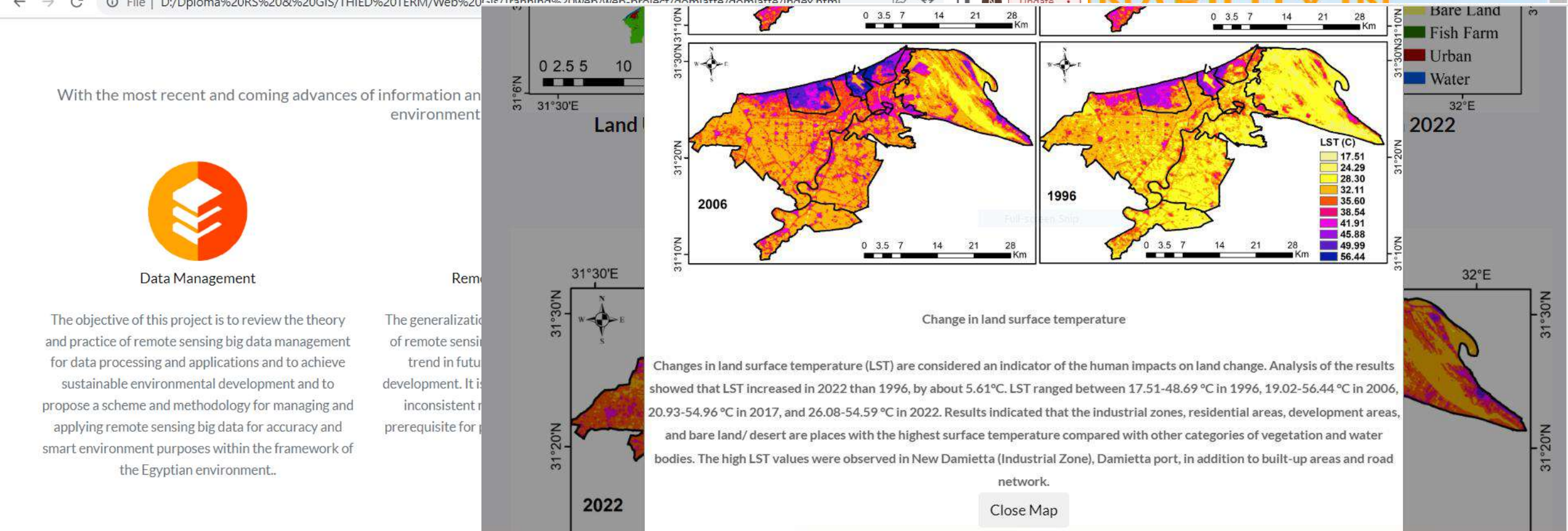
Shoreline at Damietta Port; 1990,1999,2003, and 2015, with location of breakwaters (Source: Esmail et al, 2018).

Define the area under risk

- A GIS model was developed to define the areas under risk and facing environmental degradation according to the previous analysis and monitoring.
- Considering the spatial variations of **land cover, land surface temperature, and air quality**.
- The areas with green color in classes 1 and 2 are less exposed to environmental degradation compared to the areas in red color (4 and 5) which are exposed to higher environmental degradation.
- The area in yellow color (class 3) is moderately degraded.
- These highly degraded areas are located in the new Damietta region near the industrial zone and the center of Damietta.
- These areas need more considerations for sustainable development.



Web Design for the Project



Conclusion

- Human activities could induce various environmental issues by emitting huge quantities of pollutants over land, water, and air.
- Remote sensing is a powerful tool for assessing environmental impacts.
- Damietta is facing several environmental issues due to human activities.
- Coastal areas face high accretion and erosion rates.
- Urbanization increased in the past years, coupled with a decrease in vegetation cover.
- High rates of land cover change, land surface temperature, and air pollution levels are concentrated in New Damietta and the

Recommendations

To mitigate the impacts of anthropogenic activities on environmental sustainability, it is essential to adopt sustainable practices, such as

- **Increase public awareness.**
- Reduce greenhouse gas emissions,
- promote clean energy sources such as solar and wind.
- Replace vehicles using fossil fuel with electric cars
- Reduce waste and pollution,
- Protect natural resources.
- Prevent urban extension over agricultural land.

Acknowledgement & Thanks