Environmental survey for some Climate-Related Coastal Vulnerabilities in the Mediterranean Southern Coast, Egypt

Ahmed A. Othman

National Authority for Remote Sensing and Space Sciences (NARSS)

AfricaGIS 2025

UN-GGIM: AFRICA
UNITED NATIONS GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

AfricaGIS 2025 and
UN-GGIM: Africa XI Joint Conference

Harnessing Geospatial Intelligence for Africa's Sustainable and Resilient Future

17-21 November 2025, Alisa Hotel, Accra, Ghana

NARSS
NATIONAL AUTHORITY FOR REMOTE SENSING & SPACE SCIENCES

GMES AND AFRICA

United Nations Economic Commission for Africa

EIS

LiSAG

FIG
International Federation of Surveyors
Fédération Internationale des Géomètres
Internationale Vereinigung der Vermessungsingenieure

LANDS COMMISSION
GHANA

UNIVERSITY OF GHANA

Contents

Introduction

Importance of the Mediterranean Sea as a Biodiversity Hotspot

- The Mediterranean Sea hosts over **17,000 species**, making it one of the most significant global biodiversity hotspots (UNEP-MAP, 2020).
- Despite representing less than 1% of the world's ocean area, it supports ~18% of known marine species due to its unique ecological and hydrological conditions.

Role of Chlorophyll-a as a Universal Parameter

- Chlorophyll-a (Chl-a) is the standard indicator for phytoplankton biomass, which forms the base of the marine food web (NASA Ocean Biology Program).

  Chl-a helps assess:

  - Primary productivity
  - Nutrient availability
  - Ecosystem health
  - Impacts of climate change on marine life
- Variability in Chl-a directly reflects environmental stress and shifts in marine biodiversity.

Basics

The Mediterranean Sea System

- A **semi-enclosed basin** with limited water exchange, making it highly sensitive to environmental changes and anthropogenic pressures.
- Exhibits natural **oligotrophic conditions** (low nutrients), particularly in the eastern basin.

Chlorophyll-a = Indicator of Phytoplankton Biomass

- Phytoplankton respond rapidly to:
  - Sea Surface Temperature (SST)
  - Salinity changes
  - Stratification
  - Nutrient inputs
- Therefore, Chl-a acts as a **climate-sensitive ecological indicator**.

Future Climate Projections

- According to IPCC AR6:
  - The Mediterranean will warm **2–3× faster** than global oceans.
  - Surface warming increases stratification → **reduces vertical nutrient mixing**.
  - Result: Expected **decline in chlorophyll productivity**, especially in eastern Mediterranean waters.

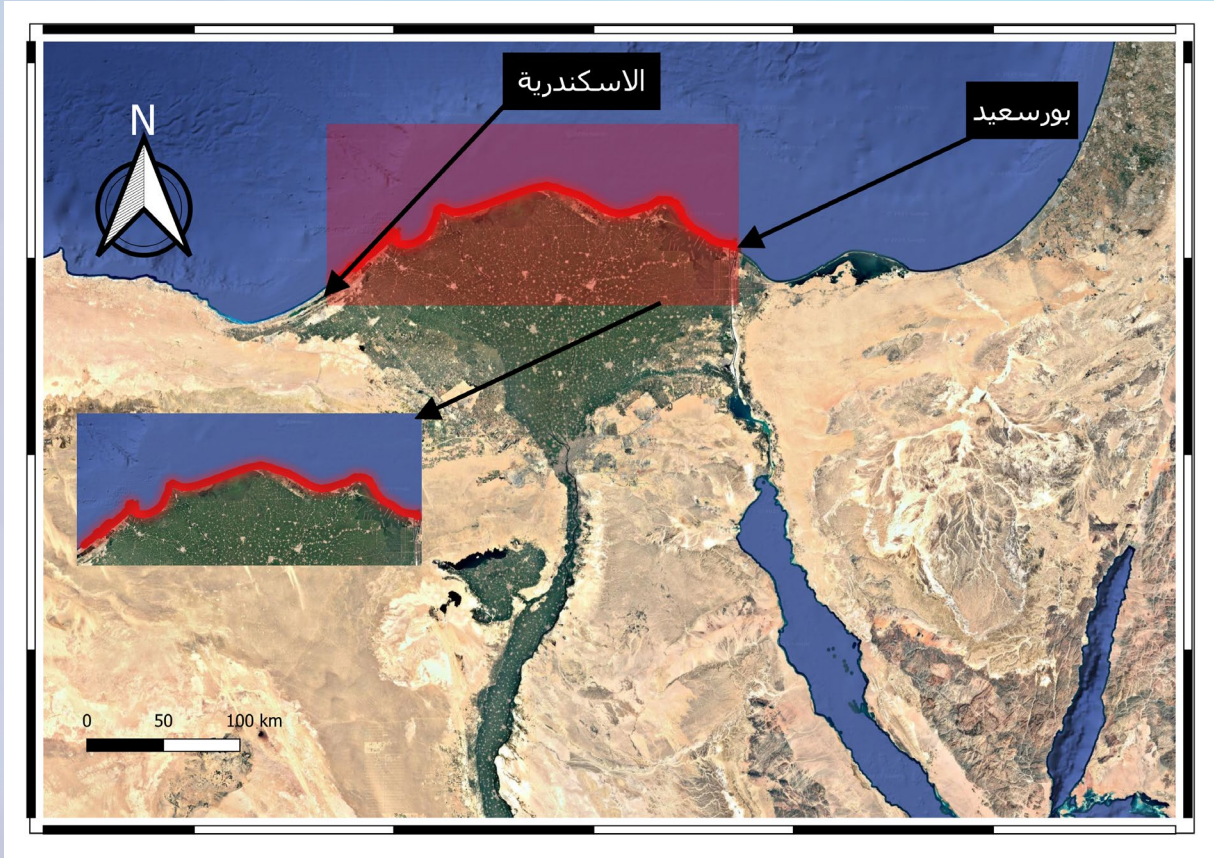
Study Area

Geographical Focus

- Southern Mediterranean coast of Egypt
- Extends from Port Said to Western Alexandria

Why This Area

- **Ecologically and socio-economically critical:**
  - Fisheries, ports, tourism, industrial zones
- **Increasing vulnerability to climate-driven stressors:**
  - Rising SST
  - Increasing SSS
  - Sea-level rise
  - Coastal erosion
  - Variability in atmospheric conditions (humidity, wind, evaporation)



AfricaGIS 2025

UN-GGIM: AFRICA
UNITED NATIONS
GLOBAL GEOSPATIAL
INFORMATION MANAGEMENT

Research Statement:

- Decline or variability in chlorophyll affects marine food webs and fisheries.
- Lack of long-term integrated datasets combining Chl-a, SST, SSS, AT for the Egyptian Mediterranean coast.
- Limited predictive modeling of chlorophyll under future climate scenarios.
- Need to understand how SST, stratification, and nutrient inputs shape chlorophyll dynamics over time.

Aim of the Study

To **assess and predict changes in chlorophyll content** in the Mediterranean Sea—particularly along the southern coast of Egypt—as a response to climate change up to the year **2100**, using remote sensing, climate datasets, and predictive modeling.

Objectives

Quantify Temporal & Spatial Variations of Chlorophyll (2000–Present)

- Tools: MODIS & Sentinel-3 imagery, thematic maps, climate datasets
- Data Sources: NASA OBPG, ESA Copernicus, CMEMS, NOAA

Project Future Chlorophyll Changes (to 2100)

- Based on IPCC climate models
- Using RCP / SSP scenarios (4.5, SSP2, 8.5)

Analyze Environmental Correlations

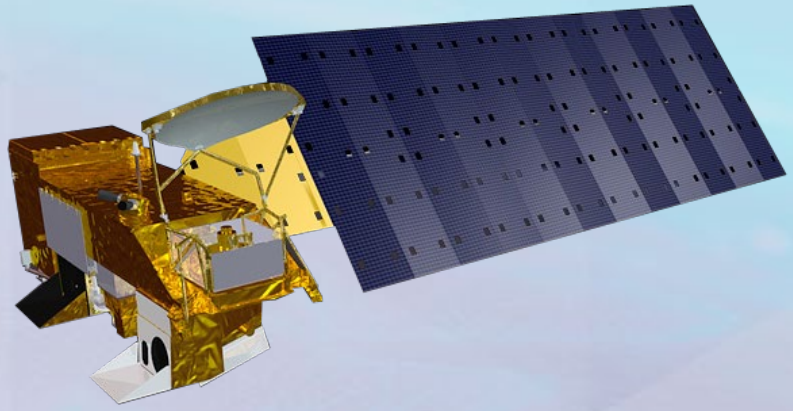
- Chlorophyll trends vs.:
  - Sea Surface Temperature (SST)
  - Sea Surface Salinity (SSS)
  - Atmospheric factors: air temperature, wind, humidity, evaporation

Evaluate Ecological Implications

- Effects on marine biodiversity
- Identification of productivity hotspots
- Risks to fisheries & coastal ecosystems
- Implications for adaptation strategies

Data Sources

- MODIS-Aqua, Sentinel-3 OLCI (Chl-a, SST)
- Copernicus Marine Service (SSS)
- Google Earth Engine
- ERA5 & NOAA reanalysis (air temperature, wind, humidity)
- Multi-year (2004–2024) datasets
- GIS-based spatial analysis for trends and vulnerability mapping



Copernicus Marine Service

AfricaGIS 2025

UN-GGIM: AFRICA
UNITED NATIONS GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

Methodology

Data Collection

- Download satellite images
- Acquire climatic/oceanographic datasets
- Gather geomorphological and hydrological data

Pre-Processing

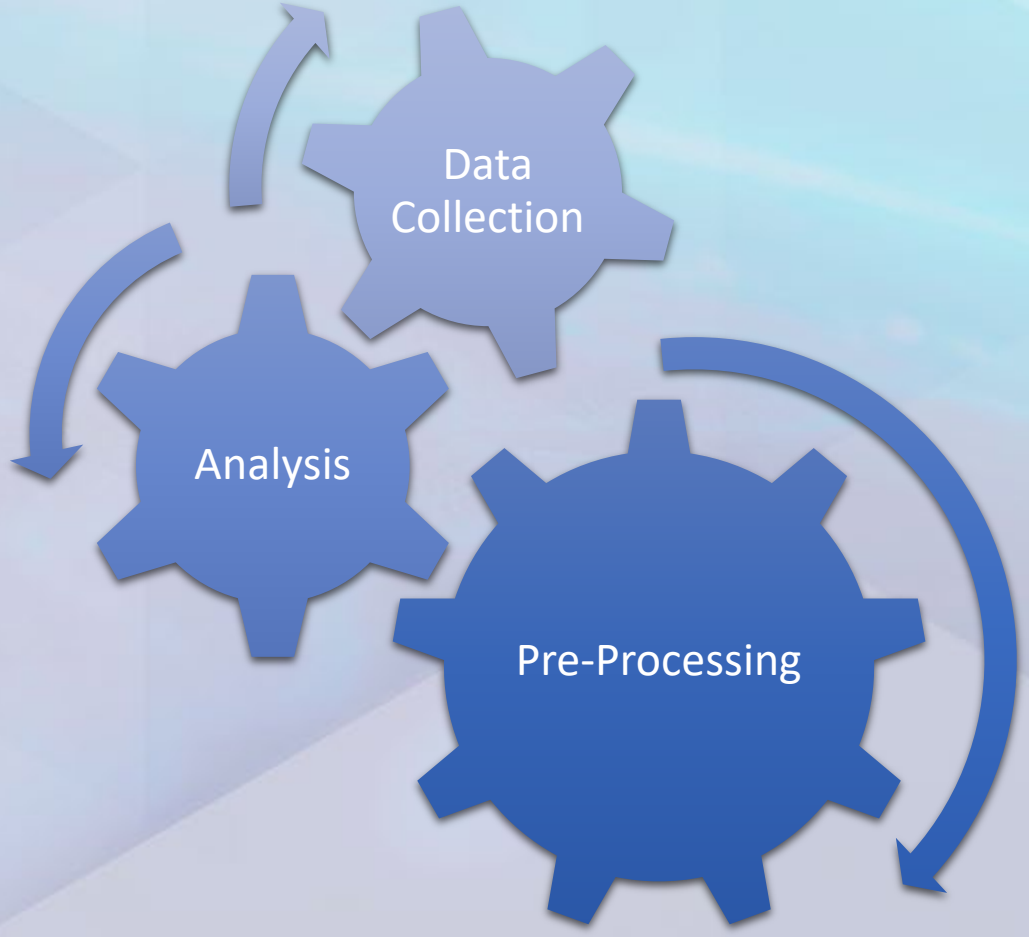
- Atmospheric & radiometric correction
- Georeferencing
- Spatial subsetting for study area

Analysis

- Extraction of Chl-a, SST, SSS
- Time-series analysis (seasonal + long-term trends)
- Correlation & regression modeling
- Spatial GIS mapping

Vulnerability Assessment

- Identify areas of ecological stress
- Map hotspots of productivity decline



Acknowledgment

AfricaGIS 2025

UN-GGIM: AFRICA
UNITED NATIONS
GLOBAL GEOSPATIAL
INFORMATION MANAGEMENT

GMES AND AFRICA

"I would like to express my gratitude to the GEMS & Africa Scholarship Program for supporting my academic and research journey. Their contribution has played a major role in enabling this work and strengthening my capacity in climate change and environmental studies."

AfricaGIS 2025

UN-GGIM: AFRICA
UNITED NATIONS GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

" My special thanks are also extended to

Dr. Elham Mahmoud Ali, my supervisor, whose expert guidance, critical insights, and continuous encouragement have been invaluable throughout all stages of this work."

Thanks

- +20-1010651192
- ahmed.ahot.su@gmail.com
- https://www.linkedin.com/in/ahmed-ashraf-hussien10899/

AfricaGIS 2025

UN-GGIM: AFRICA
UNITED NATIONS
GLOBAL GEOSPATIAL
INFORMATION MANAGEMENT