Cartographic Modeling for Sustainable Urban Development in a Coastal Zone Under the Stress of Sea Level Rise, Northern Nile Delta, Egypt.

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Land use Planning ***is a decision-making process that leads to a choice between a set of alternatives to satisfy certain objectives.***

YET ……

The realization of these objectives may cause a conflict between the environment and the adverse impacts of human activities which may lead to environmental deterioration.

Therefore …..

How can we ensure the sustainability of an urban development plan in a simple and comprehensive approach ?????

This is the main question for which this study attempts to find a solution…

The SEA Tiered Levels for Land Use Plans

Level of government	Land use Plans	Policies (SEA)	Plans (SEA)	Programs (SEA)	Projects (SEA)
National	National Land use plan	National policy	Long term plan	Ex five year program	Ex construction of a motorway
Regional	Regional land use plan		Regional strategic plan		
Sub-regional	Sub-regional land use plan			Sub-regional investment program	
Local	Local land use plan				Ex local infra-structure project

Goal of the Study

- This study aims at experimenting simple methodologies for Sustainable urban planning of Vulnerable Coastal Zones under environmental Stress, in this study we have the sea level rise stress.

Environmental Concerns

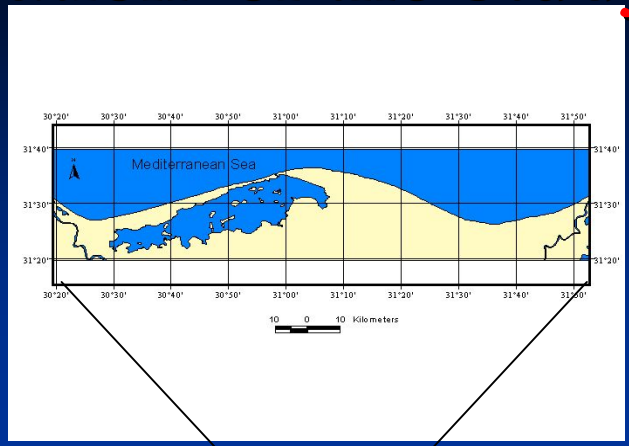
- The mean sea level rise at the Nile Delta has an average1.2-1.3 mm/yr.
- Land subsidence ranges between 1.5 mm/yr.
- Sea water intrusion causes rise in underground water level and increase in its salinity.
- The shoreline is suffering from severe erosion with some accretion zones.
- Environmental changes caused by Natural and Anthropogenic factors.

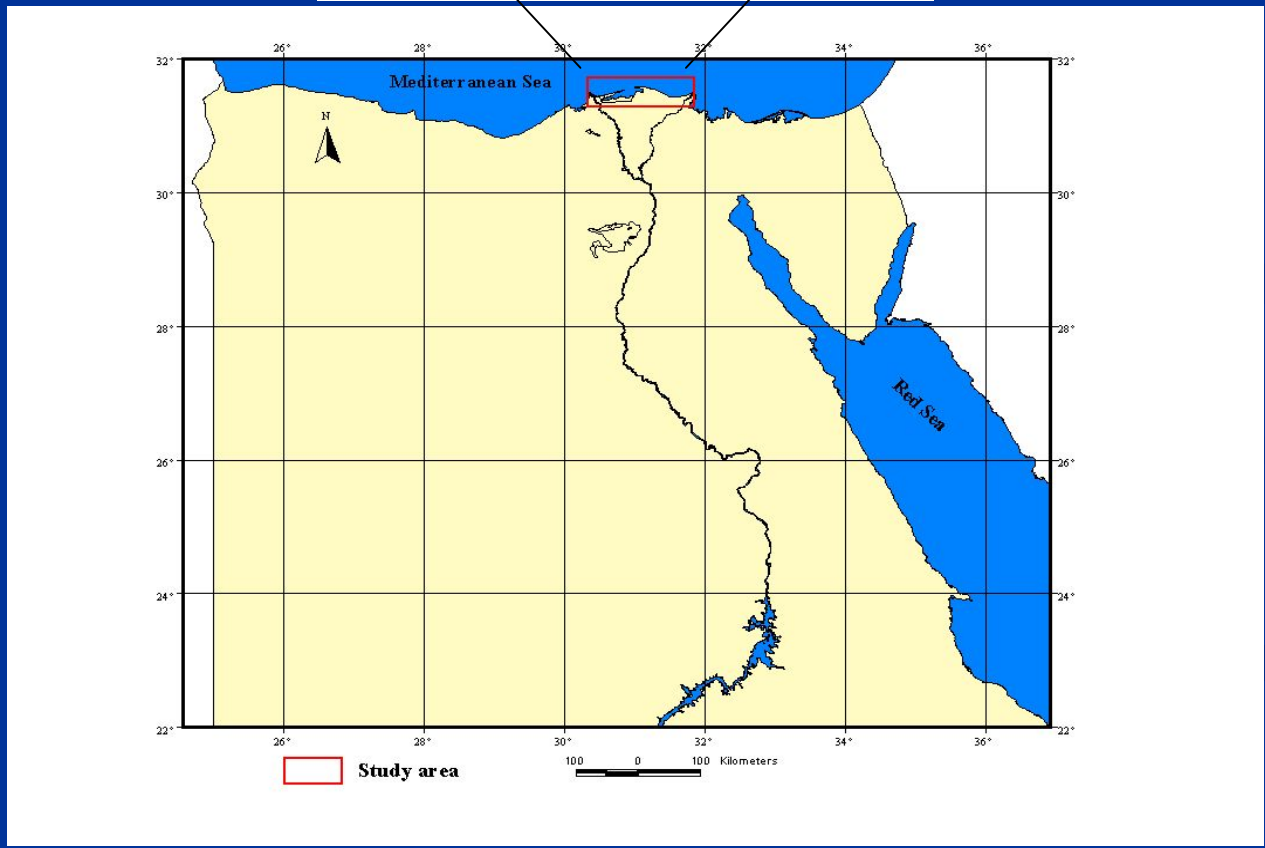
Objectives

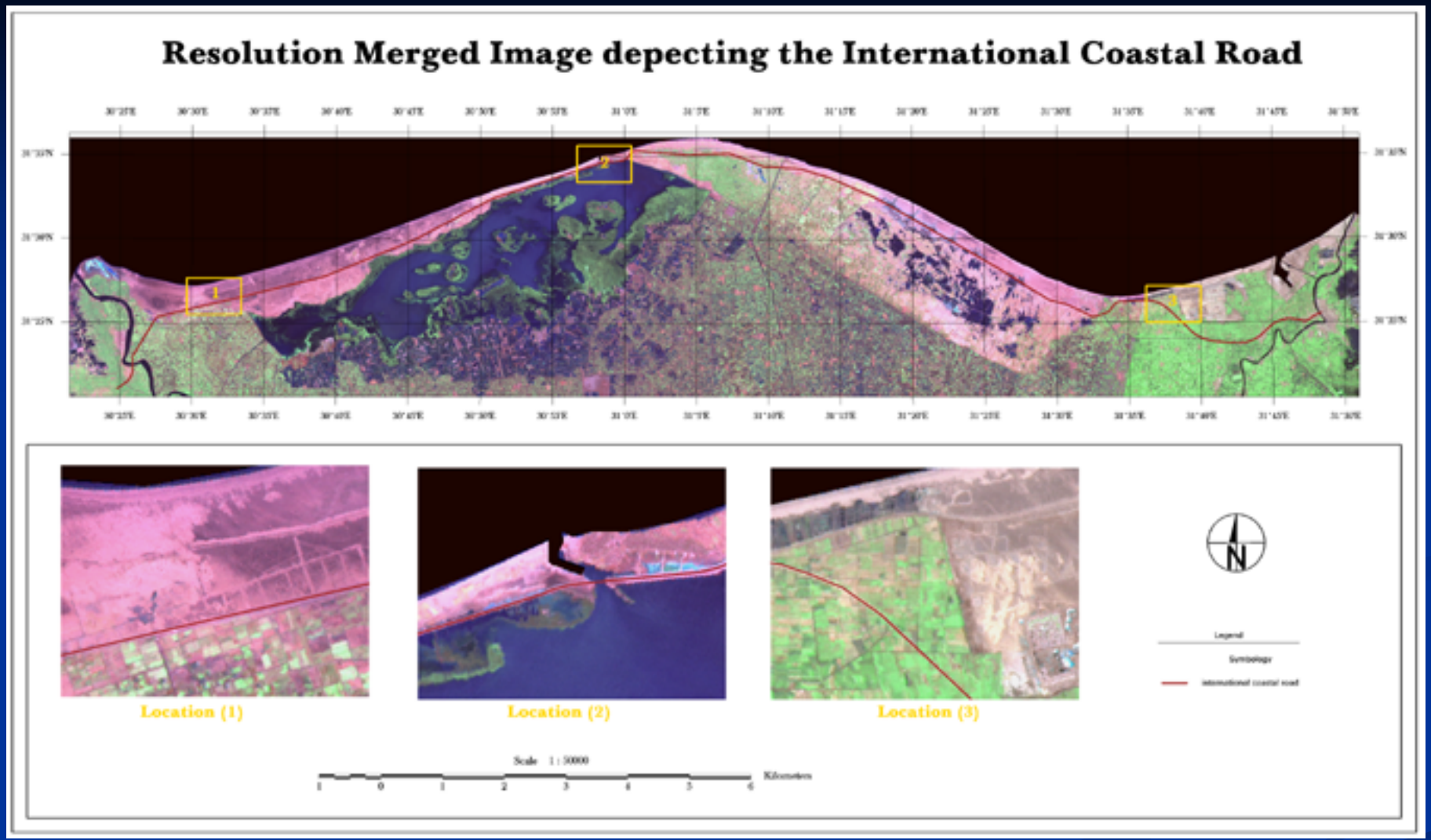
- To study the Vulnerability of the study area (the constraints) and integrate those parameters into physical planning decisions.

- To study the Potentials and capability of the area for a sustainable development plan.

Location of the Study Area

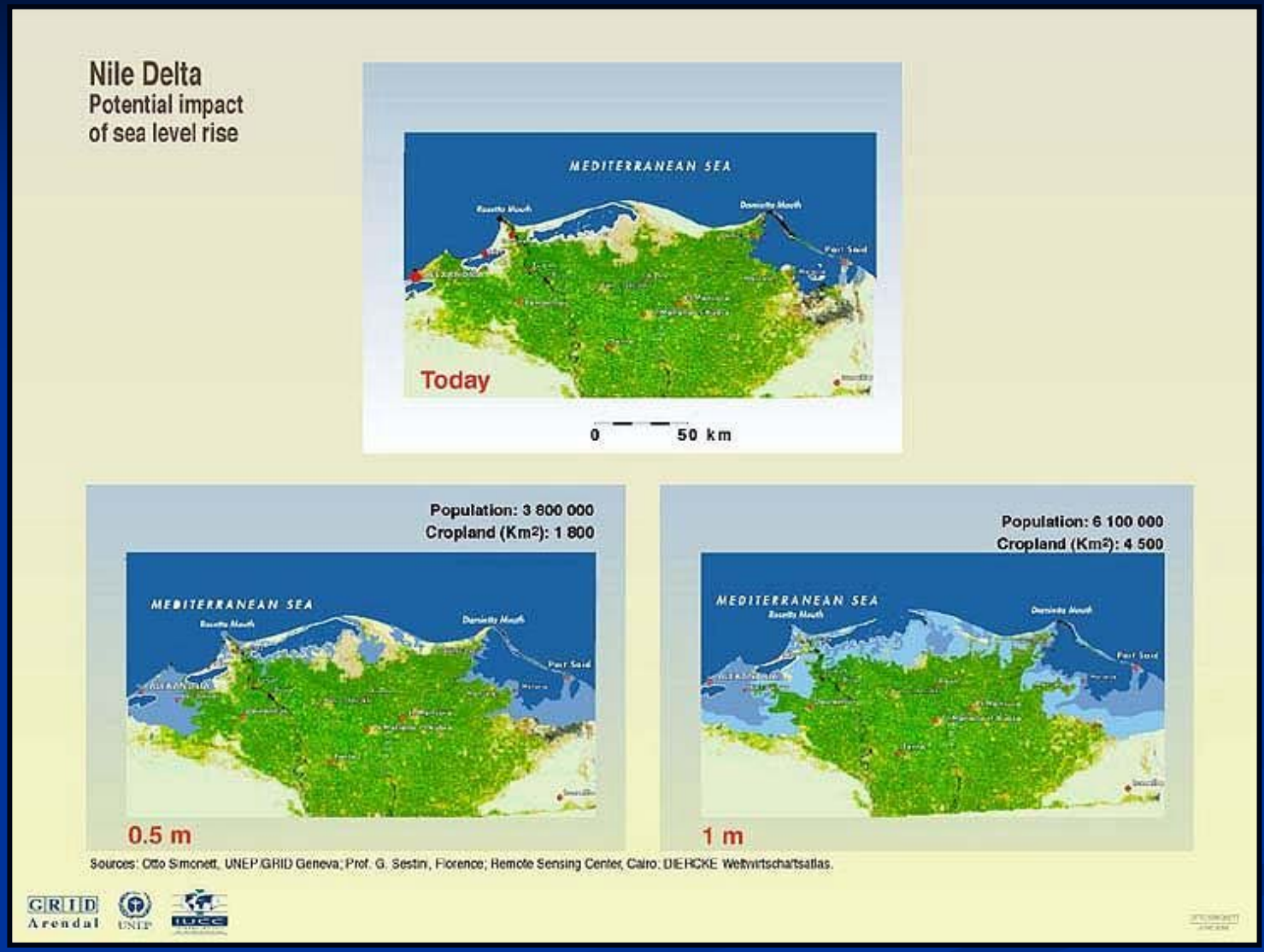






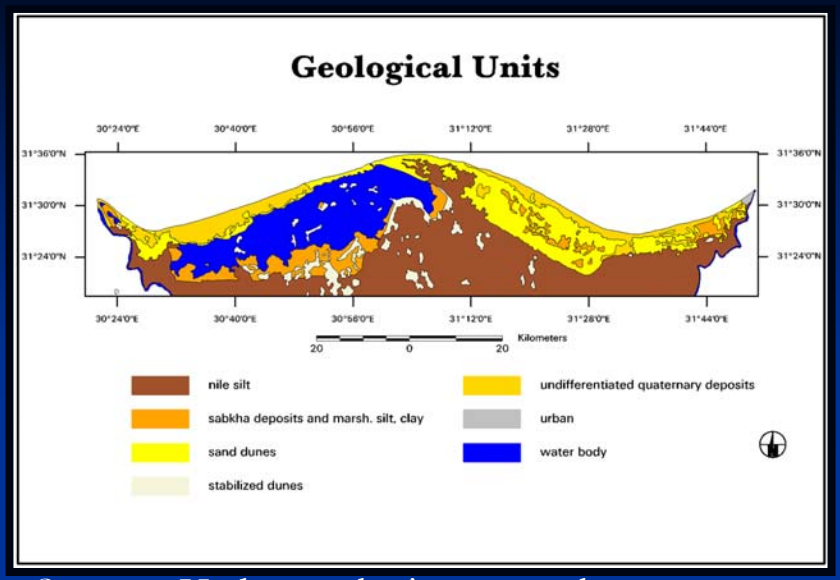
The study area extends between the two branches of the Nile outlets for 160 Kilometers occupying the Northern delta coastal zone between 30° 25 and 31° 55 East and 31° 36 and 31° 20 North

The Sea Level Rise Scenario

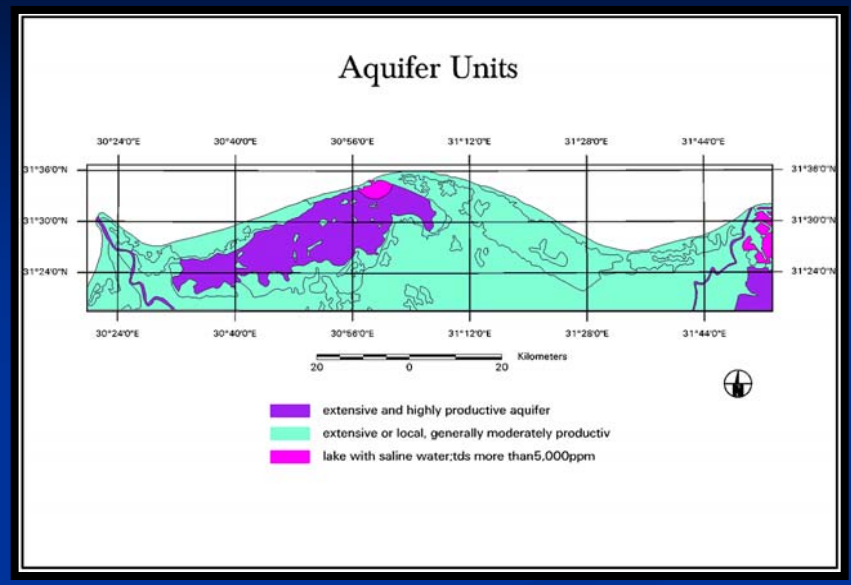


Source: Sestini, UNEP/GRID

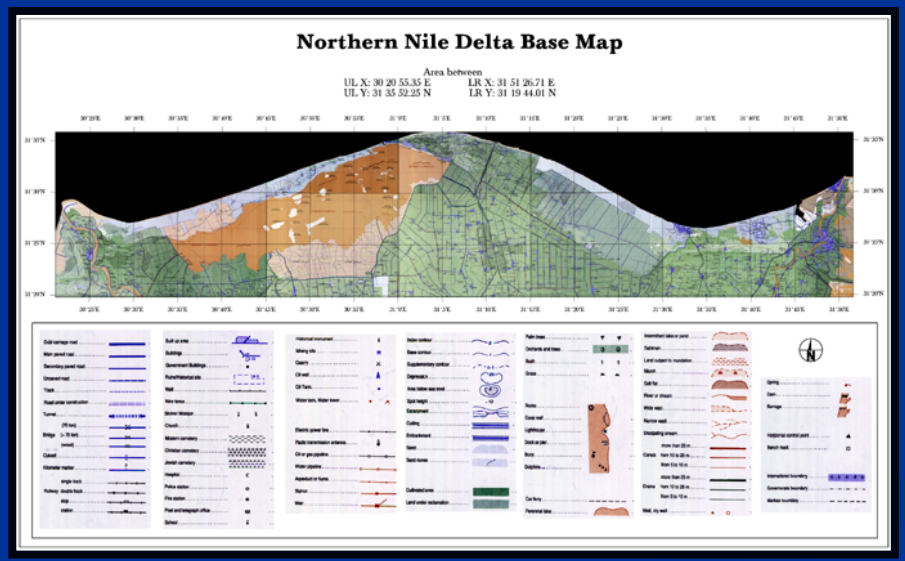
Data	Data Type	Data Source
Topographic	Maps scale 1:50,000	EGSA
Hydro-geological	Maps scale 1: 250,000	RIGW
Land sat TM 1987	Satellite image	NARSS
Land sat ETM+2000	Satellite image	NARSS
Descriptive	Reports	EEAA
Literature	Papers / Reports	Internet / Universities/ Libraries.



Source : Hydro-geologic map scale 1:250,000 after RIGW



Source : Hydro-geologic map scale 1:250,000 after RIGW



Source : Topological map scale 1:50,000

Survey of Land Vulnerability through change detection

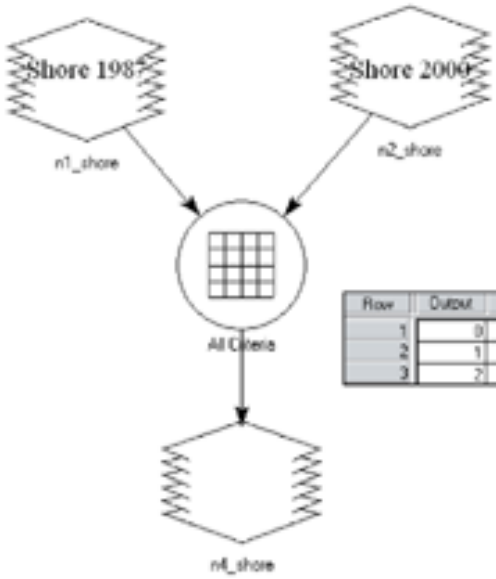
- **Erosion of the shoreline** threatens the coastal development projects.

- **Anthropogenic factors** cause changes in land cover leading to environmental deterioration.

Shore Line Change Detection Model

Rasterization

Shore Line border 1987



Row	Output	$n1_shore	$n2_shore
1	0	==1	==1
2	1	==1	==0
3	2	==0	==1

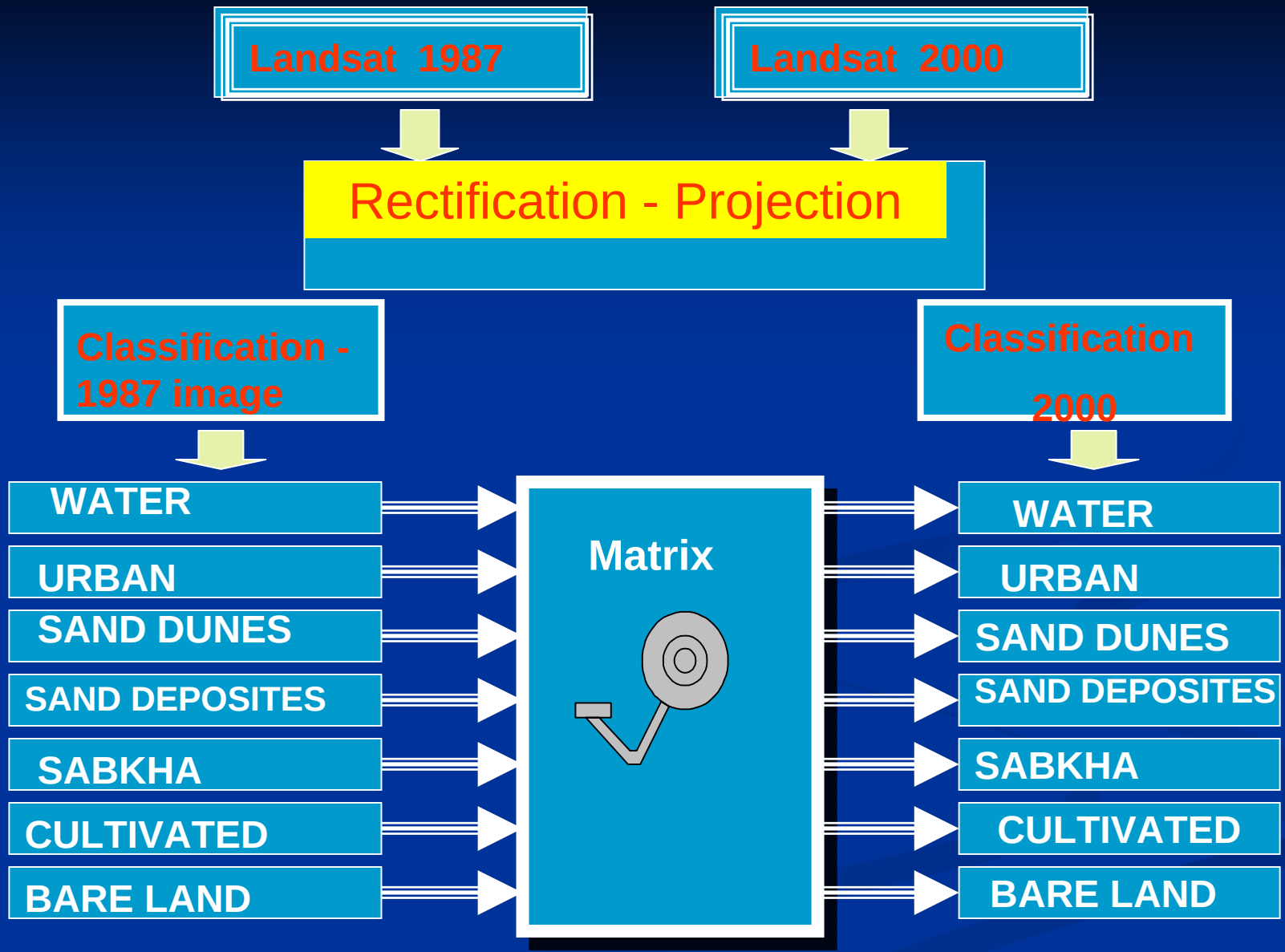
Rasterization

Shore Line border 2000

Model Output

Legend

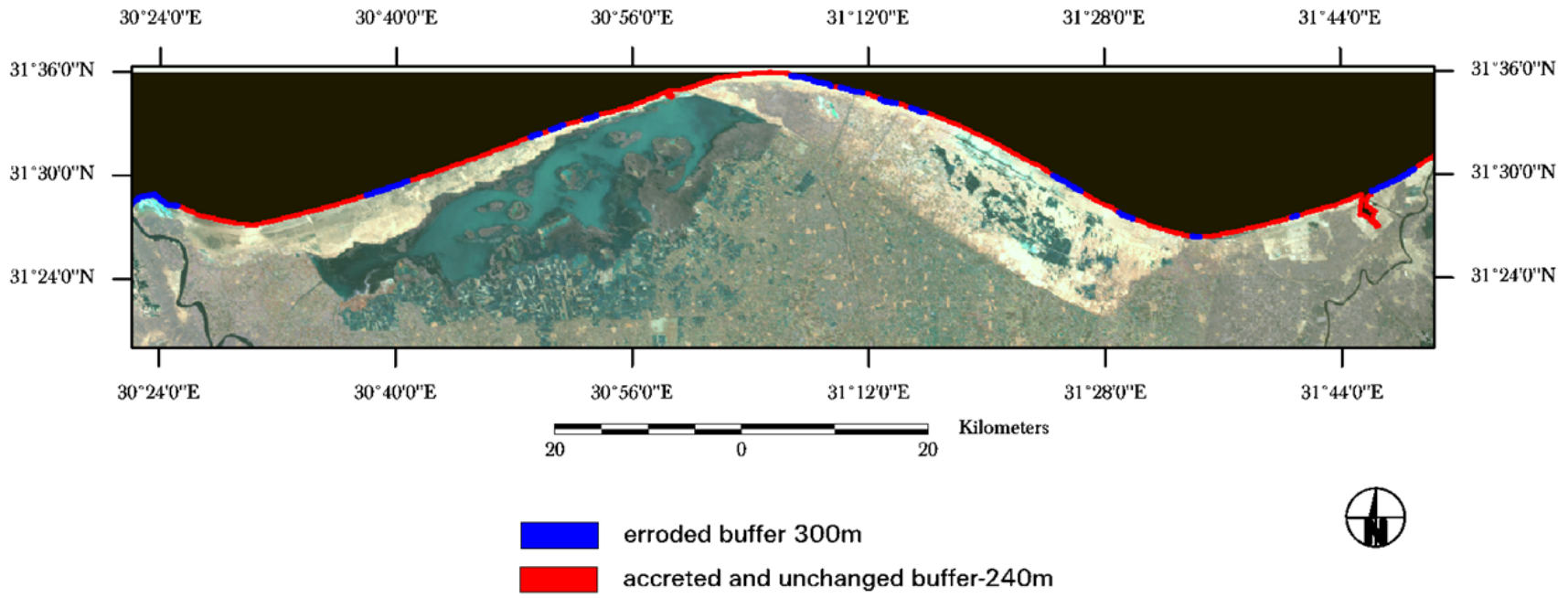
Class_Names	Area
Background	0
Erroded areas from 87-00	687.42
Accreted areas from 87-00	797.22


Landsat 1987
Landsat 2000
Rectification - Projection
Classification - 1987 image
Classification 2000
WATER
URBAN
SAND DUNES
SAND DEPOSITES
SABKHA
CULTIVATED
BARE LAND
Matrix
WATER
URBAN
SAND DUNES
SAND DEPOSITES
SABKHA
CULTIVATED
BARE LAND

Results

Classifying the shoreline

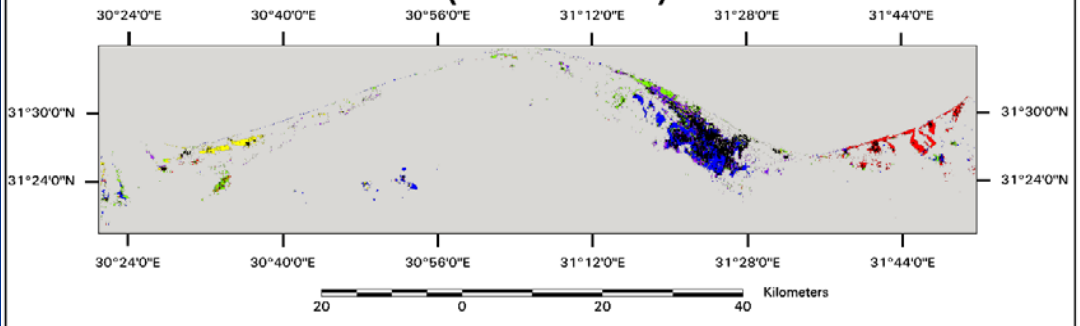
Based on the change detection model



Result of land inventory and Trend of Land use Changes

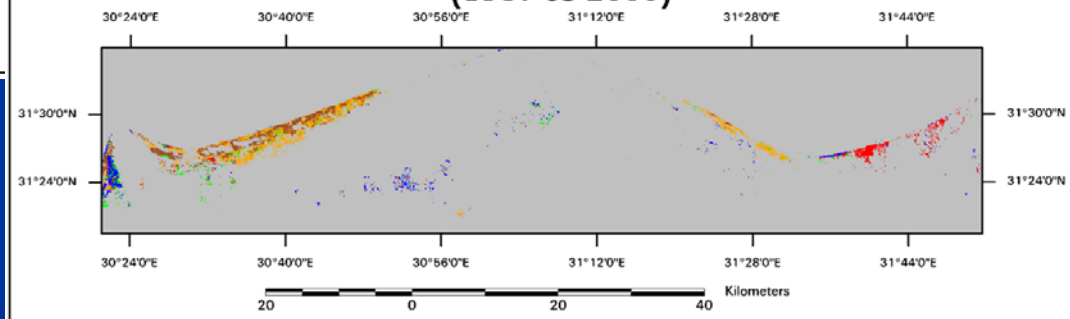
Land Cover Category	1987		2000	
	Area Km sq	Percentage	Area Km sq	Percentage
Water	545.518	18.73	904.0	31.30
Urban	51.045	1.75	208.0	7.20
Sand deposit	206.592	7.09	78.0	2.70
Sand dunes	153.868	5.28	65.0	2.25
Sabkha	159.795	5.49	120.0	4.16
Vegetation	1065.510	36.59	1353.0	46.85
Bare Land	703.246	24.15	160.0	5.54
Total	2887.00	100.00	2887.00	100.00

Changes from Sabkha to Other Landuse (1987 to 2000)



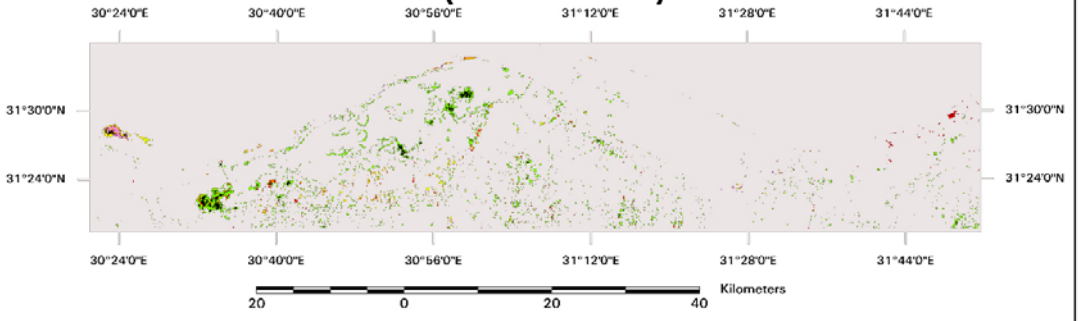
From	To	Area (sq.Km)	Percentage
sabkha	water	41.3496	1.43%
sabkha	urban	23.4072	0.81%
sabkha	sand deposit	12.5577	0.43%
sabkha	sand dunes	10.7784	0.37%
sabkha	sabkha	25.0929	0.87%
sabkha	vegetation	25.5807	0.89%
sabkha	bare land	20.3616	0.71%

Changes from Sand Dunes to Other Landuse (1987 to 2000)



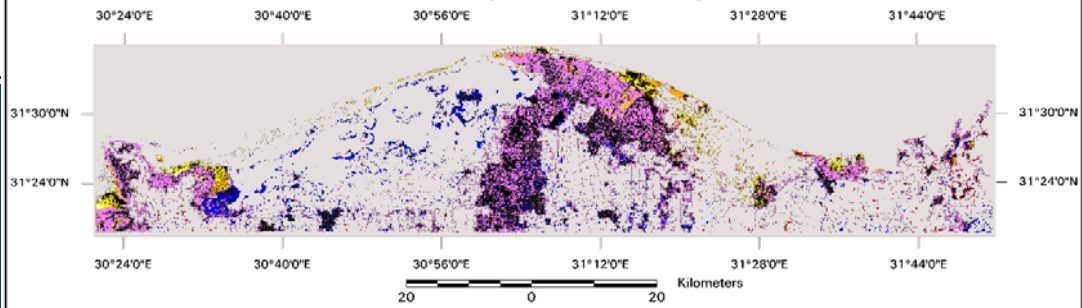
From	To	Area (sq-Km)
Sand Dunes	water	17.4789
Sand Dunes	urban	17.2701
Sand Dunes	sand deposit	34.542
Sand Dunes	sabkha	50.5458
Sand Dunes	vegetation	13.4325

Changes from Water to Other Landuse (1987 to 2000)



From	To	Area (sq.Km)	Percentage
water	water	433.571	15.01%
water	urban	7.8723	0.27%
water	sand deposit	8.73	0.30%
water	sand dunes	0.1575	0.01%
water	sabkha	6.4305	0.22%
water	vegetation	80.8533	2.8%
water	bare land	3.7638	0.13%

Changes from Other Landuse to Vegetation (1987 to 2000)



From	To	Area (sq.Km)	Percentage
water	vegetation	80.8533	2.80%
urban	vegetation	10.6605	0.37%
sand deposit	vegetation	43.6779	1.51%
sand dunes	vegetation	13.4325	0.47%
sabkha	vegetation	25.5807	0.89%
vegetation	vegetation	818.111	28.33%
bare land	vegetation	358.575	12.42%

Suitability Mapping for the Northern Nile Delta Coastal Zone, considering the stress of Sea Level Rise

Define the Criteria for Urban development based on the environmental baseline information

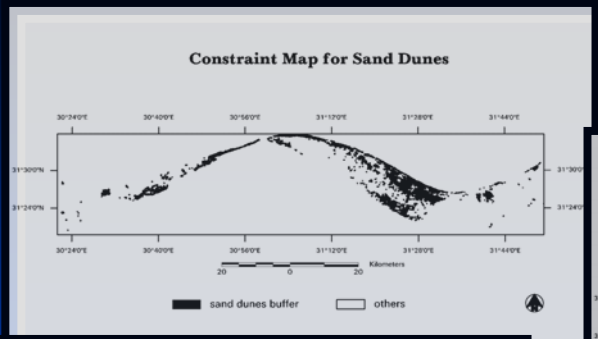
Constraints

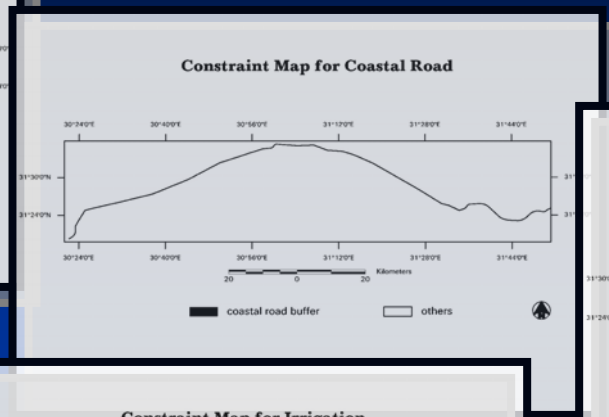
- Wetlands
- Water bodies
- Sand dunes
- Road network
- Cultivated land
- Irrigation network
- Urban
- Coastal road
- Shoreline (buffer)

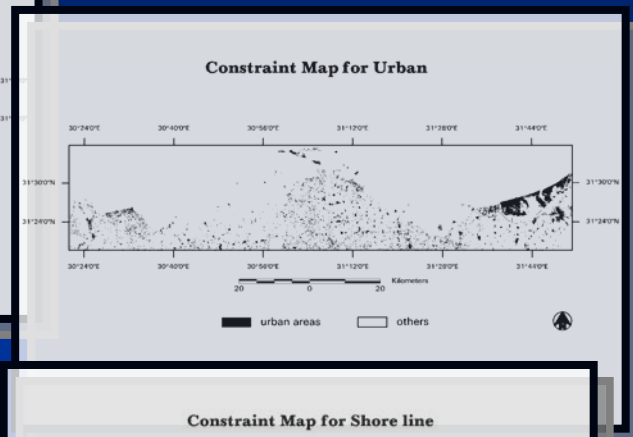
Factors

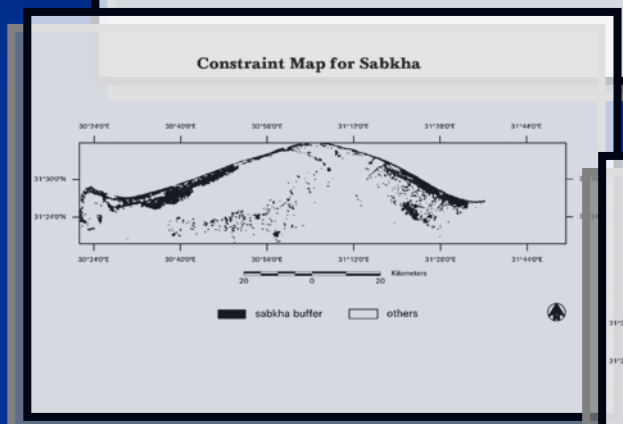
- Elevation
- Shoreline status
- Slope
- Proximity to roads

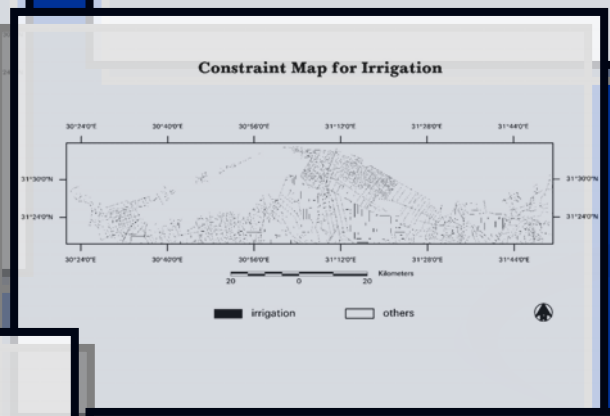
The Constraints Maps

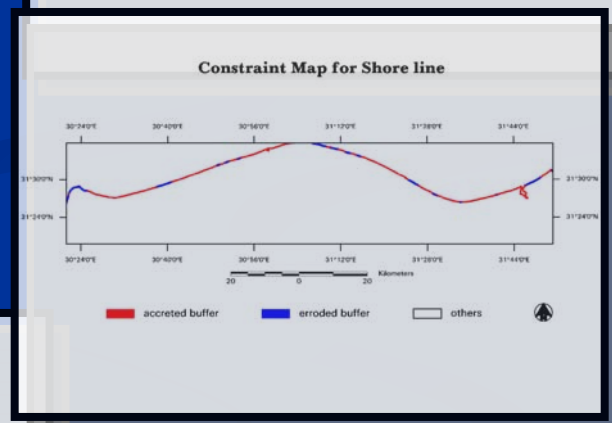


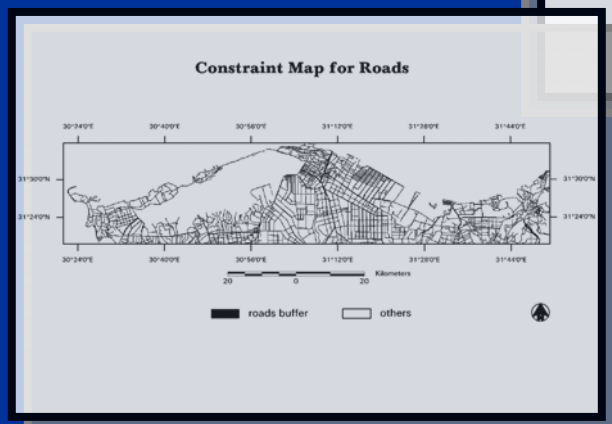


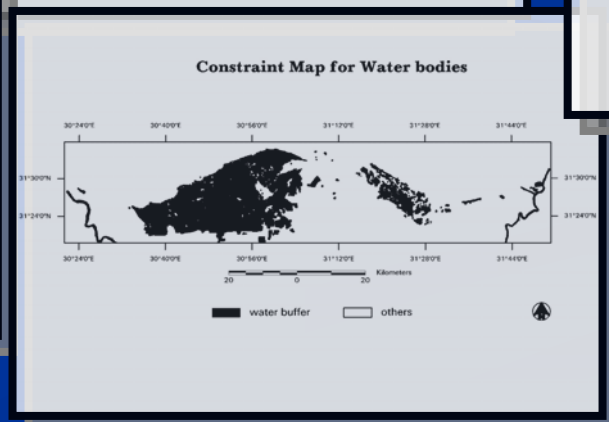




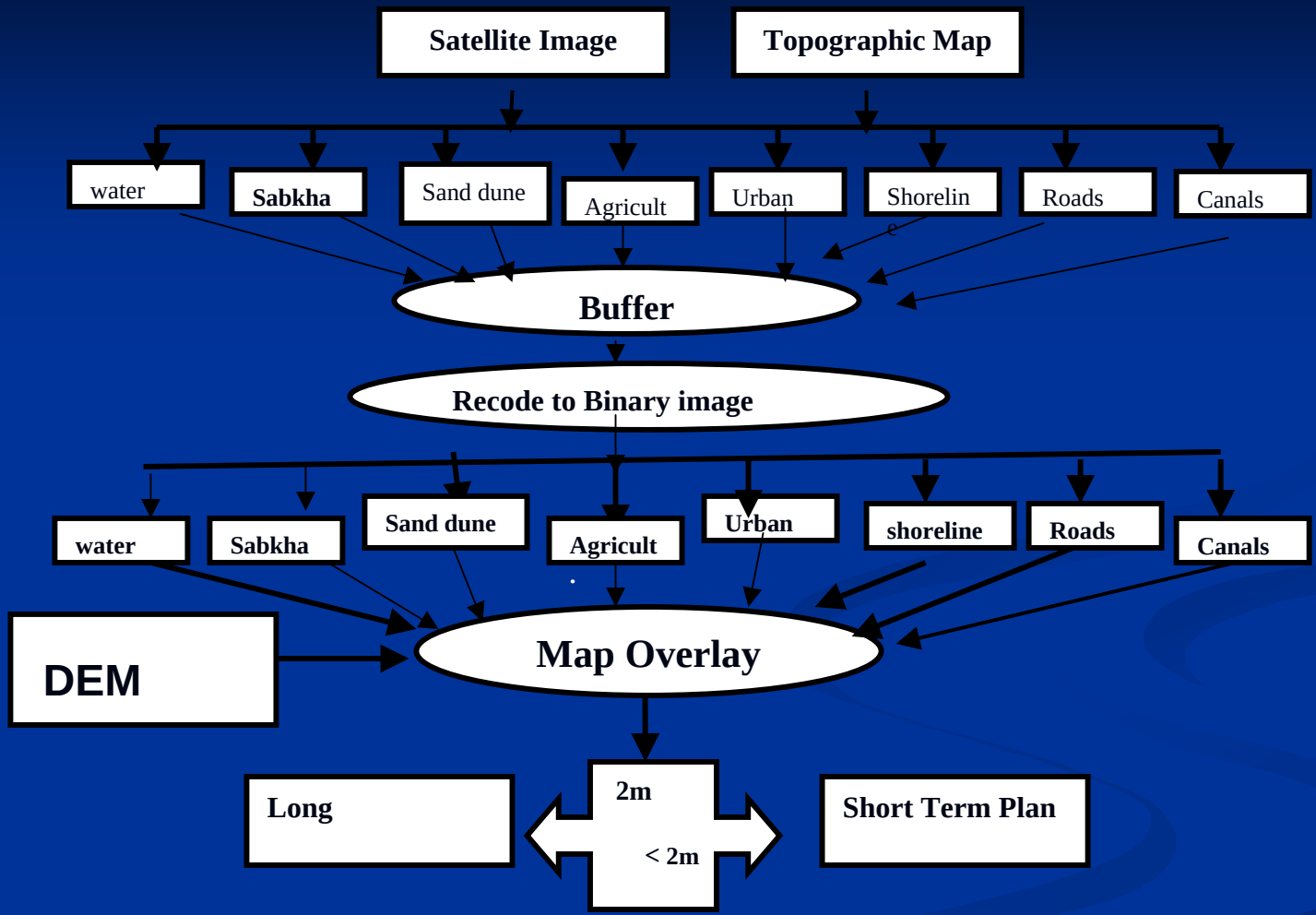


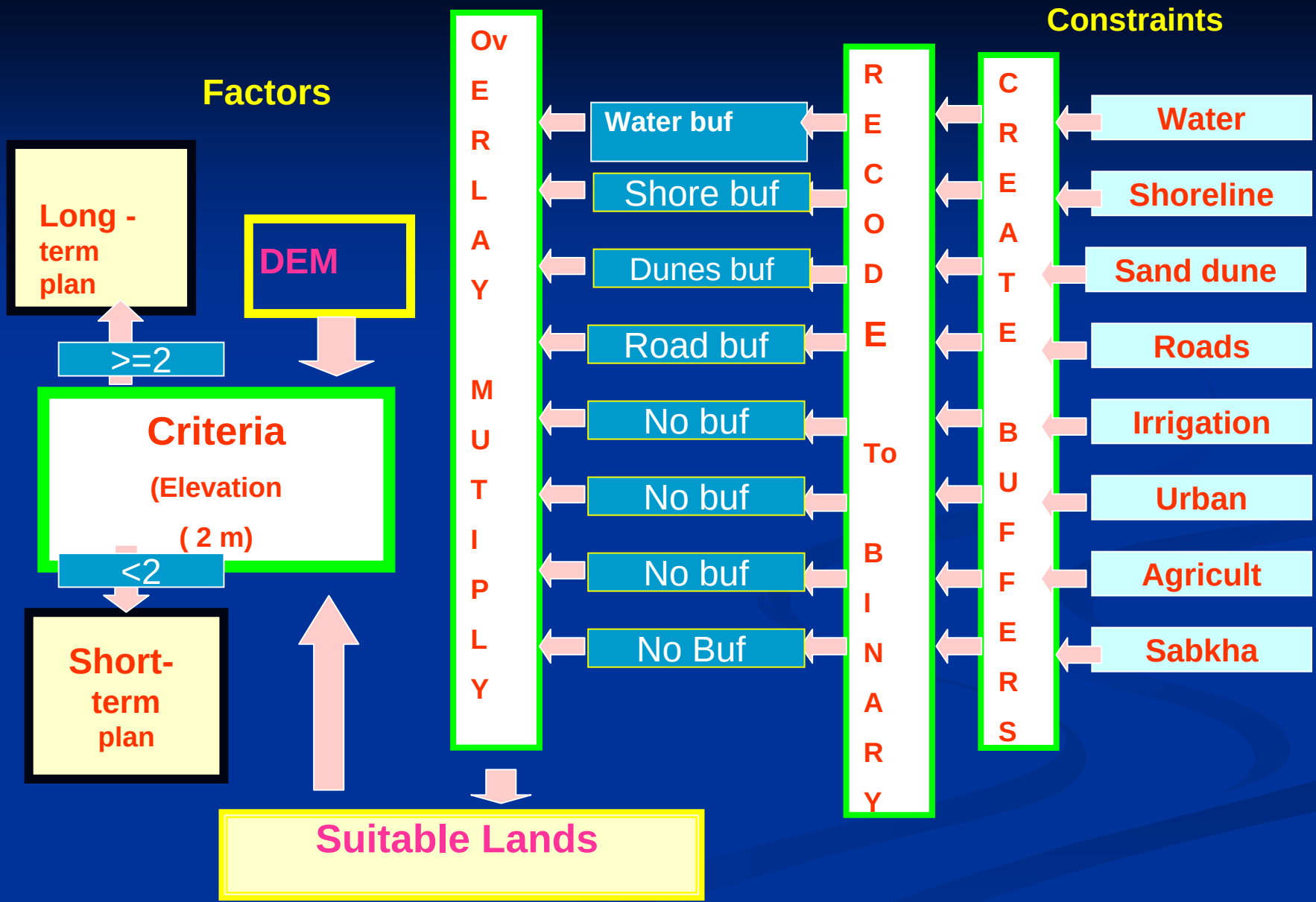






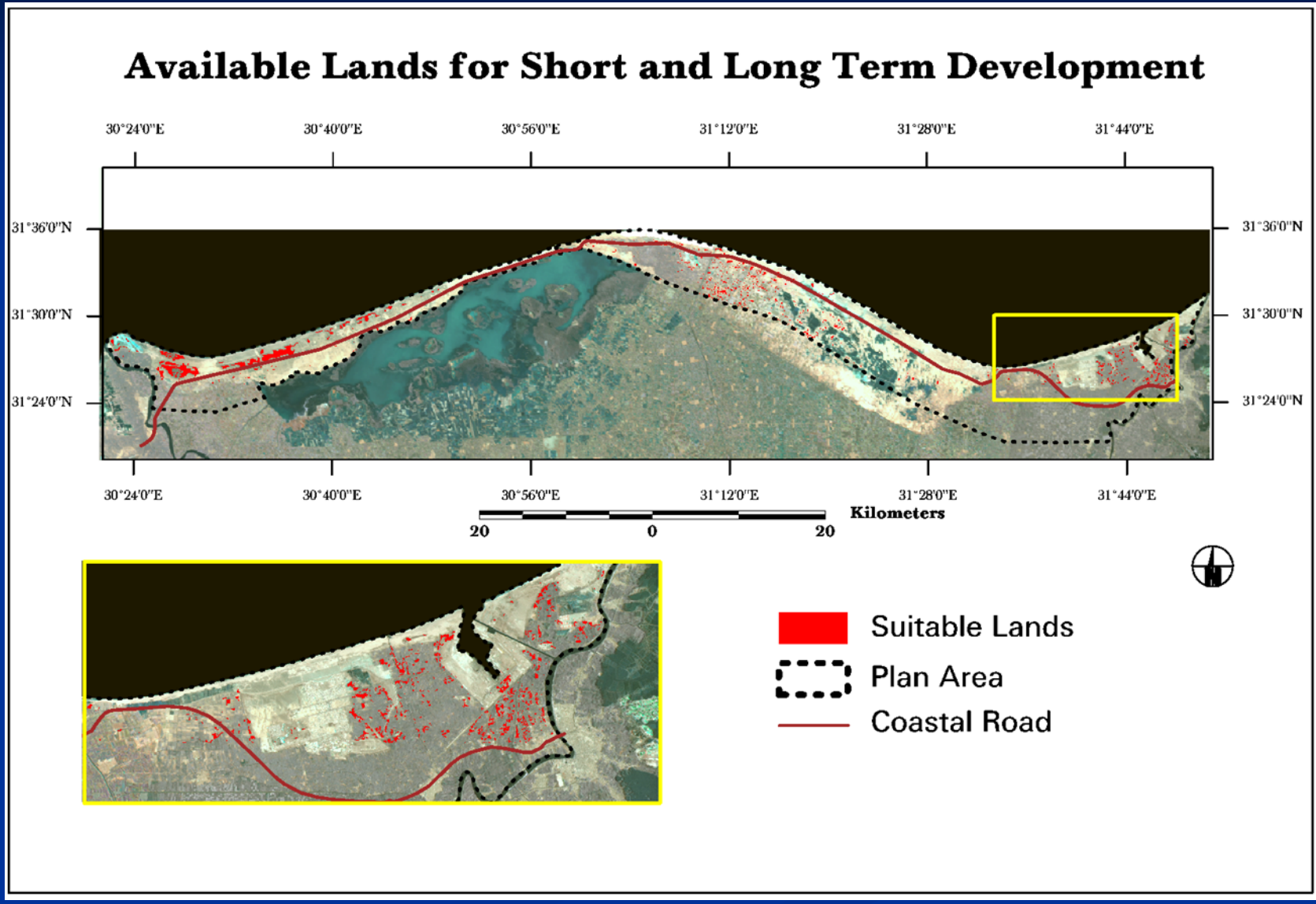
Land Suitability Model for Urban Development



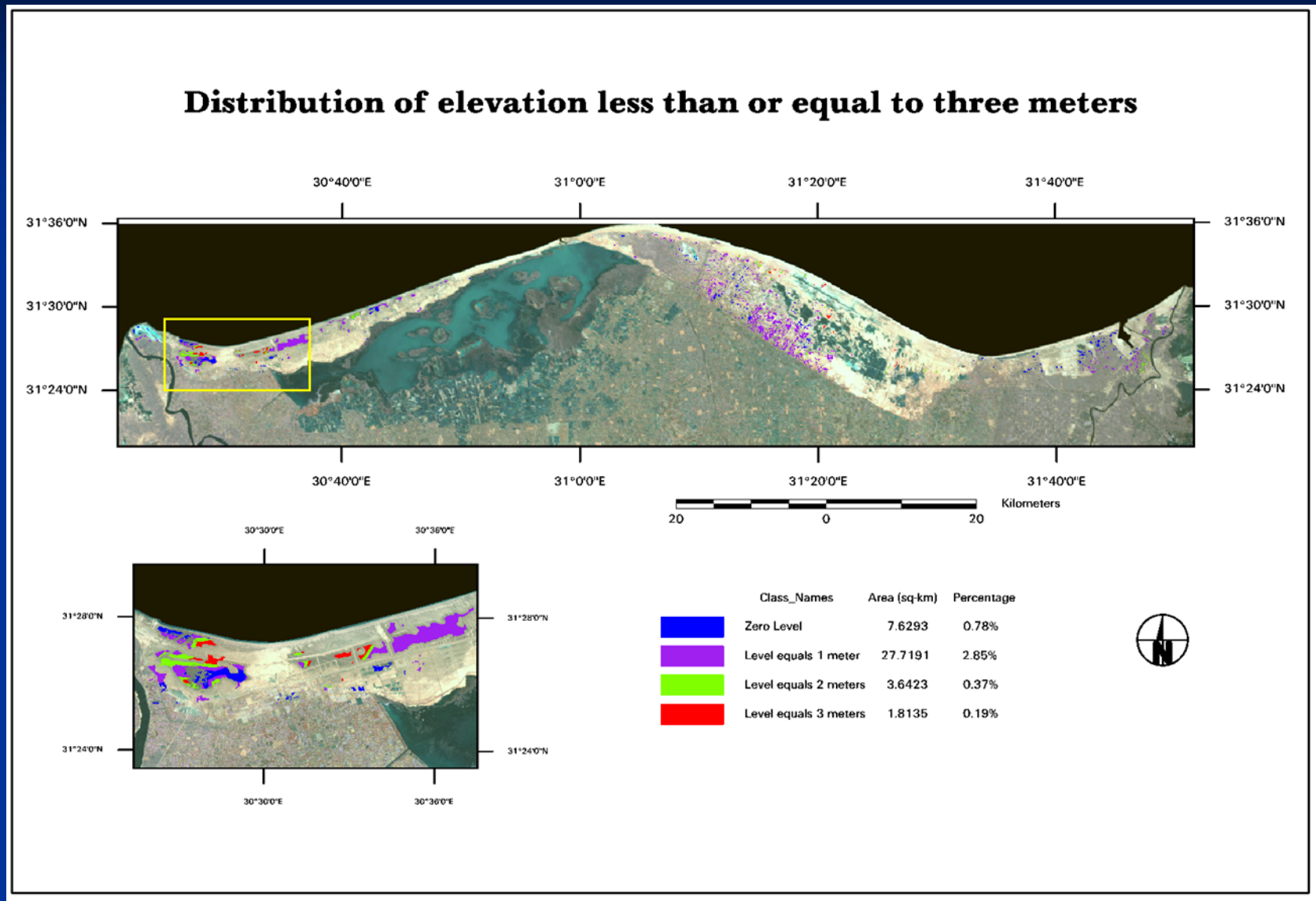

Factors
Long - term plan
DEM
>=2
Criteria
(Elevation
(2 m)
<2
Short- term plan
Suitable Lands
OVERLAY MUTIPLY
Water buf
Shore buf
Dunes buf
Road buf
No buf
No buf
No buf
No Buf
RECODE To BINARY
Constraints
CREATE BUFFERS
Water
Shoreline
Sand dune
Roads
Irrigation
Urban
Agricult
Sabkha

Results

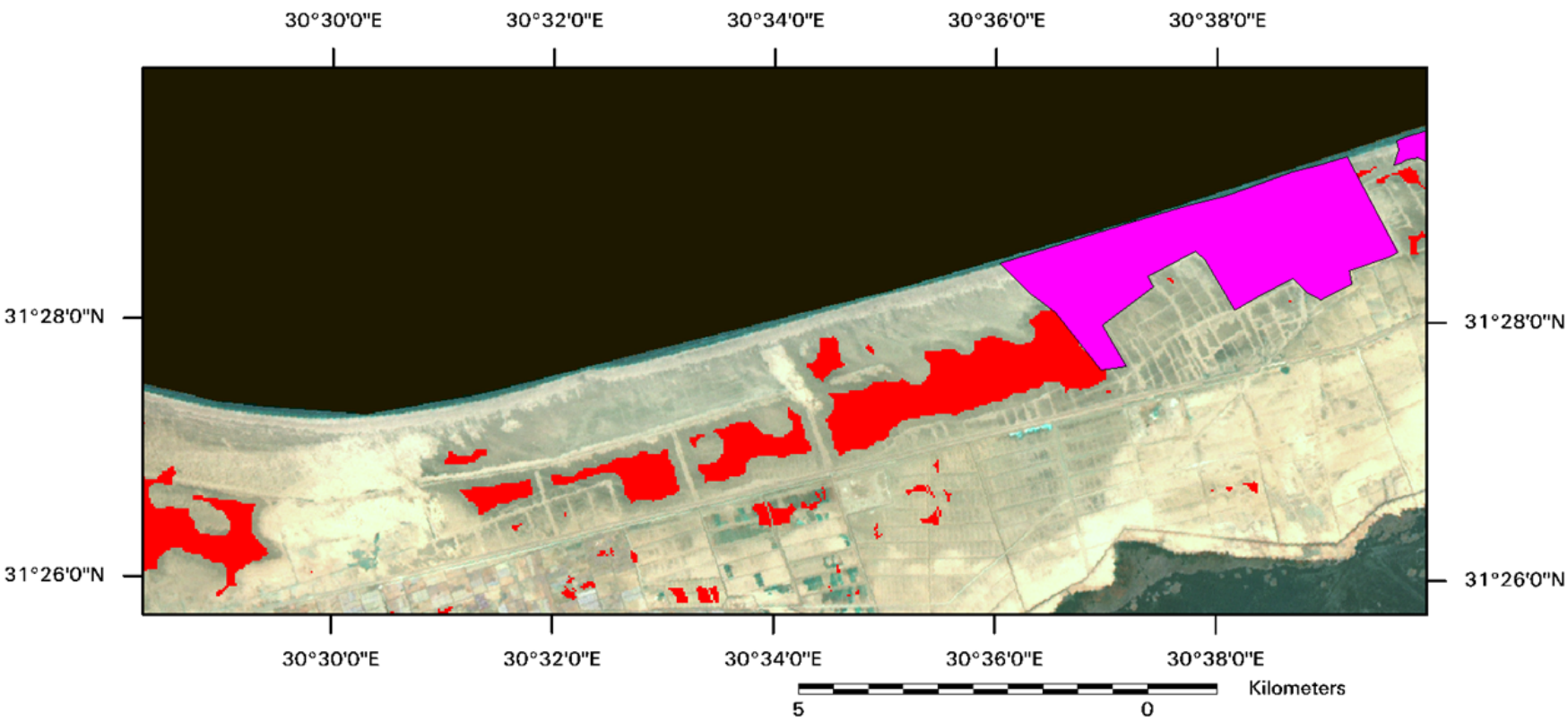
Model Result

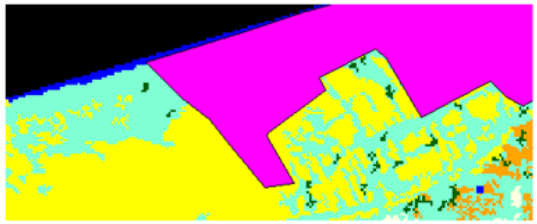


Model Output Classified according to the Digital Elevation Model (DEM)



Overlay: Suitable Lands with Proposed Recreational Use





Suitable Lands

Proposed Recreation / Resorts

Sand Deposit

Sabkha

Areas and Percentages of the distribution of elevation zones in the Suitable lands

Land Elevation	**Area (in Square kilometers)**	**% of the overall Suitable Lands Area**
Zero level	7.629	18.698
1-meter above sea level	27.719	67.938
2-meters above sea level	3.642	8.926
>=3 meters above sea level	1.813	4.444
Total	40.8000	100.000

Conclusion

- The results of the study show that the study area is undergoing both anthropogenic and natural changes.
- The most significant changes are reflected in the transformation of the wetlands either to water bodies used as fish farms or dried up for urbanization.
- New water bodies emerged due to sea water intrusion raising the ground water level and the conversion of wetland to fish farms amounting to 41.3 sq km.
- Eroded shoreline amounted to 6.87Km while accreted shoreline amounted to 7.97 Km during the study period.

Conclusion

- The total area for the overall lands suitable for urban development amounted to 40.80 square kilometers.
- Areas of lands less than 2 meters above sea level (short-term plans) amounted to 35.348 square kilometers. Areas of suitable lands for long term plans amounted to 6.35 square kilometers.
- RS and GIS proved to be an effective tool for sustainable land use decisions.

References

- **H.A. Effat , H.El Gamily ,M.N.Nagu b , A.N.Hassan, M.Ebeid ,and A.Yehia** :Environmental Assessment of Urban Development Plans on Coastal Zones using Remote Sensing and Geographic Information Systems,(2004) Proceedings of the 6th African Association of Remote Sensing of the Environment (AARSEE), 30 October-2 November,2006. Cairo, Egypt.
- **H.A.Effat and M.N.Hegazy;** A GIS-based tool for mapping a coastal highway sensitivity index, a case study for the Mediterranean coastal highway in Egypt. (2006)The Egyptian Journal of Remote Sensing and Space Sciences, VolumeX, p.3-20 ,2007.
- **Ebeid,M.I, Yehia,M.A., Hassan,A.N., El Gamily, H.I and Effat,H.A., (2005**),Change Detection of Land Cover in the Northern Nile Delta as a Base for Sustainable Land Use Planning. Journal of Environmental Science, Institute of Environmental Studies& Research, Volume (10), No(1) June,2005,p.131-142.

Thank You