Major challenges of Climate Change and its Impacts of sea level Rise, Saltwater on the Groundwater and Agriculture in The Nile Delta

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The main objectives of this Research Study are:

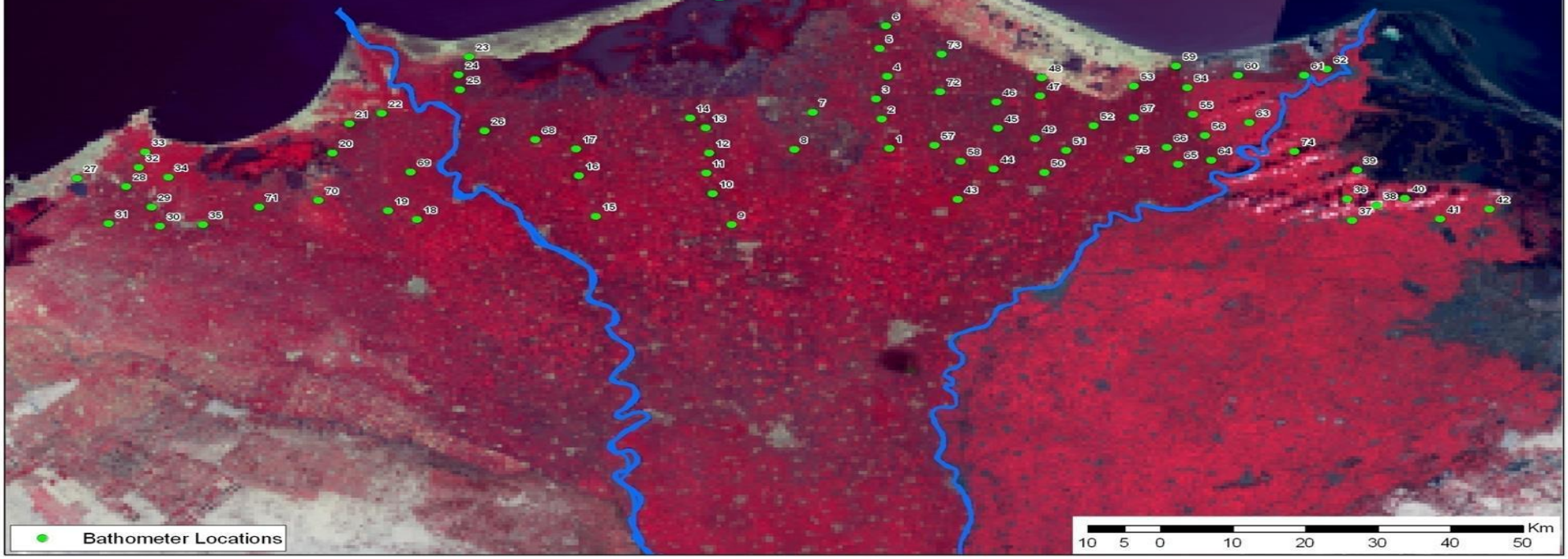
1. **Impacts of sea level Rise (SLR), saltwater intrusion on ground water tables as well as groundwater and soil salinity on the agricultural production in the coastal area of the Nile Delta.**

2. **The interaction of SLR, Saltwater Intrusion, Water quality and Soil salinity on agricultural Productivity and related to socioeconomic effects.**

3. **Impacts of population, Agricultural extent and growth Domestic Production (GDP) by SLR in the Middle east and North Africa region.**

Climate change Impacts
ON SEA LEVEL RISE

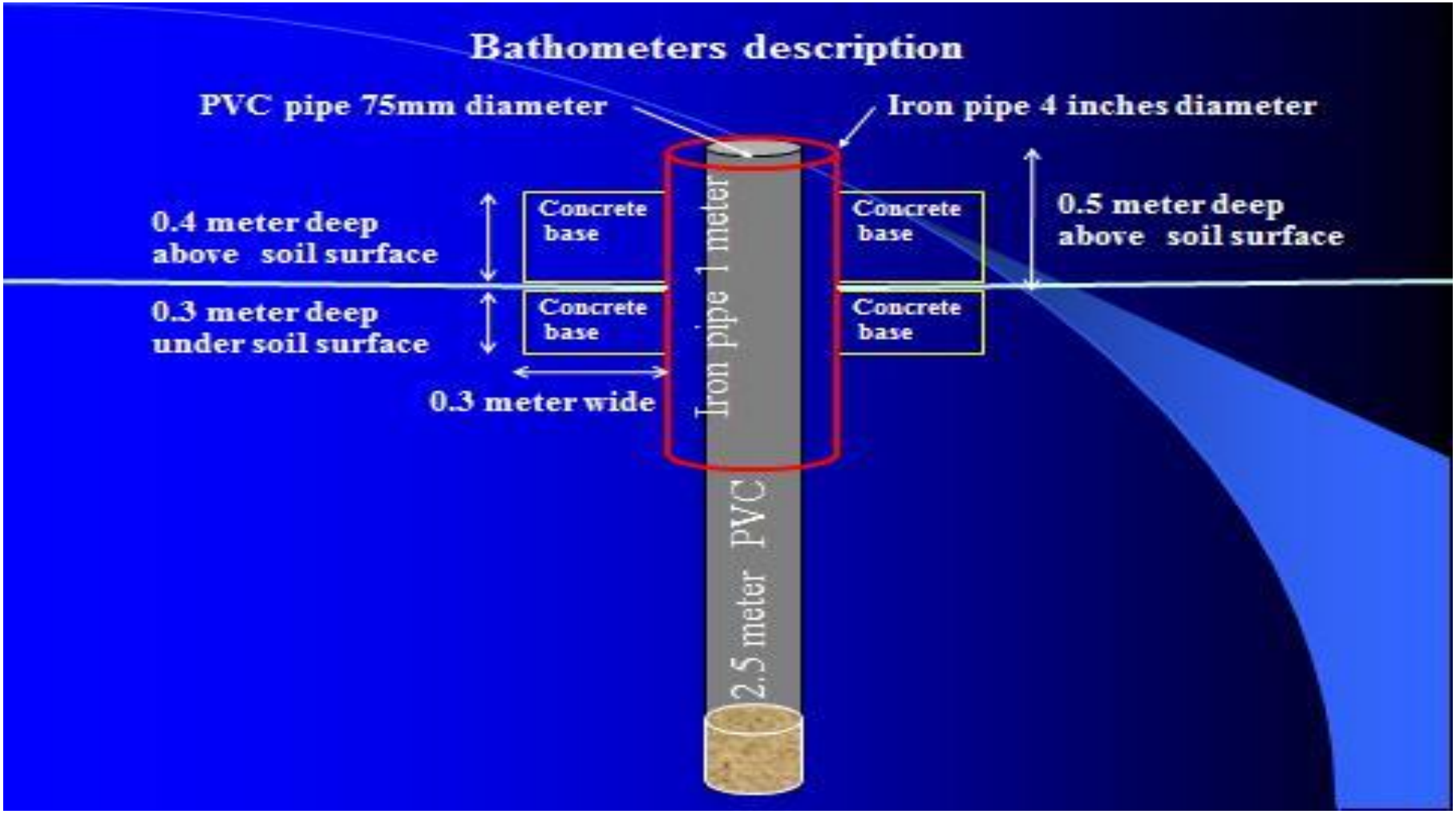
Monitoring of Climate Change Risk Impacts of Sea Level Rise on Groundwater and Agriculture in the Nile Delta



- Has about one half of the total cultivated area (about 4.3 million Feddan).
- Has 53% of the total population.
- More than 65% contribution in the national agricultural production.
- About 93 % of the total Delta land is "old land" (clay soil/ heavy- Medium).
- Irrigation source: Nile -Surface irrigation systems (50% efficiency).

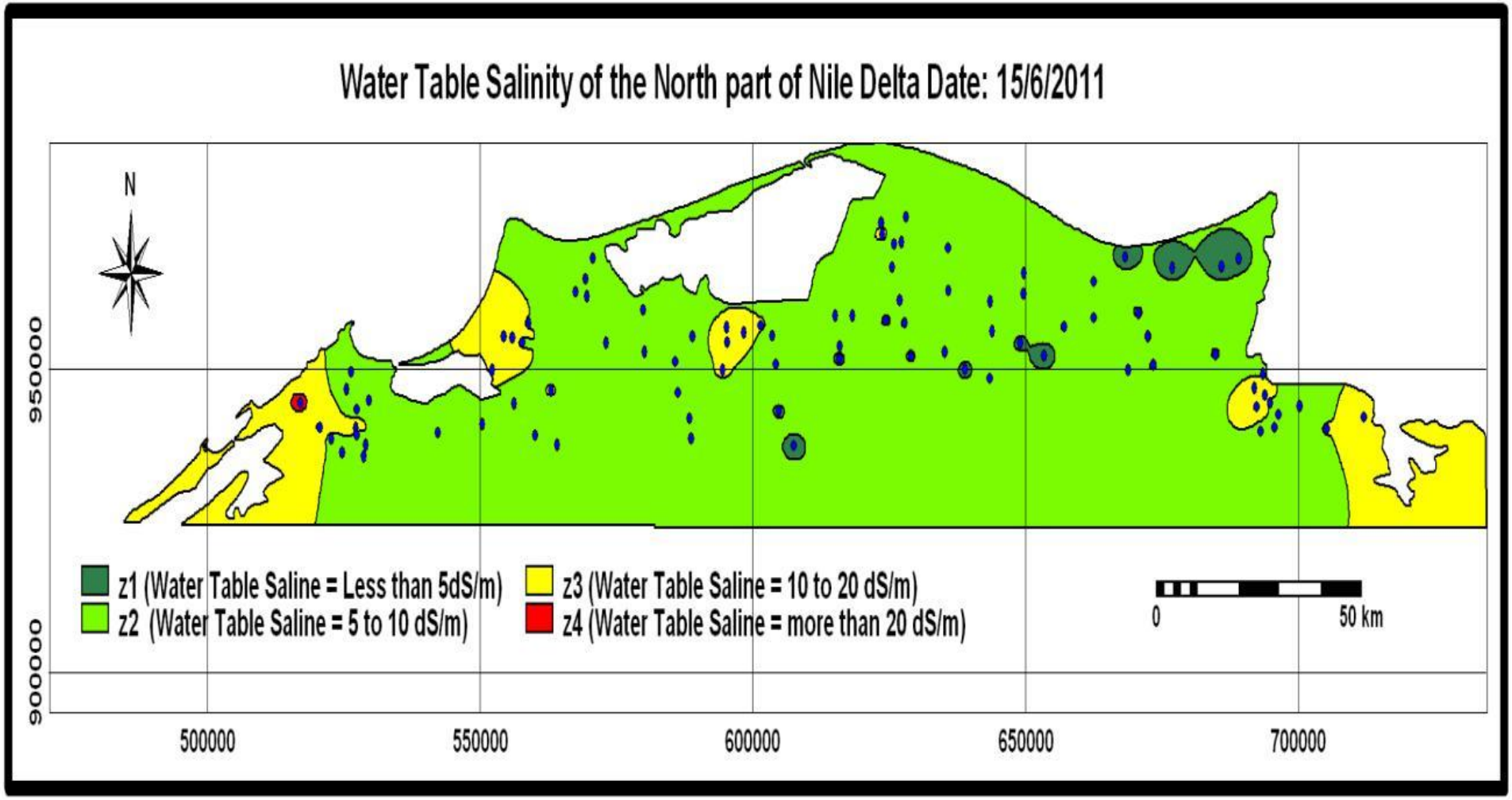
Agriculture in the Nile Delta …*why it's a unique case?*

Figure 2: **Initial bathometer design parameters**



Establishment of **Seventy Five bathometers** (2.5 m PVC pipe 75 mm diameter deep with **0.5 m on soil surface** + 1 m iron pipe 4 inches with cover to protect the PVC pipe + concrete base for the pipe deep 30 cm, 40 cm on surface (30 x 30 cm dimension) in **the Mediterranean costal area between Rashid and Dumyat in Egypt** to collect the **data of ground water level, salinity and salinity composition**.

Figure 3: Groundwater salinity-SWERI soil and *water monitoring* sites



The water table is the upper surface of the zone of saturation.

Source: SWERI, The relation among sea level rise, groundwater table and salinization of soils and groundwater. Presentation given at the project inception workshop

Figure 4: Depth-to-water table - SWERI soil and water monitoring sites

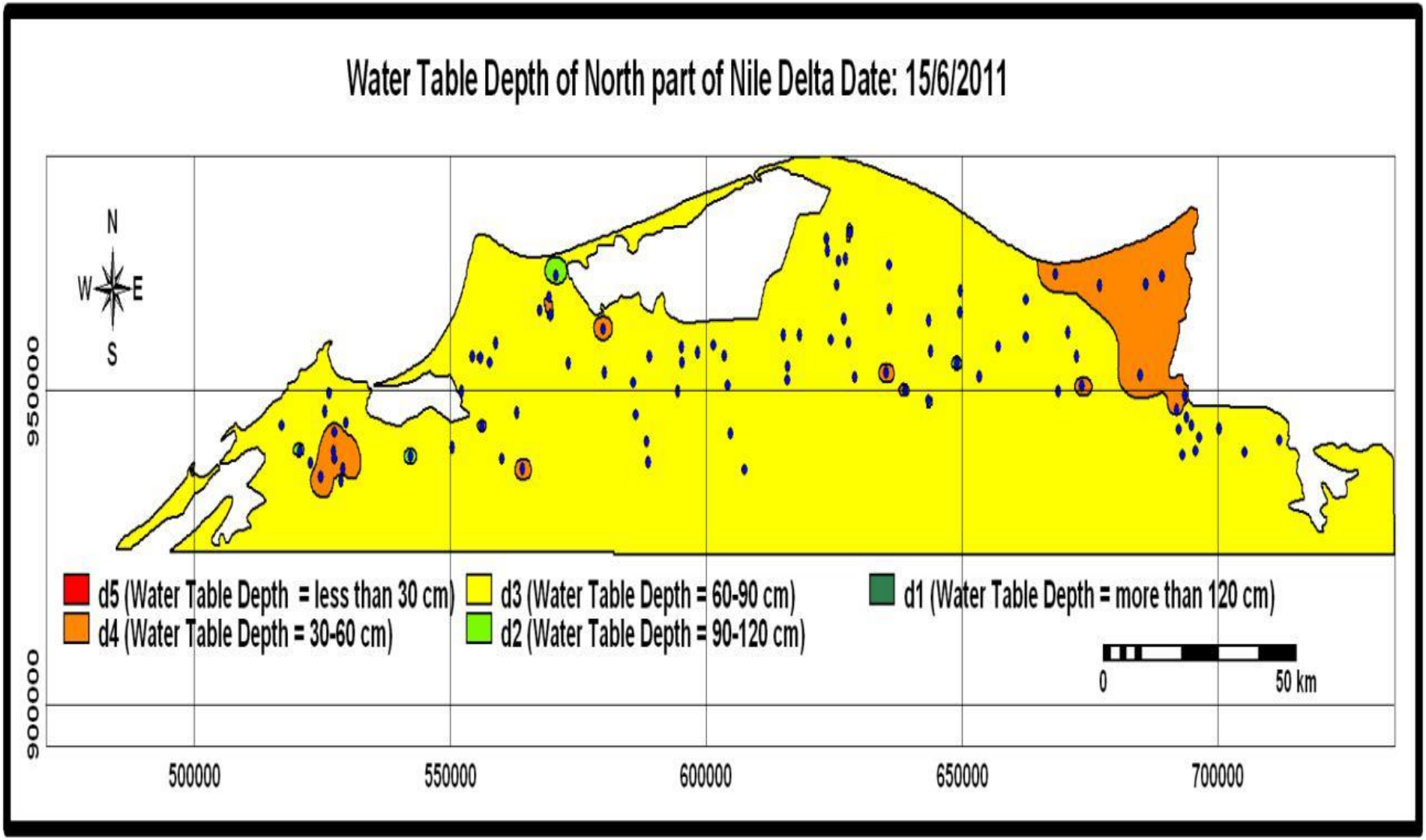
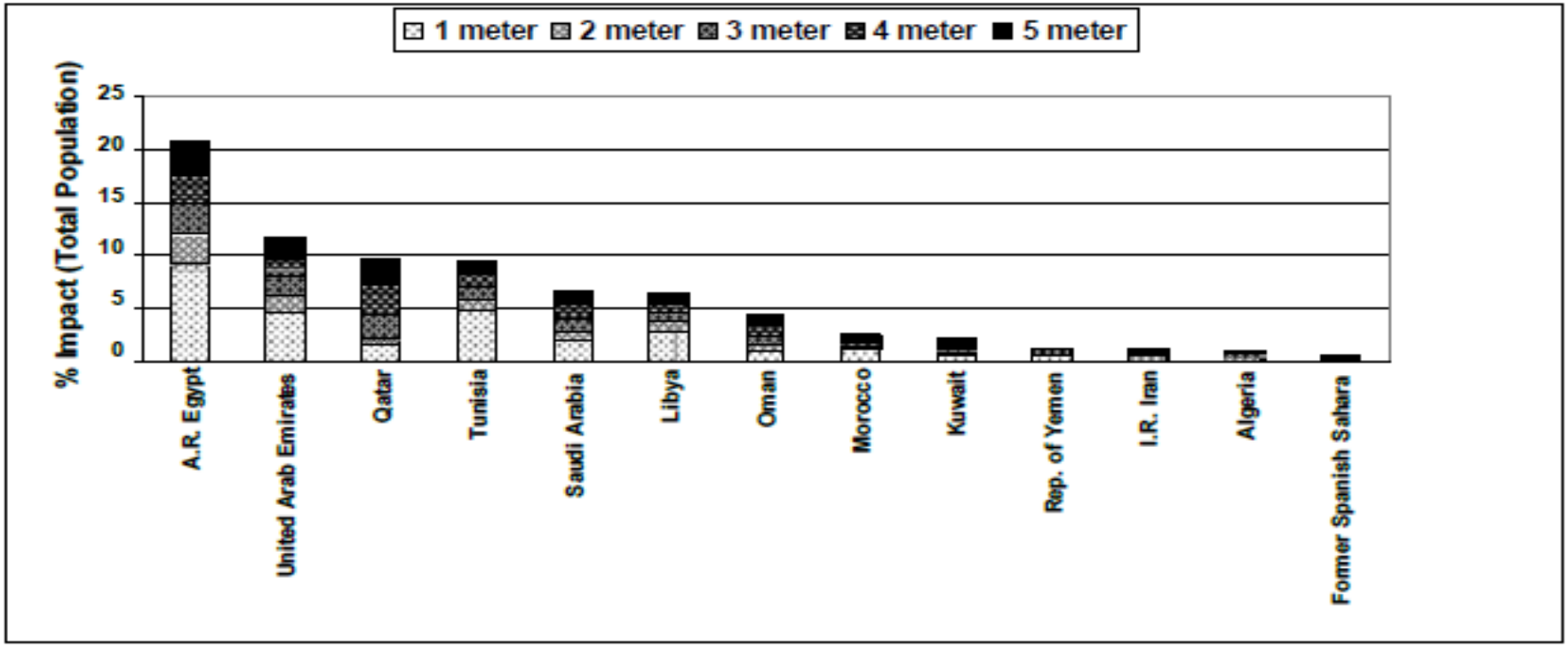


Figure 5: Middle East and North Africa region: Population impacted by SLR

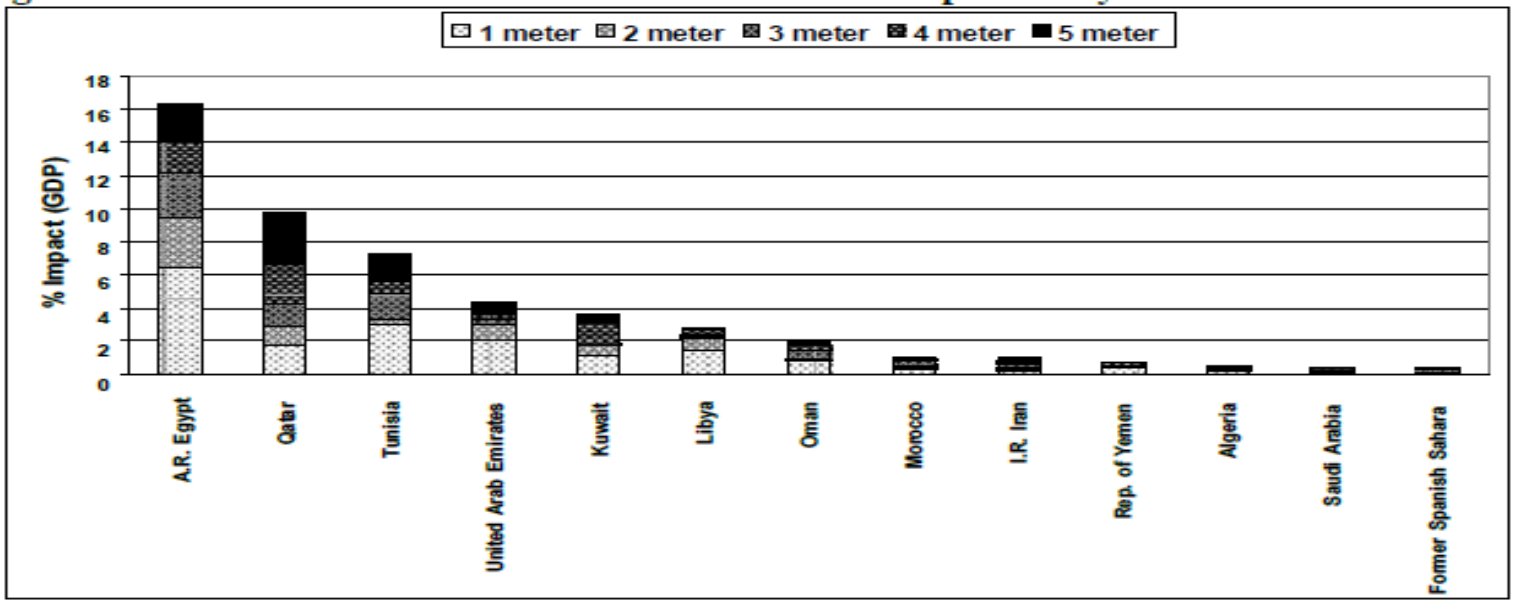


Source: Dasgupta et al (2007)

In their comparative analysis of the impacts of SLR on developing countries, Dasgupta et al (2007) used the GAE-2 data set of the ***International Food Policy Research Institute (IFPRI) for calculating the agricultural extent of exposure to different levels of SLR.***

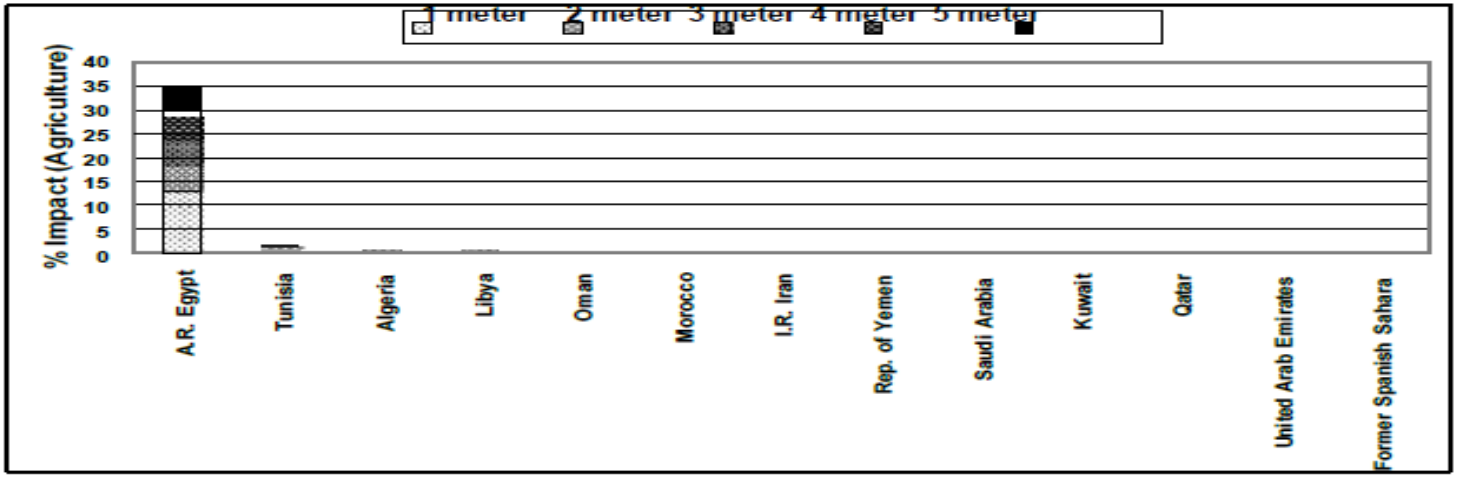
For Egypt, this study concluded that a ***1 m SLR*** would affect approximately ***10 % of the total population***, mostly located in the Nile Delta and almost ***12,5 % of the countries agricultural*** extent in terms of the total agricultural area ***(20 % of total population and 35 % of agricultural extent, respectively, with 5 m SLR).*** Accordingly, for the Middle East and North Africa region, Egypt is undoubtedly amongst the most seriously affected countries (see figures 5 to 7)

Figure 6: Middle East and North Africa: GDP impacted by SLR



Source: Dasgupta et al (2007)

Figure 7: Middle East and North Africa: Agricultural extent impacted by SLR



Source: Dasgupta et al (2007)

Sea Level Rise and Land Subsidence Rates in the Nile Delta for the past 3 decades

Region	Alexandria (West Delta)	Al-Burullus (Middle Delta)	Port-Said (East Delta)
SLR (mm/yr)	1.6	2.3	5.3
Subsidence (mm/yr)	0.4	1.1	3.35

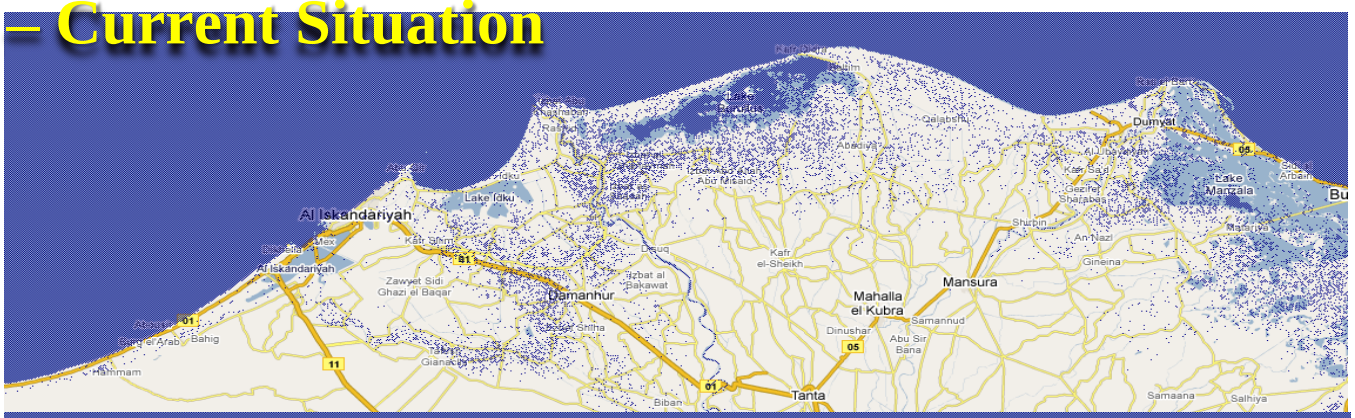
Assumption: Same increase rate of air temperature from IPCC 2007 of 0.6 degrees C/yr.

Projected average annual Sea Level Rise (cm) relative to year 2000 sea level

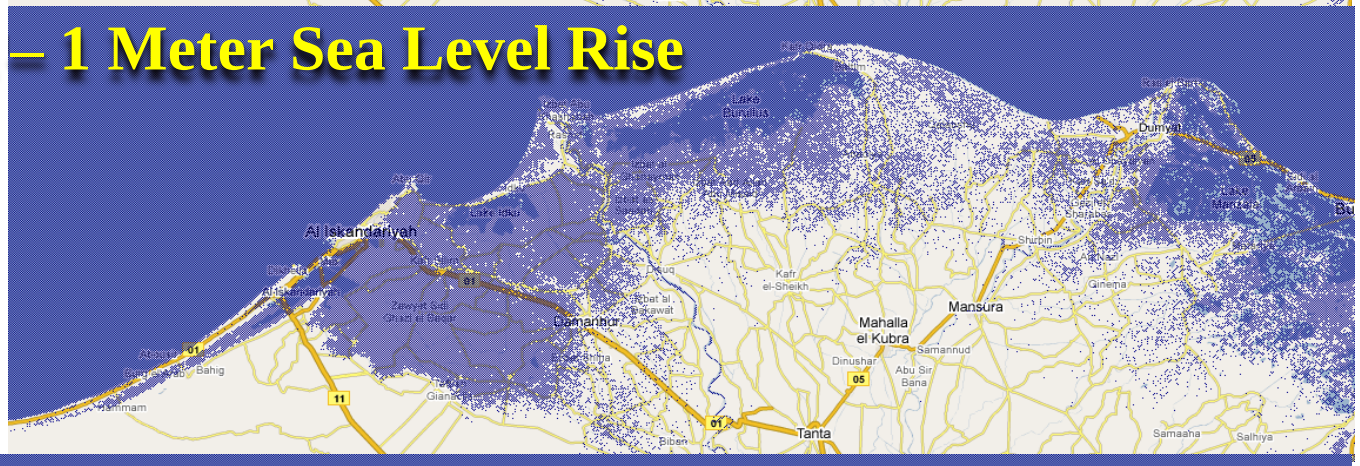
City	Scenario	2025	2050	2075	2100
Port Said (East Delta)	CoRI	13.25	26.5	39.75	*53.0*
	B1	18.12	39.5	64.3	*72.5*
	A1F1	27.9	68.8	109.6	*144.0*
Al-Burullus (Middle Delta)	CoRI	5.75	11.5	17.25	23.0
	B1	8.75	19.5	32.25	35.0
	A1F1	14.75	37.5	60.3	79.0
Alexandria (West Delta)	CoRI	4.0	8.0	12.0	*16.0*
	B1	7.0	16.0	27.0	*28.0*
	A1F1	13.0	34.0	55.0	*72.0*

Climate Change & Sea Water Rise

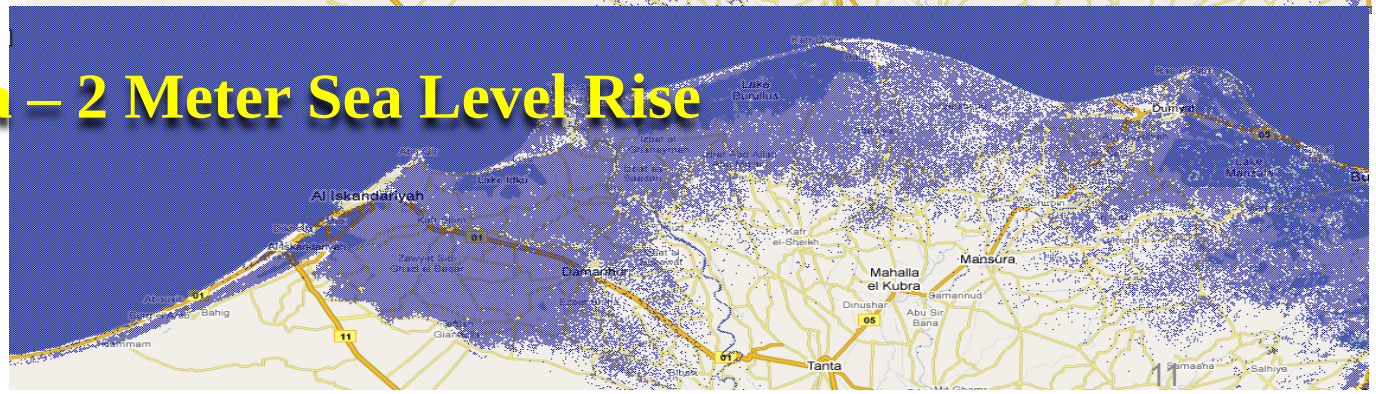
Nile Delta – Current Situation



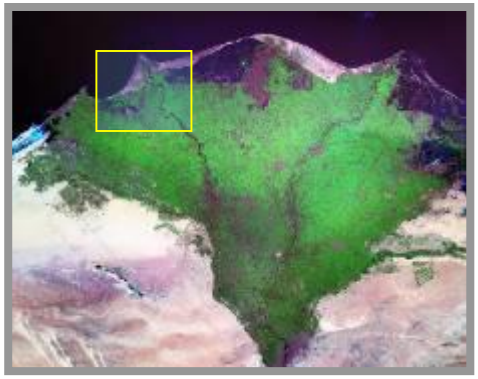
Nile Delta – 1 Meter Sea Level Rise

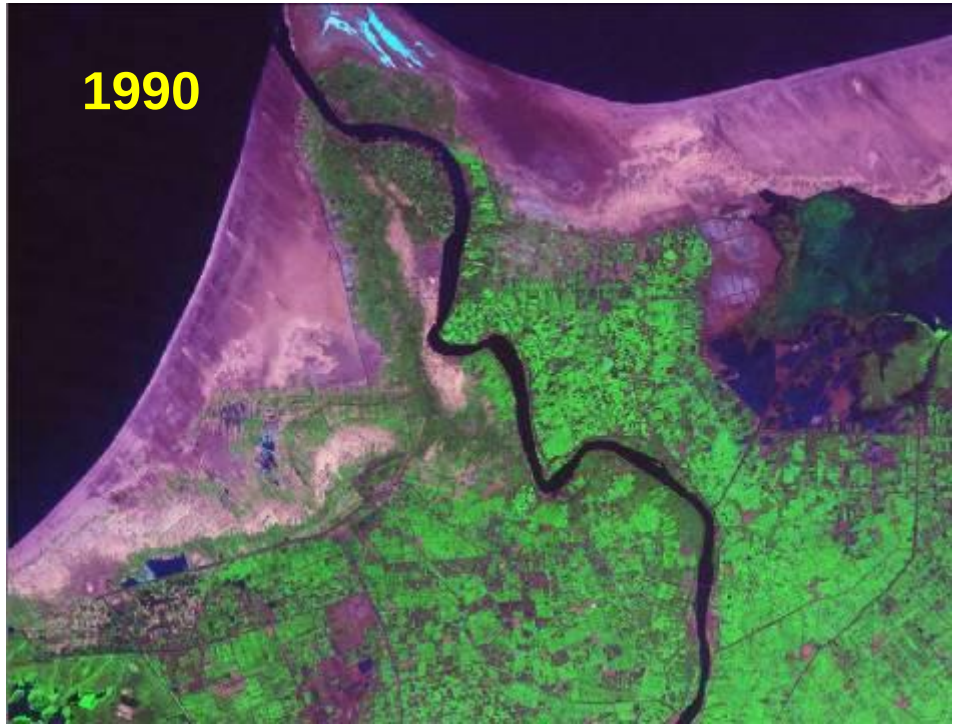


Nile Delta – 2 Meter Sea Level Rise



Swift Urbanization



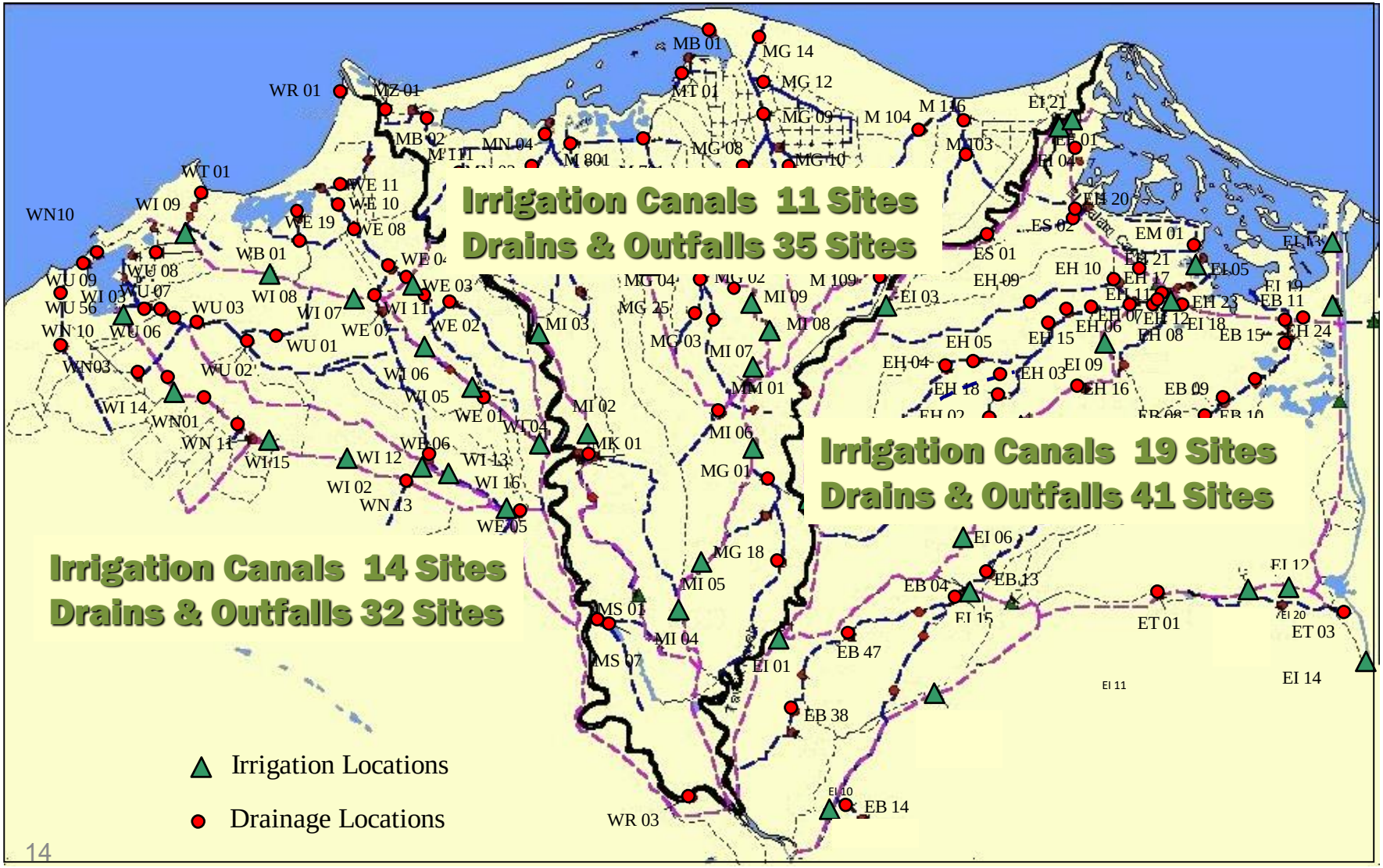


Western Delta Region

Water Quality Deterioration and its impact on the environment Protection

- **Pollution caused by fast growing cities and industries**
- **Insufficient wastewater treatment facilities**
- **Poor or non-existing solid-waste management**

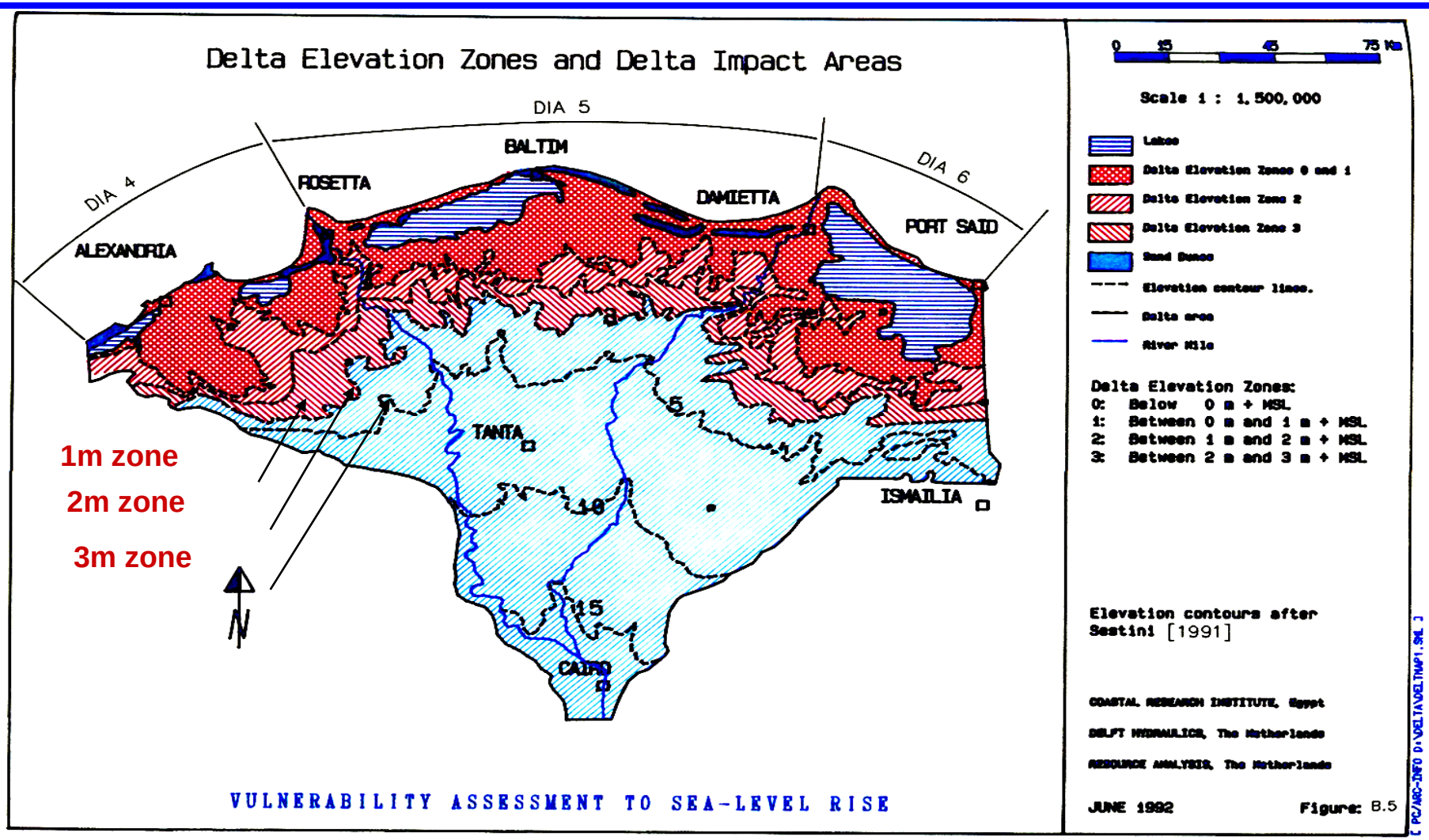
National Water Quality Monitoring Program
Monitoring Sites in the Delta



Mediterranean Coastline

- Sea level rise
- Impact on human settlements
- Impact on touristic villages in Northern coast (e.g Marina), thus impacting economy
- Impact on agricultural areas (saltwater intrusion)

Results of the study show the vulnerable areas to sea level rise in the Nile Delta with different water levels




Ras Al-Bar Resort under sea attack before the construction of protection works
Ras Al-Bar

Sand Dunes at Middle Delta Coast and coastal protection works

Impact of Climate Change on Agricultural Resources

- **The Nile delta region, the most fertile land of Egypt, is highly vulnerable to the impacts of sea level rise, salt water intrusion and soil salinization.**

- **Reduced irrigation supplies from the Nile**
- **Shortage of water resources delays many agricultural developmental plans.**

Change in crop yield [%]

Crop	Change %		Reference
	2050s	2100s	
Rice	-11%		Eid and EL-Marsafawy (2002)
Maize	-19%		Eid et al. 1997b
	-14%	-20%	Hassanein and Medany, 2007
Soybeans	-28%		Eid and EL-Marsafawy (2002)
Barley	-20%		Eid et al. 1997b
Cotton	+17%*	+31%**	Eid et al. 1997a

* *Temperature increased by 2°C*

** *Temperature increased by 4°C*

Change in evapotranspiration of major crops(millions m3) due to climate change (millions m) IN EGYPT

Crop	Area (Million feddan)	Total ET (Millions m3)	Change	Deficit of Excess
Wheat	2.123642	2730.313		-27.303
Maize	1.683108	2890.968	+8	+231.28
Cotton	0.81535	2358.324	+10	+235.832
Sorghum	0.33868	811.642	+8	+64.93
Barley	0.179792	109.673	-2	-2.19
Rice	1.291342	4703.449	+16	+752.551
Soybean	0.050381	271.851	+15	+40.777

Change in major crops production (excess or deficit) in Egypt by the year 2050 due to climate change.

Crop	Base Yield (t/ fed)	Area (Mfed)	Yield (Mt)	Change	Deficit or Excess (Mt)
Wheat	2.175	2.123642	4.629216	-18	-0.833259
Maize	2.718	1.683108	4.576779	-19	-0.869588
Cotton	1.099	0.815350	0.903090	+17	+0.153525
Sorghum	2.086	0.33868	0.705404	-19	-0.134027
Barley	0.888	0.179792	0.124212	-18	- 0.022358
Rice	3.263	1.291342	4.241457	-11	-0.466560
Soybean	1.167	0.050381	0.058888	-28	-0.016488

Conclusion

- ***In their comparative analysis of the impacts of SLR on developing countries, Dasgupta et al (2007) used the GAE-2 data set of the International Food Policy Research Institute (IFPRI) for calculating the agricultural extent of exposure to different levels of SLR.***

- ***For Egypt, this study concluded that a 1 m SLR would affect approximately 10 % of the total population, mostly located in the Nile Delta and almost 12,5 % of the countries agricultural extent in terms of the total agricultural area (20 % of total population and 35 % of agricultural extent, respectively, with 5 m SLR). Accordingly, for the Middle East and North Africa region, Egypt is the most seriously affected countries (see figures 5 to 7).***

- ***Annual subsidence rates are estimated to vary from a minimum of 1 mm per year at Burullus, to 1.6 mm per year for Alexandria and a maximum of 2.3 mm per year for Port Said. On the other hand, El Shinnawy (2011) of CORI for his the simulations used the following average values for annual subsidence rates: 0.4 mm for Alexandria; 1.1 mm for Burullus and 4.0 mm for Port Said.***

- ***The total population affected by SLR is estimated at 3.8 million for a SLR of 0.5 m, and 6.1 million for SLR of 1.0 m, respectively. For these 2 scenarios of SLR, the total crop land affected in this study was estimated at 1,800 km2 and 4,500 km2, respectively.***

- ***While most of the studies carried out so far on the likely negative impacts of SLR and sea water intrusion on agriculture in the Nile Delta are quite heterogeneous as regards their detailed methodological approaches***

- ***on the other hand very homogeneous in using remote sensing and GIS technology for estimating the major impacts in terms of the total and agricultural areas that would be impacted. Depending on the resolution of the satellite images, these area estimates might be more or less accurate.***

- ***In any case, estimating agricultural land use and detailed cropping patterns based on the use of satellite images remains a rather big challenge and in order to be as accurate as possible needs to be complemented by thorough ground truthing and checking.***

Recommendations

- ***The coastal zone of the Nile Delta region of Egypt is highly vulnerable to the potential impacts of climate change. In particular:***

- ***The Nile Delta region is acutely vulnerable to temperature rise, sea level rise, saltwater intrusion and increasing frequency and severity of extreme events. The potential direct impacts will lead to significant socioeconomic implications,***

- ***The government and the private sector must carry out proactive adaptation policies and measures to minimize potential impacts of climate change on the Nile delta. These should include establishing institutional coastal monitoring capabilities, enforcing laws and regulations, enacting integrated coastal zone management, and raising awareness of climate risks and adaptation responses.***


Thank you