وزارة الموارد المائية والرى
جمهورية مصر العربية
Ministry of Water Resources and Irrigation
Arab Republic of Egypt

Climate Change Impact on Egypt and the National Strategy for Climate Change Adaptation

By

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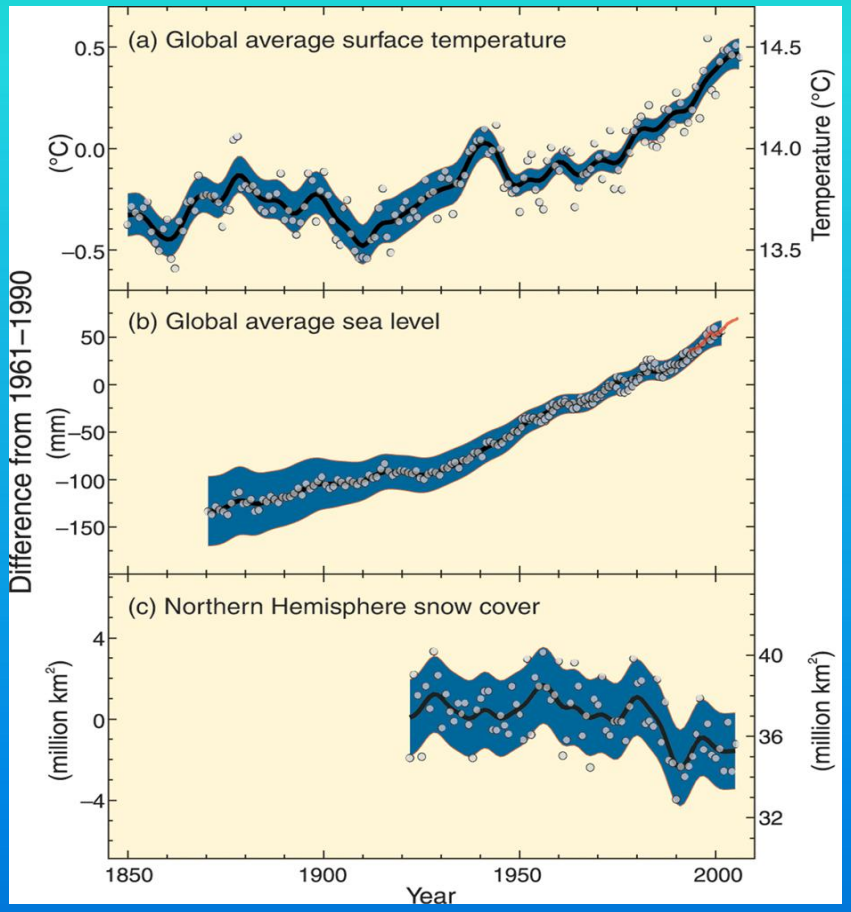
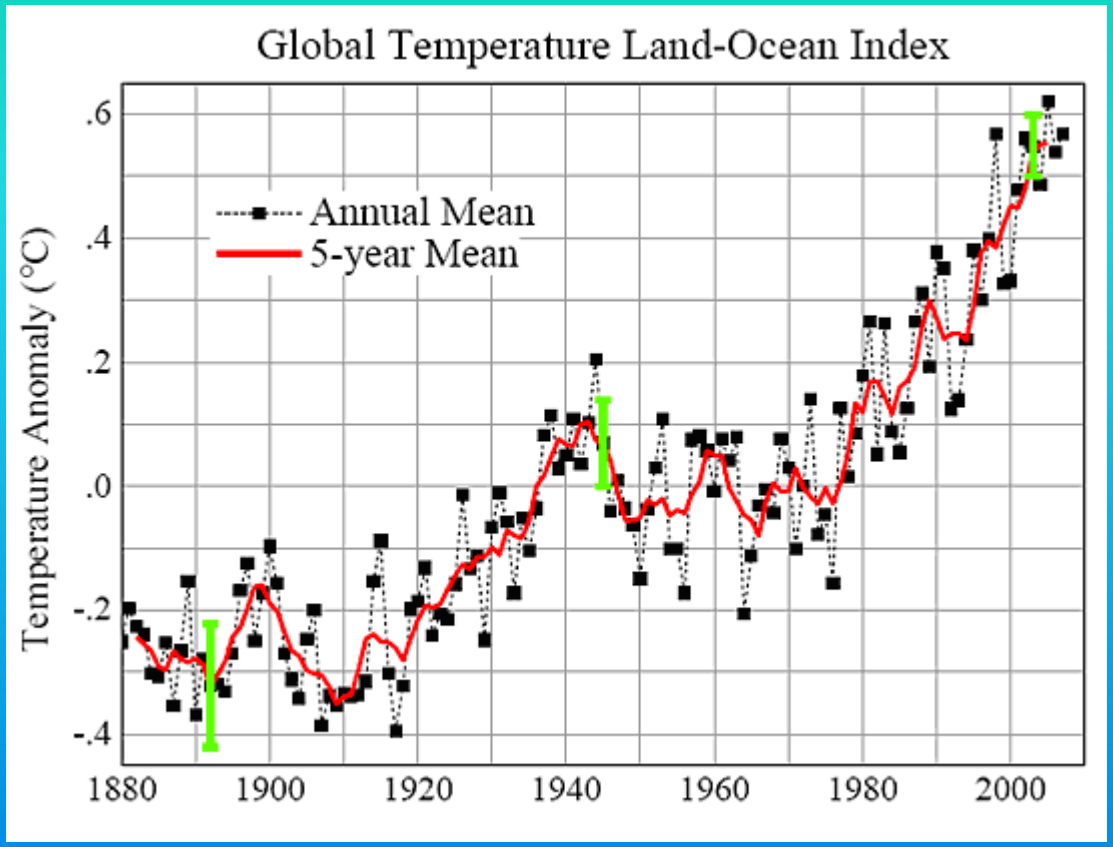
Climate Change

- Climate is the average weather includes temperature, precipitation (rain or snow), humidity, wind and seasons
- When climate history is no longer a reliable predictor of the future, we experience a climate change

Global Warming of Climate

- Warming of the climate is definitely occurring and can be observed by the:
  - Increases in global sea and air temperatures
  - Widespread melting of snow and ice
  - Rising global sea level



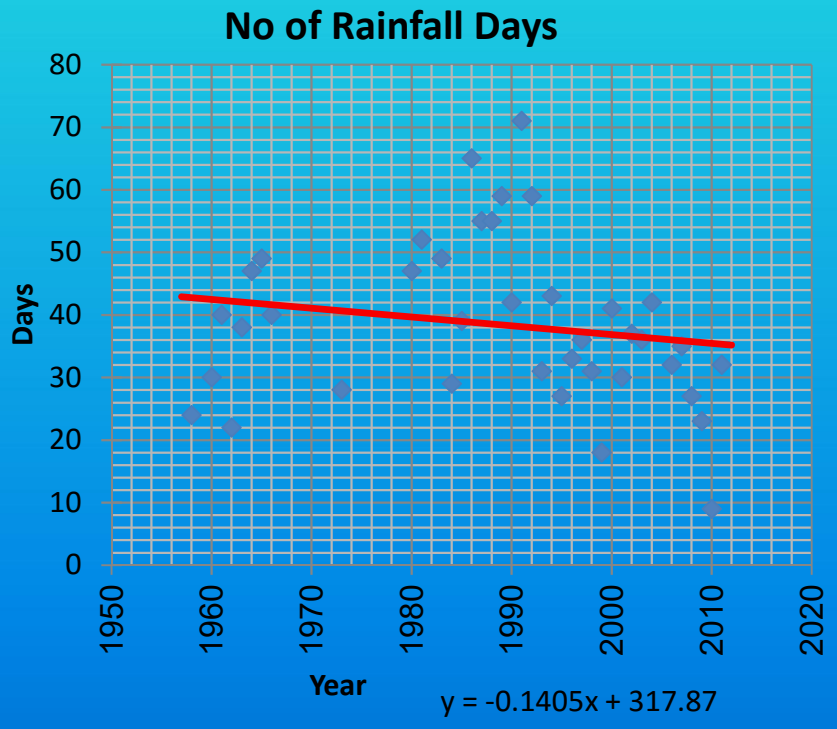


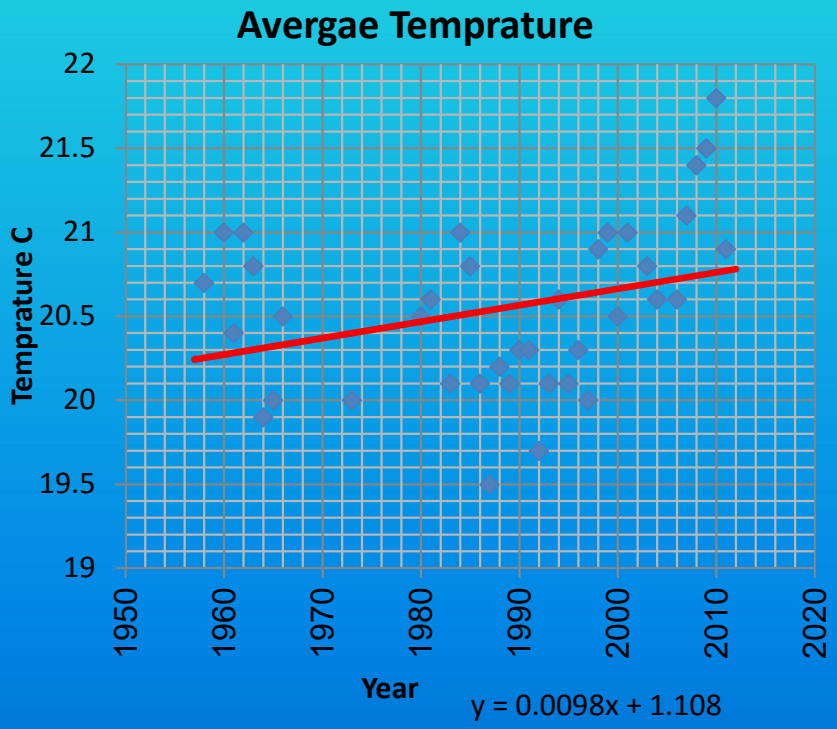
The land-ocean temperature index combines data on air temperatures over land with data on sea surface temperatures. ("Mean" is the midpoint between the highest and lowest.) The black line shows the annual changes; the red line tracks 5-year periods. Source: NASA Goddard institute for Space Studies. (January 11, 2008)

Impacts of Climate Change

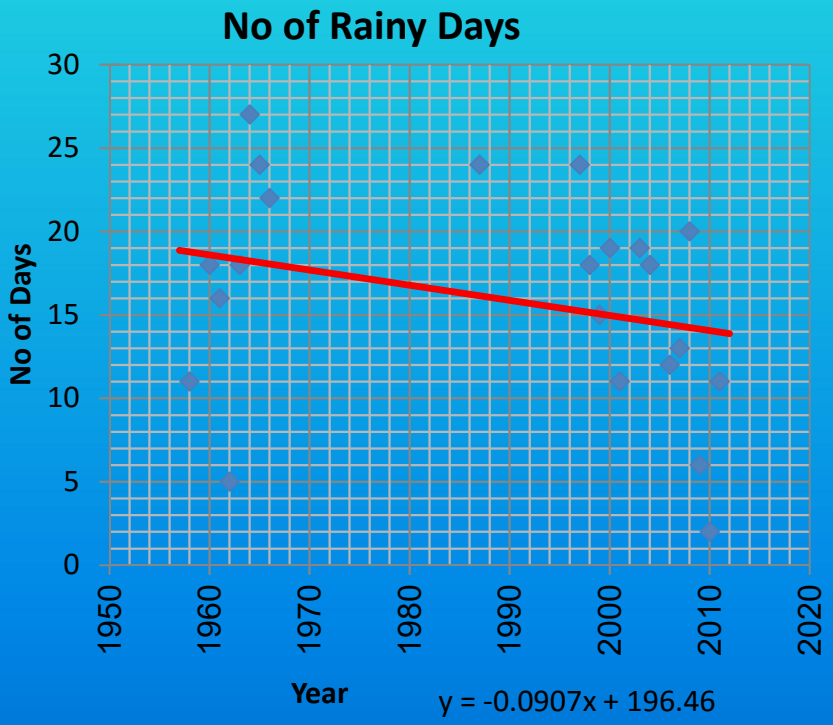
Evidence of Climate Change in Egypt

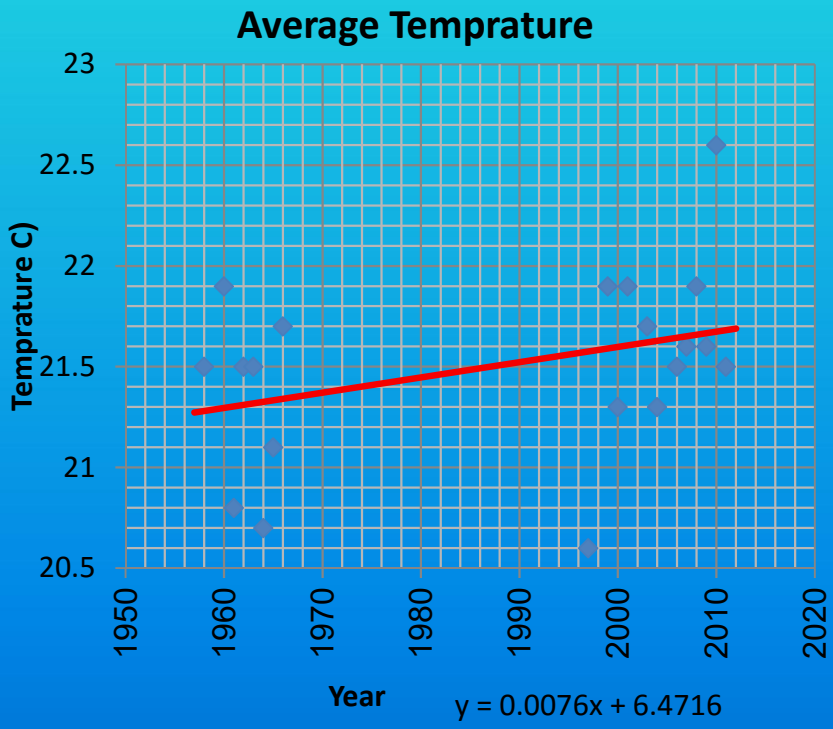
- City of Alexandria from 1957 to 2011





Port Said City at the Entrance of Suez Canal





SLR HOW IT GENERATES

Vulnerabilities Sectors and Zones

1- Most vulnerable sectors to climate change are:

1)Coastal Zones

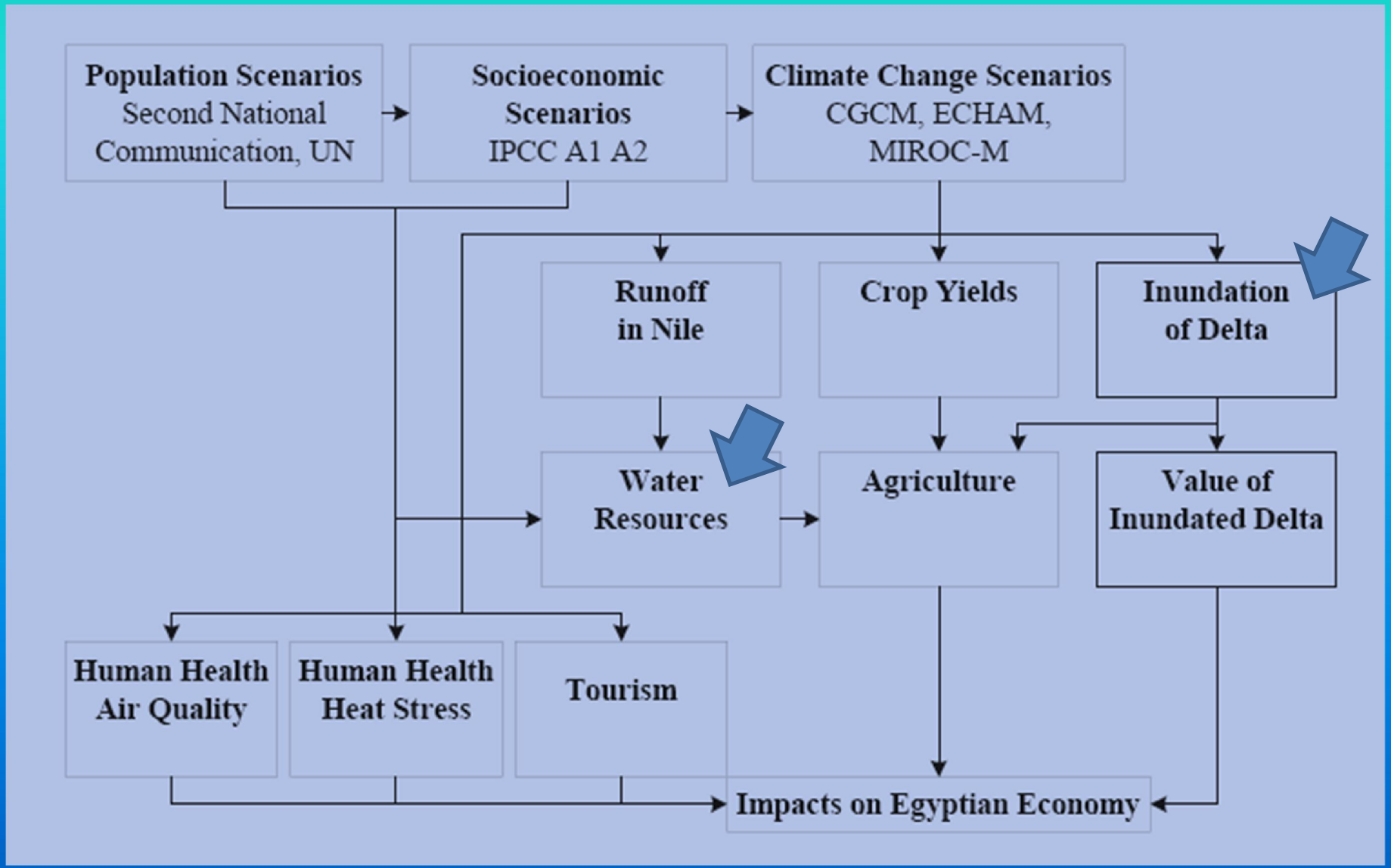
2) Water Resources

3) Agriculture (14% of GDP)

2- Most Vulnerable Areas:

- Delta Area: Most Populated Area
- 40 Million are living in Nile Delta
- Coastal Zones (Mediterranean and
- Red Sea Coasts)
- Upper Nile Plateau

Approach for Studying the Impact of Climate Change on Egypt



Impact of Climate Change on the Different Sectors in Egypt

Impact of Climate Change on Water Resources Sector

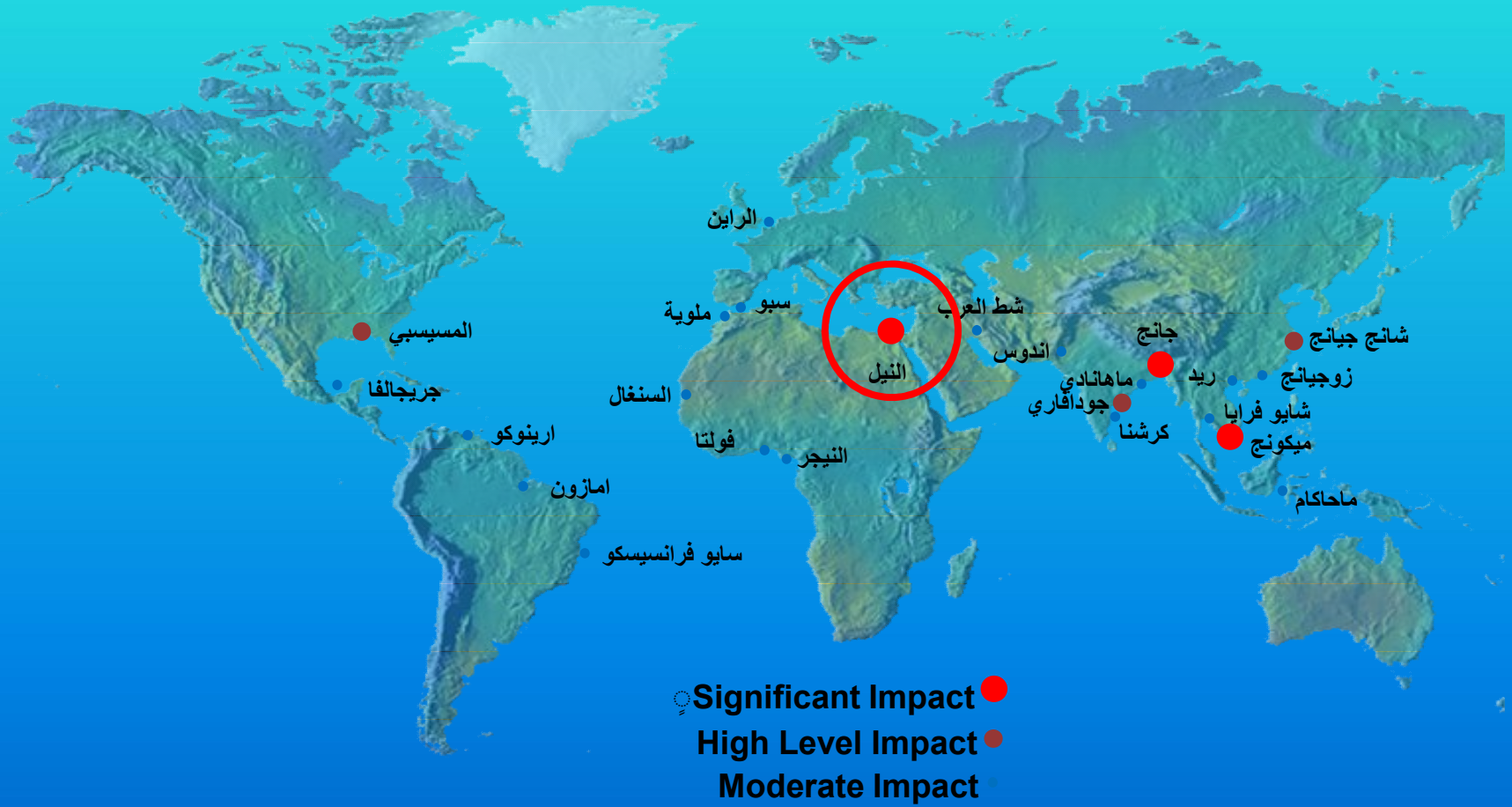
Inflow to High Aswan Dam

Projected change in mean annual flow into the HAD

General circulation model	Egypt allocation 2000 (BCM)	2030 (BCM)	2060 (BCM)
Small decreased flow	55.5	52.3 (-6)	49.1 (-12)
Large decreased flow	55.5	45.5 (-18)	35.6 (-36)

Value in parentheses is % change in flow.

Impact of Climate Change on Coastal Resources Sector



Impact of Climate Change on Coastal Resources Sector

Potential inundation of Nile Delta from high SLR in 2060.

Amount and percentage loss of agricultural lands in the northern Nile Delta in 2060

	Northeast Nile Delta		North-Middle Nile Delta		West Nile Delta	
Climate scenarios for SLR	km^2	%	km^2	%	km^2	%
High SLR 2060 protected	25.8	1.8	137.2	2.7	15.0	0.3
High SLR 2060 unprotected	774.3	52.7	523.9	10.4	625.6	13.2
Low SLR 2060 protected	4.8	0.4	31.2	0.6	0.0	0.0
Low SLR 2060 unprotected	449.3	30.6	129.5	2.5	10.6	0.2

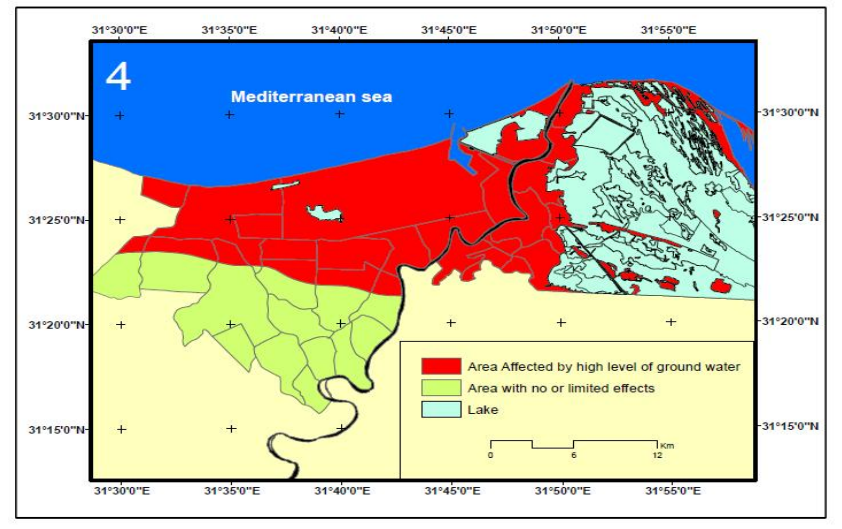
Impact of Climate Change on Coastal Resources Sector (cont'd)

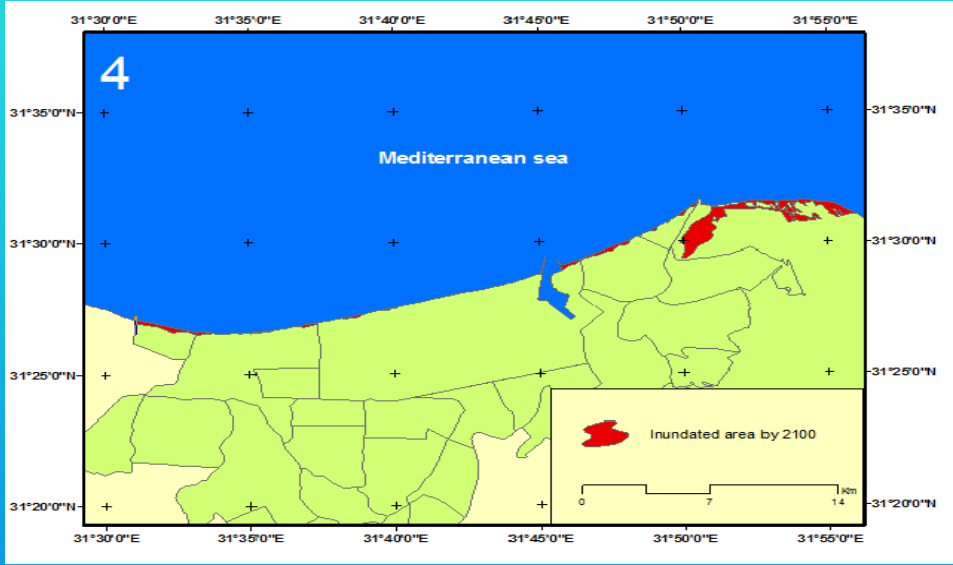
Annual value of housing units and roads in the Nile Delta at risk from SLR (billion EGP)

	Housing units		Roads	
	2030	2060	2030	2060
Low	1.0	1.9	1.4	4.4
Middle	1.0	2.4	1.5	5.5
High	1.1	7.2	1.6	16.3

Potential inundation of Nile Delta from high SLR in 2060.

Impacts of SLR and the vulnerability of coastal communities, economic sectors and natural systems in the areas of Ras El Bar, New Damietta City and Gamasa





Cultivated land affected by high levels of groundwater until 2100

land affected by high levels of groundwater until 2100

Adaptation

- The UNFCCC defines it as actions taken to help communities and ecosystems cope with changing climate condition
- The IPCC describes it as adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities

Elements of adaptation

- Observation
- Assessment
- Planning
- Implementation
- Monitoring and Evaluation

Observation
&
Assessment

Certain & Un-Certain Future Challenges Facing WR in Egypt

	2015	2025	2050	2075	2100
Estimated Rise in mean air Temperature (°C)	--	1.0	1.7	2.5	3.5
Estimated % change in mean ETo & Water Requirements	--	4 %	8 %	13 %	18 %
Estimated Population (million)	--	104	145	191	237
Estimated % change in Nile Flows **Drying Scenario**	--	- 6 %	-15 %	-20 %	-31 %
Estimated % change in Nile Flows **Wetting Scenario**	--	+10%	+21%	+24%	+27%
Rough Estimate of Reduction (Bil m3/yr)	3	5	8	10.5	13
Sea Level Rise		0.1-.22	.24-.5	0.4-.8	.5-.95

-Since **we do not know** what climate scenario would prevail in **future**, there will be **UNERTAINTY** in the developed adaptation strategy.

-**To** Reduce this UnCertainty, we will considerd two average Scenarios:

1- **An average range** for the Wetting Nile flow scenarios (+ 27% for 2100) , and

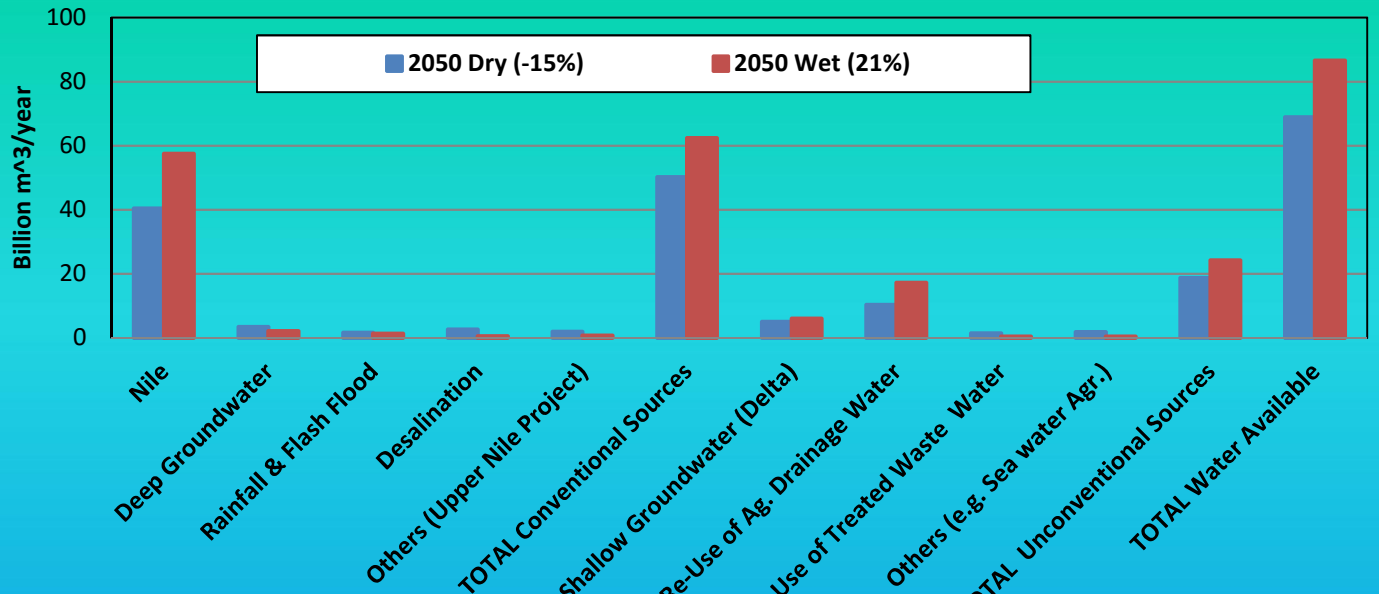
2- **An average one for the Drying** Nile flow scenarios **(- 31% for 2100)**

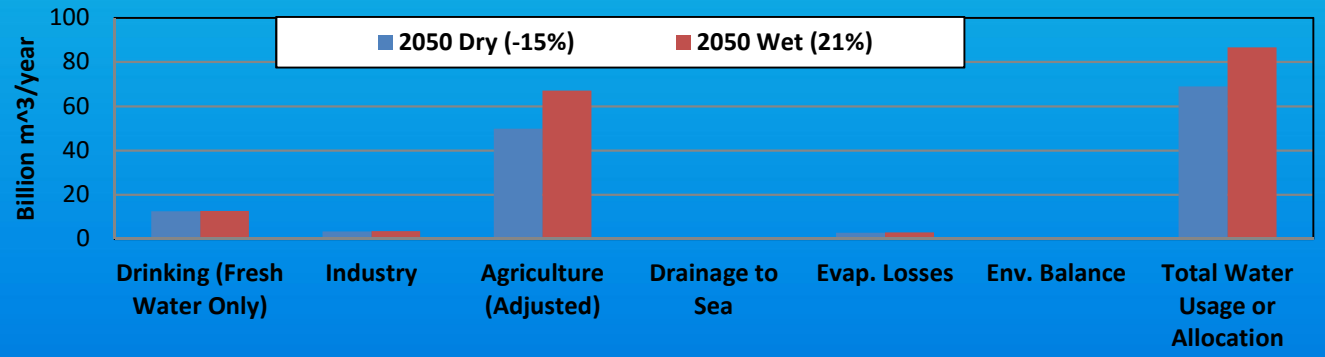
- Therefore **Two Sets** of estimated **Future Water Budget Trends** (2025, 2050, 2075 & 2100) are developed **(**one for the **Drying scenario** and one for the **Wetting Scenario)**

Assessment

Main Simplifying Assumptions used in developing these trends

- **Future Population** are based on those of the Water Holding Company
- **Do not expect Increase in Nile Flows in the near future,** situation my improve in future
- **Transbounday** are based on very little information
- **Deep GW** is non-renewable and has limitations
- **Rainfall Harvesting** has relatively little contribution
- **Desalination** will have a significant role w.r.t .drinking water
- **Shallow GW in the Delta** is renewable & related to Nile flow and irrigation efficiency
- **Agricultural Drainage Re-Use** is related to Irrigation efficiency and Nile Flows
- **Treated Waste Water** will have increased contribution with increased municipal allocation
- **Drainage Water disposal to Sea** is related to water availability but a must for salt balance
- **Sea Water Agriculture** is still in research stage and is promising should have more attention
- **Water Quality**: It is assumed that all possible measures will be taken to protect water bodies


Billion m^3/year
100
80
60
40
20
0
2050 Dry (-15%)
2050 Wet (21%)
Nile
Deep Groundwater
Rainfall & Flash Flood
Desalination
Others (Upper Nile Project)
TOTAL Conventional Sources
Shallow Groundwater (Delta)
Re-Use of Ag. Drainage Water
Re-Use of Treated Waste Water
Others (e.g. Sea water Agr.)
TOTAL Unconventional Sources
TOTAL Water Available


Billion m^3/year
100
80
60
40
20
0
2050 Dry (-15%)
2050 Wet (21%)
Drinking (Fresh Water Only)
Industry
Agriculture (Adjusted)
Drainage to Sea
Evap. Losses
Env. Balance
Total Water Usage or Allocation

Planning

Risks to Egypt Water Security

- R1: Drought and Water Scarcity
- R2: Floods
- R3: High Water Consumption
- R4: Sea Level Rise

•Each of these Risks has its Consequences

•Adaptation Measures are Defined & Classified for these Consequences

Adaptation Measures are Defined for the Consequences & Classified according to :

- **Category** : (Infra-structure, Managerial, or Technical)
- **Scale and Size**: (Regional, National , or Local)
- **Technical Feasibility**: (Low, Moderate, or High)
- **Adaptive Capacity**: (Low, Moderate, or High)
- **Potential Cost: (**Low, Moderate, or High)
- **Time Span**: (Short, Medium, or Long)
- **Response:** (Proactive, or Reactive) , and
- **Regret**: (Low regret, No regret, or Regrettable)

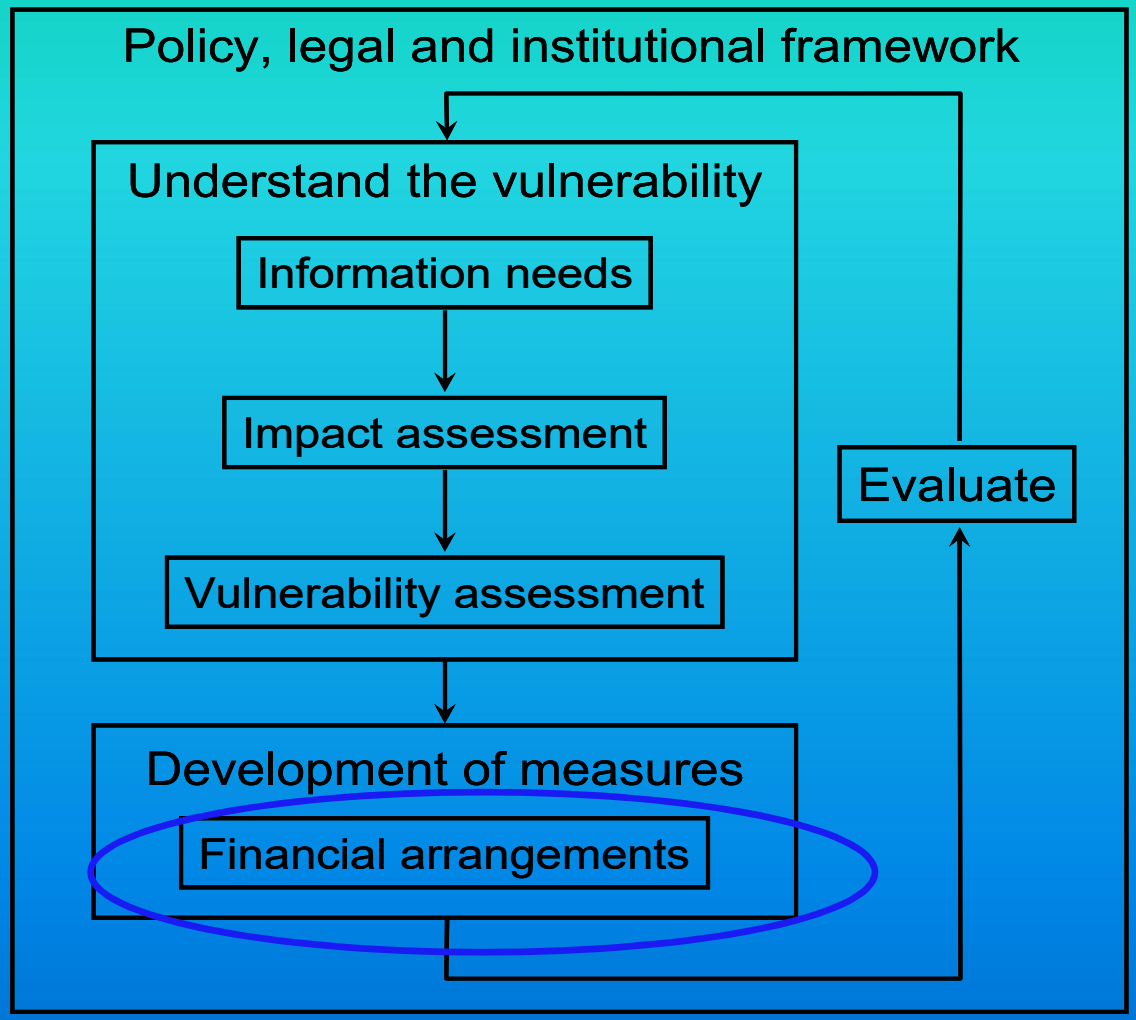
Risks and Consequences	Adaptation Measures	Category	Scale	Adaptive Capacity	Feasibility	Potential Cost	Time Span	Response	Regret	Success Chance
R1.Droughts and water scarcity										
R1.a Reduced Water supply	-Development of deep groundwater	I	L	H	H	H	M	P	N	S
	-Increased Agricultural Drainage water re-use	I	N	H	H	M	S	P	L	P
	-Construct & encourage Desalination plants	I	L	M	H	H	S	P	N	S
	-Resolve conflicts with Nile Basin countries	M	R	L	H	M	L	R	N	P
	-Increase regional-level rainfall harvesting	T	R	L	L	L	L	R	N	P
	-Research &applications on Demand Management	M	L	L	M	L	M	P	N	S
	-Local use of Treated Waste Water	I	L	H	H	H	M	P	N	S
	-Enhance research to develop new resources	T	R	M	M	M	L	P	N	P
	-Enhance research on saline & sea water usage	I	L	M	L	M	M	P	N	S
	-Reduce evaporation losses from Lake Nasser	I	L	M	M	H	M	P	N	S
	-Reduce water disposal to the Mediterranean	T	N	H	L	L	S	R	L	P
	-Optimize operating rules of the HAD	M	N	H	M	L	S	R	L	S
	-Regional cooperation & enhance prediction tools	M	R	M	M	L	S	P	N	S
R1.b Conflicts among competing users & sectors on scarce resources	-Distribute water on Volumetric Basis	I	N	L	M	H	M	P	N	S
	-Activate Role & Laws of Water User Associations	M	N	M	H	L	M	P	N	S
	-Issue new Rules and standards for Water Rights	M	N	M	M	L	M	P	N	S
	-Efficient Awareness programs	M	N	M	M	L	L	P	N	S
R1.c Increased pollution in streams	-Strict Environmental Regulation	M	N	M	M	L	S	P	N	S
	-Effective Monitoring & treatment systems	T	N	M	H	H	M	P	N	S
	-Efficient Awareness programs (same as above)	M	N	M	M	L	L	P	N	S
	-Active role of Communities and participation	M	N	M	H	L	M	P	N	S
R1.d Cross cutting issues										
i. Public health deterioration	-Related to Health sector									
ii. Soil salinity & land use changes	-Related to Agricultural sector									
iii. Less hydropower generation	-Related to Energy Sector									
iv. Less inland navigation activities	-Related to Transportation Sector									

Risks and Consequences	Adaptation Measures	Category	Scale	Adaptive	Feasibility	Potential Cost	Time Span	Response	Regret	Success Chance
R2. Increased Floods										
R2.a Inundation of low-lying lands	-Protection works in exposed areas (banks, …)	I	L	H	H	M	S	R	L	S
	-Enhance Toshka spillway	I	L	H	H	M	M	P	N	S
	-Adjust HAD operating rules	M	N	H	M	L	S	R	L	S
	-Enhance early warning and prediction tools	T	R	H	H	L	M	P	N	S
	-Building capacity to deal with flood risk	T	R	M	M	L	M	P	N	S
	-Monitoring & Evaluation programs	T	N	M	H	L	L	P	N	S
R2.b Erosion in main Nile & canals	-Protect exposed reaches of water streams	I	L	H	H	M	M	R	L	S
R2.c More Frequent and high intensity of flash floods	-Construct protection works in exposed areas & to recharge groundwater from flashfloods	I	L	M	M	M	M	R	L	P
	-Improve forecasting systems	T	R	M	H	L	S	P	N	P
	-Building capacity to make use of flash floods	M	N	H	H	L	S	P	N	S

Risks and Consequences	Adaptation Measures	Category	Scale	Adaptive Capacity	Feasibility	Potential Cost	Time Span	Response	Regret	Success Chance
R3. Higher water consumption										
R3.a Decreased water availability for agriculture	-Investment in efficient irrigation equipment (piped mesqas-marwas,& trickle irrigation….)	I	N	H	H	H	M	P	N	P
	-Develop & Apply volumetric water quota system	I	N	M	M	H	L	P	N	P
	-Enhance role of water user associations	M	R	M	M	L	M	P	N	S
	-Strict rules on high water consumption crops	M	N	L	M	L	M	P	N	P
	-Reduce irrigated areas & seasons	M	N	L	L	L	S	R	R	F
	-Reduce Water Duty for irrigated lands	M	N	M	M	L	S	P	N	S
	-Generalize controlled drainage in rice areas	I	R	M	H	M	L	P	N	P
	-Efficient water quality protection programs	M	N	M	H	M	S	P	N	P
	-Wide Use of drought and salt tolerant crops	M	R	H	M	L	L	P	N	S
	-Create incentives to conserve irrigation water	M	N	L	M	L	L	P	N	P
	-Activate fair & social water tariff system	M	N	M	H	L	S	P	N	P
	-Efficient Awareness programs (same as above)	M	N	M	M	L	L	P	N	P
R3.bDecreased water availability for the municipal sector	-Effective Awareness & educational programs among users to use conservative practices	M	N	M	M	L	L	P	N	P
	-Reduce leakage from public networks	T	L	M	H	H	L	P	N	S
	-Develop tariffs leading to water conservation	M	N	H	H	L	S	P	N	S
	-Install meters for all users	I	N	H	H	M	M	P	N	S
	-Apply conservative water regulations	M	N	M	M	L	S	p	N	P
	-Construct & encourage Desalination plants	I	L	M	H	H	S	P	N	S
R3.c Decreased water availability for industrial sector	Apply strict regulations for effluent quality	M	N	H	M	L	S	P	N	S
	Enhance water recycling & offer incentives	T	L	M	H	M	S	P	N	P

Risks and Consequences	Adaptation Measures	Category	Scale	Adaptive Capacity	Feasibility	Potential Cost	Time Span	Response	Regret	Success Chance
R4. Sea Level Rise										
R4.a Inundation of low-lying lands	- Conduct detailed studies on the effectiveness of the proposed measures	T	N	M	H	L	M	P	N	S
	-Creating wetlands in vulnerable low lying areas (e.g. Lake Manzala & Lake Burullus)	I	L	M	H	L	M	P	N	S
	-Periodic beach nourishment and groins	T	L	H	H	H	S	R	N	S
	-Reinforcing natural protection by sand dunes	I	L	H	H	M	S	P	N	S
	-Protection & enforcement existing protection works	I	L	H	H	H	M	P	N	S
	- Construct breakwaters and/or sea walls	I	L	M	H	H	M	P	N	S
	-Reinforcing the international road along the Mediterranean coast, as second defense line	I	N	H	H	M	M	P	N	S
	- Using Al-Salam Canal banks as first protection line	I	N	H	H	M	M	P	N	P
	-Apply the integrated coastal zone management plan	M	N	M	H	M	L	P	N	S
	-Create additional rules for coastal development, covering CC impact	M	N	M	H	M	L	P	N	S
R4.b Sea Water Intrusion	-Conduct more research to update effectiveness of the proposed measures	M	L	H	H	L	S	P	N	S
	-Increased rice areas on Northern regions	T	L	H	M	L	M	P	N	S
	-Regulate pumping at coastal areas	I	L	M	M	M	M	P	N	P
	- Excavate interceptor drains parallel to the coast	I	L	M	H	H	M	P	N	P
	- Create hydrodynamic barrier by line of injection wells parallel to the coast	I	L	M	M	M	M	P	N	P
	-Extracting/injecting combination	I	L	L	M	H	M	R	L	P
	-Constructing impermeable subsurface barriers	I	L	L	M	M	M	R	L	P
R4.c Damage to Northern Lakes and communities	-building dikes with wide banks (20 meters) and sufficient height 2.5 to 3.0 meters) to protect the lakes and store water inside lakes.	I	L	H	H	H	M	P	N	S
	-more studies are needed to identify vulnerability and potential adaptations	T	N	M	H	L	M	P	N	S
R4.d Coral reefs near the Red Sea shore line	-Reinforce natural protection to the rocky coral reefs adjacent to the Red Sea shore	I	L	L	M	H	M	P	L	S

- Developing Implementation Plans



The Dynamic nature of climate change adaptation strategies

Next Step

Budget Details for different risks

(Personal Assessment)

No	Adaption Measures		2010	2015	2020	2025	2030	2040	2050	2075	2100	Remarks
R1	**Droughts and Water Scacity**											
Ad1-1	Development of Deep Groundwater Wells											
	Targeted deep Groundwater Volume [Drying scenario]	(Billion m3/yr)	2.00	2.00	2.15	2.30	2.52	2.96	3.40	4.50	6.00	Drying scenario
	Estimated Budget for Period	(LE Billion)	0	0.2	0.302	0.347	0.453	1.70	1.70			4.70
Ad1-2	Agricultural Drainage Water Re-Use											Existing Drainage Re-Use amounts are subjec to future reductions under drying scenario, and may increase slightly under the wetting scenario and may not need additional budget
	Re-Use Volume under Drying Scenario	(Billion m3)	16.00	15.50	14.50	13.50	12.86	11.50	10.30	9.6	8.7	
	Estimated Budget for Period	(LE Billion)		0.1	0.15	0.2	0.25	0.3	0.3			1.30
Ad1-3	Construction of Desalination plants											
	Targeted Desalination Volume [Drying scenario]	(Billion m3/yr)	0.2	0.25	0.6	0.95	1.31	1.95	2.75	4.75	6.5	under drying Scenario
	Estimated Budget for Period	(LE Billion)		1.00	6.65	6.30	5.76	17.92	19.20			56.83
Ad1-4	Local use of Treated Waste Water											
	Targeted Treated WW Re-Use Volume [Drying scenario]	(Billion m3/yr)	0	0	0.20	0.40	0.62	1.06	1.50	2.10	3.75	under drying Scenario / Cost of treatment is not for CC adaptatin only
	Estimated Budget for Period	(LE Billion)		1.60	1.60	1.60	1.75	5.30	5.30			17.15
Ad1-5	Use of Saline & Sea Water for Agriculture											Use of sea water for agriculture is still an applied research (2012), therefore it is not cpnsidered significant till 2050. The amounts mentioned here are the equivalent fresh water amounts. ROUGH
	Targeted Used salineor sea Volume /yr [Drying scenario]	(Billion m3/yr)	0	0	0.00	0.00	0.25	0.80	1.90	3.00	5.50	
	Estimated Budget for Period	(LE Billion)	0	0.08	0.20	1.00	2.00	2.50	3.00			8.78
Ad1-6	Closing Khors in Lake Nasser to Reduce Evaporation Losses											Rough estimate of how much savings from evaporation losses can be achieved. If water levels are reduced (due to reduced flows or due to modifying lake levels) evaporation losses will decrease as well.
	Targeted Reduced Volume/yr	(Billion m3/yr)	0	0.2	0.4	0.6	0.8	1.0				
	Estimated Budget for Period	(LE Billion)		0.10	0.20	0.30	0.40	0.50				1.50
Ad1-7	Volumetric Control on Water Distribution to Branch Canals											Volumetric water control to branch canals is not an easy task, and it will need some time to build capacity and decisde on appropriate control mechanism. But it will help in distributing water shortage
	Targeted Controlled Volume/yr	(Billion m3/yr)	0.00	0.00	0.40	1.00	2.00	4.00	7.00	18.00	30.00	
	Corresponding area under volumetric control	(1000 fed.)	0.00	0.00	59	147	294	588	1029			
	Estimated Budget for Period	(LE Billion)		0.10	0.50	0.75	1.00	1.50	2.50			6.35
Ad1-8	Soft Interventions											
	-Efficient Awareness programs and campaigns											* Includes: training on water conservation, conflict resolution, effective water control, monitoring & Evaluation…
	-Capacity Building*											
	-Applied and Adaptive Research**											** Includes: developing new water resources, energy, control algorithms, water quality management,sea water agriculture, ..etc..
	-Optimize perating rules of the HAD											
	-Reduce water Duty for irrigated lands											
	-Strict Environmental Regulations											
	-Issue new rules and standards for water rights											
	-Activate& Strengthen role & laws of Water user associations											
	-Enhancement of prediction tools											
	Estimated Budget for Period	(LE Billion)		0.07	0.10	0.15	0.30	0.40	0.50			1.52
	TOTAL Estimated Budget for Risk-1	**per period** (LE Billion)		3.25	9.70	10.65	11.91	30.12	32.50			98.13
	Estimated Annual Budget for Risk-1	(LE Billion/yr)		0.65	1.94	2.13	2.38	3.01	3.25			

Budget Details for different risks

(Personal Assessment)

No	Adaption Measures		2010	2015	2020	2025	2030	2040	2050	2075	2100	Remarks
R2	**Increased Floods**											
Ad2-1	Protection works at exposed reaches (banks,….)											These works include remodeling and raising banks in low-lying reaches, and/or provide more regulation on water levels. Budget cannot be estimated at this stage, but can be estimated by ministry experts
	Targeted length/level of protection this period	(km)		500	1000	1500	2000	2500	3000	2000	1000	
	Estimated Budget for Period	(LE Billion)		0.25	0.50	0.50	0.75	0.75	1.00			
Ad2-2	Enhancement of Toshka Spillway & Depressions											Enhancements to accoodate probable high floods and in case of emergency. Budget is roughly estimated and needs to be checked ministry experts
	Targeted Additional Capacity	(Billion m3)		0	3	7	10	12				
	Estimated Budget for Period	(LE Billion)		0.10	0.20	0.25	0.50	0.50				
Ad2-3	Flash Floods Protection Works & Groundwater Recharge facilities											needs more information from relevant departments to estimate size f works and budgeting
	Targeted protection works											
	Estimated Budget for Period	(LE Billion)		0.10	0.25	0.40	0.50	0.60	0.75			2.50
Ad2-4	Soft Interventions											
	-Efficient Awareness programs and campaigns											* Includes: training on flood risk management, monitoring & Evaluation, groundwater recharge ..etc
	-Capacity Building*											
	-Applied and Adaptive Research**											** Includes: weather forecasting and climate mdeling, flood risk assessment and management, protection works…
	-Adjust HAD operating rules											
	-Enhance early warning and prediction tools											
	-Monitoring & Evaluation programs											
	Estimated Budget for Period (all soft interventions)	(LE Billion)		0.05	0.10	0.15	0.30	0.40	0.50			1.50
	TOTAL estimated Budget for Risk-2	(LE Billion)		0.50	1.05	1.30	2.05	2.25	2.25			9.40
	Estimated Annual Budget for Risk-2	(LE Billion/yr)		0.10	0.21	0.26	0.41	0.23	0.23			

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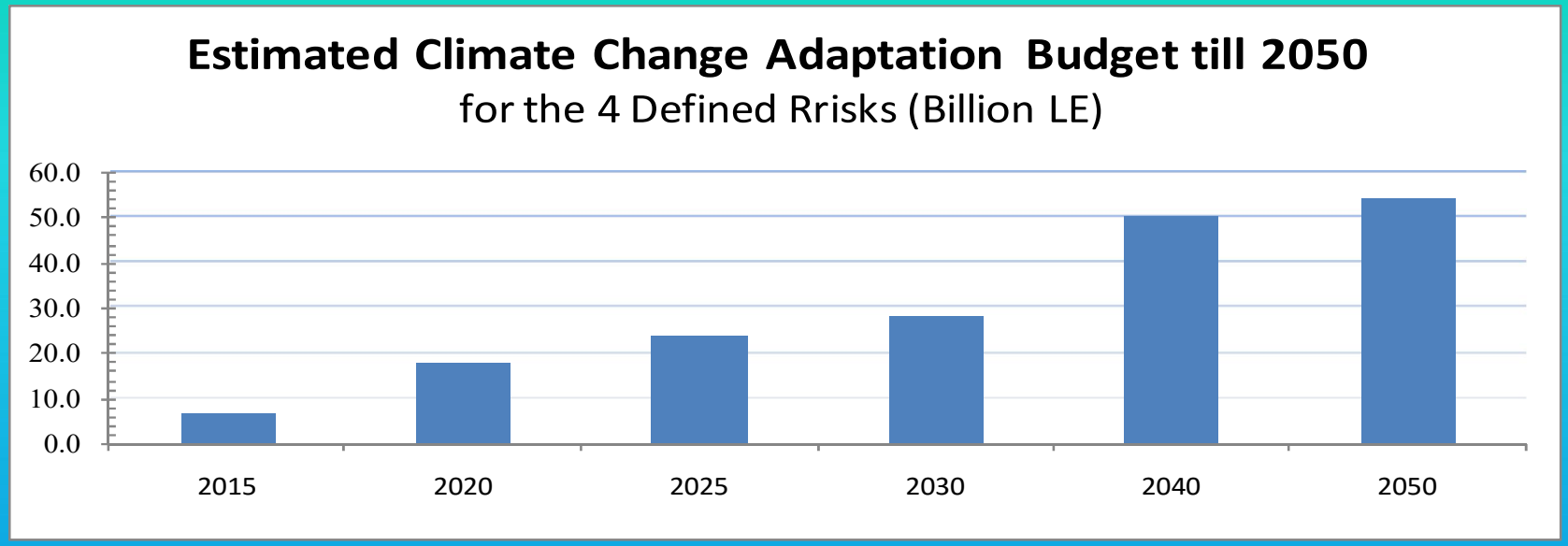
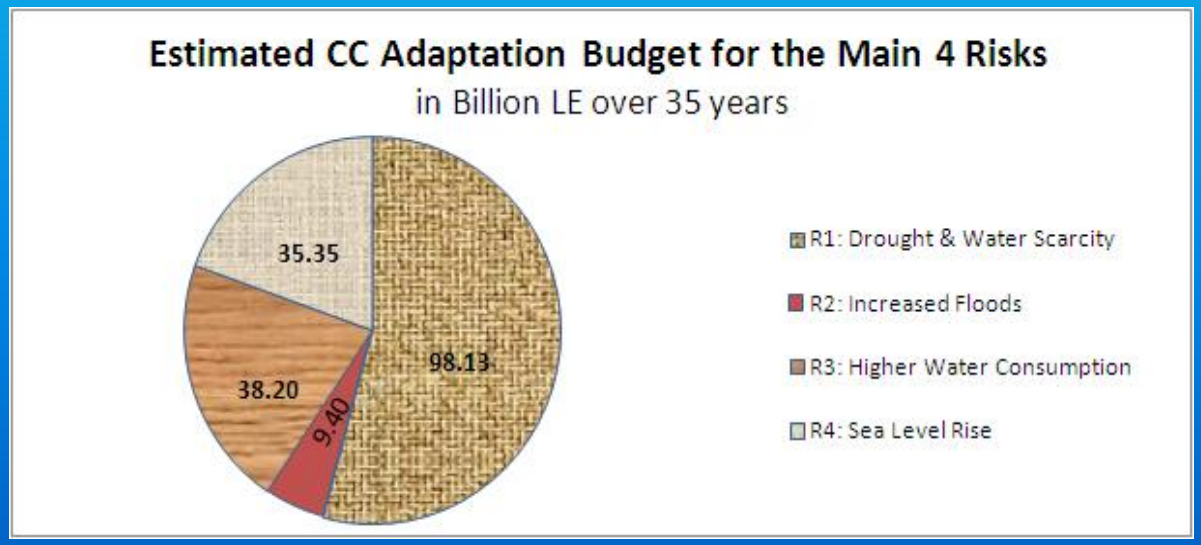
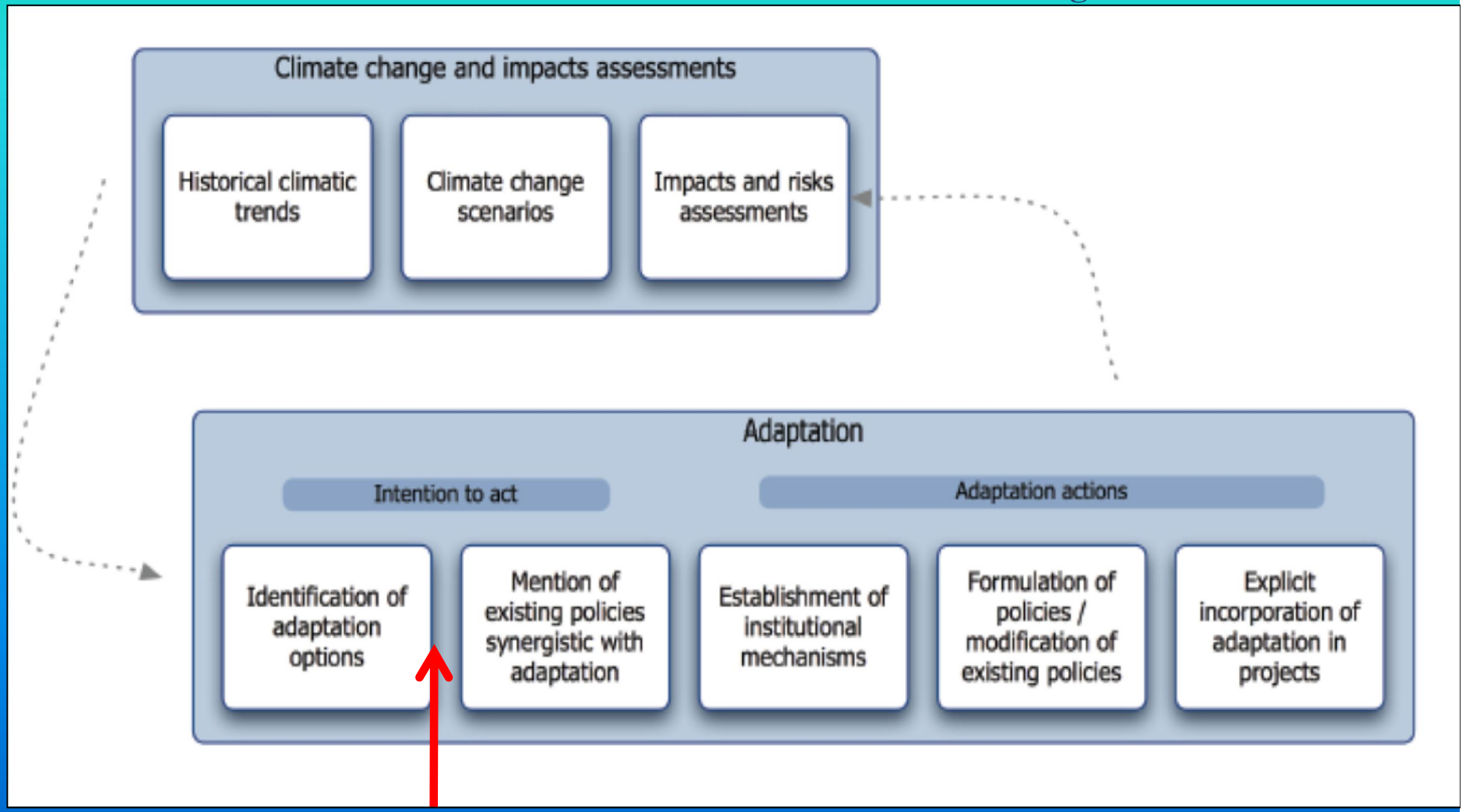
Total Budget , CC Adaptation Strategy , (Personal Assessment)





Where we are Standing NOW,

We still at the very Beginning; BUT on the Road, and we have to start Acting



ROAD MAP for Implementing CC Aaptation Strategy

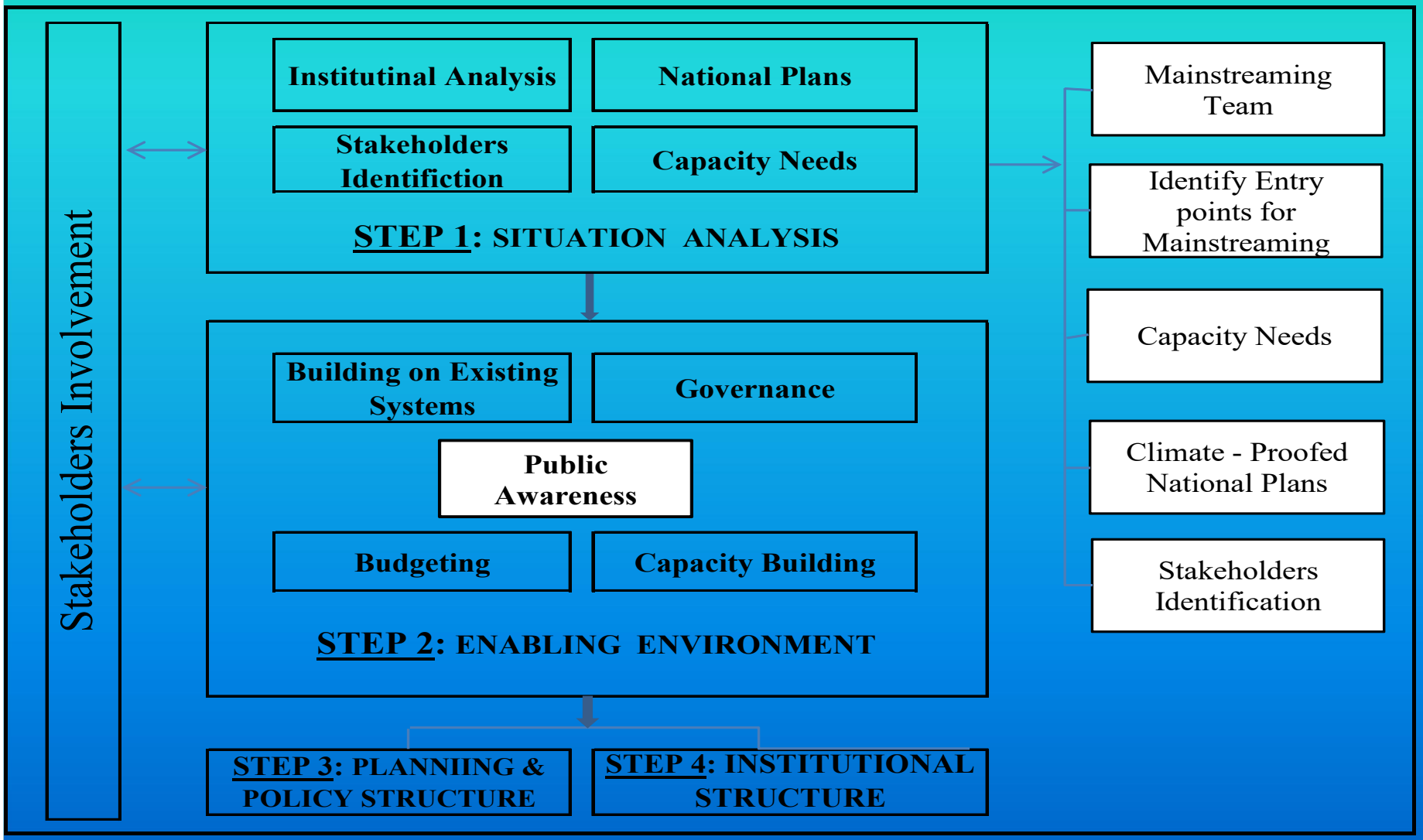
- The Road Map is a set of forward looking strategies within a time frame,
- A road map must be: **S M A R T**

  [**S**pecific, **M**easurable, **A**chievable, **R**ealistic, **T**ime-bound]

  - The Road Map Should **Involve** all stakeholders like:
    - Policy makers and planners
    - Research and Educational Institutions
    - Community Organizations
    - Development Institutions
    - Private Companies
- 4 Steps to formulate the Road Map …..

Guidelines for Mainstreaming Climate Change Adaptation in the Water Sector

- **4 Main Steps**



Flow Diagram of Mainstreaming CC Adaptation

The Way Forward

- Create informed consensus on climate change risks, objectives and policies.
- Define the roles and responsibilities of all stakeholders (sectoral agencies, different ministries and different levels implementing and evaluating bodies).
- Strengthen the networks in Knowledge creation and dissemination
- Network among capacity building agencies and institutions
- Implementing suitable support system
- Feedback to national policies, state policies and international negotiations

Adaptation Process
Example: Coastal Zone

- Sand Dunes systems should be treated as the first defensive line for the Nile Delta.
- Coastal Lakes are appropriate adaptive measure against sea level rise.
- International Coastal Road may be considered as the second protection measure and studies to support it are urgently required.
- Coastal Protection work needs regular maintenance and should be considered in any coastal zone management plans.
- The Northwest Coast extended from Alexandria to the Egyptian-Libyan borders is not vulnerable as it has elevation more than 10 m above average sea water level.

1- Utilizing Dredged Bed Material from Damietta Port Approaching Channel in Beach Nourishment

Proposed nourished areas

2- Coastal Sand Dunes Stabilizing

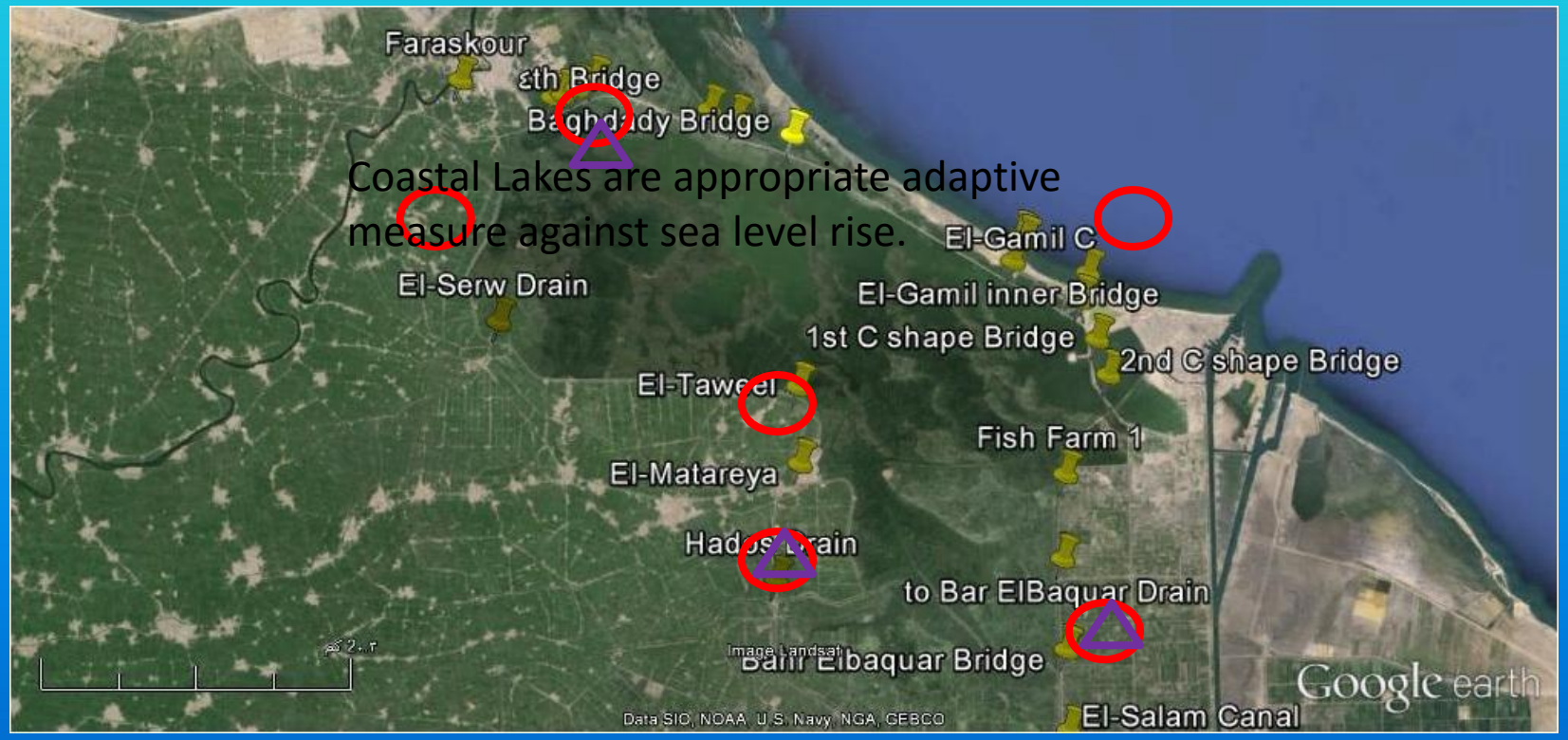
International coastal road

Sand Dunes At the West

Side of Rosseta Region

3- Coastal Lakes as an Appropriate Adaptive Measure against Sea Level Rise

Manzala Lake management



Sampling locations According to DO According to NH_3

4- Managed Alignment


Thank you