Simulation of Seawater Intrusion Due to Climate Change Impacts in North Gaza Aquifer Using SEAWAT

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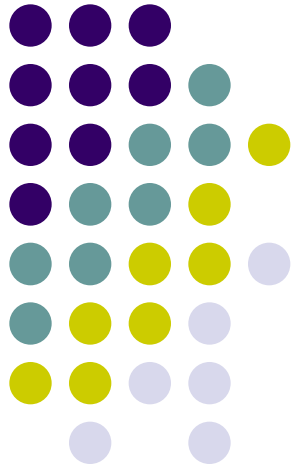
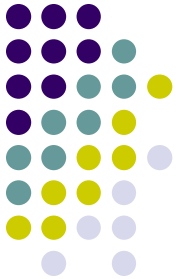


Overview



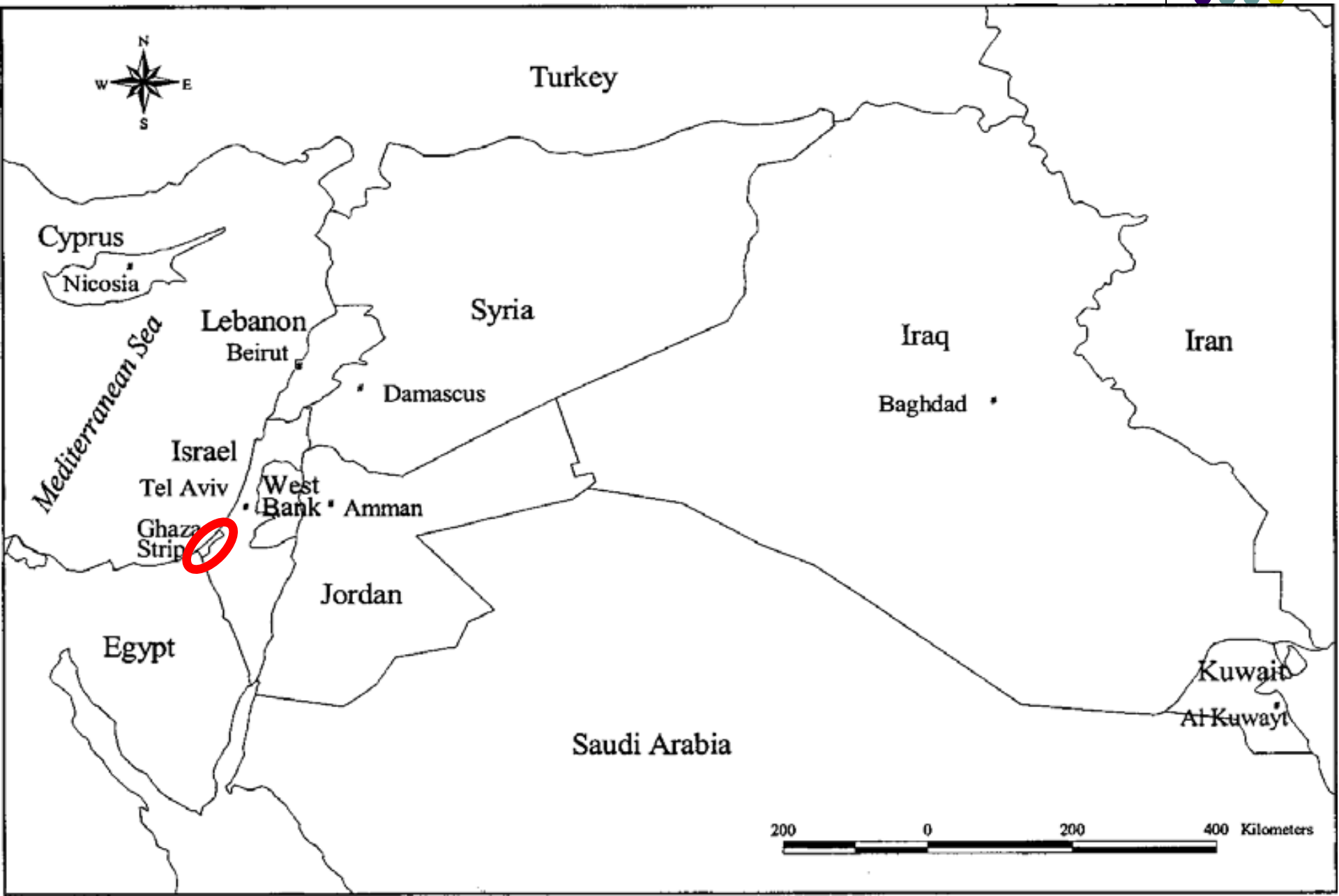
- Management of groundwater in coastal areas is very important.
- Over pumping and climate change cause seawater intrusion.
- Seawater intrusion should be controlled to protect G.W resources.

Objective

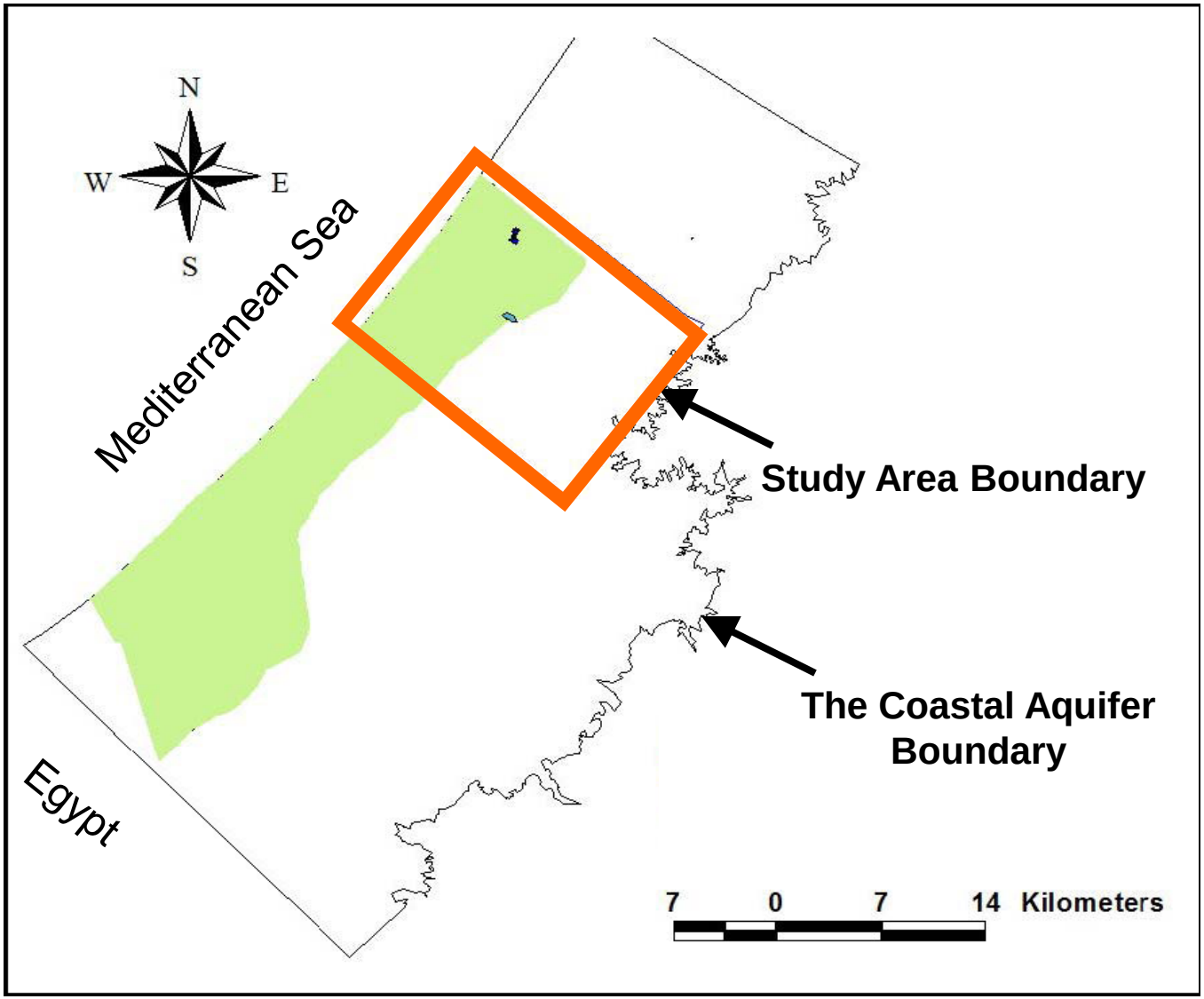
- This research deals with the groundwater resources assessment and future forecasting under various scenarios.

- These scenarios are related to human stresses and climate changes in order to increase our understanding of the seawater intrusion in the North Gaza aquifer using SEAWAT.

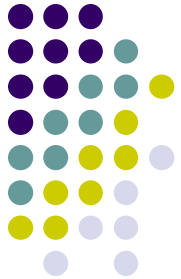
Regional Location of Gaza Strip



Study Area

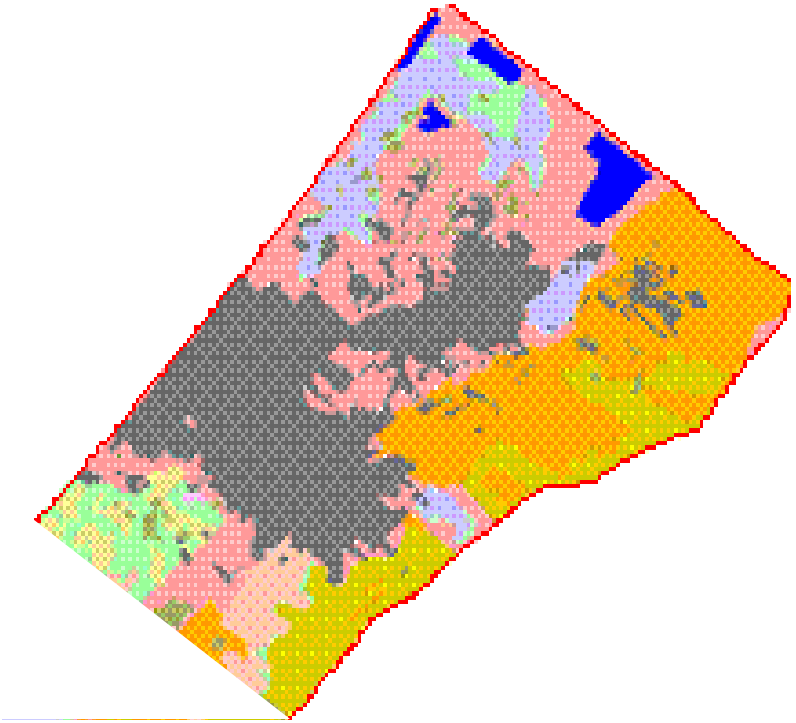

N
W
E
S
Mediterranean Sea
Egypt
Study Area Boundary
The Coastal Aquifer Boundary
7 0 7 14 Kilometers

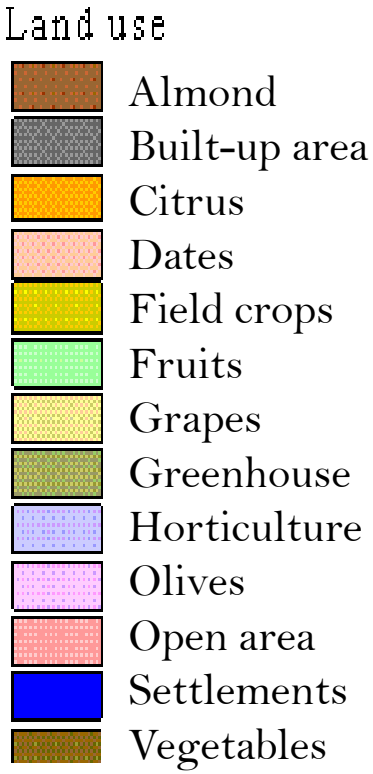
Why choosing North GAZA?



- North Gaza total area 109 Km^2 (~ 30% of total Gaza area)
- Total population at 2010 is 840,000 ~ 40% of Gaza population
- Over pumping
- Seawater intrusion
- Geographical location
- Contamination from agricultural and domestic wastes

Land Use



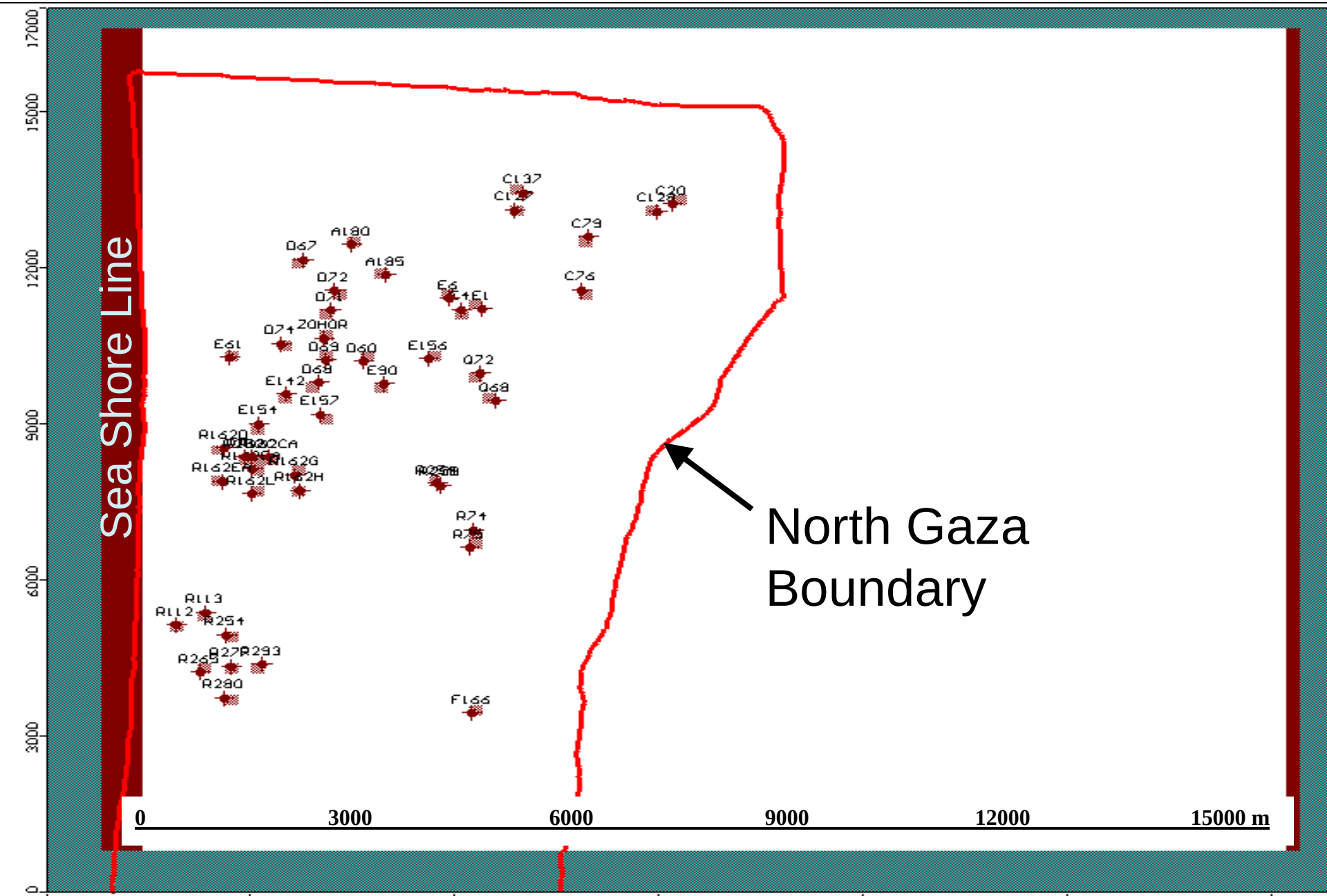


26% Built Up Area

56% Agricultural Lands

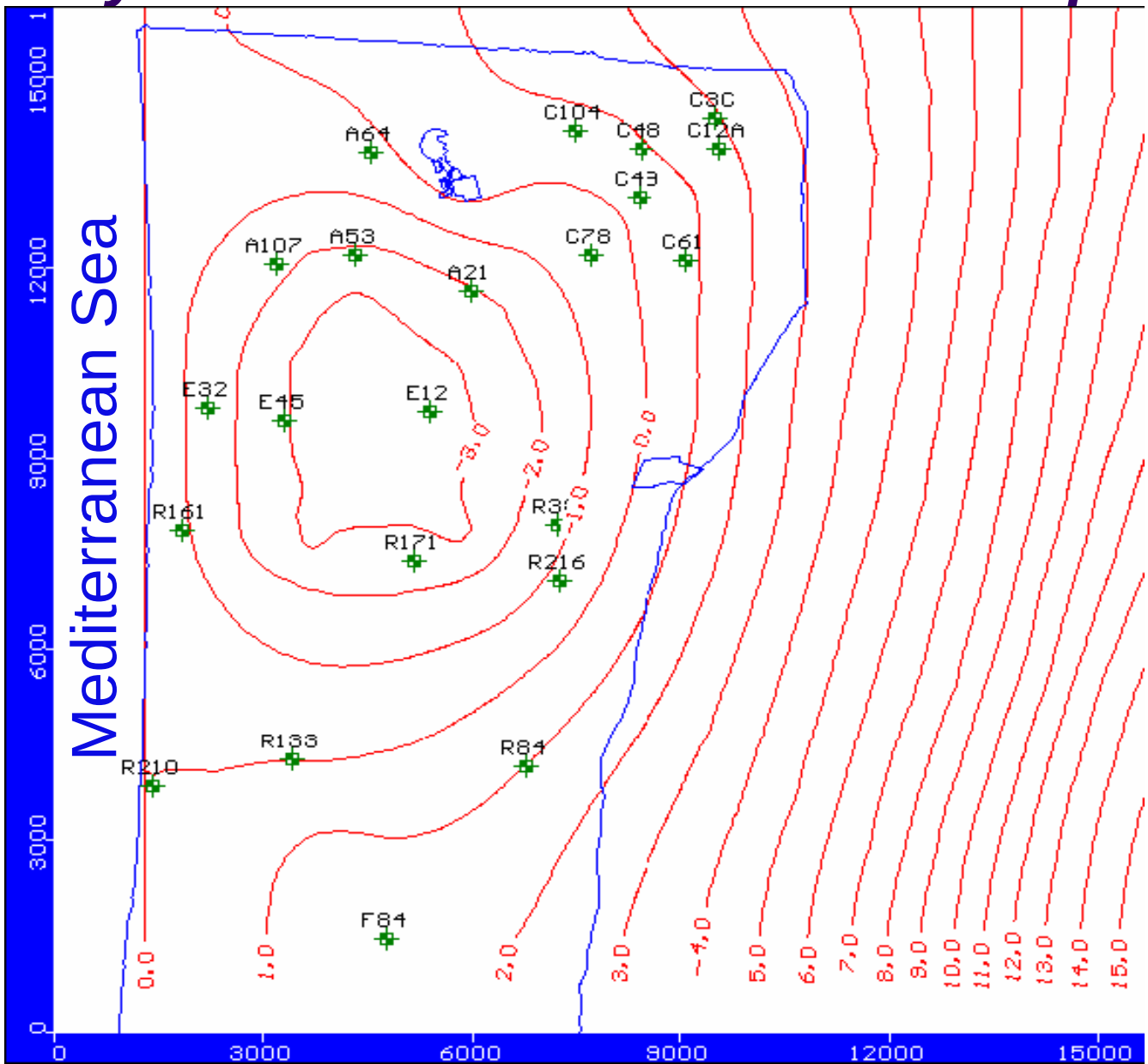
18% Open Areas

Domestic Wells and C.H.B.

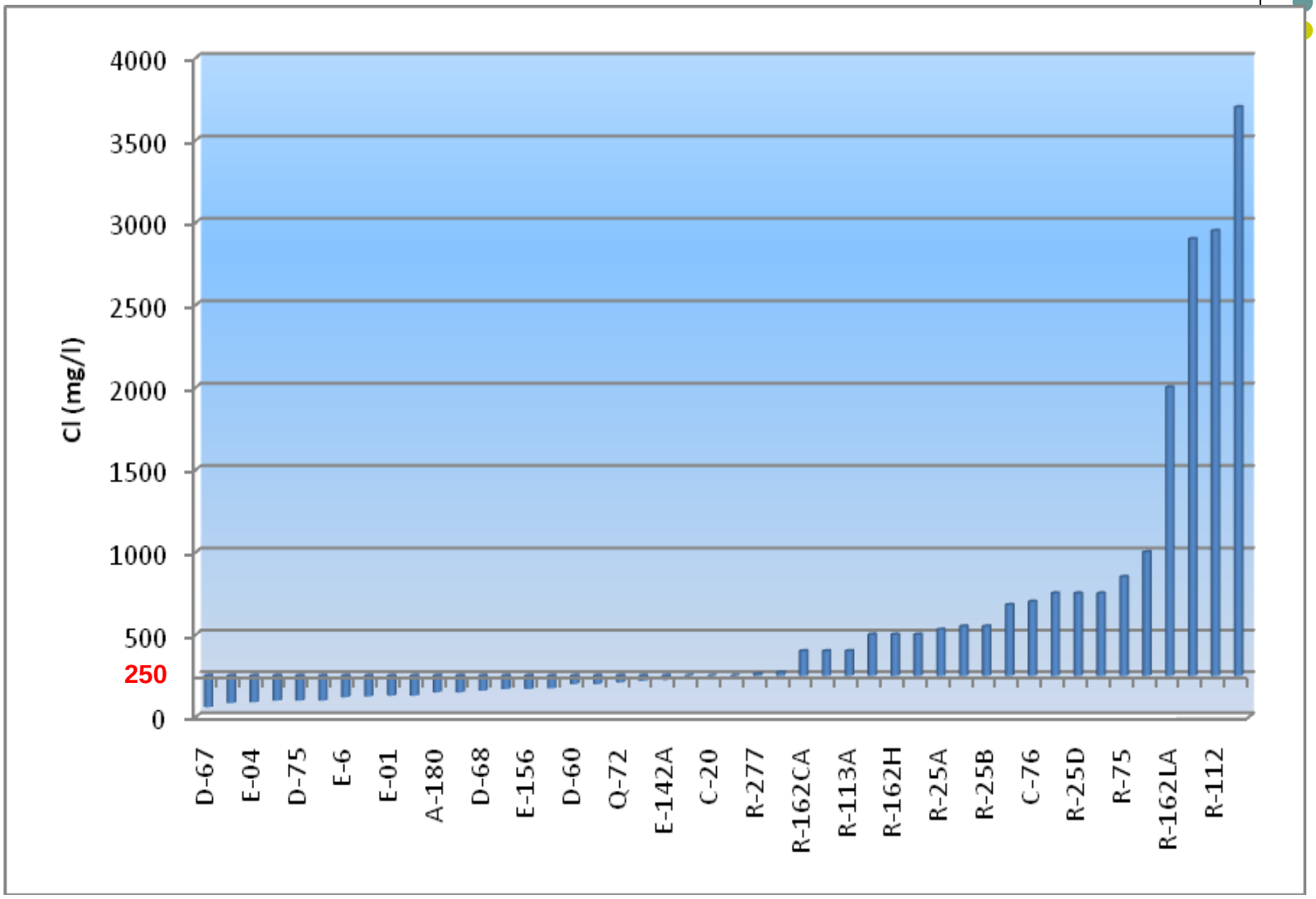


Over pumping results

Steady State Water Level Contour Map

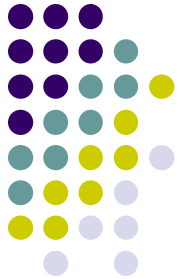


Water Quality



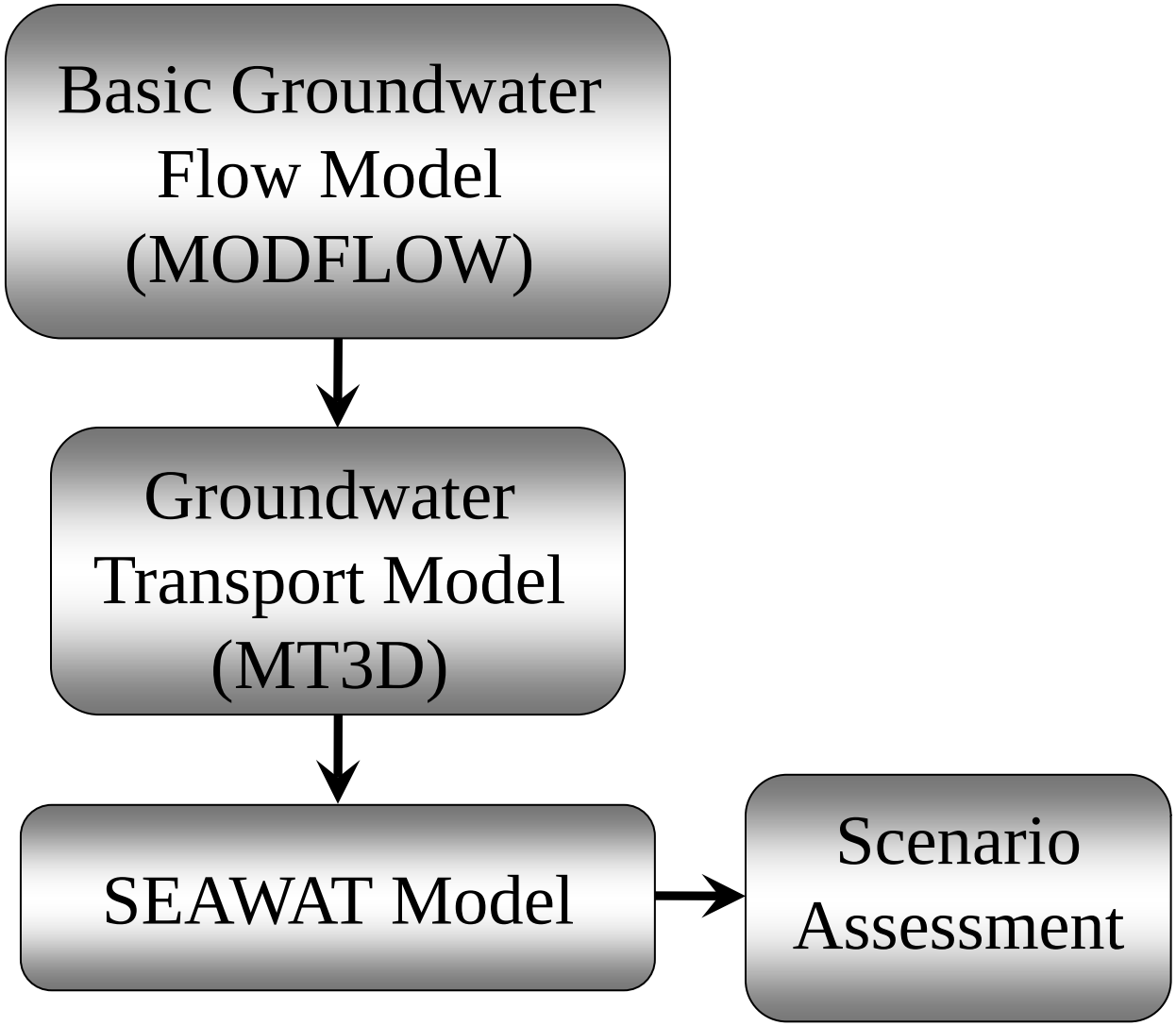
(Source: Palestinian Water Authority (PWA) reports, 2009)

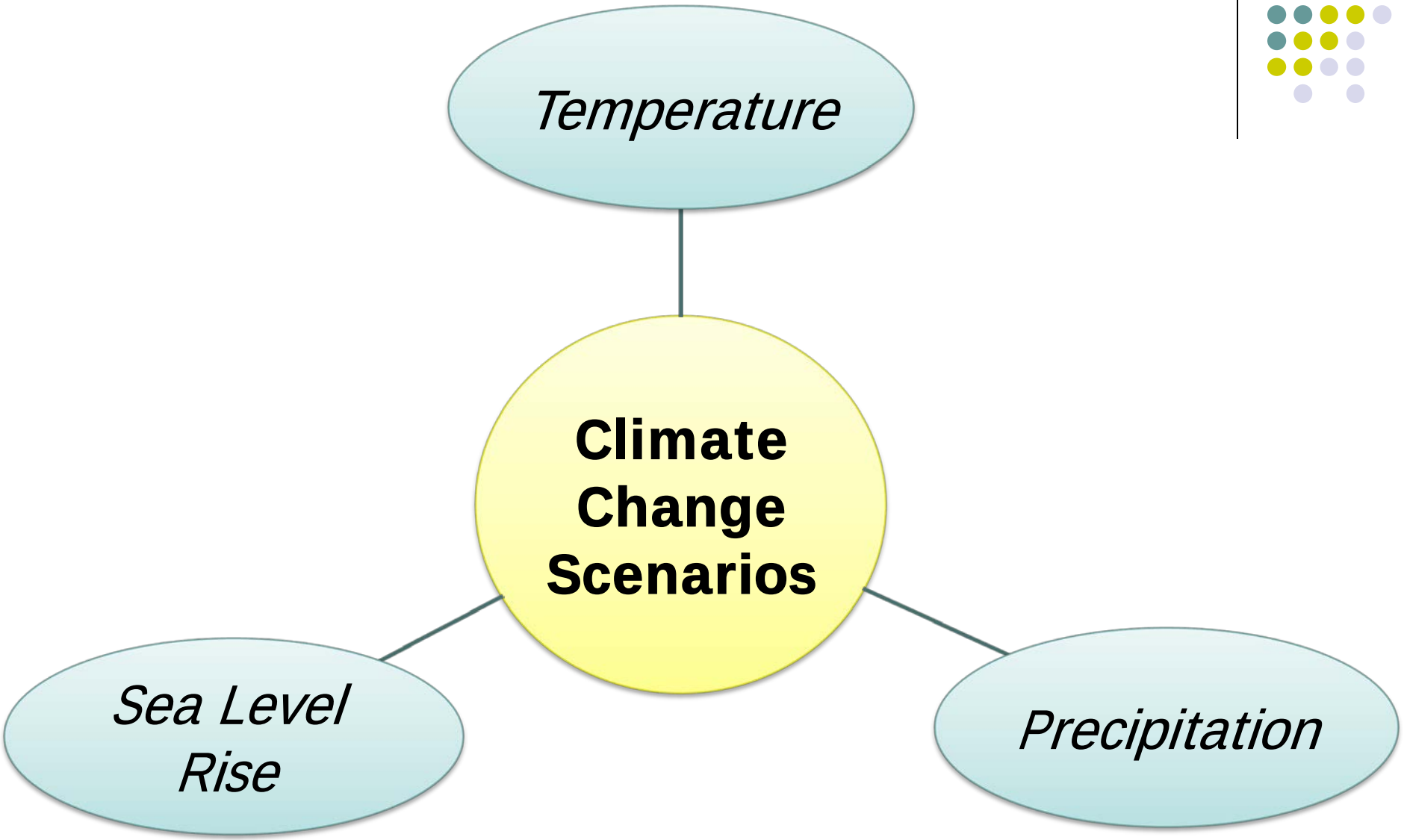
Water Balance



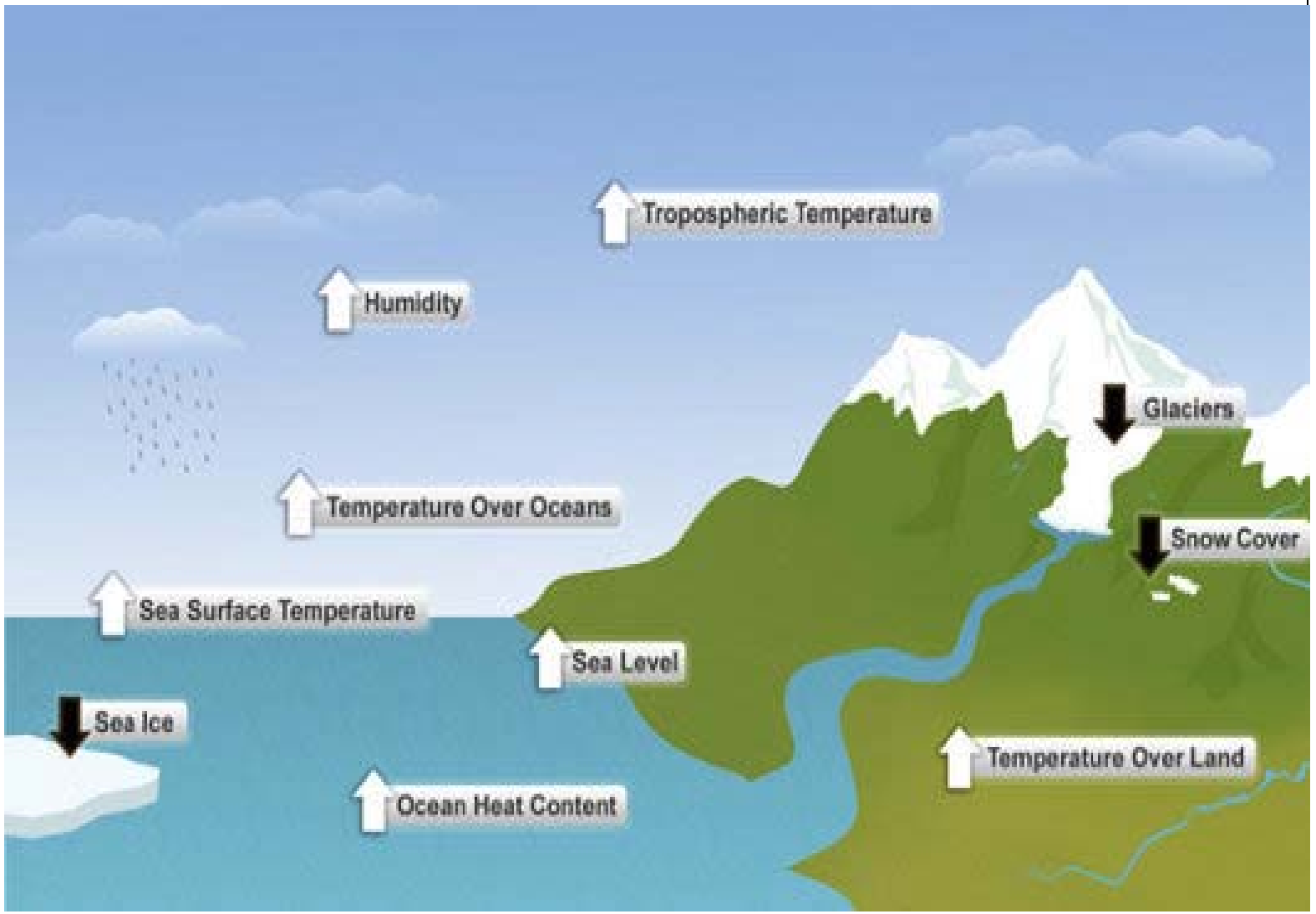
Inflow (MCM)		Outflow (MCM)	
Rainfall Recharge	27.7	Municipal Abstraction	62.8
Lateral Inflow	26.6	Agricultural Abstraction	28.9
Return Flows	17.7	Lateral Outflow	1.92
Total	72	Total	93.62
Net Balance		-21.62	

SEAWAT Model




Temperature
Climate Change Scenarios
Sea Level Rise
Precipitation

Warming World Indicators

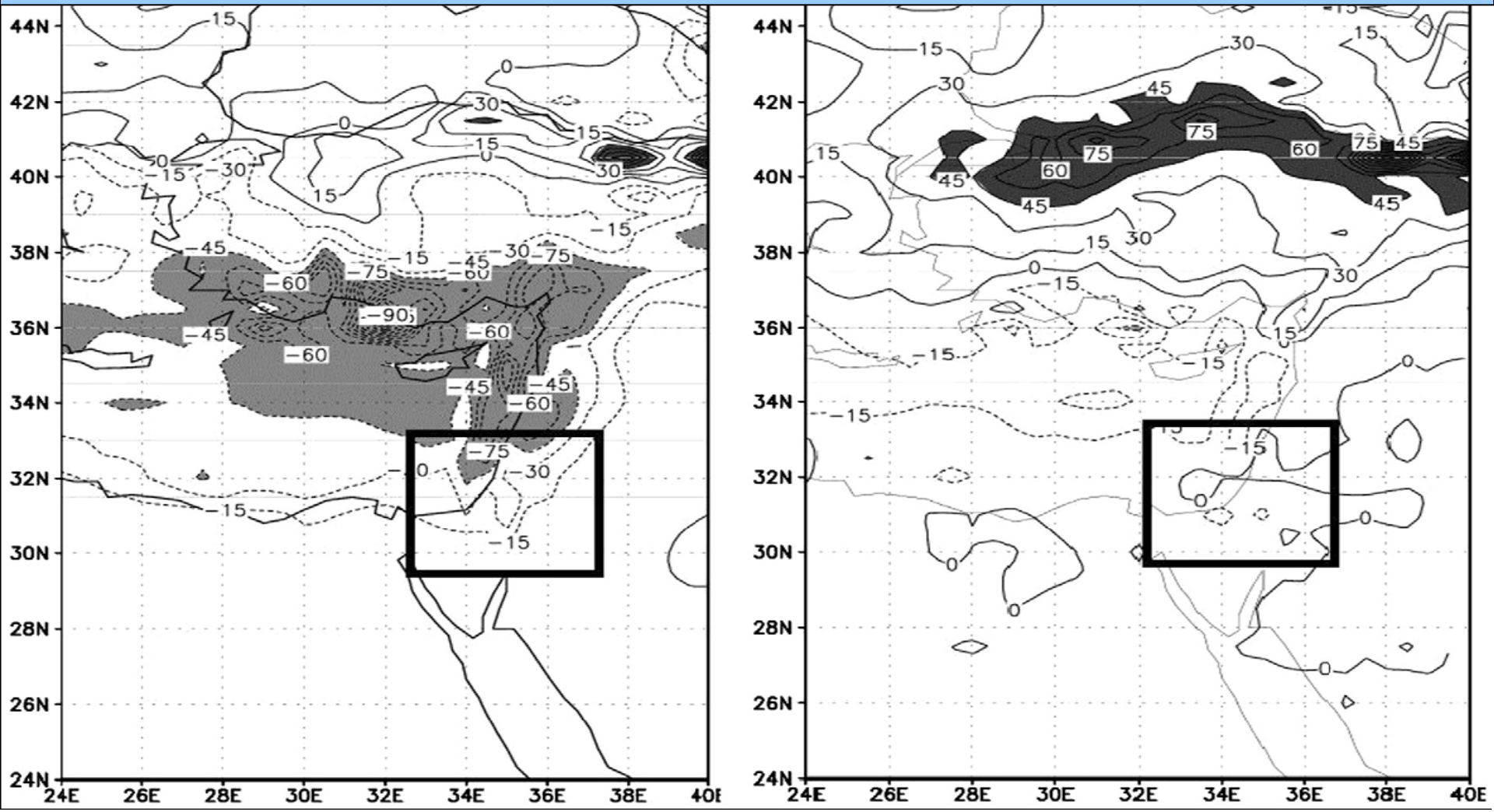


(Source: National Oceanic and Atmospheric Administration (NOAA), July 2010)

Precipitation Predictions for Mediterranean Region

A2- Control DJF seasonal precipitation (mm)

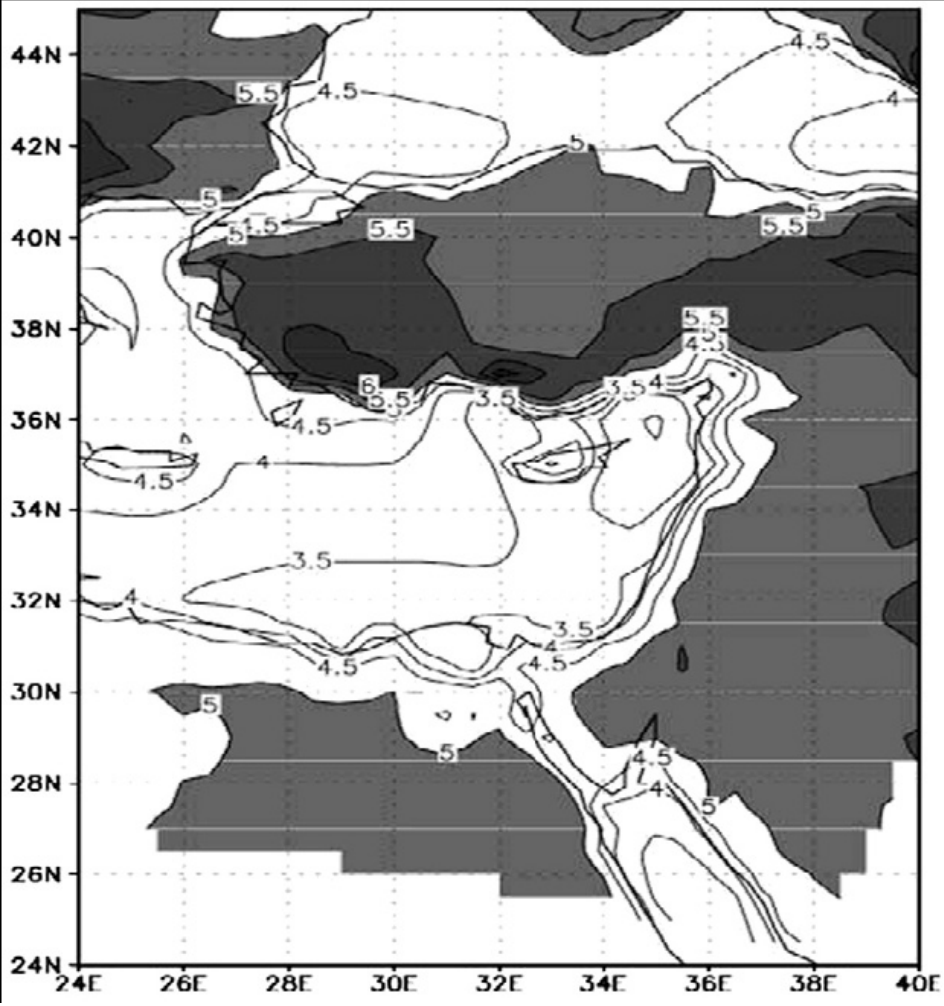
B2- Control DJF seasonal precipitation (mm)



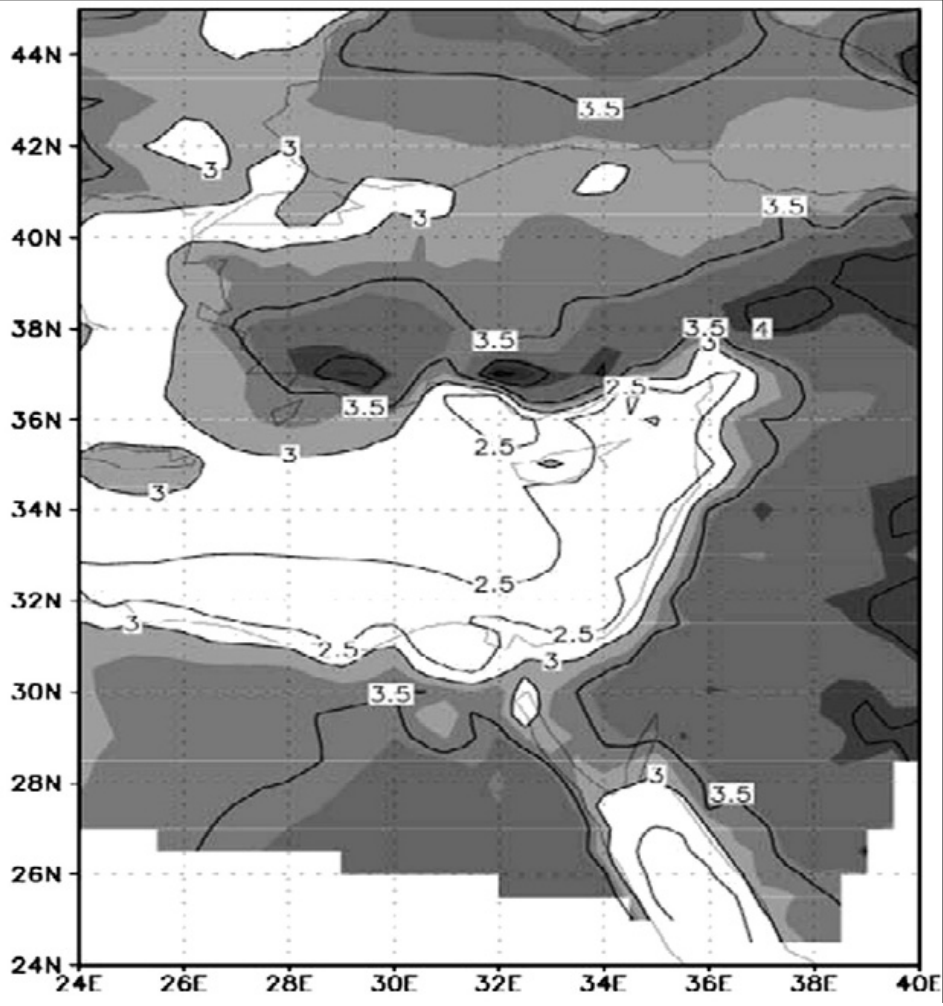
Source: The Intergovernmental Panel on Climate Change, (IPCC, 2007)

Temperature Predictions for Mediterranean Region

A2- Control JJA
Max. Temp (C°)



B2- Control JJA
Max. Temp (C°)



Source: The Intergovernmental Panel on Climate Change, (IPCC, 2007)

Climate Change Predictions

Indicator	Description	Magnitude
Temperature	Increase	4° to 6°C
Precipitation	Decrease	-10% to -30%
Evapotranspiration	Increase	10%
Winter Rains	Delay	--
Rain Intensity	Increase	--
Rainy season	Shortened	--
Seasonal temperature variability	Greater	--
Sea level rise	Increase	18-59 cm/100yr

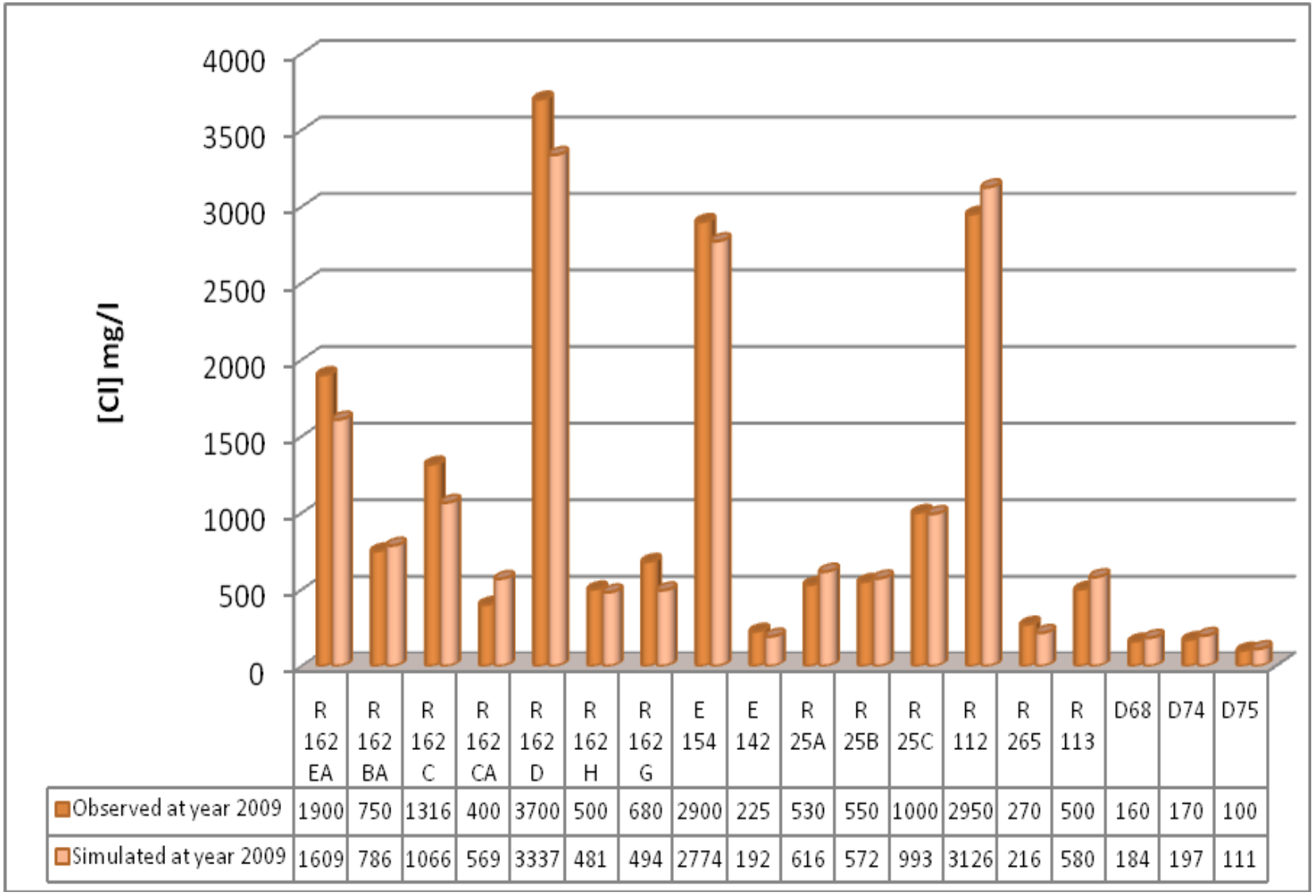
The Studied Scenarios

ID	Description	Q	R	S
Sc. 1	Existing conditions: **(reference scenario)**: continue pumping at the current rate with no consideration of climate change in Q, R and S	No change	No change	No change
Sc. 2	Sensitivity to pumping: take a range for changing pumping rates between -30% and +30% with no consideration of climate change.	Varies by a constant factor	No change	No change
Sc. 3	Impact of sea level rise: take the maximum increase in sea level with the assumption that there is no change in both recharge and pumping rates.	No change	No change	Max. rate

The Studied Scenarios

ID	Description	Q	R	S
Sc. 4	Sensitivity to recharge: take a range for changing recharge rates between -30% and+30% with no consideration of climate change.	No change	Varies by a constant factor	No change
Sc. 5	Extreme impacts of climate change: take the maximum rate of sea level rise and the minimum rate of recharge. No change in pumping rate is considered.	No change	Min. rate	Max. rate
Sc. 6	Management Scenario: decreasing pumping due to the reuse of treated wastewater and desalination to cover agricultural and municipal abstraction, respectively.	decrease	Min. rate	Max. rate

Model Verification

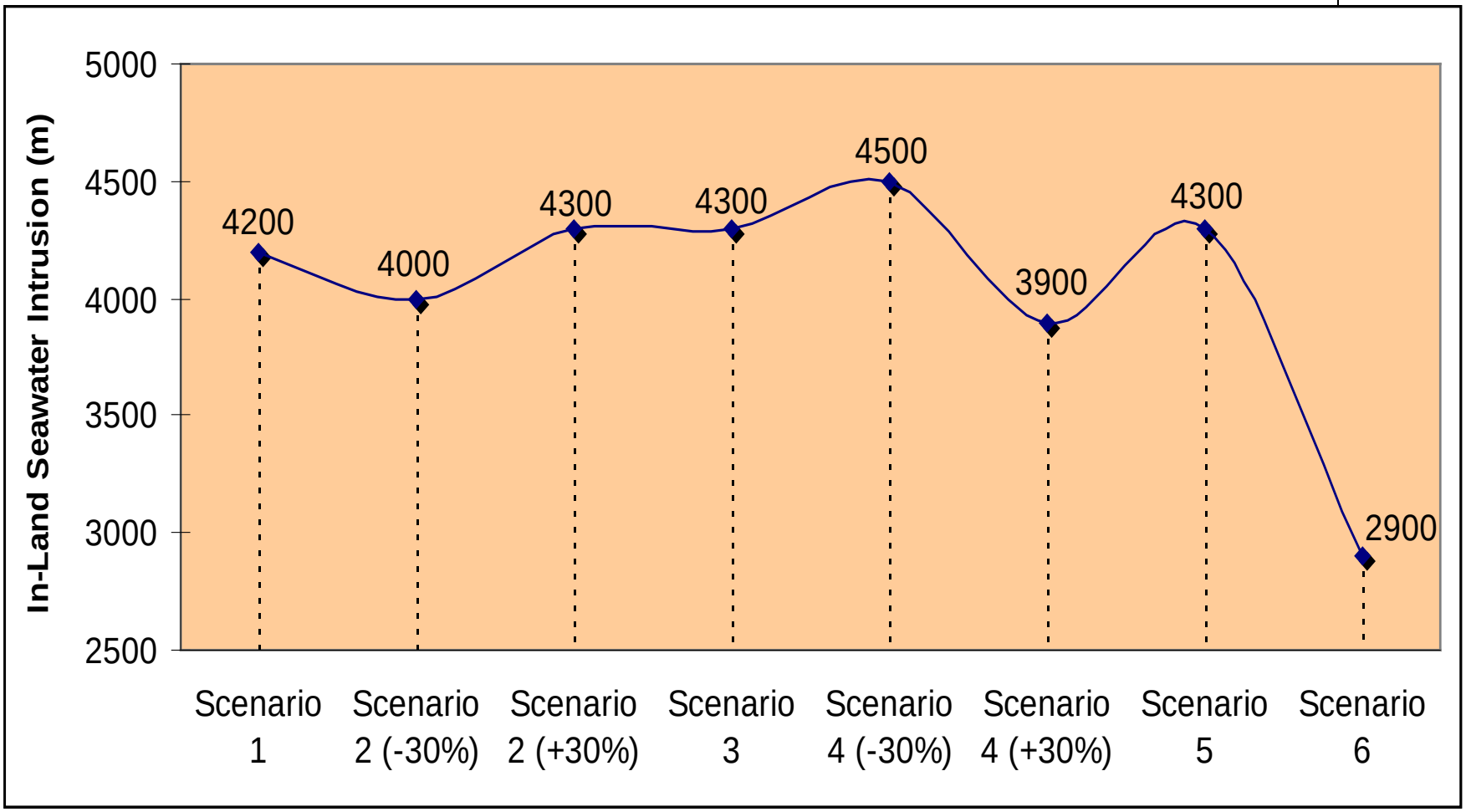


	R 162 EA	R 162 BA	R 162 C	R 162 CA	R 162 D	R 162 H	R 162 G	E 154	E 142	R 25A	R 25B	R 25C	R 112	R 265	R 113	D68	D74	D75
Observed at year 2009	1900	750	1316	400	3700	500	680	2900	225	530	550	1000	2950	270	500	160	170	100
Simulated at year 2009	1609	786	1066	569	3337	481	494	2774	192	616	572	993	3126	216	580	184	197	111

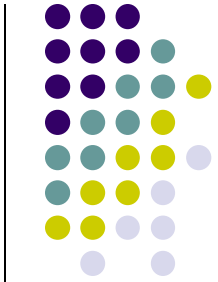
Results

Indicator	Sc. 1 (Existing condition)	Sc. 2 (variable pumping rates)		Sc. 3 (Max. SLR)	Sc. 4 (variable recharge rates)		Sc. 5 (Max. CC impact)	Sc. 6 (Manag. Sc.)
		- 30%	+ 30%		- 30%	+ 30%		
[Cl] extent (m) at year 2035	4,200	4,000	4,300	4,300	4,500	3,900	4,300	2,900
Seawater intrusion (m/yr) at year 2035	65	60	70	70	80	50	70	35
[Cl] (± %) at wells compared to Sc. 1 at year 2035	--	-20% to -43%	7% to 24%	0.2% to 0.5%	8% to 20%	-17% to -30%	3% to 8%	-81% to -99%

Results


In-Land Seawater Intrusion (m)
5000
4500
4000
3500
3000
2500
4200
4000
4300
4300
4500
3900
4300
2900
Scenario 1
Scenario 2 (-30%)
Scenario 2 (+30%)
Scenario 3
Scenario 4 (-30%)
Scenario 4 (+30%)
Scenario 5
Scenario 6

Conclusions



- Continuity of the current situation will cause shutdown of about 50% of the wells.
- Seawater intrusion is more sensitive to recharge decrease than pumping rates increase.
- The outcomes of Sc. 6 confirms the potency of PWA management plan.

Conclusions

- Reuse of treated WW for agriculture use will save ~ 38% of agriculture abstraction.

- Desalinization plants for domestic use will save ~ 55% of municipal abstraction.

Recommendations

- PWA must go ahead in implementing the strategic plan.
- Existing wastewater treatment plants must be developed.
- Random and illegal abstraction must stop immediately.
- Improving the municipalities' water network system (system efficiency).
- Agricultural sector should be managed through efficient use of treated wastewater.

Many Thanks
for Your Attention