هيئة البيئة – أبوظبي

Economic and Engineering Optimization for Groundwater Assessment, Use and Management in Agriculture Sector in GCC Countries

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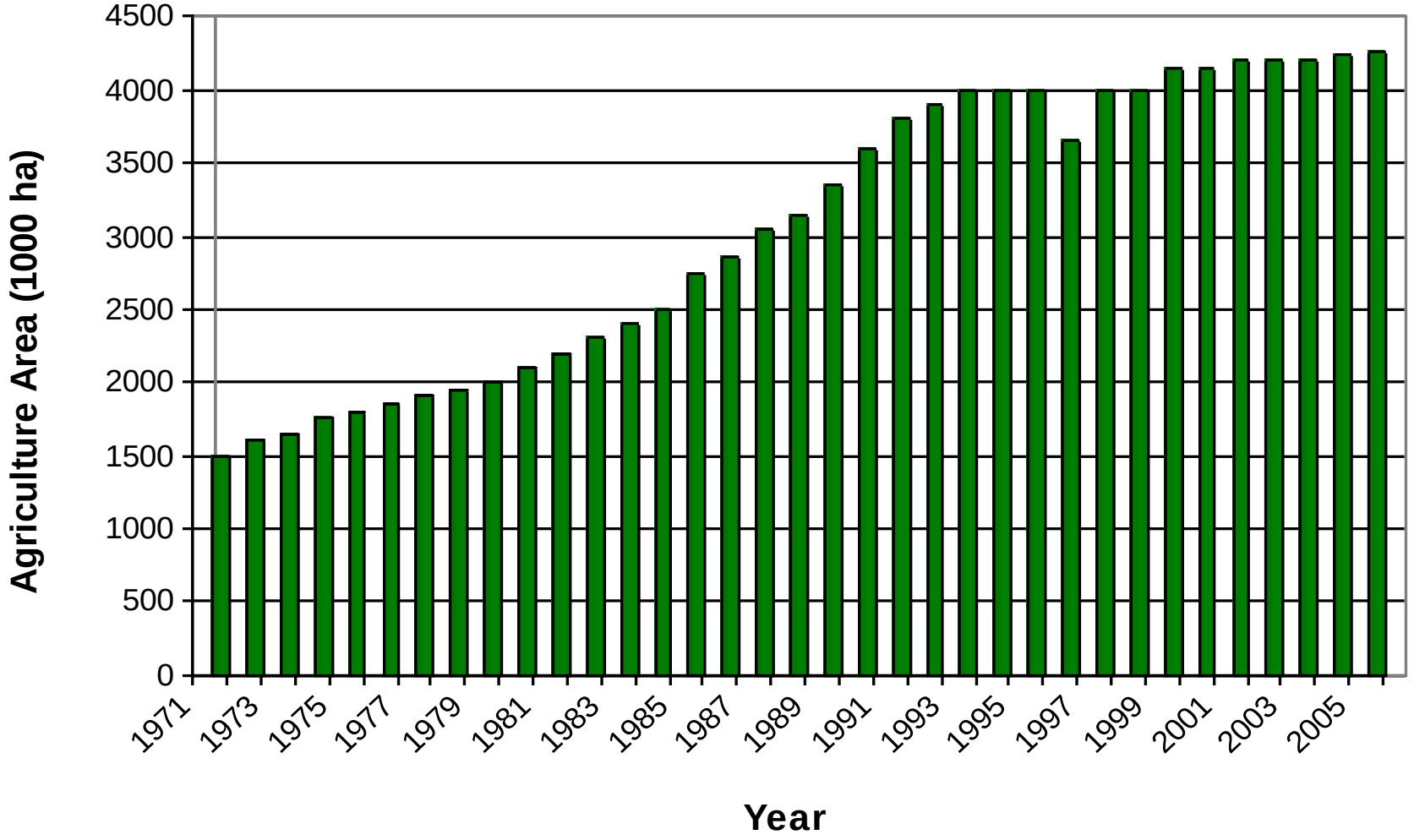
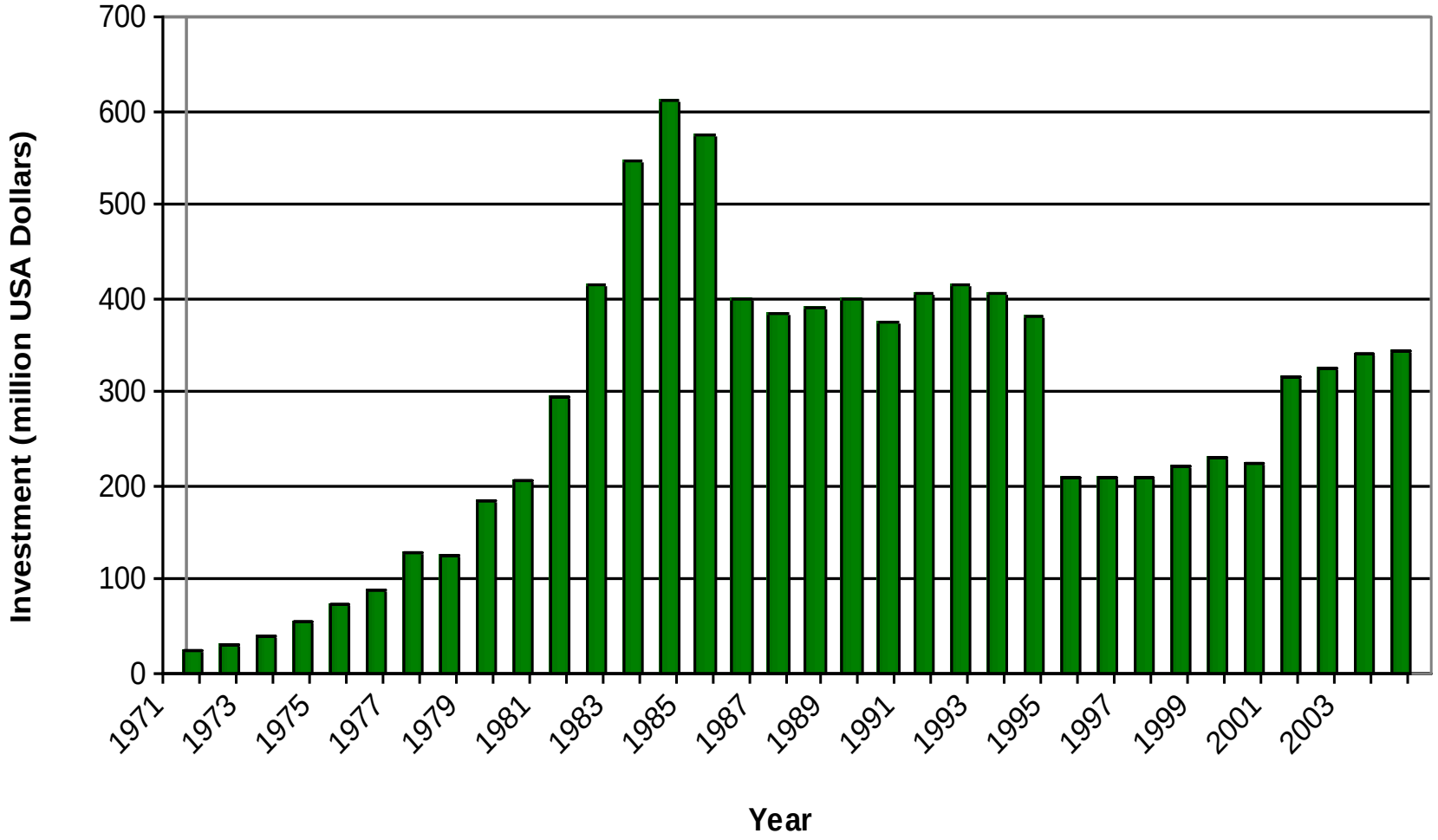
1. General Background (Aridity)

2. Agriculture Development (1970-2006)



3. Investment in Agriculture Sector (1970-2006)



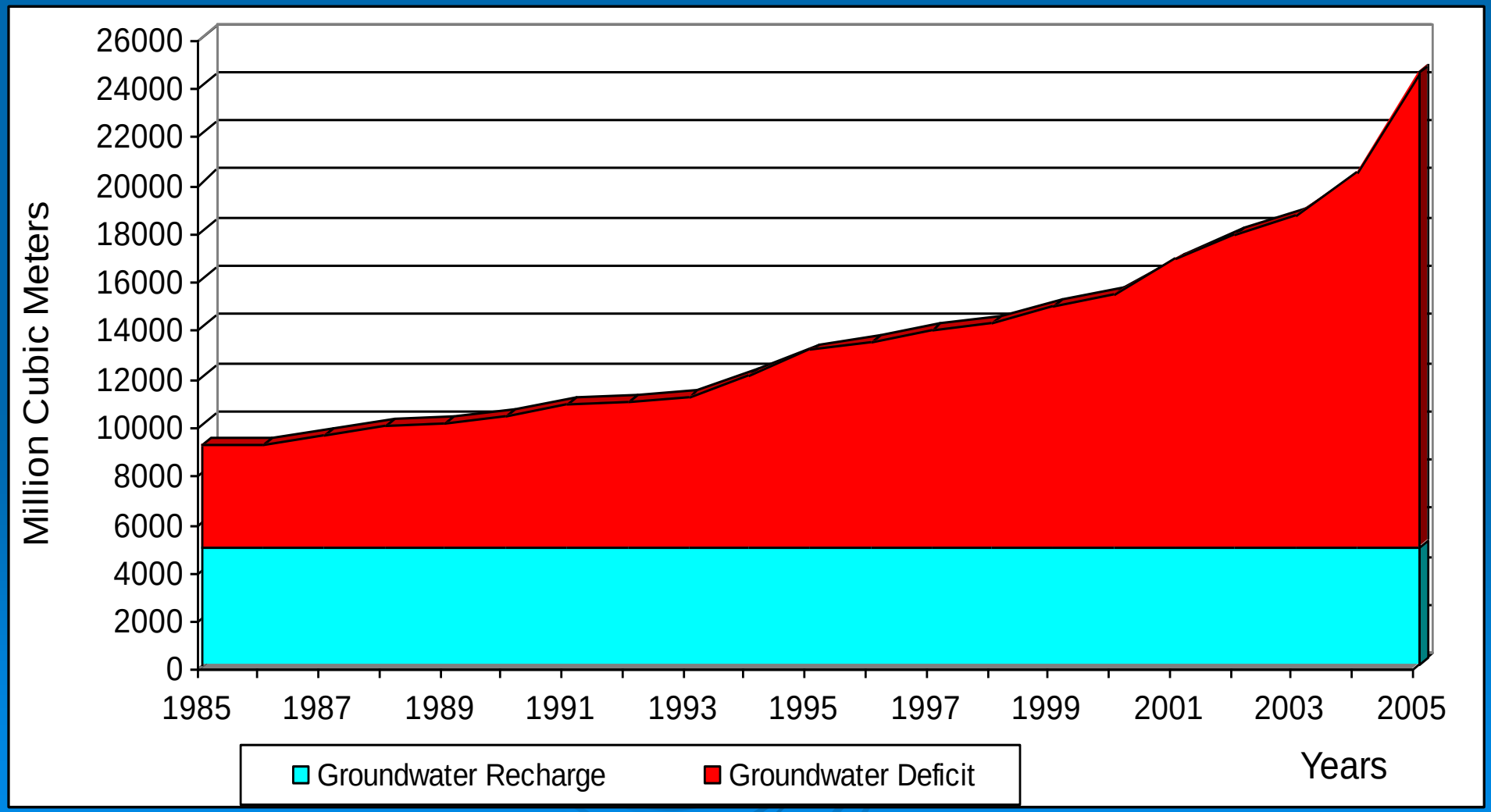
Increase in water use in agriculture sector in GCC countries

Country	Water Use (MCM)				Ration of increase % (1995-2025)
	1995	2000	2005	2025	
Bahrain	115	124	251	290	141
Kuwait	74	110	521	458	472
Oman	1129	1270	1325	1896	65
Qatar	98	185	245	298	173
Saudi Arabia	1489	15000	15854	17320	19
UAE	943	1400	2547	2935	208
Total	17254	18089	20743	23197	36

Agriculture Sector share in GDP.

Country	2005		2005
	Irrigation Water (MCM/Year)	Total Groundwater Abstraction (MCM/Year)	Agriculture GDP share (%)
Bahrain	251	258	0.85
Kuwait	521	405	0.40
Oman	1325	1690	2.81
Qatar	245	185	0.85
KSA	15854	14430	6.23
UAE	2547	2650	3.34
Total	20743	19618	

Increase in groundwater deficit (1985-2005).



Measuring the costs of groundwater use

		Water Supply Costs			Social Opportunities Costs	External Costs
Cost of Groundwater Abstraction	Full Economics	Capital Costs (Fixed Costs)	Operation and Maintenance Costs (O&M Costs)	Resources Administration Costs	Foregone Value of Alternative Uses (Present/Future)	In Situ Value (Cost of Salinity increase, land degradation, drought buffer, ..etc.)
	Paid by Users	Capital Costs (Credit sometimes subsidized)	Operation and Maintenance) (Energy Often subsidized)	Resources Admin. Charges		

frequently not levied or do not cover real costs

ROUGH ESTIMATES OF DIRECT COST OF GROUNDWATER IRRIGATION IN RELATION TO CROP VALUE

- The economic feasibility of groundwater irrigation is mainly conditioned by the crop value.
- High value crops can usually be developed even using low permeability or deep aquifers.
- In most normal aquifers the cost of abstracting groundwater is usually affordable to grow any type of crops.
- These data explain why, in the last decades, the farmers in most arid and semiarid countries have intensively developed groundwater irrigation.

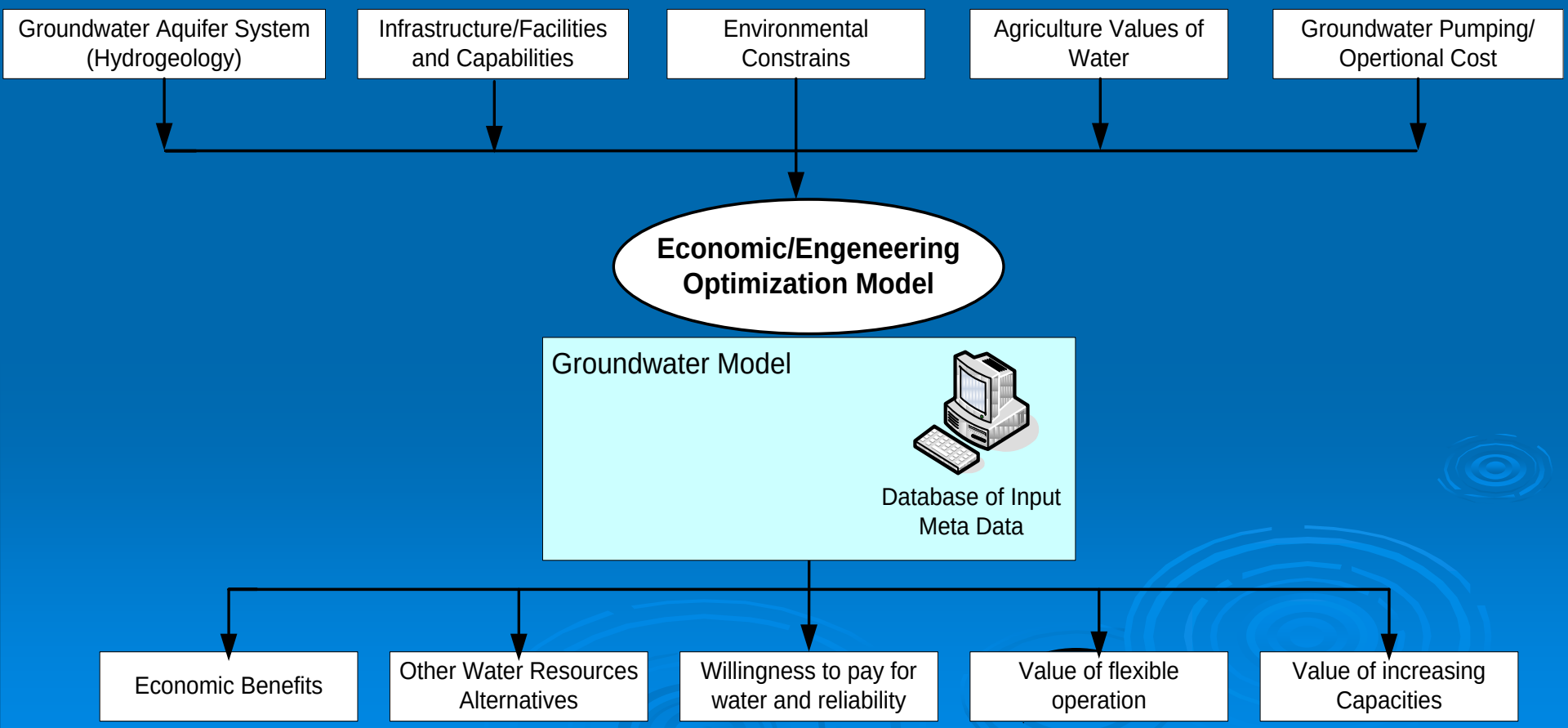
CAUSES OF THIS SPECTACULAR DEVELOPMENT

DRIVING FORCE: ECONOMICS.

- Mostly private initiative, although the initial steps governmental action.
- The full direct cost of abstracting groundwater for irrigation is only a small fraction of the value of the crops grown using groundwater.
- The externalities or the decrease of the in situ value of groundwater are rarely taken into account.

Scientific and technological factors.

Schematic Diagram for the Optimization Process.



Framework for Economic Analysis

- Economic considerations
- Equity considerations
- Intergenerational effects
- Sustainability of resource systems
- Social risk aversion
  - **Economic analysis is used to help organize available information**
  - **Economic analysis should not be the sole determinant of choices**

GROUNDWATER MINING

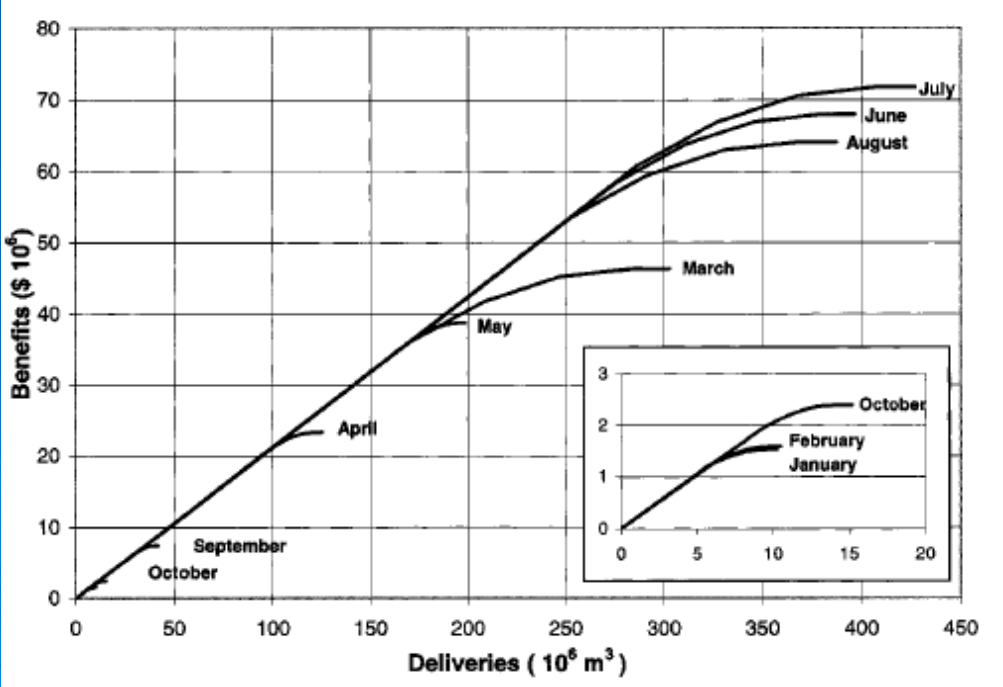
- Essential issue for GCC countries. It must be analyzed in the context of these countries.
- The long-term sustainability: a complex concept.
- Under certain circumstances groundwater mining may be a reasonable option, not necessarily against ethical principles. The following factors should be considered:
  - The mining can be technically and economically maintained for some time (e.g. more than 50 years).
  - The ecological costs are compensated by its socio-economic benefits.
  - To give appropriate information to the users about the present and future situation.

Optimization Model Development

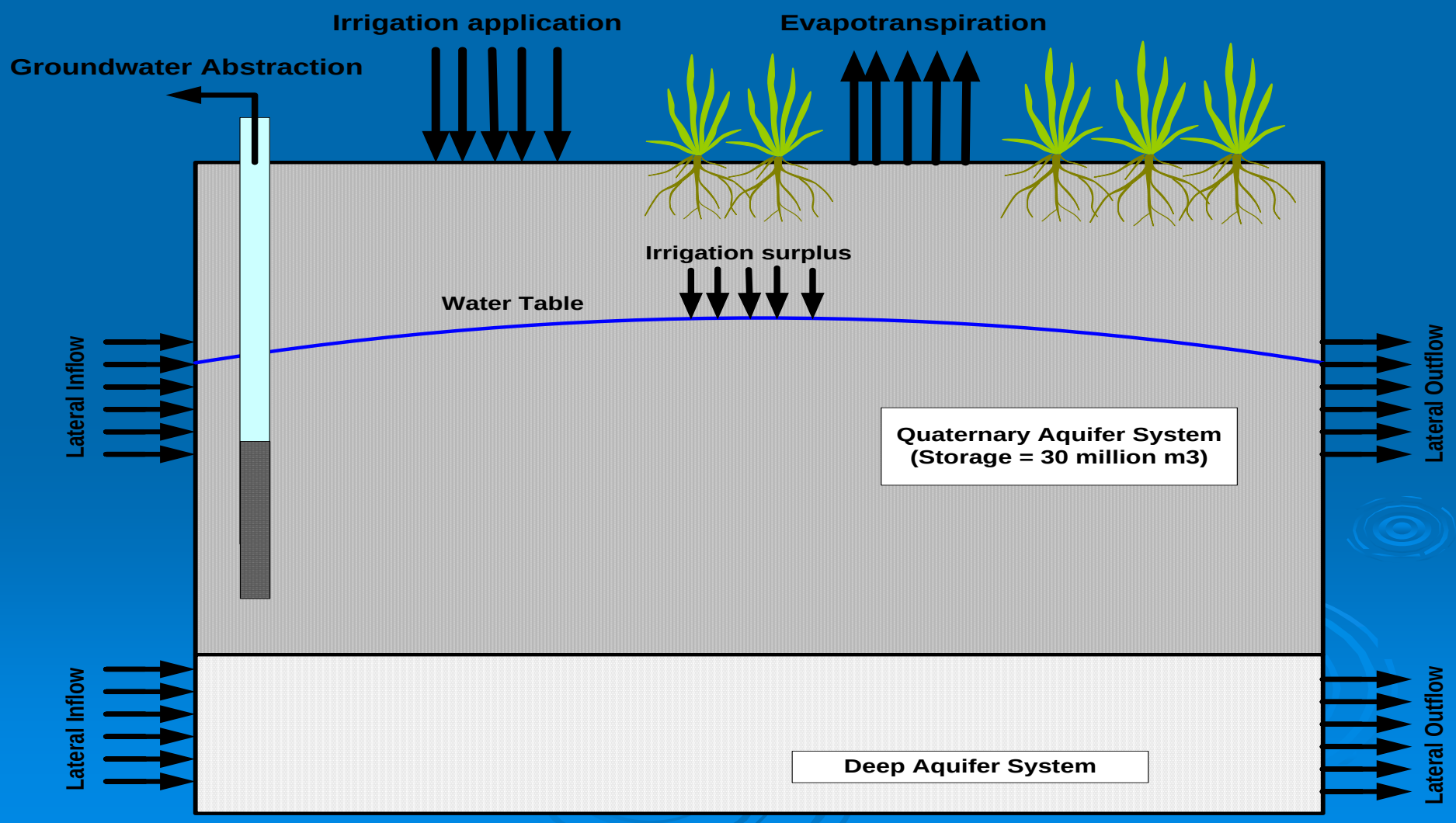
- Management Requirements (Available groundwater resources in terms of quality and quantity, groundwater abstraction cost, aquifer deterioration, ….etc)

- Agricultural Economic Values for Water Use

Example set of agricultural water value functions



Schematic Diagram for the simulated aquifer system



SOME SUGGESTIONS AND CONCLUSIONS

- There is not a *blue print*.
- Transfer of new technology is relevant.
- The driving force of the intensive development of groundwater for irrigation is the low economic cost of its abstraction in relation to the value of crops.
- Reduction of perverse subsidies is also relevant, but requires time, education, transparency and public participation.
- Institutions for collective surface water management have a long tradition in the region. This may facilitate the set up of similar institutions for groundwater management.

Water Use Efficiency Improvement Measures

Increasing the Re-use of Treated Wastewater

Achieving Sustainable Aquifer Management

Water Laws, Regulation and Legal Reform

Thanks