1st Teaching Workshop on Environmental Economics

for the Middle East and North Africa

December 5-16, 2005 - ICTP, Trieste, Italy

Global Water Concerns

Lecture I.1

Yacov Tsur

The Hebrew University of Jerusalem

Global Water Concerns

Lecture I.1

Yacov Tsur

The Hebrew University of Jerusalem

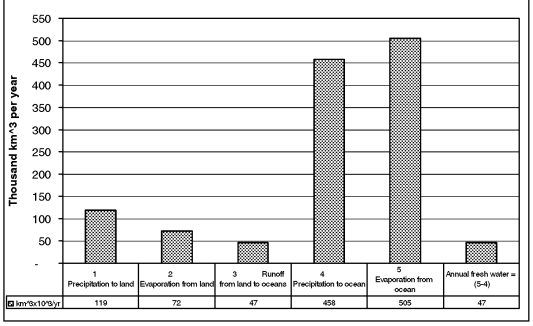
1st Teaching Workshop on Environmental Economics for the Middle East and North Africa

December 5-16, 2005 - ICTP, Trieste, Italy

1

Global water cycle

Figure 2.1: Global Hydrologic Cycle



Population trends and water

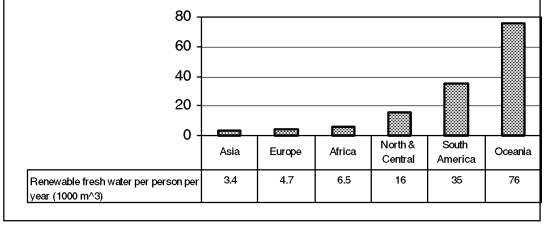
- Global world population have grown from
- 1Billion people in 1800 to
- 2.5 Billion in1950 to
- 6 Billion in 2000 to ?
- 11 Billion ? 17 Billion ? 6 Billion in 2100
- With population growth came

Increase in water use per Capita

3

Water per capita -- continents

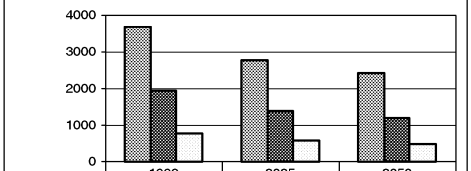
Figure 1.2: 1993 Global Fresh Water Distribution (1000 m^3 per person per year)



4

Water per capita: Asia – India – Tamil Nadu

Figure 1.3: Renewable Fresh Water per Capita (m^3/yr)

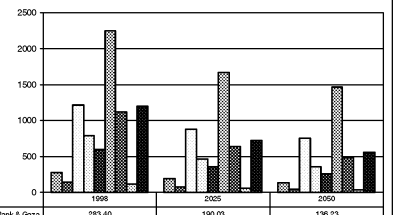


	1998	2025	2050
Asia	3679.91	2760.13	2426.56
India	1931.57	1390.77	1207.04
Tamil Nadu	787.56	567.06	492.15

5

Water per capita – Middle East

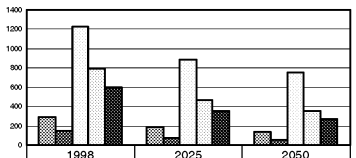
Figure 1.4: Middle East's Renewable Fresh Water per Capita (m^3/yr)



	1998	2025	2050
Israel, W.Bank & Gaza	283.40	190.03	136.23
Jordan	147.75	73.99	52.79
Lebanon	1221.04	881.56	751.59
Syria	795.57	463.83	354.00
Iraq	594.77	353.89	264.65
Turkey	2245.82	1669.17	1462.55
Iran	1116.94	636.25	479.24
Saudi Arabia	118.77	56.65	40.13
Middle East	1198.79	727.96	561.51

Water per capita: Jordan Basin

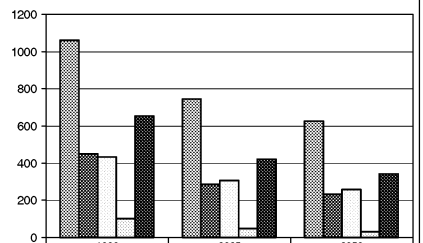
Figure 1.5: JRB Renewable Fresh Water per Capita (m^3/yr)



	1998	2025	2050
Israel, W. Bank & Gaza	283.40	190.03	136.23
Jordan	147.75	73.99	52.79
Lebanon	1221.04	881.56	751.59
Syria	795.57	463.83	354.00
Basin	594.77	353.89	264.65

Water per capita: Maghreb

Figure 1.6: Maghreb's Renewable Fresh Water per Capita (m^3/yr)

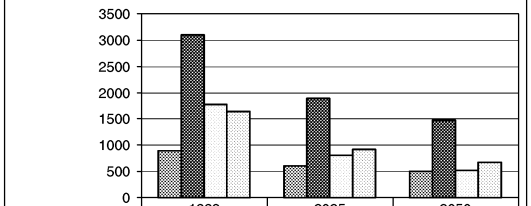


	1998	2025	2050
Morocco	1060	744	628
Algiria	450	287	230
Tunisia	434	305	259
Lybia	100	47	31
Maghreb	651	422	340

8

Water per capita: North East Africa

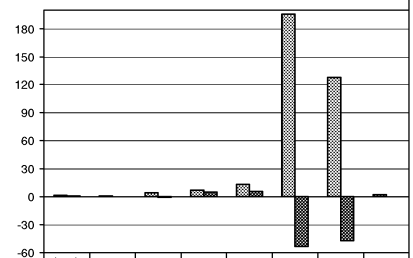
Figure 1.7: North-East Africa Renewable Fresh Water per Capita (m^3/yr)



	1998	2025	2050
Egypt	888	609	505
Sudan	3102	1889	1476
Ethiopia	1771	807	517
North-East Africa	1643	921	662

Joint water: Middle East

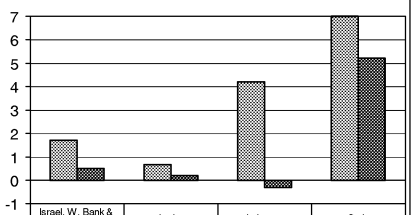
Middle East renewable fresh water resources (km^3/yr)



	Israel, W.Bank & Gaza	Jordan	Lebanon	Syria	Iraq	Turkey	Iran	Saudi Arabia
Internal renewable fresh water (km^3/yr)	1.70	0.68	4.20	7.00	13.58	196	128.200	2.4
Net river flow: inflow minus outflow (km^3/	0.50	0.20	-0.30	5.20	5.60	-52.8	-46.60	0

Joint water: Jordan Basin

Jordan River basin's renewablr fresh water resources (km^3/yr)



	Israel, W. Bank & Gaza	Jordan	Lebanon	Syria
Internal renewable fresh water resources (km^3/yr)	1.70	0.68	4.20	7.00
Net river flow: inflow minus outflow (km^3/yr)	0.50	0.20	-0.30	5.20

11

Dimensions of water

- Source -surface vs. ground
- Strategic decision
  - Supply expansion
  - Demand management
  - Quality control
- Allocation system -queuing vs. pricing vs. markets
- Consumptive Use — Non consumptive use
  - Agricultural-major use — Environmental
  - Industrial — Hydro
  - Municipal — Recreational

12

Benefits of irrigation

Irrigation allowed us to overcome population growth

Irrigated land has increased from 50 mha (million hectares) in 1900 to 267 mha today.

Between 1962 and 1996 the irrigated area in developing countries increased at 2% annually.

- The 17% irrigated land produces 40% of global food
- The value of output of irrigated cropland is about $625/ha/year ($95/ha/year for rain-fed cropland and $17.50/ha/year for rangelands).
- High productivity of agriculture slowed expansion of deforestation.

Water supply limits

- Water consumption in 2000 is 4-5 times as in 1950
- Most "economical" sources of water diversion are used
- Will need more water to accommodate more people
- There is appreciation for environmental services of water

14

More bad news

- **Environmental cost** - lose of habitat
- **Increase of water and land salinity**

  Soil Salinity reduce productivity of 20% of irrigated land 1.5 million hectares of these lands are deserted annually
- *Water logging Costs $11 Billion annually*
- ***Ground water depletion***
  - 8% of India's food produced with depleted aquifers
  - In 1973, 3% of India's groundwater pumped below 10 meters in 1994 46%.

15

Social Concerns

- **Water born diseases**
  - kill 4-5 million annually
- **Displacement**
  - 40 – 80 million people has been displaced 1950-99.
- **International conflicts and water supply**

16

References for Tsur's lectures

Tsur, Y. Economic Aspects of Irrigation Water Pricing, 2005, *Canadian Water Resources Journal*, 30(1), 31-46.

Tsur, Y. and A. Zemel, 2004. Endangered aquifers: Groundwater Management under Threats of Catastrophic Events, *Water Resources Research*, 40 (W06S20).

Tsur, Y., Roe, T., Doukkali, R. and Dinar, A. 2004. *Pricing Irrigation Water: Principles and Cases from Developing Countries,* RFF Press, Washington D.C.

Shani, U., Y. Tsur and A. Zemel, 2004. Optimal Dynamic Irrigation Schemes *Optimal Control Applications and Methods*, 25 (2), 91-106.

Tsur, Y. and T. Graham-Tomasi. 1991. The buffer value of groundwater with stochastic surface water supplies, Journal of Environmental Economics and Management 21, 811-818.

Tsur, Y. 1990. The stabilization value of groundwater when surface water supplies are uncertain: The implications for groundwater development, Water Resources Research, 26, 811-818.