

# Overview of Water Resources and Water Pollution

Nadim Farajalla, PhD

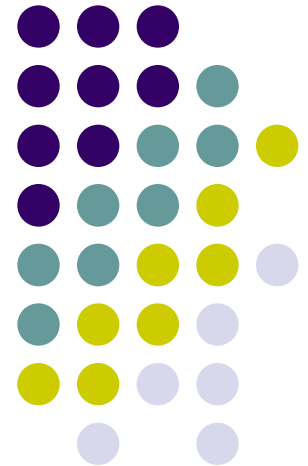
*Director*

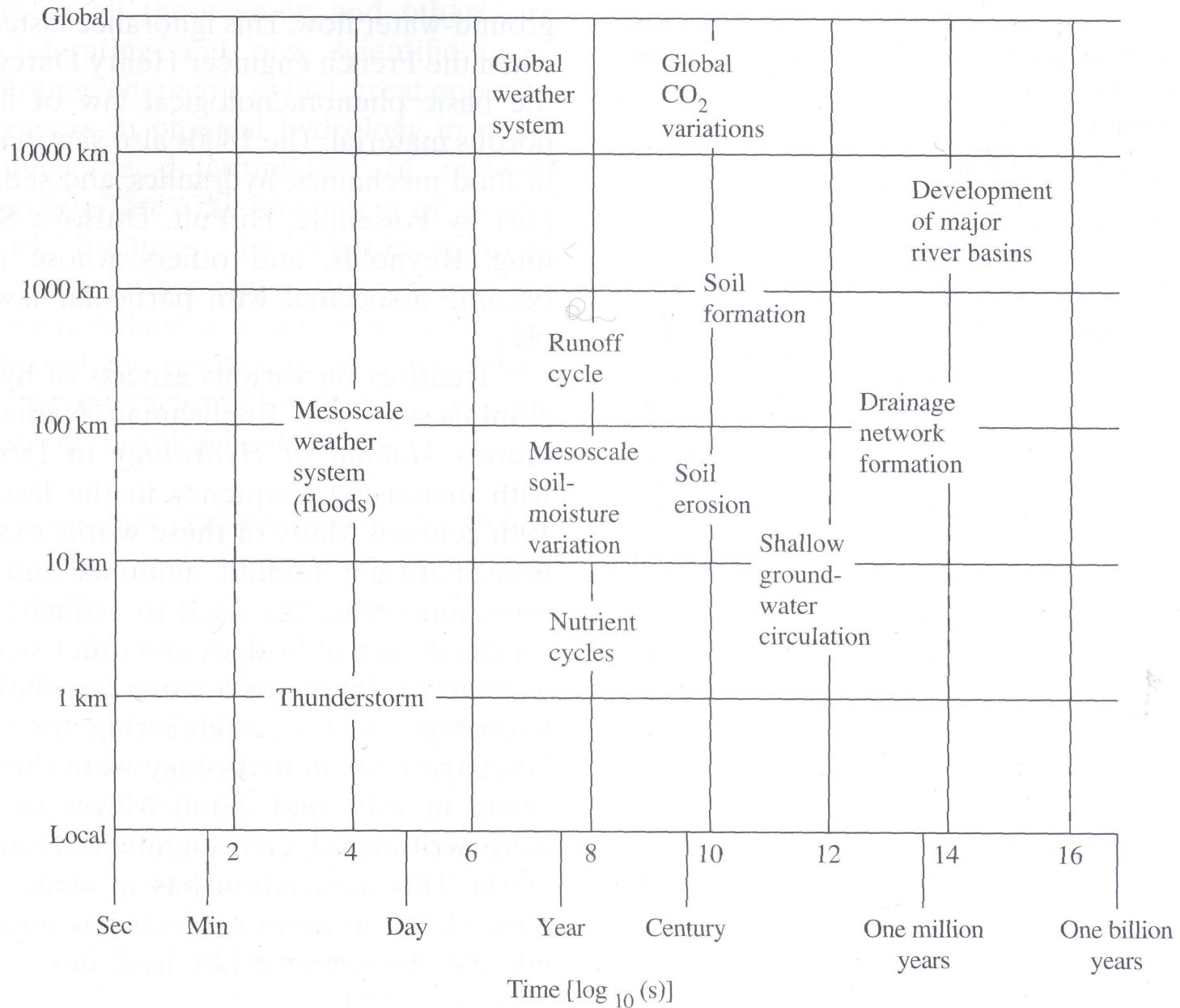
Climate Change and Environment Program

Issam Fares Institute for Public Policy and

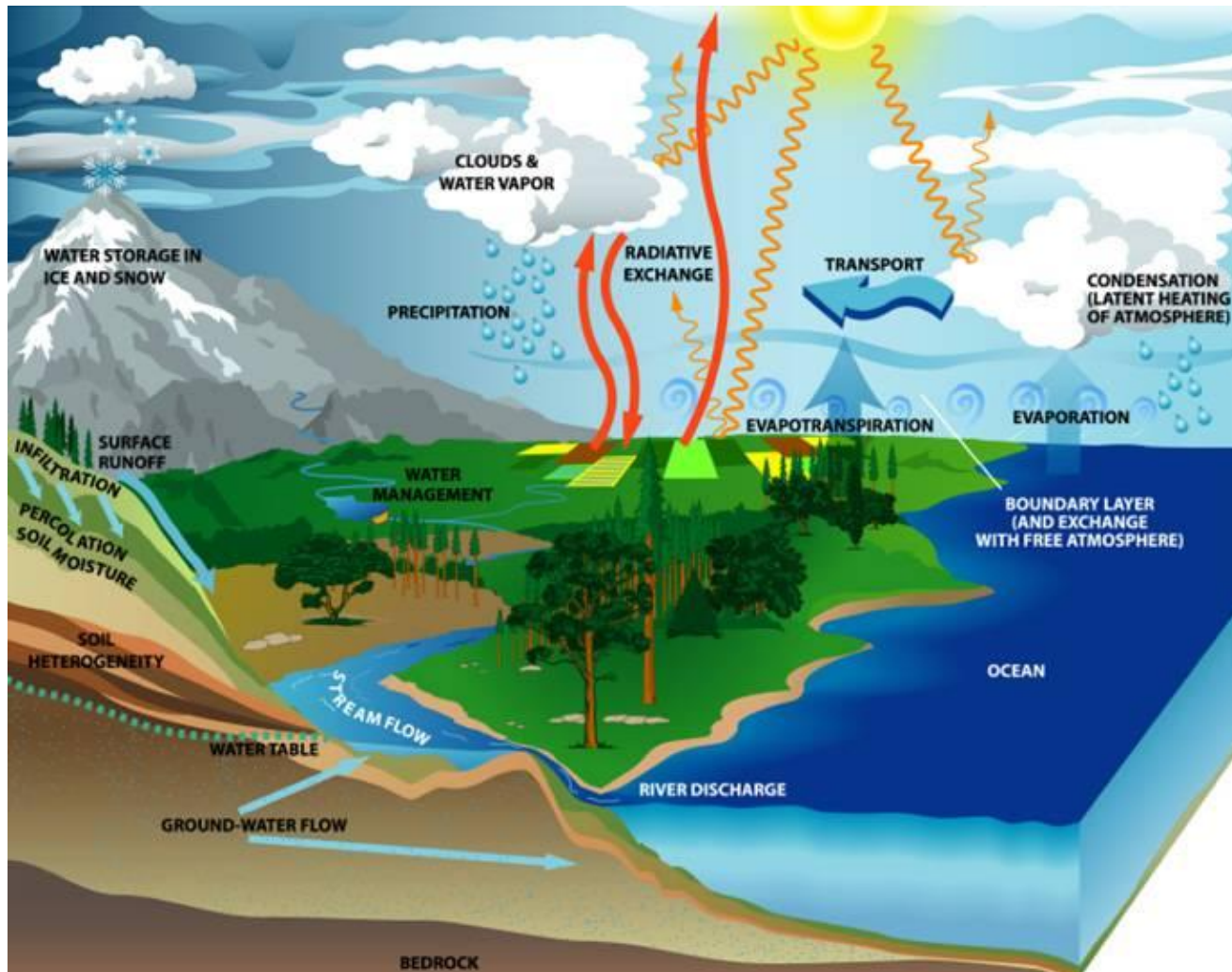
International Affairs

American University of Beirut





# Hydrologic Cycle



# Surface Water Sources

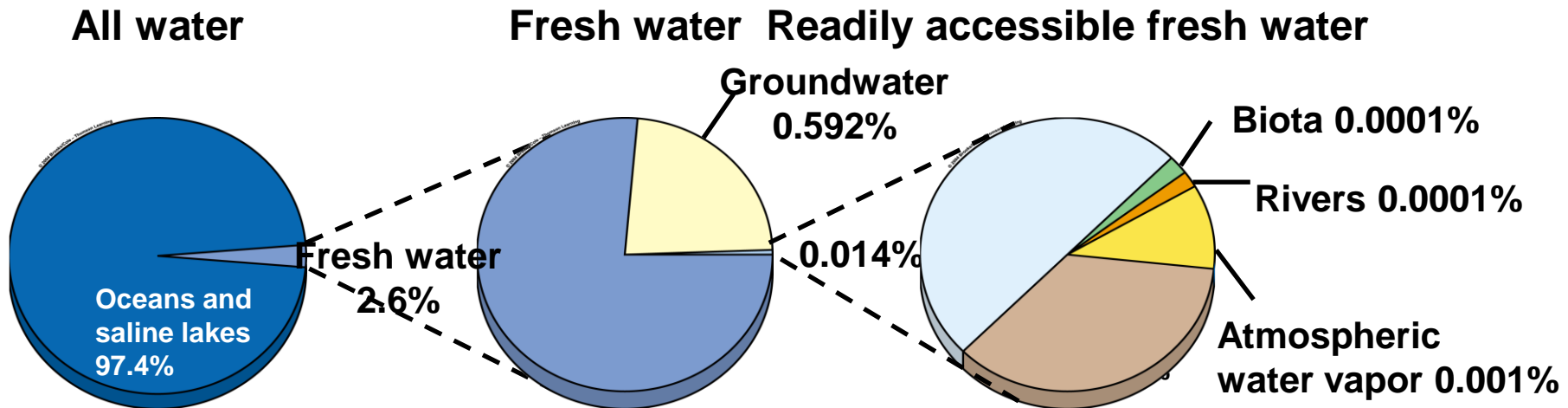




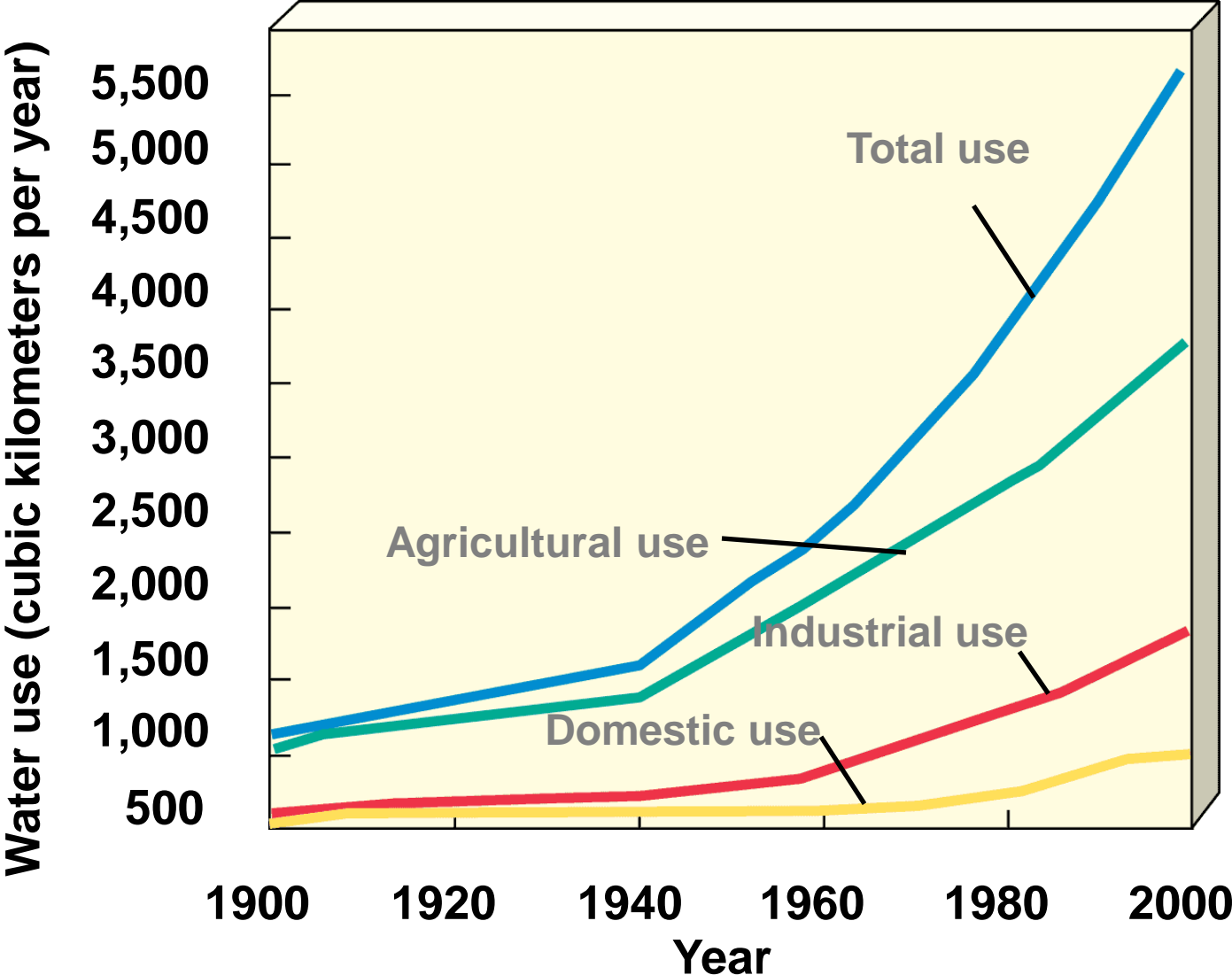
# Groundwater Source



# Global Water Distribution



# Global Water Use

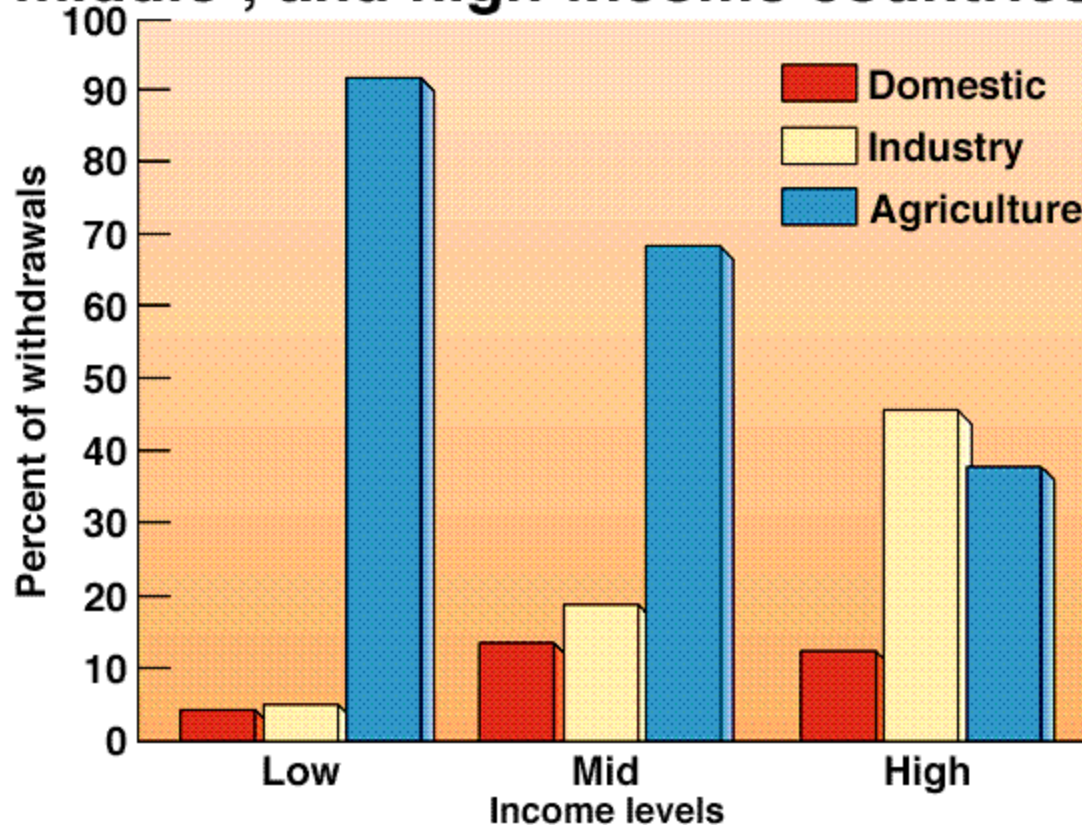




# Global Water Use

Cunningham/Saigo, *Environmental Science, A Global Concern*, 5th ed. © 1999 The McGraw-Hill Companies, Inc. All rights reserved.

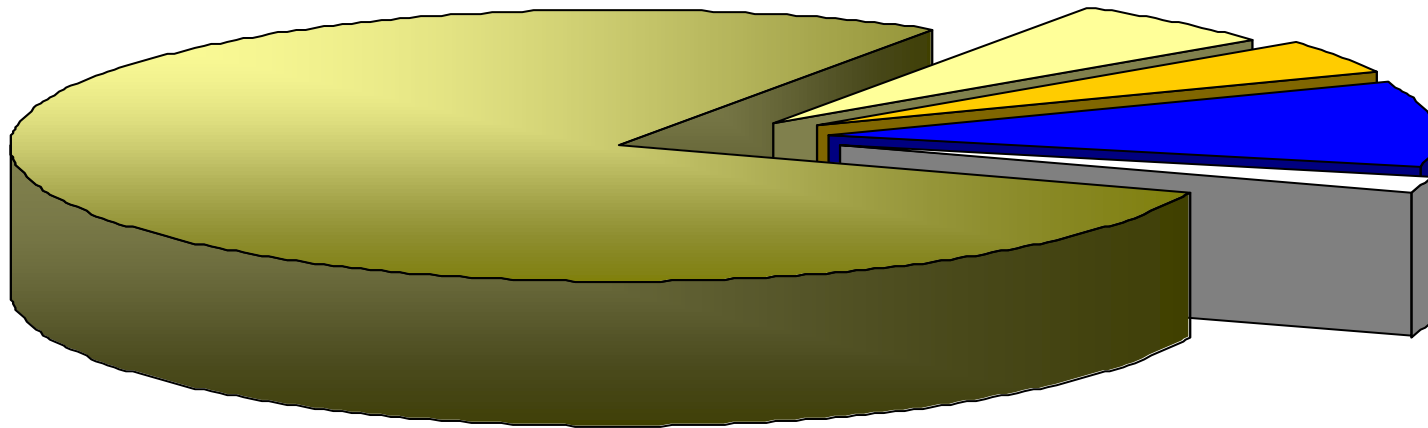
## Water withdrawals by sector in low-, middle-, and high-income countries.







# Global Water Use



■ Agriculture 78%

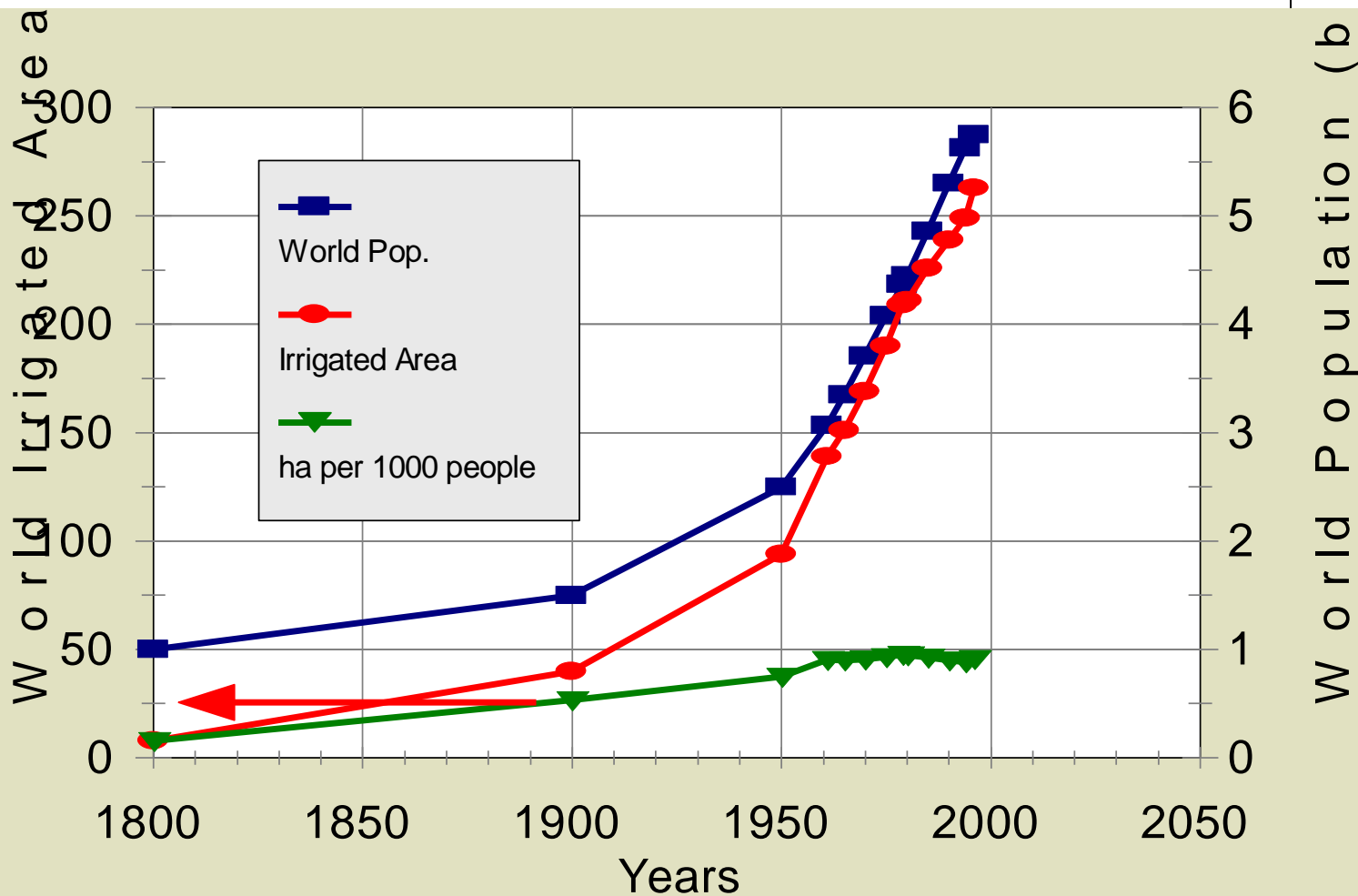
■ Municipal 6%

■ Industrial 4%

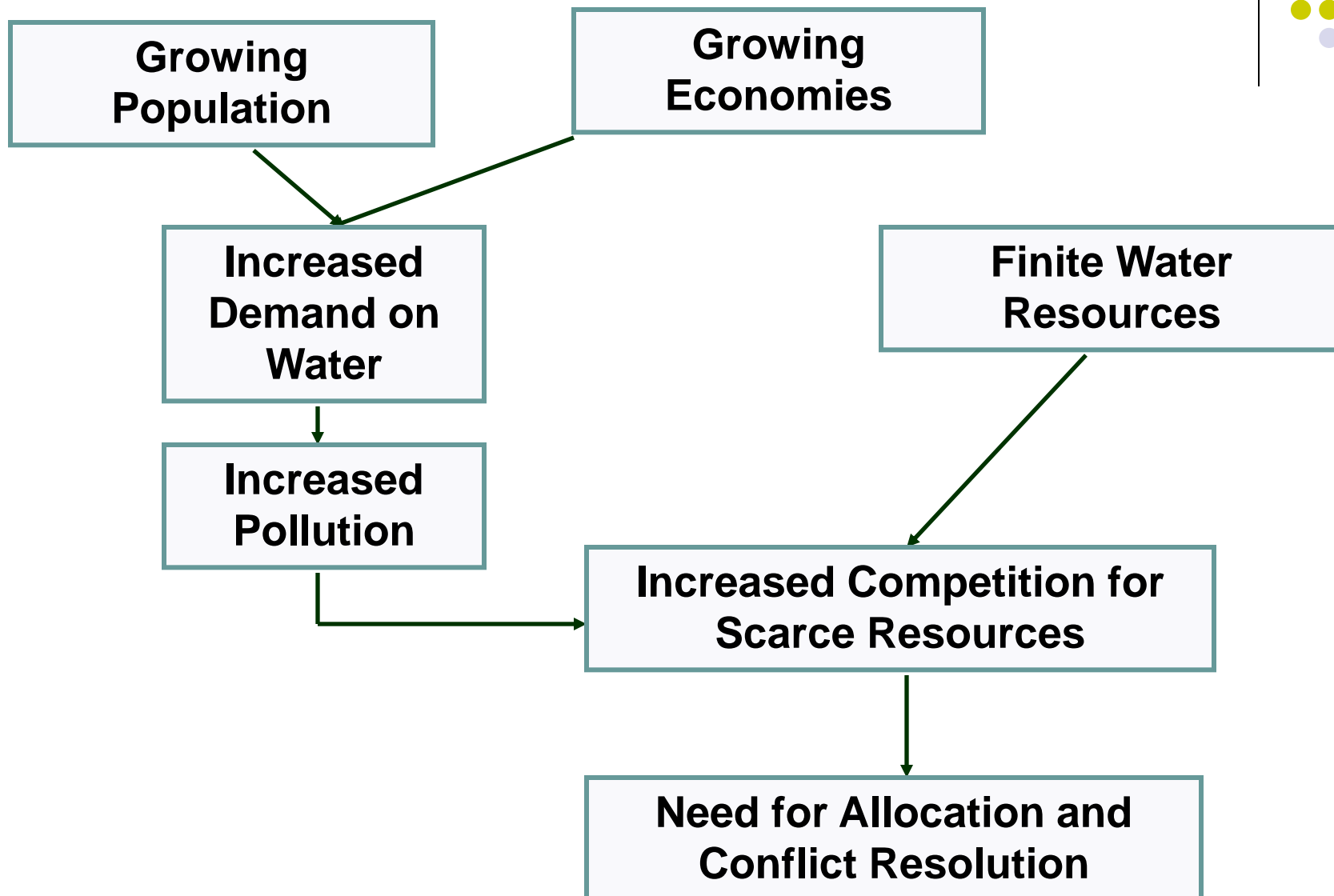
■ Environ. Flows 10%

□ Open water evap. 2%

# Global Water Use



# Water Resources Under Increased Pressure



# Regional Perspective



- Water shortages now plague almost every country in North Africa and the Middle East

# Water Use in ESCWA Countries: 1995 - 2015



<b>Domestic (%)</b>	<b>Agricultural (%)</b>	<b>Industrial (%)</b>
<b>7.5</b>	<b>87.8</b>	<b>4.7</b>
<b>7.7</b>	<b>83.2</b>	<b>9.1</b>
<b>12.2</b>	<b>77.6</b>	<b>10.2</b>





# Facts and Figures

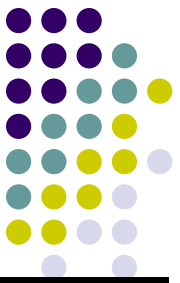
- **Water Stress:  $< 1700 \text{ m}^3/\text{person}/\text{year}$**   
shortage will be local and infrequent
- **Water Scarcity:  $< 1000 \text{ m}^3/\text{person}/\text{year}$**   
shortage will hamper health, economic development,  
and general human well being
- **Severe Water Scarcity:  $< 500 \text{ m}^3/\text{person}/\text{year}$**   
water availability will be primary constraint to life



# Facts and Figures

- The top ten countries with the least amount of available water:
  1. Kuwait (10 m<sup>3</sup>/capita/year)
  2. Gaza Strip (52 m<sup>3</sup>/capita/year)
  3. UAE (58 m<sup>3</sup>/capita/year)
  4. Bahamas (66 m<sup>3</sup>/capita/year)
  5. Qatar (94 m<sup>3</sup>/capita/year)
  6. Maldives (103 m<sup>3</sup>/capita/year)
  7. Libya (113 m<sup>3</sup>/capita/year)
  8. Saudi Arabia (118 m<sup>3</sup>/capita/year)
  9. Malta (129 m<sup>3</sup>/capita/year)
  10. Singapore (149 m<sup>3</sup>/capita/year)

# Water Use in ESCWA Countries



Country	Supply Used Annually (%)
Libya	374
United Arab Emirates	300
Qatar	174
Saudi Arabia	164
Yemen	136
Bahrain	>100
Israel	>100
Jordan	>100
Kuwait	>100
Oman	>100



# Facts and Figures

- 507 water conflict incidents have been documented.
- 21 led to military action - 18 involved Israel and its neighbors



# Problems in the Water Sector

- Natural water scarcity – aridity of region
- Absence of national plans and policies for water resource management and use
- Outdated water legislation and non-existent enforcement mechanisms - lack of political will
- Fragmented water institutions and ineffective coordination of related water activities at the national level



# Problems in the Water Sector



- Data availability – general lack of credible data on quantity and quality of water resources
- Unreliable forecasts on water demand
- Lack of awareness for the rational use and management of water resources
- Poor human capacity at institutions
- Old fashioned – traditional approach to water resources management (focus on source development)



# Water Quality

# Water Pollution Pathways



# Types of Pollution Sources



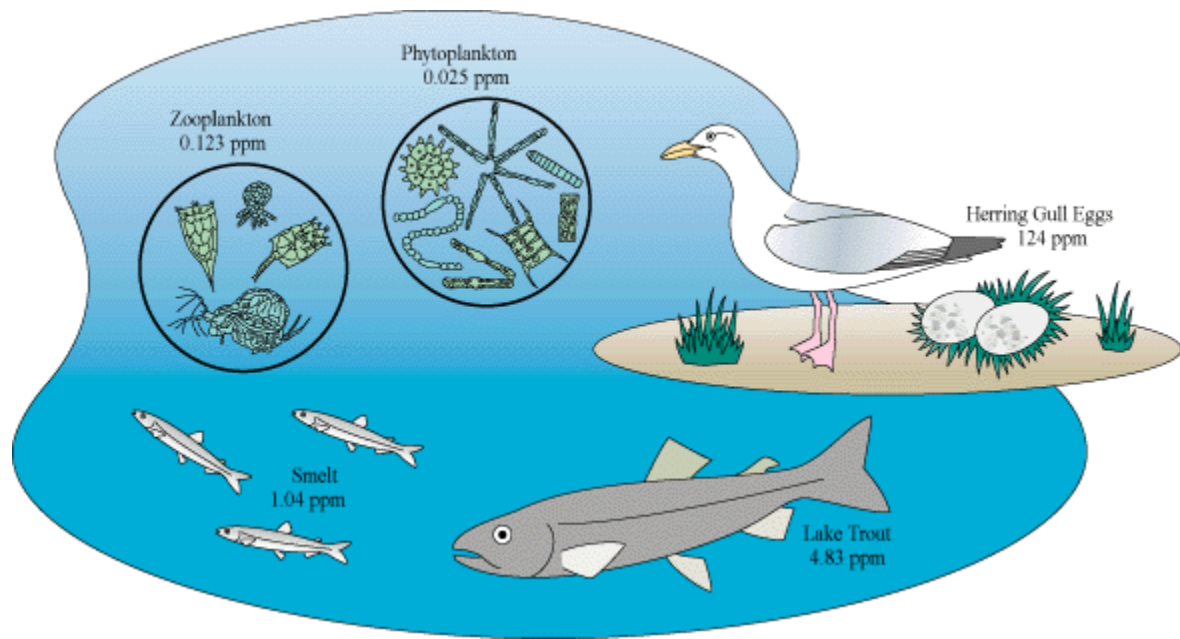
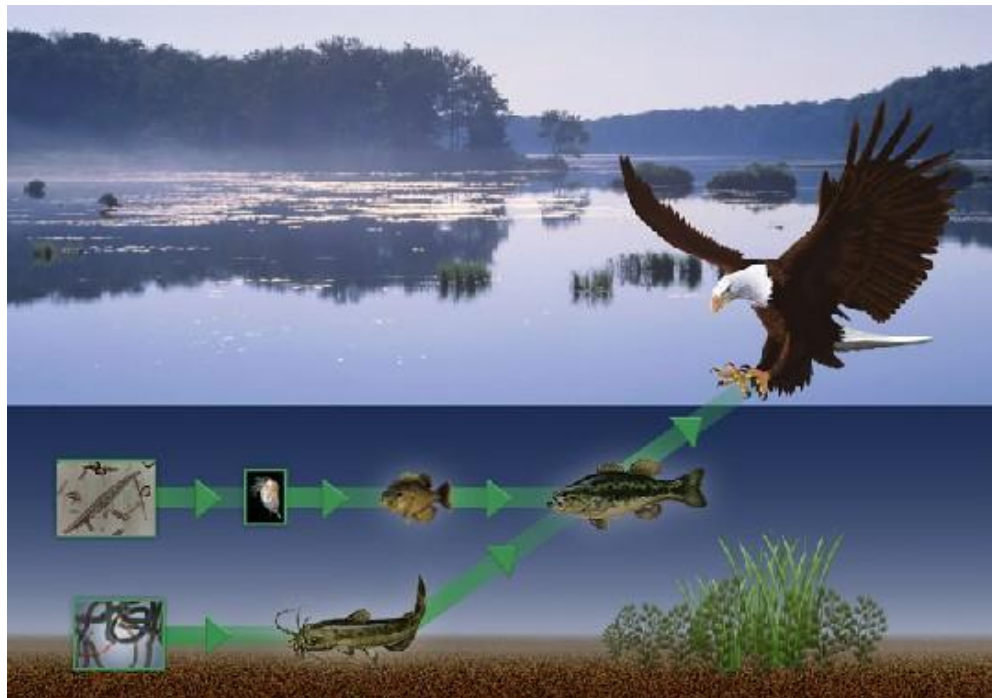
- Point Sources: i.e. discharge from factories, sewage treatment facilities, etc. Mitigation and treatment are relatively easy and straightforward – but expensive
- Nonpoint Sources of Pollution (NPS): diffuse in nature, typically from agricultural fields, roadways etc. Mitigation and treatment are more complex but may be cheaper in the long run.

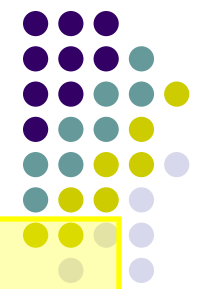


# Types of Pollution Sources

- Uncontrolled extraction of river water
- Dumping of solid waste: household waste, factory waste, animal carcasses, etc.
- Infringement on the riparian zone: building in the flood plain, building in the river itself,
- Discharge of industrial or household effluent







- Leakage and Leaching of untreated municipal waste-water
- Seepage and run-off of agro-chemicals
- Sea water intrusion into coastal aquifers

**Surface and Groundwater Pollution**

- Seepage from unsanitary landfills
- Water-logging in some irrigated areas
- Untreated industrial effluents discharged into municipal sewer systems



## Water Pollution

**Impact on Health**

## Water-Related Diseases

Four types of categories:

1. Water-borne disease, relate to water as agent of disease transmission
2. Water-washed disease, relate to inadequate sanitation or contact with contaminated water
3. Water-based disease, relate to hosts in water
4. Water-related insect vector relate to disease entities that spread by insects

**Water-related diseases are in the order of 250 million cases annually with 5 to 10 million deaths**

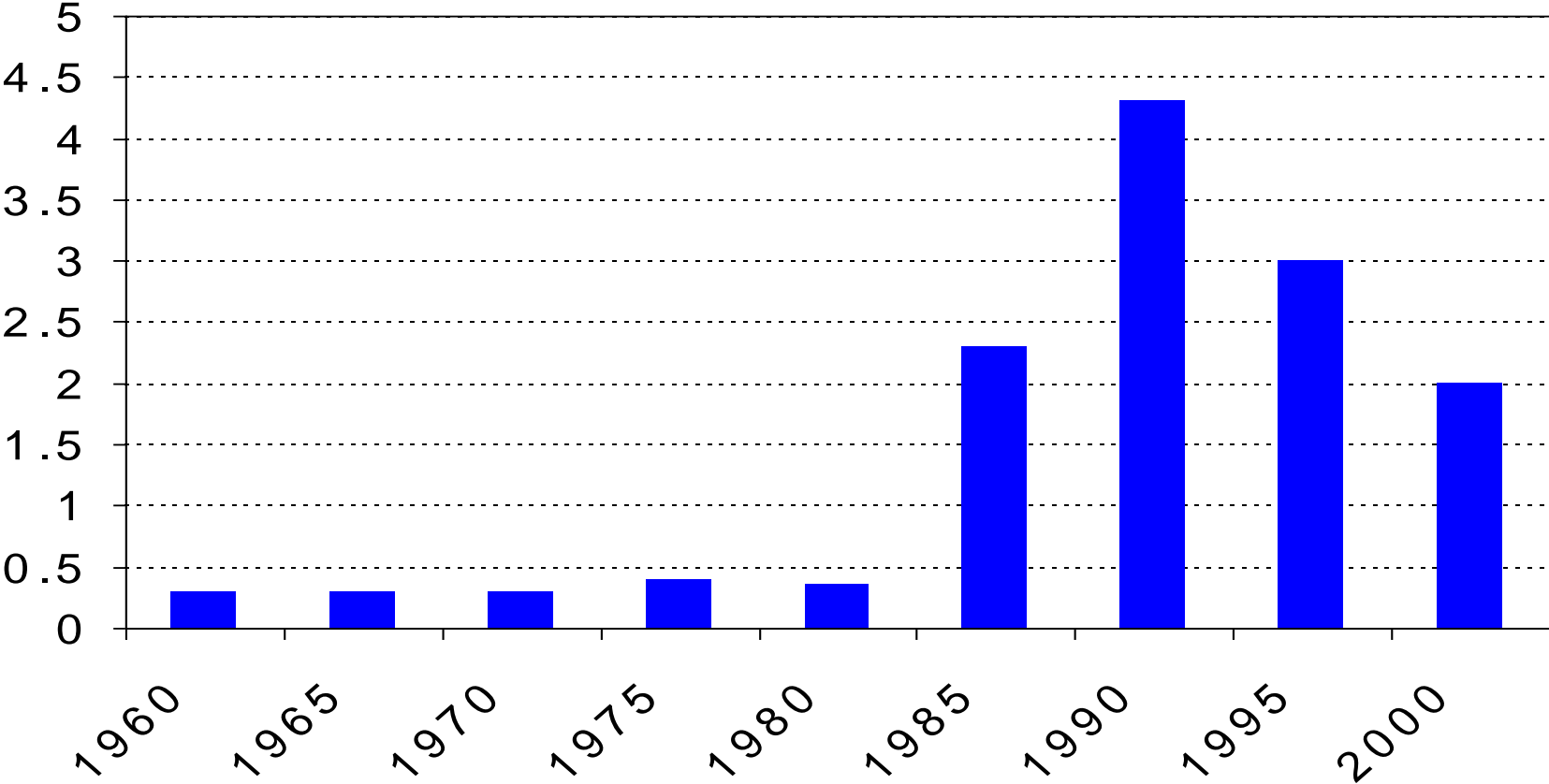


# Problems – Quality and Quantity



**.....on the planning side**

# Grain Production in Saudi Arabia



# Grain Production in Saudi Arabia



# Water Development Projects – the Aral Sea



- The greatest environmental catastrophe ever recorded.
- Once the fourth largest lake in the world, the Aral Sea began shrinking in the 1960s.
- The Soviet Union diverted the waters from two of its feeders to irrigate the cotton crops of Kazakhstan and Uzbekistan.
- During the 1980s, several years passed in which little or no water reached the Aral Sea.
- The lake began to quickly evaporate and shrink. Eventually splitting into two sections.
- Today the inland sea covers about half of its former area and its water volume has decreased by about 75 percent.

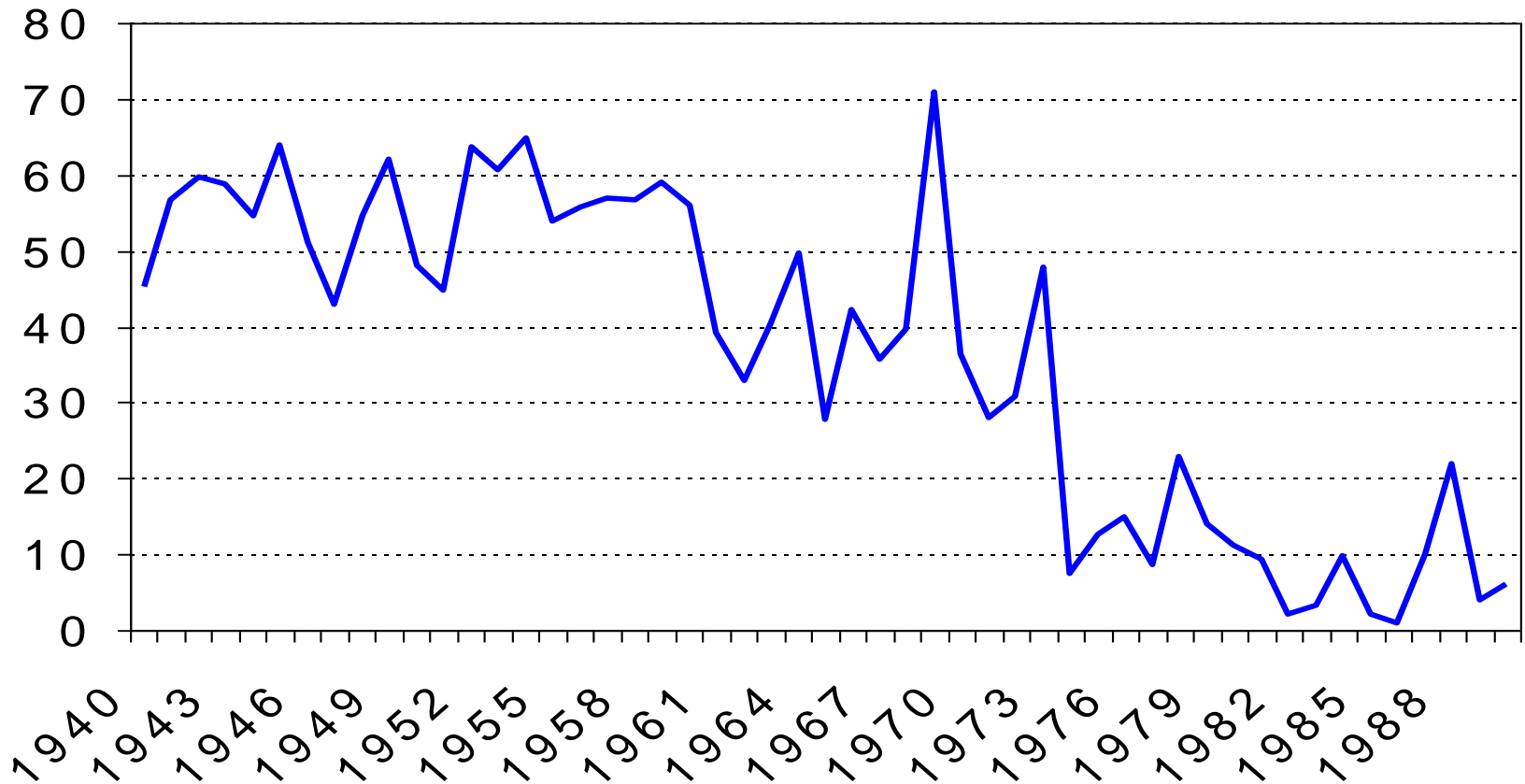


# Water Development Projects – the Aral Sea



- The salinity of the lake's waters has tripled, killing plant and animal life.
- As it recedes, the lake leaves behind a harmful layer of chemical pesticides and natural salts. Blown into noxious dust storms, seriously affecting the health of the people who live in the area.
- Cancer and respiratory diseases have increased, as have infant mortality rates.
- The fishing industry, which once employed thousands of people, has been destroyed.
- The climate has even been affected.
  - Summer and winter temperatures have become more extreme.

# River Flow Into the Aral Sea, 1940-90 (in billions of cubic meters)





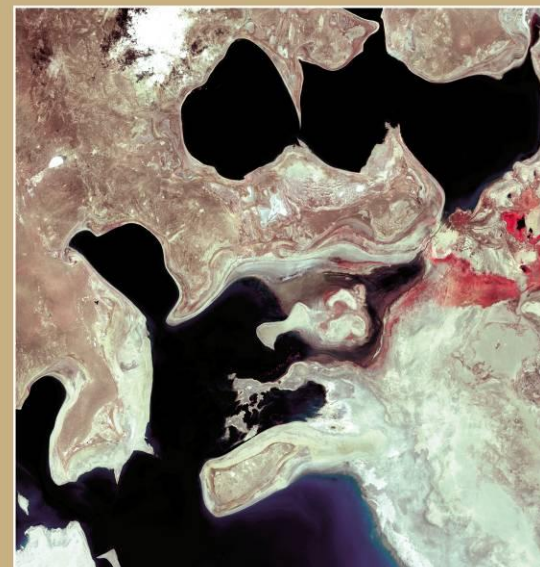
## Aral Sea, Kazakhstan



Landsat MSS  
May 29, 1973



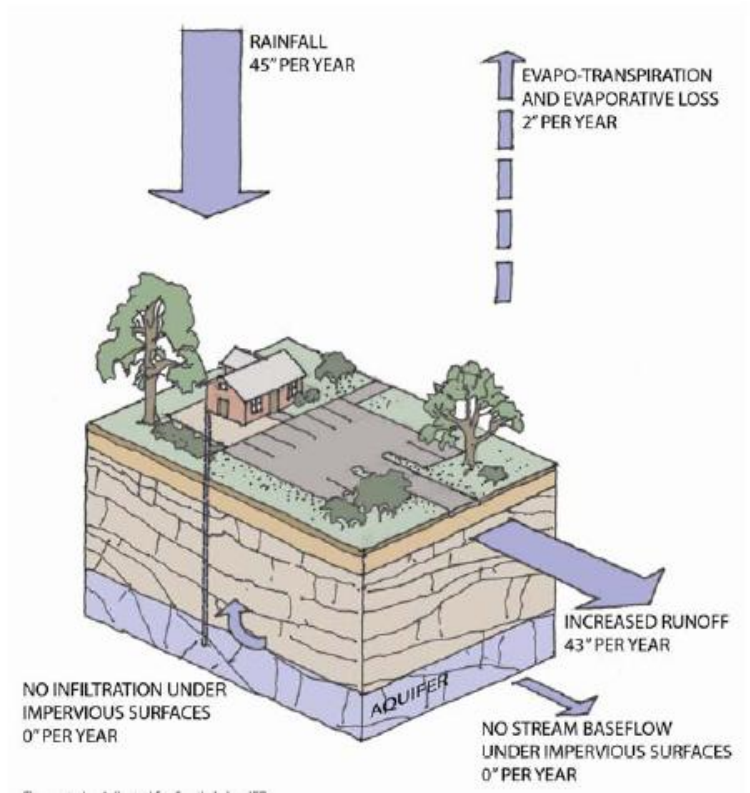
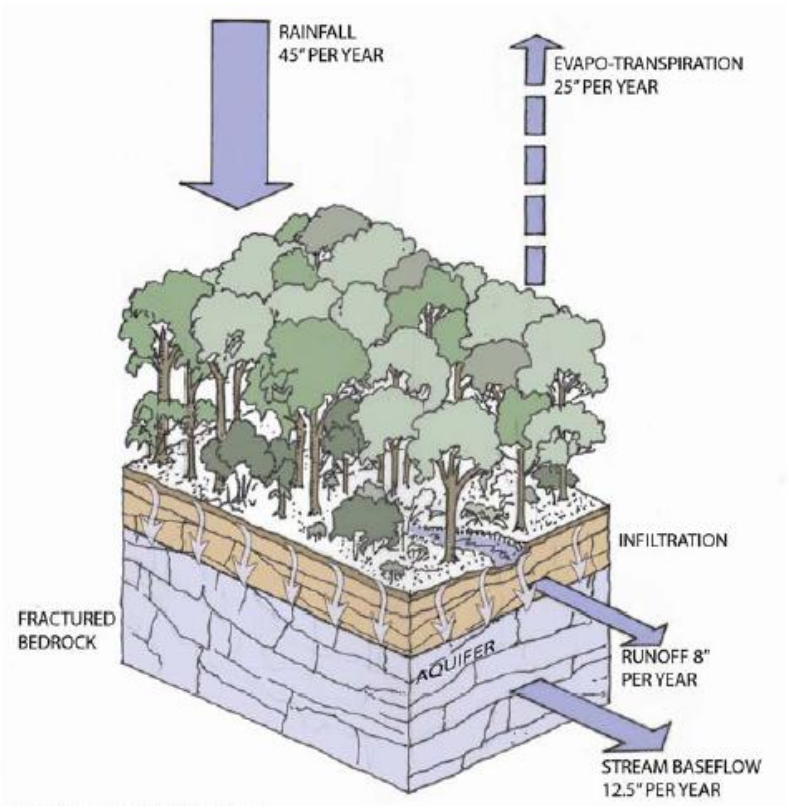
Landsat MSS  
August 19, 1987



Landsat ETM+  
July 29, 2000

**.... on the management side**





# Zalka – Nahr El-Maout





# Nahr El Kalb







# Nahr El Ghadir



# Nahr El Ghadir





# Nahr Beirut



# Polluted Drainage – Beka'a





# Sainiq River



# Sewage Floating in Bay of Jounieh



# Sewage Floating in Bay of Jounieh





# Water Wasting















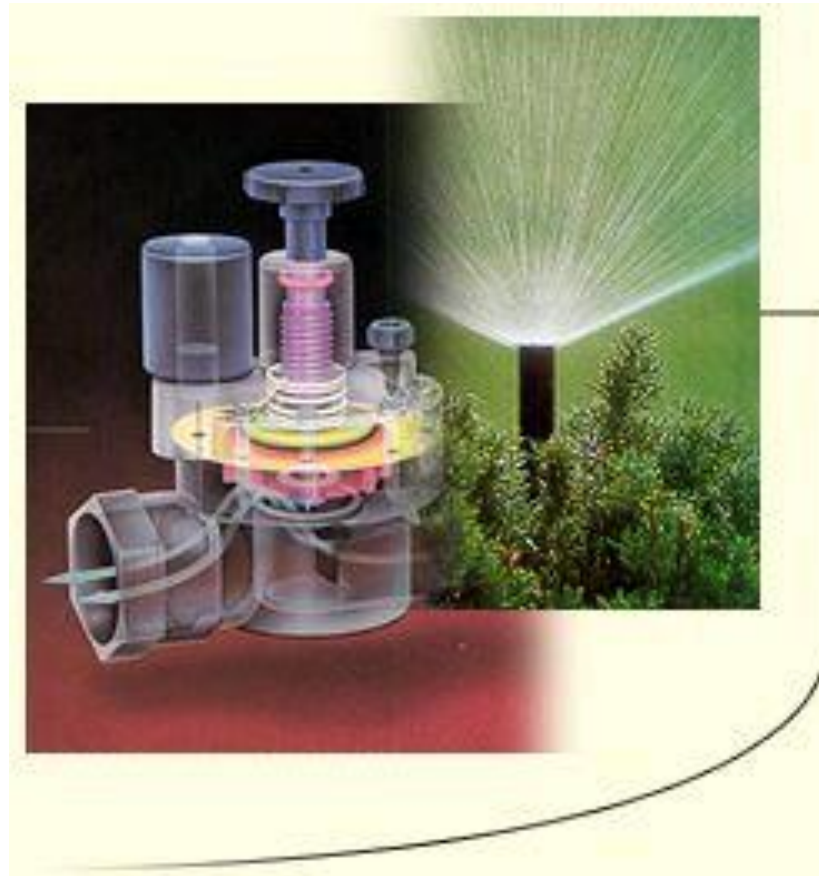


# Some Solutions

# Specialized Irrigation



# Spray Sprinkler





# Drip System





# Stormwater Collection







