WATER SUPPLY AND DEMANDS

Statistical, Economic and Social Research and Training Centre for Islamic Countries
Higher Council for Environment and Natural Resources
“Water Resources Management”

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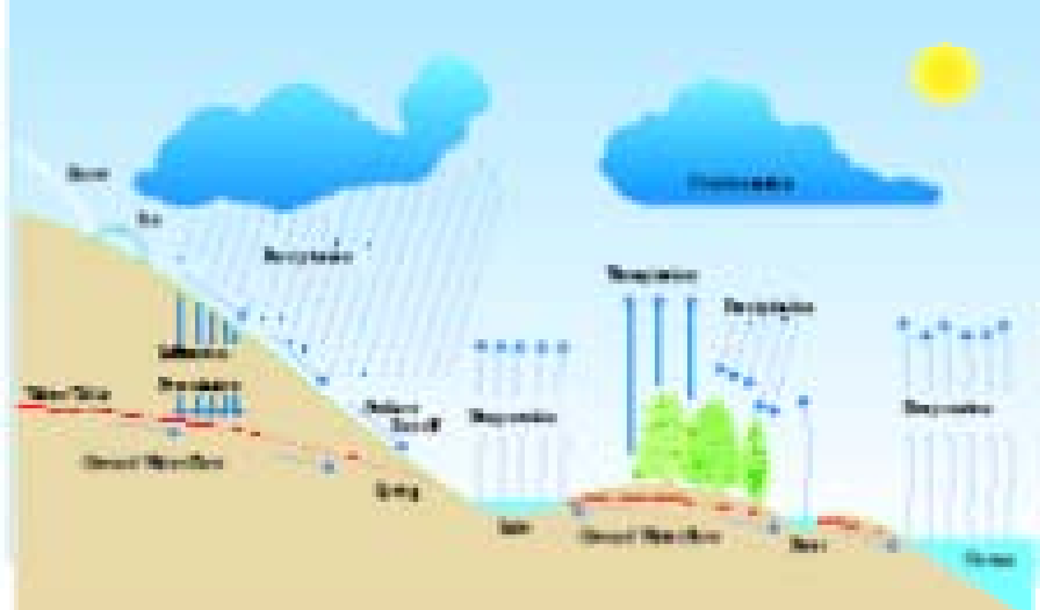
IWRM: balancing water demand and supply

- WRM = matching water supply with demand
- Requires knowledge of likely future supply and demand for water
- Supply can be increased but eventually is limited (physical scarcity)
- Demand can be influenced and reduced to certain minimum (Australia)

Water supply



3 types of water distinguished in hydrological cycle :
– white,
– blue, and
– green

Supply

- naturally fluctuates in time
- Water occurs in different forms, with often different uses

3 types of water distinguished in hydrological cycle :

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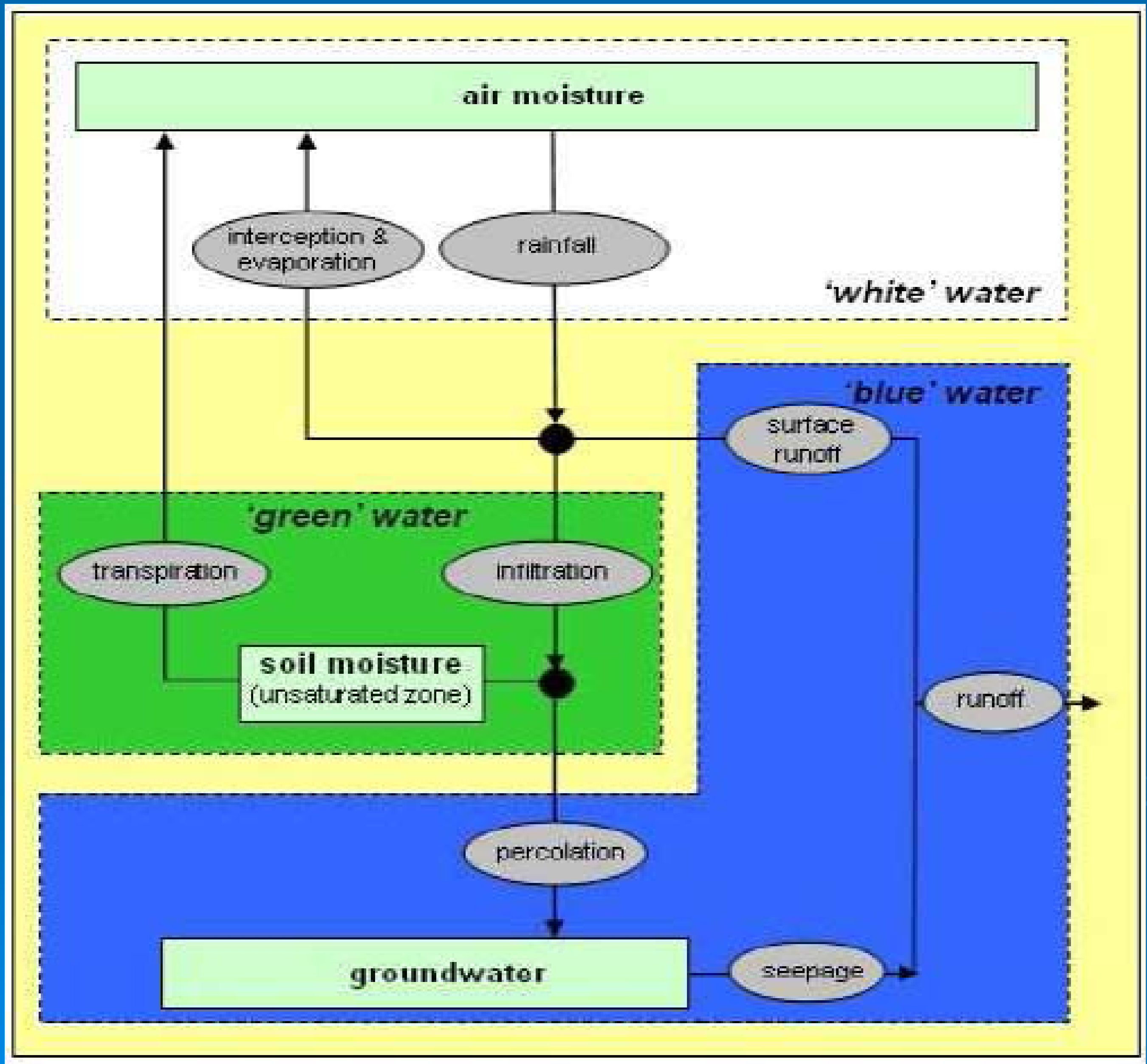


Water Balance

$$\frac{\Delta S}{\Delta t} = I(t) - O(t)$$

where I = inflow in [L^3/T] [L = unit of length; T = unit of time]

O = outflow in [L^3/T]

$\Delta S/\Delta t$ = change in storage over a time step [L^3/T]

Water balance of a drainage basin

$$dS/dt = P - (E+T) - Q$$

Units: catchment area = $\boldsymbol{A}$ (L^2)

precipitation = $\boldsymbol{P * A}$ ($(L/T) * L^2 = L^3/T$)

evaporation+transpiration = $\boldsymbol{ET * A}$ ($(L/T) * L^2 = L^3/T$)

runoff = $\boldsymbol{Q}$ (L^3/T)

storage = $\boldsymbol{S}$ (L^3)

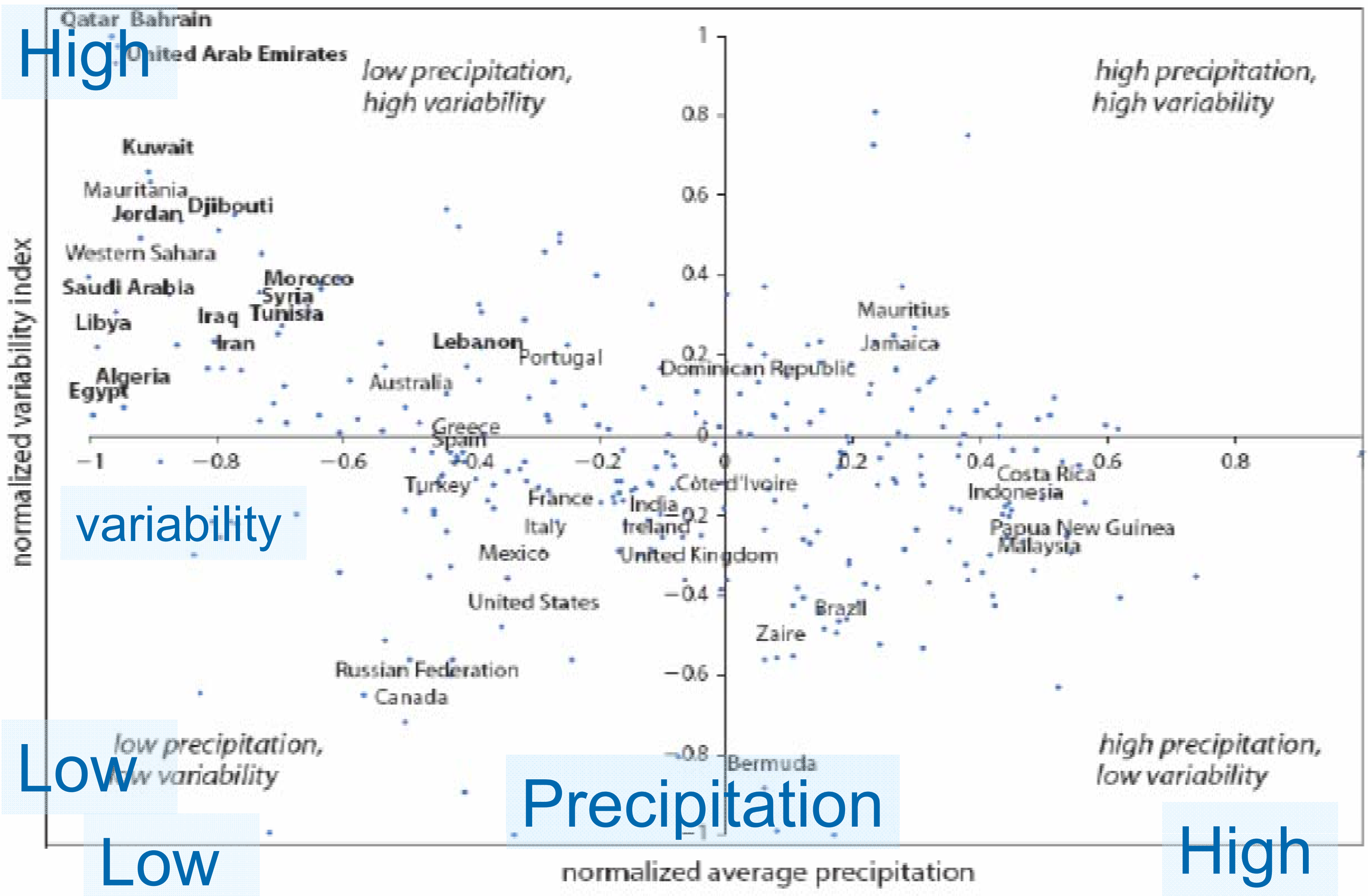
Then:

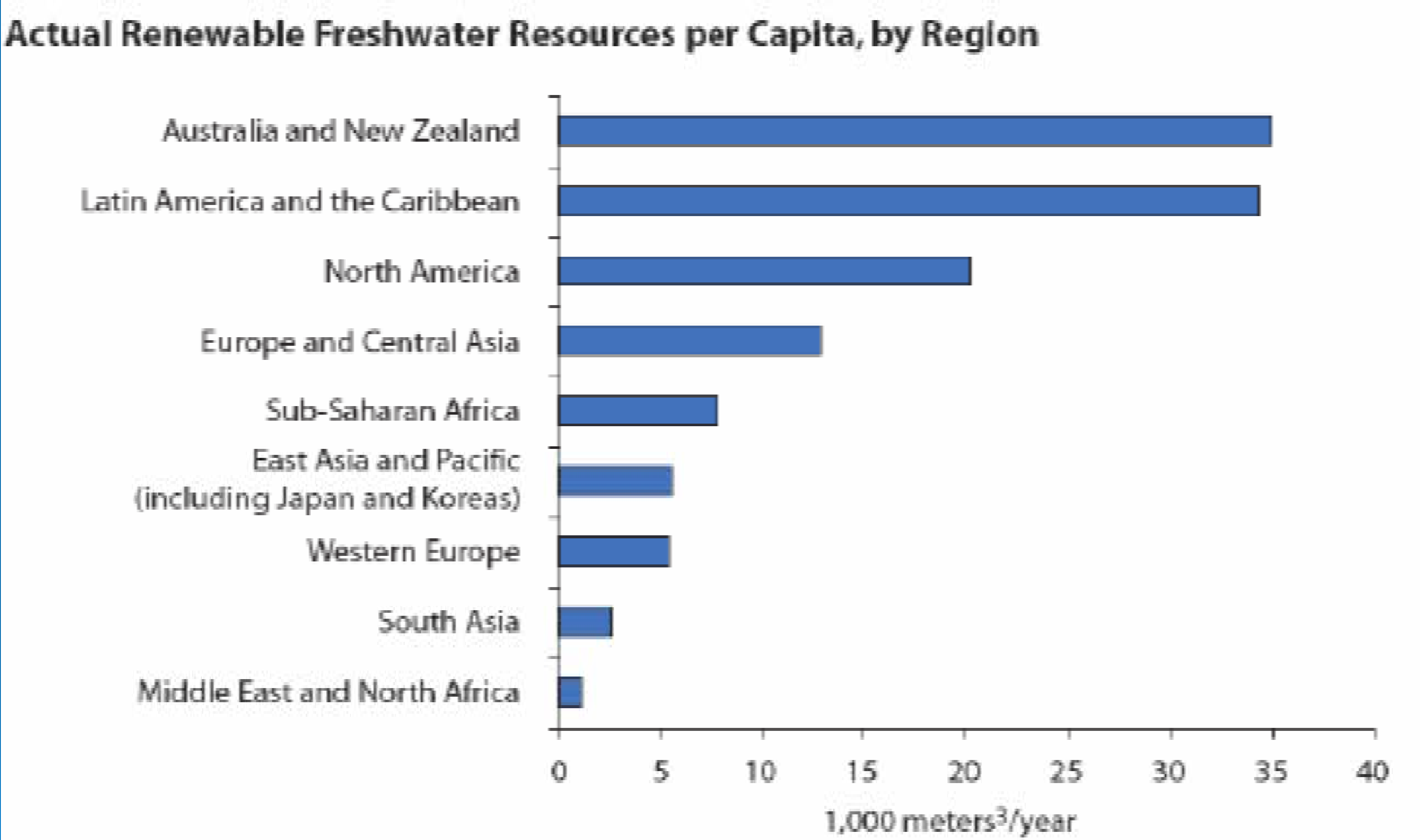
$$dS/dt = (P - ET) A - Q$$

Water demand

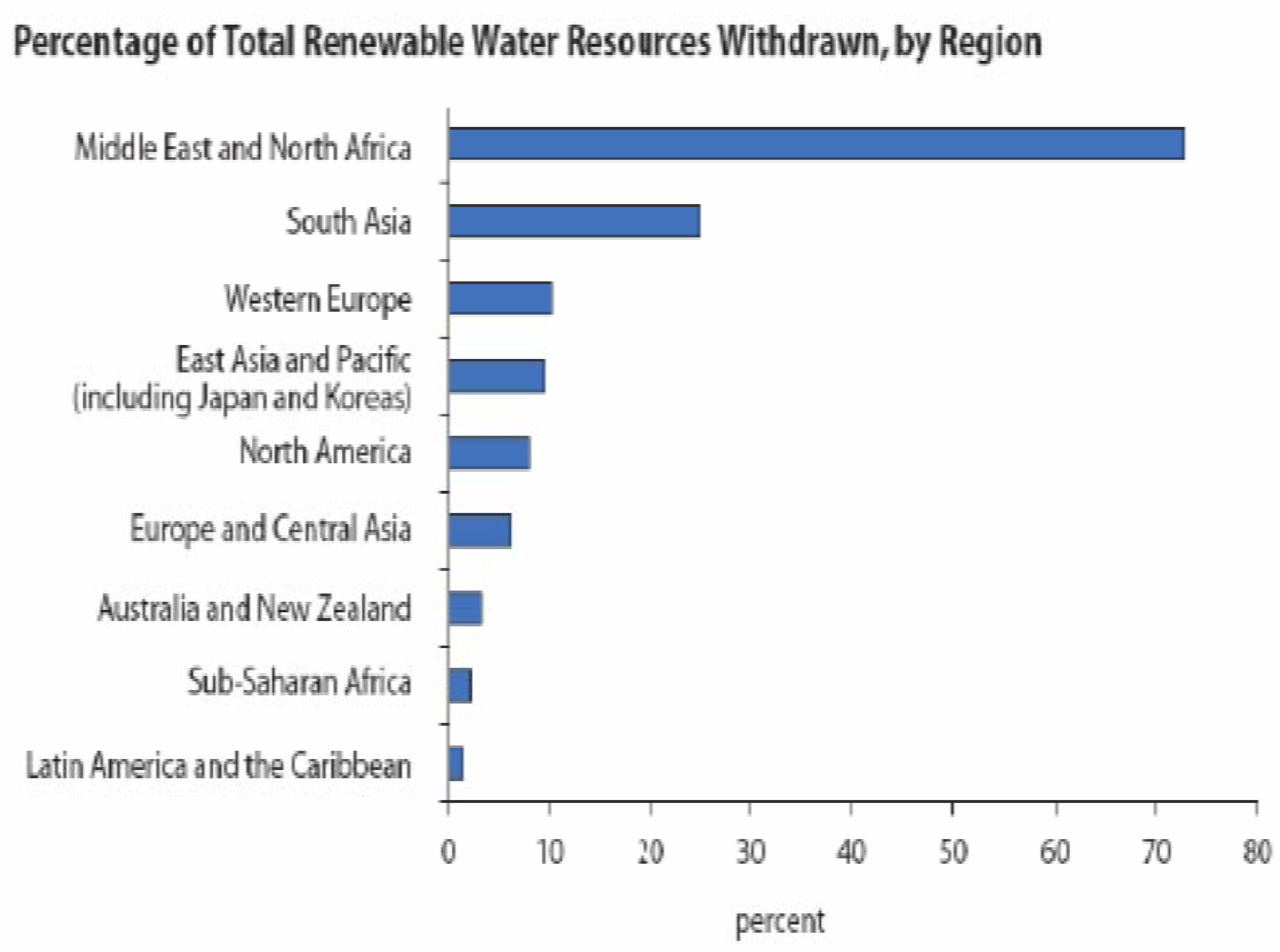
- Fluctuates; often out of sync with natural water availability
- Summer: high temperatures and evaporation while low precipitation many water uses are (partially) consumptive
- Many uses of water generate return flow
- Different types of water use require different levels of assurance (failure rate): irrigation < domestic water supply

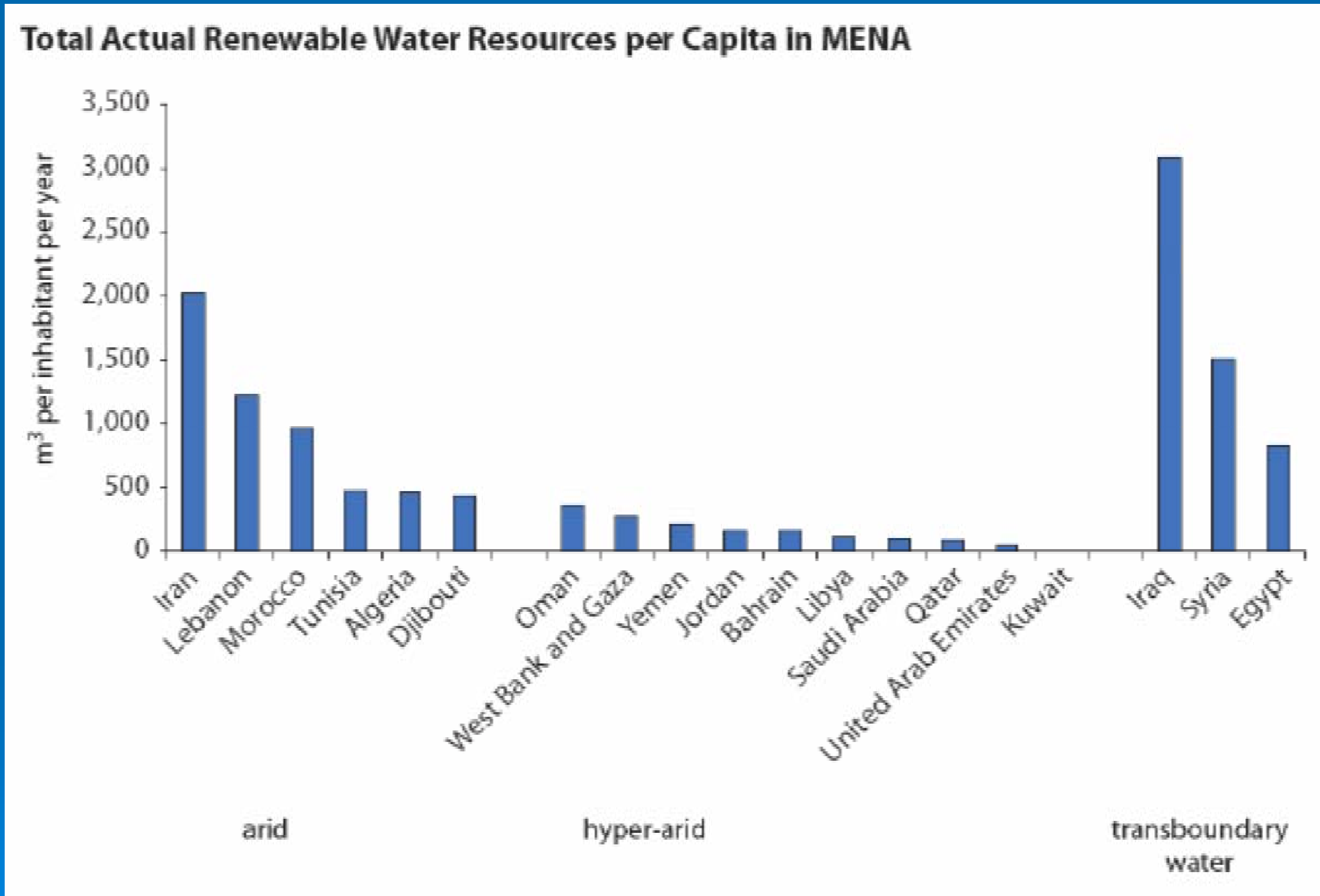
The Unusual Combination of Low Precipitation and High Variability in MENA Countries





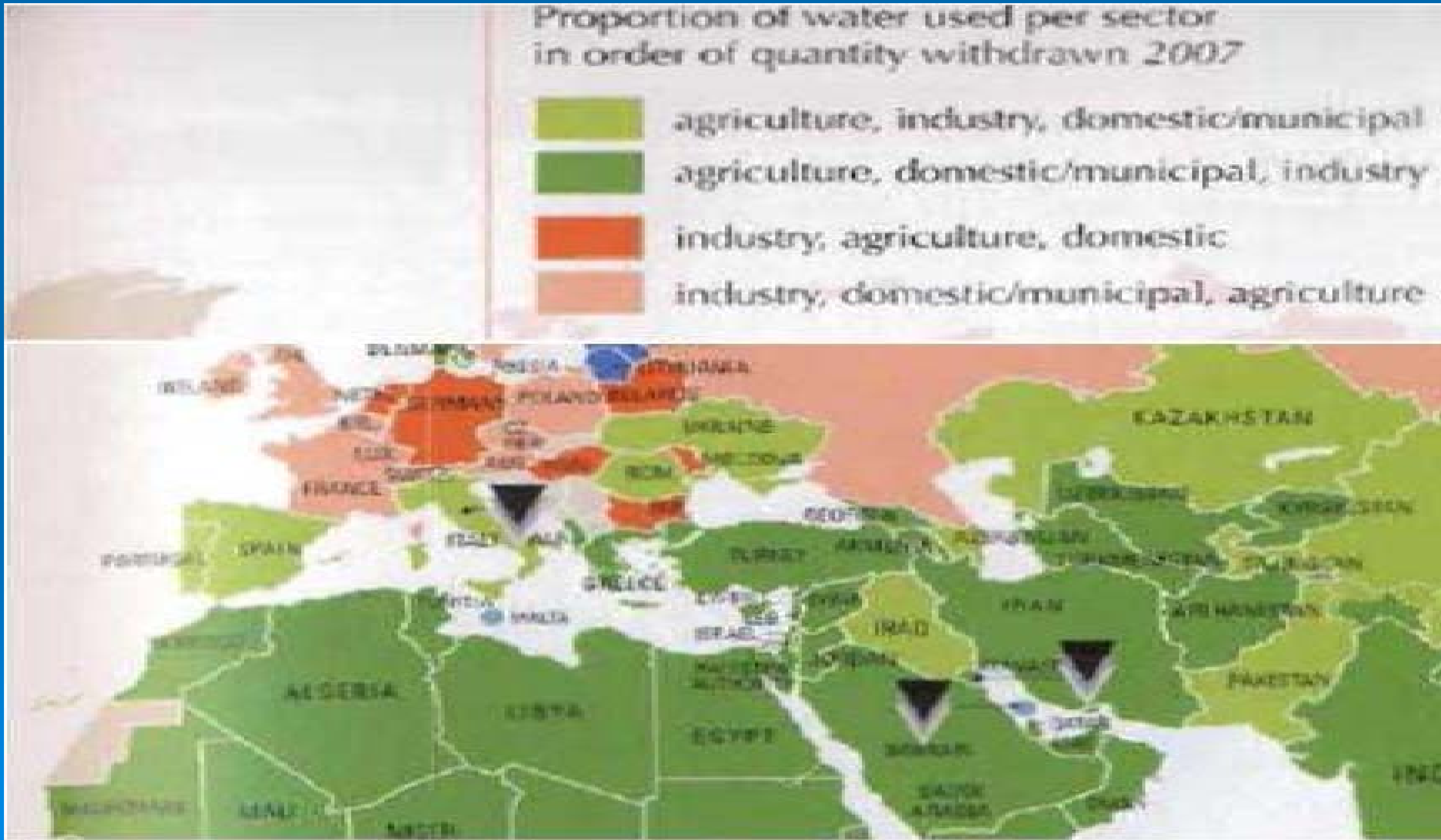
Actual Renewable Freshwater Resources per Capita, by Region
Australia and New Zealand
Latin America and the Caribbean
North America
Europe and Central Asia
Sub-Saharan Africa
East Asia and Pacific
(including Japan and Koreas)
Western Europe
South Asia
Middle East and North Africa
0
5
10
15
20
25
30
35
40
1,000 meters3/year


Percentage of Total Renewable Water Resources Withdrawn, by Region
Middle East and North Africa
South Asia
Western Europe
East Asia and Pacific
(including Japan and Koreas)
North America
Europe and Central Asia
Australia and New Zealand
Sub-Saharan Africa
Latin America and the Caribbean
0
10
20
30
40
50
60
70
80
percent

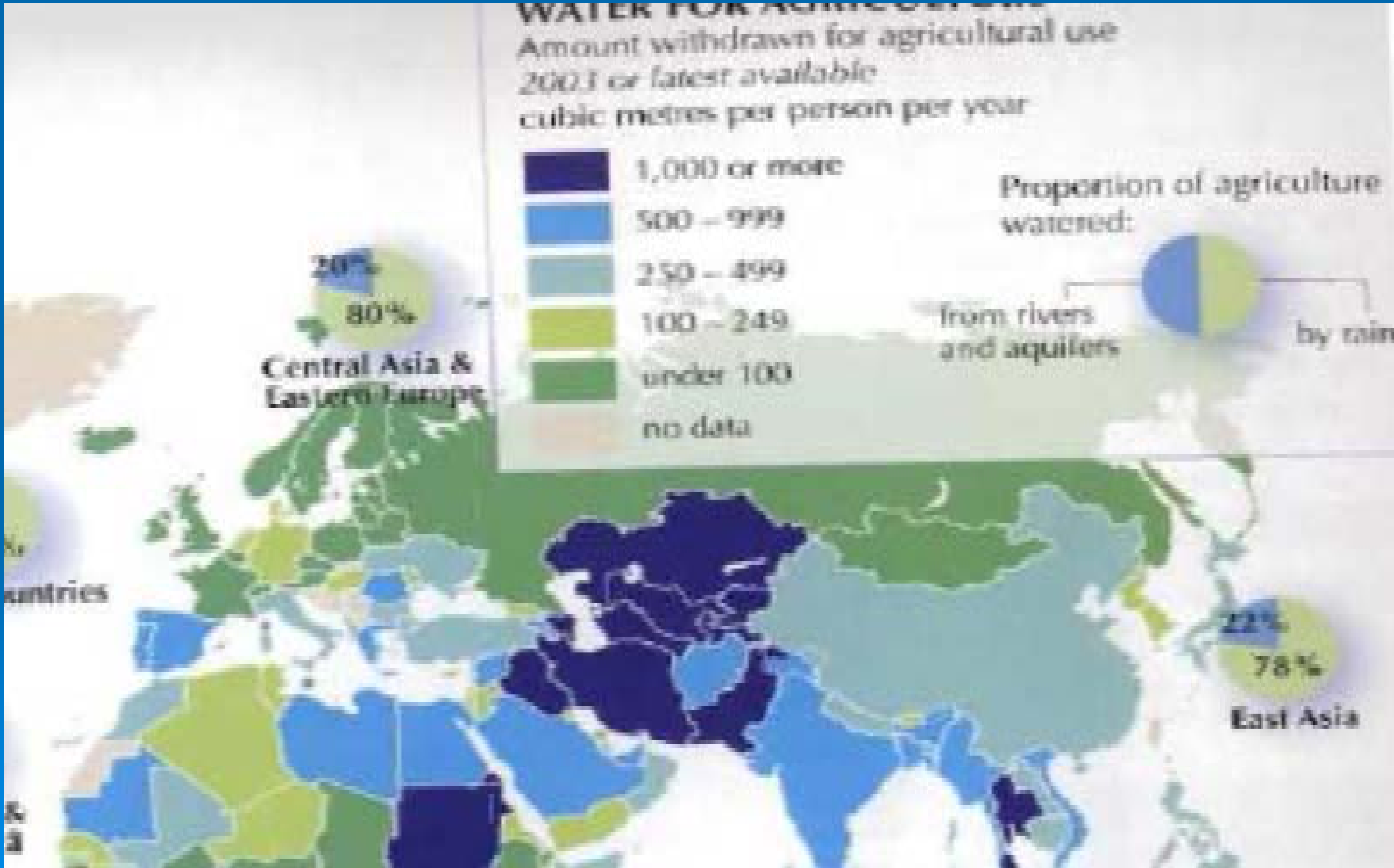


Total Actual Renewable Water Resources per Capita in MENA
m3 per inhabitant per year
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Iran
Lebanon
Morocco
Tunisia
Algeria
Djibouti
Oman
West Bank and Gaza
Yemen
Jordan
Bahrain
Libya
Saudi Arabia
Qatar
United Arab Emirates
Kuwait
Iraq
Syria
Egypt
arid
hyper-arid
transboundary water

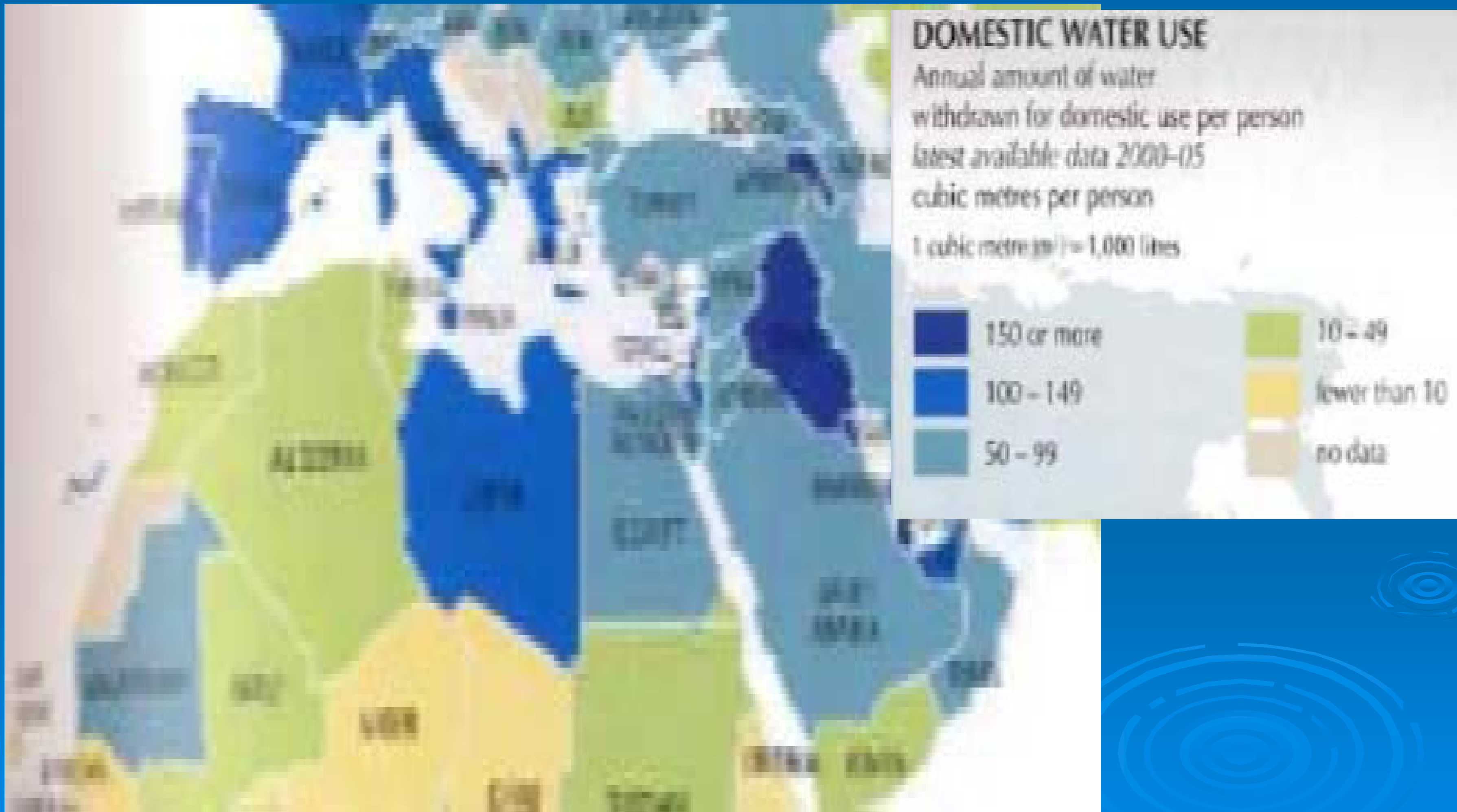
Water Use (proportions for agriculture, domestic, industry)



Water for agriculture m3/ca.y



Water withdrawn for domestic use m3/ca



Supply ↔ demand: municipal water supply

Supply Option		**Demand Option**	
Increase reservoir capacity	Expensive, env. impacts	Incentives to use less	Needs institutional framework
Increase Withdrawals	Env. impacts	Water-use standards	Cost-inefficient
Inter-basin transfers	Expensive, env impacts	Reduce leakage	Expensive (old systems!)
Desalinization	Expensive		

Supply ⟺ demand: irrigation

Supply Option		Demand Option	
Increase source capacity	Expensive, env. impacts	Increase irrigation efficiency	Technology, price increases
		Change crop patterns	Requiring less water

Supply ⟺ demand: flooding

Supply Option		Demand Option	
Increase flood protection	Expensive, env. impacts	Improved flood warning system	Technical limitations
Catchment source control to reduce peak discharge	For small floods	Curb floodplain development	Socioeconomic problems

Factors influencing water demand

- Driver
  - Population growth
  - Rainfall/Droughts
  - Economic development
- Institutional measures
  - Rationing
  - Water pricing

Water Allocation: a tool to balance supply and demand

Access to clean water is a human right and is vested in the law of most countries, but:

scarce water resources → common view emerging that management of the resource goes beyond the basic legal rights to water

Climate change

- Design of water management systems based on historic climate and hydrological data (variability and extremes)
- Implicit assumption of stationary weather and water system behaviour
- Forecasted climate change will affect predicatability and put investments at risk

Climate change: potential effects

1. Possible change in arid regions:
   - Increased frequency of droughts
   - Decline in precipitation
   - Increased rainfall variability
   - Increased temperatures
2. Possible effects:
   - Impact on river flows (sensitive to changes in rainfall => quality, navigation, water supply)
   - Impact on groundwater recharge rates
   - Increased water demand (domestic, agriculture) due to T ↑ and reduced precipitation

Climate change: potential effects

3. Institutional effects:

- Current shortages are likely to get worse due to climate change
- Further reduced water supply will increase competition and conflicts
- Especially if basin reaches closure: if all water has been allocated

- Such increased competititon and conflicts will affect institutions (=> might affect water rights)

Climate change: responses

1. Supply focused measures
   - meeting existing + emerging demand
   - long-term infrastructure planning and investments
   - uncertainty (future water availability)
   - Risk if future conditions are not predicted well
   - Institutions: large, centralised nature

Climate change: responses

2. Demand management measures

- Shaping needs to water availability
- Range of small scale interventions improving economic / technical efficiency
- Regulation, pricing
- Flexible
- Institutions: wider range involved from national to local level
- Public awareness to enable behavourial changes

Climate change: responses

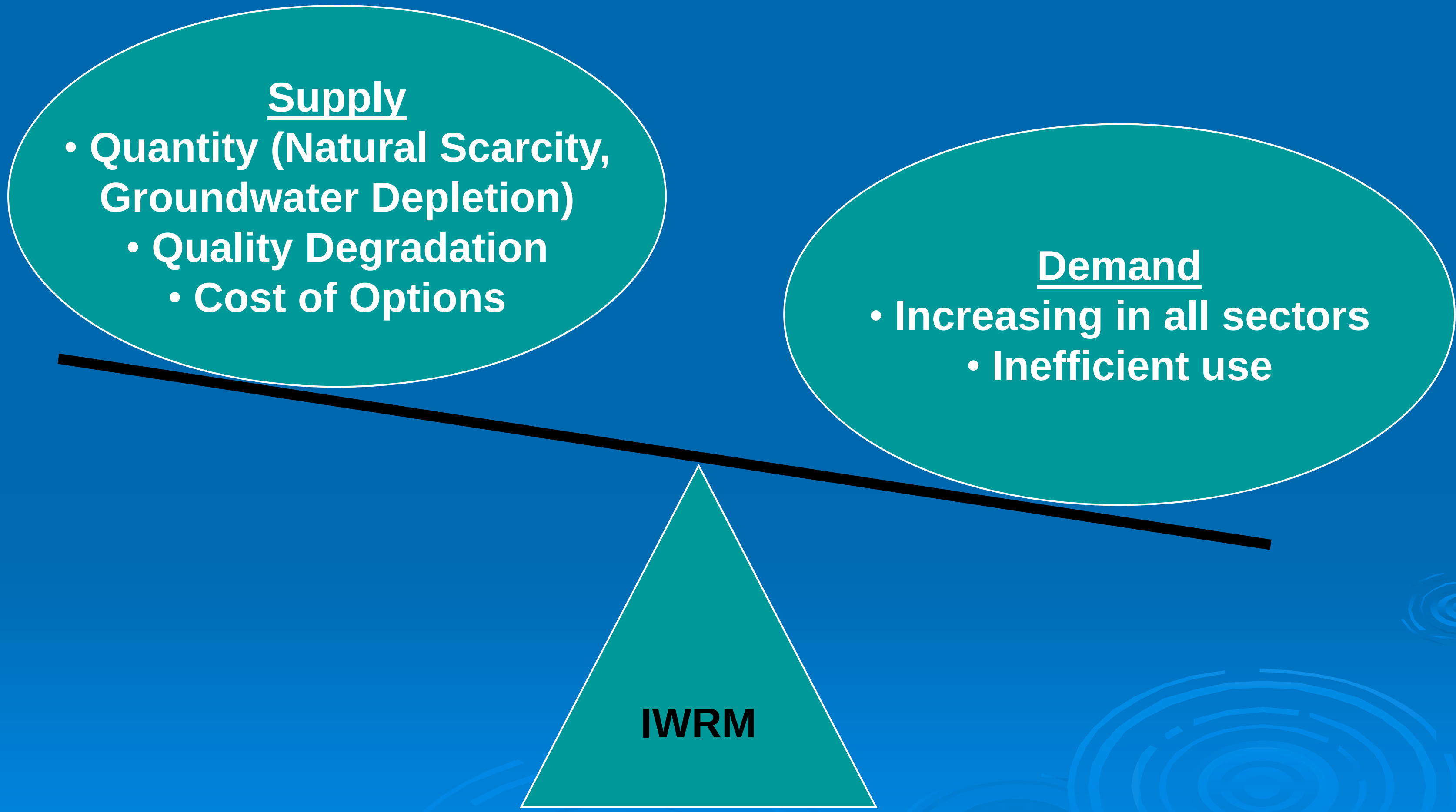
Flood control in large river basins

1. Focus on structural measures
   - Dams, embankments, diversions
2. Focus on mitigating flooding impacts
   - Discourage vulnerable activities / investments in floodplains

Climate change: role of IWRM

1. IWRM is a response to deal with increased pressures and challenges (population growth and socio-economic developments)
2. Change from traditional WRM approach
   - Supply oriented, sector focused and engineering-based
   - Top-down 'water' master planning to
3. Integrated WRM:
   - Demand-oriented, multi-sectoral approach

What is IWRM? – A Water Balancing Act



THANK YOU FOR YOUR ATTENTION…