Consultancy and Engineering

Sustainable Water Integrated Management (SWIM) - Support Mechanism

SUB-REGIONAL WORKSHOP 9-12 July 2012 Israel

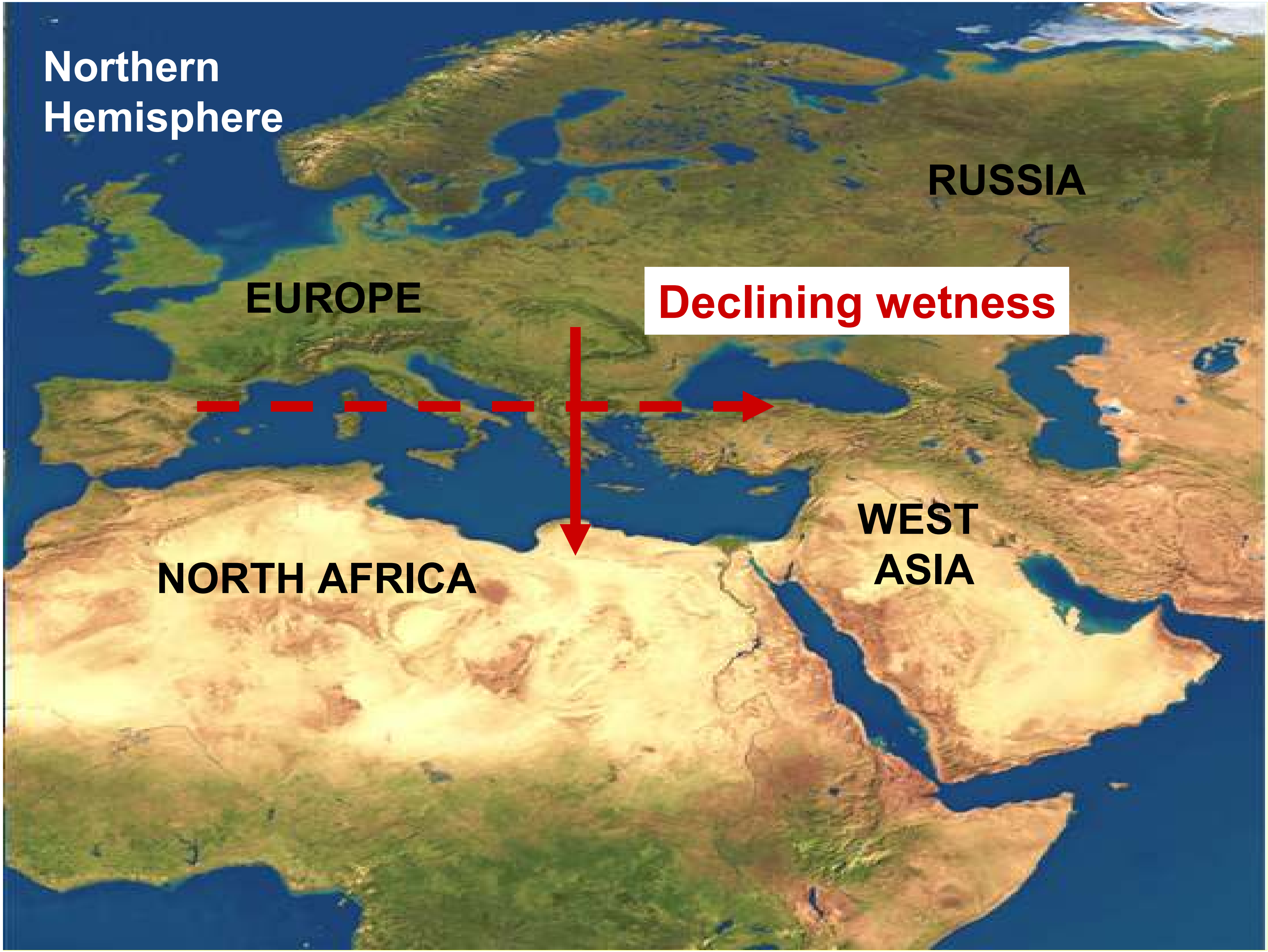
Reclaimed water quality requirements, based on environmental risk assessment and management

Eldad Elron

July 2012

Outline:

- Climate and water scarcity
- treated wastewater reuse
  - Options
  - Risks
- Risk assessment
  - Definition and process
  - Example – Rivers and stream
- Regulation and management


Northern
Hemisphere
RUSSIA
EUROPE
Declining wetness
NORTH AFRICA
WEST
ASIA

Water demand and climate

arid and semi-arid regions

1. Wide climate variability
2. Droughts
3. Less-developed countries
4. High population growth

Severe water shortage

- **Imbalances between water availability and demand**
- **Degradation of groundwater and surface water quality**
- **Inter-sectoral competition**

Some of the most driest countries in the world are situated in the Middle East and North African. Expanding water reuse could significantly increase countries water resource and decrease the demand for freshwater.

Treated wastewater reuse options:

Agriculture irrigation

- Food crops
- Non-food crops

Nature

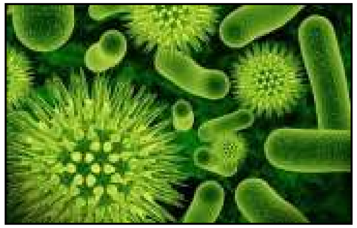
- Rivers and streams
- Lakes
- Estuaries
- Ocean

- Aquifer recharge
- Urban irrigation
- Industrial cooling
- Aquaculture

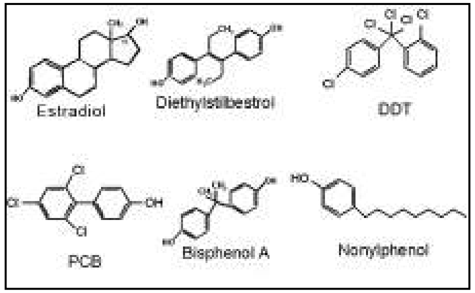
Risks involved in using treated wastewater:

- **Public Health**
- **Environmental**
- **Economic**

Risks



Public Health



Pathogenic microorganisms

- bacteria
- viruses
- protozoans
- parasitic worms (Helminth-Nematode)
- Fungi, algal toxins

Heavy metals

- mercury
- cadmium
- arsenic
- lead
- selenium
- nickel

Harmful organic chemicals

- pesticides
- oil and grease comp.
- endocrine disruptors (EDCs)
- pharmaceutically-active compounds

Risks

Environmental

Salinisation and Sodicity

- chloride
- sodium

Nutrients

- nitrogen
- phosphorus

Boron

Risk assessment

What is Risk Assessment?

It is a process of estimate the potential chemical and microbial hazards to human health and environmental quality.

Risk assessment

Stepwise process:

1. Decide what are the designated uses of the water.

Risk assessment

Stepwise process:

1. Decide what are the designated uses of the water.
2. **Identify the risks (hazards).**

Risk assessment

Stepwise process:

1. Decide what are the designated uses of the water.
2. Identify the risks (hazards).
3. **Determine whether a hazard exists and what the magnitude of that hazard may be.**

Risk assessment

Stepwise process:

1. Decide what are the designated uses of the water.
2. Identify the risks (hazards).
3. Determine whether a hazard exists and what the magnitude of that hazard may be.
4. **Evaluate scientifically-based information that is available and consult with experts.**

Risk assessment

Stepwise process:

1. Decide what are the designated uses of the water.
2. Identify the risks (hazards).
3. Determine whether a hazard exists and what the magnitude of that hazard may be.
4. Evaluate scientifically-based information that is available and consult with experts.
5. **Determine what is the needed quality ("fit for purpose") and developed Regulations and Guidelines.**

Rivers and streams

Related chemical risks with wastewater reuse:

- **Biodegradable organics**
- **Suspended solids**
- **Nitrogen and phosphorus**
- **Un-ionized Ammonia (NH_3)**
- **Salinity (especially chloride and sodium)**
- **Heavy metals**
- **Surfactants**
- **Endocrine disruptors**
- **Chlorine residuals** (by-products of disinfection processes)

Rivers and streams

Evaluate scientific information

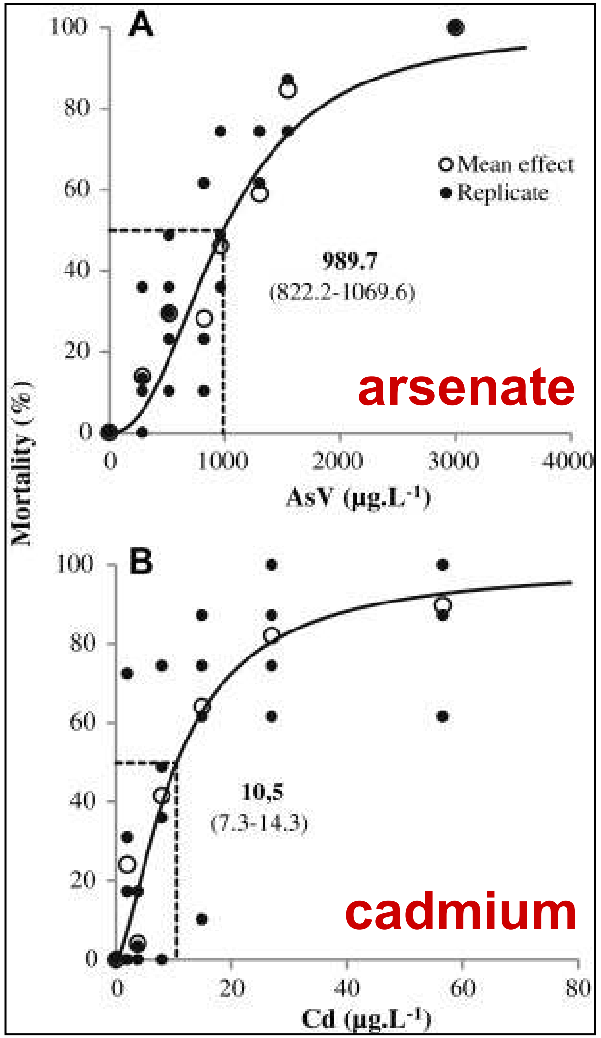
(plus “expert judgment”)

Species level –
Acute and chronic Toxicity tests

Consultancy and Engineering

Aquatic indicators

<u>Example 1</u>: *Gammarus pulex*
(freshwater amphipod crustacean)



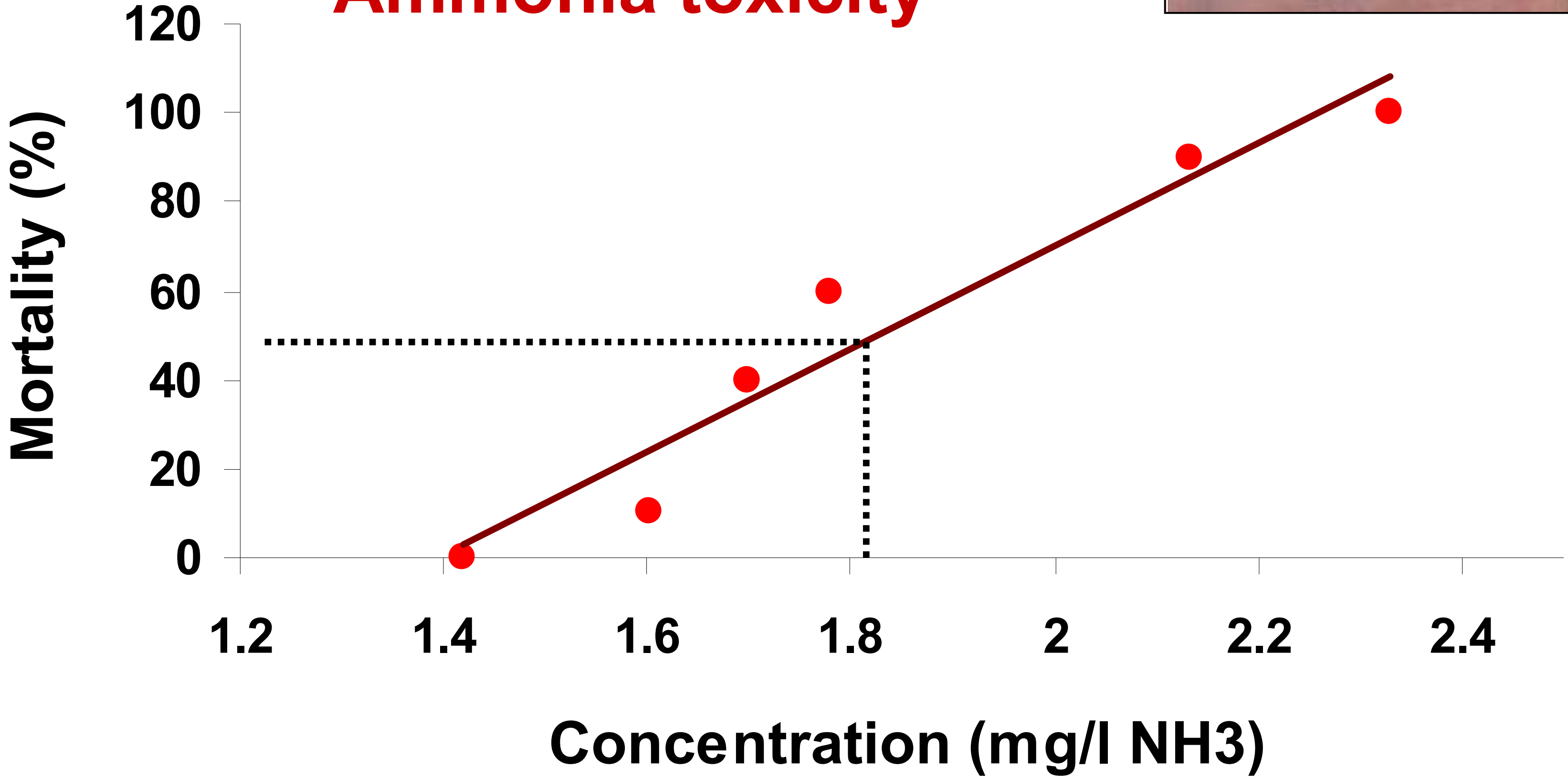
Vellinger et al., 2012
Environmental pollution 160: 66-73

Gateway to solutions

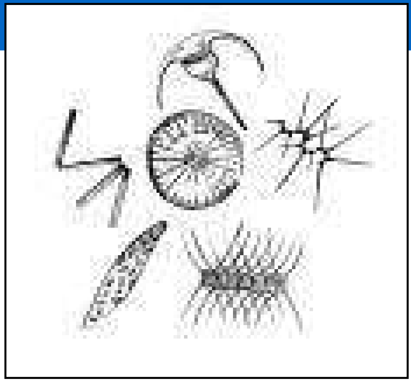
Species level –
Acute and chronic Toxicity tests

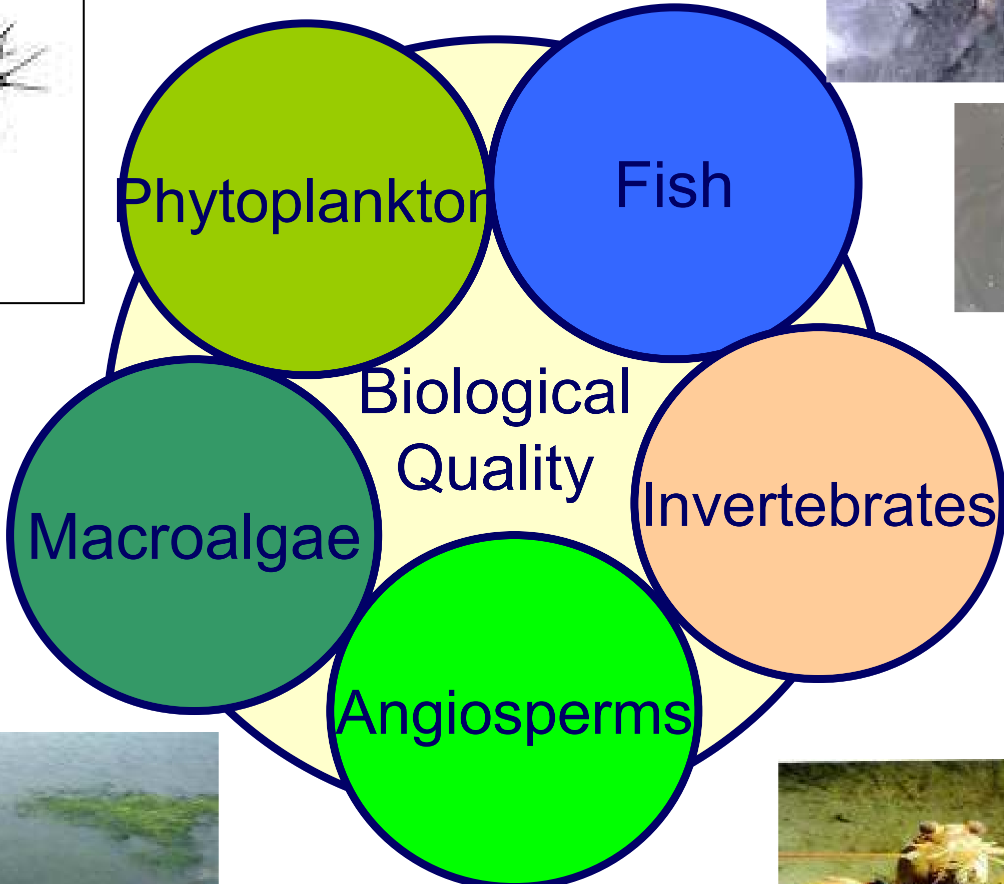
<u>Example 2</u>: ***Acanthobrama telavivensis***
(endemic fish, Israel coastal streams)

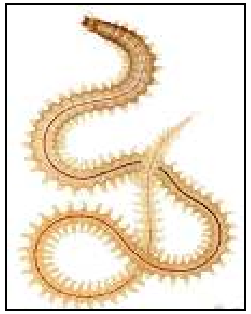
Ammonia toxicity



Community level







Aquatic Invertebrates - Examples

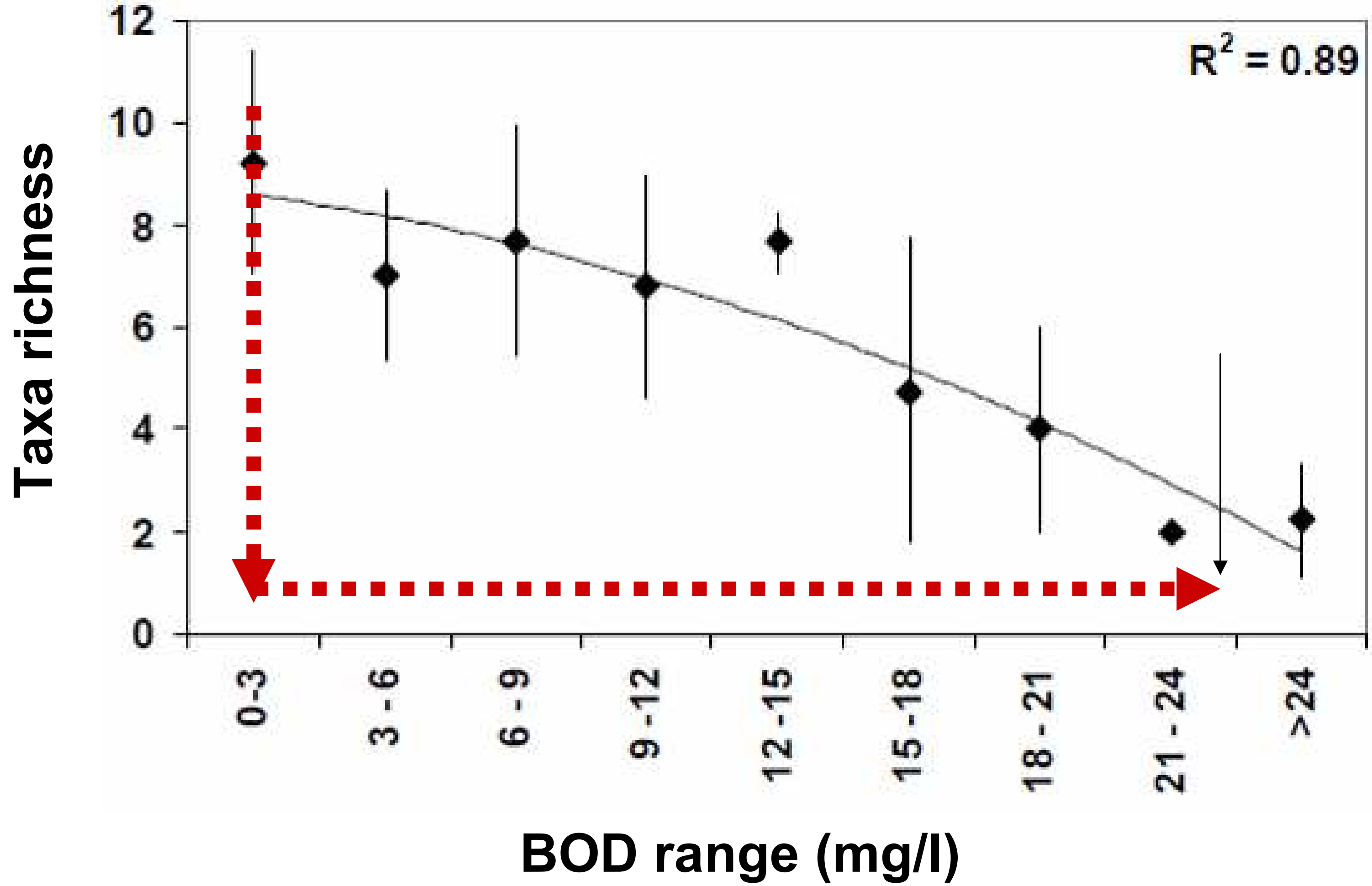






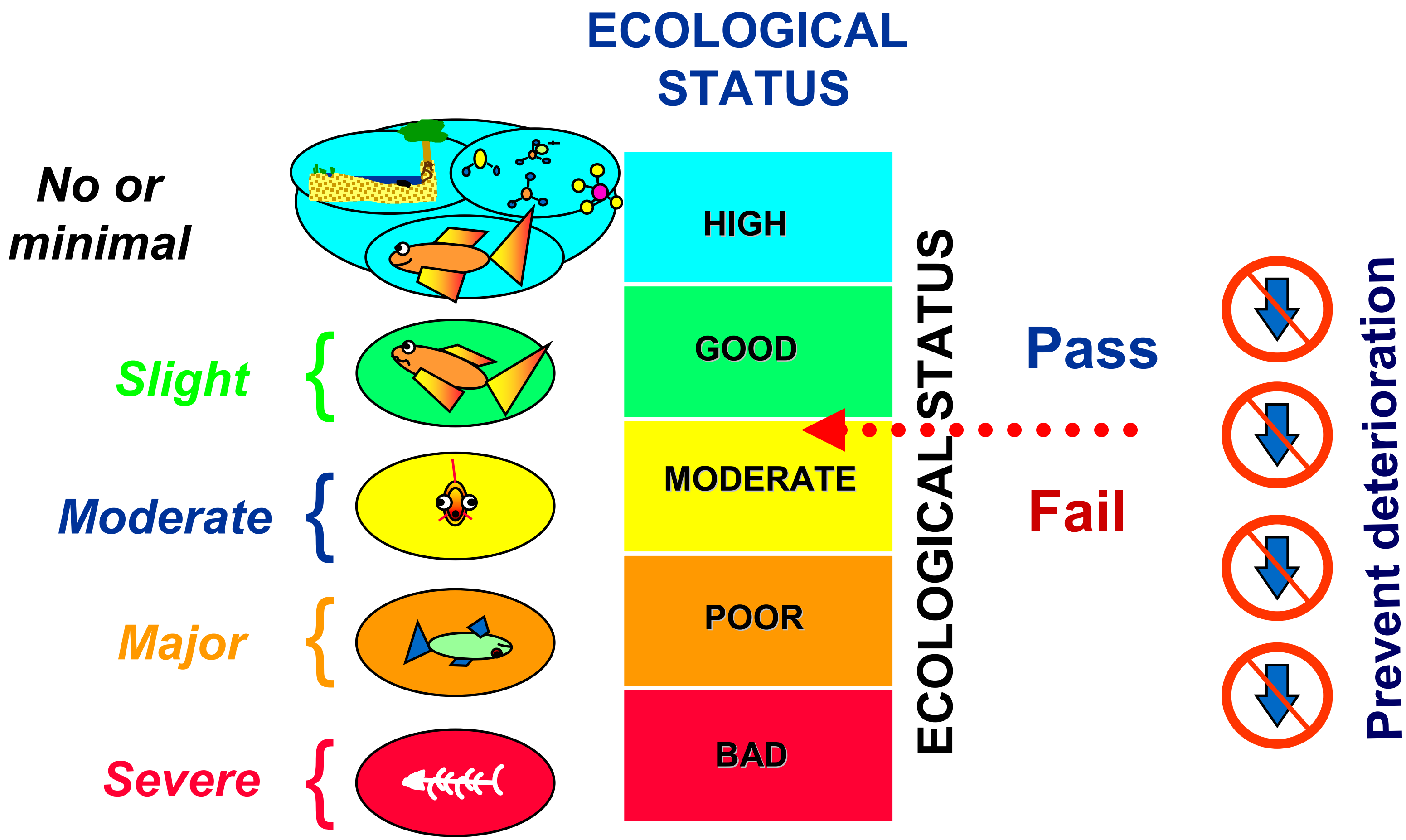


Relationship between taxa richness (mean ±SD) and ranges of organic matter concentration in selected sites along the Yarqon river (2000-2001)



(Source: Yaron Hershkovitz, M.Sc thesis, Tel Aviv University)

Community level



Developed Regulations (water quality standards)

Israel's Public Health Regulations (Effluent Quality Standards and Wastewater Treatment Rules)

[officially published: April 2010]

Substance	Unit	Unrestricted Irrigation	Disposal at Streams
Aluminum	mg/l	5	
Anionic detergent	mg/l	2	0.5
Arsine	mg/l	0.1	0.1
Beryllium	mg/l	0.1	
BOD_5	mg/l	10	10
Boron	mg/l	0.4	
Cadmium	mg/l	0.01	0.005
Chloride	mg/l	250	400
Chrome	mg/l	0.1	0.05
Cobalt	mg/l	0.05	
COD	mg/l	100	70
Conductivity	dS/m	1.4	
Copper	mg/l	0.2	0.02
Cyanide	mg/l	0.1	0.005
Dissolved Oxygen	mg/l	>0.5	>3
E. Coli	Units per 100 ml	10	200
Fluoride	mg/l	2	
Iron	mg/l	2	
Lead	mg/l	0.1	0.008
Lithium	mg/l	2.5	
Manganese	mg/l	0.2	
Mercury	mg/l	0.002	0.0005
Mineral Oil	mg/l		1
Molybdenum	mg/l	0.01	
Nickel	mg/l	0.2	0.05
Nitrogen (ammonia)	mg/l	10	1.5
pH		6.5–8.5	7.0–8.5
Remaining Chlorine	mg/l	1	0.05
SAR	$(mmol/l)^{0.5}$	5	
Selenium	mg/l	0.02	
Sodium	mg/l	150	200
Total Nitrogen	mg/l	25	10
Total Phosphorus	mg/l	5	1
TSS	mg/l	10	10
Vanadium	mg/l	0.1	
Zinc	mg/l	2	0.2

Israel's Public Health Regulations (Effluent Quality Standards and Wastewater Treatment Rules)

[officially published: April 2010]

Maximum level of the main parameters for unlimited irrigation and for rivers flow

Parameter	Units	Unlimited irrigation	Rivers flow
Electrical conductivity	dS/m	1.4	
BOD	Mg/L	10	10
TSS	Mg/L	10	10
COD	Mg/L	100	70
Nitrogen (ammonia)	Mg/L	**10**	1.5
Nitrogen (general)	Mg/L	25	10
Phosphorous (general)	Mg/L	5	1.0
Chloride	Mg/L	250	400
Koli	Units/100mL	10	200
Boron	Mg/L	0.4	

Israel's Public Health Regulations (Effluent Quality Standards and Wastewater Treatment Rules)
[officially published: April 2010]

Maximum level of the main parameters for unlimited irrigation and for rivers flow

Parameter	Units	Unlimited irrigation	Rivers flow
Electrical conductivity	dS/m	1.4	
BOD	Mg/L	10	10
TSS	Mg/L	10	10
COD	Mg/L	100	70
Nitrogen (ammonia)	Mg/L	10	1.5
Nitrogen (general)	Mg/L	25	10
Phosphorous (general)	Mg/L	5	1.0
Chloride	Mg/L	250	400
Koli	Units/100mL	10	200
Boron	Mg/L	0.4	

Israel's Public Health Regulations (Effluent Quality Standards and Wastewater Treatment Rules)

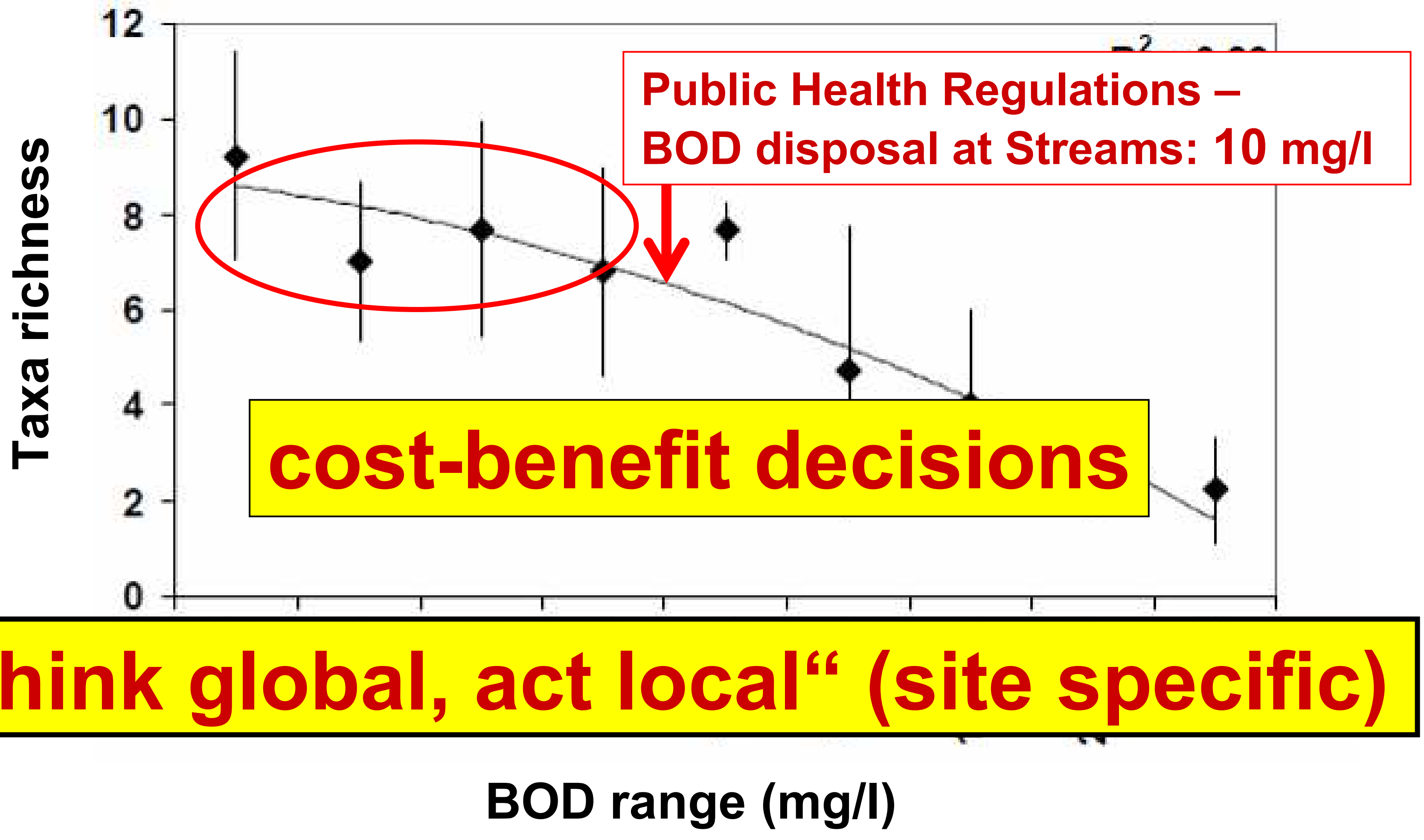
[officially published: April 2010]

Maximum level of the main parameters for unlimited irrigation and for rivers flow

Parameter	Units	Unlimited irrigation	Rivers flow
Electrical conductivity	dS/m	1.4	
BOD	Mg/L	10	10
TSS	Mg/L	10	10
COD	Mg/L	[illegible]	[illegible]
Nitrogen (ammonia)	Mg/L	[illegible]	[illegible]
Nitrogen (general)	Mg/L	25	10
Phosphorous (general)	Mg/L	5	1.0
Chloride	Mg/L	250	400
Koli	Units/100mL	10	200
Boron	Mg/L	0.4	

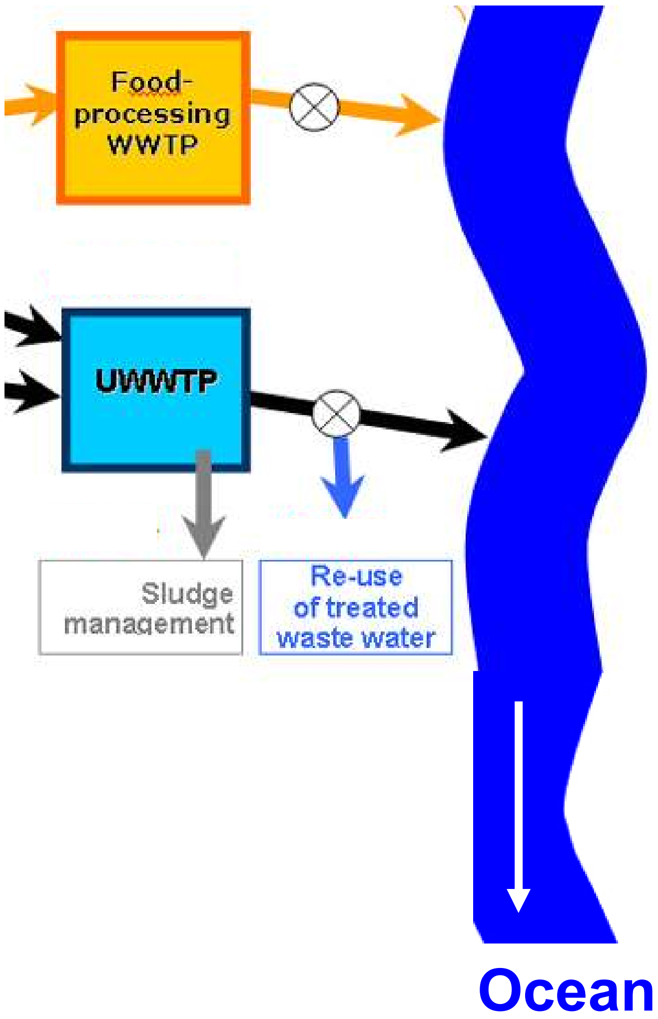
Is it "good enough"?

Relationship between taxa richness (mean ±SD) and ranges of organic matter concentration in selected sites along the Yarqon stream (2000-2001)



(Source: Yaron Hershkovitz, Ph.D. dissertation, Tel Aviv University)

Management



- Level of wastewater treatment
- Carefully managed use of recycled water
- Public Health Regulations
- Discharge permits
- Routine monitoring and assessments
- Enforcement

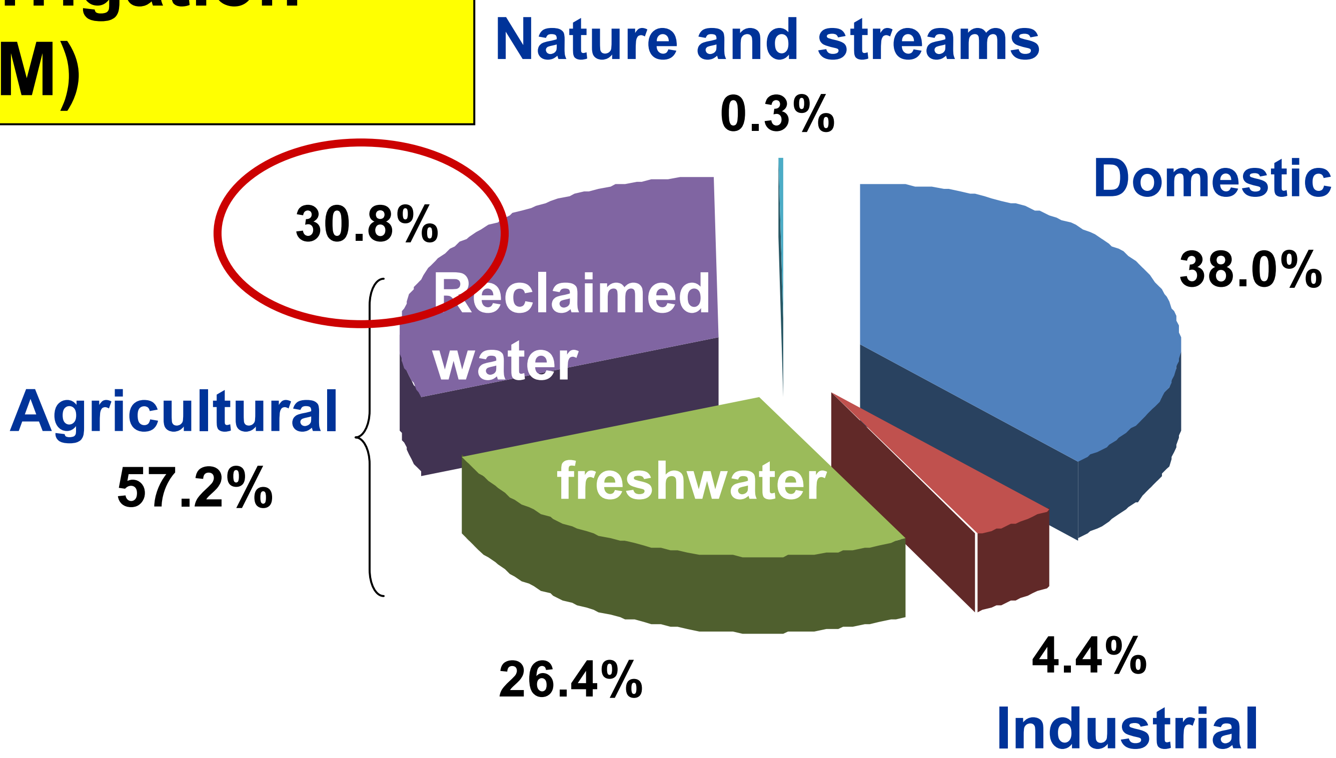
Thank you for Listening

The Israeli experience:

About 80% of treated wastewater are reuse for agriculture irrigation (Ca. 620 MCM)

…ption and uses in Israel

…ter withdrawal: 2007 MCM)

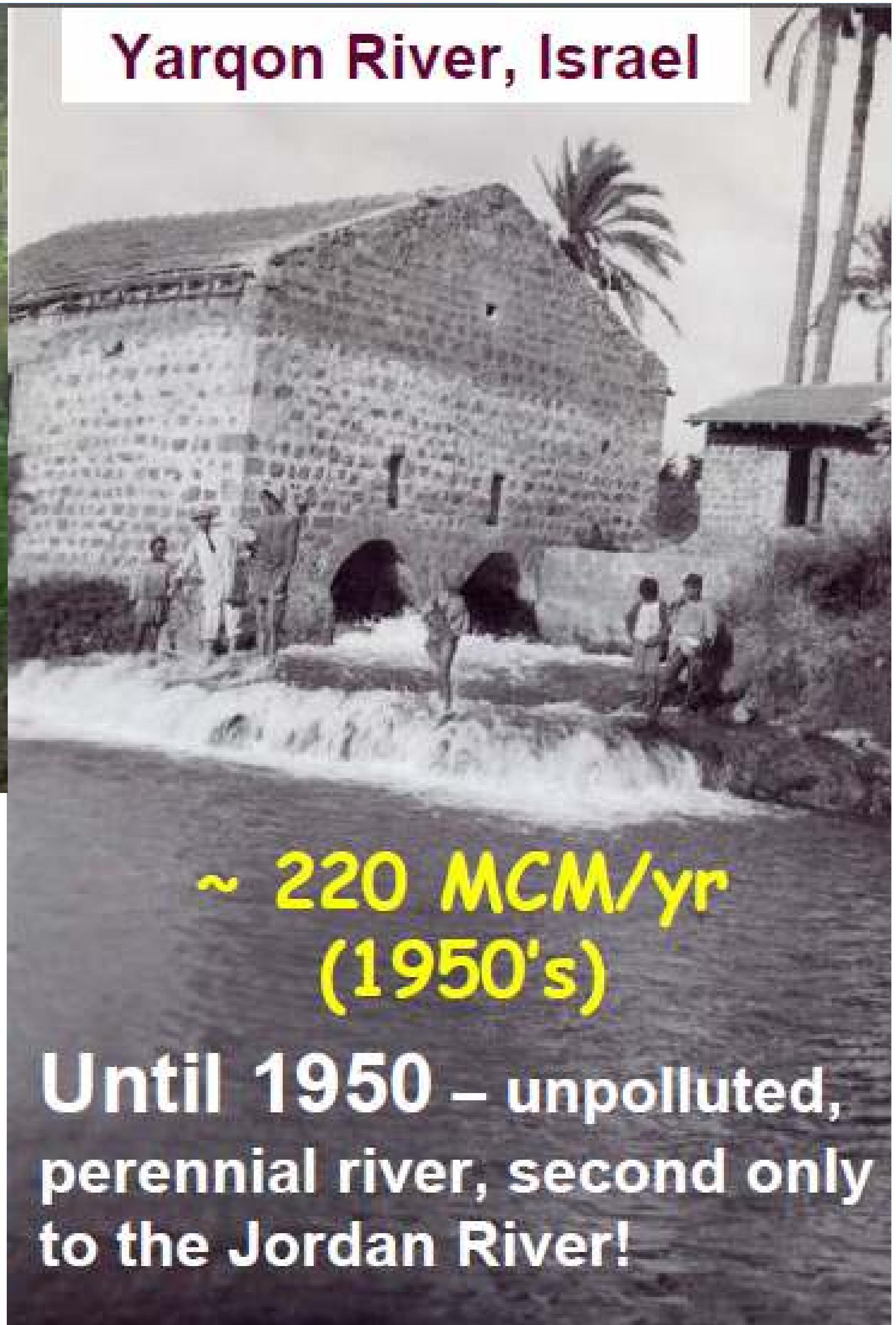


Water Framework Directive:

"*Ecological Status*" is an expression of the **quality of the structure and functioning of aquatic ecosystems**

Good ecological status is a condition in which:

- Biological quality elements show only slight deviation from the type-specific reference condition
- Physico-chemical elements are at levels capable of supporting the functioning of the type-specific ecosystem



Today – hardly flowing'
Polluted stream

(Source: Avital Gasith, Tel Aviv university)

Gateway to solutions

Israel's Public Health Regulations (Effluent Quality Standards and Wastewater Treatment Rules)
[officially published: April 2010]

Maximum level of the main parameters for unlimited irrigation and for rivers flow

Parameter	Units	Unlimited irrigation	Rivers flow
Electrical conductivity	dS/m	1.4	
BOD	Mg/L	10	10
TSS	Mg/L	10	10
COD	Mg/L	100	70
Nitrogen (ammonia)	Mg/L	10	1.5
Nitrogen (general)	Mg/L	25	10
Phosphorous (general)	Mg/L	5	1.0
Chloride	Mg/L	250	400
Koli	Units/100mL	10	200
Boron	Mg/L	0.4	