Water Reuse in the Greece & EU: Current Practice and Trends

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Themes

- Water reuse history
- Water reuse in EU & Greece
- Water reuse trends
- Need for uniform terminology and regulatory framework
- Closing thoughts

Water reuse history

"Rains are generated from the evaporation (atmis) that is sent up from the earth toward under the sun "

Hippolytus of Rome (170-236 AD),
Ref. I6, 1-7-D.559 W.10

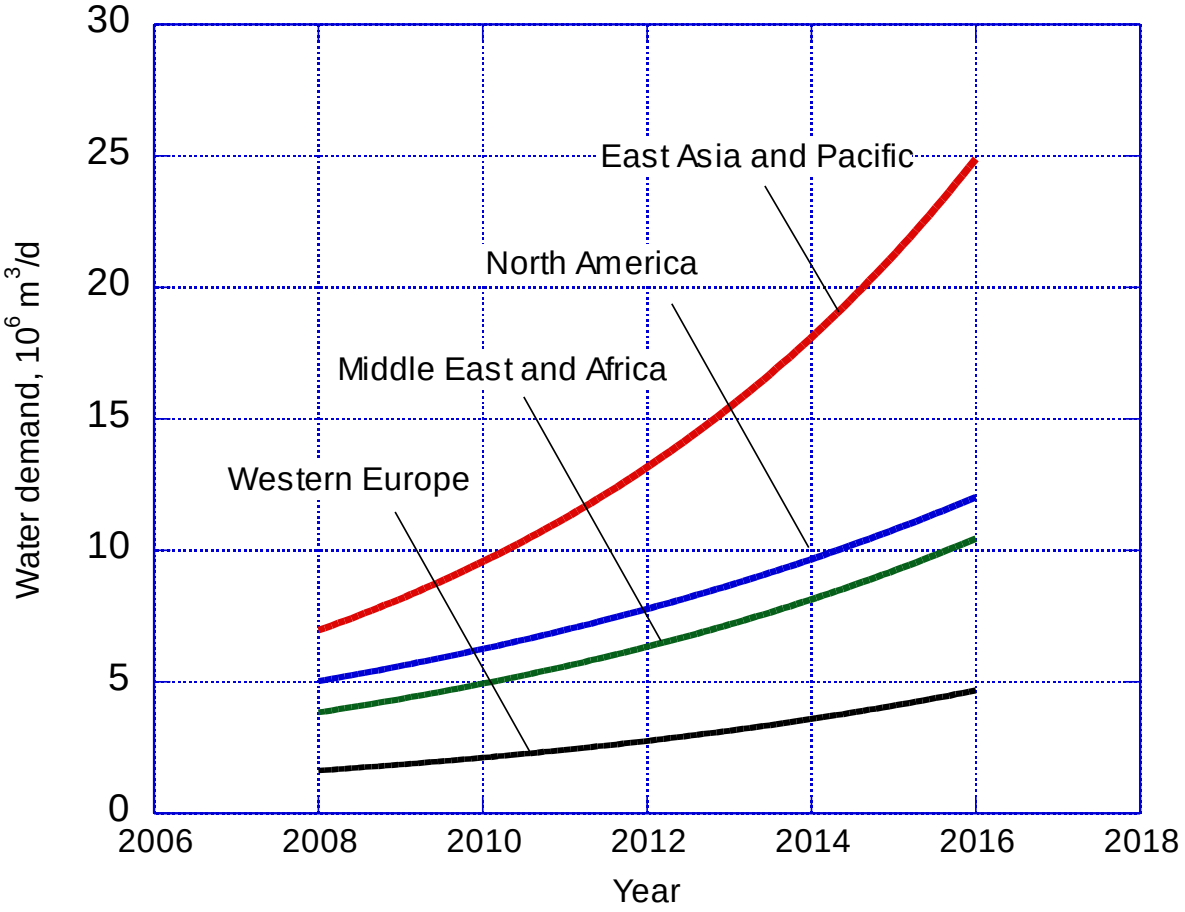
Water reuse is misunderstood

The true is that all water is reused, always

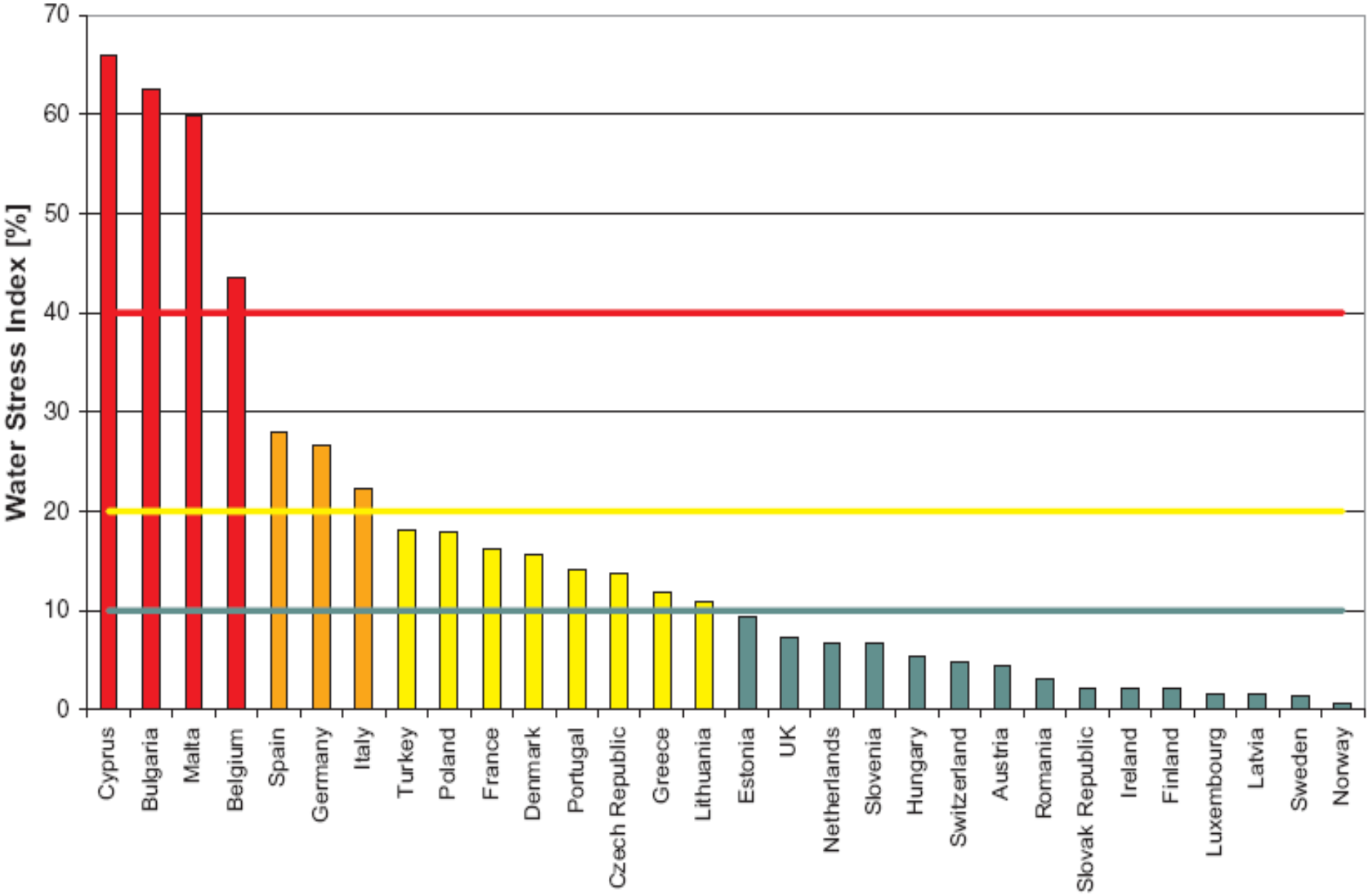
Urbanization Along Coastal Areas

- It is estimated that by 2050 the world's population will be 9.5 billion which will mostly settle in urban areas.
- By 2030, 60 % of world's population will near a coastal region.
- Withdrawing water from inland areas, transporting it to urban population centers, treating it, using using it once, and discharging it to the coastal waters (e. g. Athens) is unsustainable.

Reuse: Projected Worldwide Growth



Source: GWI Global Water Market 2008



WSI % (abstraction/availability ratio) WSI below 10%: low; WSI from 10% to 20%: moderate, WSI from 20% to 40%: high and WSI above 40%: severe

Water Reuse Status in EU

✓Water reuse status are quite different between north and south EU

✓In EU more than 150 Mm^3/d of municipal wastewater effluent is discharged in the oceans, seas, rivers, and lands.

✓About 200 water reuse projects have been implemented in EU with an estimated volume of 750 Mm^3/yr (USA 3,850 Mm^3/yr). Also many others are in an advanced planning phase.

✓Water reuse volume at EU level in 2025 is 3,222 Mm^3/yr; that volume would save 0,9% of the total water abstraction in the year 2025. However, in southern countries, e. g. Malta, Cyprus, and Greece, Spain could cover up 26%, 7.6%, 5%, and 3% of their future water demand, respectively.

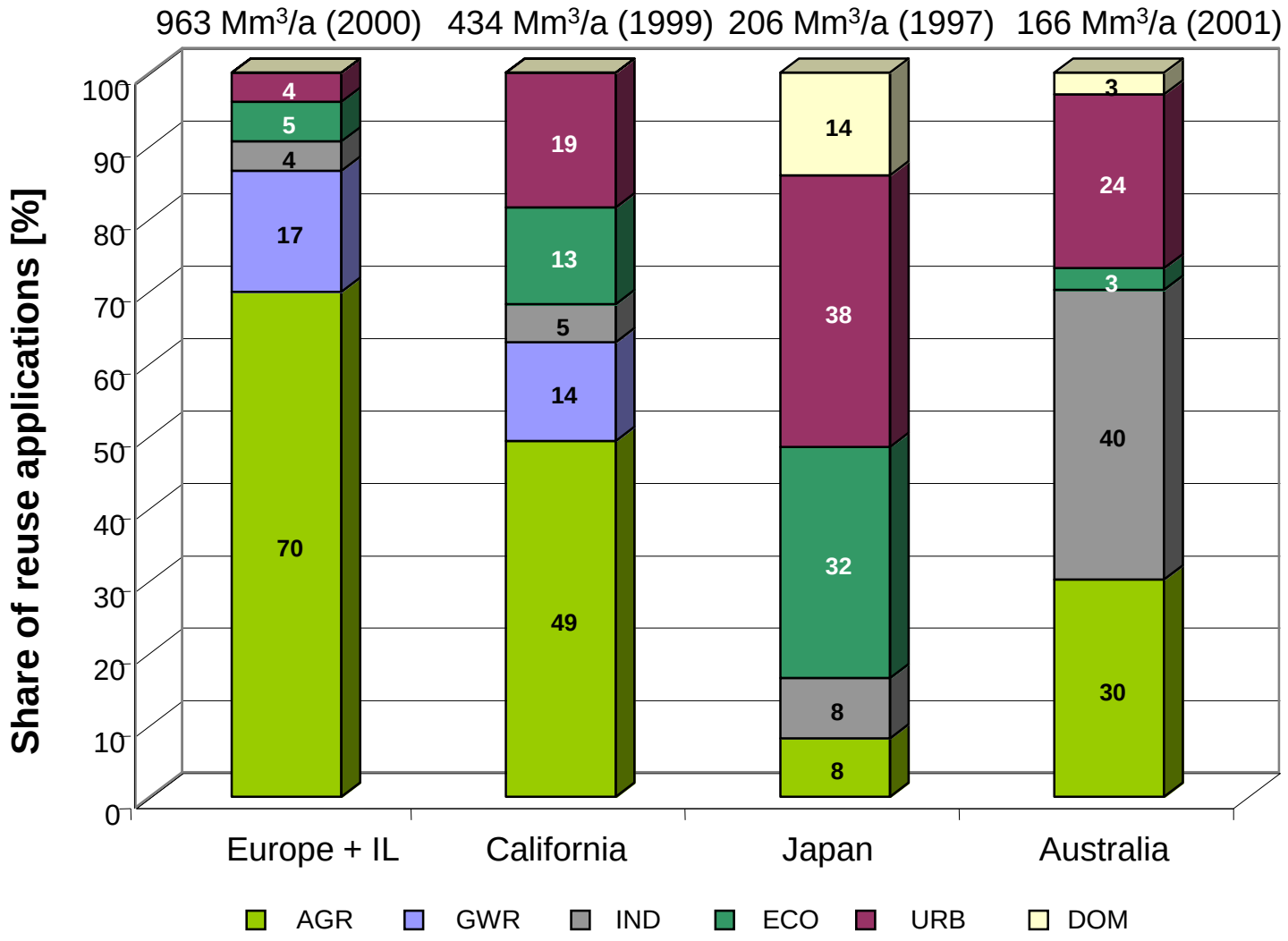
Major water reuse sites in Hellas (adapted from Ilias et al., 2014)

Project	Region	Capacity (m^3/d)[a]	Irrigated area (ha)	Crops
Irrigation of agricultural land				
Thessaloniki (Sindos)	Central Macedonia	165,000	2500	Corn, sugarbeets, rice, etc.
Iraklion[b]	Crete	9,500	570	Grapes & Olive trees
Levadia	Central Hellas	3,500		Cotton, corn
Chersonissos	Crete	4,500	270	Olive trees
Malia	Crete	2,500	150	
Kos	North Aegean	3,500	210	Olive trees & citrus
Others		11,750		Various
Irrigation of other land (parks, forest, etc.)				
Chalkida	Central Hellas	4,000	50	
Karistos	North Aegean	1,450	30	
Ierissos	South Aegean	1,500	25	
Others		3,300		
Indirect reuse				
Larissa	Thessaly	25,000		Cotton, corn, etc
Tripoli	Peloponnesus	18,000		
Others		65,000		
Total		318,500		

[a]The effluent is used only during the dry period of the year, ranging from 3 to 6 months/yr depending on climate, agronomical and other local conditions.

[b] Also a new NMR reuse project of 6,000 m^3/d is currently under construction.

Water reuse in different regions



Source: Hochstrat et al. Development of integrated water reuse strategies. Desalination, 2007, 218, 208-217
with data from AQUAREC (2004), Asano (2000), ATSE (2004)

Major water reuse applications and constrains

Application	Major constrains
Agricultural irrigation	Seasonal demand and need for winter storage. Usually away from the point of water reclamation.
Landscape irrigation	Dispersed nature of landscape irrigation. Cost of parallel distribution system.
Industrial use	Constant demand but site specific. Limited demand.
Non-potable urban uses	Limited demand. Requirement for dual piping systems.
Recreation/environmental uses	Site specific.
Indirect potable reuse	Most communities lack suitable hydrology for groundwater recharge. Availability of nearby suitable surface storage.
Direct potable use	Public perception issues.

So What is the Answer?

If a significant amount of wastewater is to be recycled from large cities without the availability of suitable environmental buffers (either groundwater or surface water), then direct potable reuse, with adequate protective measures will have to be implemented

Science versus criteria

Pre 1880s

Physical observations - No Science - Common sense practices (regulations)

Enlightenment 1880-1980s

Science develops - Semi-scientific, observational, and empirical regulations follow

Post 1980s

Science leaps ahead - Science based regulations have evolved, but have not kept pace - Semi-empirical and empirical legacy regulations persist.

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Comparison of EU-Med Countries for unrestricted irrigation with those of major worldwide philosophies (Paranychianakis *et al*., 2014)

Agency, Country or State	Indicators	Targets (log reduction)
WHO (2006)	*E. coli*[a]: 10-10^5 cfu/100 mL	Rotavirus: 7 *Cambylobacter* *Cryptosporidium*
Australia (2006)	*E. coli* ≤1.0 cfu/100 mL	Rotavirus: 6.0 *Campylobacter* : 5.0 *Giardia* : 5.0
Calif. (Title 22, 2000)	TC ≤ 2.2 cfu/100 mL	-
Cyprus	FC: ≤5[a] cfu/100 mL Helminth eggs: ? 0 /L	-
France	*E. coli* ≤ 250 cfu/100 mL	Bacteriohages ? 4 Enterococci ? 4 A.S.B. ? 4
Greece	*E. coli* ≤5[b] cfu/100 mL TC ≤2[c] cfu/100 mL	-
Italy	*E. coli* ≤10 cfu/100 mL	-
Malta	No set ?	-
Portugal[d]	FC ≤100 cfu/100 mL Helminth eggs ?1.0 /L	-
Spain[e]	*E. coli* ≤100 cfu/100 mL Helminth eggs: <1/10L	-

[a]Values must not be exceeded in 80% of samples/month; [b]For agricultural crops; [c]For urban irrigation; [d]'Unrestricted irrigation' actually is not described in these criteria; [g]For urban uses 0 is required

Need for accepted terminology

Issues

- There is a need to speak with one voice
- Not everyone agrees that indirect potable reuse is acceptable
- Little standardization of terms (e. g., indirect and direct potable reuse)

Consequence

- Everyone says whatever suits their particular interest
- The public is confused, especially about the safety of reclaimed water.
- A uniform terminology is of critical importance, if reuse projects are to be discussed rationally

Closing thoughts

- Water recycling and reuse will be a critical element in the development of sustainable strategies for water resources management
- Technology is now available to produce water for any use including direct potable pipe to pipe reuse
- Must resolve disconnect between existing criteria and regulations and scientific findings
- In promoting water reuse, the profession must speak with a unified terminology

Take home message

Think about wastewater as a renewable recoverable source of energy, nutrients, and water

Photo of Eridanos river

Factors Limiting Nonpotable and Indirect Potable Reuse

Agricultural Irrigation

- Large distance between recycled water and agricultural demand
- Need to provide winter storage

Landscape Irrigation

- Dispersed nature of landscape irrigation
- Cost of parallel distribution system

Indirect Potable Reuse

- Most communities lack suitable hydrology for groundwater recharge
- Availability of nearby suitable surface storage

Offsetting Potable Water Demand for Irrigation

(System has been in Operation for 25 Years, Upland, CA)

Courtesy D. Ripley

Water Reuse Status in EU

✓Water reuse status are quite different between north and south EU: in southern EU, water is reused predominantly for agricultural irrigation and for urban or environmental applications; in northern EU, the uses are mainly for urban or environmental applications or industrial.

✓In EU more than 150 Mm^3/d of municipal wastewater effluent is discharged in the oceans, seas, rivers, and lands.

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