Perspectives on water reuse in Europe

Windhoek, 18-19 October 2018
How far are we from potable reuse?

1. Very far, it’s never going to happen
2. Maybe not so far
3. Well, it’s already happening
4. Actually, it’s been happening for a long time
Significant resources from surface and underground water

- 3,500 m³/y per inhabitant

But a heterogeneous repartition of resources (seasonal and geographical)

- From 11,000 to 100 m³/y per inhabitant
- ~10% of renewable fresh water extracted in average
- But can reach >40% (severe stress) in many parts of Europe during summer

Source: European Environmental Agency
An increasing pressure from competing needs, especially over the summer period.

Source: European Environmental Agency
Municipal wastewater remains an untapped resource:
- In 2015 ~1,100 Mm³/y of recycled water
- ~2.4% of treated urban wastewater
- and <0.5% of annual EU freshwater withdrawals

Regulations for water reuse in several countries:
- Italy, 2003
- Spain, 2007
- Greece, 2011
- France, 2010...

Lack of consistency in regulation ➔ risk!
Lack of incentives ➔ cost!

Source: Water Reuse Europe
European Regulation on Minimum Requirements for Water Reuse
- for agricultural irrigation

Amendments to include landscape (and recreational irrigation) have been proposed under class A water

Focusing on microbiological risks depending on irrigation scheme and type of product

Validation required only for Class A water – used for irrigation of crops consumed raw

<table>
<thead>
<tr>
<th>Reclaimed water quality class</th>
<th>Indicator microorganisms</th>
<th>Performance targets for the treatment train ($\log_{10}$ reduction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A</td>
<td>E. coli</td>
<td>$\geq 5.0$</td>
</tr>
<tr>
<td></td>
<td>Total coliphages/F-specific coliphages/ somatic coliphages*</td>
<td>$\geq 6.0$</td>
</tr>
<tr>
<td></td>
<td>Clostridium perfringens spores/spore-forming sulphite-reducing bacteria**</td>
<td>$\geq 5.0$</td>
</tr>
</tbody>
</table>

Source: JRC report, 2017
## A maturing regulatory landscape

<table>
<thead>
<tr>
<th>Class</th>
<th>Indicative technology target</th>
<th>( E. \ coli ) (cfu/100 ml)</th>
<th>( BOD_5 ) (mg/l)</th>
<th>TSS (mg/l)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A</td>
<td>Secondary treatment, filtration, and disinfection (advanced water treatments)</td>
<td>≤10 or below detection limit</td>
<td>≤10</td>
<td>≤10</td>
<td>≤5</td>
</tr>
<tr>
<td>Class B</td>
<td>Secondary treatment, and disinfection</td>
<td>≤100</td>
<td>According to Directive 91/271/EEC</td>
<td>According to Directive 91/271/EEC</td>
<td>-</td>
</tr>
<tr>
<td>Class C</td>
<td>Secondary treatment, and disinfection</td>
<td>≤1,000</td>
<td>According to Directive 91/271/EEC</td>
<td>According to Directive 91/271/EEC</td>
<td>-</td>
</tr>
<tr>
<td>Class D</td>
<td>Secondary treatment, and disinfection</td>
<td>≤10,000</td>
<td>According to Directive 91/271/EEC</td>
<td>According to Directive 91/271/EEC</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: JRC report, 2017
## A maturing regulatory landscape

<table>
<thead>
<tr>
<th>Crop category</th>
<th>Minimum reclaimed water quality class</th>
<th>Irrigation method</th>
</tr>
</thead>
<tbody>
<tr>
<td>All food crops, including root crops consumed raw and food crops where the</td>
<td>Class A</td>
<td>All irrigation methods allowed</td>
</tr>
<tr>
<td>edible portion is in direct contact with reclaimed water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food crops consumed raw where the edible portion is produced above ground</td>
<td>Class B</td>
<td>All irrigation methods allowed</td>
</tr>
<tr>
<td>and is not in direct contact with reclaimed water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class C</td>
<td>Drip irrigation only</td>
<td></td>
</tr>
<tr>
<td>Processed food crops</td>
<td>Class B</td>
<td>All irrigation methods allowed</td>
</tr>
<tr>
<td></td>
<td>Class C</td>
<td>Drip irrigation only</td>
</tr>
<tr>
<td>Non-food crops including crops to feed milk- or meat-producing animals</td>
<td>Class B</td>
<td>All irrigation methods allowed</td>
</tr>
<tr>
<td></td>
<td>Class C</td>
<td>Drip irrigation only</td>
</tr>
<tr>
<td>Industrial, energy, and seeded crops</td>
<td>Class D</td>
<td>All irrigation methods allowed</td>
</tr>
</tbody>
</table>

Source: JRC report, 2017
But one can’t always wait…

... and some are already planning for potable reuse!

2 case studies from the European funded project Demoware

➢ Vendée Eau, France
➢ El Port de la Selva, Spain

http://demoware.eu/en
Located on west coast of France
- Relying primarily on limited surface reservoir resources
- Peak period of competing demand over summer from tourism & agriculture:
  - 650,000 inhabitants & 5,000,000 tourists per year
- Risk of shortage on drinking water supply already exists

Year 2005

Source: Vendée eau
Vendée Eau – Jourdain project

**Improvement of existing assets performance and demand management**

- Reduction of water consumption by awareness campaigns
  
  \(<100\text{m}^3/\text{y/inhabitant}\)

- Improvement of drinking water distribution network
  
  \(<1\text{m}^3/\text{km/year loss}\)

- Transfer pipes from dams to dams
  
  120 km

- Improvement of existing dam capacity

**Alternative resources**

- Seawater desalination

- Indirect potable reuse

Source: Vendée eau
Vendée Eau – Jourdain project

- Demonstration project for 150 m³/h
- 2017 – 2024

Source: Vendée eau
Vendée Eau – Jourdain project
El Port de la Selva, Spain

- Resident population: 994
- Summer population: > 10,000
- Water supply: 20,000 m³ (January), 70,000 m³ (August)

Source: DEMOWARE
Relying exclusively on underground water

Impossible to connect to other water main (> 30 km through mountains)

Over-extraction led to saline water intrusion

Tertiary treatment (2004) for 25 m3/h:
  - Coagulation + Multimedia filtration + UV disinfection
  - Non-potable urban uses (garden irrigation)

Assess the potential for aquifer recharge:
  - Risk assessment
  - Water quality monitoring and modeling
  - Design and operations optimization
  - LCA
El Port de la Selva, Spain

- WWTP effluent
  - Tertiary treatment:
    - Coagulation
    - Dual stage filtration
    - UV disinfection
  - Chlorine disinfection
- Urban uses
- Infiltration ponds
- Treated water reservoir
- Potable water
- Infiltration ponds

Source: DEMOWARE
El Port de la Selva, Spain

- WWTP effluent
- Tertiary treatment:
  - Coagulation
  - Dual stage filtration
  - UV disinfection
  - Chlorine disinfection

Urban uses:
- Infiltration ponds

Seasons:
- Summer
- Winter

Infiltration ponds

Source: DEMOWARE
But one can’t always wait…

… and some have already implemented it.

➢ *Groundwater recharge at Torreele, Belgium*

➢ *River bank filtration in Berlin, Germany*
Triggers for water reuse at IWVA:

- *Increased potable water demand*

- *Need for sustainable groundwater extraction to prevent saline intrusion*

- *Need for ecological management of the dune area*

*Source: Intermunicipal Water Company of the Veurne Region (IWVA)*
The Torreele water plant, Belgium

Integration of wastewater reuse into an existing drinking-water production scheme

Source: Intermunicipal Water Company of the Veurne Region (IWVA)
The Torreele water plant, Belgium

Monochloramines to prevent biofouling

pH control and antiscalant dosing to prevent scaling

Redox control for membrane protection

Source: Intermunicipal Water Company of the Veurne Region (IWVA)
In operation since 2002:

- ~2 Mm3/year of water reclaimed (~40% of local water demand)
- Combination of UF/RO produces water of excellent quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>UF Filtrate</th>
<th>RO Filtrate</th>
<th>Infiltration Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity (µS/cm)</td>
<td>1.148 (481 - 1.474)</td>
<td>23 (10 - 39)</td>
<td>43 (16 - 94)</td>
</tr>
<tr>
<td>Total Organic Carbon (mg/l)</td>
<td>8.4 (4.3 - 11.8)</td>
<td>&lt;0.2</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td>Total hardness (mg/l as CaCO₃)</td>
<td>27.9 (13.3 - 37.6)</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Total alkalinity (mg/l as CaCO₃)</td>
<td>22.3 (9.0 - 31.2)</td>
<td>&lt;1</td>
<td>2.3 (1.3 - 4.7)</td>
</tr>
<tr>
<td>Chloride (mg/l)</td>
<td>204 (74 - 286)</td>
<td>2.9 (&lt;1 - 5.0)</td>
<td>2.9 (1.5 - 4.6)</td>
</tr>
<tr>
<td>Total Nitrogen (mg N/l)</td>
<td>8.0 (3.0 - 14.9)</td>
<td>&lt;2</td>
<td></td>
</tr>
<tr>
<td>Nitrate (mg NO₃/l)</td>
<td></td>
<td></td>
<td>2.4 (&lt;1 - 6.3)</td>
</tr>
<tr>
<td>Ammonia (mg NH₄/l)</td>
<td></td>
<td></td>
<td>&lt;0.1 (&lt;0.05 - 0.23)</td>
</tr>
<tr>
<td>Total Phosphorous (mg P/l)</td>
<td>0.7 (0.2 - 1.7)</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Silica (mg SiO₂/l)</td>
<td>19.0 (9.5 - 25.1)</td>
<td>0.25 (&lt;0.1 - 0.4)</td>
<td>0.23 (0.1 - 0.3)</td>
</tr>
<tr>
<td>Sodium (mg/l)</td>
<td>144 (50 - 197)</td>
<td>3.7 (1.4 - 6.4)</td>
<td>10.3 (3.7 - 16.5)</td>
</tr>
<tr>
<td>Total Coliform (counts/100ml)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E. Coli (counts/100 ml)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Heterotrophic plate count (22°C)</td>
<td>8 (0 - 31)</td>
<td>&lt;1 (0 - 1)</td>
<td>&lt;1 (0 - 20)</td>
</tr>
</tbody>
</table>

Source: Intermunicipal Water Company of the Veurne Region (IWVA)
The Torreele water plant, Belgium

In operation since 2002:

- ~2 Mm3/year of water reclaimed (~40% of local water demand)
- Combination of UF/RO produced water of excellent quality
- Combination with infiltration in dune area enabled sustainable groundwater management and enhanced ecological value of this dune area:
  - **Higher groundwater levels in the dunes**:  
    - No risk of saline intrusion in the future: water flows out of dunes to sea and polders  
    - Enhanced natural values in the dunes
  - **Improved drinking-water quality**:  
    - DW is softer than prior to infiltration;  
    - DW is brighter

*Source: Intermunicipal Water Company of the Veurne Region (IWVA)*
Recent upgrade work

- Subterranean infiltration
  - No clogging and no recontamination
  - More stable temperature: warmer in winter, thus higher infiltration rate and moderate in summer

- Willow treatment of RO concentrate

Source: Intermunicipal Water Company of the Veurne Region (IWVA)
Situation

- For the past 70 years, bank filtration has produced approximately 60% of the city’s drinking water.
- Water abstraction in Berlin occurs in around 650 wells and is part of a semi-closed water cycle.
- Bank filtration lakes containing between 17 - 35% of Berlin’s advanced treated wastewater.

Drinking water quantity in Berlin, 2004

Source: Pawlowski.L 2007
River bank filtration, Germany

Windhoek, 19 October 2018
... chances are that you are already reusing water for drinking water production.

‘De-facto’ or ‘unplanned’ potable reuse
What is de-facto reuse?

- Treated wastewater goes back to the environment
- Unless when discharged in coastal water bodies, the water will be available for downstream users
- Even if not recognized broadly this ‘unplanned’ or ‘de-facto’ water reuse is common throughout Europe
- Impacts depend on dilution ratio in the surface water bodies
Study report released in 2017 by TUM for the European commission

Benchmark the current degree of unplanned water reuse in Europe, in particular in areas that are practicing agriculture irrigation and artificial groundwater recharge using surface water.
Some conclusions:

- Ebro river basin in Spain: 3 to 11% of wastewater depending on flow conditions
- Llobregat river district, Spain: 8 to 82%
- Adda and the Oglio rivers, Italy: 7-27% and 4-15%, respectively. Up to 68% under low flow conditions
- Loir river, France: 0.3 and 2.6% in average, but up to 24% under low flow conditions
- Montpellier river basin: 1.5 to 51% in average
“The Case Studies presented in this study clearly illustrated that surface water qualities in areas in different regions of Europe where agricultural irrigation is practiced are impacted by wastewater effluents to a significant degree.”

This conclusion cannot be substantially different for surface water feeding potable water plants.
Europe is far behind pioneer places like Namibia, Singapore, the USA or Australia

- Lack of consistent and effective regulation at European level
- Lack of financial incentives at national and regional level
- Primary focus is on other types of use (agriculture, industry, urban…)

However, the perspectives for water reuse in Europe are not all dark

- Changing landscape due to climate variability, urbanization, competing needs
- Many existing water reuse schemes for irrigation, industrial usage…
- Strong expertise in process design, engineering, operation and maintenance

Local needs drive action

- Emerging projects for potable reuse in planning driven by local/regional utilities
- Existing schemes that have been in operations for years and have proven reliable
Acknowledgement:
Emmanuel Van Houtte (IWVA)

Thank you!
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