Drivers and barriers for market uptake of DEMEAU technologies

Results from WA 5

This project has received funding from the European Union’s Seventh Programme for Research, Technological Development and Demonstration under Grant Agreement no. 308339.
• Aims and approach of WA5
• Case studies in Demeau WA1-4
• Findings from the case studies
  → WA1: MAR at Sant Vicenç dels Horts
  → WA2: HCMS pilot at WWTP Birsfelden
  → WA3: Ozonation at Neugut
  → WA4: Bioassays at WaterNet
• Overarching drivers and barriers
Focus of WA5 on the socio-technical system
Fostering the uptake of novel technologies in the water sector

A sustainability driven approach
• **Environmental and public health benefits (mostly local):** Avoided impacts from reduced concentration of emerging contaminants in WWTP effluent and drinking water

• **Environmental impacts (often off-site):** Induced impacts from increased resources demand (energy, chemicals, waste products etc.)

• **USEtox® tool:** LCA characterization factors for DEMEAU calculated and applied based on eco-tox and human-tox data
• **Economic feasibility**: analysis of life cycle costs of innovative technologies/arrangements

• **Compared to alternative solutions**: estimation of the life cycle costs of the currently best-available competing technologies
• **Implementation drivers and barriers:** assessment of enabling and constraining factors that influence implementation of technologies

• **Zooming out to socio-technical system:** focus on interaction between society (stakeholders) and technology

• **Multi-step analysis:** preliminary inventory, extensive survey, interactive workshops/interviews.
Throughout the innovation cycle...

<table>
<thead>
<tr>
<th>Idea generation</th>
<th>Research institute</th>
<th>Government (Nat.)</th>
<th>Government (Reg.)</th>
<th>Water utility</th>
<th>Engineering comp.</th>
<th>Consultant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research and experimentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilot projects and tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology optimization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up-scaling to full scale operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Policy &amp; guideline development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authorization, legal regulation, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-scale implementation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Case studies across the four Work Areas

1. Preliminary inventory among WA leaders
2. Online survey among stakeholders
3. In-depth interactive workshops/interviews
   *(ongoing for WA3 and WA4)*

- Major barriers?
- Expectations from various stakeholder groups?
- Recommendations towards implementation?
<table>
<thead>
<tr>
<th>BARRIERS</th>
<th>REQUIRED FROM SCIENTIFIC COMMUNITY</th>
<th>REQUIRED FROM ADMINISTRATION</th>
<th>REQUIRED FROM OPERATORS</th>
</tr>
</thead>
</table>
| **TECHNOLOGICAL** | - Establishment of MAR communities, with special attention to the science-policy interface: exchange of knowledge, local options and consequences  
- Cooperate on realistic guidelines and regulations that consider the health and environmental effects in a measurable way  
- Willingness to communicate with each other, openness, transparency  
- Model clogging effects and find solutions  
- Translate experiences from other countries to local projects  
- Stop solving problems that already have been solved somewhere else  
- Determine the boundary conditions under which MAR is an effective solution. | - Make existing technological questions explicit | - Make plants/playgrounds available for pilots and tests |
| **REGULATORY** | - Regulators still see too many risks  
- Regulation are inflexible  
- Conservative attitude of regulators  
- Regulation does not (yet) include the variety of water qualities (incl recycled water)  
- Lack of health and environmental parameters  
- Complex communication among various administrative levels  
- Define health and environmental parameters to be able to make MAR practices measurable  
- Listing priority substances to monitor  
- Dissemination to and coordination with regulators | - Aim for regulations that are locally adaptable  
- Include measurable parameters (also of emerging pollutants) in regulations that allow measurement of the effects on water quality (instead of being strict on the inflow water)  
- Consider water quality on basin level  
- Don’t come up with new regulations, but improve existing ones  
- Improve communication among adm. levels  
- Adapt EU regulations to local circumstances | - Be transparent: show results, provide test data, real costs, reasons for failure, etc. to look jointly for solutions  
- Participate in discussions (especially local discussions regarding specific solutions)  
- Don’t just ‘assume’ that regulations are and will always be a barrier. |
| **FINANCIAL** | - MAR competes with other water related solutions  
- High costs for pre-treatment of (recycled) water for well injection  
- Open question of who pays the bill  
- Viability of solution is questioned  
- Conduct and communicate Lifecycle Costing and Lifecycle assessments to clarify the “choices” and longer term effects | - Aim for public funding on a longer term (avoid limited subsidies)  
- Integrate costs of water reclamation in water bill (to allow for higher investments)  
- Consider also the (partly qualitative) savings done by reclaiming water  
- Extending exploitation period (for operators), redistribution of costs  
- Not “coffee for all” (refers to autonomous regions) | - Contribute financially to development and maintenance of technology and regulations (is already done by some)  
- Invest in tertiary treatment (which enables infiltration of cleaner water) |
| **SOCIAL** | - Conservative attitude of consumers  
- Lack of dissemination on local level  
- Communicate findings (in understandable language) outside scientific community | - Start public dialogue about MAR, including various stakeholders | - |
• Aims and approach of WA5
• Case studies in Demeau WA1-4
• Findings from the case studies
  → WA1: MAR at Sant Vicenç dels Horts
  → WA2: HCMS pilot at WWTP Birsfelden
  → WA3: Ozonation at Neugut
  → WA4: Bioassays at Waternet
• Overarching drivers and barriers
# Building upon case studies from the four DEMEAU work areas

<table>
<thead>
<tr>
<th>WA1: Managed Aquifer Recharge</th>
<th>WA2: Hybrid Ceramic Membrane Systems &amp; ANCS</th>
<th>WA3: Oxidative processes</th>
<th>WA4: Bioassays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sant Vicenç dels Horts</td>
<td>Dunea</td>
<td>Birsfelden</td>
<td>WAG</td>
</tr>
<tr>
<td>© CETaqua</td>
<td>© Dunea</td>
<td>© Jan Svojitka</td>
<td>© Aquatune</td>
</tr>
</tbody>
</table>

- **Aquifer recharge + potential water reuse**
  - Drinking water treatment
  - Wastewater treatment
  - Drinking water treatment
  - Wastewater treatment
  - Drinking water treatment
  - Effects-based monitoring in DW treatment

- **Infiltration ponds + organic layer**
  - **Dune infiltration + AOP**
  - **Ceramic UF + PAC**
  - **treatment + ANCS**
  - **Ozonation + Sand filtration**
  - **Dune infiltration + AOP**
  - **Bioassays**
• Aims and approach of WA5
• Case studies in Demeau WA1-4
• Findings from the case studies
  → WA1: MAR at Sant Vicenç dels Horts
  → WA2: HCMS pilot at WWTP Birsfelden
  → WA3: Ozonation at Neugut
  → WA4: Bioassays at Waternet
• Overarching drivers and barriers
Key application areas

- River water infiltration for aquifer recharge
- Potential for water reuse

Motivation for implementation at SVH

- MAR: Improving groundwater quantity and quality
- Organic layer: Potential for water reuse from WWTP effluent (multi-barrier approach)
PERCEIVED BARRIERS FROM WORKSHOP

• **Technological**
  
  Well clogging / lack of maintenance protocols
  
  Infiltration water quality (unknown effects on ecosystem)

• **Regulatory**
  
  Lack of differentiated approach for various infiltration qualities
  
  Complex mix of administrative responsibilities

• **Financial**
  
  High costs for wastewater pre-treatment (before infiltration)
  
  Competes with other (more feasible) solutions

• **Social**
  
  Conservative / risk averse attitude of stakeholders
  
  Lack of involvement of local level stakeholders (e.g. consumers)
**SCIENCE**
- Model clogging effects
- Translate international experiences
- Determine boundary conditions
- Define health and environmental parameters
- List priority substances to monitor
- Coordinate with regulators
- Communicate findings outside scientific community

**ADMINISTRATION**
- Make explicit which questions still exist
- Improve current regulations (instead of extra)
- Improve coordination among adm. levels
- Consider water quality on basin level
- Long-term vision on funds and savings
- Start public dialogue

**UTILITIES**
- Open plants for pilots/tests
- Transparency, share data on costs and failures
- Participation in local discussions
- Don’t ‘assume’ that regulations never change
- Invest in tertiary treatment
OVERARCHING RECOMMENDATIONS FROM WORKSHOP:

• Establish MAR communities (science – policy – practice – public)

• Cooperate on realistic measurable guidelines/regulations

• Transparent, open, constructive communication
• Aims and approach of WA5
• Case studies in Demeau WA1-4
• Findings from the case studies
  → WA1: MAR at Sant Vicenç dels Horts
  → WA2: HCMS pilot at WWTP Birsfelden
  → WA3: Ozonation at Neugut
  → WA4: Bioassays at Waternet
• Overarching drivers and barriers
Key application areas

• Advanced wastewater treatment
• Wide spectrum of emerging contaminants removal

Motivation for pilot at WWTP Birsfelden

• New regulations in Switzerland to upgrade WWTPs with additional removal of emerging contaminants
• Experiments on operating conditions (PAC dosage, aeration, backwash etc.) and the removal efficiency for emerging contaminants
PERCEIVED BARRIERS FROM WORKSHOP (membranes)

- **Technological**
  - Expected increased energy demand
  - Is it really feasible/possible in practice?
  - Required raw materials for PAC (environmental impact)

- **Regulatory**

- **Financial**
  - Costs of upgrading existing treatment plant

- **Social**
  - Unawareness (utilities) of benefits of ceramic membranes
Ceramic membranes

**SCIENCE**
- Communicating benefits
- Un-scientifying Outcomes/results (accessibility)
- Research on alternative raw materials (PAC)

**ADMINISTRATION**
- Facilitate exchange with other application areas
- Support pilot projects
- Developing guidelines on PAC production

**UTILITIES**
- Optimization to reduce energy demand
- Actively engage in knowledge transfer

Exchange experiences/knowledge with other application areas
PERCEIVED BARRIERS FROM WORKSHOP (ANCS)

• **Technological**
  Not all operational conditions included in algorithm

• **Regulatory**
  Possible resistance by administration (water safety!)

• **Financial**
  Considerable initial investment required

• **Social**
  Lack of transparency of optimisation process (what is happening?)
  Fear of job loss due to automation
SCIENCE

- Technical communication
- Visualization of results
- Interaction with administration
- Independent scientific validation

ADMINISTRATION

- Better implementation of national regulations (energy efficiency)
- Openness to innovation
- Cost and environmental conscious decision making

UTILITIES

- Include utility staff in ANCS introduction
- Transparency; show how it works in practice
- Knowledge sharing within organization
- Training of operators
- Job security atmosphere
• Aims and approach of WA5
• Case studies in Demeau WA1-4
• Findings from the case studies
  → WA1: MAR at Sant Vicenç dels Horts
  → WA2: HCMS pilot at WWTP Birsfelden
  → WA3: Ozonation at Neugut
  → WA4: Bioassays at Waternet
• Overarching drivers and barriers
Key application areas

- Advanced wastewater treatment
- Wide spectrum of emerging contaminants removal

Motivation for ozonation at WWTP Neugut

- New regulations in Switzerland to upgrade WWTPs with additional removal of emerging contaminants
- High micropollutant concentration in receiving water bodies
From the online survey...

Mainly drivers:

- Efficient/effective cooperation between research, utility and local administration
- Third project with same group of stakeholders
- First full-scale ozonation for wastewater treatment in Switzerland: gaining experience for future plants

BUT: further investigation planned!
• Aims and approach of WA5
• Case studies in Demeau WA1-4
• Findings from the case studies
  ➔ WA1: MAR at Sant Vicenç dels Horts
  ➔ WA2: HCMS pilot at WWTP Birsfelden
  ➔ WA3: Ozonation at Neugut
  ➔ WA4: Bioassays at Waternet
• Overarching drivers and barriers
### Key application areas

- Monitoring of water quality in different treatment steps of drinking water plants
- Measuring effects of complex mixtures of compounds

### Motivation for bioassays at Waternet

- Interest in **actual (toxic) effects** instead of presence of separate compounds
- **Cost effective way** of monitoring impact of subsequent treatment steps on water quality
BARRIERS FROM ONLINE SURVEY

• Technological

Which bioassays to use for which specific applications?
Still investigating threshold values (req. for implementation)

• Regulatory

Low involvement of policy makers (why?)
Lack of regulatory pressure to measure effects of mixtures
(focus on individual compounds)

• Financial

Lack of financial support for required tests and pilots
Perceived as ‘extra’ costs (does not replace other costs initially)

• Social

Lack of awareness of benefits of bioassays
• Aims and approach of WA5
• Case studies in Demeau WA1-4
• Findings from the case studies
  → WA1: MAR at Sant Vicenç dels Horts
  → WA2: HCMS pilot at WWTP Birsfelden
  → WA3: Ozonation at Neugut
  → WA4: Bioassays at Waternet
• Overarching drivers and barriers
OVERARCHING INSIGHTS:

- Regulatory pressure is a VERY important incentive
- Close cross-stakeholder communities with transparent communication!
- Explicate remaining questions on interface science – policy – practice
- Need for standards, BUT also sensitivity to local circumstances
- Effectively addressing risk perception (vital importance of water safety)
- Locally avoided eco-tox and human-tox impacts come with global trade-offs
Thank you for your attention!

This project has received funding from the European Union’s Seventh Programme for Research, Technological Development and Demonstration under Grant Agreement no. 308339.