Socio-economic interests of treated wastewater reuse in agriculture

Clermont-Ferrand case study cost-benefits analysis

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Which wastewater reuse scenario?

SUSTAINABLE SCENARIOS?
THE MOST PROFITABLE SCENARIO?

Sustainability of a wastewater reuse project = Security × Profitability × Feasibility × Acceptability × Organisation

Security:
- sanitary
- agronomical
- environmental

Profitability:
- economic
- financial viability

Feasibility:
- technical
- (process) regulatory

Acceptability:
- social
- political

Organisation:
- legal framework
- institutional

Source: Ecofilae, 2015
Cost-Benefit analysis methodology

✓ Used for analyzing project to determine whether or not they are of public interest (economic profitability)
✓ To identify which stakeholders lose/win and the actions to implement to reach win/win solutions

1) Sphere analysis characterization (time line, geography, stakeholders involved)
2) Identification of the different projects scenarios (reuse scenario(s) and business-as-usual scenario)
3) Costs and benefits identification and assessment for the different scenarios
4) Net present value (NPV) calculations
5) Sensitivity analysis of NPV to the main parameters
**Net Present Value**

the relevant economic indicator

\[
NPV = \sum_{t=0}^{T} \frac{B_t}{(1 + r)^t} - \sum_{t=0}^{T} \frac{C_t}{(1 + r)^t}
\]

\(NPV = \text{Net Present Value}\)
\(B = \text{Benefits}\)
\(C = \text{Costs}\)
\(T = \text{time horizon set}\)
\(r = \text{discount rate}\)

<table>
<thead>
<tr>
<th>Community NPV</th>
<th>Private NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>public</strong></td>
<td>+</td>
</tr>
<tr>
<td><strong>NPV</strong></td>
<td></td>
</tr>
<tr>
<td><strong>+</strong></td>
<td>Project feasible without intervention</td>
</tr>
<tr>
<td><strong>---</strong></td>
<td>Project to be dissuaded</td>
</tr>
</tbody>
</table>
Clermont-Ferrand case study
Treated wastewater reuse scenario

Clermont-Ferrand WWTP

**Owner:** Communauté d’Agglo de CF  
**Manager:** Veolia  
**Capacity:** 425 000 EH  
**Treatment:** Activated sludge + (Treatment N et P)

**Discharge**  
40 Mm3/year

Artièrè – Allier  
Sustain compulsory environmental flows

Sugar refinery lagoons  
Tertiary treatment

**Step 1:** sugar effluents  
**Step 2:** TWW (price 0 €/m3)

**Step 1:** spread of effluents  
200 000 m3/year – End of winter  
**Step 2:** irrigation  
900 000 m3/year – 5/6 months

Irrigation association perimeter  
1400 Ha equipped – 700 Ha irrigated  
Seed maize, maize, beetroots, wheat
Contrefactual business-as-usual scenario

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Capacity: 425 000 EH
Treatment: Activated sludge + (Treatment N et P)

Discharge
40 Mm3/year

Artière – Allier
Sustain compulsory environmental flows

Sugar refinery

Bedat river
Individual uptakes

Lagoons

Irrigation
200 000 m3/year

Agricultural area
200 Ha irrigated
Wheat, Maize, No seed maize
Scenario comparison

Agricultural gross margin

Reuse scenario

- Seed maize (irrigated): 252
- Maize for consumption (irrigated): 126
- Beetroots (irrigated): 322
- Maize for consumption (rain-fed): 119
- Beetroots (rain-fed): 147
- Wheat (rain-fed): 73.3 M€

Contrefactual scenario

- Seed maize (irrigated): 50
- Maize for consumption (irrigated): 50
- Beetroots (irrigated): 300
- Maize for consumption (rain-fed): 100
- Beetroots (rain-fed): 200
- Wheat (rain-fed): 60.6 M€

73.3 M€

60.6 M€
Main cost and benefit considered

- **Investments** (irrigation material, lagoons rehabilitation, distribution system, sanitary studies)
- **Annual charges** (operational, maintenance, energy)
- **Agricultural gross margin**
- **Avoided cost** of treatment for the sugar factory effluents
- **Subsidies** from funding agencies
Net Present Value

<table>
<thead>
<tr>
<th>Category</th>
<th>NPV (Millions €)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers</td>
<td>5.72</td>
</tr>
<tr>
<td>Sugar factory</td>
<td>9.60</td>
</tr>
<tr>
<td>Funding agencies</td>
<td>-5.22</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10.10</strong></td>
</tr>
</tbody>
</table>
### Sensitivity Analysis

Monte-Carlo method to deal with uncertainty

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>Hypothesis</th>
<th>Uncertainties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy price increase rate</td>
<td>0%/year (0,05€/m$^3$)</td>
<td>[0% ; +5%]</td>
</tr>
<tr>
<td>Sugar factory effluents treatment costs</td>
<td>1,9 €/m$^3$</td>
<td>[-20% ; +30%]</td>
</tr>
<tr>
<td>Irrigation equipment life-time</td>
<td>20 and 50 years</td>
<td>[-30% ; +30%]</td>
</tr>
<tr>
<td>Crops water needs</td>
<td>1 200 to 1 400 m$^3$/Ha</td>
<td>[-10% ; +20%]</td>
</tr>
<tr>
<td>Agricultural production price variation</td>
<td>180 to 270 €/T</td>
<td>[-30% ; +30%]</td>
</tr>
<tr>
<td>Seed maize area variation</td>
<td>434 Ha (reuse)</td>
<td>[-30% ; +10%]</td>
</tr>
</tbody>
</table>

1 0000 random draws

NPV dispersion
Sensitivity analysis

NPV dispersion

$y = \text{Prob. NPV} < x$

$x = \text{NPV (M€)}$

- NPV Farmers
- NPV Sugar factory
- NPV total
To go further...

- CBA = An economic support tool for decision-makers

- In Clermont-Ferrand TWWR is profitable but collective incentives could be implemented to allocate equally the collective net benefit

- Investment subsidies could have been lower

- Need to consider different time horizons and present time preference from the collectivity and the private point of view

- Difficulties to account for the possibility that agricultural land would be used for another activity in the business-as-usual scenario

- Need for further methodological developments → TWWR tailored environmental and social indicators

- Need for more feedbacks / lessons from experiences
Thank you for your attention