GIS & Multi-criteria based help-decision tool for food waste valorisation in the Basque Country (Spain)

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AZTI-Tecnalia: Sustainability Area

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INTRODUCTION

The world population is increasing enormously in recent years.

METHODOLOGY

The demand for natural resources.

RESULTS & DISCUSSION

A high organic waste generation, by food industry and retail trade.

CONCLUSIONS

A high potential to be valued as raw material for:
• Animal feed
• Biogas production
• ...

Need to be managed under appropriate conditions.

Almost three quartes of organic wastes end up in a dump.

ACKNOWLEDGEMENTS

www.lifegiswaste.eu
Profitability of these valorisation alternatives when they are full-scale implemented.

A great number of viability factors:
- Technical
- Economic
- Geographic
- Environmental

High risk of underestimating some of these factors

Unprofitable implementation of these valorisation alternatives

It is necessary to minimize that risk.
Title: “GIS based decision making tool for food by-products valorisation alternatives in Basque Country”

Co-funded by LIFE Program

Start-Finish date: 15/07/2013 → 30/06/2017

Consortium:

Coordinator

Beneficiary

Beneficiary

Beneficiary

www.lifegiswaste.eu
AZTI is a Technology Centre expert in marine and food research, committed to social and economic development of the fisheries, marine and food sector in the context of sustainable development.
Aim:
- To develop a GIS based tool which...

... helps to take the right decision about waste-management.

... minimizes the inherent risk of a full-scale implementation of a new food waste valorisation facility.
INTRODUCTION METHODOLOGY RESULTS & DISCUSSION CONCLUSIONS ACKNOWLEDGEMENTS

Scheme of the GISwaste tool

1.-Problem Definition

2.-Key Viability Factors
   - Relative importance
   - Limiting & conditional ranges
   - Matrix & rules decision

3.-Software programing

4.-Validation

AHP method

ArcGIS

GIS BASED TOOL

ANIMAL FEED

BIOGAS

ENVIRONMENTAL KEY VIABILITY FACTOR
   1 2 3 4

ECONOMIC KEY VIABILITY FACTOR
   5 6 7 8

TECHNICAL KEY VIABILITY FACTOR
   9 10 11 12

GIS (Geographic Information System)

GIS BASED TOOL

GIS LAYERS

SOFTWARE

FEASIBILITY ASSESSMENT: 1 Animal feed + 1 Biogas

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1. Problem Definition

Case Study:

- Geographic area: **Basque Country (in Spain)**

  GISWASTE tool will be transferable to other EU regions

- Valorization alternatives: **Animal Feed** and **Biogas production**

- Organic wastes: **Vegetable; Meat** and **Dairy by-products**, generated by food industry and retail trade.
2. Key Viability Factors

IDENTIFICATION

**TECHNICAL VIABILITY FACTORS**
- Type
- Monthly quantities
- Etc...

**GEOGRAPHICAL VIABILITY FACTORS**
- Availability of industrial land
- Distance to main roads
- Etc...

**ECONOMIC VIABILITY FACTORS**
- Cost for 1st plant and machinery implementation
- Revenues for selling biogas into NG grid
- Etc...

**ENVIRONMENTAL VIABILITY FACTORS**
- Carbon footprint
- Water footprint
- Etc...
2. Key Viability Factors

IDENTIFICATION

ANIMAL FEED

GEOGRAPHICAL VIABILITY FACTORS
- Industrial land available
- Plant size
- Etc...

TECHNICAL VIABILITY FACTORS
- Type
- Quantity per month
- Etc...

ENVIRONMENTAL VIABILITY FACTORS
- Carbon footprint
- Water footprint
- Etc...

ECONOMIC VIABILITY FACTORS
- Income for the management of by-products
- Income for selling the produced flour
- Etc...
2. Key Viability Factors

<table>
<thead>
<tr>
<th><strong>1st Hierarchy level</strong></th>
<th><strong>2nd Hierarchy level</strong></th>
<th><strong>Total Hierarchy level</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>TECHNICAL FACTORS</strong></td>
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<td>20%</td>
<td>Potential methanation</td>
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<td></td>
<td>Total solids</td>
<td>10%</td>
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<td>Volatile solids</td>
<td>10%</td>
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<td>MOD/MO</td>
<td>30%</td>
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<td></td>
<td>C/N</td>
<td>10%</td>
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<tr>
<td><strong>ECONOMIC FACTORS</strong></td>
<td>Cost for 1st plant and machinery implementation</td>
<td>5%</td>
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<tr>
<td></td>
<td>Income for selling biogas or for heat saving</td>
<td>10%</td>
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<tr>
<td></td>
<td>Income for selling digestate</td>
<td>5%</td>
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<tr>
<td></td>
<td>Cost for collecting by-products</td>
<td>10%</td>
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<td></td>
<td>Cost for processing by-products</td>
<td>5%</td>
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<td></td>
<td>Cost for 1st land implementation</td>
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<td></td>
<td>Cost for administrative issues</td>
<td>5%</td>
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<tr>
<td></td>
<td>Cost for the hypothetic plant decommissioning</td>
<td>5%</td>
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<tr>
<td></td>
<td>Income for selling electricity</td>
<td>20%</td>
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<tr>
<td></td>
<td>Income for managing by-products</td>
<td>15%</td>
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<tr>
<td></td>
<td>Cost for buying by-products</td>
<td>15%</td>
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<tr>
<td><strong>GEOGRAPHICAL FACTORS</strong></td>
<td>Shape coefficient</td>
<td>10%</td>
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<tr>
<td></td>
<td>Radio Maximum of the Geographic Area</td>
<td>30%</td>
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<tr>
<td></td>
<td>Minimum critical mass</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>Industrial land available</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Plant size</td>
<td>10%</td>
</tr>
<tr>
<td><strong>ENVIRONMENTAL FACTORS</strong></td>
<td>Carbon footprint</td>
<td>40%</td>
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<tr>
<td></td>
<td>Water footprint</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>Eutrophication potential</td>
<td>20%</td>
</tr>
</tbody>
</table>
### 2. Key Viability Factors

#### RELATIVE IMPORTANCE

<table>
<thead>
<tr>
<th>ANIMAL FEED</th>
<th>1st Hierarchy level</th>
<th>2nd Hierarchy level</th>
<th>Total Hierarchy level</th>
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</thead>
<tbody>
<tr>
<td>TECHNICAL FACTORS</td>
<td>20%</td>
<td>Moisture</td>
<td>20%</td>
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<tr>
<td></td>
<td></td>
<td>VFA</td>
<td>10%</td>
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<tr>
<td></td>
<td></td>
<td>Digestibility</td>
<td>10%</td>
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<td></td>
<td></td>
<td>Energy</td>
<td>10%</td>
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<td></td>
<td></td>
<td>Acid detergent fiber</td>
<td>5%</td>
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<tr>
<td></td>
<td></td>
<td>Crude fiber</td>
<td>5%</td>
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<tr>
<td></td>
<td></td>
<td>Neutral detergent fiber</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crude fat</td>
<td>10%</td>
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<tr>
<td></td>
<td></td>
<td>Carbohydrates</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crude protein</td>
<td>15%</td>
</tr>
<tr>
<td>ECONOMIC FACTORS</td>
<td>50%</td>
<td>Cost for the 1st plant and machinery implementation</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Income for selling the produced flour</td>
<td>30%</td>
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<tr>
<td></td>
<td></td>
<td>Cost for the by-products collection</td>
<td>10%</td>
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<tr>
<td></td>
<td></td>
<td>Cost for processing by-products</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost for the 1st land implementation</td>
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<td>40%</td>
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<td></td>
<td></td>
<td>Eutrophication potential</td>
<td>20%</td>
</tr>
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</table>
2. Key Viability Factors

**LIMITING RANGES** for the Viability Factors:

Limits above or below of which a type of by-product or a valorisation option is **not viable and it must be rejected**.

**CONDITIONAL RANGES** for the Viability Factors:

Values which are within the limiting ranges, which involves that a type of by-product or a valorisation option is **feasible**.

However, a higher or lower value (depending on the factor) determines **higher or lower viability**.

<table>
<thead>
<tr>
<th>VIABILITY FACTOR</th>
<th>Limiting ranges</th>
<th>Conditional ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum value</td>
<td>Minimum value</td>
</tr>
<tr>
<td>Price of the vegetable flour for animal feed (€/tn)</td>
<td>500</td>
<td>125</td>
</tr>
</tbody>
</table>

Options:
- \( \geq 500 \text{ €/tn} \) → **FEASIBLE** → 10 points (higher score)
- \((500-125) \text{ €/tn}\) → **FEASIBLE** → 10 – 1 points (lineal proportional score)
- \(< 125 \text{ €/tn}\) → **NOT FEASIBLE** → 0 points (lower score)
- 312,5 €/tn → **FEASIBLE** → 5,5 points
2. Geographic Information

GIS LAYERS

- About specific thematic, necessaries to assess the geographic feasibility:
  - Basic mapping: rivers, roads, orto-photo, etc.
  - Mapping about physical environment: geologic, etc.
  - Uses and soil classification: protected maps, industrial soil, etc.
  - Weather: isohyets, isotherms, etc.
  - Other sectorial mapping
2. Geographic Information

GIS LAYERS

• About viability factors, necessaries to assess the technical, economic and environmental feasibility:
  ✓ Quantities of by-products
  ✓ Seasonality
  ✓ Composition, etc.
3. Software programing
3. Software programming

**GEOGRAPHICAL ASSESSMENT**

- Food Waste generation data
- Raw Scenario
- Technical assessment
- Net Scenario
- Geographical assessment
- Site Location
- Logistic Routes
INTRODUCTION METHODOLOGY RESULTS & DISCUSSION CONCLUSIONS ACKNOWLEDGEMENTS

3. Software programing

FINAL REPORTS OF GISWASTE tool

- Technical Report
  - Suitability
  - Quantification
  - Etc...

- Geographical Report
  - Location
  - Logistics routes
  - Etc...

- Economic Report
  - Economic Balance
  - Investment return period
  - Etc...

- Environmental Report
  - Carbon Foot print
  - Water Foot print
  - Etc...

Final version of the TOOL
Foreseen end 2016
GIS based decision-making tool will contribute to:

- Reduce the high risk associated with a full-scale implementation of a new food waste valorization alternative by taking into account all the factors that have any influence in their feasibility and by giving an extra information to public or private organisms about different waste management options.

- Reduce the environmental impact of waste treatment facilities by taking into account environmental aspects at the time of its implementation.

- Reduce the management costs by analyzing the economic profitability of each valorization alternative and by making simulations.

- Improve the synergies between different organic wastes by providing integrated and feasible solutions.

- Stimulate the food waste valorization by promoting the setting-up and the development of new economic activities.
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THANK YOU FOR YOUR ATTENTION!
ANY QUESTION?

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