Integrated assessment of water flows and urban water networks in smart parks.
Application to the service sector

**Anna Petit-Boix**, Sidnei Pereira Silva, Aldo Ometto, Frederico Yuri Hanai, Ademir Barbassa, Alejandro Josa, Xavier Gabarrell, Joan Rieradevall

ISIE Conference 2015. Taking Stock of Industrial Ecology

7-10th July 2015 - Surrey, Guildford, UK
1. Introduction to Smart Parks

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   4.2 Environmental performance

5. Conclusions
The service sector represents 70% of the world’s GDP*


Savills and TW Research Associates, 2004 The Definitive Guide to Retail and Leisure Parks
Trevor Wood Associates, 5 Penn Road, Hazlemere, High Wycombe, Bucks HP15 7LN
A sustainable management of these areas is required, especially when their dimensions become larger and more services are offered.
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Need to integrate the concept of smart park

Kazemersky and Winters (1999): “an innovative model designed to integrate the inflows and outflows of energy, water and waste streams for multiple businesses in a sustainable and synergistic manner”

Inputs
- Energy
- Food
- Water
- Products
- Transport

Outputs
- Emissions
- Products
- Transport

Kazemersky, P. and Winters, K. 1999 Chattanooga SMART. Park Education of Graduate Students Through the Use of Real World Projects. ASEE Southeast Sect. Conf., US.
**AIM:** To environmentally assess water self-sufficiency in retail parks from the perspective of smart parks.

**SPECIFIC OBJECTIVES:**

- To propose rainwater harvesting (RWH) scenarios in individual and collective systems and analyse the RWH potential
- To assess the environmental impacts of these scenarios in a case study area using LCA
- To determine the net environmental impacts of implementing RWH instead of business as usual (BAU)
Methods

Case study selection

Sant Boi de Llobregat

Climate: Mediterranean
Population: 82,000 inhabitants
Average precipitation: 650 mm/year

El Baix Llobregat, located in the Metropolitan Area of Barcelona
General features of the retail park

- 36,260 m² – Food, clothes and others
- 2,300 m² – Clothes
- 10,065 m² – Furniture, gardening, DIY
- 4,200 m² – Toys
- 2,800 m² – Electronics
- 4,760 m² – Sports
- 410 m² – Fast Food
- 400 m² – Fast Food
- 1,240 m² – Car maintenance

Water consumption: 98 m³/day
Customers: 12,323/day
Other impervious areas: 150,000 m²
Building type: one storey
Methods

Scenario proposal

Scenario 0

BAU – Potable water coming from a plant located 3.5 km away

Scenario 1

*Individual approach*

Company-based rainwater harvesting
Methods

Scenario proposal

Scenario 2
*Collective approach*

Single-tank rainwater harvesting

- Rainwater tank
- Rainwater collection
- Rainwater consumption
# Methods

## Methodological approach

1. **Tank sizing**

Modelling of buildings with large catchment areas

### Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>system demand</td>
<td>m³ · day</td>
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<tr>
<td>% drinking water demand</td>
<td>%</td>
</tr>
<tr>
<td>users · day</td>
<td>adim.</td>
</tr>
<tr>
<td>roof catchment area</td>
<td>m²</td>
</tr>
<tr>
<td>soil catchment area</td>
<td>m²</td>
</tr>
<tr>
<td>rain water (roof) tank volume</td>
<td>m³</td>
</tr>
<tr>
<td>grey water tank volume</td>
<td>m³</td>
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<tr>
<td>roof runoff coefficient</td>
<td>adim.</td>
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<tr>
<td>filter efficiency coefficient</td>
<td>adim.</td>
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<tr>
<td>soil runoff coefficient</td>
<td>adim.</td>
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</tbody>
</table>

Methodological approach

1. **Tank sizing**
   - Modelling of large surfaces according to water demand, roof and soil area, etc.

2. **Life cycle impacts**
   - TANKS and DISTRIBUTION NETWORK
     - Structurally optimized superficial concrete tanks
     - HDPE pipes with a diameter of 90 mm

System boundaries:

- **Raw material extraction**
- **Pipe production**
- **Transport**
- **On-site installation**
- **Operation**
- **End of life**

**FU:** 1 m³ of water demand covered by RWH

BAU → Potable water treatment plant
- 1.26·10⁸ m³ treated/year
- 3.5 km of HDPE pipes with a diameter of 90 mm

System boundaries:
For each scenario, Plugrisost® was run using a 20-year precipitation series.

Modelling stopped when an increase in the tank size did not entail a relevant increase in the rainwater harvested.

The selection ensured an average demand coverage of >85% and up to 100%.

The collective approach enabled the collection of only 1% more rainwater than the individual scenario.
Results

Life cycle impacts

Gross environmental impact

40-60%

CML 2001 & Cumulative Energy Demand
ecoinvent v2
Results

Life cycle impacts

Gross environmental impact

40-60%

750 m³ subdivided into 8 different tanks are not efficient in harvesting rainwater → the cost is larger

Breakdown of Scenario 1

The largest tank (1000 m³) provides 60% of the park’s water and accounts for 40% of the total impacts
Results

2 Life cycle impacts

Net environmental impact (NEI)

**IMPLEMENTATION BURDENS:**
Environmental impact of RWH

**AVOITED BURDENS:**
Environmental impact of treating and transporting the demand covered by RWH

Other impact categories:
2-20% impact reduction

Ozone Layer Depletion

![Graph showing Ozone Layer Depletion with scenarios and impact reductions.](image)

- Most remarkable changes in ozone depletion
- Reduced chlorination requirements
Conclusions

An integrated water management of a retail park from a smart park perspective might have different benefits:

• It provides water self-sufficiency in water stressed areas

• It promotes synergies among independent companies: collective rainwater harvesting can represent up to 60% fewer impacts than individual tanks

• A collective approach reduces the material and energy requirements and environmental burdens of an expanded system: there are avoided impacts related to potable water treatment plants (50% of ODP reduction in the best scenario)

• It is a first step towards integrating other synergies such as green energy production, local food, etc.
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