Summary Outline

- Introduction
- LCA Methodology
- SEA “vs” LCA
  - LCA as an integrated part of SEA
- LCA “in” SEA
  - Case studies
- LCA “for” SEA (ENEA project)
  - Methodology
  - Sectors
  - Indicators
  - Assessment
- Potential, Limits and further Research
- Conclusion
Introduction

- An SEA explicit purpose: ensure that significant effects on the environment are taken into account in the preparation and adoption of plans (SEA Directive);
- No definition of system boundaries of the environmental assessment, no definition of impact prediction tools;
- At local level SEAs usually have narrow perspective, they don’t take into account the influence on activities far beyond the immediate technical and geographical boundaries;
- LCA has a wider system perspective (ISO2006) taking into account both direct and indirect impacts;
- LCA vs. SEA?
LCA Methodology (1/2)

a “from cradle to grave” assessment

Source: Danish EPA
LCA Methodology (2/2)

ISO 14040:2006

- MATERIALS
- PROCESSES
- INVENTORY
- EMISSIONS AND RESOURCES
- CLASSIFICATION
- CHARACTERIZATION
- NORMALIZATION
- IMPACT ASSESSMENT
- INTERPRETATION (SENSITIVITY ANALYSIS, ..)

Impact Assessment Methods:
- ECO-INDICATOR 99
- EPS 2000
- EDIP 97
- IMPACT 2002

Competencies: Engineering, Physics, Environmental Sciences, Natural Sciences, Biology, Chemistry, Medicine, Economics, etc.

Comprehensive approach to sustainable development.

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SEA vs LCA?
Various Scales

Assessment of a process, a material

Assessment of a project, a building, an infrastructure, a service

Assessment of a region, a city, a neighborhood
<table>
<thead>
<tr>
<th><strong>SEA</strong></th>
<th><strong>LCA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plans and Programmes (and Policies..)</td>
<td>(certain) Plans, Products, Processes, Activities, …</td>
</tr>
<tr>
<td>Public participation</td>
<td>Direct and indirect impact</td>
</tr>
<tr>
<td>Scenario planning, strategic view</td>
<td>Hardly includes non-quantitative issues</td>
</tr>
<tr>
<td>Non quantitative aspects (social, landscape, etc.)</td>
<td>Time consuming (i.e. expensive)</td>
</tr>
</tbody>
</table>

**LCA as an integrated part of SEA?**
LCA as an integrated part of SEA?

- Need to transform SEA planning policies into practical actions and consequences (processes, activities, etc.) - [estimation, approximation]
- Environmental assessment with LCA, qualitative indicators of selected measures;
- Alternative scenarios
- Sensitivity analysis (ISO14040-14046:2006)

⇒ Into SEA Report, for further consultation
LCA “in” SEA: case studies

By ENEA, Italian National Agency for New Technologies, Energy and Sustainable Development
LCA of a Redevelopment Plan (1/5)

“Rubattino” Redevelopment Plan (MILAN), 2006-2010

Area: 611.207 mq
Building area: 301.975 mq
### LCA of a Redevelopment Plan (2/5)

#### Construction Phase
- **Energy**
  - Electrical Grid Construction
- **Buildings**
  - Buildings Construction
- **Transportation**
  - Construction
- **Green Areas**
  - Construction of Green Area
- **Water Mgmt**
  - Construction (pipelines, etc.)

#### Use Phase
- **Energy**
  - Energy Consumption, Maintenance
- **Buildings**
  - Building Maintenance
- **Transportation**
  - Single Transport, Public Transport, Maintenance
- **Green Areas**
  - Ecological Balance, Maintenance of Green
- **Water Mgmt**
  - Water Consumption Maintenance
- **Waste Mgmt**
  - Waste Management

#### End-of-life
- **Energy**
  - Deactivation, Disposal
- **Buildings**
  - Disposal
- **Transportation**
  - Disposal
- **Green Areas**
  - Disposal
- **Water Mgmt**
  - Disposal
- **Waste Mgmt**
  - Disposal

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LCA of a Redevelopment Plan (3/5)

- THERMAL AND ELECTRIC ENERGY FOR HEATING, COOLING, LIGHTENING, ETC. (software Recal10 e PAN2)

**ENERGY**

**BUILDINGS**

**TRANSPORTATION**

**GREEN AREAS**

**WATER MGMT.**

**WASTE MGMT.**

- **RESIDENTIAL**
  - $\rho = 0.4409 \text{ W/m}^2\text{yr}$

- **COMMERCIAL**
  - $\rho = 0.4561 \text{ W/m}^2\text{yr}$

- **RENOVATION**
  - $\rho = 0.3501 \text{ W/m}^2\text{yr}$

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LCA of a Redevelopment Plan (4/5)

Impact Assessment (Impact 2002+)

- Total impact (6.16e5 Pt) is mainly caused by ENERGY (53.9%)
- TRANSPORTATION (35.8%), has high impact because of the massive use of private cars
- The remaining impact of 10% is caused by MAINTENANCE and WATER

Impact Assessment (EcoInd. 99)

- Total impact (8.87e7 Pt) is mainly caused by ENERGY (64.8%) for winter heating and electricity consumption
- TRANSPORTATION (42.2%) has high impact because of the massive use of private cars
- RENOVATION has positive impact (-19.2%)
LCA of a Redevelopment Plan (5/5)

**ALTERNATIVES:**
- Construction of a new electric tram-line connected to existing public transport system of the area (metro, tram, bus)
LCA of a Waste Management Plan

- Province of Parma (2002-2012)
  - LCA provided the impact prediction tool to assess the first draft plan at 3 scenarios: 2002 (no action), 2005, 2012
  - LCA provided impact assessment of alternatives:
    - different recycling objective
    - different waste production rate
    - different paths for waste transportation
  - LCA provided economic assessment (internal and external cost)
  - did NOT include other aspects (social, local interference, etc.)
    - LCA is not site-specific
    - (Incinerator was not questioned)
  - (young) SEA had to face many other aspects...

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LCA of a Mobility Plan
(1/2)


- LCA provided the assessment tool to evaluate the first draft plan
  - Assessment of the current status
  - Assessment of the first draft plan

- Economic aspects
  - Cost evaluation for:
    - cars, buses
    - road maintenance
    - ticket fare system
    - Insurance, drivers pay

- Social aspects:
  - Car accidents (and mortality)
  - Consequent social costs
LCA of a Mobility Plan (2/2)

- **Assessment of Alternatives:**
  - 50% decrease in flows;
  - methane public buses (and cars);
  - hybrid motors (electric, DITECH)
  - new public buses;
  - Increase in goods transportation in railways
  - less car scrapping and more recycling

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Comparing 1 p life cycle 'LCA traffico situazione attuale' with 1 p life cycle 'LCA traffico situazione proposta'. Method: Eco-indicator 99 (E)CWMDD\[1\]
Proposal of an Impact Prediction tool for the environmental assessment of projects and spatial planning, based on LCA’ by ENEA Bologna (Italy)
Assessment tool based on LCA (1/8)

- Research commissioned by the Municipality of Florence (Jan 2011) had the aim to define an assessment tool to be used by local authorities (Florence and other surrounding municipalities) in order to evaluate the environmental impact of projects and spatial planning that needs preliminary approval, like the construction permit of a building, the EIA (Environmental Impact Assessment), the SEA (Strategic Environmental Planning).

- The proposed assessment tool makes an estimation of the environmental impact, even if with approximation, without using life cycle software and methodology (specific ‘ad-hoc’ LCA), assessment methods (such as IMPACT2000) and other software that requires time and specific competences (such as using SimaPro software).

- The proposed tool also estimates the externalities, which can be useful for public policies in order to help the decision making process.
Assessment tool based on LCA (2/8)

- LCA can help avoid a narrow outlook on environmental concerns by:
  - compiling an inventory of relevant inputs and outputs,
  - evaluating the potential environmental impacts associated with those inputs and outputs,
  - interpreting the results of the inventory and impact phases in relation to the objectives of the study.

- When using LCA methodology, an estimation of many variables is made:
  - emission to air, to water, to soil, natural resources (minerals, fossil fuels, water, wood, land use, solar and wind energy);

- The characterization process is made using impact categories:
  - such as global warming, acidification, eutrophization, ozone production, human health, ecosystem toxicity, land use, biodiversity, mineral consumption, non renewable energy consumption, etc.

- Impact Assessment:
  - Each impact category is measured with its specific unit. Damage categories are later identified by giving weight to human health, ecosystem quality, resources, etc.
  - Finally, the damage categories are normalized, in order not to have units of measurement and obtain a value for the total impact of the process.
Choice of **INDEPENDENT VARIABLES** (INPUT) (most challenging part)

- choice of the reference process, or processes, for each sector considered (house, incinerator, etc.);
- analysis of the main characteristic of the selected process, in order to **understand from which data its impact its mostly affected**;
- **Network assessment** of the impact of the process: using the network, it is possible to analyze the process life cycle considering all the **sub-processes** involved.
- Among the sub-processes, the ones that contribute the most to the total impact are selected and further studied, in order to obtain independent variables;
- Variables have to be well-known and shared, according to the information available by the user, and to the level of current knowledge (such as **law requirement**, **protocol**, etc.).
- the process is never related to a specific area: the environmental effects are referred to the European area for local impact, to the planet area for global impact (global warming, depletion of resources).
Choice of INDICATORS (OUTPUT) (from internationally available indicator):

- Human Health: unit DALY, number of years lost by the European population (384E6 inhabitats);
- Ecosystem Quality: unit PDFm2yr, the percentage of European species disappeared, multiplied by the European area (2.16*1012m2) and the time of the emissions.
- Climate change: unit kgCO2eq;
- Resources: unit MJ primary;
- Total Impact: unit Pt, that is obtained by multiplying with a normalization factor the four above categories, normalizing and weighting the results.
- Total energy or Renewable energy or non renewable energy: in Eco-indicator 99
- External cost, unit ELU (year 2000);
- Internal cost;
Choice of SECTORS (available database, local area characteristic)

- **Building and Urban structure**: new house (passive house), new house (type 1 and 2), emergency house, new public building, industrial building, renovation of existing house, renovation of existing public building, urban renewal;

- **Infrastructure**: roads, railways, electricity pipeline, water pipeline;

- **Mobility**: passenger transport, good transport, public transport (bus), urban traffic (management);

- **Energy**: electric energy production from natural gas, heating from natural gas, heating from solar energy, heating from heat pump, electric energy from photovoltaic panel Multi-Si, electric energy from photovoltaic panel CdTe, electricity energy production from hydropower powerplant, electricity energy production from biomass powerplant, electricity energy production from wind powerplant;

- **Waste treatment**: landfill, incinerator, composting, iron recycling, aluminum recycling, sewage treatment, waste management;

- **Industrial production**: wood production, paper production, cement production, paint production, bricks production, plastic production, fabric production, mechanics production;

- **Farming and agriculture**: milk production, ham production, grass production, crop production, corn production, oil production, wine production, apricots jam production;
Assessment tool based on LCA (6/8)

- **USER INTERFACE** (spreadsheets converted into a website)
  - Interactive and easy-to-use tool for the municipality decision makers, in order to have a preliminary assessment of projects/plans/programmes

[Image: the.onionx.com/firenze/]

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**LCA lab**

*Indicatori di impatto ambientale per l'uso del territorio*

**COMUNE DI FIRENZE**

<table>
<thead>
<tr>
<th>scelta del comparto:</th>
<th>allevamento</th>
<th>coltivazione</th>
<th>rifiuti</th>
<th>industria</th>
<th>energia</th>
<th>infrastruttura</th>
<th>traffico</th>
<th>edilizia</th>
</tr>
</thead>
</table>
Assessment tool based on LCA (7/8)

- User interface (spreadsheets converted into a website)

- Quick assessment without using time consuming LCA evaluation, especially when detailed data is not available, or the project/plan is at its preliminary phase

- Quick comparison of different alternatives can be made, by modifying some indicators and analyzing the different results obtained.

options: size (surface), population, lifetime, residential/commercial rate, transport systems, etc.
Assessment tool based on LCA (8/8)

Impact comparison

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Incinerator</th>
<th>Discarica</th>
<th>Δ Impact</th>
<th>Σ Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salute umana</td>
<td></td>
<td></td>
<td>0.00004284 PI</td>
<td>0.00004635 PI</td>
</tr>
<tr>
<td>Qualità dell'ecosistema</td>
<td></td>
<td></td>
<td>0.00003512 PI</td>
<td>0.00002133 PI</td>
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<td>Cambiamenti climatici</td>
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<td>0.00001495 PI</td>
<td>0.00006798 PI</td>
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<tr>
<td>Risorse</td>
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<td></td>
<td>0.00001726 PI</td>
<td>0.000005503 PI</td>
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</tbody>
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Cumulative impact
Potential

- Innovative approach to designing the scope of the environmental assessment
- Help defining assessing alternatives for SEA
- Support tool for decision makers at various scales
- More transparency to SEA
- No border limits, indirect impact, etc.

Limits

- Can be NON-transparent
- Not site-specific
- Lack of geographical resolution of inventory data
- High estimation, high errors
- LCA need to be complemented with other tools

Further Research

- Methodological development
- Practical experience
- Integration with other assessment tools
- ...

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References

Thanks for attention