
# Swiss Centre for Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

ETH

EPFL

PSI

EMPA

EAWAG

FAL

4th International Conference:
Life Cycle Assessment in the Agri-food sector
October 6-8, 2003 Horsens, Denmark

Swiss Centre
For Life Cycle
Inventories

A joint initiative of the
ETH domain and Swiss
Federal Offices

# Land occupation and land transformation in life cycle inventories

Niels Jungbluth, Rolf Frischknecht

ESU-services, Uster, www.esu-services.ch
jungbluth@esu-services.ch

# Challenges

- New findings in land use impact assessment, but no consensus reached yet for a method
- Different approaches for inventory modelling
- Harmonisation and actualisation of Swiss LCI database (ecoinvent 2000) started two years ago

➢ Flexible inventory items required

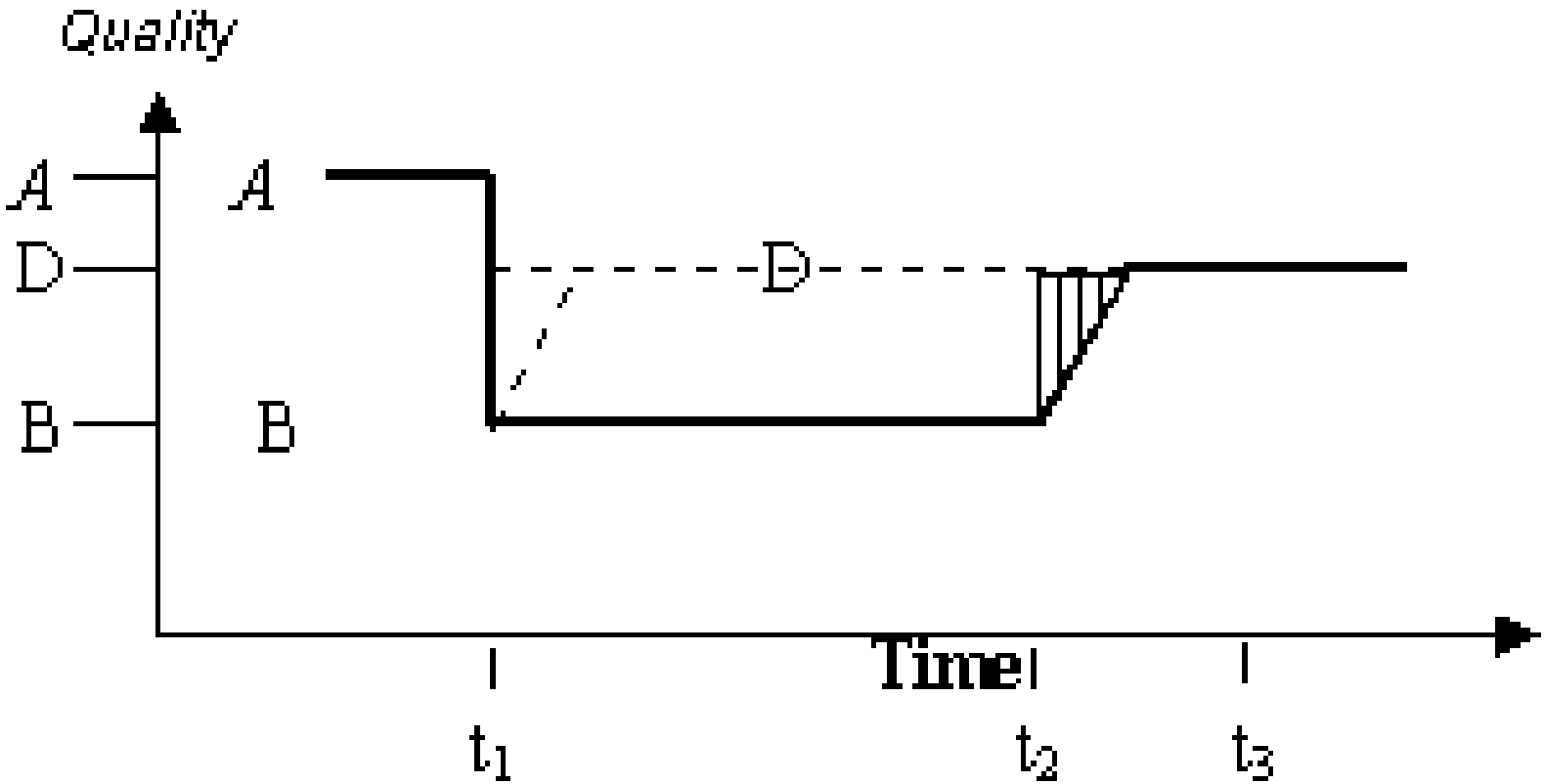
Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

# Land use impact

Swiss Centre
For Life Cycle
Inventories

A joint initiative of the
ETH domain and Swiss
Federal Offices




Lindeijer et al. (2001)

# Environmental impacts

- Increase of land competition

Impacts on

- **Biodiversity**
- Life support function
- Man-made environment

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

➢ Focus in ecoinvent are impacts on biodiversity

# Land cover nomenclature

Approach based on CORINE land cover classes:

121: industrial area

131: mineral extraction site

132: dump site

21: arable

22: permanent crop

31: forest

etc.

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

# Transformation - occupation

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

Distinction for two types of intervention:

- Land transformation
  e.g., conversion of agricultural land to built up land

- Land occupation
  e.g., covering with buildings and thus influence of the occupation on the biodiversity of the used land

# Land occupation

- Surface area
- Duration of occupation
- Amount of products / services manufactured / delivered
- Land quality during occupation
  e.g., road, industrial area, arable land, etc.

Land occupation recorded as

$m^2$ times year per unit output

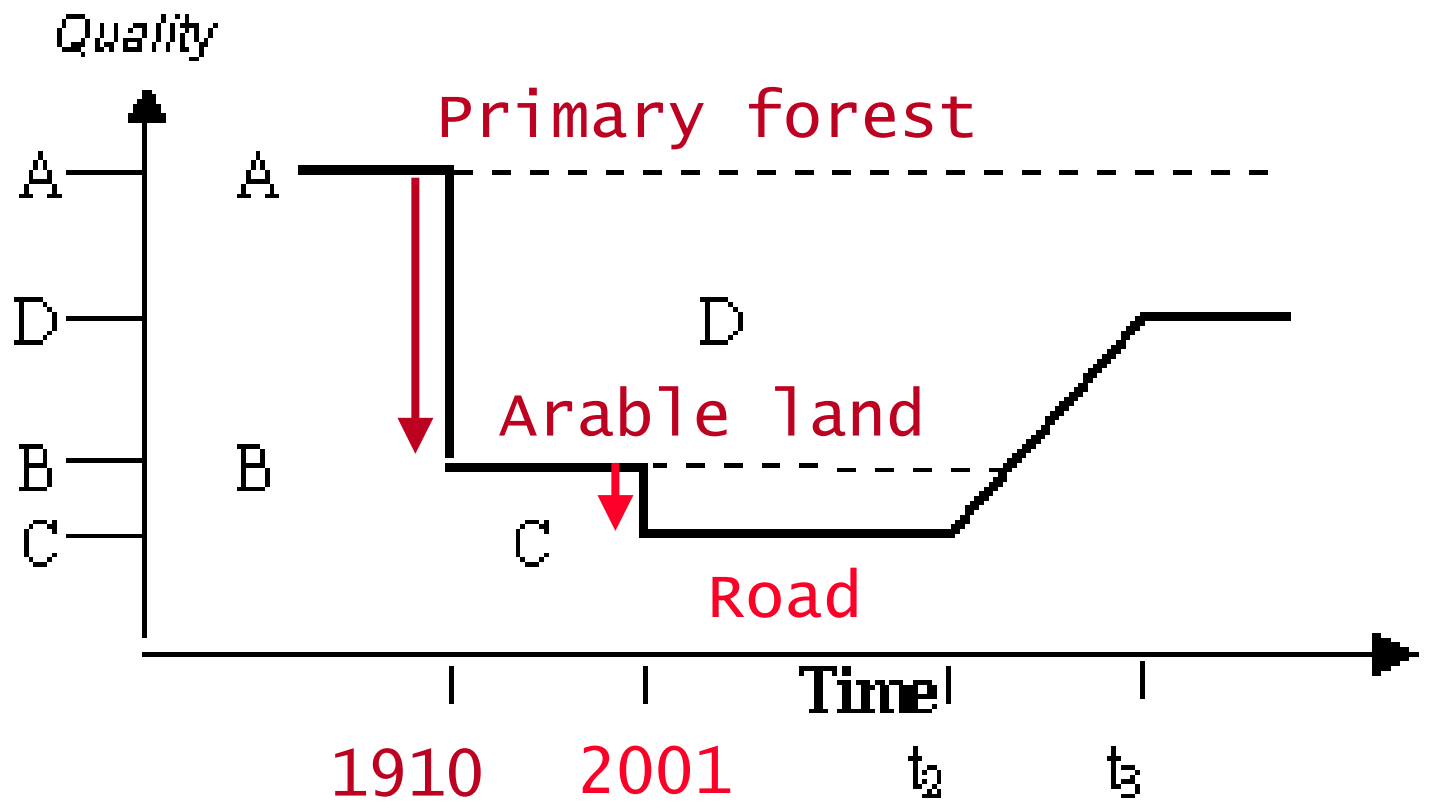
Example:

0.3 $m^2$a occupation, mineral extraction site (CORINE 131) per kg gravel

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

# Land transformation




- Main difficulty: Definition of reference state, quite often unknown

# Land transformation

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

occurs

- **Before** an artificial process
  (road, power plant construction, agriculture, forestry, etc.)
- **During** an artificial process
  (lignite open cast mining)
- **After** an artificial process
  (conversion to another industrial use, active restoration, natural succession)

➢ If change or restoration is not foreseeable (e.g., roads, hydroelectric power plants): No land transformation at the end of its initial use

# Land transformation inventory

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

Two directions are recorded:

- Land transformation from state A
- Land transformation to state B

Information required:

- Amount of surface & land cover types
- Amount of products / services manufactured / delivered

# Depreciation period for transformation

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

- Time period for which land transformation is made

  => defines amount of products / services

  => standard "lifetimes" for ecoinvent if duration is not known

- Examples:
  - Industrial areas: 50a
  - roads, railways: 100a
  - agriculture (arable crops): 1a
  - agriculture (permanent crops): 20-30a
  - forestry: 80a

# Example: Gravel extraction

- total surface: 10’000m$^2$
- site lifetime: 20 year
- gravel extracted : 1’000 tons per year
- duration active restoration: 2 years
- Diesel consumption:
  - extraction: 200’000 MJ/year
  - restoration: 40’000 MJ

ecoinvent Centre

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

# Example: Gravel extraction

| | | | unit process raw data | | LCI result |
|---|---|---|---|---|---|
| | | | gravel, crushed, at mine | restauration, gravel extraction | gravel, crushed, at mine |
| | | | t | $m^2$ | t |
| resource, land | occupation, mineral extraction site | $m^2a$ | 10 | | 10 |
| | occupation construction site | $m^2a$ | | 2 | 1 |
| | transformation, from unknown | $m^2$ | 0.5 | | 0.5 |
| | transformation, to resource extraction | $m^2$ | 0.5 | | 0.5 |
| | transformation, from resource extraction | $m^2$ | | 1 | 0.5 |
| | transformation, to forest | $m^2$ | | 1 | 0.5 |
| resource, in ground | gravel, in ground | t | 1 | | 1 |
| Technosphere inputs | restauration, gravel extraction | $m^2$ | 0.5 | | 0.5 |
| | diesel, burned in building machine | MJ | 200 | 4 | 202 |
| | ... | ... | | | |
| Reference product | gravel, crushed at mine | kg | 1 | | 1 |
| | restauration, gravel extraction | $m^2$ | | 1 | |

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

# Example: Gravel extraction

| | | | unit process raw data | | LCI result |
|---|---|---|---|---|---|
| | | | gravel, crushed, at mine<br>t | restauration, gravel extraction<br>$m^2$ | gravel, crushed, at mine<br>t |
| resource, land | occupation, mineral extraction site | $m^2a$ | 10 | | 10 |
| | occupation construction site | $m^2a$ | | 2 | 1 |
| | transformation, from unknown | $m^2$ | 0.5 | | 0.5 |
| | **transformation, to resource extraction** | **m2** | **0.5** | | **0.5** |
| | **transformation, from resource extraction** | **m2** | | **1** | **0.5** |
| | transformation, to forest | $m^2$ | | 1 | 0.5 |
| resource, in ground | gravel, in ground | t | 1 | | 1 |
| Technosphere inputs | restauration, gravel extraction | $m^2$ | 0.5 | | 0.5 |
| | diesel, burned in building machine | MJ | 200 | 4 | 202 |
| | ... | ... | | | |
| Reference product | gravel, crushed at mine | kg | 1 | | 1 |
| | restauration, gravel extraction | $m^2$ | | 1 | |

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

# LCI result
## Example , excerpt : Solar and Wood heating

| | Unit | heat, at solar+wood heating, flat plate, one-family house, CH<br>MJ<br>0 |
|---|---|---|
| Occupation, forest, intensive, normal | m2a | 4.08E-2 |
| Occupation, industrial area | m2a | 1.55E-4 |
| Occupation, traffic area, road embankment | m2a | 4.09E-4 |
| Transformation, from arable, non-irrigated | m2 | 5.03E-5 |
| Transformation, from forest, extensive | m2 | 3.43E-4 |
| Transformation, from unknown | m2 | 1.15E-5 |
| Transformation, to arable, non-irrigated | m2 | 5.03E-5 |
| Transformation, to forest, intensive, normal | m2 | 3.39E-4 |
| Transformation, to industrial area | m2 | 7.48E-6 |

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

# Damage factors, Eco-indicator 99

Damage factors for occupation

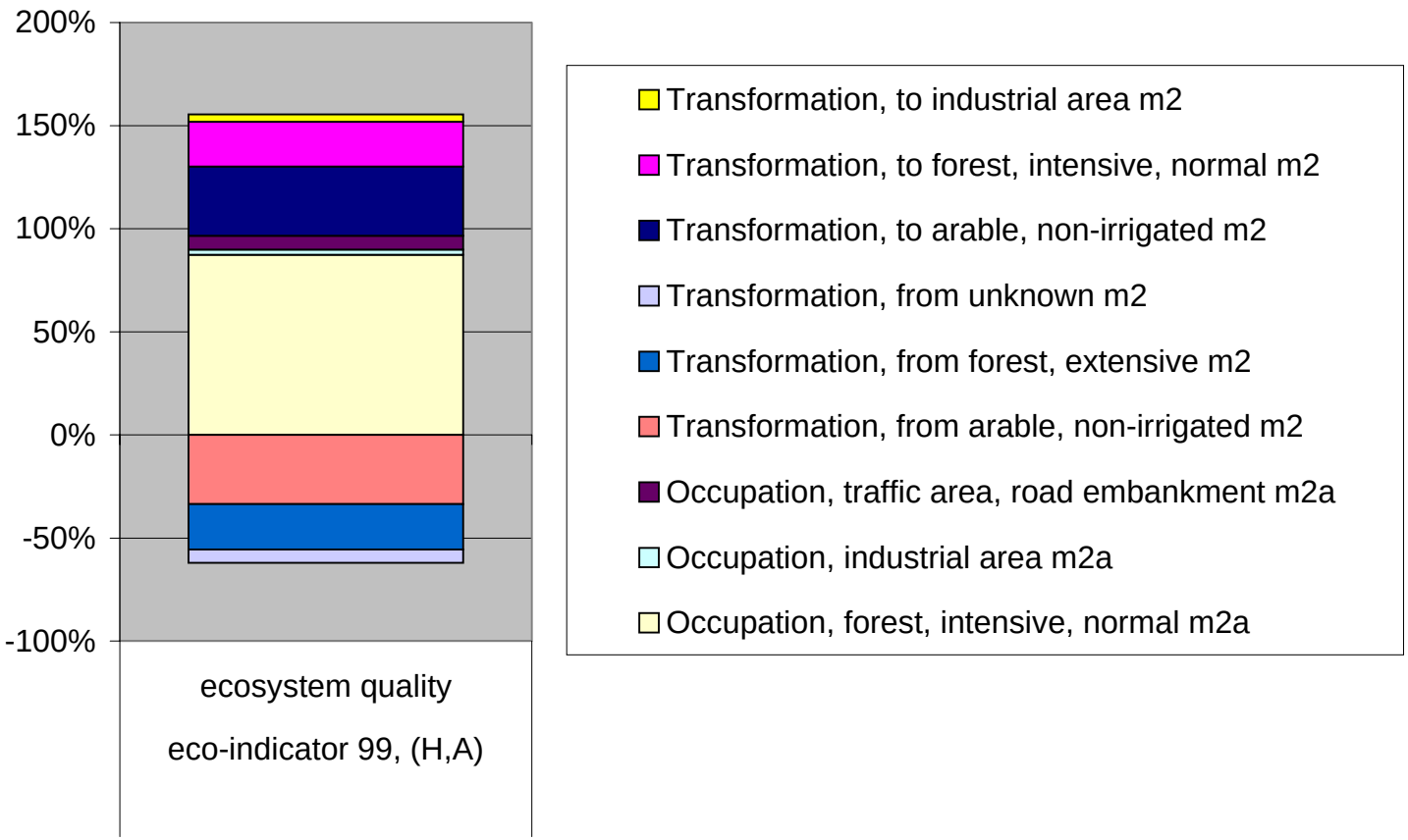
Positive factors for „transformation to ...“

Negative factors for „transformation from ...“

Average factor for „unknown“

| | | eco-indicator 99, (H,A) |
|---|---|---|
| | | ecosystem quality |
| | | land occupation |
| | | points |
| Occupation, forest, intensive, normal | m2a | 0.00858 |
| Occupation, industrial area | m2a | 0.0655 |
| Occupation, traffic area, road embankment | m2a | 0.0655 |
| Transformation, from arable, non-irrigated | m2 | -2.68 |
| Transformation, from forest, extensive | m2 | -0.257 |
| Transformation, from unknown | m2 | -2.24 |
| Transformation, to arable, non-irrigated | m2 | 2.68 |
| Transformation, to forest, intensive, normal | m2 | 0.257 |
| Transformation, to industrial area | m2 | 1.96 |

# Results: LCIA (EI'99), land use
## Example: Solar and Wood heating




ecoinvent Centre

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

# Summary

- Transformation and occupation are separated
- "Transformation, from" and "transformation, to" are separated
- 41 different land use classes (nomenclature based on CORINE land cover classes)
- Methodology open for the use of different impact assessment approaches
- Land use type before occupation is difficult to determine

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices