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# Comparing climate footprints with impact-oriented life cycle methods: A meta-analysis

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# Introduction

- Carbon footprinting is hot!
- Many methods available to perform LCAs
- Which method should we use to evaluate products?
- Does it make a difference?

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- Aim
- Method
- Results
- Conclusions



# Climate footprint

The **climate footprint** is a measure of the total amount of carbon dioxide equivalent emissions over the life cycle of a material, product or service

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# Meta-analysis

A **meta-analysis** is a statistical procedure to combine a large number of existing studies.

Effects which are hard or impossible to discern in the individual studies can be made visible

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# Aims of the study

- Comparison of climate footprinting with three single-score impact methodologies by statistical analysis of the results for 498 materials
- Understand influence of fossil energy use on the results

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# Method overview

Method	Key characteristic
1. Climate Footprint (CF)	Life-cycle greenhouse gas emissions
2. Ecological Scarcity (ES97)	“Distance -to-political target” weighing
3. Environmental Priority Strategy (EPS2000)	Monetarization of life -cycle impacts
4. Eco -Indicator 99 (EI99)	Panel weighing of life -cycle impacts

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# 1. Climate footprint

- Direct and indirect GHG emissions
- GWPs from IPCC (2007)
- Unit is CO<sub>2</sub>-equivalents

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## 2. Ecological Scarcity

- Distance to political target principle
- Emissions and resources
  - Air emissions
  - Water emissions
  - Soil emissions, including waste
  - Energy
- Unit is environmental impact points

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## 3. Environmental Priority Strategy

- Damage towards protection targets
  - Human health
  - Ecosystem productivity
  - Biodiversity
  - Abiotic resources
- Monetary approach for weighting
- Environmental Load Units (= Euro)

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## 4. Ecoindicator 99

- Damage towards protection targets
  - Human health
  - Ecosystem health
  - Resources
- Panel procedure for weighting
- Unit is Ecopoints

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# Data selection

- Swiss ecoinvent database v1.3 + European Plastics Industry

Product group	Number of materials
Agricultural products	65
Construction and insulation materials	42
Glass	11
Inorganic substances	121
Organic substances	146
Plastics	33
Metals	51
Paper and cardboard	29
<b>Total</b>	<b>498</b>

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# Standard and non-fossil dataset

## Standard selection:

- Includes all processes relevant for the material life cycles considered

## Non-fossil selection:

- Excludes transport, electricity and heat production processes fuelled by fossil energy.
- Fossil feedstocks are excluded as well

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# Statistical Analysis

- Univariate log-linear regression analysis with Climate Footprint (CF) as explaining variable

$$\log IS = a \cdot \log CF + b$$

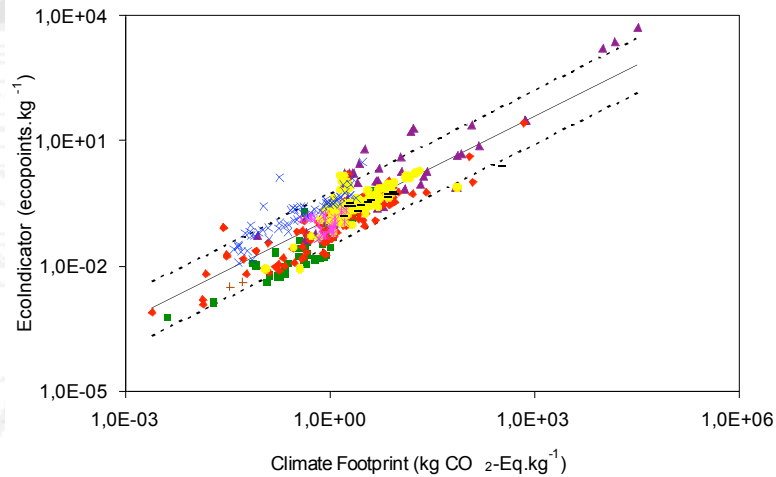
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IS = Impact Score



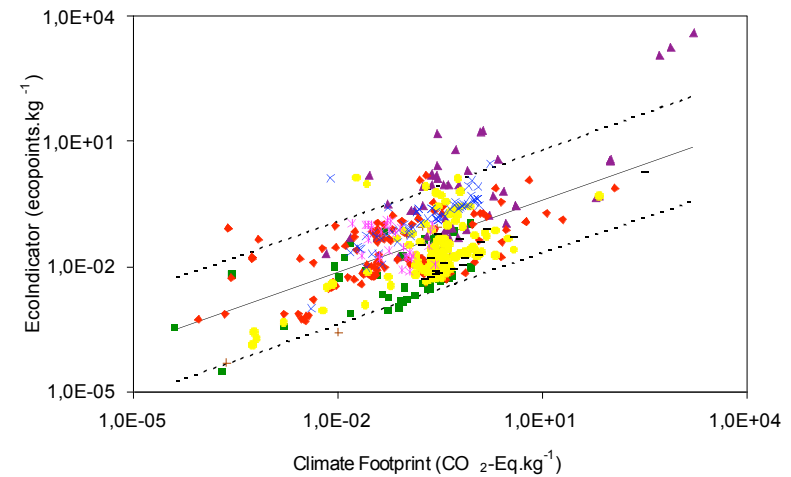
# Regression analysis – Ecoindicator

## Standard inventory



$$\log EI = 0.8 \log CF - 0.9$$
$$R^2 = 0.74; SE = 0.38$$

## Non-fossil inventory

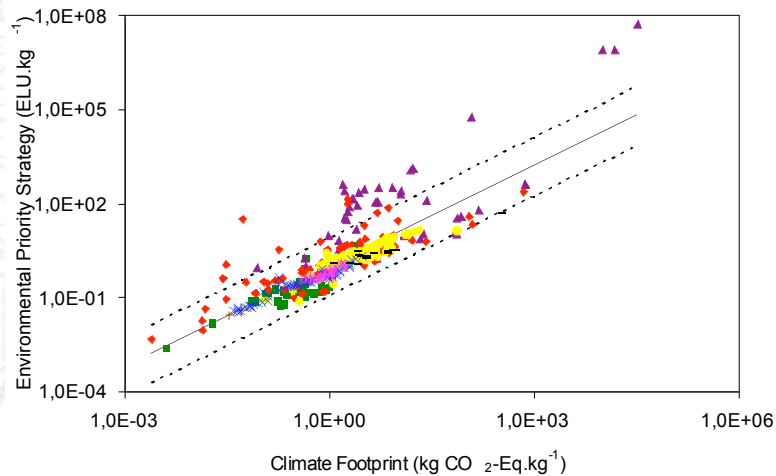


$$\log EI = 0.6 \log CF - 1.0$$
$$R^2 = 0.35; SE = 0.75$$



# Environmental Priority Strategy

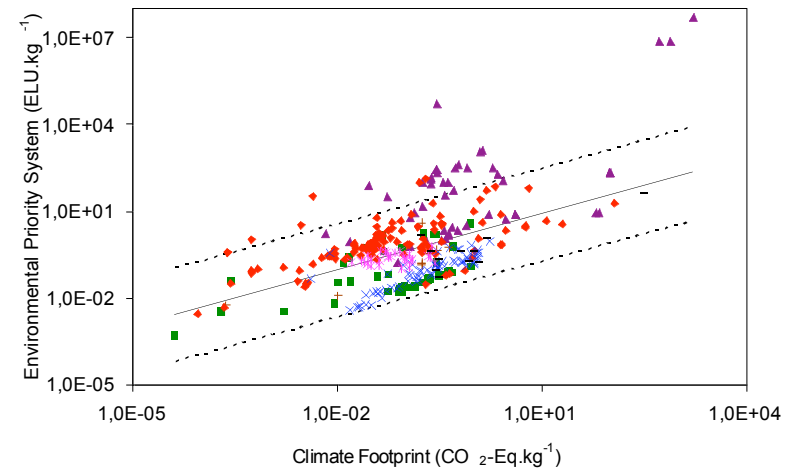
## Standard inventory



$$\log EPS = 1.1 \log CF + 0.0$$

$$R^2 = 0.69; SE = 0.55$$

## Non-fossil inventory



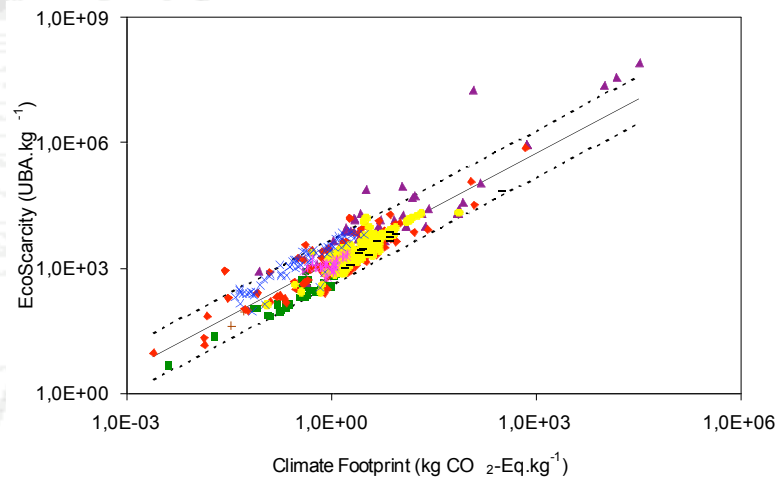
$$\log EPS = 0.7 \log CF + 0.3$$

$$R^2 = 0.29; SE = 0.97$$



# Ecoscarcity

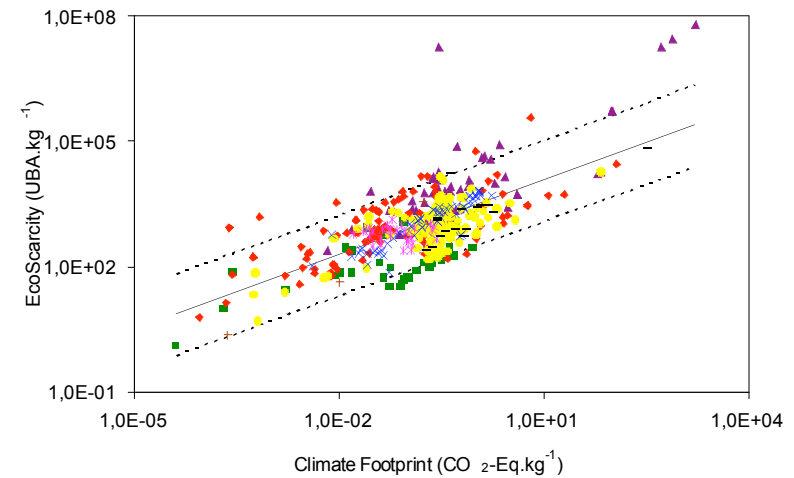
## Standard inventory



$$\log ES = 0.9 \log CF + 3.2$$

$$R^2 = 0.80; SE = 0.33$$

## Non-fossil inventory



$$\log ES = 0.6 \log CF + 3.5$$

$$R^2 = 0.49; SE = 0.59$$



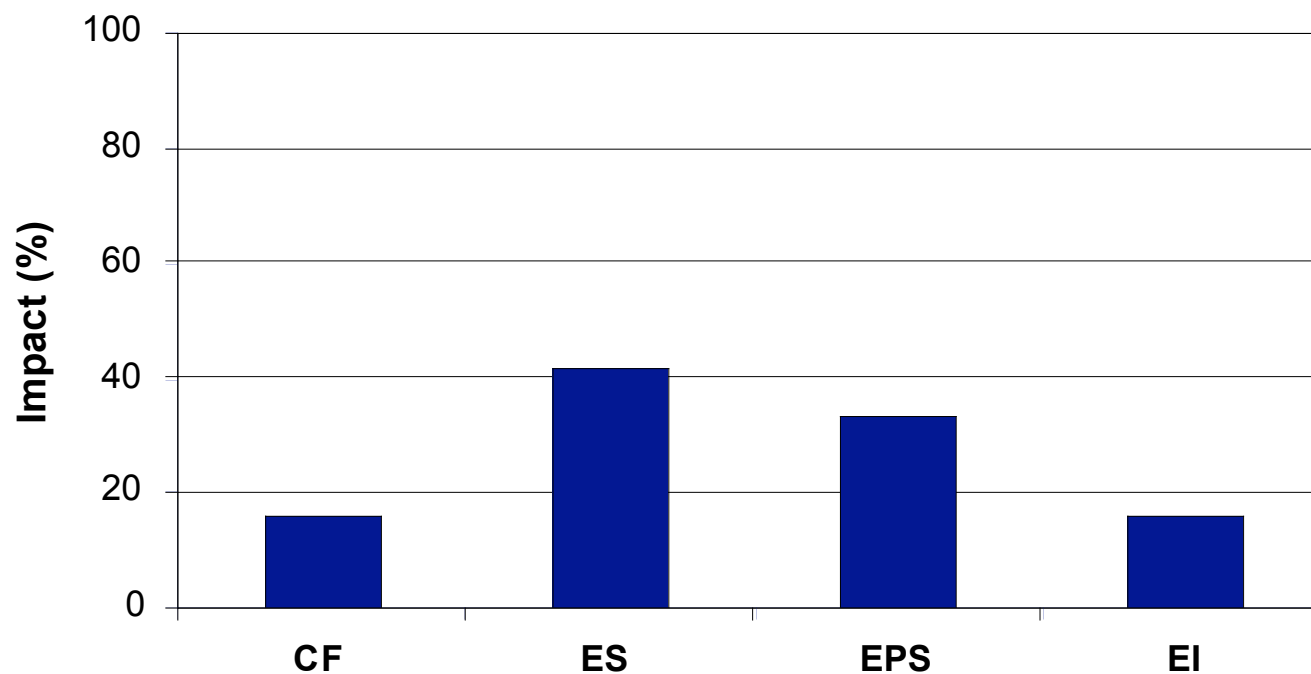


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# Non-fossil average contribution – Organic chemicals

Organic chemicals



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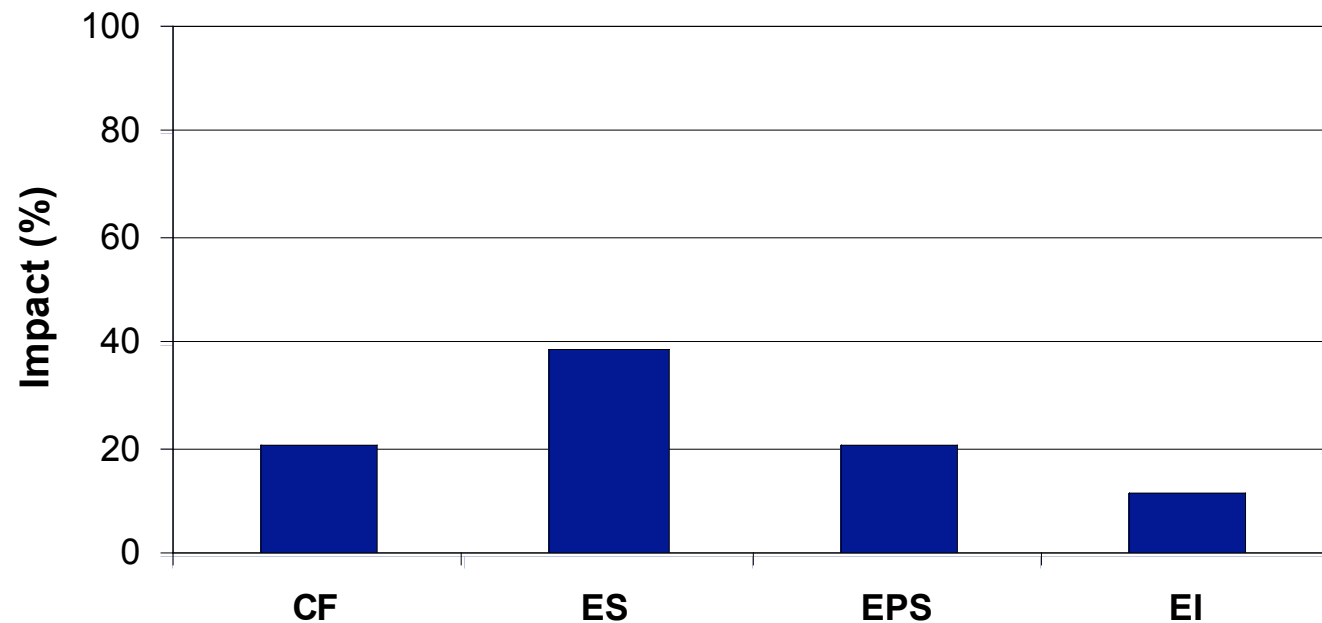


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# Non-fossil average contribution – Plastics

Plastics

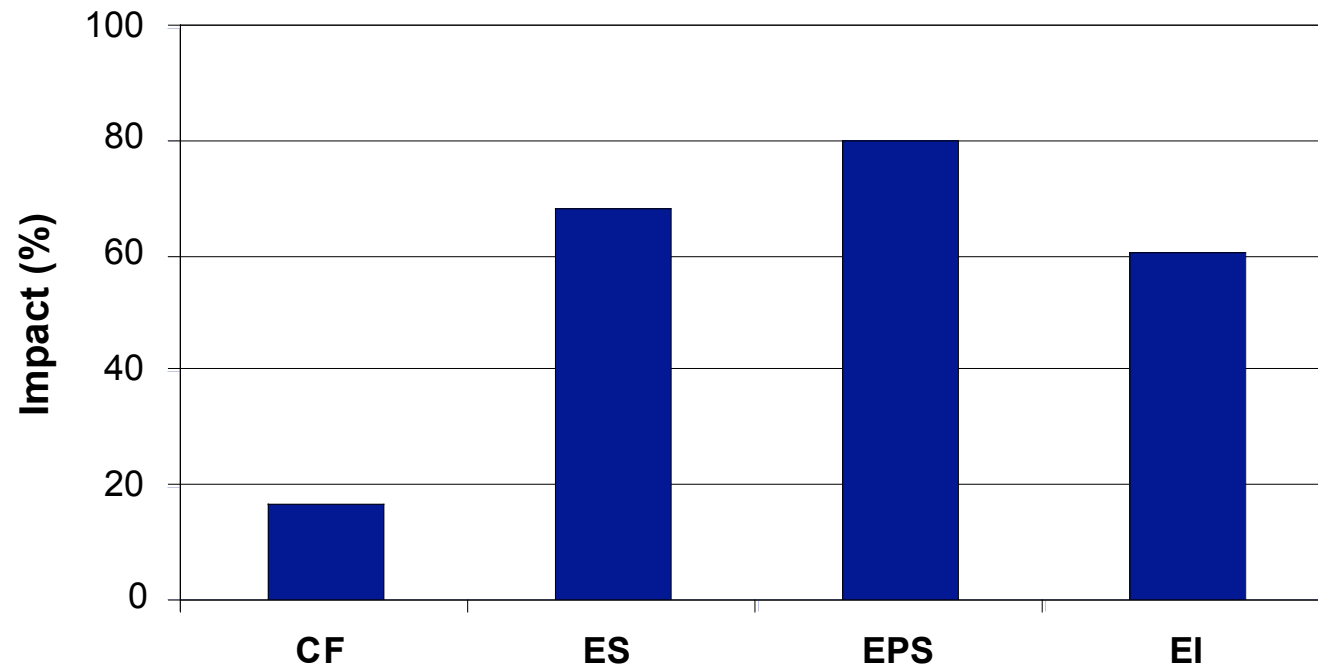


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# Non-fossil average contribution - Metals

Metals



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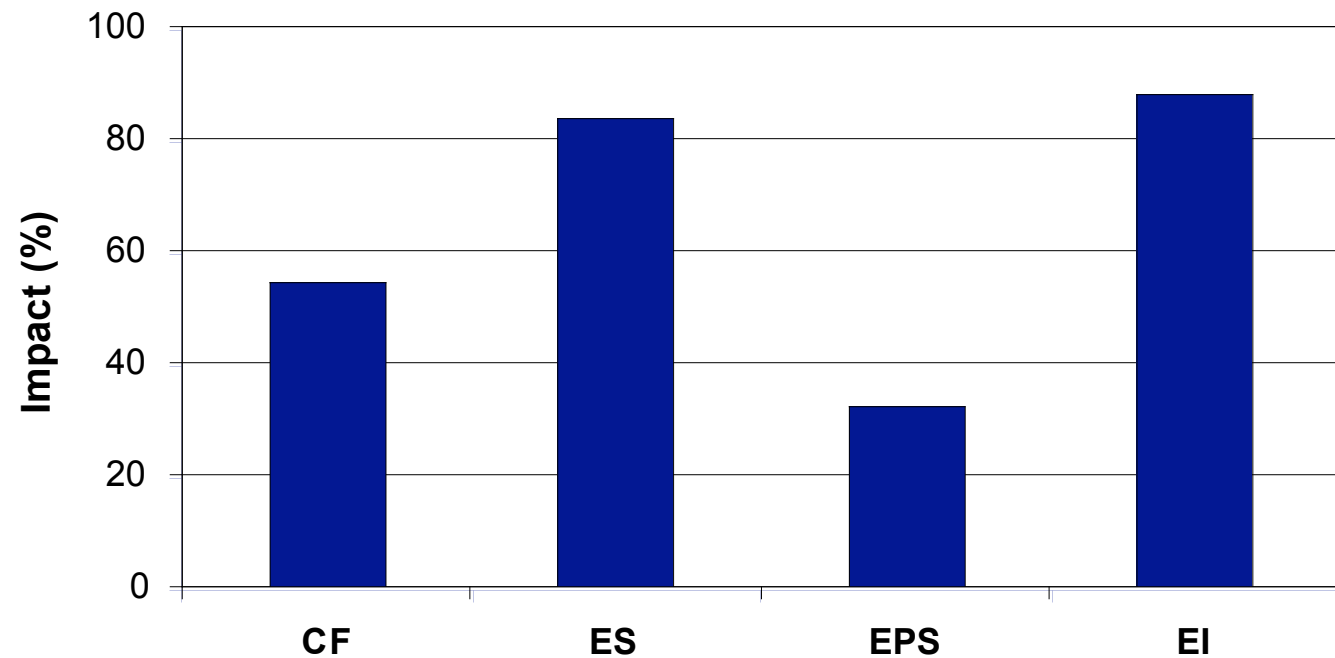


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# Non-fossil average contribution - Agriculture

Agricultural products



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# Conclusions

1. Climate Footprints point to the same conclusions as more comprehensive impact assessment methods
2. Fossil energy use has the most important contribution to the environmental burden of many materials included
3. For metal and agricultural products, non-fossil energy related impacts dominate. This aspect is not (fully) covered by climate footprinting

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