

Towards an advanced methodology for assessing the global environmental impacts caused by the material flows of a national economy

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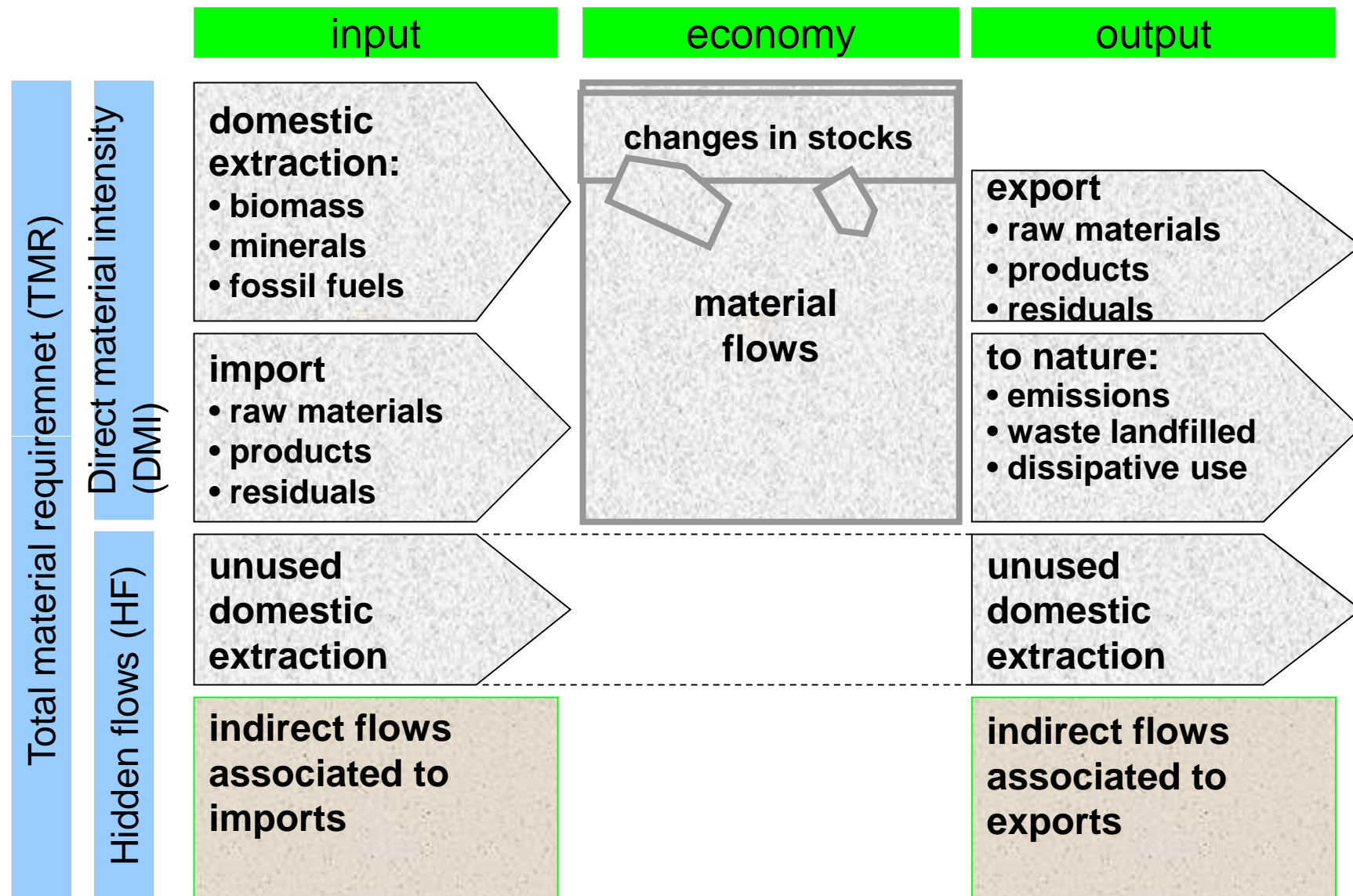
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Material flow balance of an economy (Mäenpää 2004 and EEA 2003)



Finnish Environmentally Extended Input-Output (EE-IO) Model – Envimat

- 151 industry sectors and over 900 products and services
 - main material accounts for Finland in 2002 and 2005 (import, domestic extraction, export)
 - all “relevant” environmental loads (emissions, wastes, land use) related to the industry sectors
 - domestic data for activities in Finland (national emission inventories, Finnish statistics)
 - options for upstream (activities abroad, import)
 - **option 1:** Ecoinvent (LCI)+ Danish LCA food database + Domestic emission and resource factors
 - **option 2:** Ecoinvent (LCI)+ Danish LCA food database + EIOLCA
 - **option 3:** EIOLCA
 - **option 4:** Domestic emission and resource factors
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Environmental impact assessment

Characterisation

- alternative approaches for characterisation factors to calculate environmental impact category indicator results
 - * option 1: **CML2002** (Guinee et al. 2002)
 - * option 2: **ReCiPe** (Sleeswijk et al. 2007)
 - * option 3: **Europe**
 - site-generic European CFs derived from the country-dependent methods of CFs (peer-reviewed methods for eutrophication, acidification, tropospheric ozone formation, particulate matters)
 - toxicity from ReCiPe
 - global CFs for global impact categories
 - * option 4: **Finland specific**
 - Finland specific CFs for domestic data
 - site-generic European CFs for import (same CFs as in the Europe model above)
 - global CFs for global impact categories
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Bases for characterisation (Number = a method, E=expert judgment, M= modified)

	CML2002	ReCiPe	Europe	Fin specific
Climate change	1	1	1	1
Stratospheric ozone depletion	2	2	2	2
Acidification	3	4	5	5
Eutrophication	6	7		
* unspecified				
* subcategories for marine and freshwater				
* aquatic			8+E	8
* terrestrial	9	9		
Tropospheric ozone formation	10			
* unspecified				
* human health		11	12	12
* vegetation			12	12
Ecotoxicity				
* freshwater	13	14	14	14+M
* marine	13	14	14	14
* terrestrial	13	14	14	14
Human toxicity	15	16	16	16+M
Particulate matter	15	17	17	17
Abiotic resource depletion				
* minerals, fossil fuels	18		18	18
* only fossil fuels		19		
Depletion of biodiversity				20

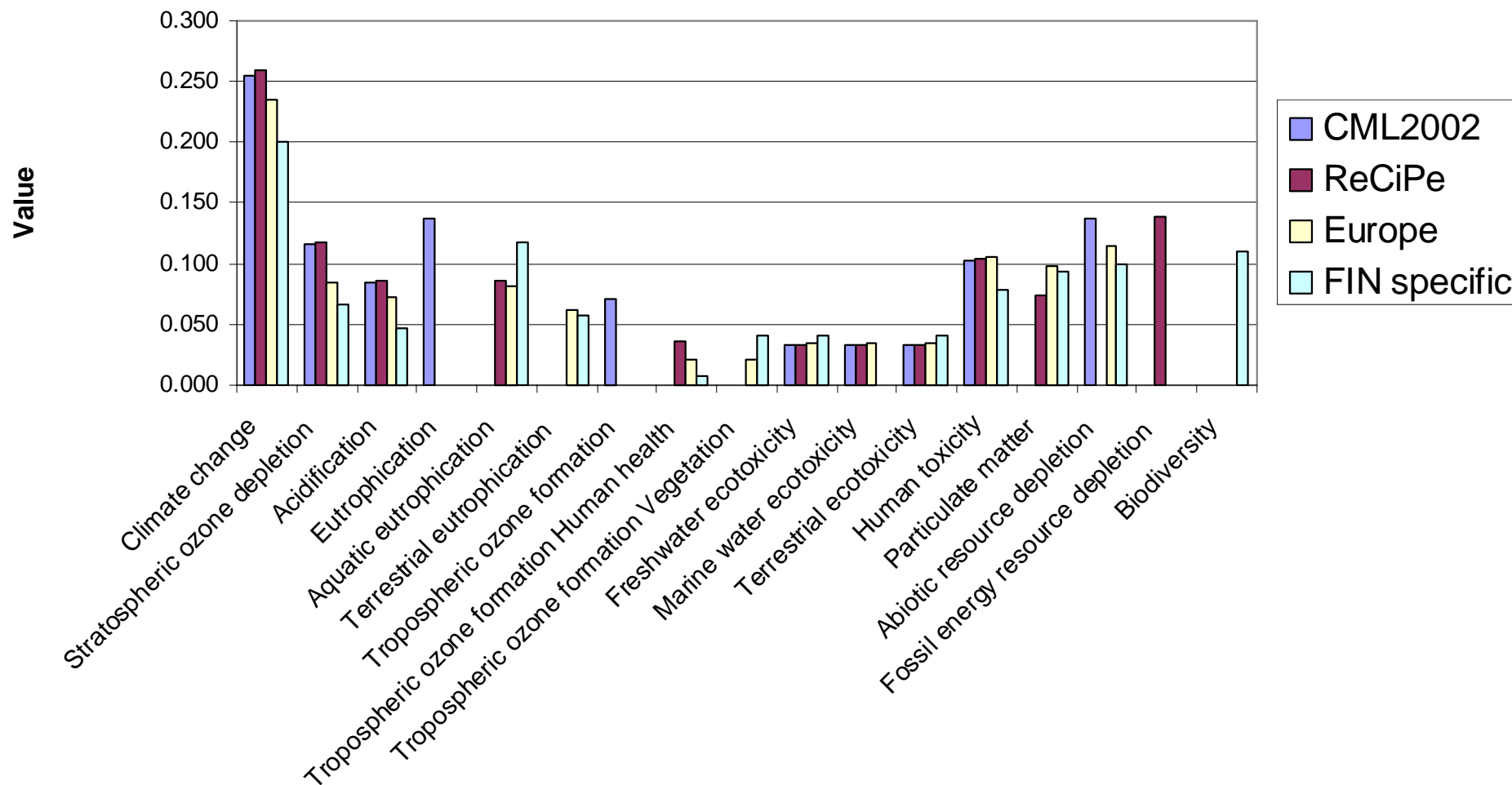
Environmental impact assessment

Optional elements: **normalisation and weighting**

- * Geographical area of reference and weighting factors used in each methods
 - * **CML2002** : World
 - * **ReCiPe** : World
 - * **Europe** : Europe
 - * **Finland specific** : Finland

 - * Weighting factors were derived from an international weighting survey (not yet published) in which a panel method was used. The respondents (n=50) were :
 - World: n=43 (Finland : 5, France: 8, Holland: 4, Germany: 4, Slovenia: 5, Canada 3, Brazil : 8, China: 6).
 - Europe: n=26 (Finland : 5, France: 8, Holland: 4, Germany: 4, Slovenia: 5)
 - Finland: n=22 (Finland: 22)
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Average weighting factors for impact categories



The Finnish EE-IO model - Envimat

Monetary input-output tables (MIOT)

Physical input-output tables (PIOT)

Environmental tables

Added values
Employment

TMR, DMI

Emissions, impact category-
results, Ecoindex

Output categories

Domestic

+

Imports

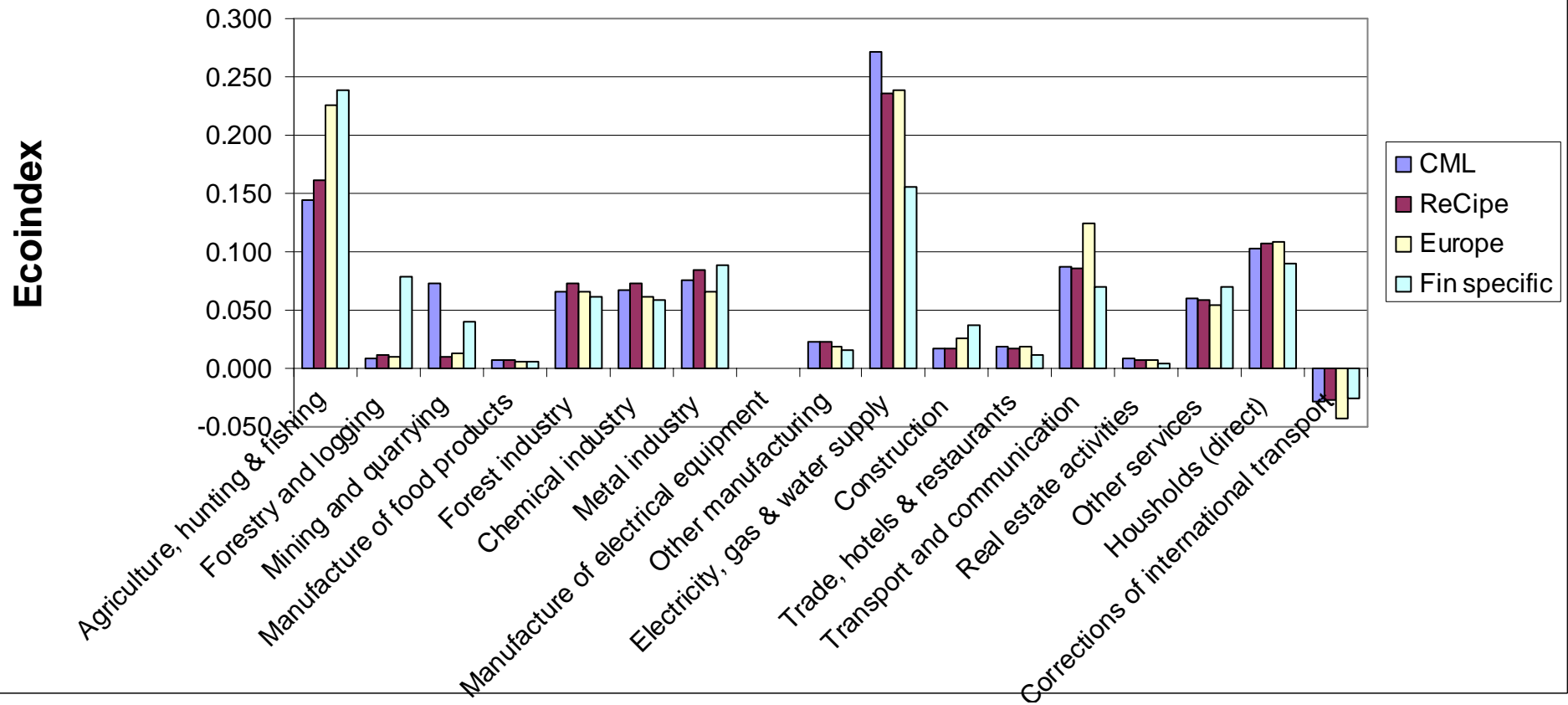
Consumption expenditure

Economic sectors

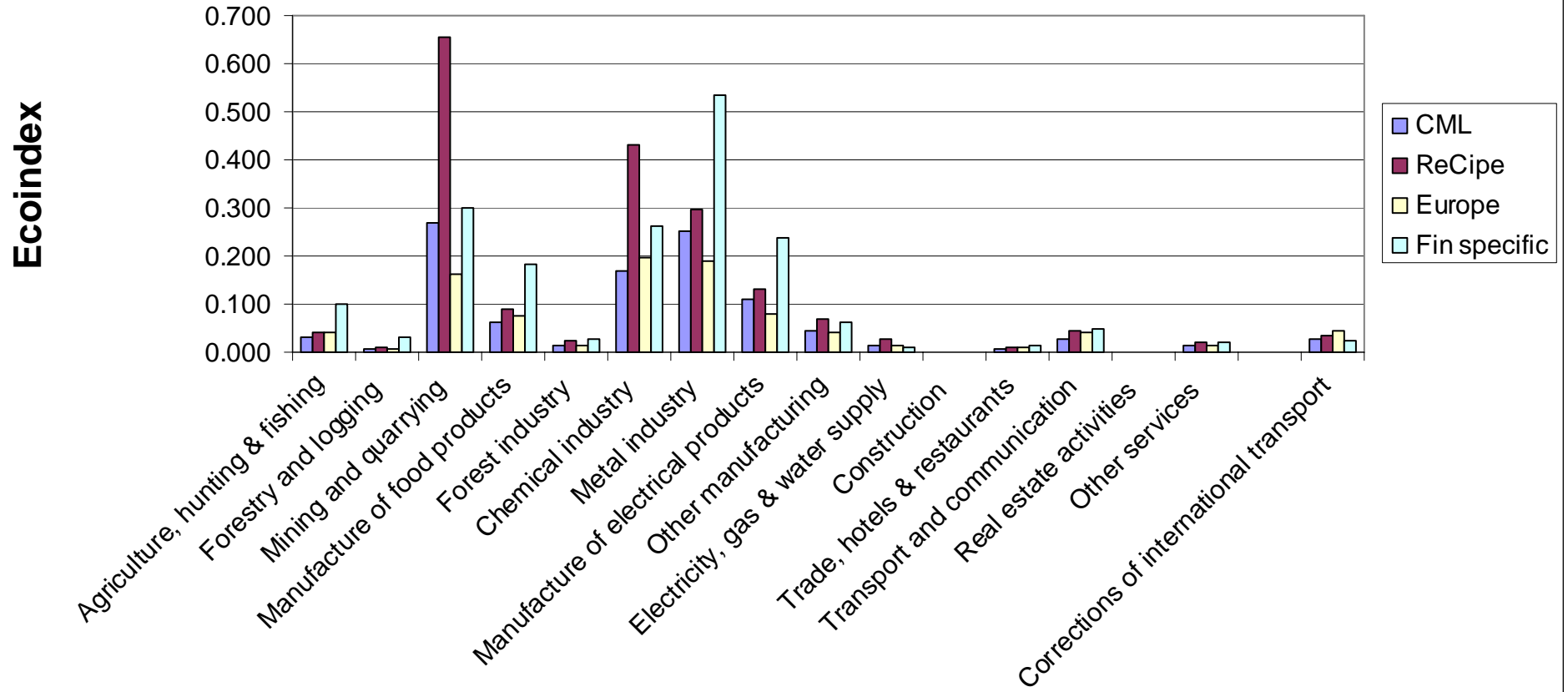
Product groups

RESULTS

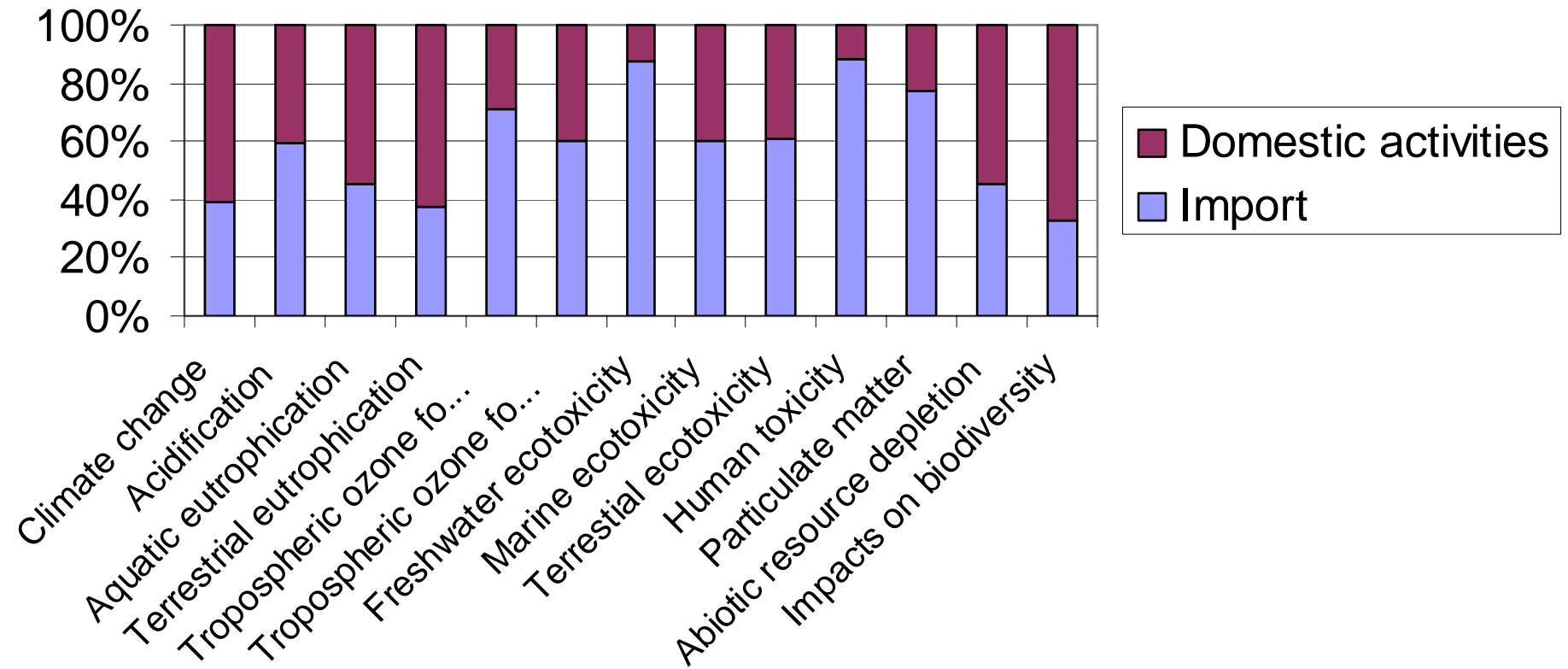
Direct environmental impacts caused by domestic activities



Direct environmental impacts caused by imports



Finland specific approach: Contributions of import and domestic activities to impact category indicator results

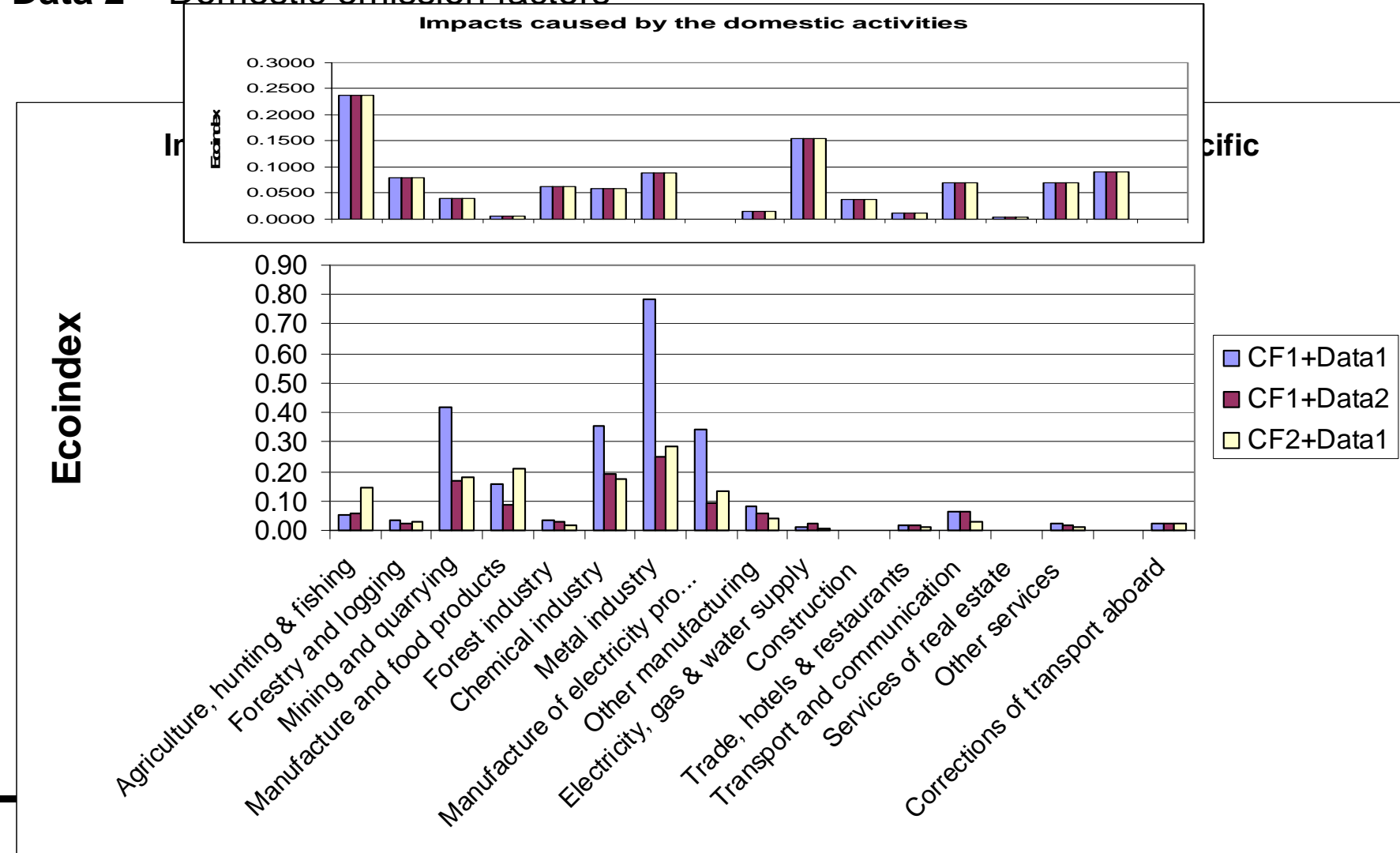


CF 1 = European site-generic characterisation factors for import

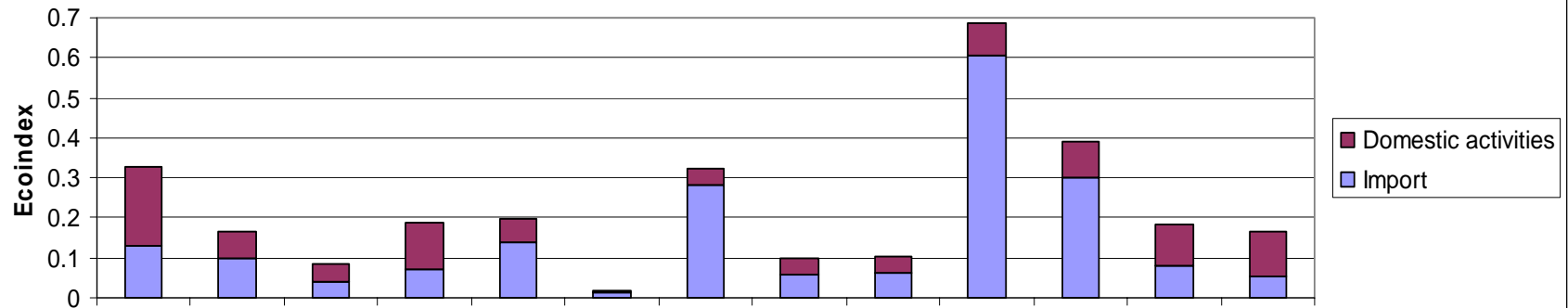
CF 2 = Finland-specific characterisation factors for import

Data 1 = Ecoinvent (LCI)+ Danish LCA food database + Domestic emission factors

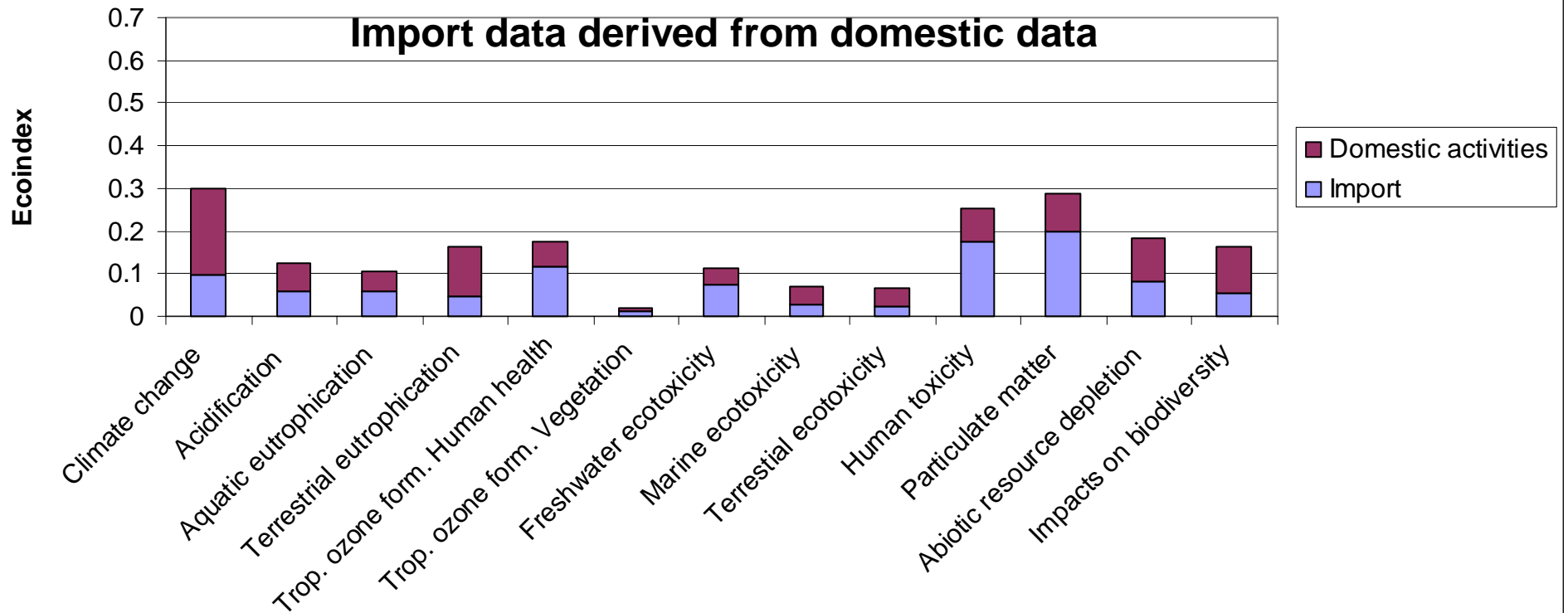
Data 2 = Domestic emission factors



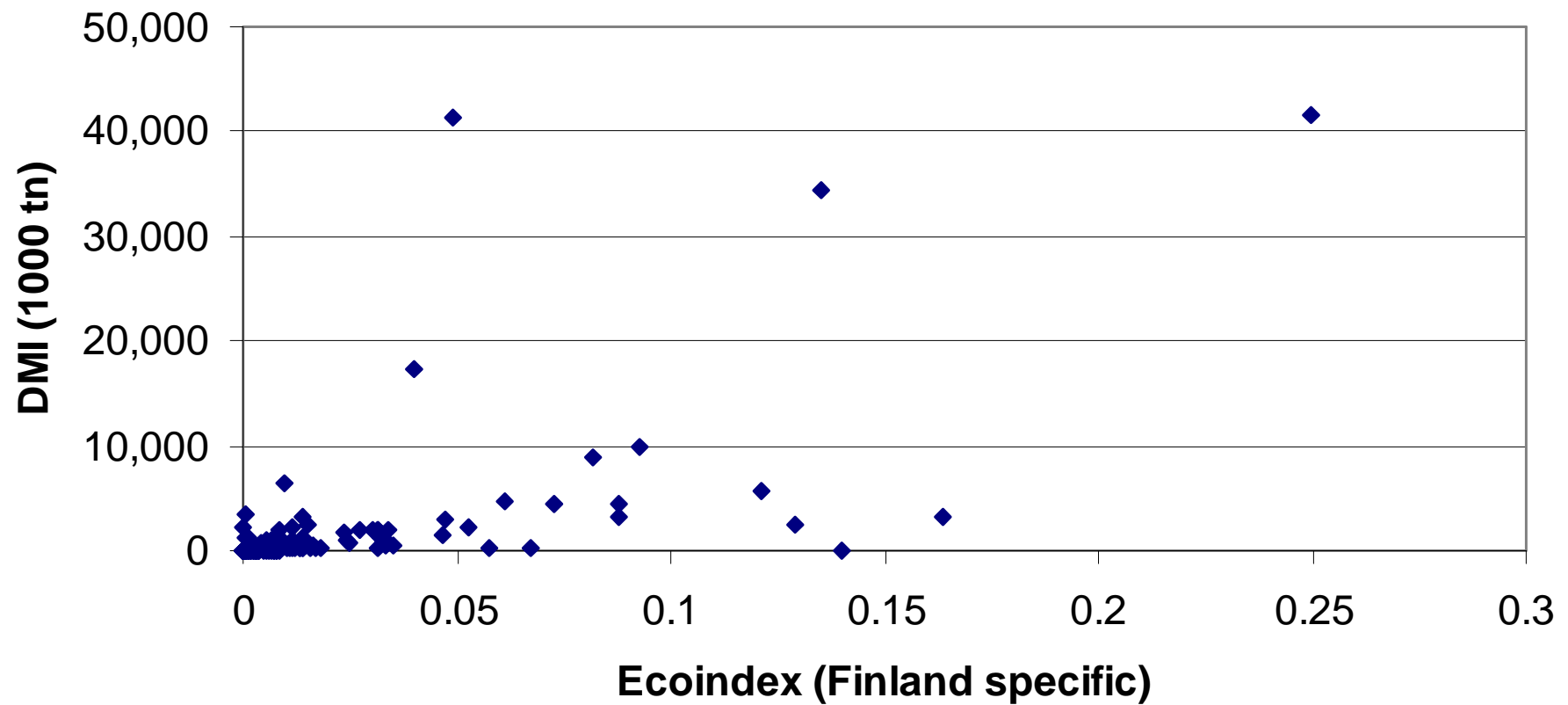
Finland specific approach: impacts of import
Import data derived from Ecoinvent, Danish LCA food database
and domestic data



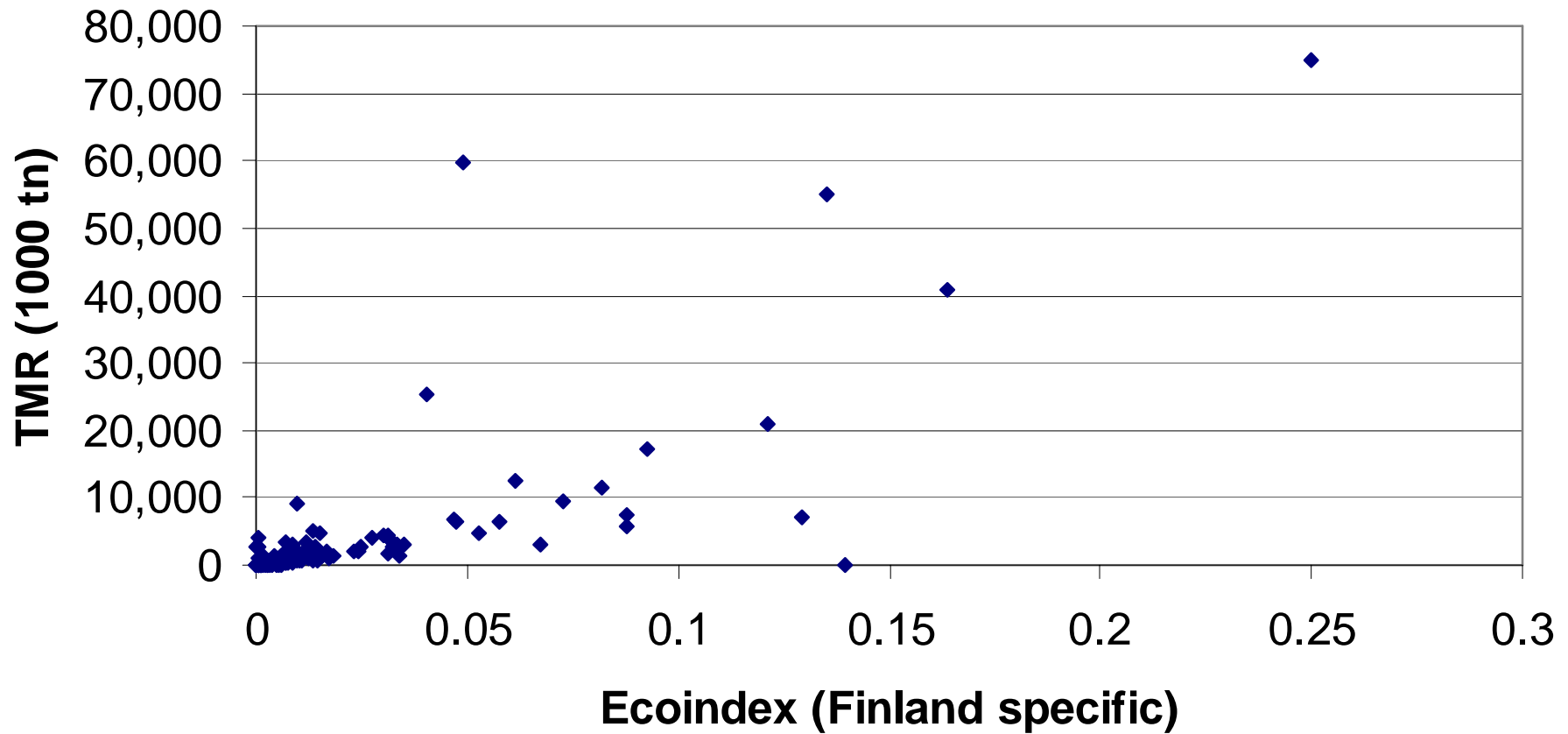
Import data derived from domestic data



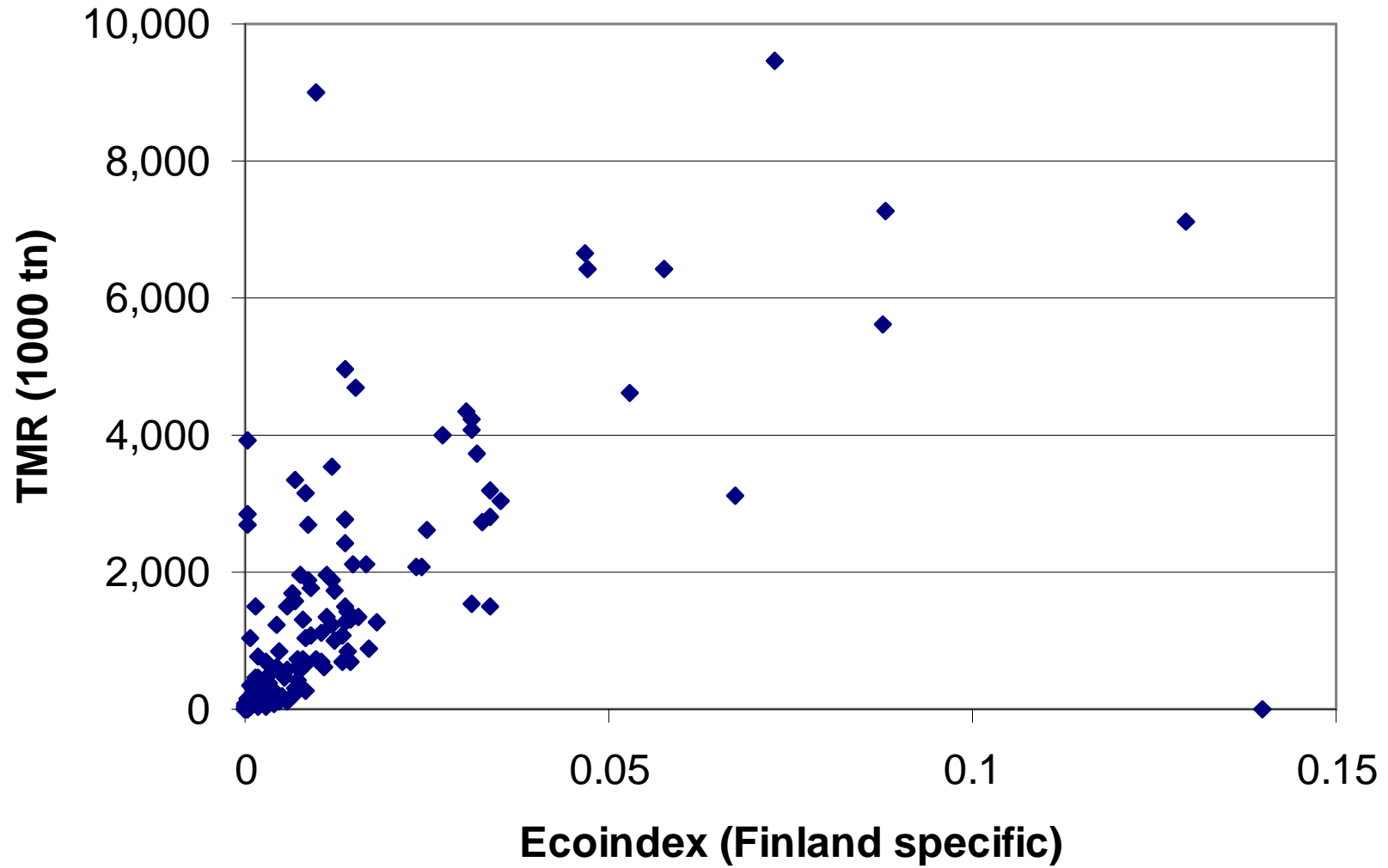
Relationships between the DMI and Ecoindex values of product groups (n=155)



**Relationships between the values of TMR and Ecoindex
in different product groups (n=155)**



Relationships between the TMR and Ecoindex values of product groups (n=146)



Conclusions and Future Outlook (1/2)

- The data sources used for import lead to a great variation on the results
 - LCI databases offer an attractive manner to construct import data, but they do not cover all important products. In addition, they represent average data
 - The use of different impact assessment methods offers a good starting point for checking errors and misunderstandings in input data
 - The use of normalisation and weighting as optional elements in LCIA helps the interpretation. However, the uncertainty in reference and weighting factors means that the aggregated results are only indicative
 - The toxicity issues play important role in the final results because of
 - incomplete data of hazardous substances
 - uncertainty in the emission data of sectors and products
 - uncertainty in characterisation factors of hazardous substances
 - uncertainty in global emissions of hazardous substances in order to construct reference values in normalisation
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Conclusions and Future Outlook 2/2

- The study showed that site-specific impact assessment can offer very different overview about the total environmental impacts caused by an economy – in this study there is a need to carry out a more detailed impact analysis for the most important material flows imported in the future
 - Sensitivity and uncertainty analyses should be developed in the context of EE-IO
 - The relationships between TMR and total environmental impact indicators are weak. However, total material requirement (TMR) seems to indicate the total environmental impacts better than direct material input (DMI).
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