

Environmental Impacts Caused by the Material Flows of the Finnish Economy

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Summary

The processing of natural resources causes different impacts on the environment. For achieving sustainable development, it is important to recognize the material flows which cause the most stress to the environment or even exceed environmental capacity. For this purpose, a team consisting of researchers from the Finnish Environment Institute (in charge), the Thule Institute (University of Oulu), the MTT Agrifood Research Finland and the VTT Technical Research Centre of Finland, have started a project named ENVIMAT. The aim is to define the life cycle environmental impacts of the material flows used for production and consumption in the Finnish economy based on different activity sectors and product groups. The focus of the project is not restricted to domestic environmental loads. Impacts on the environment caused by the main imported raw materials and goods are also taken into account. The final objective of the project is to create a hybrid model by which the relationships between environmental impacts and economic effects from the use of natural resources in Finland can be assessed. In the environmental assessment, life cycle methodology and databases will be combined with the national material flow accounts and input-output analysis. In particular there is a need to develop impact assessment methodology concerned with land use. The project is one of the projects funded by the Finnish Environmental Cluster Research Programme (4th phase: Eco-efficient Society). The ENVIMAT project started in May 2006 and will be finished by the end of October 2008.

Keywords: Environmental impacts, material flows, LCA, material flow accounts, I-O analysis, Finnish national economy

Introduction

According to the statistics of the European Environment Agency (EEA 2003), Finland has one of the highest rates of natural resource consumption per capita in Europe. This result has sparked a debate among Finnish environmental administrators and political decision makers because it is assumed that natural resource consumption rates in Finland reflect directly the environmental impacts caused by the Finnish economy. However this has raised questions over what natural resource consumption can really tell us about environmental impacts?

Both natural resource consumption and gross domestic product (GDP) have increased in the Finnish economy during the last few decades. A similar trend can be seen in other developed countries. However, a study carried out by Bringezu (2002) shows that the relationship between the Total Total Material Requirements (TMR) and the GDP of the Finnish Economy is different from that of many other countries. TMR is an indicator of natural resource consumption describing all direct and indirect material flows (so-called "hidden" flows) associated with imports and domestic extraction (e.g., European Commission 2001a). In Finland the growth of TMR has been exceptionally high compared with other developed economies, which is mostly attributable to the raw material extractions by the Finnish metal and forestry industries. Within a competitive market companies have only retained their profits by increasing their product volumes. In practice, the growth of production volumes has been achieved by increasing imports of mineral ores and wood. This raises a further question within Finland: what are the environmental impacts of the Finnish economy abroad?

It was against this background that an extensive R&D project, Environmental Impacts of Material Flows Caused by the Finnish Economy (ENVIMAT), was started in spring 2006 as part of the Finnish Environmental Cluster Research Programme 2006-2009. The Finnish Environment Institute (SYKE) is in charge of the project. Research partners include the Thule Institute (University of Oulu), the MTT Agrifood Research Finland and the VTT Technical Research Centre of Finland. The project will be finished by the end of October 2008.

The Aim of the Study

The aim of the study is to assess life cycle environmental impacts caused by production and consumption within the Finnish economy. The basic assessment will be made according to economic sectors and main product groups. The purpose is to identify the most harmful material flows from the point of view of their environmental impacts. Of special interest is an attempt to clarify the meaning of hidden flows of material accounts on environmental impacts and to develop impact assessment methodology concerning land use. The environmental impact assessment in the project will include domestic activities and activities abroad that are related to Finnish materials and energy. However, environmental impacts abroad caused by export goods are not assessed.

Materials and Methods

Material flows are a general basis from which most environmental impacts emanate. For this reason, material flow accounts (MFA) give an interesting starting point for an environmental analysis of the Finnish economy. MFAs have been conducted in several countries of the European Union (Eurostat 2002). The calculation rules for the so-called MFA indicators are documented in a guidebook published by the European Commission (2001). The guidebook presents calculation rules for basic indicators of material use. In practice, input-output analysis of economics offers a framework for MFA calculations. Input-output analysis presents trading among economic sectors in table form and in monetary terms. In MFA the use of materials in each sector is assessed and material flows between economic sectors are calculated according to the monetary flows between the corresponding sectors.

The aim of the study is to create a Finnish specific hybrid model based on economic input-output tables associated with material flows and environmental loads. Furthermore, life cycle based environmental impact assessment tools will be combined with the input-output framework. Environmental loads refers here to information on emissions, wastes and land use, whereas material flows covers raw materials, fuels, electricity and products according to the MFA principles.

The EIPRO project (IPTS 2005) funded by the EU Commission includes the framework for the development of the hybrid model. In the EIPRO project, the environmental impacts of goods were analyzed from the point of view of 25 EU countries. In the ENVIMAT project the aim is to create a more advanced model for assessing the environmental impacts of the Finnish Economy. For this purpose, the input-output tables of physical flow accounts for the Finnish economy in 1999 conducted by Mäenpää (2005) offer a starting point for methodological development. The tables including 151 industry sectors and 718 products cover the following main physical accounts for Finland:

- raw materials, air and water (from environment to the economy)
- unused extraction (from the environment to the environment)
- products, residuals and net accumulation (from the economy to the economy)
- emissions into air, water vapour, discharges into water, dissipative use (from the economy to the environment)
- indirect inputs of imports

In the ENVIMAT project the tables for the physical flow accounts will be updated and completed with new environmental data from the situation in 2002 and in 2005. In addition, improvements will be made to the existing weaknesses of the input-output tables. The improvements will be made to the fields of a) electricity and central heating, b) transport and c) production capital and infrastructure.

The aim during the inventory phase is to assess emissions and wastes of industry sectors by using, for example, a national emission register (called VAHTI), the Finnish air pollutant inventories (calculated by national as well as the EMEP/CORINAIR guidebook methods) and finally the life cycle inventory databases. The latter source is the most suitable for assessing environmental loads of import material flows. One of the most challenging phases concerns how input data on land use can be gathered. In practice, land use based data is still lacking in the Finland-specific LCI data sources.

Environmental impacts caused by the environmental loads of economic sectors will be assessed by midpoint based life cycle impact assessment (LCIA) methodology. This includes at least the following environmental impact categories:

- climate change
- ozone depletion
- acidification
- tropospheric ozone formation
- aquatic eutrophication
- terrestrial eutrophication
- particulate matter
- ecotoxicity
- human toxicity
- depletion of natural resources
- impacts on biodiversity
- other land use related impacts.

The aim is to search for the best impact assessment practice or practices for each impact category on the basis of the results of international co-operation (e.g. the results of the UNEP/SETAC Life Cycle Initiative and European platform on LCA). In the project, there is a particular need to develop impact assessment methodology for land use from a domestic viewpoint. Another challenge is how the impact abroad and especially outside of Europe can be assessed. For this reason, a land use methodology used in the context of ecological footprint (Global Footprint Network 2006) will be used as one alternative approach for the worldwide impact assessment of land use.

A further objective of the project is to also demonstrate how the impact results will vary based on country-specific characterisation factors compared with the results derived from traditional site-generic characterisation factors (see e.g. Seppälä et al. 2005). In addition, the results of the recommended characterization methods will be compared with the results produced by the impact assessment methods used in EIPRO.

In order to clarify the relative importance of different impacts a normalisation phase of LCIA and a valuation task for determining European weighting factors in each impact categories will be conducted. The intention is to conduct the valuation task in co-operation with European research institutions, universities and consultants.

Finally, the calculation rules of input-output tables will be developed so that the correlations between different material flows and environmental impacts can be tested. The testing will also include a comparison between the results of MIPS (=material inputs per service, see Wuppertal Institute 2006) calculations and the results of LCA based material flow accounts. The MIPS calculations for products and services will be based on the TMR values. The MIPS data will be obtained from FIN-MIPS (2006), another project of the Finnish Environmental Cluster Research Programme.

Future Outlook

The study will create new knowledge about the role of natural resource consumption, which can be applied in order to minimize environmental impacts caused by the Finnish economy. On the basis of the results it will be easier to focus environmental measurements on the material flows that cause the most harmful effects to the environment. During the project state of the art impact assessment methodology will be clarified and new inventory data on materials based on life cycle thinking will be gathered. This information will also contribute to the practical implementation of Integrated Product Policy (IPP) (European Commission 2001b). For example, the aim is to use the data and the impact assessment methodology developed in the ENVIMAT project to express environmental impacts based on consumer choice and for communicating environmental impacts to consumers (see e.g. CONSENV 2006).

The hybrid model will not only clarify the complex relationships between environmental impacts, product groups and economic sectors but the framework will also include economic flows. It will also be possible to add employment data to the model. Thus, the long term aim is to construct a sustainable assessment tool for the Finnish economy, which can be used to construct different scenarios and assessments of environmental and socio-economic impacts.

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