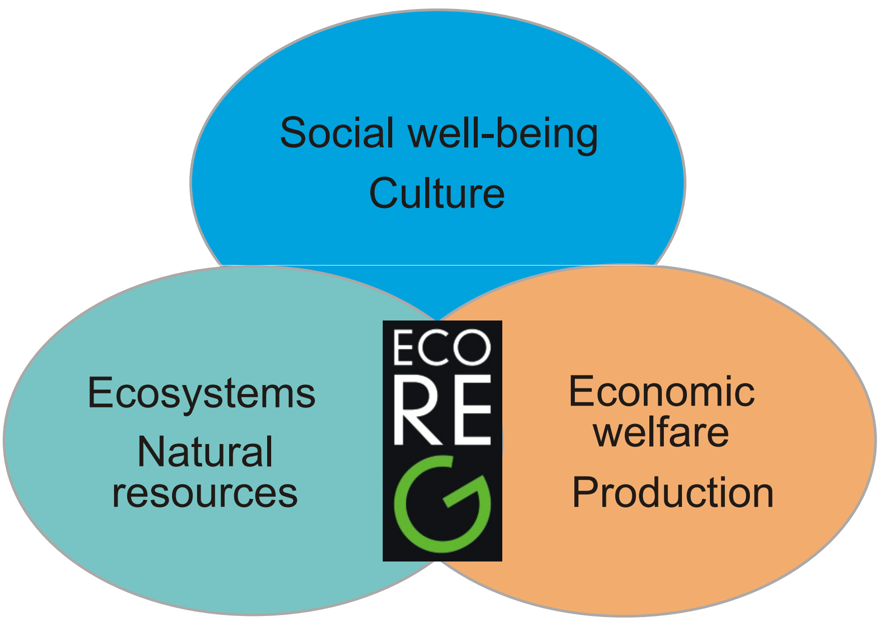
The Finnish Environment 735en

ENVIRONMENTAL PROTECTION

Matti Melanen, Jyri Seppälä, Tuuli Myllymaa, Per Mickwitz, Ulla Rosenström, Sirkka Koskela, Jyrki Tenhunen, Ilmo Mäenpää, Frank Hering, Alec Estlander, Marja-Riitta Hiltunen, Mika Toikka, Esa Mänty, Lasse Liljeqvist and Juha Pesari

Measuring regional eco-efficiency – case Kymenlaakso

Key results of the ECOREG project



FINNISH ENVIRONMENT INSTITUTE

The Finnish Environment 735en

Matti Melanen, Jyri Seppälä, Tuuli Myllymaa, Per Mickwitz,
Ulla Rosenström, Sirkka Koskela, Jyrki Tenhunen, Ilmo Mäenpää,
Frank Hering, Alec Estlander, Marja-Riitta Hiltunen, Mika Toikka,
Esa Mänty, Lasse Liljeqvist and Juha Pesari

Measuring regional eco-efficiency – case Kymenlaakso

Key results of the ECOREG project

HELSINKI 2004

FINNISH ENVIRONMENT INSTITUTE

This publication is also available in the Internet
www.environment.fi/publications

ISBN 952-11-1900-4
ISBN 952-11-1901-2 (PDF)
ISSN 1238-7312

Cover picture: Katariina Kytönen
Page layout: DTPage Oy

Printer: Edita Prima Oy, Helsinki 2004

Foreword

The Finnish Environment Institute (SYKE), the Southeast Finland Regional Environment Centre, the Regional Council of Kymenlaakso and the Thule Institute at the University of Oulu conducted (1 September 2002 – 31 December 2004) a LIFE project named "The Eco-efficiency of Regions – Case Kymenlaakso (ECOREG)" (LIFE02 ENV/FIN/000331). The project was financed by the European Community's LIFE programme (support obtained from LIFE-Environment) and the Finnish Ministry of the Environment.

The goal of the ECOREG project was to demonstrate the concept of eco-efficiency and evaluation of eco-efficiency on a regional scale. In the project the Kymenlaakso region located in Southeast Finland was used as an example.

The previous reports of the ECOREG project (publications 697, 698 and 699 and their English translations 697en, 698en and 699en in the Finnish Environment Series) documented the work by means of which economic, environmental and socio-cultural indicators were designed for Kymenlaakso. This current report presents the key results of the ECOREG project particularly focusing on the indicators of regional eco-efficiency and its measuring (monitoring and evaluation mechanism), processes and methods utilised in the project as well as reproducibility and transferability of the ECOREG results in other parts of Finland and Europe.

The interim results of the ECOREG project were dealt with several times by the project's steering group and at the three workshops arranged in Kymenlaakso. The decision makers and experts of the Kymenlaakso region who participated in the activities of the steering group and the workshops significantly contributed to the final outcome of the project – without the local expertise, it would not have been possible to successfully carry out this kind of a project.

The ECOREG project and its results were also presented at several international events such as the International Eco-Efficiency Conference held in Leiden, the Netherlands, in April 2004, and the 9th European Roundtable on Sustainable Consumption and Production (erScp 2004) in Bilbao, Spain, in May 2004.

Matti Melanen
Project Manager, ECOREG project

Contents

Introduction

1.1 What is eco-efficiency?

The concept of eco-efficiency gained international awareness in the 1990s, when both the OECD (Organisation for Economic Co-operation and Development) and the WBCSD (World Business Council for Sustainable Development) incorporated the concept of eco-efficiency into their programmes and started promoting its implementation. The WBCSD launched eco-efficiency as a "business link to sustainable development" (e.g. Lehni 1998, WBCSD 2000b). For companies eco-efficiency means, above all, "saving resources – improving competitiveness" (Klaus Wiesehügel in Die Effizienz-Agentur NRW … 2001).

Originally, the WBCSD (2000b) defined eco-efficiency as follows:

> "Eco-efficiency is achieved by the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle, to a level at least in line with the earth's estimated carrying capacity."

This broad definition combines welfare, competitiveness, the products' ecological impacts throughout their life cycle, the use of natural resources and the environmental carrying capacity. The OECD (1998) presents the same matter more concisely but still in a broad sense:

> Eco-efficiency is "the efficiency with which ecological resources are used to meet human needs".

The essence of the eco-efficiency approach has crystallised into the following statement:

> Eco-efficient operations produce more value with less impacts.

The prefix "eco" refers both to economic and ecological/environmental performance. Thus, the concept of eco-efficiency connects economic welfare and environmental quality to each other, and accordingly, eco-efficiency is easier to grasp when regarding it as a quotient or a ratio (e.g. OECD 1998, Lehni 1998, Keffer and Shimp 1999, Müller and Sturm 2001, Sturm et al. 2002):

(1) Eco-efficiency =
(Added) economic value / (Added) environmental influence
or conversely
(2) Eco-efficiency =
(Added) environmental influence / (Added) economic value

Eco-efficiency is a relative concept and if it is considered according to Equation 1 given above, eco-efficiency may increase even if the environmental burden increases at the same time. Consequently, the increase in eco-efficiency may, at least theoretically, contradict the principle of sustainable development. It is to this very point that the justified criticism presented against the concept of eco-efficiency is connected (e.g. Welford 1996, Dyllick and Hockerts 2002). Welford (1996) even states that "as such it [eco-efficiency] represents the hijacking of traditional notions of environmentalism."

One can be certain that the increase in eco-efficiency is implemented in accordance with sustainable development, if the economic value or welfare increases while the environmental impacts simultaneously decrease (see the graph in the middle of Fig. 1).

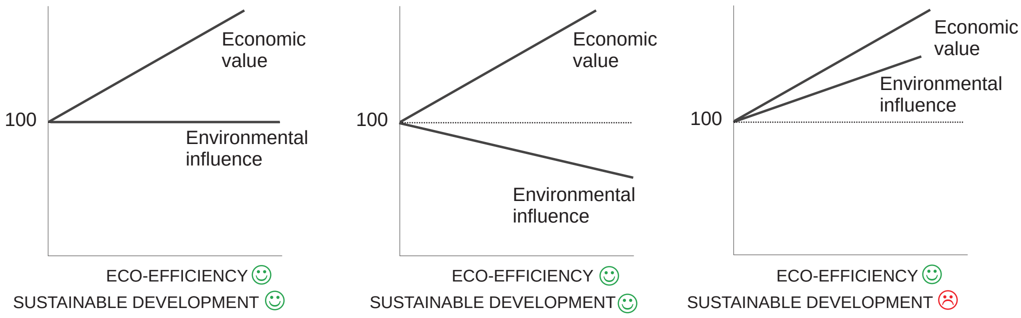


Figure 1. Eco-efficiency is not always implemented in accordance with environmental interests. Horizontal axis: time, vertical axis: change (original source: Rosenström and Mickwitz 2004).

The following development trends are typical for companies and other actors striving at increasing their eco-efficiency, in other words creating more value and, at the same time, decreasing the resulting environmental burden (WBCSD 2000b):

- the products' material dependance is decreased – less materials per unit produced or used
- energy dependance is reduced – less energy per unit
- the use of harmful substances is decreased
- product recyclability is enhanced
- the use of renewable resources is maximised
- the products' durability and service life is extended
- the share of services is increased in commodity production.

Summarised, it can be said that these means serve three comprehensive goals (WBCSD 2000a):

- reduction of utilisation of natural resources
- decrease in (other) environmental impacts
- increase in the products' value.

Eco-efficiency can be examined at different levels. The development of eco-efficiency can be assessed focusing on national economies (for example, Adriaanse et al. 1997, Hoffrén 2001, Mäenpää and Juutinen 2002, EEA 2002), regions (such as the Basque Country, IHOBE 2003), companies (such as M-real 2001) or products. It is hoped that companies and other larger actors – for instance at the regional level – would use measures which are as similar as possible or, at least, instruments which are derived by adopting the same principles. That was among the conclusions which could be drawn from the discussions at the 9th European Roundtable on Sustainable Consumption and Production (erScp 2004) held in Bilbao, Spain, in May 2004.[1]

In the last few years the focus has been placed on the European "regions" and hence the promotion of their competitiveness – and, by this means, their eco-efficiency – has become a central issue (e.g. Hinterberger et al. 2000). Reducing material intensity is among the major issues dealing with the increasing of regional eco-efficiency (Fig. 2), although there is little chance to actually control material flows in today's world of free competition and global economy.

As can be concluded from above, the socio-cultural dimension has not really been included in the eco-efficiency analyses of the applications used so far. Usually, eco-efficiency is merely regarded as a relation between the economy and the environment. The problem is that the concept of eco-efficiency might easily expand into sustainable development, although sustainable development is a goal and eco-efficiency is one of the means by which sustainable development is sought to be implemented.

However, it would be necessary to include some kind of socio-cultural perspective when evaluating eco-efficiency. It is obvious that solutions concerning eco-efficiency influence society's overall welfare, but, via social dynamics, social and cultural welfare – which are manifested, for example, by a high level of education – are also important critical aspects and preconditions for economic activities (Fig. 3).

The concepts of eco-efficiency and sustainable development are complicated both for the public and for decision makers. It is difficult to measure sustainable development, but, however, we already know only too well what is unsustainable. Researchers should be able to convey these data to the public but that has turned out to be challenging (Niemi-Iilahti 2001). Furthermore, eco-efficiency monitoring supports the measuring of sustainable development.

[1] The 9th European Roundtable on Sustainable Consumption and Production (erScp 2004); http://www.erscp2004.net/

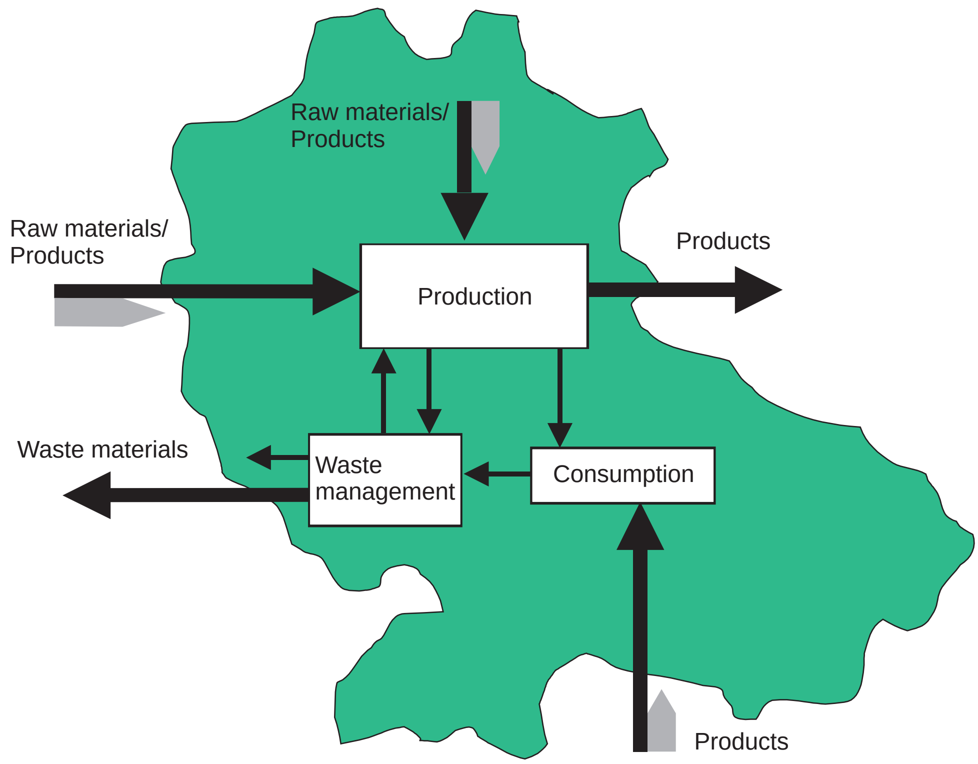


Figure 2. Regional eco-efficiency can be influenced by making changes to material flows. Black arrows delineate direct material inputs and flows, grey arrows hidden flows. (The Figure is adapted for Kymenlaakso from the figure originally presented by Hinterberger and Schneider (2001)).

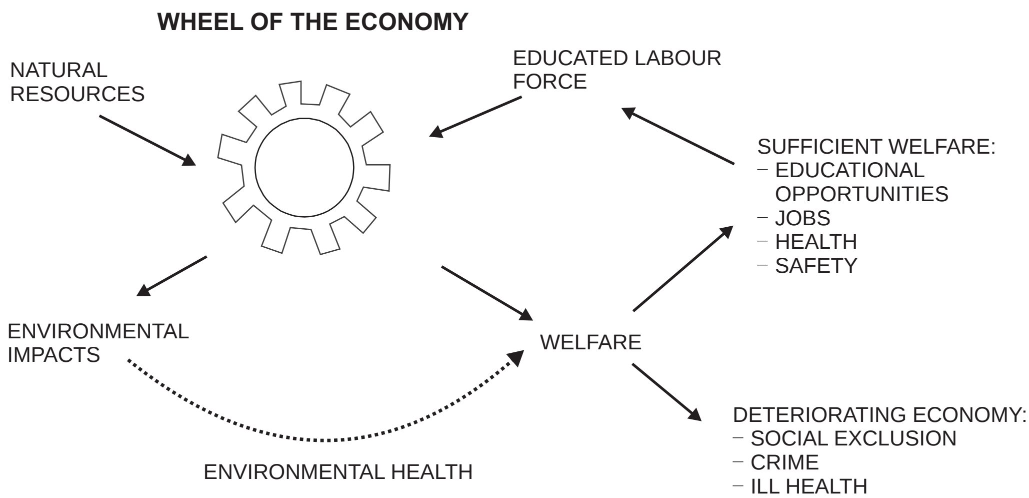


Figure 3. Socio-cultural perspective on eco-efficiency (Rosenström and Mickwitz 2004).

1.2 Need for regional data and indicators

The need for regional data can be particularly grounded by the fact that, in a democratic society, the majority of decisions are taken at the regional or municipal level. Also, decision makers at the national level need knowledge of regional conditions. The levels of data and decision making should always meet.

Companies need regional data in order to reach decisions. The level of education, the age structure and availability of social services in a region may influence companies' decisions on founding production plants or moving them elsewhere. Companies substantially affect regional eco-efficiency and, to a large extent, the state of the environment and its welfare, which is why communicating information to these companies is crucial. In addition, information has a central role to play in the participation of citizens. In issues relating to sustainable development, companies and consumers are, in the end, those having the most direct influence on the state of society and the environment. (Lafferty and Narodoslawsky 2003, Hirst 2000)

The role of indicators efficiently representing the data and supporting decision making has increased in the last few years. Nonetheless, indicators are not an entirely new means of data communicating. The first wave of indicators took place as early as in the 1970s in the form of measures determining welfare (Sauli and Simpura 2004). At the time the main reason for creating indicators was, however, the researchers' need to develop a range of various indicators and therefore indicators did not gain wide popularity. In the 1990s indicators were again more widely used, chiefly via the measuring of environmental problems (Bell and Morse 2003). At the turn of the century, decision makers also noted the usefulness of indicators and their utilisation was established.

Indicator properties:

- The task of the indicators is to compress a large amount of data into an understandable form or to indirectly interpret such phenomena which cannot be directly measured.
- Indicators should be easy to interpret and as unambiguous as possible.
- A good indicator is scientifically grounded and its theoretical basis is stable and accurate.
- At their best, indicators produce valuable information on the phenomena or properties studied.

Most of the indicators currently used are so far either very general (national or global) (for example, Rosenström and Palosaari 2000, OECD 2001, EEA 2002) or very detailed, such as the measures utilised by municipalities or companies (for instance, Helsingin kaupungin tietokeskus 2000 and Metso 2003). The very general-level measuring methods have both strengths and weaknesses. Their strengths are as follows: there are economic resources for data updating and the stock of statistics is comprehensive up to a certain point. For instance, countries with similarly advanced compilation of statistics are able to report jointly (e.g. OECD 2001, Nordic Council 2003). The weaknesses are the following: the indicators are of general character and average value because of the large geographical size of the area studied. In other words, the regional changes taking place within a country are not detected when making a large group of variables commensurable. For instance, the age structure of old-growth forests in northern Finland is very different from that of in southern Finland, thus making the average value almost useless. Besides, decision makers find it difficult to interpret the average Finnish values; when studying the suicide figures, they ask themselves whether all Finns are doing this badly or whether self-destruction is more common in towns and cities and in those remote rural areas which are impoverished by unemployment. Decision makers need more detailed regional data in order to take action.

Even so, there are still only few regional indicators. There are statistics but they are very comprehensive and they often present data in such a way that only experts are able to understand them. Although the need for regional indicators is obvious, gathering the data needed is often problematic. National statistics authorities collect data from municipalities and these data are published in larger compilations. The gathering of more detailed data often requires the use of search functions which are subject to a charge. As for environmental data, the situation is even more complicated: environmental impacts are not restricted by any state borders, which makes data collecting difficult. Nevertheless, in some cases a more restricted geographic area may facilitate data collecting and make it easier to conduct interview studies. In order to ensure the continuity of data monitoring it is, however, important to institutionalise data collecting, and that is why the utilisation of national data sources is recommended even at the regional level.

The comparability of data is another reason for using official statistics – such as statistics compiled by Statistics Finland. For instance, the members of the Finnish Parliament need to be able to compare the data concerning different regions, and for regional decision makers it is important to be able to proportion the situation in their own region to that of other regions. Among such indicators are, in particular, the unemployment rate and gross domestic product (GDP). By means of using official statistics, the comparability of data is ensured as regards methodological aspects.

1.3 Report contents

This report presents the key results of the project named "The Eco-efficiency of Regions – Case Kymenlaakso (ECOREG)" implemented in 2002–2004. The project was supported by the European Community's LIFE programme (LIFE-Environment).

The report has the following structure:

- Chapter 2 – The ECOREG goals and work process
- Chapter 3 – Kymenlaakso region used as an example
- Chapter 4 – The measuring of eco-efficiency, the indicators created in the project for Kymenlaakso and the methods and processes used
- Chapter 5 – The eco-efficiency monitoring and evaluation mechanism based on the use of the indicators developed in the project
- Chapter 6 – An outline analysis based on the project results concerning the eco-efficiency in Kymenlaakso
- Chapter 7 – Reproducibility and transferability of the ECOREG results and their more general significance
- Chapter 8 – Summary of the project results.

2 The ECOREG project

2.1 Goals and implementation

The goal of the ECOREG project was to demonstrate the concept of eco-efficiency and eco-efficiency evaluation on a regional scale, using Kymenlaakso region as an example (Fig. 4). The ECOREG project was carried out by the Finnish Environment Institute (coordinator), the Thule Institute at the University of Oulu, and by two important bodies located in the Kymenlaakso region; the Southeast Finland Regional Environment Centre and the Regional Council of Kymenlaakso (Fig. 5, Annex 1). In addition, the ECOREG project had a steering group comprising decision makers and experts of the Kymenlaakso region (Annex 1).

Figure 4. The location of the Kymenlaakso region.

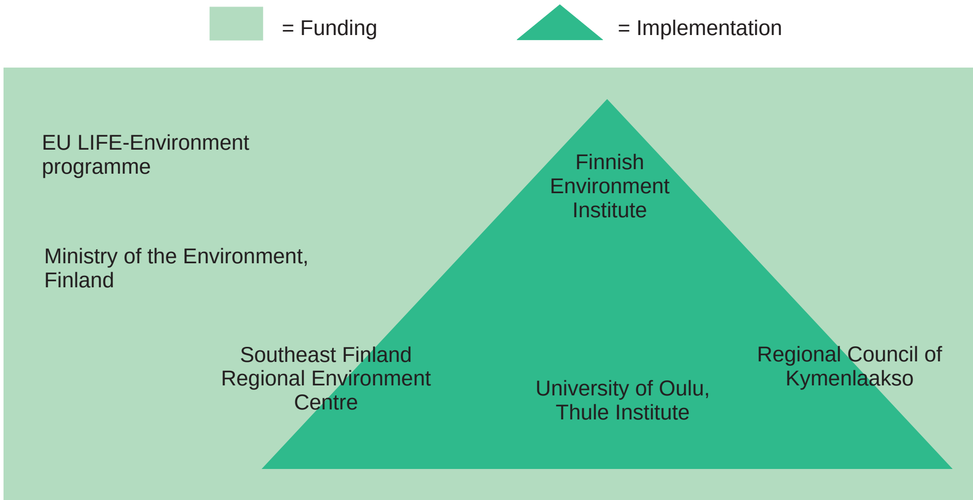


Figure 5. The ECOREG project actors and financiers.

ECOREG was a demonstration and innovation project with the following concrete goals:

- the design of eco-efficiency indicators for the Kymenlaakso region
- using these indicators for the evaluation of eco-efficiency development in Kymenlaakso and the necessary action to be taken
- preparing a long-term mechanism for monitoring and evaluating the eco-efficiency development in Kymenlaakso
- preparing – on the basis of the above mentioned long-term mechanism – a more general monitoring and evaluation mechanism which can be adapted to the conditions of other parts of Finland and the EU.

The starting point for the developing of indicators was to first design the indicators describing the economy, environment and socio-cultural aspects in Kymenlaakso. Next they were shaped into indicators describing regional eco-efficiency and into an eco-efficiency monitoring and evaluation mechanism (Fig. 6).

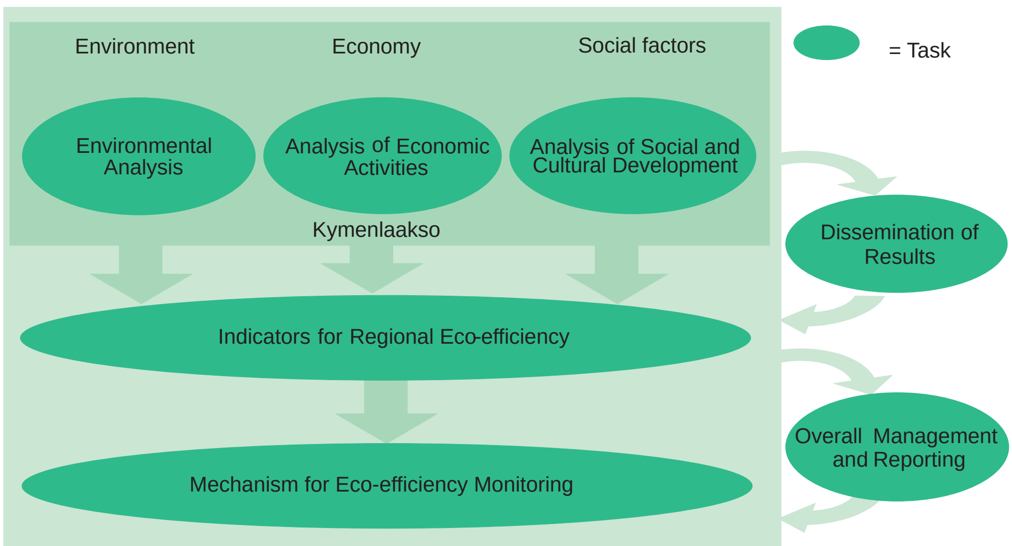


Figure 6. The organisation of sub-projects.

The ECOREG project and its implementation were featured by the following special innovative aspects:

- The ECOREG project combined the use of the newest methods (particularly life cycle assessment and material flow analysis), the use of statistical data publicly available in the EU Member States, and the use of different kinds of indicators. That was done in order to create measures describing eco-efficiency development at the regional level.
- The third dimension of sustainable development, in other words social development, was included by designing socio-cultural indicators which support the measuring of eco-efficiency of Kymenlaakso.
- By means of the developed methods it was possible to deal with the share of imports into the Kymenlaakso region and their role in the development of regional eco-efficiency.
- The eco-efficiency indicators, the results obtained by means of these indicators and the action needed to be taken in order to increase eco-efficiency were evaluated together with local actors during the ECOREG project. A significant instrument of evaluation was – apart from the discussions conducted by the steering group – the work of the regional workshops, which were held three times (Fig. 7, Annex 2).

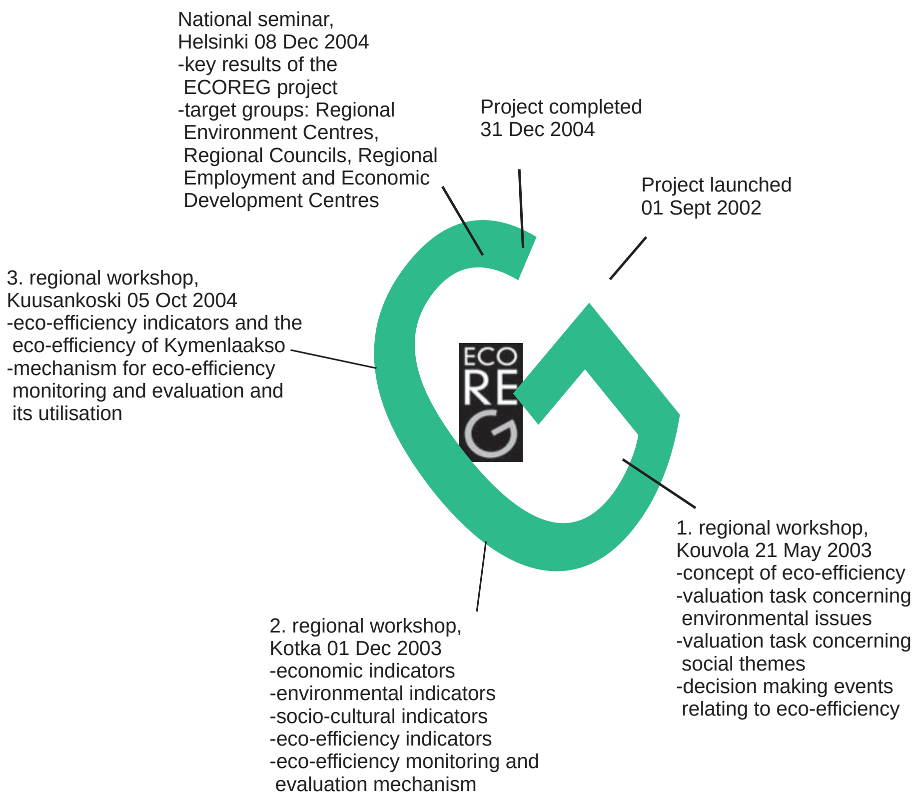


Figure 7. The time span of the ECOREG project – the most important events.

The ECOREG approach can also be seen as an application of Industrial Ecology analyses. During the ECOREG project an exact picture was built concerning the activities carried out in the Kymenlaakso region as well as their interconnections and environmental impacts. Likewise, a relatively clear picture of the economic value of imports and material inputs into Kymenlaakso was created, whereas the environmental impacts of imports into Kymenlaakso were dealt with at a much more general level. The influence which the exports from Kymenlaakso had on outside the region was not dealt with in this project. Thus, the systems studied in the ECOREG project comprised the Kymenlaakso region and its imports from other parts of Finland and abroad.

2.2 The entire work process

Right from the beginning a few central principles affected the planning and implementation of the ECOREG project. The first principle was a view according to which local actors know best what significance the different factors influencing eco-efficiency have in a local context. The second principle was that people are more likely to utilise data systems and data in practical decision making, if they have had the opportunity to influence their definitions and boundaries. In addition, by means of arranging the opportunity for continuous dialogue, mutual learning can be promoted among the eco-efficiency specialists and the experts of the Kymenlaakso region.

Three main groups participated in the ECOREG work process. In each group the expertise in eco-efficiency and local conditions was combined (Fig. 8):

- the project group (Annex 1)
- the project steering group comprising decision makers and experts of Kymenlaakso (Annex 1)
- local decision makers and experts having participated in the workshops of the project and the local media having reported on the project.

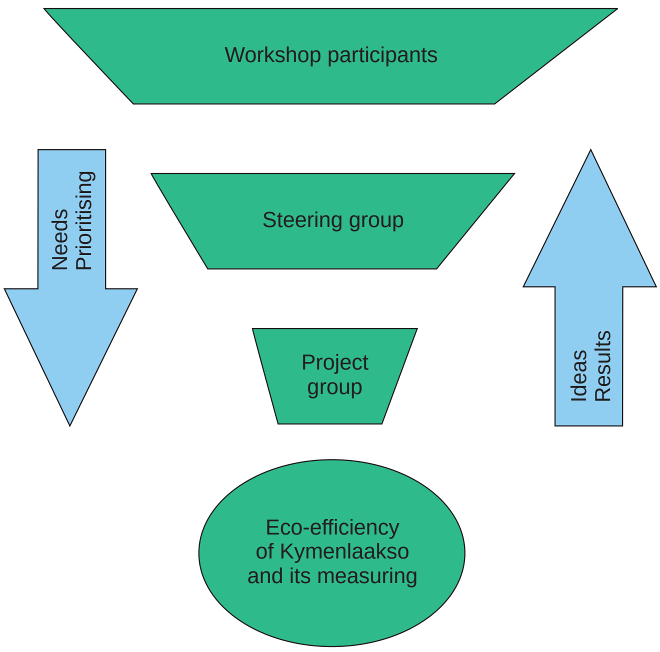


Figure 8. The ECOREG project actors and the implemented processes.

All the main proposals of the project group as well as the most significant interim results were first subjected to discussion in the steering group and required to receive its approval. This arrangement turned out to be successful, as the steering group members representing different specialist fields and industries had profound knowledge of Kymenlaakso's special features, needs and plans. This way they were able to directly influence the forming of solutions. After the steering group's handling of the interim results and proposals, the results and proposals were presented on the ECOREG project's website. That usually took place before the gatherings of the regional workshops, and by this method the data on the website functioned as background material for the workshops.

The ECOREG project organised three regional workshops in Kymenlaakso (programmes presented in Annex 2). The goal of these workshops was not only to implement the demonstration and dissemination nature of the ECOREG project but also to receive feedback and views from local decision makers and experts. That was done in order to ensure that the indicators and methods to be developed in the project were relevant for the Kymenlaakso region.

Consequently, the workshops turned out to be vital for the outcome of the ECOREG project. They functioned as a forum in which the participants were together able to outline the needs and opportunities as regards the issues concerning eco-efficiency of Kymenlaakso. Also, the participants were able to prioritise themes and choices – and to learn from each other (Fig. 9). A representative group of decision makers and experts from different backgrounds (Table 1) participated in the workshops.

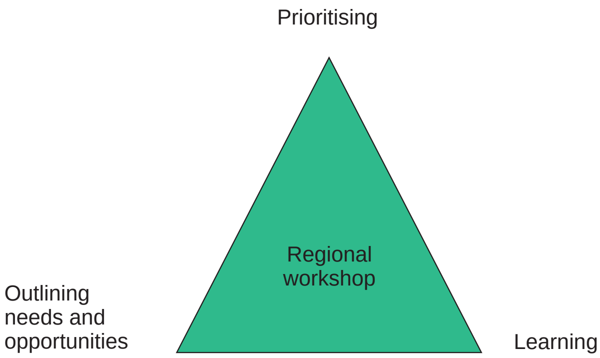


Figure 9. The regional workshops formed the core of the ECOREG work process.

Table 1. The number of decision makers and experts of Kymenlaakso and their major speciality field. Average of three workshops.

	Economy	Environment	Socio-cultural issues	Total
Industry [a]	5	4	-	9
Authorities [b]	5	11	2	18
R&D community [c]	2	11	2	15
Other [d]	1	1	-	2
Total	13	27	4	44

[a] Industry in a broad sense, including primary production
[b] Regional and municipal authorities
[c] R&D and education (including the ECOREG project group members participating in the workshops)
[d] NGOs, media

The workshops promoted networking around the theme of eco-efficiency. These networks are utilised in the mechanism for monitoring and evaluating the eco-efficiency of Kymenlaakso presented in Chapter 5.

For communicating the results, the project has a website both in Finnish and in English:

http://www.ymparisto.fi/syke/ecoreg
http://www.environment.fi/syke/ecoreg

3 Kymenlaakso region as an example

The case in the ECOREG project – the Kymenlaakso region located in Southeast Finland (Fig. 4 in Section 2.1) – is a good object of study as regards a large variety of issues connected with regional eco-efficiency. The population density in Kymenlaakso is among the highest in Finland and the region is more urbanised than most other Finnish regions, although its population density is only about one third of an average population density in the EU Member States. The Kymenlaakso region is characterised by industry, ports and the proximity of the Russian border, which form the basis for its success (Figures 4, 10 and 11).

On the north–south axis Kymenlaakso is, at its most, some 120 kilometres long, and on the east–west axis the distance is 90 kilometres. Despite its fairly small geographical size, there are different kinds of landscapes in Kymenlaakso and hence it has been called Finland in miniature. The sea (Gulf of Finland), the River Kymijoki and the Salpausselkä ridge divide the region into the archipelago and coastal district, the eastern rugged hill district, the western clay-soil district and the northern wilderness and lake district. The rich variety of nature and landscape is also indicated by the fact that there are three national parks in Kymenlaakso – Repovesi National Park (lake landscape), Valkmusa National Park (marsh landscape) and the Eastern Gulf of Finland National Park (archipelago).

In Kymenlaakso there are 12 municipalities, which are situated within the two strong sub-regions, Kotka-Hamina and Kouvola. Due to the dense network of service centres and transport services, the Kymenlaakso rural and urban areas form a mosaic-like whole. The distances between rural and urban areas are short. Nevertheless, there is an exception: the archipelago, which is different from the other districts of Kymenlaakso because of its isolated location.

In 2003 there were some 186 000 residents in Kymenlaakso. Although the economic development of the region has been favourable for the last ten years, the population has been decreasing for a long time (Fig. 12)[2]. Because of the imbalanced supply of employment, a large number of educated people move away from Kymenlaakso, chiefly to the Helsinki Metropolitan Area. This migration has distorted the population's age structure; the share of those in working age decreases and the relative share of the elderly increases. The state of employment has improved in Kymenlaakso during the last few years, but the unemployment figures are higher than the Finnish average.

In addition, many people have been concerned by the fact that Kymenlaakso does not have a university of its own. But, on the other hand, Kymenlaakso Polytechnic, permanently established in 1999, develops briskly. In addition, the Centre of Expertise in Southeast Finland, the expertise clusters of different fields, awarding of grants to professors as well as universities' regional units and networks bring a large number of university connections and expertise and development opportunities to the Kymenlaakso region.

Among the strengths of the business economy of Kymenlaakso are forest industry, the forest cluster formed around and supporting the forest industry, and logistics expertise (Table 2). Regarding all the Finnish regions, the Kymen-

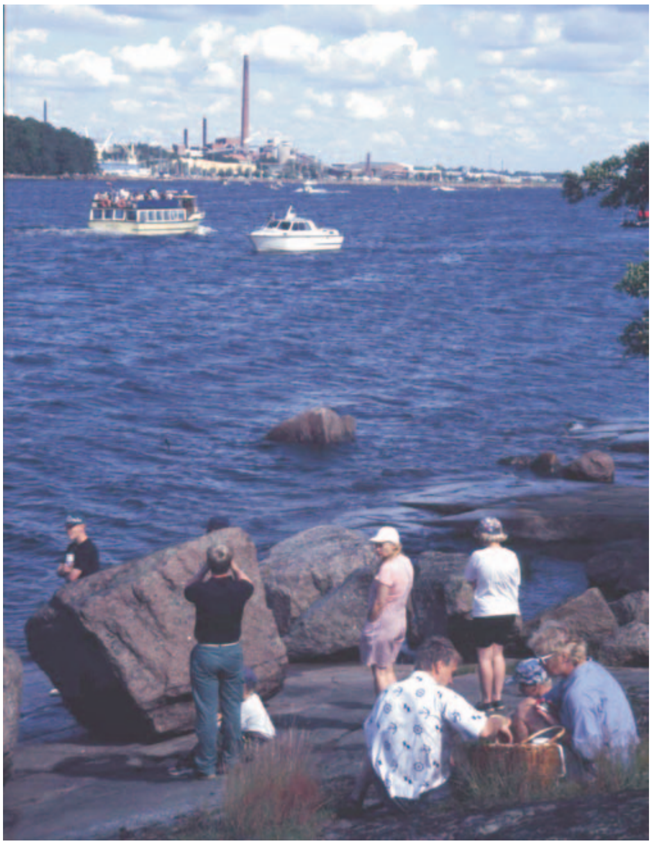
[2] *However, the population decrease stopped at the end of 2003.*

laakso region is on the leading edge when calculating the gross domestic product per resident. A good half of the value of the products is created in Kymenlaakso, the rest resulting from the imports from other parts of Finland and abroad (Fig. 13). About half of the value of the products is directed to final use – in other words consumption and investments – in the Kymenlaakso region, the other half being exported to other parts of Finland and abroad.

Myllykoski Paper, Anjalankoski
Photo: Myllykoski Paper Oy

Seashore meadows, Virojoki
Photo: Frank Hering

Kasarminmäki area in Kouvola
Photo: Frank Hering



Holidaymakers in Kotka
Photo: AV Centre of Kotka

Figure 10. Kymenlaakso is a highly industrialised, forest-industry-dominated and export-oriented region which has preserved its rich natural assets.

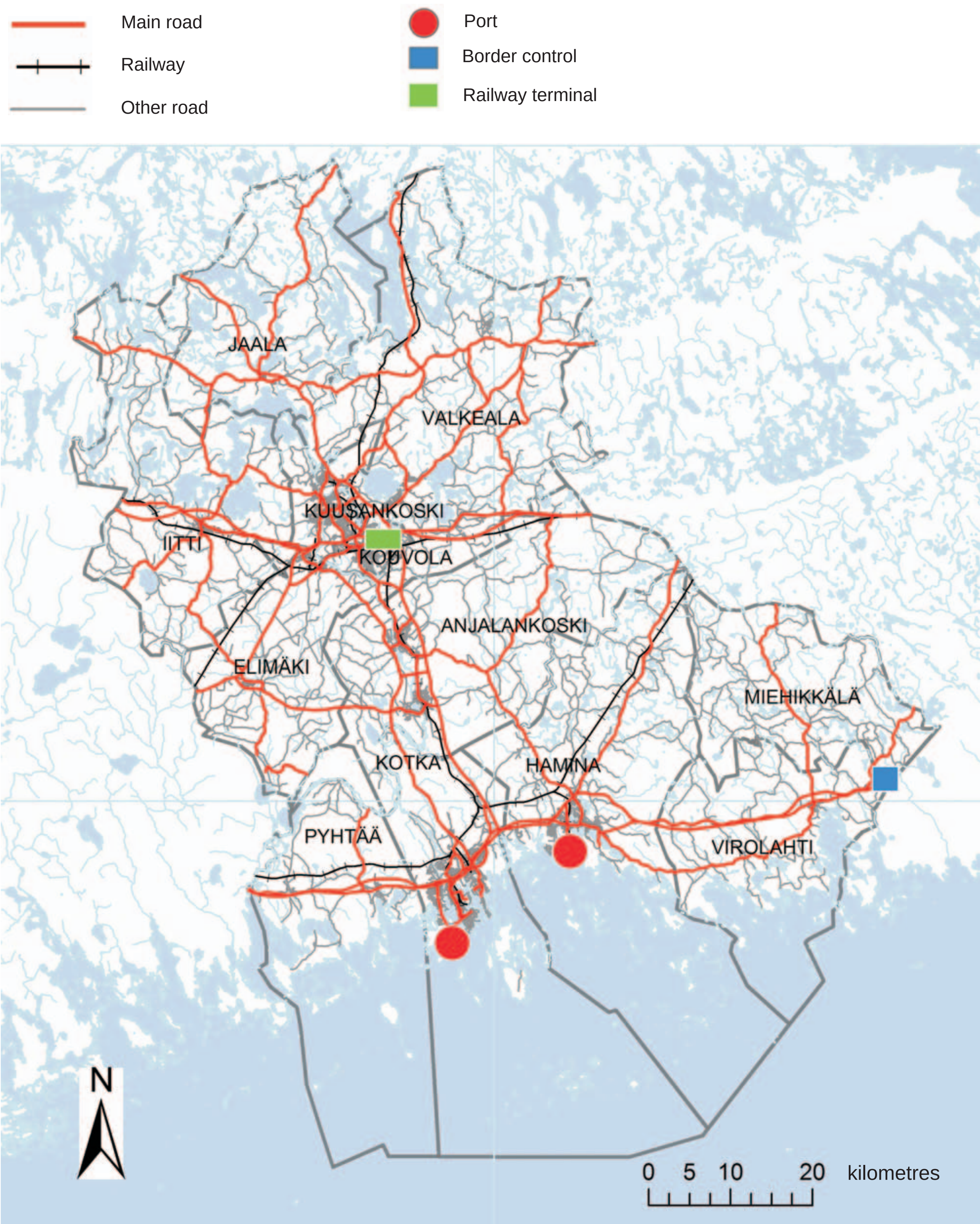


Figure 11. Infrastructure in Kymenlaakso.

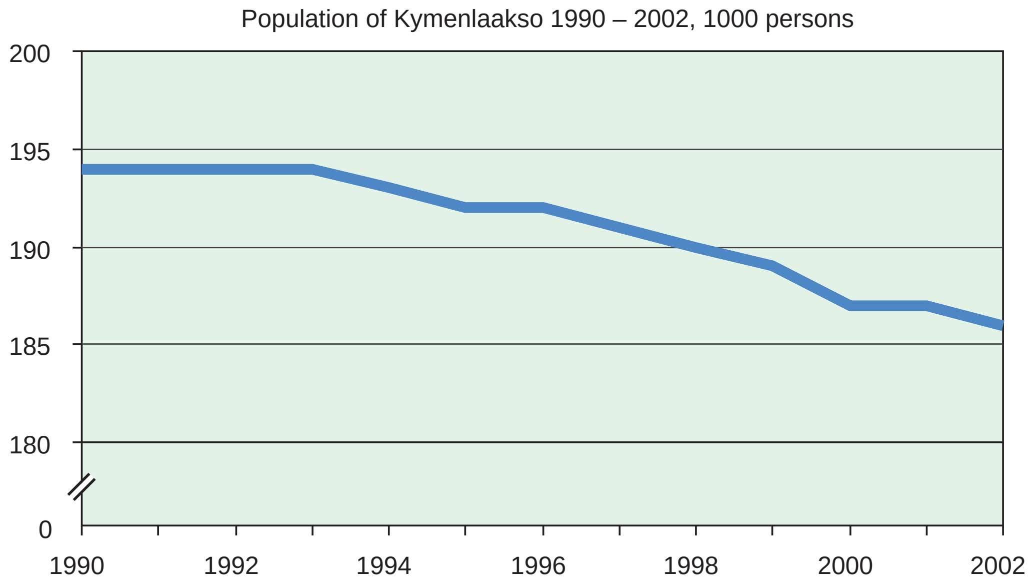


Figure 12. The development of the Kymenlaakso population in 1990–2002, 1 000 persons (Mäenpää and Mänty 2004).

Table 2. The proportions of different industries as regards value added and employment in Kymenlaakso 2000, %. For comparison, the proportions of different industries concerning value added in the whole of Finland 2000, % (Mäenpää and Mänty 2004).

		Kymenlaakso		Finland
	Industry	Value added	Employment	Value added
1	Agriculture, hunting & fishing	1.5	5.2	1.6
2	Forestry and logging	1.9	0.8	2.2
3	Mining and quarrying	0.2	0.2	0.2
4	Manufacture of food products	1.9	1.8	1.6
5	Forest industry	26.8	11.7	7.4
6	Chemical industry	2.0	1.3	2.6
7	Metal industry	1.4	1.8	2.8
8	Other manufacturing	5.1	5.2	12.3
9	Electricity, gas and water supply	1.6	0.8	1.8
10	Construction	5.9	7.0	5.9
11	Transport and communication	14.8	10.3	10.7
12	Other services	31.6	43.0	46.1
13	Public administration	5.3	10.7	4.9
	Total	100.0	100.0	100.0

The secondary production's share of the value added in Kymenlaakso was 43 per cent in the year 2000. A quarter of the residents are employed by industry. The proportion of Kymenlaakso's forest industry out of the Finnish pulp and paper industry's production and exports is about 20 per cent. The brisk development of ICT in the latter part of the 1990s did not bring as many new jobs to Kymenlaakso as to other parts of Finland.

Nevertheless, a large number of jobs have been created in the transport services, as Kymenlaakso functions as a hub for the transport activities between Finland and Russia. Most of the transit transports delivered via Finland are dealt with by Kotka and Hamina ports, which are the most important Finnish ports as regards forest industry exports. Kouvola is a major hub for railway traffic, and Vaalimaa hosts the busiest and most modern customs and border crossing point between Finland and Russia (Fig. 11).

Kymenlaakso has been a border region for nearly the whole history of Finland, which has enhanced its rich cultural environment. Among the major factors influencing Kymenlaakso's cultural history and history of settlement have been the roads leading to the town of Vyborg as early as in the Middle Ages and the boat route from east to west in the Kymenlaakso archipelago. Apart from this boat route, the port operations have even created connections to the economic areas of the Baltic States and Central Europe. Today, Kymenlaakso's connections to Russia can be observed as active trading and transit transport and as some specific features in population development. Of those foreigners who have moved to Kymenlaakso a large proportion come from Russia.

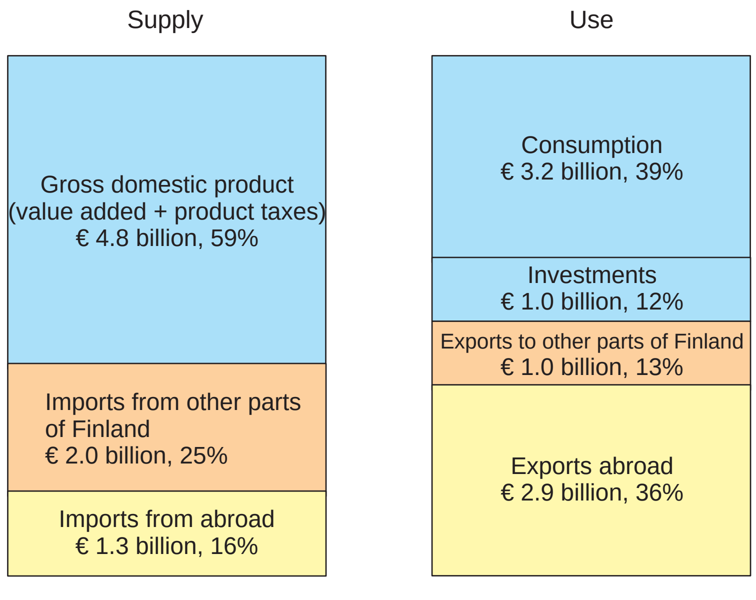


Figure 13. The supply and use balance of product flows in the economy of Kymenlaakso 2000 (Mäenpää and Mänty 2004).

4 Measuring eco-efficiency and monitoring the development

4.1 Basic principles

Production and other activities in Kymenlaakso, including consumption, have environmental impacts on the region and on areas outside the region. The "product system" analysed in this work included the region of Kymenlaakso and its imports from elsewhere in Finland and abroad ("upstream" in Fig. 14). The impacts of Kymenlaakso's exports on areas outside the region ("downstream" in Fig. 14) have not been included in the analysis, because it is even more difficult to estimate the environmental burden of exports than that of imports. The normal boundaries used in life cycle assessments (LCAs), based on the "from cradle to gate" principle, are also used in the present study.

When studying regional eco-efficiency, both the activities of the region and the impacts of its imports should be considered. Therefore, the case of Kymenlaakso is studied in two respects:

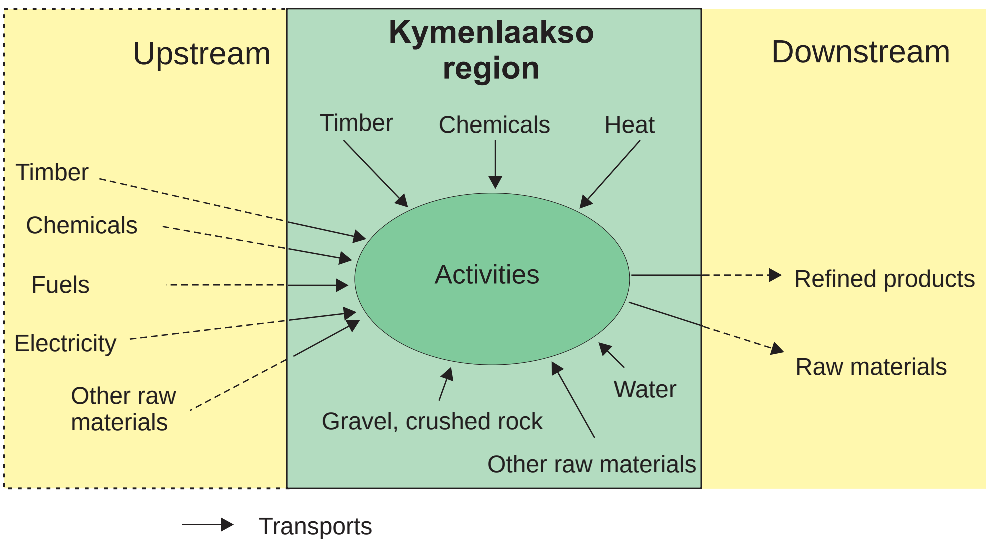


Figure 14. Boundaries of the ECOREG study – regional environmental burden (Kymenlaakso region), environmental burden by imports ("upstream"), exports ("downstream") – and a schematic presentation of the main material and energy flows included.

In the **basic approach**, the eco-efficiency ratio **EE1** for a region can be described by:

(3) $EE1 = VI / EI$

where VI = added economic value of goods and services produced in the region

EI = environmental influence caused by the production of these goods and services

Furthermore, sector-specific eco-efficiency ratios can be calculated by:

(4) $EE1_s = VI_s / EI_s$

where s stands for economic sector (e.g. agriculture, forestry, forest industry, transportations)

In the **broader approach**, the eco-efficiency ratio **EE2** can be described by:

(5) $EE2 = UVI / UEI$

where $UVI = VI + VI^U$

VI^U = value of products produced by the upstream processes (intermediate and end consumption)

$UEI = EI + EI^U$

EI^U = environmental influence of upstream processes ("upstream" in Fig. 14)

In sector-specific cases, Equation 5 can be transformed into:

(6) $EE2_s = UVI_s / UEI_s$

where s stands for economic sector (e.g. agriculture, forestry, forest industry, transportations)

Environmental impacts cannot be objectively presented using a single variable, and several indicators are needed to describe the overall effects. Therefore, it is recommended to study the development of eco-efficiency by means of a graphic illustration, where the economic value and environmental impacts of the activity are presented as time-series. A relative scale is used in the graphic presentation, since different indicators employ different units. The value of the indicators is set as 100, for example, at the beginning of the study period (Fig. 15).

In this report, eco-efficiency is understood as the relationship between the value of a region's economic activities, or "economic well-being", and environmental impacts – in accordance with internationally adopted standards (Fig. 15, higher graph). Since such a concept of eco-efficiency lacks the social and cultural dimensions, the study of regional development of eco-efficiency needs to be accompanied by a simultaneous monitoring of socio-cultural factors (Fig. 15, lower graph).

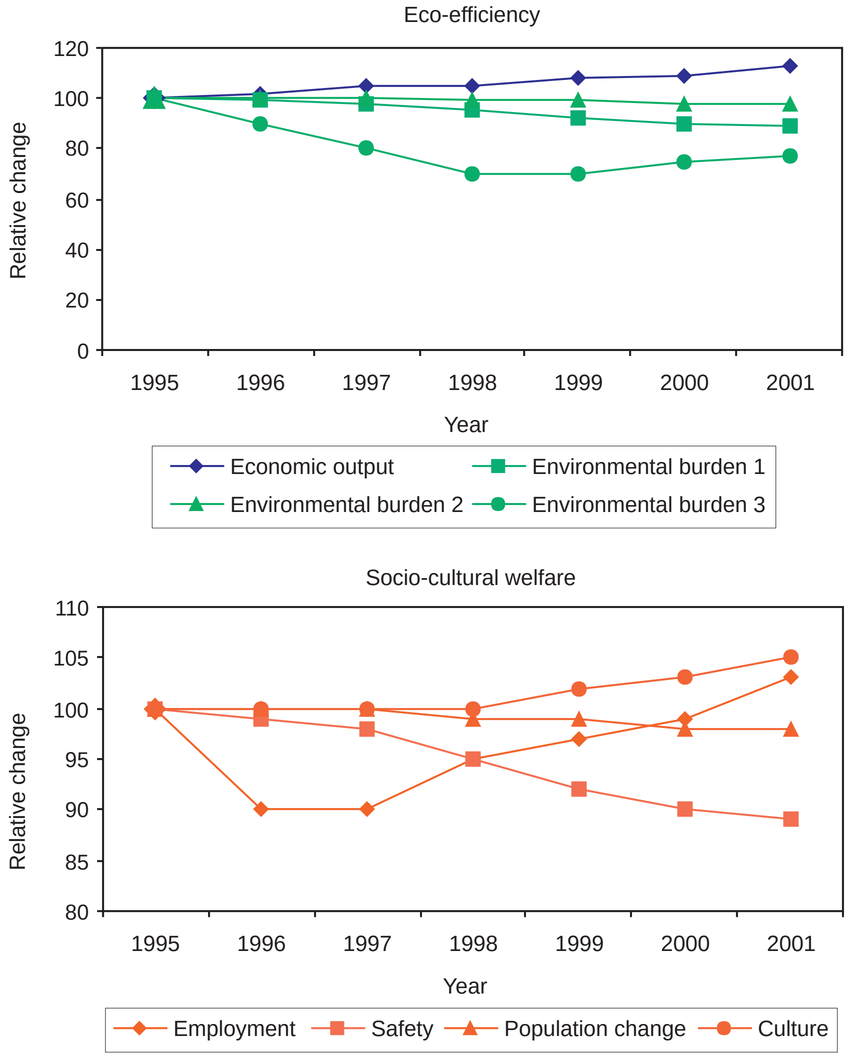


Figure 15. An example diagram representing simultaneously the development of eco-efficiency and socio-cultural factors of a region. Themes (e.g. safety) are expressed with suitable indicators.

4.2 Measuring the value of the products

The value of the goods and services produced in a region can be measured using three variables:

- value added
- gross domestic product (GDP), and
- output.

The value added of a production unit is obtained by taking the value of the products it has produced – i.e. the output – and subtracting from this figure the value of the products used for their production. Thus, value added can be considered to measure the amount of the new economic value that the production unit has produced. The most well-known concept in the System of National Accounts is the GDP at market prices. It is obtained by adding to the value added – or gross domestic product at producer prices – the taxes on products that are included in the market prices of products used in the economy (e.g., value-added tax, fuel taxes), and subtracting the subsidies on products.

The measure of added economic value used in Equations 3 and 4 is value added or GDP, and in Equations 5 and 6 the output. The principles of calculating value added, GDP and output are internationally approved (e.g. System of National Accounts 1993).

The value added, GDP and output in Kymenlaakso by industrial sector in 2000 and some time-series have been calculated in Mäenpää and Mänty (2004). The report also presents the annually monitored economic indicators (Table 3), designed for Kymenlaakso in the ECOREG project, which can be used for eco-efficiency analyses and other studies concerning the entire region.

Table 3. The economic indicators for annual monitoring in Kymenlaakso (adapted from Mäenpää and Mänty 2004).

Theme	Link to eco-efficiency	Indicators
Background factors	Provide a sense of proportion for comparisons between regions.	Total area of the region Average population Population density
Economic growth	Both value added and gross domestic product can be used as the numerator denoting the economic values in eco-efficiency indicators for the entire economy. Indices calculated per capita and per area facilitate comparisons among regions.	Value added at constant prices Gross domestic product at market prices Gross domestic product per resident Gross domestic product per area Output
Economic welfare of the population	Can be used as the numerator in eco-efficiency indicators when the measurement of economic benefits focuses on the economic welfare of the population rather than on economic activity as such.	Real disposable household income per person

The economic indicators selected for Kymenlaakso are based on the time-series of Statistics Finland's Regional Accounts (Statistics Finland 2003), regional domestic product calculations of the Statistical Office of the European Communities (Eurostat 2004) and Kymenlaakso's monetary input-output tables (MIOT) compiled in the ECOREG project.

The industry classification used in the study was based on categories of the European industry classification SIC 1995 (NACE, confirmed by an EU regulation). The starting point was a division into 25 categories, which were usually aggregated into 13 categories when displaying the results (Table 4). Results of the calculation, Kymenlaakso's monetary input-output tables for the year 2000, are presented in Annex 3.

Table 4. Industrial classification used in economic and material flow analyses and their relations to the European industrial classification SIC 1995 codes (Mäenpää and Mänty 2004).

No	Industry	SIC 1995		Aggregated industrial classification	No
1	Agriculture and hunting	01	1	Agriculture, hunting and fishing	1, 3 [a]
2	Forestry and logging	02	2	Forestry and logging	2
3	Fishing	05	3	Mining and quarrying	4
4	Mining and quarrying	10 – 14	4	Manufacture of food products	5
5	Manufacture of food products and beverages	15 – 16	5	Forest industry	7, 8, 9
6	Manufacture of textile products	17 – 19	6	Chemical industry	10
7	Manufacture of wood products	20	7	Metal industry	12-15
8	Manufacture of pulp and paper	21	8	Other manufacturing	6, 11, 16
9	Publishing and printing	22	9	Electricity, gas and water supply	17
10	Manufacture of chemical products	23 – 25	10	Construction	18
11	Manufacture of non-metal mineral products	26	11	Transport and communication	21
12	Manuf. of basic metals and metal prod.	27 – 28	12	Other services	19, 20, 22, 23, 25
13	Manufacture of machinery and equipment	29	13	Public administration	24
14	Manufacture of electrical equipment	30 – 33			
15	Manufacture of transport equipment	34 – 35			
16	Other manufacturing and recycling	36 – 37			
17	Electricity, gas and water supply	40 – 41			
18	Construction	45			
19	Wholesale and retail trade	50 – 52			
20	Hotels and restaurants	55			
21	Transport, storage and communication	60 – 64			
22	Business services	65 – 70, not 7021			
23	Dwellings	7021			
24	Public administration, compulsory social insurance	75			
25	Other services	80 – 95			

[a] Numbers assigned for the industries in the other part of the table

4.3 Measuring environmental impacts

There are two types of environmental impact indicators used in the Kymenlaakso application:

- indicators describing environmental change and interventions; and
- indicators describing the consumption of natural resources.

4.3.1 Indicators describing environmental change and interventions

Development process and methods used

The indicators describing environmental change and interventions were based on a regional environmental analysis made for Kymenlaakso on the data for year 2000 (Koskela 2004). The goal of this analysis was to identify the most significant change and intervention factors in the region. It is appropriate to repeat the en-

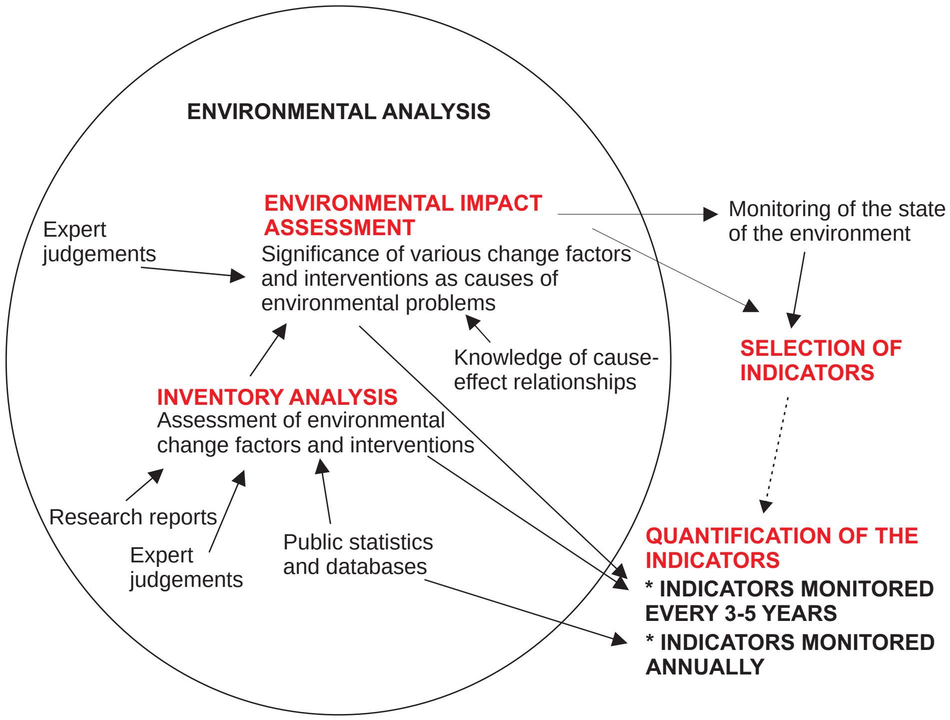


Figure 16. Environmental analysis sets a foundation for selecting the indicators for environmental change and interventions.

tire analysis every 3 to 5 years in the future and meanwhile use the annually monitored indicators selected on the basis of the analysis (Fig. 16).

Life-cycle thinking is needed in order to gain a truthful picture of the eco-efficiency of a product or activity. Therefore, the principles and techniques of life cycle assessment (LCA) were applied to Kymenlaakso's environmental analysis to include inventory analysis, life cycle impact assessment (LCIA) and interpretation of the results (ISO 14040). In the inventory analysis, some simplifications and individual applications were made from the basis of the ISO standard[3]. For example, inventory results were calculated per annual production of the different industrial sectors in Kymenlaakso – thus lacking the functional unit included in the ISO standard. However, the impact assessment of the life cycle assessment was carried out entirely according to the standard's principles.

The study was extended to cover the environmental impact of imports, in addition to the local environmental change factors and interventions (Fig. 14):

> **Regional environmental burden** = environmental emissions and other burdens caused by various activity sectors within Kymenlaakso
>
> **Environmental burden of imports** = environmental emissions (and other burdens) caused at the production stage of products and energy produced outside Kymenlaakso but used within it

[3] *Each individual application is described transparently in the documentation report of the Kymenlaakso environmental analysis (Koskela 2004).*

The estimation of the emissions caused by the production of imported goods was limited to fuels, electrical energy and the largest (>100 000 t/a) industrial raw material flows, because the estimation of emissions from smaller raw material flows and consumer goods is extremely difficult, in some cases even impossible, due to the broad range of products and the lack of data. Material flows included in the emission inventory constituted 86 per cent of Kymenlaakso's total import material flows. A profile of average electricity production in Finland between 2000 and 2002 was used as a basis for assessing the emissions from electricity production. Exports were excluded from the study, so the product system consisted of activities within Kymenlaakso and activities resulting from its imports (Fig. 14).

The SIC (NACE) industry classification (Table 4) was also used in the material flow calculation of the environmental analysis. The activity sectors in the regional emission inventory – i.e., agriculture, forestry, fish farming, peat production, land extraction, industry, communities and traffic – were selected largely on the basis of the Finnish common practice of recording environmental emission statistics regionally. The environmental burden of each industrial sector could not be assessed separately. In fact, many of these industries were located under "communities" in the regional environmental analysis. When calculating regional environmental burden and burden from imports, the boundaries of agriculture, forestry and industry matched each other best (Koskela et al. 2004a).

After the inventory stage, the emissions and other environmental burdens were analysed using decision analysis and an impact assessment model employing the methods used in life cycle assessment (Fig. 17). In the model, the environmental impact assessment problem is described as a hierarchical value tree (Fig. 18). The activities compared are the activity sectors in the Kymenlaakso region causing different kinds of emissions, land use effects and impacts on natural resource depletion. Imports are included as an activity sector. The activity sectors constitute the lowest level of the hierarchy. Their emissions and other interventions are placed on the next level of the hierarchy, and they provide the input data for the environmental impacts. The impact categories (environmental problem categories, Annex 4), describing the groups of environmental effects constitute the third level of the hierarchy. Together, they make up the total impact, which constitutes the highest level of the hierarchy.

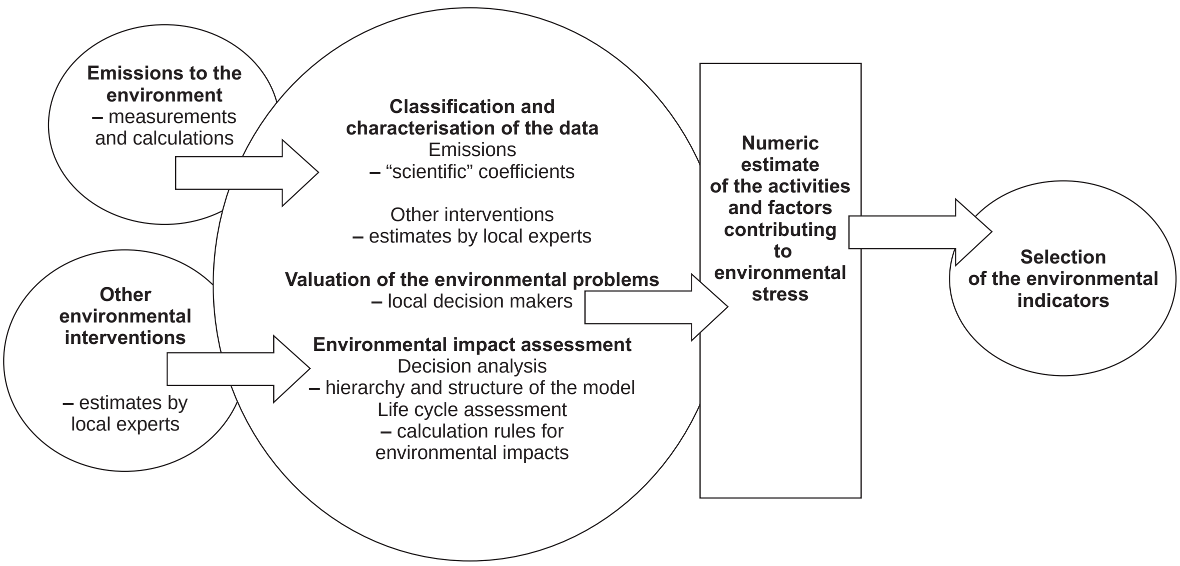


Figure 17. The assessment model for environmental change factors and interventions (Tenhunen et al. 2004, Part 2 in Koskela 2004).

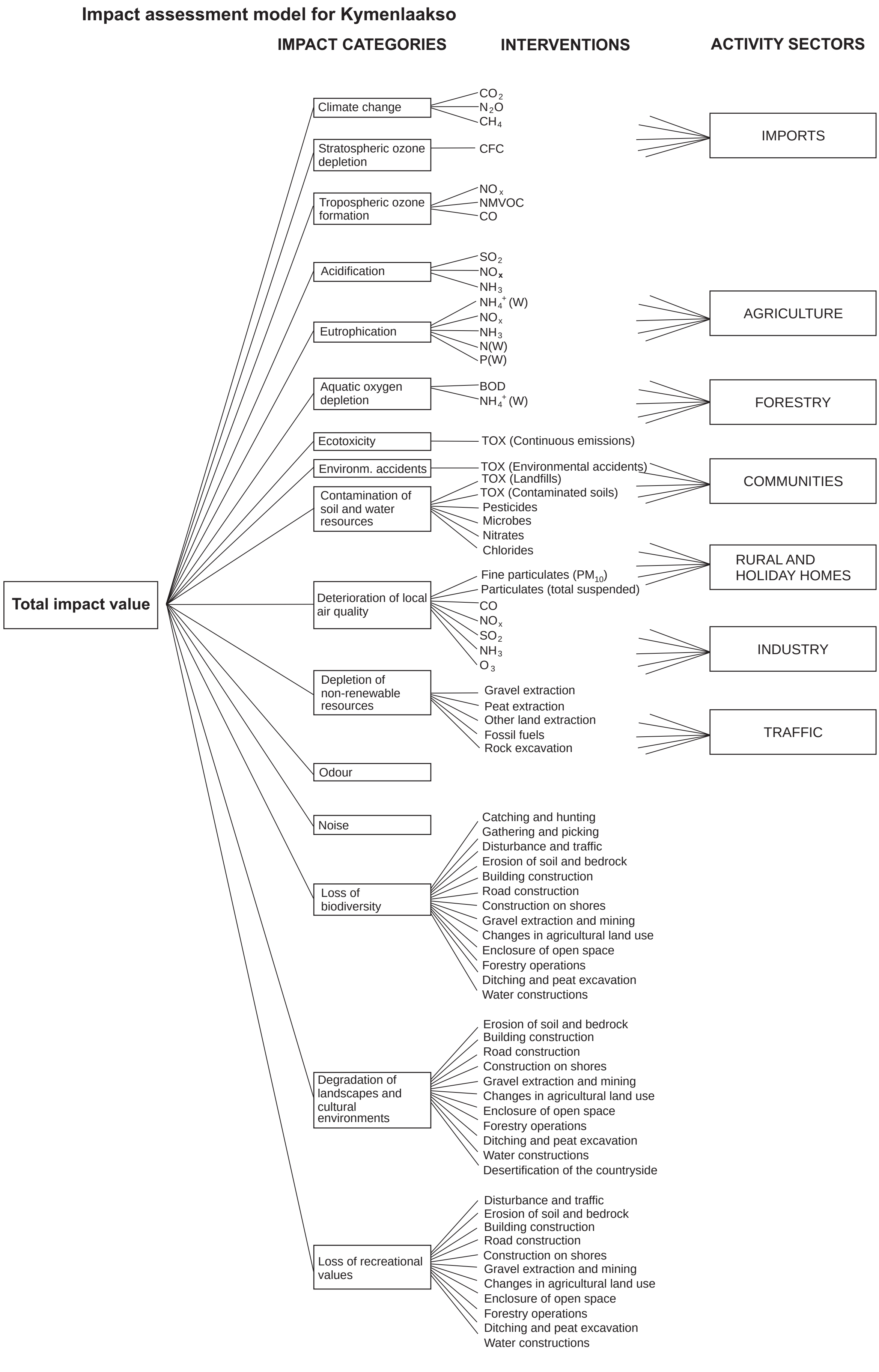


Figure 18. Structure of the impact assessment model for Kymenlaakso (Tenhunen et al. 2004, Part 2 in Koskela 2004).

A valuation task with instructions was given out to the participants of the first ECOREG workshop arranged in Kouvola in May 2003 (Annex 5), aiming to elicit the weighting factors for the relevant environmental problem categories (impact categories in the impact assessment) in Kymenlaakso. The valuation task was completed by a total of 34 participants of the workshop, and Figure 19 presents the mean weightings calculated on the basis of the responses.

The mean weights were used as weights of different impact categories in the impact assessment of the environmental analysis. The theoretical and mathematical bases of the impact assessment have been described in detail in Tenhunen et al. (2004). The impact assessment enabled the creation of an overall picture that uncovers the proportions of environmental change factors and interventions of different industries as a cause for environmental damage (Fig. 20). This information was used when deciding which factors were to be selected as indicators.

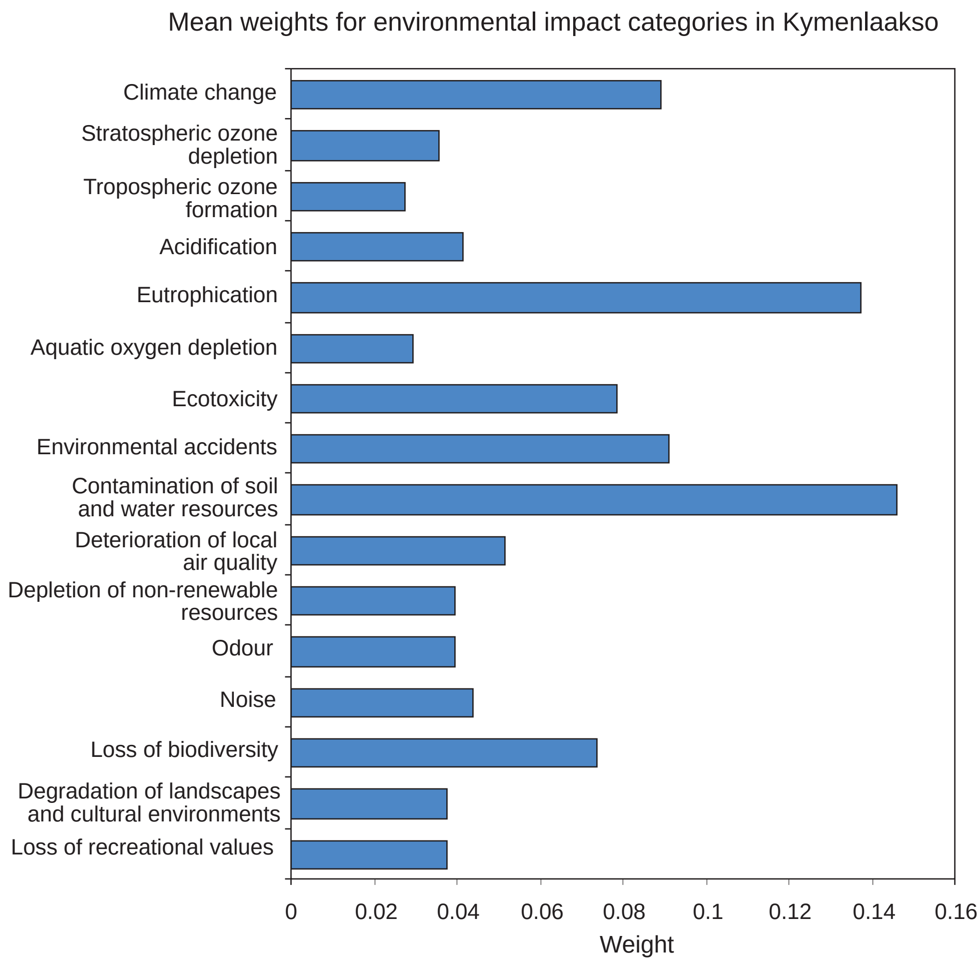


Figure 19. The weights attributed by environmental decision makers/experts in Kymenlaakso for the environmental problem categories at the workshop in Kouvola (Tenhunen et al. 2004, Part 2 in Koskela 2004).

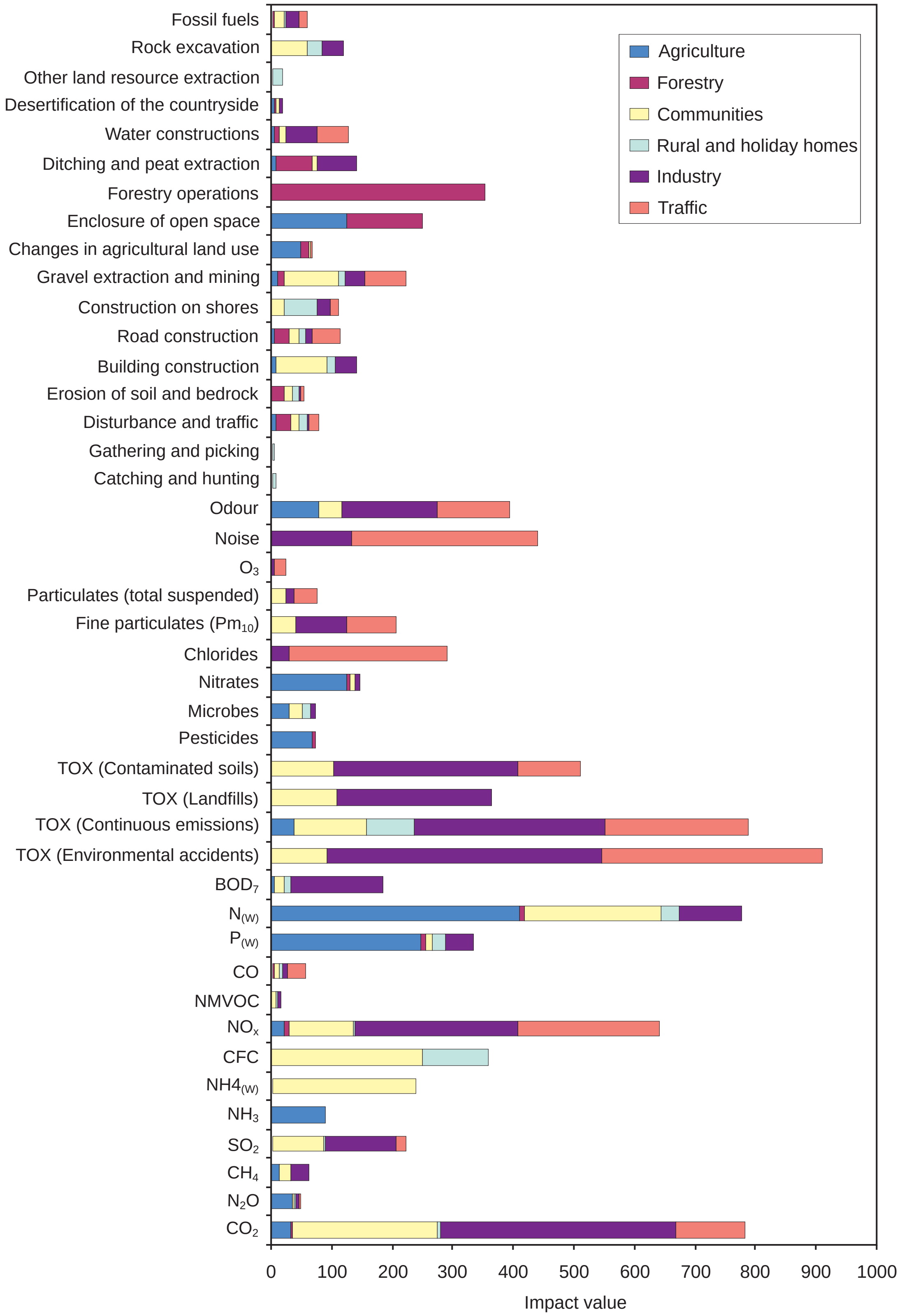


Figure 20. Impact values calculated for the environmental interventions in Kymenlaakso using the impact assessment model (Tenhunen et al. 2004, Part 2 in Koskela 2004).

Annually monitored indicators

On the basis of the environmental analysis, environmental indicators for annual monitoring were designed for Kymenlaakso (Table 5). Most of the indicators selected were factors describing environmental conditions or environmental loads, but the indicators also included a few environmental measures targeted at the

Table 5. The environmental indicators for annual monitoring in the Kymenlaakso region (Koskela et al. 2004b, Part 3 in Koskela 2004).

	Indicator	Connection to impact (problem) categories in the impact assessment [a]
1.	Carbon dioxide emissions from industry, energy production and road traffic [b]	Climate change
2.	Nitrogen oxide emissions from industry, energy production and road traffic	Tropospheric ozone formation, acidification, eutrophication, local air quality
3.	Sulphur dioxide emissions from industry and energy production	Acidification, local air quality
4. a)	Passenger traffic mileages by car and by bus	Climate change, tropospheric ozone formation, local air quality, noise
b)	Goods traffic mileages by road and by rail	
5. a)	Riparian zone contracts concerning special measures of agri-environmental support (number, ha)	Eutrophication
b)	Nitrogen loads to waters from communities, rural settlements and industry	
6. a)	Number of oil and chemical accidents	Environmental accidents
b)	Amount of oil and chemicals released into the environment in accidents	
7. a)	Emissions of dioxins and furans	Ecotoxicity
b)	Emissions of polyaromatic hydrocarbons (PAH emissions)	
c)	Emissions of metals (Cd, Pb, Hg)	
8. a)	Groundwater chloride concentrations	Contamination of soil and water resources
b)	Groundwater nitrate-nitrogen concentrations	
9.	Average number of days when the limit value for the average daily concentration (50 $\mu g/m^3$) of fine particulates (PM_{10}) is exceeded	Local air quality
10.	Average number of days when the average concentration of odorous sulphur compounds (TRS) exceeds 4 $\mu g/m^3$	Odour, local air quality
11. a)	Traditional biotope, landscape management and biodiversity enhancement contracts concerning special measures of agri-environmental support (number, ha)	Loss of biodiversity, degradation of landscapes and cultural environments, loss of recreational values
b)	Contracts concerning environmental support for forestry (number, ha)	
c)	Total area of conservation areas	
d)	Area of regeneration fellings	
e)	Development of the growing stock of forests (increment/fellings)	
12.	Quantity of gravel and rock extracted	Depletion of non-renewable natural resources
13. a)	Landfilling of municipal waste from households (kg/capita)	Depletion of natural resources
b)	Recovery rate of municipal waste from households	
14. a)	Consumption of electricity and district heat	Climate change, acidification, depletion of non-renewable natural resources
b)	Self-sufficiency in energy production	

[a] See Annex 4, [b] Carbon dioxide emissions caused by the use of fossil fuels

biodiversity preservation. The indicators have a strong connection to the impact categories in the impact assessment (see impact assessment in the environmental analysis, Tenhunen et al. 2004).

The purpose of the annually monitored indicators is to effortlessly provide a conception of environmental changes taking place. Their values can be obtained from publicly available statistics or existing databases. Some of the time-series of the indicators from mid-1990s onwards are presented in Chapter 6.

Other indicators and their use

The inventory of the environmental analysis made it possible to produce regional overall estimates of the most common emission variables for the year 2000 (Koskela 2004). These variables can be used as environmental indicators in Equations 3 and 4 when assessing the development of eco-efficiency in the entire region or in a certain sector. When the emissions from imports are added to their values, the results can be used as indicators and values in Equations 5 and 6. It is in principle possible to produce time-series describing the annual environmental loads of the entire region (Fig. 21). In practice, however, this is only achievable in certain years, since it is very laborious to produce complete emission estimations.

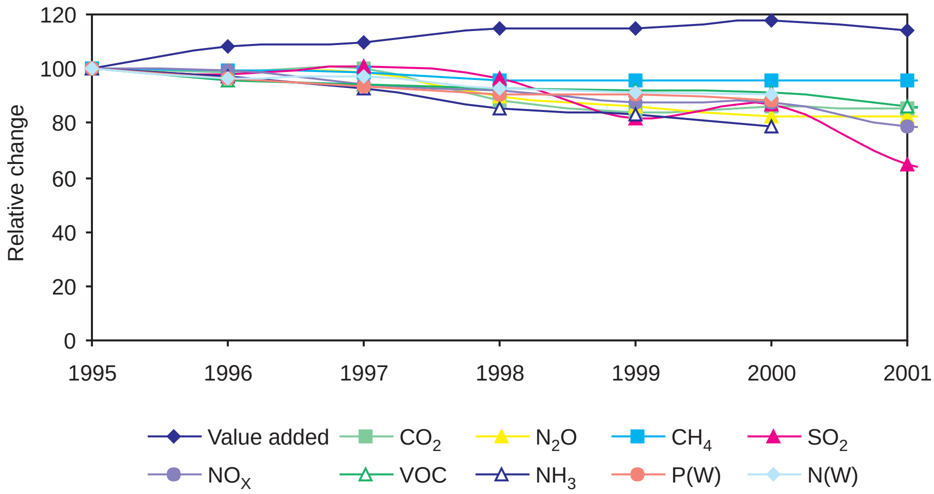


Figure 21. Value added and selected emissions caused by the activities within the Kymenlaakso region, 1995–2001 ("basic approach", Eq. 3). Value added at 2000 prices. Emission figures are accurate for 2000, rough estimates for the other years. Emissions of phosphorus and nitrogen (P, N) are releases into waters, others are atmospheric emissions.

If different indicators develop divergently over years, it may be difficult for decision makers to assess whether the environmental load has in fact decreased or increased. In such a case, commensurating emissions (see Tenhunen et al. 2004) can make it easier to read the indicators and make decisions, as it cuts down the number of environmental variables (Fig. 22). Different interventions are commensurated within each impact category using characterisation factors, resulting in an impact category indicator. The impact category indicator of climate change, for example, expresses the combined effect of all greenhouse gases on climate change. At the moment, however, there are scientific bases for calculating the impact category indicators for only a few impact categories. The Kymenlaakso application made use of the characterisation factors presented in Annex 6.

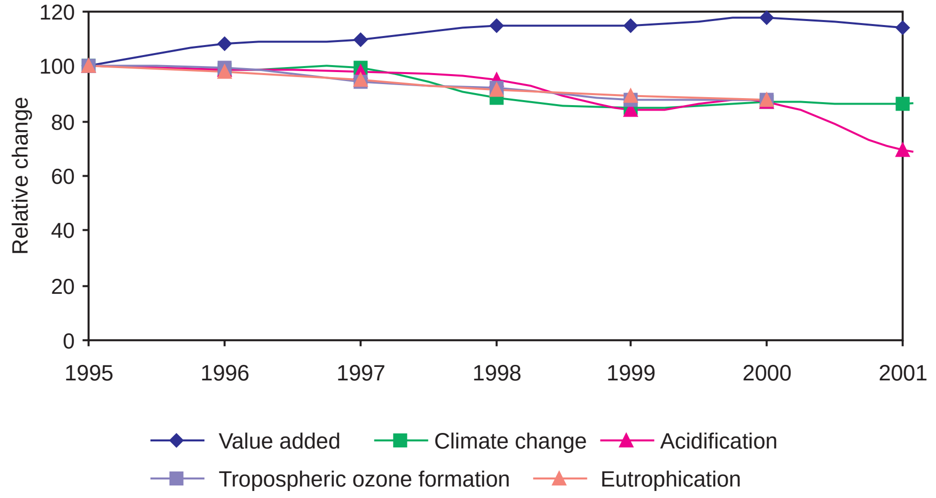


Figure 22. Value added and four impact category indicators in Kymenlaakso, 1995–2001 ("basic approach", Eq. 3). Value added at 2000 prices. The impact category indicators are calculated by means of the emission values presented in Figure 21.

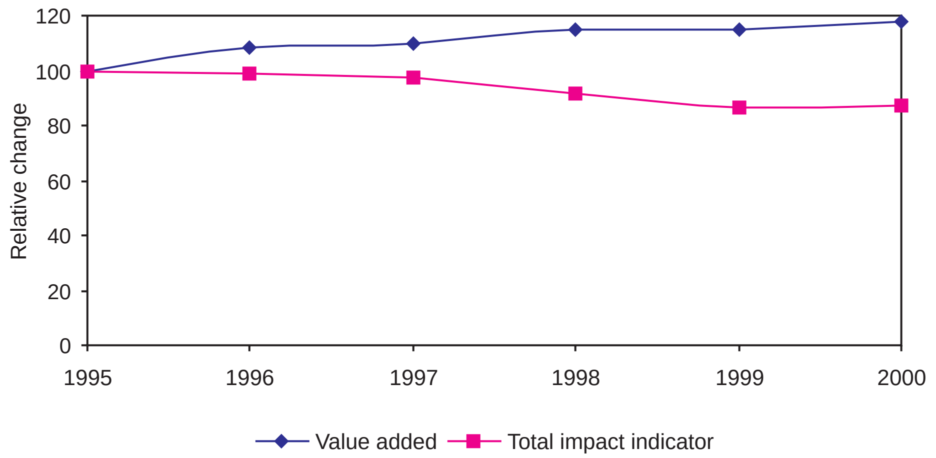


Figure 23. The development of value added and the total environmental impact indicator in Kymenlaakso, 1995–2000 ("basic approach", Eq. 3). Value added at 2000 prices. Impact categories included: climate change, stratospheric ozone depletion, tropospheric ozone formation, acidification, aquatic eutrophication and oxygen depletion in waters.

Using scientifically grounded impact category indicators makes decision making more simple, but the question remains, what is the significance of different impact categories when compared to each other. The question can be tackled by emphasising impact categories with decision analysis techniques (Seppälä 2003, Tenhunen et al. 2004), which also enables the calculation of a total environmental impact indicator by multiplying the values of impact category indicators by the weights, and then adding up the sum of the products. This way the development of an economic indicator can be compared to the development of a single environmental indicator instead of multiple indicators (Fig. 23). One remaining problem is that these types of time-series only depict some impact categories.

Subjective and scientific characterisation factors and weighting factors of impact categories are used in the environmental impact assessment method of the Kymenlaakso environmental analysis (Tenhunen et al. 2004). The model enables printing the impact values for environmental change factors and interventions (Fig. 20) and industries (see Chapter 6) included in the analysis, so that the proportions of different environmental problem categories are visible.

4.3.2 Indicators showing consumption of natural resources

Two indicators were used in the analysis to measure the consumption of natural resources (Fig. 24):

- direct material input (DMI) = direct material inputs from the region (DMI_R) + direct inputs of imports (DMI_U); and
- total material requirements (TMR) = DMI + "hidden flows" (unused extraction) ($HF_R + HF_U$), associated with the implementation of direct material inputs.

The sum of direct material inputs and regional hidden flows, "total material input" TMI ($DMI_U + DMI_R + HF_R$), is commensurable with the GDP and value added, so it can be used to roughly explain the environmental impacts in the eco-efficiency Equation 3 above. On the other hand, TMR is suitable as a denominator in Equation 5, where import products ("upstream processes") are included as well.

The material flow indicators for Kymenlaakso were based on physical input-output tables (PIOT; Annex 7) calculated in the ECOREG project using input data from the year 2000. Monetary input-output tables described in Section 4.2 (Mäenpää and Mänty 2004) were used when creating the physical input-output tables. The industry classification used in the analysis of monetary product flows (Table 4) was also used in this analysis.

The calculation of material flows was based on guidelines established by the Statistical Office of the European Communities, Eurostat (European Commission 2001, Eurostat 2001, 2002).

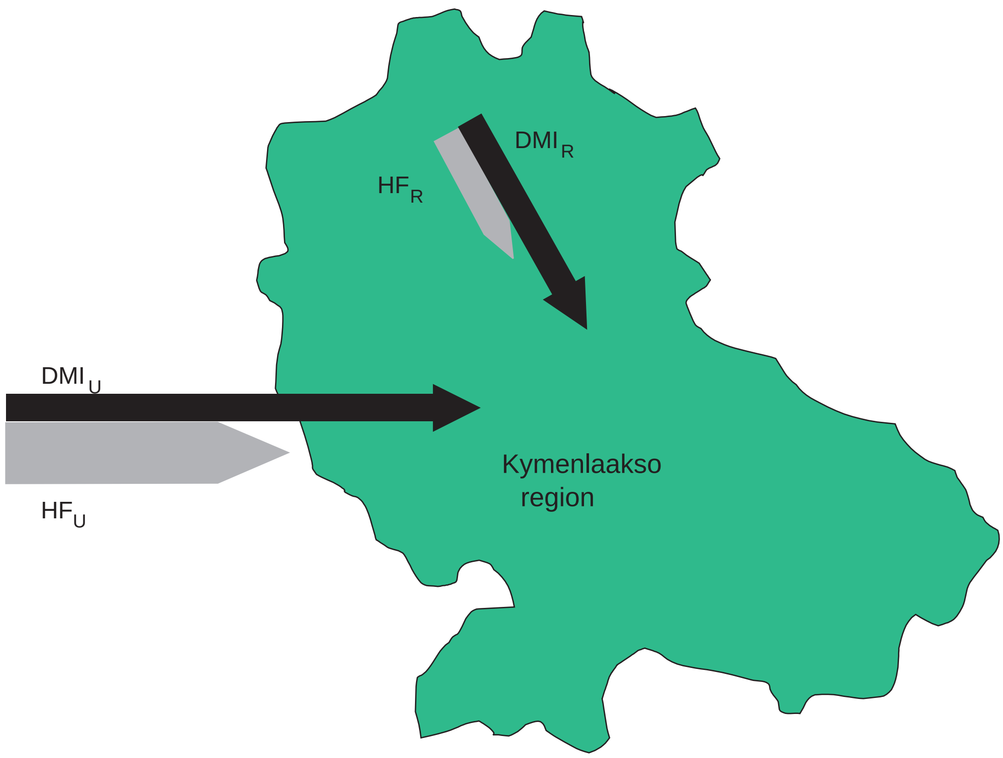


Figure 24. Main components of the region's material flows in the input end.

Material flows were analysed in the framework of the general economy-wide material flow balance presented in Figure 25. However, the Kymenlaakso application did not include all of the material flows depicted in Figure 25. Missing flows in the output end included solid wastes and emissions to waters and air. Solid wastes and emissions to waters and air were, however, included in the regional environmental analysis (see Koskela 2004).

The material flow through the economy (national economy in Fig. 25) consists of direct domestic and imported material inputs, which, combined with domestic hidden flows, make up the material flow that forms the base of the domestic environmental burden. The imported hidden flows indicate the additional global ecological rucksack connected to the material flow of the economy.

On the regional level, it is laborious to construct time-series for total material requirement, because imports into the region are not monitored, as in national statistics. Material flows from imports have to be estimated separately. Therefore, the ECOREG project only investigated the material flows of Kymenlaakso for the year 2000. In the future, it is most useful to repeat the material flow calculations every 3 to 5 years, simultaneously with the environmental analysis described in Section 4.3.1.

The DMI and TMR for Kymenlaakso in 2000 have been calculated (even by industry) in Mäenpää and Mänty (2004), which also presents indicators chosen for the region, describing material flows and material intensity (Table 6). In addition to total material requirements (TMR) and direct material inputs (DMI), total material consumption (TMC) has been suggested for an indicator. TMC describes the total consumption of natural resources required for the final use of the region, which can be calculated by subtracting the natural resources required by exports from the total material requirements (TMR).

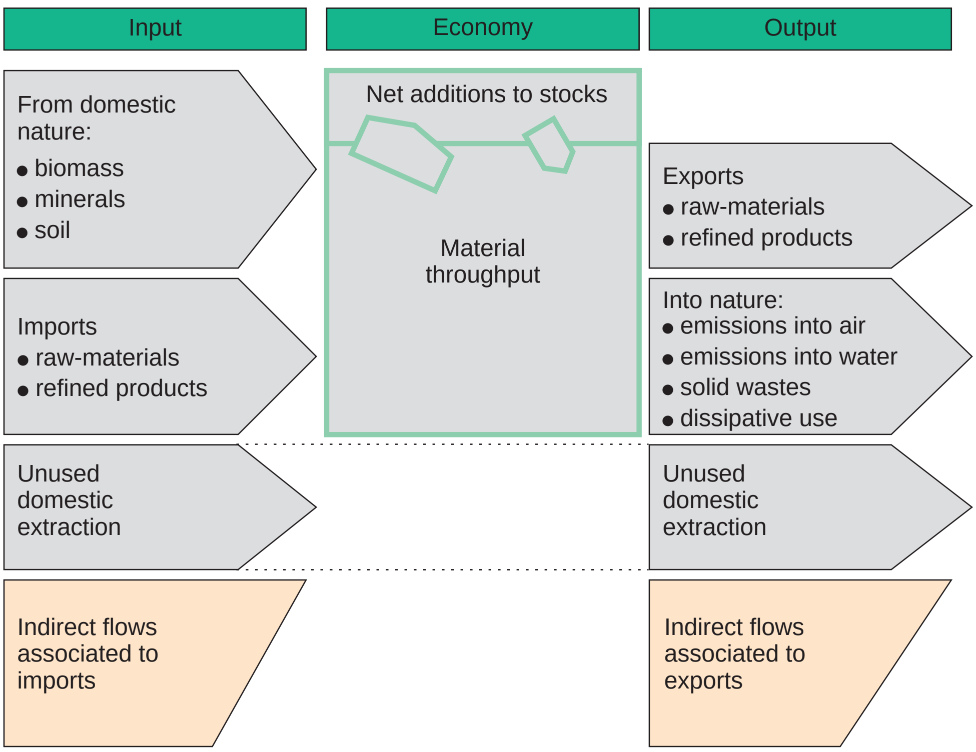


Figure 25. General structure of the national-economy-wide material flow balance. Unused domestic extraction stands for domestic "hidden flows".

Table 6. Material flow indicators for the Kymenlaakso region (Mäenpää and Mänty 2004).

Theme	Link to eco-efficiency	Indicators
Material flows	Material flows entering the economy form the overall basis of the environmental burdens of the economy at the origin of the material flows, in the intake of natural resources, and at their end, as emissions and wastes.	Total material requirement (TMR) Direct material inputs (DMI) Total material consumption (TMC)

4.3.3 Conclusions

It is impossible to name a single "best" variable for describing environmental impacts. Material flow indicators have the advantage of their relatively straight-forward calculation rules. However, assessing regional material flows is laborious. In addition, their power of explaining environmental impacts is controversial, since a similar amount of each substance has specific impacts on the environment.

The advantage of emission indicators is that they are generally well-known, but it is difficult to draw conclusions on the changes of the quality of the environment on their basis. Other environmental change indicators share this problem. The weakness of status indicators is that they do not necessarily describe the status of the entire region. Furthermore, all environment issues cannot be depicted using quantitative indicators.

The use of impact category indicators is restricted by the fact that they can be calculated with scientific bases only for a few impact categories. In order to reach high commensurability for the total environmental impact indicator, impact categories have to be weighted. This will lead to subjective results, and therefore this approach alone is not recommended to be used for presenting environmental issues for decision makers. From the decision maker's point of view, presenting different variables simultaneously in the same graph is a good solution. It will, for example, enable them to use their own weightings for different impact indicators.

4.4 Monitoring socio-cultural changes

The socio-cultural indicators serving the measurement of eco-efficiency in Kymenlaakso (Rosenström and Mickwitz 2004) were developed in a working process where the involvement of local actors played a very significant role. By taking the socio-cultural development indicators that specifically supported eco-efficiency measurement as a starting point, we sought to avoid the augmentation of the concept of eco-efficiency into the concept of sustainable development, mentioned earlier in Section 1.1.

The socio-cultural indicators have been grouped into eight themes (Table 7), which can roughly be divided into two parts: the first four describe the social state of Kymenlaakso and the productional conditions from a social point of view; the other four describe the appeal of the region and the potential for population increase. Table 7 presents both the indicators' communicative names and the more precise names of the statistics the indicators are based on.

The time-series of the indicators are presented in Annex 8.

Table 7. The socio-cultural themes and indicators supporting the measurement of eco-efficiency in Kymenlaakso (Rosenström and Mickwitz 2004).

Theme	Indicator	Statistics
Population change	Migration in the region	Net migration
	Population change	Excess of births
	Population dependent on those employed	Dependency ratio
	Population growth through immigration	Number of foreigners
Employment	Unemployment	Unemployment rate
	Job structure	Job structure by sector
Social exclusion	Social assistance to the less-advantaged	Households receiving social assistance
	People falling outside the social safety net	Number of suicides
	Poverty	Poverty rate
Health	Life expectancy	Life expectancy of newborns
	Premature deaths	Deaths before age 65
Safety	Traffic safety	Development of traffic safety
	Violent crime	Offences against life and health
	Traffic accidents	Number of traffic accidents
Education	Level of education	Number of those completing secondary and higher education
	Research and development	Research and development expenditures
Culture	Resources for educational and cultural provision	Net public expenditures on education and culture
	Use of public libraries	Number of loans from public libraries
Local identity	Participation in decision making	Voting rate in municipal elections
	Tourist visits	Nights spent in hotels
	Newspaper circulation	Circulation of newspapers

The regional workshops organised by the ECOREG project have played an especially important role in designing the socio-cultural indicators supporting the measurement of eco-efficiency in Kymenlaakso (see Kouvola and Kotka workshop programmes, Annex 2). Discussions with experts from the Kymenlaakso Welfare Research and Development Centre (HYTKES) (see Kymenlaakson väestön hyvinvoinnin tila ... 2001) and examining the municipal action programmes for sustainable development in the region (Agenda 21) supplemented the vision of suitable indicators for Kymenlaakso.

The price and availability of information in the future as well as today were central criteria for selecting the indicators. The aim was to find as many of the indicators as possible in the free STATFIN Internet database maintained by Statistics Finland.

5 Eco-efficiency monitoring and evaluation mechanism

5.1 The mechanism's structure and operating principles

The mechanism for monitoring and evaluating eco-efficiency of Kymenlaakso created in the ECOREG project comprises four functional sections which are further divided into different work phases (Fig. 26). As a result of the introduction of the mechanism, a region receives a calculation tool for monitoring the development of eco-efficiency. This calculation tool created for Kymenlaakso in the ECOREG project is Excel-based (Section 5.2).

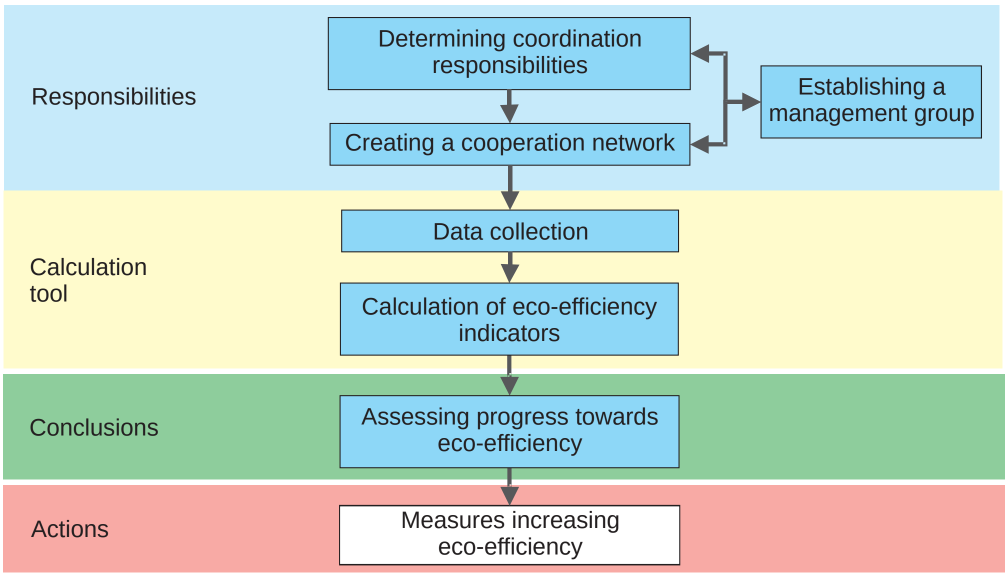


Figure 26. General structure of the eco-efficiency monitoring and evaluation mechanism.

Responsibilities and creating the cooperation network

The responsibility for creating and later maintaining the mechanism is borne by some central organisation in the region concerned. This coordinator gathers an expert management group consisting of the most significant actors of the local businesses and other sectors. In addition, the coordinator creates a cooperation network to facilitate data collecting.

One of the tasks of the management group is to help the coordinator to find contacts for the cooperation network and to maintain this network. The management group also guides the process of selecting the indicators and helps in analysing the results and making conclusions. The broader the presentation of the management group of the region's environmental, economic, business and cultural fields, the better the result.

In order to select the indicators which describe the region concerned in the best way, it is necessary to conduct a study on the region's economic factors, material flows, environmental burdens and socio-cultural special features. The collectors of these data, inevitably, deal with several different providers of information. At the time when the indicators are chosen, it becomes clear from which bodies – forming the cooperation network – it is necessary to later obtain data.

Calculation mechanism – the management environment of indicators, source data and results

The implementation of the mechanism in a region is started by conducting a thorough study on economic, environmental and socio-cultural background factors (cf. Chapter 4). Based on these results, the indicators are then selected and grouped into different themes. The indicators will be annually monitored and utilised until the next comprehensive analysis is carried out.

Selecting the indicators is a process in which large volumes of data are dealt with by means of different methods (Koskela 2004, Mäenpää and Mänty 2004, Rosenström and Mickwitz 2004). It is therefore important that these large volumes of data can be processed as one entity. In order to support the ECOREG mechanism an Excel-based spreadsheet tool was created. By means of this tool the coordinator is able to manage the complex data entity (Fig. 27).

In Kymenlaakso, general economic variables have been selected to function as economic indicators describing the region. The data of these variables have been collected – for each industrial sector – from national and regional statistics (Mäenpää and Mänty 2004). By means of the calculation mechanism, economic factors can be processed in the way presented in Table 8.

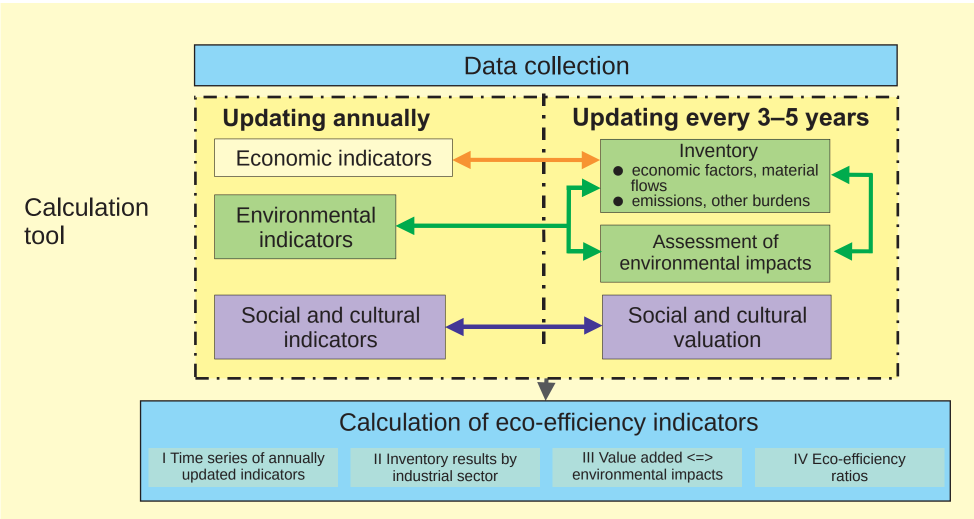


Figure 27. The user interface for the calculation mechanism. Different sections are entered by clicking the text icon desired.

Table 8. Data processing within the calculation mechanism.

Economic data	• Entering the annually updated economic indicators into a table template divided into four different themes: background factors, economic growth, the population's economic welfare and other indicators. • Entering the time-series of the annual indicator values into a table template spanning 21 years. • Entering the numerical values of value added and output for each industrial sector into a table template of the inventory. That is done in those years when a comprehensive environmental inventory is conducted. • Analysing the time-series of economic indicators in the same graph with the indicators which belong to other themes. • Analysing the economic factors of the whole region, or those of different industries, simultaneously with different pollutants detected in the environmental inventory. • Analysing value added simultaneously with the potential environmental impacts (i.e. impact category indicators) of the pollutants detected in the inventory. • Studying economic factors as eco-efficiency ratios in which a pollutant or a potential environmental impact (impact category indicator) is the denominator.
Data describing the state of the environment, emissions and other environmental interventions	• Entering the results concerning an inventory on different industrial sectors into table templates which cover – by industrial sector – the emissions arising in the region and caused by imports (the mechanism allows the entering of the data on the total of four successive inventories). • Simplified valuation of the environmental impacts of emissions for each industrial sector by means of six different impact categories, which are the following: climate change, stratospheric ozone depletion, acidification, tropospheric ozone formation, eutrophication and oxygen depletion. • Weighting these six impact categories by means of the coefficients obtained by regional valuation. • Entering the annually updated indicators into a table template divided into ten different themes: air, local air quality, water, traffic, environmental accidents, biodiversity, use of natural resources, energy consumption, indicators which are updated more rarely, and other (new) indicators. • Entering the time-series of the annual indicator values into a table template spanning 21 years. • Analysing the time-series of environmental indicators in the same graph with the indicators which belong to other themes. • Analysing (from the perspective of a region or that of each industrial sector) the pollutants (detected in the inventory on different industrial sectors) simultaneously with the analysis of economic factors. • Analysing the potential environmental impacts (impact category indicators) of the pollutants (detected in the inventory) simultaneously with the analysis of value added. • Studying environmental factors as eco-efficiency ratios in which a pollutant or a potential environmental impact (impact category indicator) is the denominator and a corresponding economic factor is the numerator.
Material flow data	• Entering material flow indicators into table templates made for inventories on different industrial sectors (the mechanism allows the entering of the data on the total of four successive inventories). • Analysing the time-series of material flow indicators in the same graph with the indicators which belong to other themes. • Analysing (from the perspective of a region or that of each industrial sector) material flows simultaneously with the pollutants detected in the inventory on different industrial sectors. • Studying material flows as eco-efficiency ratios in which material flow is the denominator and a corresponding economic factor is the numerator.
Socio-cultural data	• Entering the annually updated indicators into a table template divided into nine different themes: population change, safety, employment, social exclusion, health, education, culture, local identity and other (new) indicators. • Entering the time-series of the annual indicator values into a table template spanning 21 years (+ data from the past 18 years). • Analysing the time-series of socio-cultural indicators in the same graph with the indicators which belong to other themes.

Selecting the indicators describing the environmental change and interventions is a three-phase process (Koskela 2004):

1. Inventory on different industrial sectors
   – The emissions taking place from each industrial sector in the region are examined.
   – The emissions caused by imports are examined as closely as necessary.
2. Valuation and assessment of environmental impacts
   – The potential environmental impacts of emissions and other factors causing environmental changes are assessed by impact category.
   – The experts of the region and other local actors are asked to weight the different environmental impacts in relation to each other.
   – Impact values ("damage scores") are calculated for factors causing environmental burden and change. These impact values denote the relative difference in significance as regards the causing of environmental impacts by different factors.
3. Selecting the environmental indicators
   – Looking for the emission components, other components causing environmental burden and industries which are the most significant causes of environmental impacts.
   – Selecting the most suitable indicators for monitoring the development of the most critical sub-sectors.

Because of the release cycles of environmental statistics, schedules of administrative plans and ageing of data, it is useful to select (or revise) indicators every 3-5 years. By means of the calculation mechanism, the indicators delineating environmental burdens and changes and the indicators showing consumption of natural resources can be processed as presented in Table 8.

Selecting the indicators describing socio-cultural factors can be seen as a two-phase process (Rosenström and Mickwitz 2004):

1. Valuation of the socio-cultural factors
   – Looking for those social and cultural values which are significant for measuring regional eco-efficiency. That is done by finding the views of local actors presenting different fields, experts of the region and other influential actors in the region.
   – Weighting the values which have been brought up by asking the above mentioned groups to pick out the most important values.
2. Selecting the socio-cultural indicators
   – Selecting the indicators which best represent the views of the above mentioned groups and which are the most suitable for monitoring the development of the most critical sub-sectors.

In these process phases, the calculation mechanism can be utilised in the way presented in Table 8.

Conclusions – the development trends of eco-efficiency, the reasons for changes, and goal setting

The monitoring mechanism produces information – in the form of indicators – on the development of eco-efficiency of the region. Based on this information, the coordinator and the management group are able to draw conclusions on the development trends and the reasons for changes – or the reasons for the situation remaining unchanged. This analysis can be made more profound by setting short- or long-term goals for eco-efficiency development. The means for attaining these goals are analysed in the implementation phase of the project.

Measures increasing eco-efficiency

When the coordinator has, with the help of the management group, analysed reasons for the changes in eco-efficiency, decisions can be made, by different actors, on the means which support the development promoting eco-efficiency.

Regional authorities are able to enhance eco-efficiency by means of the administrative decisions and planning procedures available for their use. They may also encourage the largest polluters in the region to act, on their own initiative, for decreasing environmental impacts, promoting employment as well as for enhancing more efficient economic activities and other activities with favourable impacts. The development trend is correct when eco-efficiency improves but none of these three aspects suffer.

5.2 The calculation mechanism developed for Kymenlaakso

For monitoring and evaluating the development of eco-efficiency in Kymenlaakso, the data collected in the ECOREG project were entered onto an Excel-based calculation mechanism, which can be downloaded on the project's website:

> http://www.environment.fi/syke/ecoreg
> (→ Eco-efficiency monitoring and evaluation mechanism)

In the calculation mechanism, step-by-step instructions can be found on the top left of each page. The instructions help the user to utilise the different sections and to enter the data desired.

5.2.1 Entering annually updated indicators into spreadsheets

It has been planned that the indicator values of different sub-sectors are complemented annually. These additions will be entered into the cells with a white background denoted as a unit given at the beginning of each indicator row.

In addition to the indicators selected in the ECOREG project, 7–14 new indicators can be added to the mechanism, depending on the sub-sector (Table 9). The mechanism automatically adds these new indicators to the spreadsheets and graphs describing the results. This way these new indicators can be processed together with the indicators already existing in the mechanism.

In order to facilitate the use of the mechanism, each sub-sector has its own theme colour; economic factors are marked with yellow (Fig. 28), environmental factors with green and socio-cultural factors with violet (Table 9). Due to the reasons relating to the processing of results, even indicators delineating material flows are entered into the economic indicators page. It is commonly considered that the material flow indicators belong to the group of environmental indicators, but their calculation principles have been documented in a report describing economic factors (Mäenpää and Mänty 2004).

Table 9. Properties of spreadsheets for entering indicator data.

	Economic indicators	Environmental indicators	Socio-cultural indicators
Existing indicators, in number	7	40 + 5	35
Indicators which can be added, in number	7	10	14
Years to be complemented, in number	15	15	15
Description of calculation principles	Documentation report 2 (Mäenpää and Mänty 2004)	Documentation report 1 (Koskela 2004)	Documentation report 3 (Rosenström and Mickwitz 2004)
The colour of the theme	Yellow	Green	Violet
Spreadsheet-specific instructions	The comment field on the top left of the spreadsheet	The comment field on the top left of the spreadsheet	The comment field on the top left of the spreadsheet

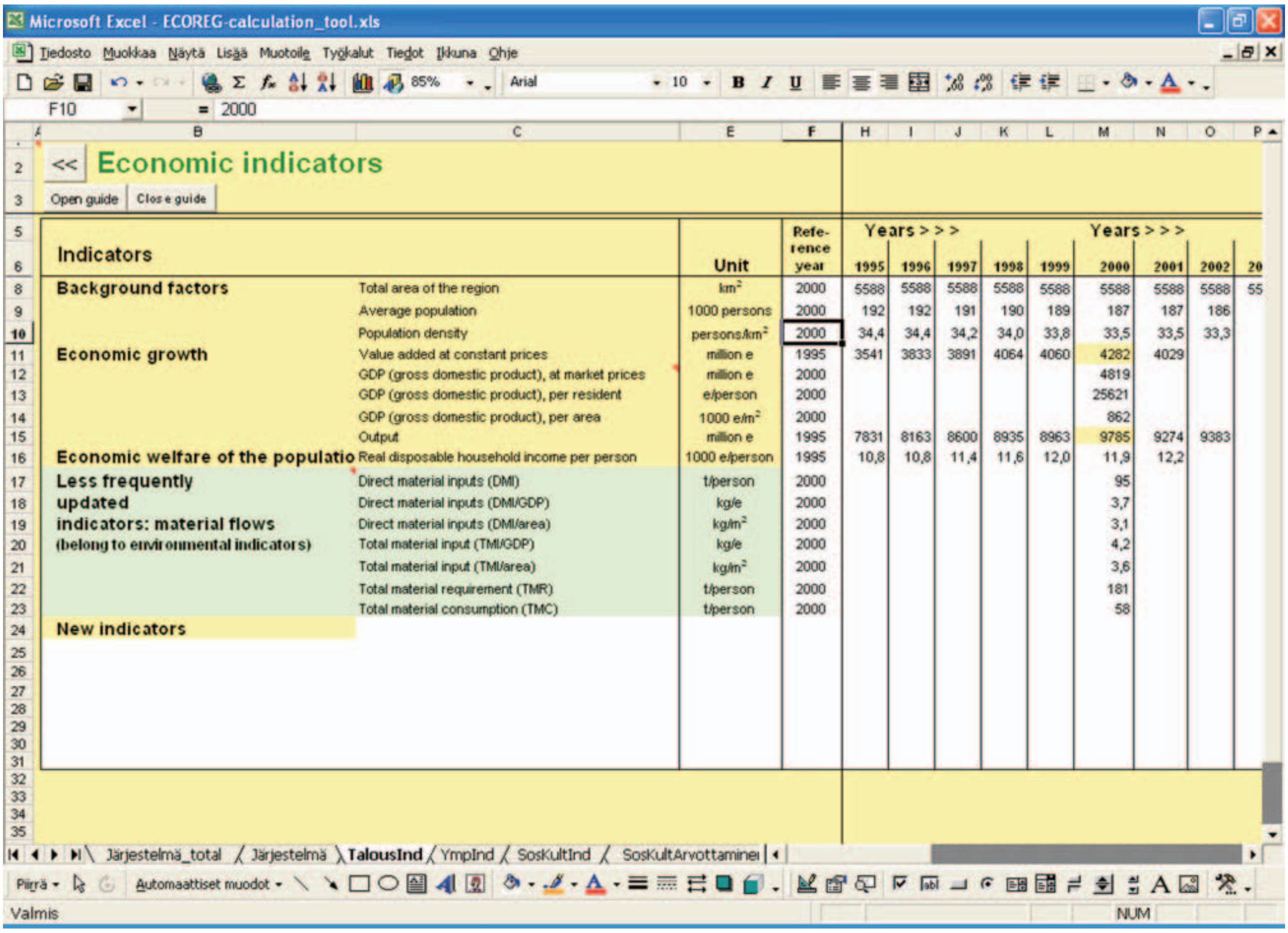


Figure 28. An example of spreadsheets for entering indicator data: economic indicators and material flow indicators. The data are entered by rows each to their own yearly columns. New indicators can be added to the white section.

5.2.2 Selecting new environmental indicators through inventories on different industrial sectors and valuation

The palette of indicators can be extended, if – on the basis of the inventory on different industrial sectors and assessment of environmental impacts – new monitoring needs emerge.

Inventory on different industrial sectors

In order to reproduce inventories on different industrial sectors in the calculation mechanism, the mechanism has three templates for data collecting, to which emissions, material inputs and economic factors are entered for each industrial sector. Because emission-specific analyses are conducted on inventory results, the same emission and material input factors are utilised in all inventories.

The characterisation coefficients making emissions commensurable by impact category can, if necessary, be updated, in each inventory, to correspond with the latest information. The assumption is that each inventory template has been pre-filled with the coefficients used in the first industry inventory (Koskela 2004).

The industries used as source data for life cycle impact assessment (LCIA) have been marked with red font colour in the header field of the spreadsheet. In the results the different industries have been connected to six activity sectors, which are agriculture, forestry, industry, communities, rural and holiday homes and traffic. The life cycle impact assessment conducted in the ECOREG project and those conducted in Kymenlaakso in the future will be commensurable provided that the future inventories are entered with the data concerning the same industries as in the ECOREG project.

In order to analyse – by industrial sector – economic factors and factors causing environmental burden, it is necessary to obtain data on those industries which have a pale yellow background colour in their header field. In these results industries are analysed in the total of 13 different activity sectors.

Valuation and assessment of environmental impacts

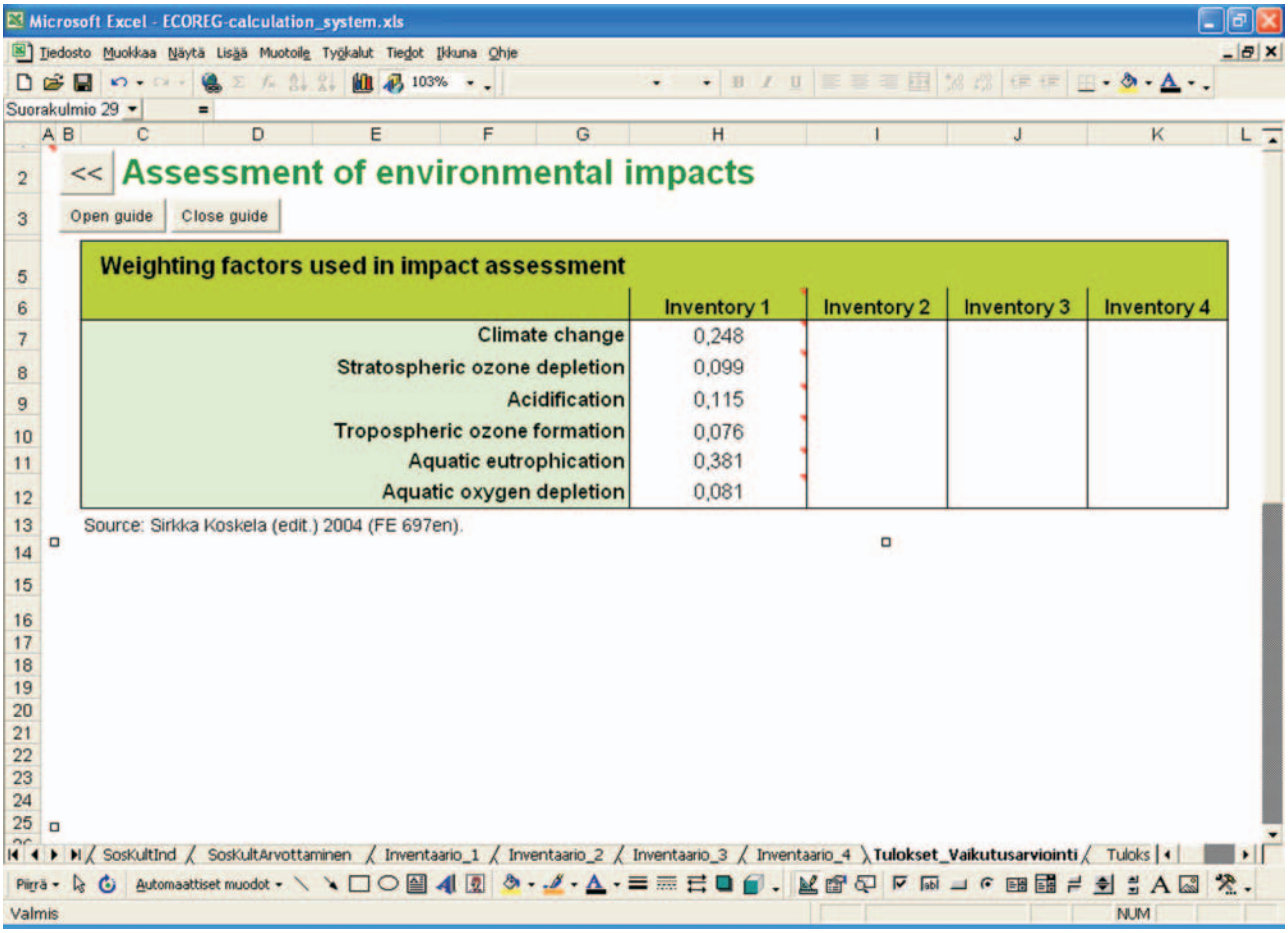
By means of weighting – i.e. valuating – environmental impact categories it is possible to form a picture of the significance of different environmental impact categories in the region (Tenhunen et al. 2004). By using the calculation mechanism, it is possible to test the effect of the weighting coefficients on results and to utilise, in each inventory, the most suitable coefficients (Table 10). The weighting coefficients are entered into a spreadsheet and so the calculation mechanism automatically utilises them in life cycle impact assessment.

The mechanism calculates the life cycle impact assessment in a simplified form compared with the one presented in Tenhunen et al. (2004); the mechanism only takes into account those impact categories which are presented in Table 10. That is because it is solely the emissions relating to the impact categories of Table 10 that can be made commensurable by means of scientific characterisation coefficients. The mechanism allows the user to change – in a separate data input spreadsheet – values concerning characterisation coefficients for emissions (cf. Annex 6). The mechanism calculates the impact category indicator values by means of the emission data and the characterisation coefficients existing in the inventory table and by means of the weights presented in Table 10.

The results of the impact assessment can be analysed by environmental burden, by impact category, or by activity sector.

In addition, the calculation mechanism contains the results of the inventory and the life cycle impact assessment (LCIA) conducted in the ECOREG project

Table 10. Data input spreadsheet of the coefficients used in impact categories, the Kymenlaakso calculation mechanism.



Weighting factors used in impact assessment

	Inventory 1	Inventory 2	Inventory 3	Inventory 4
Climate change	0,248			
Stratospheric ozone depletion	0,099			
Acidification	0,115			
Tropospheric ozone formation	0,076			
Aquatic eutrophication	0,381			
Aquatic oxygen depletion	0,081			

Source: Sirkka Koskela (edit.) 2004 (FE 697en).

(Koskela 2004) in a more comprehensive form, but this complex analysis cannot be implemented by means of the calculation mechanism. The purpose of the columns presenting the results of this more comprehensive analysis is to give a picture of the relative importance of different environmental problems (impact categories) (Fig. 36 in Section 6.2). Also, these columns illustrate the significance of the different factors causing environmental burden and change in Kymenlaakso as sources of environmental impacts (Fig. 20 in Section 4.3.1).

The environmental analysis conducted in the ECOREG project includes factors on which there are no proper monitoring data available but which are known to cause environmental impacts. However, the result obtained by means of valuation showed that these factors do have a large role in the arising of the total impacts in the region. Although the total impact values are shaped by the subjective views of the experts of the region, the end user of the monitoring and evaluation mechanism will be able to utilise these data when interpreting the results. For example, the end user is better able to evaluate the significance of the change taken place in CO_2 emissions, when he or she is able to see the share of CO_2 impact values ("damage scores") out of all the impact values for the region (Fig. 20 in Section 4.3.1). Correspondingly, it is easier for the end user to interpret the impact category indicator results (Fig. 29) calculated by the monitoring and evaluation mechanism, when the result concerning all the impact categories is available (Fig. 36 in Section 6.2).

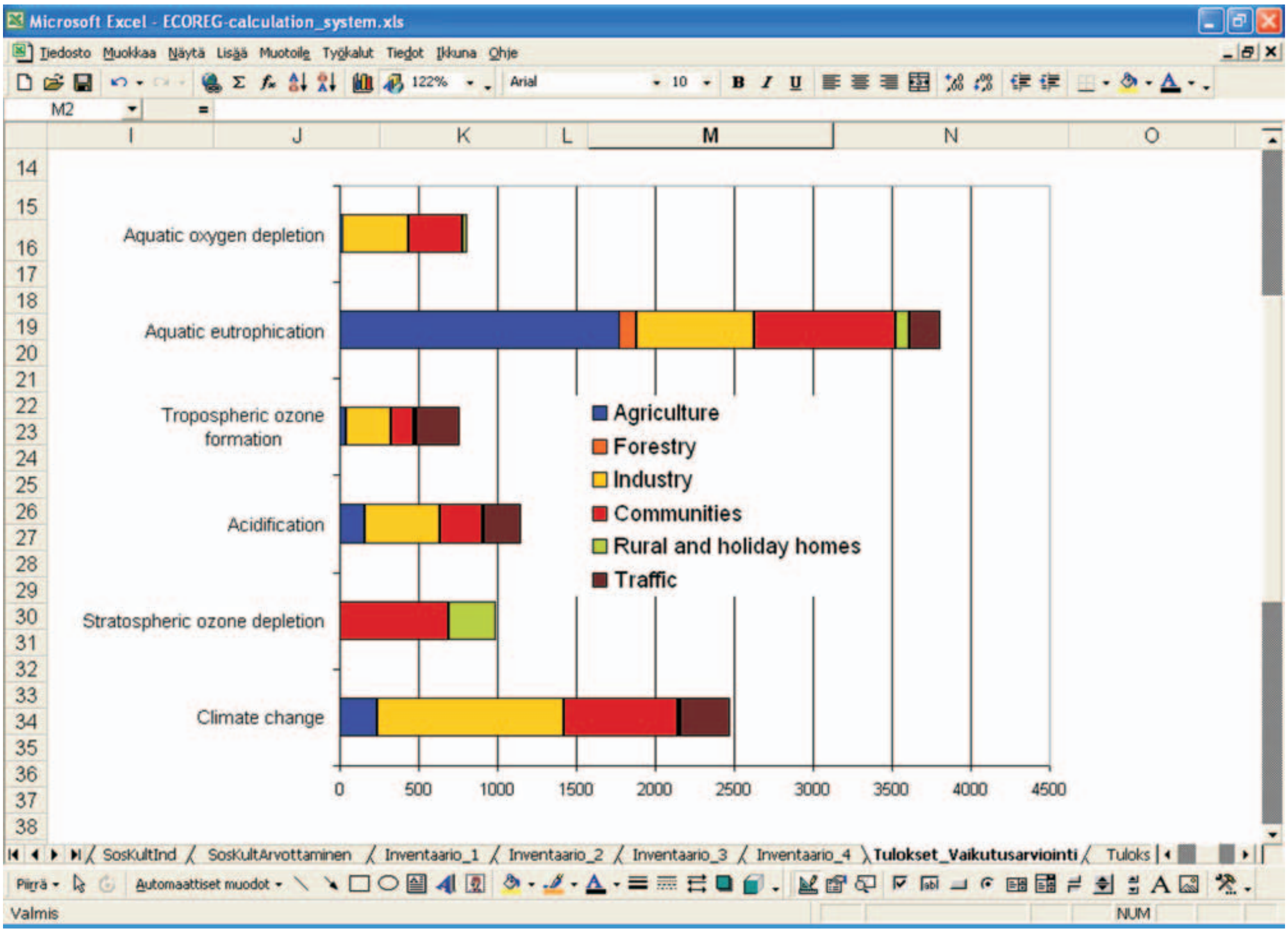


Figure 29. Analysing environmental impacts and their most significant causes by means of the Kymenlaakso calculation mechanism. Horizontal axis: impact values.

5.2.3 Selecting new socio-cultural indicators by means of valuation

The results concerning the different phases of valuation – i.e. looking for factors and weighting them – of the region's socio-cultural factors can be demonstrated and prioritised by means of the calculation mechanism. The results are presented by means of factor-specific columns in the same way as in the documentation report dealing with socio-cultural factors (Rosenström and Mickwitz 2004).

5.2.4 Analysing results

By means of the calculation mechanism the data entered into spreadsheets can be studied as time-series. Furthermore, the development trends of different factors can also be compared.

I Annually updated indicators

It is possible to compare the development of the annually updated indicators belonging to different sub-sectors by analysing the behaviour of these indicators as relative changes with respect to the selected reference year. The reference year is given the value 100 (Fig. 30).

The indicators are selected for the graph by ticking the box of the indicator desired. After this the name of the indicator will appear next to the line symbol in the key field located below the graph (Fig. 30).

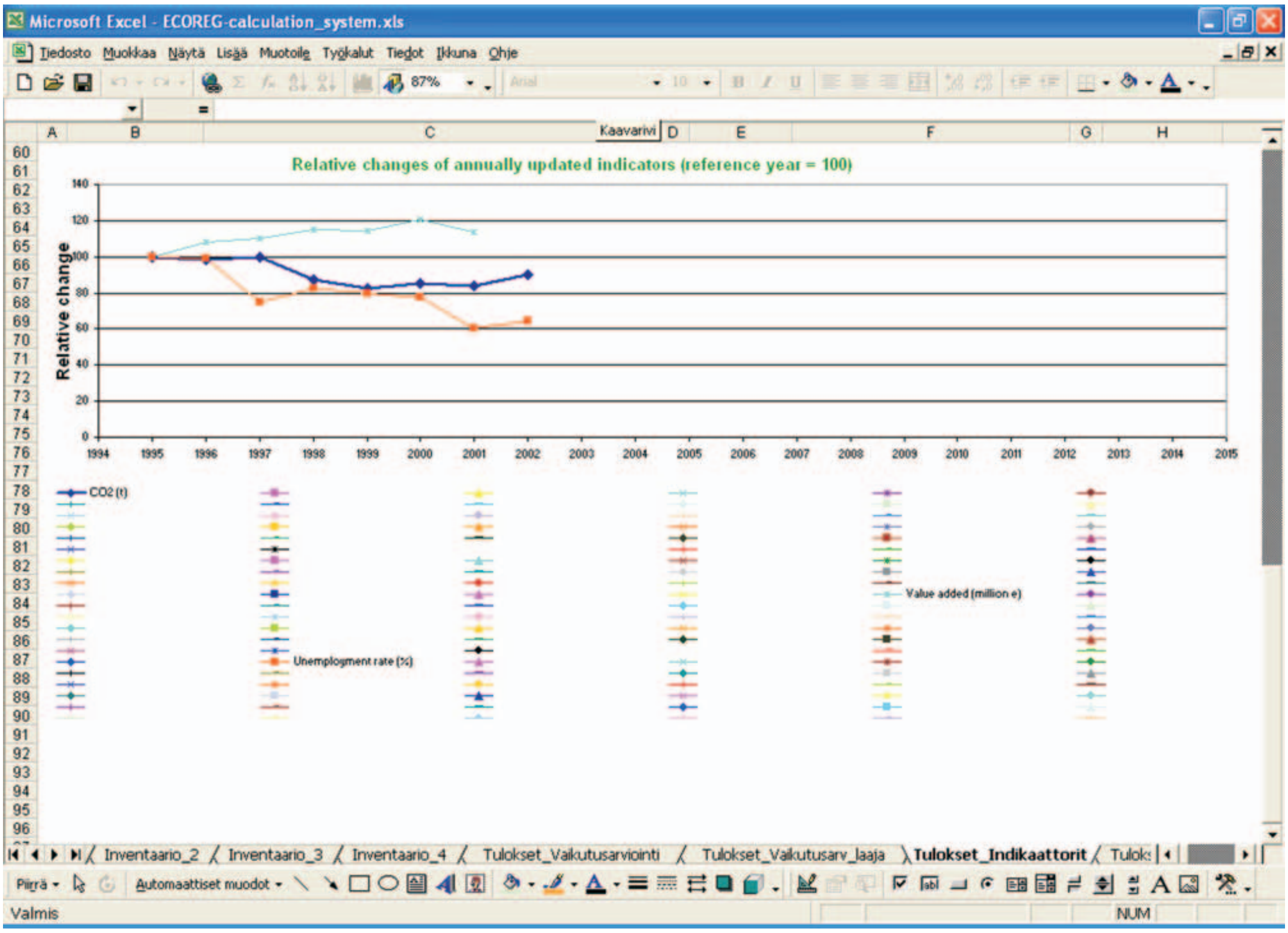


Figure 30. Comparing the annually updated indicators by means of the Kymenlaakso calculation mechanism.

II Results of the inventory on different industrial sectors

In the results section of the industry inventory, the results of different inventories can be compared by industrial sector. So far, the mechanism has a monitoring value solely for the results compiled in the ECOREG project for the year 2000 (Fig. 31). It is possible to select 15 different variables to be simultaneously analysed.

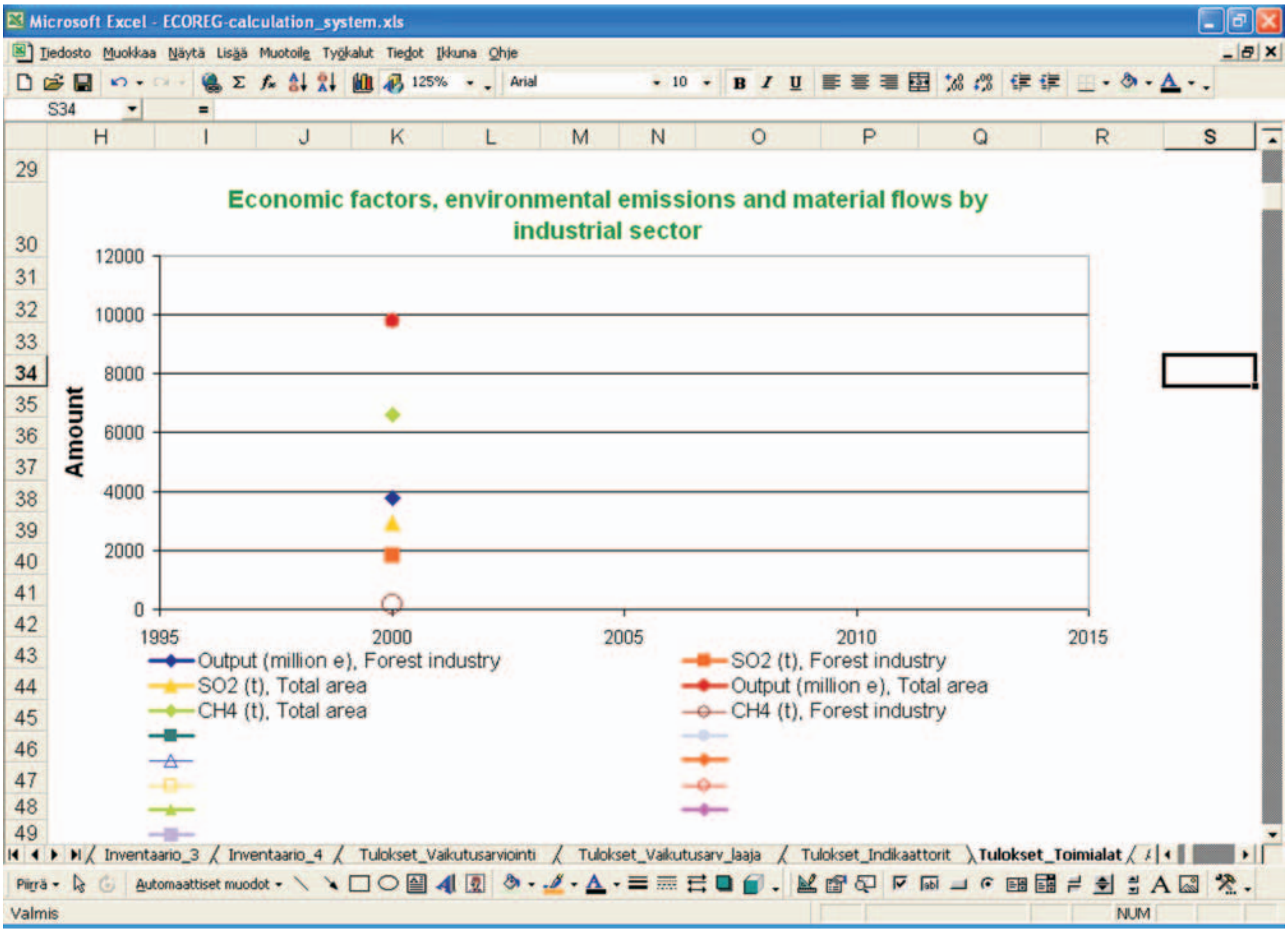


Figure 31. Analysing economic results and environmental burdens for each industrial sector by means of the Kymenlaakso calculation mechanism. The forest industry, the largest industry of the region, taken as an example.

III Value added ⇔ environmental impacts

The temporal development of the region's potential environmental impacts in relation to the development of the economic profit, i.e. added value, can be studied by comparing impact-category-specific load equivalents (Fig. 32). The load equivalent (impact category indicator) of an impact category is obtained by multiplying the emission/burden volume by a selected characterisation coefficient. Thus, the qualitative factors and the factors related to valuation do not yet affect the results at this phase. One or more impact categories can be selected for the graph by ticking the box of the impact category desired.

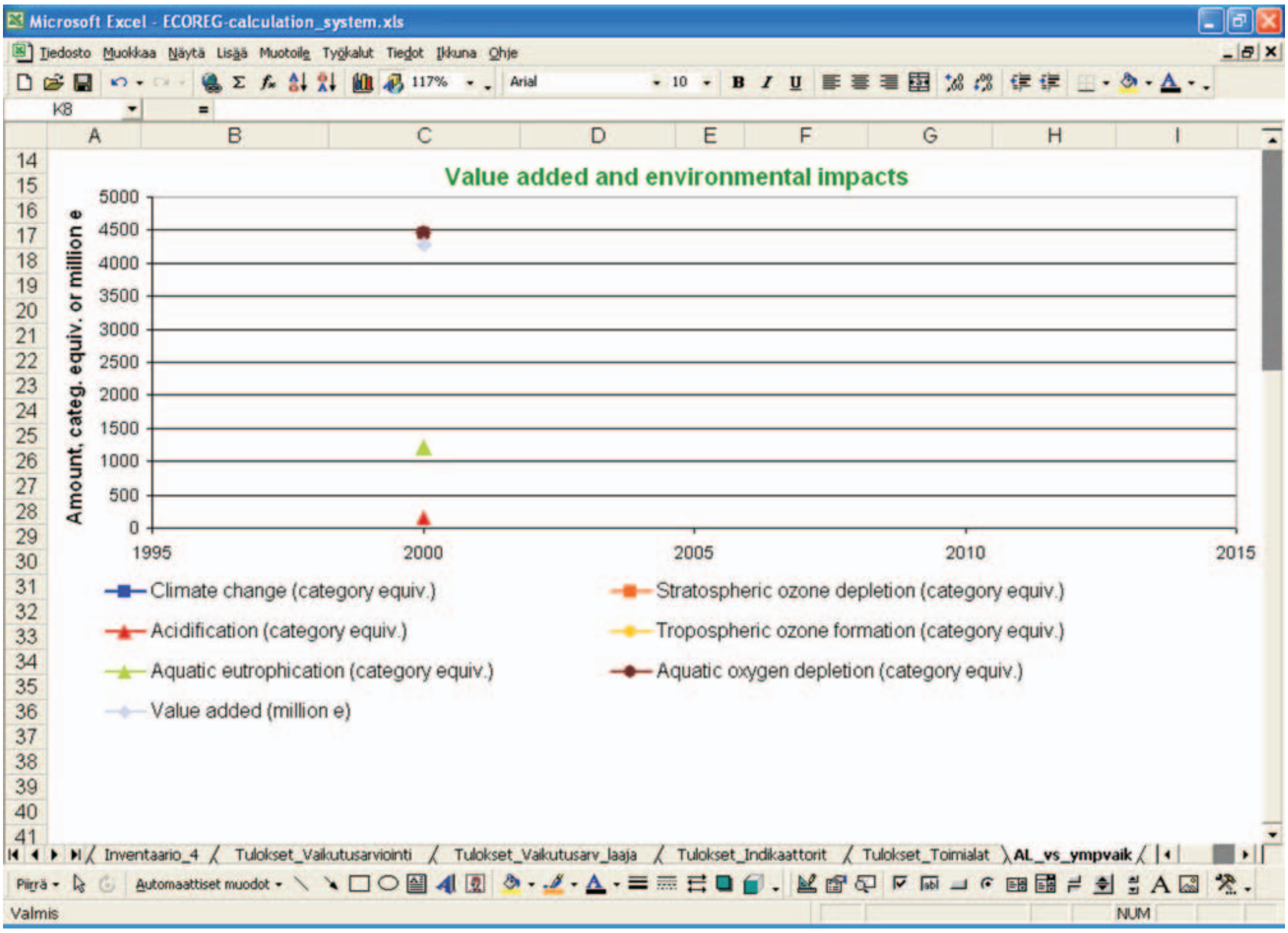


Figure 32. The simultaneous analysis of the environmental impacts (impact category indicators) and the time-series of value added by means of the Kymenlaakso calculation mechanism.

IV Eco-efficiency ratios

By means of the Kymenlaakso mechanism, eco-efficiency can also be examined as a quotient of economic and environmental factors. The economic indicators suitable for this kind of analysis are value added, gross domestic product (GDP) and output.

Value added and gross domestic product can be proportioned to the region's pollutants or impact category indicators. In addition, value added can also be studied in relation to the "total material input" (TMI), a concept belonging to the area of material flows (see Section 4.3.2). Output is a more comprehensive economic concept (see Section 4.2) than value added and gross domestic product. Output can be examined in relation to the sum of the region's emission volume and the emission volume caused by the imports, or it can be examined in relation to the region's total material requirements (TMR).

The factors for the graph presenting eco-efficiency figures are selected by ticking the boxes of the numerator and denominator. In the results all the available values can be seen (Fig. 33).

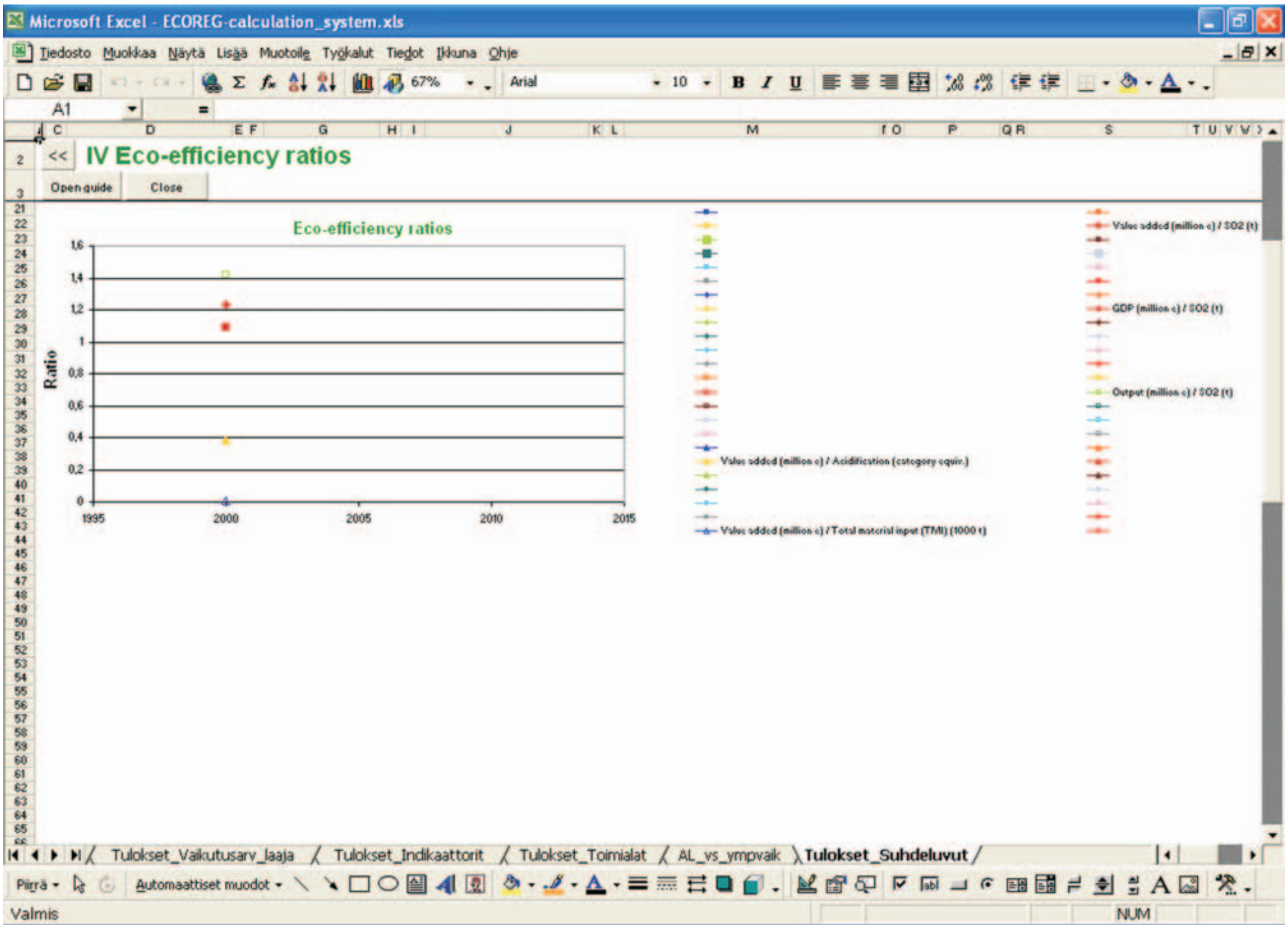


Figure 33. Analysing the eco-efficiency ratio indicators (the whole region) by means of the Kymenlaakso calculation mechanism.

The eco-efficiency of Kymenlaakso in light of the indicators used

6

Even though the principal objective of the ECOREG project was to demonstrate eco-efficiency and to develop indicators, as well as a monitoring and evaluation mechanism to serve this purpose for the region of Kymenlaakso, we can already use the indicators created and material compiled to draw some conclusions on the eco-efficiency of Kymenlaakso from the mid-1990s to the early years of the 21st century.

6.1 Development of the Kymenlaakso economy

The economy of the Kymenlaakso region grew during the years 1995–2001, except for the last year of that period when a visible downswing in the value added of the entire region was caused by the pulp and paper industry. On average, the growth was slower than in all of Finland (Fig. 34). The more modest growth is partially explained by the fact that the region did not see a similar growth in the ICT industry as did the rest of Finland. The real disposable household income of Kymenlaakso grew at a relatively steady rate but not as fast as the value added of the regional economy (Fig. 35). The development of the real disposable income remained independent of the fluctuations in productive activities.

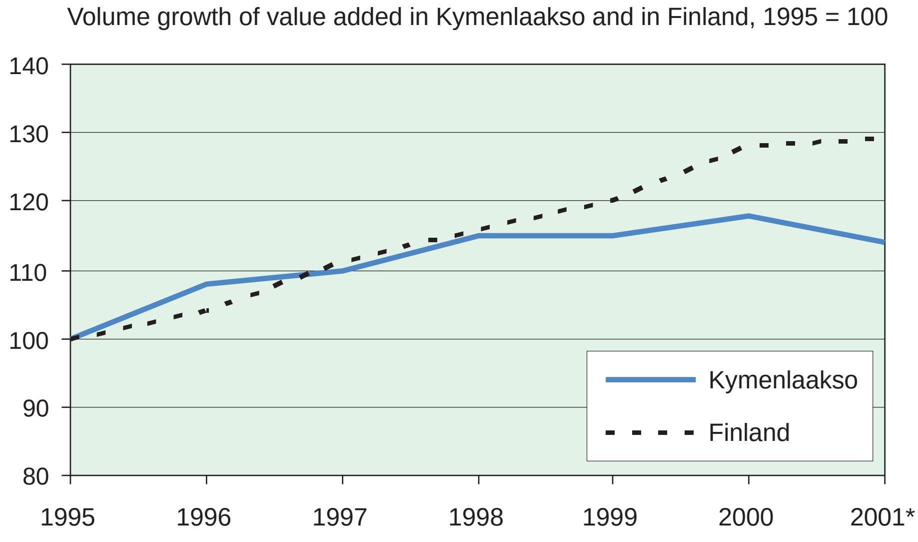


Figure 34. Volume growth of value added in Kymenlaakso and in all of Finland in 1995–2001 (Mäenpää and Mänty 2004).

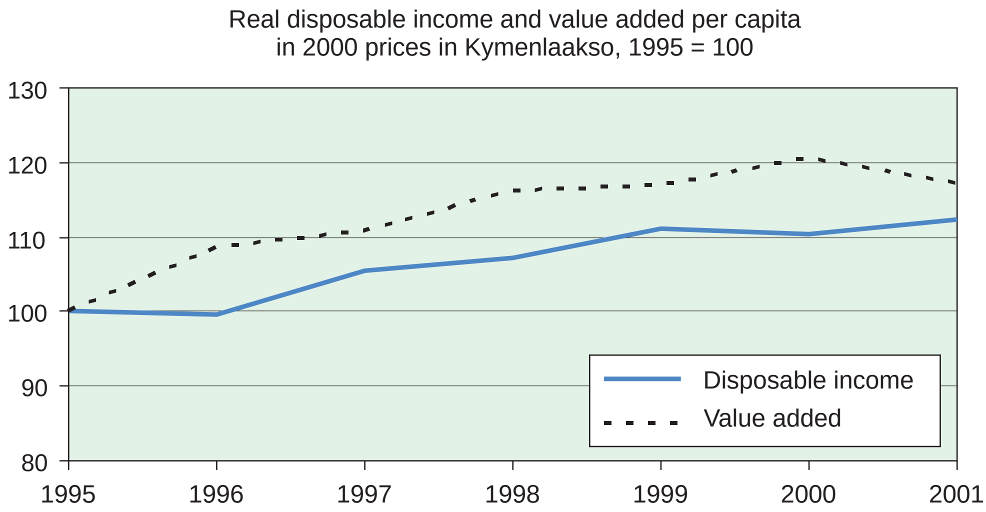


Figure 35. Real disposable income and value added per capita in Kymenlaakso in the latter half of the 1990s (Mäenpää and Mänty 2004).

6.2 Environmental impacts and their development

The result of the environmental analysis – the current situation

The environmental analysis surveying the situation in 2000–2003 identified the following as the most significant environmental burdens occurring in Kymenlaakso (see Fig. 20 in Section 4.3.1):

1. environmental accidents (risk of contamination)
2. carbon dioxide emissions originating from fossil fuels
3. continuous emissions of hazardous substances
4. nitrogen emissions into waters
5. atmospheric emissions of nitrogen oxides
6. contaminated soils
7. noise
8. odour
9. hazardous releases from landfills
10. forestry operations
11. emissions depleting ozone in the stratosphere
12. phosphorus emissions into waters.

Based on the valuation process included in the environmental analysis, the most central environmental problems[4] of the Kymenlaakso region were:

1. contamination of soil and water resources
2. eutrophication of waters
3. environmental accidents (risks)
4. climate change
5. ecotoxicity
6. loss of biodiversity.

[4] *The environmental problem categories are described in Annex 4.*

Industry and traffic play a significant role as causes of these problems, except for the releases of nutrient loads into waters. The impact assessment model of the environmental analysis enabled us to evaluate the roles of the various industries in causing each environmental problem (Figures 36 and 37). On purely scientific grounds, however, this could only be achieved for the part of climate change, stratospheric ozone depletion, acidification, tropospheric ozone formation as well as the eutrophication of waters and aquatic oxygen depletion. With the other impact categories, we had to rely on expert estimations. Industry emerges as the cause of most impacts. Traffic and communities, in equal measure, are the next-largest causes. However, these results only apply to the environmental impacts caused by the industries and activities within the Kymenlaakso region, and the impacts of imports into the region are not included in this assessment.

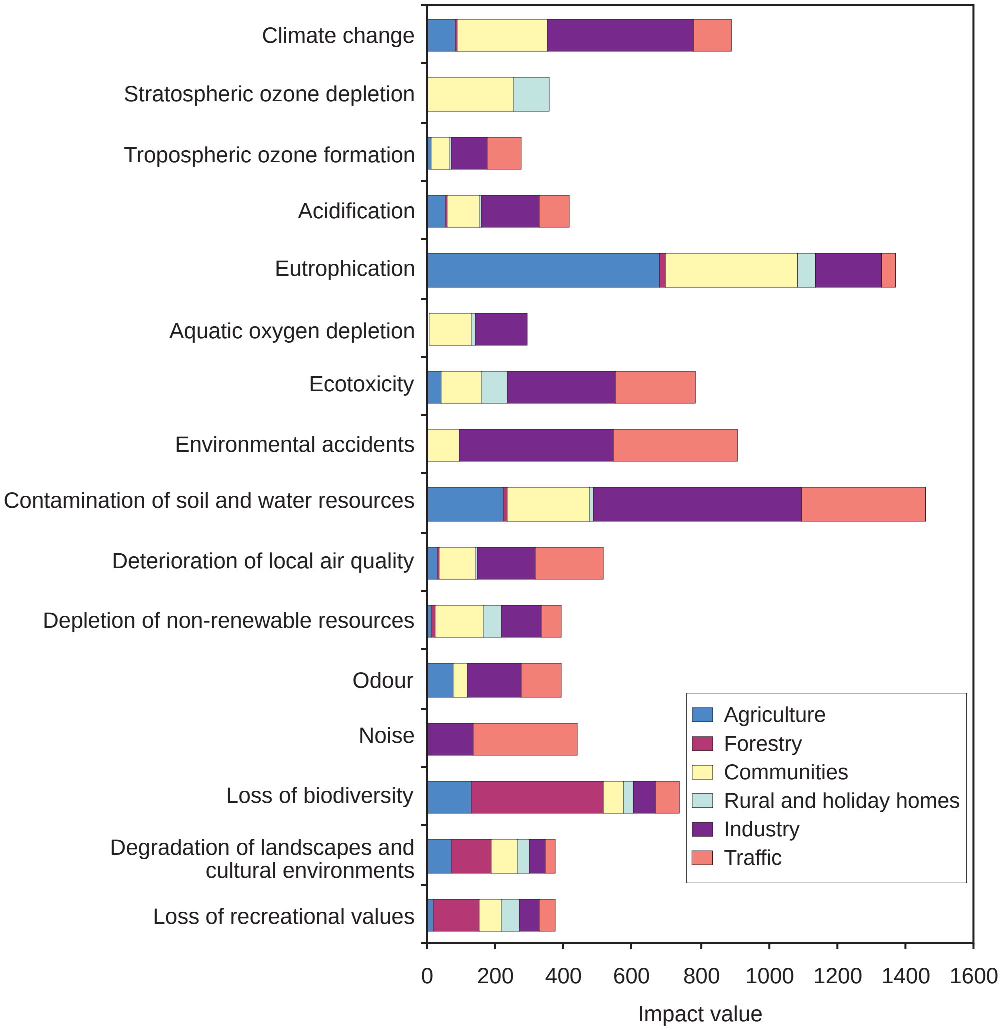


Figure 36. Impact values ("damage scores") calculated for each Kymenlaakso industry per environmental problem category, using the impact assessment model (the sum of impact values equals 10 000). (Tenhunen et al. 2004, Part 2 in Koskela 2004; cf. Fig. 19 in Section 4.3.1).

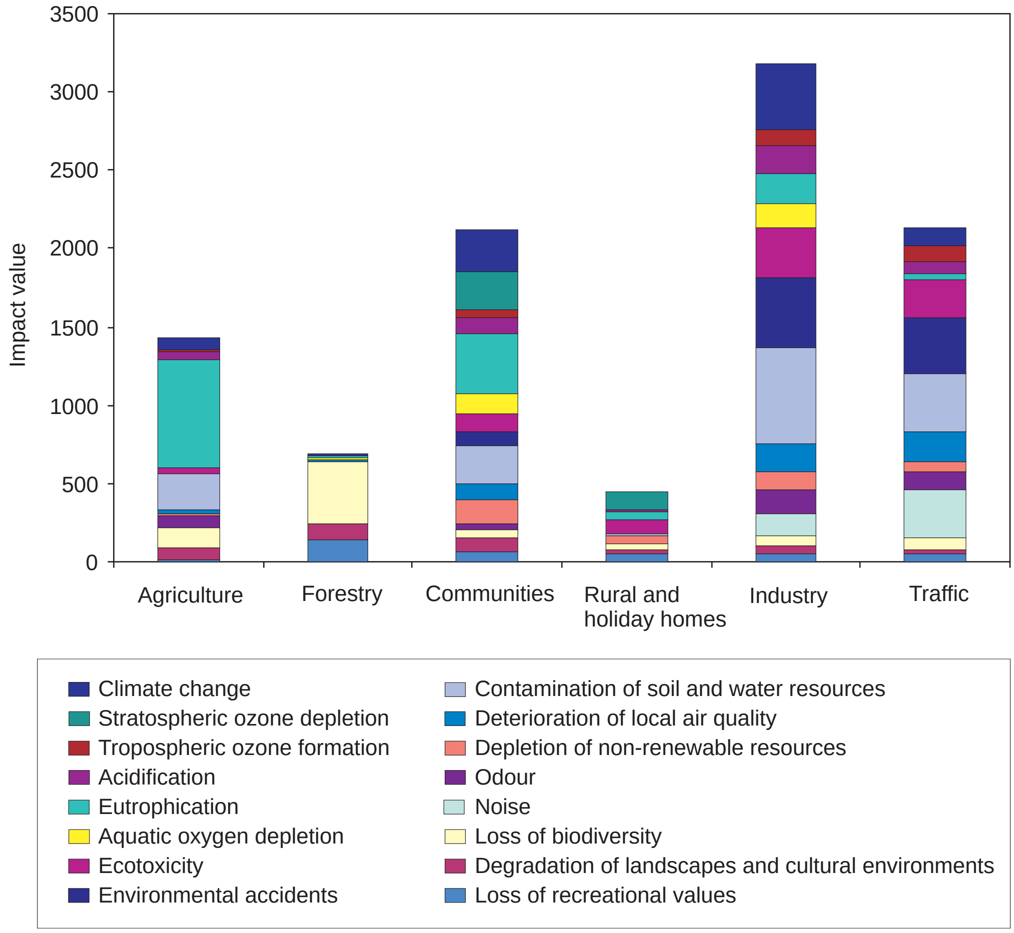


Figure 37. Impact values ("damage scores") calculated for the activity sectors in Kymenlaakso using the impact assessment model (the sum of impact values equals 10 000) (Tenhunen et al. 2004, Part 2 in Koskela 2004).

The impacts of imports could be assessed for five impact categories – climate change, acidification, tropospheric ozone formation, eutrophication and aquatic oxygen depletion – for which emissions estimates and scientific emissions aggregation coefficients, that is, characterisation coefficients, are available. This is why Figure 38, in which the environmental burden of imports has been compared with the environmental burden caused by activities within Kymenlaakso, only demonstrates the results of these five impact categories. They represent approximately 53% of the region's total impact value or "damage score" (cf. Fig. 37).

More than 80% of the timber used by the Kymenlaakso forest industry is acquired from outside the region. If one assumes that this amount of wood causes a relatively similar impact on loss of biodiversity and degradation of landscapes and recreational values outside Kymenlaakso as it does within the region, the biodiversity impacts of imported timber increase the impact value of imports from a score of 774 to 3 310 on the scale of Figure 37.

In interpreting the results of Figures 37 and 38, one must consider the fact that the absolute volumes of the different impact categories are based on the valuation process carried out within the region. With Figure 38, we must also take into account the fact that the impact calculations of imports only apply to the emissions from the raw-material flows chosen and the production of imported electricity. The calculations do not include the emissions from, for instance, raw-material transport.

In conclusion, we can state that *the significance of imports in the total environmental burden caused by Kymenlaakso activities is at least 50%*, when we take the values assigned by experts to the different regional environmental problems as the point of departure.

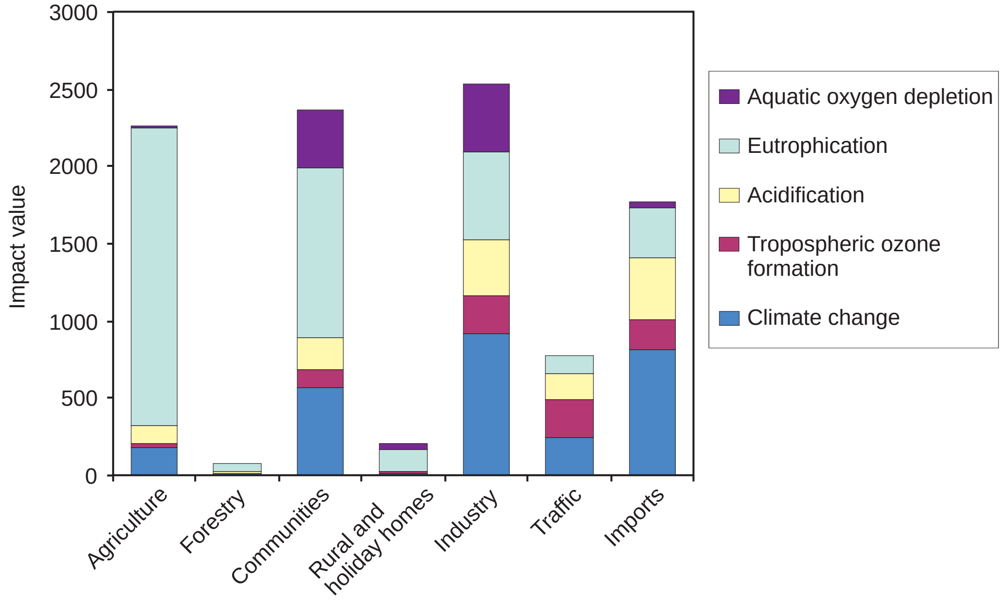


Figure 38. Impact values ("damage scores") for imports into the Kymenlaakso region as well as for emissions from within the region, as calculated using the impact assessment model with the impact categories of climate change, tropospheric ozone formation, acidification, eutrophication, and aquatic oxygen depletion (the sum of impact values equals 10 000) (Tenhunen et al. 2004, Part 2 in Koskela 2004).

The result yielded by material inputs – the current situation

From the material presented by the Kymenlaakso physical input-output tables in tons (Annex 7), we can calculate various figures describing the material intensity of the region. The material requirement figures calculated per gross domestic product (GDP), capita and total area form yardsticks for measuring eco-efficiency, and they can – if interpreted correctly – be used to make interesting comparisons between different regions (Figures 39 and 40). For the Kymenlaakso region, the following conclusions can be drawn:

- The material intensity of the region is high – the material requirement per capita is nearly double the overall Finnish average (Fig. 39). However, there are notable differences in the structures of material requirements between regions. In the direct material inputs of Kymenlaakso, the proportion of imports is 70%, whereas the corresponding proportion for the whole of the country is, on average, less than 25%.
- The high material intensity of Kymenlaakso is almost exclusively explained by exports (Fig. 40). Of the material requirement of the region, the proportion of exports is more than two thirds, whereas the proportion of exports in the material requirement of all of Finland is just over 50%.

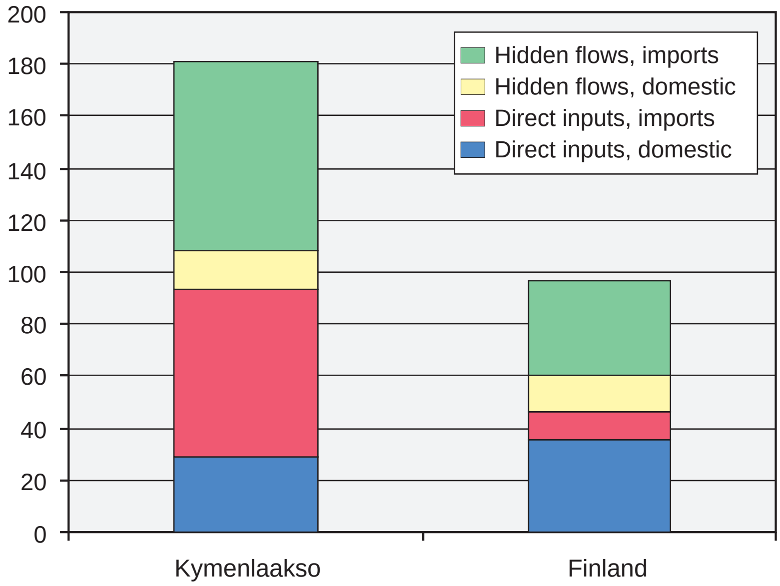


Figure 39. Total material requirements (TMR) in Kymenlaakso and in all of Finland in 2000, tons per capita (Mäenpää and Mänty 2004).

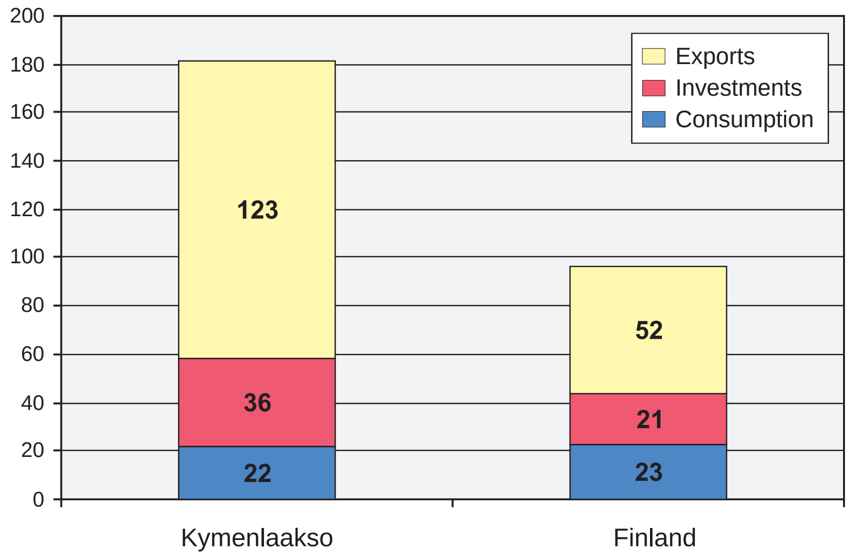


Figure 40. Total material requirements (TMR) by main final use category in Kymenlaakso and all of Finland in 2000, tons per capita (Mäenpää and Mänty 2004).

In the Kymenlaakso region, natural resource intake is, in practice, concentrated on four industries: mineral mining, forestry, agriculture and construction (Table 11). This use of resources includes so-called hidden flows (HF) which further processing does not utilise. When these flows and the hidden flows of import are added to the direct material inputs (DMI), we obtain the total material requirements (TMR). Columns 1–4 of Table 11 present the material inputs which form the DMI and TMR of the Kymenlaakso regional economy.

In analysing the material inputs of various industries, we must also include the material inputs of other industries within the regional economy, which are found in column 5 of Table 11. In studying the eco-efficiency of the industries, one should use the variables in the final two columns in Table 11; i.e., the DMI

Table 11. Measuring and interpreting material inputs, Kymenlaakso 2000; 1 000 tons (DMI = direct material input; HF = hidden flows; TMR = total material requirements).

		From regional natural resources		Imports		From within the region	The region's		The industry's	
Industries		DMI	HF	DMI	HF	DMI	DMI	TMR	DMI	TMR
		1	2	3	4	5	=1 + 3	=1+2+3+4	=1+3+5	i/o
1	Agriculture and hunting	474	0	60	199	334	533	733	867	1 020
2	Forestry and logging	1 604	722	3	1	0	1 607	2 330	1 607	2 405
3	Fishing	7	0	0	0	1	7	7	7	12
4	Mining and quarrying	2 624	453	8	11	12	2 632	3 096	2 645	3 136
5	Manufacture of food products and beverages	0	0	260	384	165	260	643	424	1 582
6	Manufacture of textile products	0	0	1	5	0	1	6	1	14
7	Manufacture of wood products	0	0	546	359	540	546	905	1 086	1 401
8	Manufacture of pulp and paper	0	0	8 045	5 710	3 333	8 045	13 755	11 378	21 837
9	Publishing and printing	0	0	1	8	33	1	8	34	112
10	Manufacture of chemical products	0	0	518	1 633	82	518	2 151	600	2 600
11	Manufacture of non-metal mineral products	0	0	318	451	49	318	769	367	1 005
12	Manufacture of basic metals and metal products	0	0	22	84	3	22	106	25	156
13	Manufacture of machinery and equipment	0	0	20	89	2	20	109	22	200
14	Manufacture of electrical equipment	0	0	1	4	0	1	5	1	13
15	Manufacture of transport equipment	0	0	1	7	0	1	9	2	17
16	Other manufacturing and recycling	0	0	18	1	193	18	19	210	34
17	Electricity, gas and water supply	0	0	258	344	10	258	603	268	824
18	Construction	697	1 598	1 628	2 994	2 752	2 325	6 916	5 077	8 271
19	Wholesale and retail trade	0	0	42	38	2	42	80	44	279
20	Hotels and restaurants	0	0	20	48	11	20	68	31	209
21	Transport, storage and communication	0	0	78	67	54	78	145	131	493
22	Business services	0	0	17	31	1	17	48	18	402
23	Dwellings	0	0	6	14	1	6	20	7	859
24	Public administration, compulsory social insurance	0	0	25	37	3	25	62	28	276
25	Other services	0	0	35	103	4	35	138	39	376
	Industries combined	5 406	2 773	11 930	12 622	7 584	17 336	32 731	24 920	47 535
	Households	0	0	195	948	232	195	1 143		
	Investments	0	0	67	149	4 318	67	216		
	Export	0	0	0	0	5 125	0	0		
	Sum total	5 406	2 773	12 193	13 719	17 260	17 599	34 090		

and TMR material inputs per industry. The material inputs of the different industries should not be compared with each other, because several industries are connected to each other. For example, pulp and paper production cannot be considered independently of the material inputs of forestry. Therefore, the material inputs for each industry primarily provide us with a basis for monitoring the development of eco-efficiency in each industry separately.

For monitoring the regional development of eco-efficiency, the most significant variables are the TMR of the region and the volume of natural resources processed within the region, i.e., the "total material input" TMI (cf. Fig. 24 in Section 4.3.2), which is derived by taking the regional DMI value (columns 1 and 3 in Table 11) and adding to it the hidden flows caused by the intake of natural resources in the region (column 2 in Table 11).

Indicator time series and their interpretations from the years 1995–2003

Contamination of soil and water resources

Concerning the contamination of soil and water resources, the development in Kymenlaakso has, on the whole, been favourable since the mid-1990s. With regard to this impact category, however, there are several considerations which cannot be monitored unless new indicators are established in connection with the next update on the environmental analysis, at the latest. In valuating the environmental problems, this impact category should also be divided into smaller subcategories (e.g., River Kymijoki sediment dioxins, contamination of soils, deterioration of surface water quality, deterioration of groundwater quality), the purpose of which is to clarify the content of the impact category. In the valuation situation, the differences between these categories and other categories should also be expressed more precisely.[5]

Eutrophication of waters

The Kymenlaakso region is responsible for approximately 5% of the water-eutrophicating discharges in Finland. The nitrogen discharges of Kymenlaakso have a much more significant role as eutrophicating discharges than phosphorus.

The release of nitrogen loads to waters from communities, rural settlements and industry, chosen as an indicator (Fig. 41), caused approximately 17% of the eutrophicating discharges of Kymenlaakso in 2000. The indicator describing the NO_x emissions from industry, energy production and road traffic explained about 35% of the region's eutrophicating emissions.

The nitrogen and phosphorus discharges from agriculture were not selected as indicators to be monitored annually, because it is not worth while to make such discharge estimates every year. The development in the number of riparian zone contracts concerning special measures of agri-environmental support, however, indirectly indicates a decrease in the nutrient washouts from agriculture (Fig. 41).

The eutrophicating discharges of Kymenlaakso have developed into a favourable direction. From 1995 to 2002, we have seen a decrease of as much as some twenty per cent.

[5] It is likely that the persons who participated in the valuation process at the Kouvola workshop have included their perceptions about, for example, the eutrophication of waters and ecotoxicity in the impact category of contamination of soil and water resources, which is why the emphasis of this category in relation to other categories is somewhat distorted.

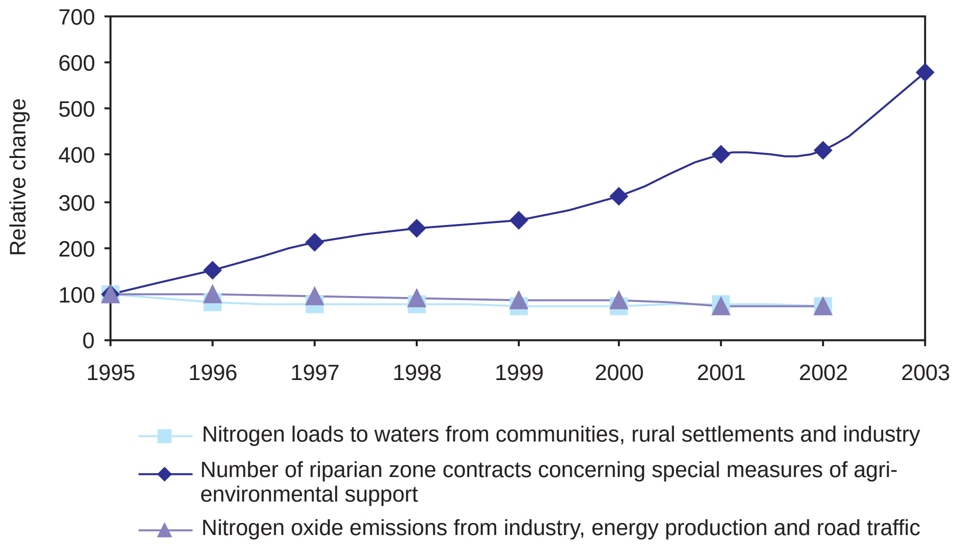


Figure 41. Indicator time series describing the environmental problem of eutrophication of waters during the years 1995–2003 (original source: Koskela et al. 2004b).

Environmental accidents

The number of reported oil and chemical accidents has increased since 1995 (Koskela et al. 2004b). However, it is uncertain whether the quantitative growth is real or a result of a change in reporting procedures. In the volumes of chemicals discharged into the environment (5 288 litres in 2000), no upward trend can be seen.[6] In road transport, the number of performances has increased notably, whereas rail transports have decreased. For the part of road transport, this would signify an improvement of eco-efficiency should the number of road transport accidents remain at the same level.

Climate change

The Kymenlaakso region is responsible for approximately 4% of the overall Finnish greenhouse gas emissions[7]. The figure is slightly higher than the proportion of Kymenlaakso in the Finnish population. Approximately 93% of the climate change impacts of greenhouse gas emissions in Kymenlaakso are caused by carbon dioxide ($CO_{2)}$. The indicator chosen for annual monitoring—the CO_2 emissions caused by the fossil fuel consumption of industry, energy production and road traffic—explained approximately 63% of the greenhouse gas emissions of Kymenlaakso in 2000. The value of this indicator has decreased from 1995 to 2002 by approximately 10% (Fig. 42).

[6] *Four disasters which occurred in the Kymenlaakso area have been left out of the results, because the oil and other chemical volumes of these accidents were more than tenfold compared to other accidents.*

[7] *The proportion of Kymenlaakso in the overall Finnish emissions contributing to climate change is obtained by dividing the climate change indicator figure, calculated as the Kymenlaakso CO_2 equivalent, by the indicator figure for the entire country. The indicator value calculated as CO_2 equivalent for all of Finland has been obtained by multiplying the volume of greenhouse gas emissions in 2000 (http://www.ymparisto.fi/default.asp?contentid=92536&lan=fi) by the corresponding characterisation coefficients of the environmental analysis.*

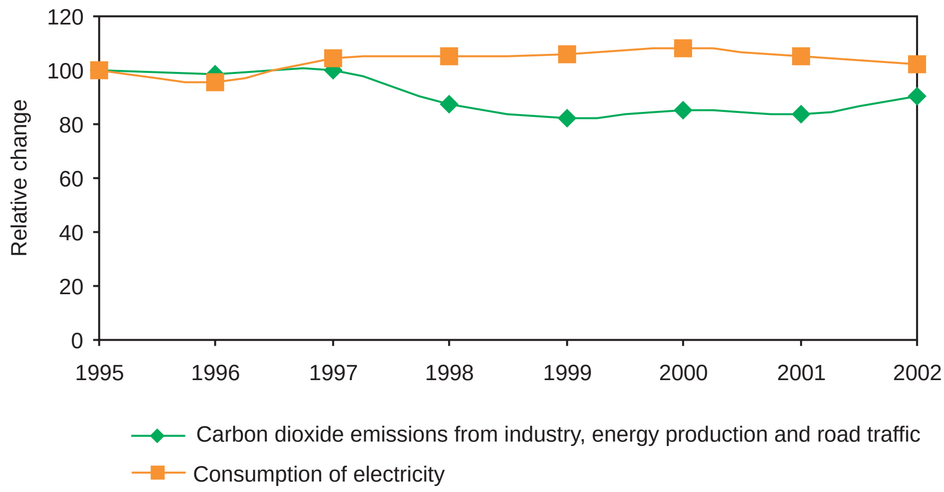


Figure 42. The changes in the CO_2 emissions (fossil fuel consumption) of industry, energy production and road traffic as well as electricity consumption in Kymenlaakso during 1995–2002 (original source: Koskela et al. 2004b).

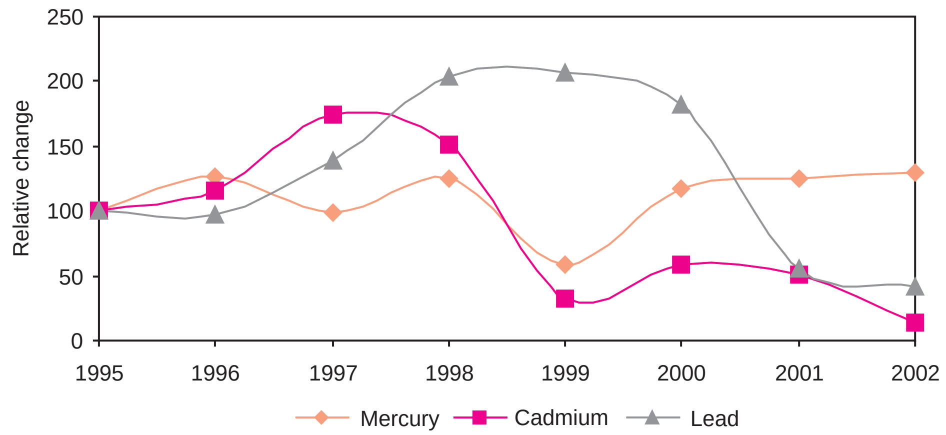
The electricity consumption of the region has remained at the same level throughout the reference period. What is noteworthy, however, is that the Kymenlaakso self-sufficiency rate in energy production was 68% in 1995, but merely 51% in 2000. What this means in practice is that part of the decrease in greenhouse gas emissions has been transferred into emissions occurring outside the region.

Ecotoxicity

In the environmental analysis impact category of ecotoxicity, continuous emissions are analysed. Emissions of mercury, lead, cadmium, PAH, dioxins and furans into the air indicate the development within this impact category. Lead and cadmium emissions have decreased from the situation in 1995 (Fig. 43), whereas the mercury emissions of Kymenlaakso, the proportion of which in the overall emissions of the country is quite large, have not decreased. All in all, the direction that the development of the ecotoxicity problem is taking is difficult to assess, when we also consider the fact that we have not been able to select indicators for the toxicity impacts of water discharges from industry and communities.

Loss of biodiversity, degradation of landscape and cultural environment, loss of recreational value

In Kymenlaakso, the threats to biodiversity are mainly concerning the utilisation of forest reserves and the loss of diversity in the agricultural environment. The figures representing the numbers of traditional biotope and landscape management contracts and biodiversity enhancement contracts, selected as indicators for agriculture, are showing an upward trend from the mid-1990s (Fig. 44). This indicates a positive change not only from the point of view of biodiversity, but also from the points of view of landscape, cultural environment and recreational value. The number of environmental support contracts for forestry also increased—from the six in 2000 (21 ha) to eleven in 2002 (29 ha).



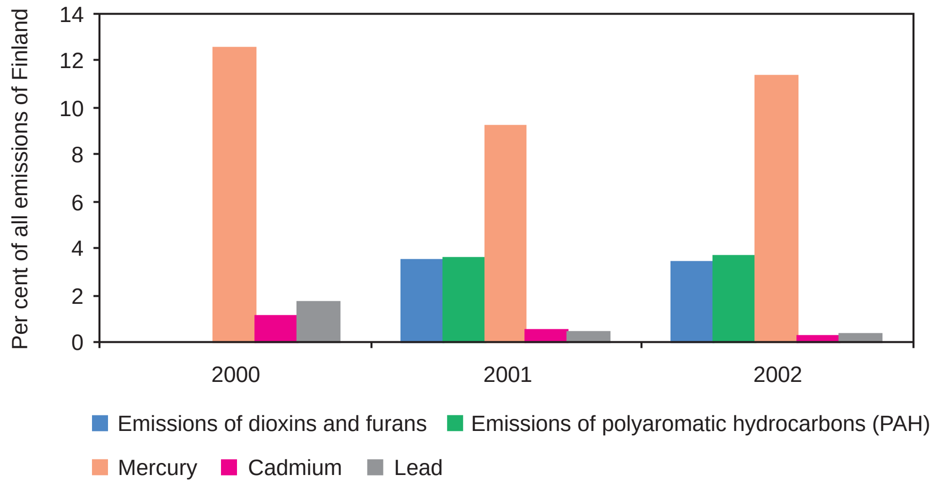


Figure 43. Changes in the annually monitored emissions indicators of ecotoxicity in 1995–2002 (original source: Koskela et al. 2004b) and the proportion of Kymenlaakso in the overall Finnish emissions of the compounds in question during 2000–2002.

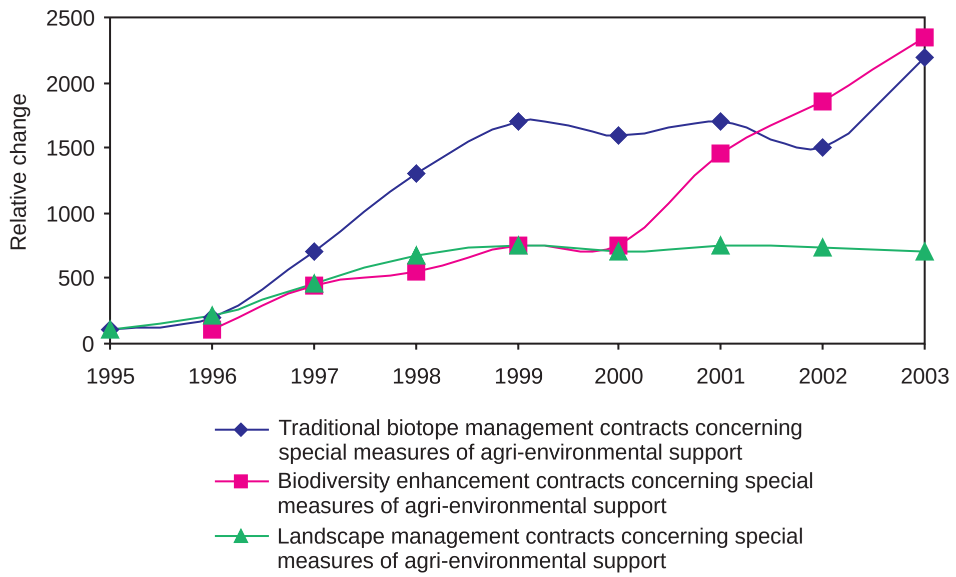


Figure 44. The development in the numbers of traditional biotope management contracts, biodiversity enhancement contracts and landscape management contracts in Kymenlaakso during 1995–2003 (original source: Koskela et al. 2004b).

Acidification

In 2002, Kymenlaakso caused approximately 4.5% of the acidifying emissions of Finland. According to the life cycle impact assessment method (LCIA) used in the environmental analysis, sulphur dioxide causes 51%, nitrogen oxides 41% and ammonia 6% of the acidifying impacts of Kymenlaakso. The annually monitored indicator—SO_2 and NO_x emissions from industry, energy production and road traffic—explained approximately 73% of the acidifying emissions in the region in 2000. There has been a marked decrease in the emissions since 1995 (Fig. 45). Some acidifying emissions have, however, merely been transferred into emissions occurring outside the region as a consequence of the decline in the self-sufficiency rate of energy production (cf. climate change).

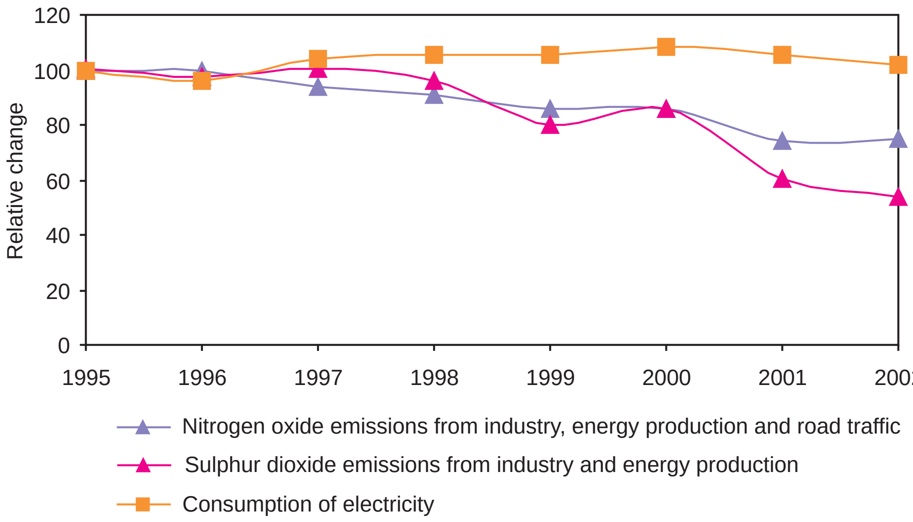


Figure 45. Changes in the indicators describing the impacts of acidifying emissions in Kymenlaakso during 1995–2002 (original source: Koskela et al. 2004b).

Tropospheric ozone formation

The marked decline in the NO_X emissions from industry, energy production and road traffic (Fig. 45) also indicated the fact that the emissions of Kymenlaakso are forming less ozone in the troposphere than before. In 2000, this indicator explained approximately half of the emissions contributing to tropospheric ozone formation in the entire region.

Noise

Today, noise is one of the most common or worst environmental problems. The increase in road traffic in Kymenlaakso (see Koskela et al. 2004b) signifies that the noise problem will become worse; unless land use planning and noise barriers can reduce the impacts. In 2003, 7 800 people in Kymenlaakso were living in road traffic noise exposure areas (over 55 dB).

Odour

The low threshold value for odorous sulphur compounds (TRS) for the forest industry has meant that the number of days exceeding the TRS odour threshold value per measuring point has remained at the same level at the beginning of the 2000s as it was in the mid-1990s. For the part of odour impacts, therefore, the situation has remained relatively unchanged.

6.3 The eco-efficiency of Kymenlaakso

The development of the eco-efficiency of the Kymenlaakso region during 1995–2002

The value added of the Kymenlaakso region has grown from 1995 to 2002 by approximately 15%. At the same time, the environmental impacts caused by activities within the region have decreased in several environmental problem categories (Table 12). The conclusions drawn in Section 6.2 have been used as a point of departure in the assessments.

Table 12. Assessment of the development of environmental impacts caused by Kymenlaakso activities by environmental problem category (+ = positive change, ++ = positive change over 10 per cent, ? = direction of change cannot be assessed, 0 = no change, - = negative change).

Environmental problem category	Change 1995/2002
Contamination of soil and water resources • dioxins of the bottom sediments of the River Kymijoki	+
Contamination of soil and water resources • contaminated soils	+
Contamination of soil and water resources • deterioration in the quality of surface waters	+
Contamination of soil and water resources • deterioration in the quality of groundwater	?
Eutrophication of waters (external loads)	++
Environmental accidents	?
Climate change	+
Ecotoxicity	?
Loss of biodiversity	+
Degradation of landscapes and cultural environments	+
Loss of recreational values	+
Local air quality	?
Acidification	++
Tropospheric ozone formation	++
Stratospheric ozone depletion	+
Aquatic oxygen depletion	?
Noise	–
Odour	0
Depletion of non-renewable resources	?

If the "+" signs in Table 12 are replaced by five per cent, the "++" signs by 10 per cent, the "?" signs by 0 per cent and the "-" sign by -5 per cent, and if we use the weighting coefficients for each impact category presented in Figure 19 (Section 4.3.1), we arrive at an improvement of approximately four per cent in environmental impacts from 1995 to 2002. This would imply that the *eco-efficiency of Kymenlaakso would have improved by 20%, when we consider only the environmental impacts caused by the activities within the region (the "basic approach" to eco-efficiency, Eq. 3 in Section 4.1), and when we take the value added as the measure of economic affluence.*

During the ECOREG project, change assessments for the material and energy inputs from outside the region by each individual environmental problem category could not be compiled, which is why the eco-efficiency development assessment is here limited to the basic approach—merely the environmental impacts caused by the Kymenlaakso activities and the economic values thereof were examined. *The material inputs from outside the region as used by Kymenlaakso also cause impacts, and their significance will be emphasised in the future. This will also bring new challenges to the carrying-out of future environmental analyses.*

The eco-efficiency of Kymenlaakso in relation to other regions

The eco-efficiency of the Kymenlaakso region cannot, at present, be compared with those of other Finnish regions, because corresponding environmental analyses or material flow analyses have not been carried out in other Finnish regions. However, national material input figures have been calculated on the EU level, which provides one point of reference for eco-efficiency comparisons based on the material inputs of Kymenlaakso.

Proportioned to the gross domestic product (GDP), the material intensity of Kymenlaakso is approximately four times higher, and the overall Finnish average double, when compared to the EU (EU-15) average (Fig. 46, part a). In assessing the potential environmental burden caused by material flows, it is also useful to analyse the flows in relation to the area of the region. In the comparison per area (Fig. 46, part b), the overall material intensity of Finland is merely one third of the EU average intensity. The Kymenlaakso intensity, however, is higher than the EU average even in comparison per area. The Kymenlaakso region is an export gateway leading from the resources to the market, and this is a characteristic that brings the material intensity of the region to a high level even when compared per area.

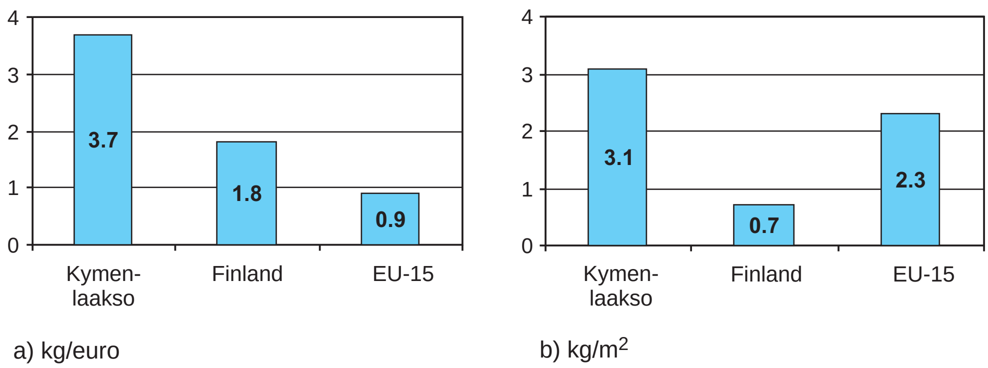


Figure 46. Direct material input (DMI) of Kymenlaakso, Finland and the European Union a) per gross domestic product and b) per area, in 2000 (Mäenpää and Mänty 2004).

Past > present > future

In light of the indicators and material used, the Kymenlaakso eco-efficiency has improved during the time period under review, which spanned from the latter half of the 1990s to the first years of the 21st century. We can also see an absolute, albeit mild, delinking between economic growth and some environmental impacts.

These conclusions, however, only apply to the region itself. Kymenlaakso is highly dependent on imports, which is why *the eco-efficiency development of imports has a great effect on the "real" eco-efficiency of the region.* The ECOREG project developed a procedure for assessing the impacts of imports, but it was not yet possible to compile time series material for a more thorough analysis. In the next environmental analysis and material flow assessment to be carried out in Kymenlaakso, this aspect should be paid particular attention to, and the economic actors of the region should take care that the eco-efficiency of the instances themselves and the entire Kymenlaakso region not be reduced by outsourcing activities.

6.4 Socio-cultural prerequisites for the development of eco-efficiency

From a social standpoint, Kymenlaakso has seen many positive changes from 1995 to 2002 (Table 13). To compensate for the decrease in the natural population, the region has attracted a potential labour force from abroad. The region's unemployment rate has dropped and the number of jobs increased. The indicators of social exclusion and health are showing a dawn of positive signals.

Table 13. Indicators describing the socio-cultural state of Kymenlaakso; development and comparison with the national average (Rosenström and Mickwitz 2004).

Indicator	Change 1995/2002*	Compared with all of Finland
Migration in the region		
Population change		
Dependency ratio per those employed		
Population growth through immigration		
Unemployment		
Job structure		
Social assistance to the less-advantaged		
People falling outside the social safety net		
Poverty		
Life expectancy		
Premature deaths		

* or the closest available years

Change in positive direction / Above or level with national average

Change in negative direction / Below national average

The indicators describing the attractiveness of the Kymenlaakso region are also giving out mostly positive signs, even though there is also room for some distress signals (Table 14). Compared to the whole of Finland, the level of education among Kymenlaakso inhabitants and the amount of research activities still remain lower. The indicators representing the cultural situation also leave Kymenlaakso second to the Finnish average. However, the region is safer than the rest of the country, and the voting rates are somewhat higher, although the rates are also low in Kymenlaakso.

Table 14. Indicators describing the socio-cultural attractiveness and potential of Kymenlaakso; development and comparison with the national average (Rosenström and Mickwitz 2004).

Indicator	**Change 1995/2002***	**Compared with all of Finland**
Traffic safety	[red]	
Violent crime	[green]	[green]
Traffic accidents	[green]	[green]
Level of education	[green]	[red]
Research and development	[green]	[red]
Resources for education and culture	[green]	[red]
Use of public libraries	[green]	[red]
Participation in decision making	[red]	[green]
Tourist visits	[green]	
Newspaper circulation	[red]	

* or the closest available years

[green] Change in positive direction / Above or level with national average
[red] Change in negative direction / Below national average

Reproducibility and transferability of the ECOREG results

7

7.1 Processes and methods

Overall working process

The Kymenlaakso region is a NUTS 3 region, as defined in the Nomenclature of Territorial Units for Statistics (NUTS; regulation [EC] No 1059/2003 of the European Parliament and of the Council), and therefore the definition of our pilot region adhered to the EU statistical territorial definitions.

One of the main objectives of the ECOREG project was to create procedures and tools that could also be used outside Kymenlaakso in other Finnish and EU regions. The eco-efficiency monitoring and evaluation mechanism of Kymenlaakso should not, however, be copied onto another region without an appropriate local process whereby it is revised into a form corresponding to regional conditions and objectives. This is where the processes and methods applied in the ECOREG project can be of use.

The first idea that can also be applied elsewhere is the ECOREG project model in which eco-efficiency experts (from outside the region) and those familiar with local conditions worked together. One of the first questions, then, which must be addressed in other applying regions is what proportion of the implementers can be selected from within the region itself and what proportion from outside the region. In the ECOREG project, both scientific expertise on, for example, material flow analyses, and experience in local affairs were represented in the project group, which guaranteed a certain kind of effectiveness in the working process.

The ECOREG steering group had several important functions. By remaining independent of the everyday project activities but still being committed to the project objectives and aware of project development, the steering group was able to see the woods for the trees even when the project group might have been blinded to it. It is crucial to select such people into the steering group who, on the one hand, are familiar with regional activities from varying points of view; and who, on the other, are well-respected in their region. We were able to find good representatives to join the ECOREG project steering group from both public government and the central businesses of the region. Expertise on both environmental and economic issues was also well represented in the steering group, whereas social expertise remained more minor. In other regions it would probably also be beneficial to get central stakeholders from various sectors to become committed to the project in the form of a steering group. Because of the industrial structure of the Kymenlaakso region, it was essential to have representatives of, for example, the forest industry and the port of Kotka involved.

The broadest and most open working forum in the ECOREG project was the series of regional workshops. Thirty to forty local actors were gathered together at the workshops to make central decisions concerning the project. It is almost impossible to over-estimate the significance of a broad and diverse exchange of information. Based on our experiences, we also consider the organising of such workshops in other applying regions to be of crucial importance. The yield of the workshops is influenced both by who participate in them and by how the participants communicate with each other during and in between the workshops.

The working methods of the workshops were individual assignments, group work and general discussions. The most important purpose of the individual and group work was to make sure that each participant can, for his or her part, further the exchange of information and ensure some input to the results of the project. The general discussions were meant for sharing information on the progress of the process, but also for creating common perceptions and interpretations.

Establishing economic and material flow indicators

The regional monetary input-output table of Kymenlaakso was compiled on the basis of regional accounting data. Its structure is in accordance with the Finnish national-level input-output tables, which in turn are produced in accordance with the European System of Accounts (ESA 1995) and which are compiled in each EU country. The monetary input-output table, then, formed the basis for the physical input-output table representing the material flows of Kymenlaakso and which adheres to the guidelines of the European Commission (European Commission 2001). The methods are outlined in Sections 4.2 and 4.3.2 and the entire process in Mäenpää and Mänty (2004). Corresponding analyses can, in principle, be carried out on any EU region using the statistical data available from national (or regional) statistics authorities. The compilation of physical input-output tables does, however, still require a separate calculation process, because all the basic data required are not yet produced for regional-level statistics.

Establishing environmental indicators

Section 4.3.1 generally outlines and the report by Koskela (2004) describes in detail the process with which the environmental indicators for annual monitoring were arrived at for Kymenlaakso, and this process is basically applicable in other Finnish and European regions. With the process and its methods, the most critical burdening and development factors for the region can be identified, which in turn will serve as the basis for establishing the most viable indicators to represent environmental pressures and changes.

The procedures which can be applied as such to other regions are the valuation of environmental problem categories and the calculation of environmental impact indicators (Chapters 4 and 5 in Tenhunen et al. 2004). What needs to be "tailored" according to the characteristics of each individual region under review are the following aspects:

- The impact categories of the environmental analysis (environmental problem categories), interventions and activity sectors (cf. Fig. 18 in Section 4.3.1) need to be decided upon for each region, following the principles of the methods described in the above.
- Impact categories, interventions and characterisation factors have to be selected according to regional data and the latest research. The characterisation coefficients for each impact category used in the Kymenlaakso application (Annex 6) are basically only applicable to Finland. In other regions, characterisation coefficients relevant to their own environment should be selected. If such region-specific coefficients are unavailable, the characterisation coefficients can be established so that they correspond to the so-called non-site-specific factors used in life cycle assessment (see, e.g., Guineé et al. 2002).

- The expert interviews or questionnaire surveys (Tables 4 and 5 in Tenhunen et al. 2004) used to form an estimate on the significance of non-measurable interventions and change factors have to be carried out for each region individually and according to the activity sectors and impact categories chosen.

In the Kymenlaakso environmental analysis, the environmental impacts of imports were also taken into account according to the principles of life cycle assessment (LCA). This method is, in principle, fully applicable to other regions. Application will, however, require further development and careful tailoring of the method according to the characteristics of each region under review, in order for the most important material flows of imports and their environmental impacts to be processed with sufficient accuracy. Particular attention should be paid to the following factors, which determine the reliability of the image portrayed of imports:

- The definition and data quality of the inventories of the region itself and its imports should be as identical and equal as possible.
- A large part of the impact categories significant to the region itself will, in practice, have to be excluded from the analysis of imports, because many of the burdening factors can only be measured qualitatively or the data required simply cannot be acquired.
- In assessing the impacts of the burdening factors of imports, the characterisation coefficients of the production site should be used (the problem is whether the production sites and their environmental conditions are known).

Establishing socio-cultural indicators

The socio-cultural indicators supporting the measurement of the eco-efficiency of Kymenlaakso were developed through an open and participatory process (Section 4.4). The process, which included workshops and document analyses, has been described in detail in the documentation report of the sub-study in question (Rosenström and Mickwitz 2004). With the help of this detailed description, indicators can also be devised through a similar process in other Finnish or European regions. The methods are cost-effective and relatively easily applied. Based on the method description, the indicators are devisable even with few resources.

7.2 Indicators

Economic and material flow indicators

Economic indicators at the regional level (value added, GDP, output) are based on the regional accounts of Statistics Finland in accordance with the European System of Accounts (ESA 1995). The compilation instructions and delivery schedule of regional accounts in compliance with ESA 1995 are uniform in all EU Member States. The material flow indicators are in accordance with the guidelines of the European Commission—as is the physical input-output table (European Commission 2001). The indicators describing the material intensity and economy of Kymenlaakso are, in principle, applicable as such in other Finnish and European regions (Tables 15 and 16). The availability of statistical material is good, except for the material flow indicators (Table 16)—in the present state of regional statistics compilation, the construction of the numerical values of material flow indicators requires separate and relatively laborious calculation.

Environmental indicators

Economic and industrial structures as well as environmental conditions in Finland and in Europe vary by region. Regardless of this, several of the environmental indicators selected for annual monitoring in Kymenlaakso can potentially be also used in other regions (Table 16). As such, they are easily applied in Finnish regions, even though there naturally is a need for other kinds of indicators within the country, as well. Activities affecting the environment common to all regions are agriculture, industry, energy production and traffic.

The protection of soil and groundwater is important everywhere, even if the quality indicators to be monitored vary. The significance of forests both to industry and to the preservation of biodiversity is emphasised in Northern Europe. In other parts of Europe, there are other themes characteristic of each region for which indicators are to be devised. The selection process presented in this report (Section 4.3.1) provides a viable tool for this purpose.

In selecting the environmental indicators of Kymenlaakso for annual monitoring, the optimally easy availability of information was emphasised. National-level data on many of the indicators selected are reported to the EU and should thus be available in the reporting systems of each country. The EU environmental support systems for agriculture and forestry are also the same in all Member States. The availability of regional-level data, however, depends greatly on the individual statistics systems of each country.

Socio-cultural indicators

The applicability and data sources of the socio-cultural indicators supporting the measurement of eco-efficiency are described in detail in the documentation report on these indicators (Rosenström and Mickwitz 2004). On all the 21 indicators chosen, corresponding statistics are also available for other Finnish regions (Table 17). The necessary data are available in the databases of either Statistics Finland or Stakes (the National Research and Development Centre for Welfare and Health), and a detailed description by indicator in the report by Rosenström and Mickwitz (2004). For EU countries, 14 of the indicators can be directly calculated from the European Regional Statistics of Eurostat (Table 17). The remaining seven can be calculated from national sources; but depending on the region in question, this may require slightly more research.

Table 15. Transferability of economic indicators – statistics in Finland and elsewhere in the EU (source: Mäenpää and Mänty 2004).

THEME	INDICATORS	AVAILABILITY OF STATISTICS (provider, statistics/database)	
		Statistics in Finland	Statistics in the EU
Background factors	Total area of the region	Statistics Finland	Eurostat, European Regional Statistics
	Average population	Statistics Finland	Eurostat, European Regional Statistics
	Population density	Statistics Finland	Eurostat, European Regional Statistics
Economic growth	Value added at constant prices	Statistics Finland, regional accounts	Eurostat, regional accounts
	Gross domestic product (GDP) at market prices	Statistics Finland, regional accounts	Eurostat, regional accounts
	Gross domestic product (GDP) per resident	Statistics Finland, regional accounts	Eurostat, regional accounts
	Gross domestic product (GDP) per area	Statistics Finland, regional accounts	Eurostat, regional accounts
	Output	Statistics Finland, regional accounts	Eurostat, regional accounts
Economic welfare of the population	Real disposable household income per person	Statistics Finland, regional accounts	The sources vary by EU member state and region

Table 16. Transferability of the environmental indicators – statistics in Finland and elsewhere in the EU (modified from Koskela 2004 and Mäenpää and Mänty 2004).

THEME	INDICATORS	AVAILABILITY OF STATISTICS (provider, statistics/database)	
		Statistics in Finland	Statistics in the EU [a]
Air	Carbon dioxide emissions from industry, energy production and road traffic	Environmental Administration, Vahti; VTT Technical Research Centre of Finland, Lipasto	Regional/local/national environmental authorities/institutes
	Nitrogen oxide emissions from industry, energy production and road traffic	Environmental Administration, Vahti; VTT, Lipasto	
	Sulphur dioxide emissions from industry and energy production	Environmental Administration, Vahti	
	Emissions of dioxins and furans	Finnish Environment Institute	
	Emissions of polyaromatic hydrocarbons (PAH emissions)	Finnish Environment Institute	
	Emissions of metals (Cd, Pb, Hg)	Environmental Administration, Vahti	
Local air quality	Average number of days when the limit value for the average daily concentration (50 $\mu g/m^3$) of fine particulates (PM_{10}) is exceeded	Finnish Meteorological Institute	Regional/local/national environmental authorities/institutes
	Average number of days when the average concentration of odorous sulphur compounds (TRS) exceeds 4 $\mu g/m^3$	Finnish Meteorological Institute	
Water	Groundwater chloride concentrations	Finnish Environment Institute	Regional/local/national environmental authorities/institutes
	Groundwater nitrate-nitrogen concentrations	Finnish Environment Institute	
	Nitrogen loads to waters from communities, rural settlements and industry	Finnish Environment Institute; Regional Environment Centre	Authorities in charge of agri-environmental support schemes
	Riparian zone contracts concerning special measures of agri-environmental support	Employment and Economic Development Centre	
Traffic	Passenger traffic mileages by car and by bus	VTT, Lipasto	Regional/national traffic/communications authorities/institutes
	Goods traffic mileages by road and by rail	VTT, Lipasto	
Environmental accidents	Number of oil and chemical accidents	Regional Environment Centre	Regional/local/national environmental authorities/institutes
	Amount of oil and chemicals released into the environment in accidents	Regional Environment Centre	
Biodiversity, landscape, cultural environment, recreation	Traditional biotope, landscape management and biodiversity enhancement contracts concerning special measures of agri-environmental support	Employment and Economic Development Centre	Authorities in charge of agri-environmental support schemes
	Contracts concerning environmental support for forestry	Forestry Centre	Forestry authorities/institutes
	Total area of conservation areas	Finnish Forest and Park Service; Regional Environment Centre	Nature conservation authorities/institutes
	Area of regeneration fellings	Forestry Centre	
	Development of the growing stock of forests	Forest Research Institute	
Consumption of natural resources	Quantity of gravel and rock extracted	Finnish Environment Institute	Regional/local/national environmental authorities/ institutes
	Landfilling of municipal waste from households	Environmental Administration, Vahti	
	Recovery rate of municipal waste from households	Waste management companies in the area	
	Total material requirement (TMR)	Must be investigated separately	Must be investigated separately
	Direct material inputs (DMI)	Must be investigated separately	Must be investigated separately
	Total material consumption (TMC)	Must be investigated separately	Must be investigated separately
Energy consumption	Consumption of electricity and district heat	Adato Oy; Finnish District Heating Association	Energy authorities/institutions
	Self-sufficiency in energy production	Environmental Administration, Vahti	Regional/national environmental authorities/institutes

a Due to the diverse ways in which the environmental statistics and databases are organised in the different EU member states and regions, it is possible to identify their accessibility just on a general level.

Table 17. Transferability of the socio-cultural indicators – statistics in Finland and elsewhere in the EU (source: Rosenström and Mickwitz 2004).

THEME	INDICATORS	AVAILABILITY OF STATISTICS (provider, statistics/database)	
		Statistics in Finland	Statistics in the EU
Population change	Net migration	Statistics Finland, STATFIN	Eurostat, European Regional Statistics
	Excess of births	Statistics Finland, STATFIN	Eurostat, European Regional Statistics
	Dependency ratio	Statistics Finland, demographics and employment	Eurostat, European Regional Statistics
	Number of foreigners	Statistics Finland, STATFIN	Eurostat, European Regional Statistics
Employment	Unemployment rate	Statistics Finland, STATFIN	Eurostat, European Regional Statistics:
	Job structure by sector	Statistics Finland, STATFIN	• Standardized unemployment figures for NUTS 3 regions • Industrial structure
Social exclusion	Households receiving social assistance	Stakes, SOTKA database [a]	Eurostat, European Regional Statistics:
	Number of suicides	Statistics Finland, STATFIN	• Cause of death statistics
	Poverty rate	Statistics Finland, poverty statistics	• Social security, endorsements
Health	Life expectancy of newborns	Statistics Finland, demographics	Eurostat, European Regional Statistics:
	Deaths before age 65	Statistics Finland, STATFIN	• Causes of death by age and sex National data sources: • Life expectancy
Safety	Development of traffic safety	Statistics Finland, STATFIN	Eurostat, European Regional Statistics:
	Offences against life and health	Statistics Finland, STATFIN	• Cause of death statistics
	Number of traffic accidents	The Finnish Motor Insurers´ Centre	National data sources: • Justice system statistics
Education	Number of those completing secondary and higher education	Statistics Finland, STATFIN; Stakes, SOTKA database	Eurostat, European Regional Statistics: • Labour Force Survey: highest degree completed
	Research and development expenditures	Statistics Finland, STATFIN	• Research and development expenditures by sector, NUTS 1 and 2
Culture	Net public expenditures on education and culture	Stakes, SOTKA database	National data sources: • Education and culture expenditures
	Number of loans from public libraries	http://tilastot.kirjastot.fi (Library statistics Internet site)	• Loans from public libraries
Local identity	Voting rate in municipal elections	Statistics Finland, STATFIN	Eurostat, European Regional Statistics:
	Nights spent in hotels	Finnish Tourist Board MEK	• Nights spent in hotels, the region's own and outside inhabitants
	Circulation of newspapers	www.levikintarkastus.fi (Newspaper Association Internet site)	National data sources: • Voting rates • Newspaper circulation

[a] Stakes = the National Research and Development Centre for Welfare and Health

7.3 *Monitoring and evaluation mechanism*

Uses for eco-efficiency data

In the ECOREG workshop arranged in Kouvola in May 2003, one of the group work assignments was to identify decision-making situations in which the various actors of Kymenlaakso can use information on eco-efficiency. The participants also outlined the kinds of data that would be especially required.

The 30 participants in the groups defined more than 130 different decision-making situations in which eco-efficiency data would be useful. The situations can be divided into three main groups (examples in Table 18):

- decisions with direct impact on the eco-efficiency of the entire Kymenlaakso region
- decisions in which eco-efficiency indicators may provide useful background information but in which other information required by the situation is more central
- decisions in which eco-efficiency indicators can chiefly act as demonstrators of eco-efficiency.

Table 18. Three different-level decision-making situations in which the Kouvola workshop participants thought eco-efficiency information would be useful.

Decision-making situations	Examples
Decisions with direct impact on the eco-efficiency of the entire Kymenlaakso region	Regional-level planning—e.g., regional strategies and plans, land-use plans, environmental programmes Decisions concerning energy systems Decisions concerning traffic systems Extensive (large) investments (and the permit decisions involved)
Decisions in which eco-efficiency indicators may provide useful background information but in which other information required by the situation is more central	Large acquisitions (private and public) Investments (and the permit decisions involved) Financing decisions Municipal planning
Decisions in which eco-efficiency indicators can chiefly act as demonstrators of eco-efficiency	Consumer acquisitions Designing single-family homes

This picture was completed with a group assignment at the Kuusankoski workshop in October 2004, the purpose of which was to provide a practical idea of the kinds of uses the method developed was considered applicable for. The questions presented were as follows:

Group assignment 2: What are the application possibilities of the eco-efficiency monitoring and evaluation mechanism?

1. In regional-level planning
   a) In which existing plans and programmes could the ECOREG mechanism be utilised?
   b) How can these plans and programmes benefit from the ECOREG mechanism?
2. In corporate activities and the activities of other actors in the region
   a) How can the ECOREG mechanism benefit corporate business?
   b) Who are the other actors who could benefit from the ECOREG mechanism, and how could they benefit from it?

In the workshop participants' view, the ECOREG monitoring and evaluation mechanism can create an overall picture—a kind of "official benchmark"—from the various points of view of regional development, and the participants found several immediate utilisation possibilities in regional-level planning (Table 19).

Table 19. Utilisation possibilities for the eco-efficiency monitoring and evaluation mechanism of Kymenlaakso in regional-level planning—results from the Kuusankoski workshop.

Plan/Programme	Utilisation possibility
Regional land use:	Setting emphases
• Regional land use plan	Allocating measures
• Land use master plan	Allocating resources
Action planning:	Setting emphases
• Regional plan	Allocating measures
• Regional programme	Allocating resources
• Regional and municipal strategies	
• Welfare strategy	
Sector plans:	Setting emphases
• Environmental health programme	Allocating measures
• Planning traffic systems	Allocating resources
• Waste management, water supply and water protection plans	
• Fire safety and rescue plans	

Because the use of the ECOREG mechanism is public and based on public statistics and other data, the workshop participants found that it also evokes the trust of the corporate world. The mechanism was also thought to produce information that would benefit companies, interest groups and educational activities. The uses and benefits that came up included:

- increased competitive strength and image benefits
- the clarifying of old business ideas and the formation of new ones
- anticipation of the future
- environmental reporting by large corporations
- training of new entrepreneurs
- teaching and teaching material compilation
- dialogue between various instances.

Transferability of the calculation mechanism

The functional item of the monitoring and evaluation mechanism, the calculation mechanism, has many strengths which enable its transferability to other regions:

- The calculation mechanism has been implemented using generally used spreadsheet software (Microsoft Excel) and thus does not require training in a new programme and operating environment.
- Region-specific indicators can be entered into the system.
- The characterisation coefficients used in the assessment of environmental impacts can be updated so that they correspond to the region under review.
- Region-specific weighting coefficients of the environmental impact categories can be updated into the mechanism.
- The spreadsheets include phase-by-phase instructions.

- The lockup function of the spreadsheets prevents accidental changes in the wrong items.
- The calculations and references are visible in the cells of the spreadsheets.
- The example fill-out with the Kymenlaakso values makes the analysis of the calculations and results easier.

7.4 Broader environmental benefits of the results and their significance for EU environmental policy

7.4.1 Environmental benefits

Overall picture – critical points – measures

The approach of the ECOREG methods is integrated. They combine environmental data with the information provided by economic and social indicators. The eco-efficiency indicators create an overall picture of the state and development of the environment and socio-economic structures of the region. At the same time, they help us to recognize the targets in which the improvements implemented reach the highest possible environmental benefits. If, in addition, the important actors and leaders in the region are included in assessing the picture of eco-efficiency portrayed by the mechanism, it may encourage the parties to make favourable emphases and decisions in their own actions.

Applications for different-size areas

The ECOREG model has been devised for the regional level, but many of its features can also be applied to larger or smaller areas. For example, if an administrative region entails areas with very different industrial structures or environmental characteristics, a local eco-efficiency assessment can be carried out for each area separately. The next potential level of application is the municipality. The reporting system of the ECOREG project may also offer a tool for municipal Agenda 21 work (sustainable development action programmes).

With the ECOREG approach, the national-level eco-efficiency assessment can also be diversified. Here the economic, environmental and social indicators naturally have to be selected from a national viewpoint. The measurement of eco-efficiency also helps with the monitoring of sustainable development.

Corporate-level applications

The methods developed in the ECOREG project also have potential applications for the corporate level—for example, for industrial facilities or logistics, such as ports or transportation companies. Data compilation and analysis must then concentrate on the factors central to each company in question. Economic and social information along with environmental information also serve the purposes of social responsibility reporting, in which many companies are currently active.

7.4.2 Relevance to the EU legislative framework

On the level of environmental policy, the results of the ECOREG project serve the objectives of the Sixth Community Environment Action Programme (Decision No 1600/2002/EC), the Green Paper and Communication on Integrated Product Policy (Commission of the European Communities 2001, 2003) and the IPPC directive (Council directive 96/61/EC). The results are also significant from the point of view of the Community Eco-management and Audit Scheme, EMAS (voluntary participation by organisations in the management and audit system of environmental issues; Regulation (EC) No 761/2001 of the European Parliament and of the Council).

The Sixth Community Environment Action Programme

The Sixth Community Environment Action Programme, "Environment 2010: Our Future, Our Choice", represents the environmental dimension in the sustainable development strategy of the European Community and places environmental issues into a context which also takes into account economic and social conditions and objectives. The purpose of the programme is to act as a link between the objectives concerning the environment and those of economic growth and competitive status of the Community.

The Sixth Environment Action Programme strongly emphasises environmental policy that is based on participation by various stakeholders, the use of the best available scientific research as well as the existence of better and more available information (Articles 2 and 10 of the programme). The programme defines four priority areas on which prompt measures are called for:

- climate change
- nature and biodiversity (preservation of unique natural resources)
- the environment and health
- sustainable use of natural resources and prevention of waste generation.

The ECOREG approach and methods provide tools for reaching the objectives of the Environment Action Programme on a regional level—but also on the industry and corporate level as well as the national level—particularly in the following ways:

- they provide information on the development of the relationship between economic growth and environmental impacts (the objective is the decoupling of this connection)
- they promote improved consideration for environmental issues in functions whose objectives are primarily of an economic or social nature (integration of environmental points of view into other fields of policy)
- they provide yardsticks (indicators) and benchmarks for monitoring progress
- they produce information that can promote a transition to more sustainable production and consumption patterns, as companies and citizens gain reliable information on their immediate environment
- they promote the participation of various stakeholders in the establishment and realisation of environmental objectives, starting from agreeing upon objectives and resulting in the implementation of measures
- they produce information which serves the priorities of the Environment Action Programme.

Green Paper and Communication on Integrated Product Policy

The ECOREG project and the approach applied in the project have several connections to the ideas presented in the Green Paper and Communication on Integrated Product Policy by the Commission of the European Communities (2001, 2003). What the ECOREG project and the integrated product policy have particularly in common are the following points concerning the approach adopted (see the Commission Communication, pp. 4–5):

- <u>Life-cycle thinking.</u> Life-cycle thinking, which serves as the point of departure in the integrated product policy, is also central in the ECOREG project. This is seen in, among other aspects, the material flow analysis, in which the regional perspective is brought to a broader, global context.

- Stakeholder involvement. The objective of integrated product policy is to encourage all parties (companies, consumers, authorities) who come across a specific product to act within their own sphere of influence and promote cooperation between the parties. In the ECOREG project, the stakeholders were included as early as at the phase of devising the indicators for regional eco-efficiency development and planning the monitoring and evaluation mechanism.
- Working with the market. Like the integrated product policy, the ECOREG procedures help to create a foundation for such courses of action that favour innovative, long-sighted companies committed to sustainable development.
- Continuous improvement. The eco-efficiency monitoring and evaluation mechanism with its indicators supports, for its part, continuous improvement in line with the objectives of the integrated product policy.

Because the integrated product policy is still a work in progress, the experiences in applying its central principles are still quite few. For its part, the ECOREG project supports the development of the integrated product policy and offers an example of the potential uses of its principles, especially on the regional level.

The IPPC directive and the EMAS system

The Directive on Integrated Pollution Prevention and Control (IPPC) approved by the European Communities on 26 September 1996 requires EU Member States to use the national legislature to create a regulatory system, based on a comprehensive environmental analysis, for the environmental pressures caused by industrial and energy production installations, reprocessing units and large livestock or poultry production facilities. The central principles of the Directive are the application of best available techniques (BAT) and the achievement of a high level of environmental protection, taking into account all aspects of the environment.

This so-called integrated emission management requires that the emissions into waters and air, waste generation, and energy consumption of the industrial installations to which the IPPC directive applies are analysed simultaneously in the environmental permit process, taking into account the interdependencies of these aspects.[8] The rational use of raw materials and the prevention and management of the risks of accident also fall within the permit process.

An emissions and environmental impacts assessment in accordance with the IPPC directive is always carried out for each facility individually. The regional eco-efficiency monitoring and evaluation mechanism developed in the ECOREG project may, however, offer useful background information for both the environmental permit applicant and the granting authorities by providing them with

- a kind of regional-level "official benchmark".

The EMAS system (the EU Eco-management and Audit Scheme) is a voluntary management and audit system for companies in the EU countries and the European Economic Area (EEA); the companies can use the system to evaluate, report and improve their performance in environmental issues. The EMAS companies can benefit from the eco-efficiency monitoring and evaluation mechanism created by the ECOREG project primarily in two ways:

- the ECOREG materials can also in this context provide a regional-level "official benchmark"
- the EMAS companies can apply the methods and procedures developed in the ECOREG project in their own reporting procedures.

[8] *Life cycle analyses do not, however, fall within the application field of the IPPC Directive.*

8 Summary

Eco-efficiency is one of the means for attaining sustainable development. The prefix "eco'" refers to both economic and ecological/environmental performance. In other words, eco-efficiency conjoins economic well-being and the quality of the environment. As the European "regions" have during the last few years become the centre of focus in many ways, enhancing their competitiveness – and thereby also their eco-efficiency – has become a serious issue in the regions.

The Finnish Environment Institute (SYKE), the Southeast Finland Regional Environment Centre, the Regional Council of Kymenlaakso and the Thule Institute at the University of Oulu carried out a LIFE project named "The Eco-efficiency of Regions – Case Kymenlaakso (ECOREG)" 1 September 2002 - 31 December 2004. The work was funded by the European Community's LIFE programme (support obtained from LIFE-Environment) and the Finnish Ministry of the Environment. The purpose of the project was to demonstrate the concept of eco-efficiency and the evaluation of eco-efficiency on a regional scale, using the region of Kymenlaakso in Southeast Finland as an example.

In the ECOREG project, indicators of eco-efficiency and an eco-efficiency monitoring and evaluation mechanism based on the use of these indicators were designed for Kymenlaakso. The project incorporated four specific innovative characteristics:

- It combined the use of the latest methods (especially life cycle assessment and material flow analysis), statistical data freely available in the EU countries and various indicators in order to create indicators for regional eco-efficiency development.
- The third dimension of sustainable development, social development, was included in the analyses by designing socio-cultural indicators that support the measurement of eco-efficiency in Kymenlaakso.
- The newly-developed methods enabled us to include the effects of imports on the development of regional eco-efficiency in the analyses.
- Eco-efficiency indicators, the results they had given and the measures needed to increase eco-efficiency were already assessed in cooperation with local actors of Kymenlaakso during the project. A central instrument in achieving this were the three regional workshops organised as the project advanced.

Constructing the indicators used for measuring eco-efficiency was based on a set of principles which defined how the value of products – goods and services – produced in Kymenlaakso and the environmental impacts caused by their production were to be measured. Production and other activities, including consumption, in Kymenlaakso have environmental impacts on both the region and on areas outside the region. The "product system" studied in this work included the region of Kymenlaakso and its imports from elsewhere in Finland and abroad. The impacts of Kymenlaakso's exports on areas outside the region have not been included in the analysis, because it is even more difficult to estimate the environmental burden of exports than that of imports. The normal boundaries used in life cycle assessments, based on the "from cradle to gate" principle, were also used in the present study.

When studying regional eco-efficiency, both the activities of the region itself and the impacts of its imports should be considered. Therefore, the case of Kymenlaakso was studied in two respects:

In the basic approach, the eco-efficiency ratio EE1 for a region can be described by:

(1) $EE1 = VI / EI$

where VI = added economic value of goods and services produced in the region
EI = environmental influence caused by the production of these goods and services

Furthermore, sector-specific eco-efficiency ratios can be calculated by:

(2) $EE1_s = VI_s / EI_s$

where s stands for economic sector (e.g. agriculture, forestry, forest industry, transportations)

In the broader approach, the eco-efficiency ratio EE2 can be described by:

(3) $EE2 = UVI / UEI$

where $UVI = VI + VI^U$
VI^U = value of products produced by the upstream processes (intermediate and end consumption)

$UEI = EI + EI^U$

EI^U = environmental influence of upstream processes (imported products)

In sector-specific cases, Equation 3 can be transformed into:

(4) $EE2_s = UVI_s / UEI_s$

where s stands for economic sector (e.g. agriculture, forestry, forest industry, transportations)

The value of the goods and services produced in the region can be measured using three variables: value added, gross domestic product (GDP) and output. The measure of added economic value used in Equations 1 and 2 is value added or GDP, and in Equations 3 and 4 the output.

In the ECOREG project, annually monitored economic indicators were designed for Kymenlaakso. These indicators can be used for eco-efficiency analyses and other studies concerning the entire region. The selected economic indicators were based on the time-series of Statistics Finland's Regional Accounts, regional domestic product calculations of the Statistical Office of the European Communities and Kymenlaakso's monetary input-output tables compiled in the ECOREG project. The industry classification used in the study was based on categories of the European industry classification SIC 1995 (NACE, confirmed by an EU regulation).

There were two main types of environmental impact indicators used in the Kymenlaakso application: indicators describing environmental change and interventions, and indicators delineating the use of natural resources.

The indicators describing environmental change and interventions were based on a regional environmental analysis made for Kymenlaakso on the data for year 2000. The environmental analysis made use of techniques of life cycle assessment and decision analysis. The goal of this analysis was to identify the most significant change and intervention factors in the region. It is appropriate to repeat the entire analysis every 3 to 5 years in the future, due to the large amount of work it requires, and meanwhile use the annually monitored indicators selected on the basis of the analysis.

Life-cycle thinking is needed to gain a truthful picture of the eco-efficiency of a product or activity. Therefore, the principles and techniques of life cycle assessment were applied to Kymenlaakso environmental analysis to include inventory analysis, impact assessment and interpretation of the results. Inventory results were calculated per annual production of the various industrial sectors in Kymenlaakso. The environmental analysis was also based on the European industry classification (SIC 1995) as far as possible. The study was extended to cover the environmental impact of imports, in addition to the local environmental change factors and interventions.

The consumption of natural resources was indicated by material flows, which can be used in eco-efficiency analyses to describe environmental impacts on an approximate level. There were two main indicators: direct material inputs (DMI) and total material requirements (TMR). DMI combined with the region's hidden flows, is commensurable with GDP and value added, so it can be used to express environmental impacts in the eco-efficiency Equation 1 above. On the other hand, TMR is suitable as a denominator in Equation 3, where import products are included as well. The material flow indicators for Kymenlaakso were based on physical input-output tables calculated in the ECOREG project using input data from the year 2000. Monetary input-output tables described above were utilised when creating these physical input-output tables.

Indicators for socio-cultural development, which support eco-efficiency measurement, were designed for Kymenlaakso to enable monitoring socio-cultural changes simultaneously. They embody eight themes – population change, employment, social exclusion, health, safety, education, culture and local identity – that reflect the local views that arose during the ECOREG project.

According to the indicators and the data analysed, an increase in eco-efficiency has taken place in Kymenlaakso within the time period studied – from the late 1990s to the early 2000s. We have also noted an absolute, even if moderate, "decoupling" of economic growth and certain environmental impacts. However, these conclusions only apply to the area of the region. Kymenlaakso is highly dependent on imports, so the eco-efficiency development of imported products has a great impact on the actual eco-efficiency of the region. The next environmental analysis and material input assessment to be carried out in Kymenlaakso must pay special attention to this. Local economic actors should also ensure that the actual eco-efficiency of their business or that of the entire region will not be weakened while outsourcing activities.

At the final stage of the ECOREG project, a mechanism was created, based on the utilisation of the methods and indicators discussed above, for monitoring and evaluating eco-efficiency in the region. As a result of its introduction, the region of Kymenlaakso now has acquired a tool which they can use for monitoring the eco-efficiency of the region. The tool was implemented for the MS Excel software.

The ECOREG project was already during its planning stage aimed at producing a system whose methods, indicators and monitoring and evaluation mechanism would be applicable for other regions in Finland and Europe as well. The project's overall working process, main principles of the monitoring and evaluation mechanism, processes and methods used for constructing indicators and a significant percentage of the indicators (especially the economic indicators) are transferable as such. It is clear, however, that it is not reasonable to copy the monitoring and evaluation mechanism for Kymenlaakso's eco-efficiency without running a suitable local process, whereby the mechanism is adapted to fit the specific local circumstances and objectives. The processes and methods applied in the ECOREG project can be useful when doing the adaptation.

The approach of the ECOREG methods is integrated. They combine environmental data with the information provided by economic and social indicators. The eco-efficiency indicators create an overall picture of the state and development of the environment and socio-economic structures of the region. At the same time, they help us identify the targets in which the improvements implemented can result in the highest possible environmental benefits. If, in addition, the region's influential actors are included in assessing the image of eco-efficiency the mechanism gives, it may encourage them to make favourable emphases and decisions in their own activities as well.

The ECOREG model has been created for regional level, but many of the features of the analysis and its reporting mechanism can be adapted to larger or smaller areas, for example municipalities, where it can offer a tool for Agenda 21 work (sustainable development action programmes). The methodology developed in the ECOREG project also has potential applications on the corporate level, for example industrial facilities or logistics, such as ports or transportation companies. Data compilation and analysis must in that case concentrate on the factors that are central to each individual company. Economic and social information along with environmental information also serve the purposes of social responsibility reporting, in which many companies are currently active.

On the level of environmental policy, the results of the ECOREG project serve the objectives of the Sixth Community Environment Action Programme (Decision No 1600/2002/EC), the Green Paper and Communication on Integrated Product Policy (Commission of the European Communities 2001, 2003) and the IPPC directive (Council directive 96/61/EC). The results are also significant from the point of view of the Community Eco-management and Audit Scheme, EMAS (voluntary participation by organisations in the management and audit system of environmental issues; Regulation (EC) No 761/2001 of the European Parliament and of the Council).

Acknowledgements

The ECOREG project was financed by the European Community's LIFE programme (support obtained from LIFE-Environment) and the Finnish Ministry of the Environment. We would like to express our sincere gratitude to both these bodies.

The project steering group and the guidelines created in its discussions had a vital role in the success of the project. We would also like to express our thanks to all the other actors in Kymenlaakso who gave us valuable feedback on the project's interim results at the three workshops. Their ideas substantially influenced the project outcome.

We would like to thank Director General Lea Kauppi and Executive Director Tapio Välinoro for reviewing the manuscript and providing constructive comments. Managing Director Vesa Junttila gave us comments which significantly improved some sections of the manuscript. We would also like to express our acknowledgement to Petrus Kautto, Lic. Sc. (Admin.) for the discussions on Integrated Product Policy.

References

Adriaanse, A., Bringezu, S., Hammond, A., Moriguchi, Y., Rodenburg, E., Rogich, D. & Schütz, H. 1997. Resource flows: the material basis of industrial economies. Washington DC., World Resources Institute.

Bell, S. & Morse, S. 2003. Measuring Sustainability. Learning from doing. London, Earthscan.

Commission of the European Communities. 2001. Green Paper on Integrated Product Policy. COM (2001) 68 final. Brussels, 07.02.2001.

Commission of the European Communities. 2003. Communication from the Commission to the Council and the European Parliament. Integrated Product Policy. Building on Environmental Life-Cycle Thinking. COM (2003) 302 final. Brussels, 18.6.2003.

Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control [Official Journal L 257, 10/10/1996].

Decision No 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme [Official Journal L 242, 10.9.2002].

Die Effizienz-Agentur NRW & Wuppertal Institute. 2001. 4 elements, 10 factors, 1 goal: eco-efficiency. Duisburg, Die Effizienz-Agentur NRW and Wuppertal Institute.

Dyllick, T. & Hockerts, K. 2002. Beyond the business case for corporate sustainability. Business Strategy and the Environment 11(2):130–141.

EEA. 2002. Environmental signals 2002 - Benchmarking the millennium. Copenhagen, European Environment Agency. Environmental assessment report No. 9. http://reports.eea.eu.int/environmental_assessment_report_2002_9/en. (26 March 2003)

ESA 1995, European System of Accounts, as defined by the Council Regulation (EC) No 2223/96 of 25 June 1996 on the European system of national and regional accounts in the Community [Official Journal L 310, 30/11/1996].

European Commission. 2001. Economy-wide material flow accounts and derived indicators. A methodological guide. Eurostat Theme 2, Economy and finance. Luxembourg, Office for Official Publications of the European Communities.

Eurostat. 2001. Material use indicators for European Union, 1980–1997. Eurostat working paper No 2/2001/B2.

Eurostat. 2002. Material use in the European Union 1980–2000: Indicators and analysis. Eurostat working papers and studies.

Eurostat. 2004. Regional GDP per capita in the EU and the Acceding Countries in 2001. Eurostat News Release 21/2004, 18th February 2004.

Guineé, J.B. (ed.), Gorrée, M., Heeijungs, R., Huppes, G., Kleijn, R., de Koning, A., van Oers, L., Sleeswijk, A.W., Suh, S., Udo de Haes, H.A., de Bruijn, H., van Duin, R., Huijbregts, M., Lindeijer, E., Roorda, A.A.H., van der Ven, B.L. & Weidema, B.P. 2002. Handbook on life cycle assessment – Operational guide to the ISO standards. Dordrecht, Kluwer Academic Publishers.

Helsingin kaupungin tietokeskus. 2000. Helsingin kestävän kehityksen A-indikaattorit (A-indicators for sustainable development in Helsinki). Keskustelualoitteita 2000:1. In Finnish.

Hinterberger, Fr., Bamberger, K., Manstein, Ch., Schepelmann, P., Scneider, Fr. & Spanberger, J. 2000. Eco-efficiency of regions: How to improve competitiveness and create jobs by reducing environmental pressure. Vienna, Sustainable Europe Research Institute (SERI).

Hinterberger, Fr. & Schneider, Fr. 2001. Eco-efficiency of regions: Toward reducing total material input. Vienna, Sustainable Europe Research Institute (SERI). A paper presented at the 7th European Roundtable on Cleaner Production, Lund, 2–4 May 2001.

Hirst, P. 2000. Democracy and Governance. In: Pierre, J. (ed.). Debating governance – Authority, steering and democracy. Oxford, Oxford University Press. Pp. 13–35.

Hoffrén, J. 2001. Measuring the eco-efficiency of welfare generation in a national economy. The case of Finland. Helsinki, Statistics Finland. Research Reports 233.

IHOBE. 2003. The Environment in the Basque Country. Ecoefficiency 2003. http://www.ingurumena.net/Descarga/Doc/Ecoefficiency_2003.pdf. (4 August 2004)
Keffer, C. & Shimp, D. 1999. Eco-efficiency indicators and reporting. London, World Business Council for Sustainable Development (WBCSD).
Koskela, S. (ed.) 2004. Environmental analysis and indicators for the Kymenlaakso region. Documentation report 1 of the ECOREG project. The Finnish Environment 697en. Helsinki, Finnish Environment Institute. http://www.environment.fi/default.asp?contentid=88865&lan=en.
Koskela, S., Hiltunen, M.-R., Myllymaa, T., Melanen, M. & Toikka, M. 2004a. Environmental burdens in 2000. In: Koskela, S. (ed.). Environmental analysis and indicators for the Kymenlaakso region. Documentation report 1 of the ECOREG project. The Finnish Environment 697en. Helsinki, Finnish Environment Institute. Part 1, pp. 11–86.
Koskela, S., Hiltunen, M.-R., Tenhunen, J., Seppälä, J., Myllymaa, T. & Melanen, M. 2004b. Environmental indicators for the Kymenlaakso region. In: Koskela, S. (ed.). Environmental analysis and indicators for the Kymenlaakso region. Documentation report 1 of the ECOREG project. The Finnish Environment 697en. Helsinki, Finnish Environment Institute. Part 3, pp. 113–143.
Kymenlaakson väestön hyvinvoinnin tila (State of well-being in Kymenlaakso). Selvitys Kymenlaakson väestön hyvinvointiin liittyvistä tekijöistä. 2001. Kymenlaakson ammattikorkeakoulu. http://www.kyamk.fi/hyvinvointiklusteri/HyvinvointiklusteriRap1.html#etukansijatekij%E4t. (20 August 2004). In Finnish, abstract in English.
Lafferty, W. & Narodoslawsky, M. (eds.). 2003. Regional Sustainable Development in Europe. The Challenge of Multi-Level Co-operative Governance. Oslo, Prosus.
Lehni, M. 1998. State-of-play report. WBCSD project on eco-efficiency metrics & reporting. Geneva, World Business Council for Sustainable Development. www.nachhaltigkeit.at/bibliothek/pdf/WBCSDecoefficiency.pdf. (12 March 2004)
Metso Oy. 2003. Kestävän kehityksen raportti (Report on sustainable development). Helsinki, Libris Oy. In Finnish.
M-real. 2001. Environmental report 2001. http://www.m-real.com/v2/environment/download/M-real_er01_eng.pdf. (27 March 2003)
Müller, K. & Sturm, A. 2001. Standardized eco-efficiency indicators – Report 1: Concept paper. Revision 1.05 / January 2001. Basel, Ellipson AG. www.ellipson.com/download/studies/studies/EcoEfficiency_Indicators_e.pdf. (20 February 2004)
Mäenpää, I. & Juutinen, A. 2002. Resource use in a small open economy: the case of Finland. Journal of Industrial Ecology 5(3):33–48.
Mäenpää, I. & Mänty, E. 2004. Economic and material flow indicators for the Kymenlaakso region. Documentation report 2 of the ECOREG project. The Finnish Environment 698en. Helsinki, Finnish Environment Institute. http://www.environment.fi/default.asp?contentid=88498&lan=en.
Niemi-Iilahti, A. 2001. In search of new implementation pattern. In: Lafferty, W. (ed.). Sustainable communities in Europe. London, Earthscan Publications. Pp. 40-57.
Nordic Council. 2003. A Nordic Set of Indicators: Achieving the Objectives 2003. Copenhagen, Nordic Council.
OECD. 1998. Eco-efficiency. Paris, Organisation for Economic Co-operation and Development.
OECD. 2001. Environmental Indicators: Towards Sustainable Development 2001. Paris, OECD.
Regulation (EC) No 761/2001 of the European Parliament and of the Council of 19 March 2001 allowing voluntary participation by organisations in a Community Eco-management and Audit Scheme (EMAS) [Official Journal L 114, 24/04/2001].
Regulation (EC) No 1059/2003 of the European Parliament and of the Council of 26 May 2003 on the establishment of a common classification of territorial units for statistics (NUTS) [Official Journal L 154 , 21/06/2003].

Rosenström, U. & Mickwitz, P. 2004. Social and cultural indicators supporting the measurement of eco-efficiency in the Kymenlaakso region. Documentation report 3 of the ECOREG project. The Finnish Environment 699en. Helsinki, Finnish Environment Institute. http://www.environment.fi/default.asp?contentid=88583&lan=en.

Rosenström, U. & Palosaari, M. (eds.) 2000. Signs of Sustainability. Sustainable development indicators for Finland 2000. Finnish Environment 404e. Helsinki, Ministry of the Environment.

Sauli, H. & Simpura, J. 2004. Auttaako indikaattoriaalto tietotulvassa? (Does the wave of indicators help to handle information overflow?). Hyvinvointikatsaus 1:2–5. In Finnish.

Seppälä, J. 2003. Life cycle impact assessment based on decision analysis. Systems Analysis Laboratory Research Reports A86. Helsinki, Helsinki University of Technology.

Statistics Finland 2003. Regional Accounts, Production and employment – Household regional consumption. SVT National Accounts 2003:12.

Sturm, A., Müller, K. & Upasena, S. 2002. Accounting framework and guidelines for eco-efficiency indicators: A manual for preparers and users. Release 1.1 / November 2002. Prepared for the United Nations Conference on Trade and Development (UNCTAD) / Intergovernmental Working Group of Experts on International Standards of Accounting and Reporting (ISAR). Basel, Ellipson / UNCTAD-ISAR.

System of National Accounts, 1993 - Glossary. Paris: United Nations Statistical Division, International Monetary Fund, World Bank, Eurostat and OECD. http://www.oecd.org/document/56/0,2340,en_2649_34245_2727800_1_1_1_1,00.html. (12 March 2004)

Tenhunen, J., Seppälä, J., Koskela, S., Hiltunen, M.-R. & Melanen, M. 2004. Regional environmental impact assessment. In: Koskela, S. (ed.). Environmental analysis and indicators for the Kymenlaakso region. Documentation report 1 of the ECOREG project. The Finnish Environment 697en. Helsinki, Finnish Environment Institute. Part 2, pp. 87–112.

WBCSD. 2000a. Eco-efficiency. Creating more value with less impact. Geneva, World Business Council for Sustainable Development.

WBCSD. 2000b. Measuring eco-efficiency. A guide to reporting company performance. Geneva, World Business Council for Sustainable Development.

Welford, R. 1996. Hijacking environmentalism? – Corporate responses to sustainable development. In: Ulhøi, J.P. & Madsen, H. (eds.). Industry and the environment: Practical applications of environmental management approaches in business. Aarhus: The Aarhus School of Business, 1996:367–380.

List of concepts

Characterisation	The processing of emissions data and other environmental burdens into impact categories—the values of environmental burdens are converted into commensurable figures in each impact category.
Characterisation coefficient	A coefficient within the impact assessment model by which the values of environmental burdens are converted into a unit of an environmental impact category.
Decision analysis	A set of methods from systems and operations research applied in supporting extensive decisions. The objective of decision analysis is to support decision making by applying models and mathematical or formal analyses.
Direct material inputs (DMI)	The amount (mass) of the material inputs directly used by an economic unit.
Eco-efficiency	The efficiency with which ecological resources are used to meet human needs (the OECD definition).
Gross domestic product (GDP), national product	Gross domestic product at market prices (GDP) refers to the final result of the production activities of domestic production units. It can be calculated by three methods—by taking the sum of the value added of the various industries, adding to it the taxes on products and then subtracting the subsidies on products; by obtaining the sum of the end use of the goods and services produced by domestic institutional units (consumption, gross capital formation, export minus import); or by calculating the sum of incomes (compensations to employees, export and import taxes minus subsidies, gross operating surplus and gross mixed income).
Hidden flows (unused extraction)	Hidden flows are material inputs used in producing direct material inputs (DMI) but not included in their amount (mass).
Impact category, environmental problem category	A category representing the environmental issues under study and to which the results of the inventory analysis (= values of environmental burdens) are aggregated.
Impact category indicator	A quantitative indicator representing the impacts of an impact category.
Impact value, damage score	The result of one or more impact categories, which indicates potential environmental impacts.
Indicator	Indicators are simple statistical figures with which large amounts of data can be summarised into an easily comprehensible form. At their best, indicators provide decision makers and citizens with quick and reliable information on important phenomena and issues.
Industrial ecology	A system analytical approach to studying the material, energy and information flows of industrial systems. The idea is to optimise the metabolism of industrial systems to a level at which they do not cause disturbances in the functions of natural ecosystems.
Intervention (environmental)	A factor causing environmental change or burden.
Inventory analysis	The phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a given product system throughout its life cycle (ISO 14040).
Life cycle assessment (LCA)	A method for analysing and assessing potential environmental impacts of a material, product or service during its entire life cycle.
Life cycle impact assessment (LCIA)	The phase in life cycle assessment (LCA) in which a significance assessment of potential environmental impacts is carried out on the basis of the inventory analysis.

Material flow accounting	Material flow accounting is a representation of the material flows entering the economy from natural resources and abroad / from outside the region; and travelling from the economy abroad / to outside the region and into nature.
Material intensity	On the level of an entire economy, material intensity can be defined as the relation between direct material inputs (DMI) or total material requirement (TMR) and the gross domestic product (DMI/GDP or TMR/GDP). On the industry and business level, material intensity can be defined as a relation either between direct material inputs and the value added of the industry or business in question, or between total material requirement and production output.
Monetary input-output table	A monetary input-output table (MIOT) represents in money terms the product flows from an industry to the intermediate product use of other industries, to domestic end use—i.e., private and public consumption—as well as to capital formation and export. It also depicts the material flows of imports on the various sectors of the economy as well as the formation of value added within the industries.
Output	The value of products produced during one year.
Physical input-output table	A physical input-output table (PIOT) represents the material flows between the industries of an economy and end use. A physical input-output table often also includes the material flows passing through the economy, from nature into the economy and from the economy into nature.
Product chain, supply chain	Those involved, through upstream and downstream linkages, in processes and activities delivering value in the form of products to the user (ISO/TR 14062).
Real disposable household income	The real value of the incomes of households, which represents the development of the purchasing power of households. The real disposable income is derived by dividing the income by the consumer price index.
Regional environmental analysis	A method for assessing the relevance of various regional industrial and other activities which burden or alter the environment, as sources of environmental impacts.
Sustainable development	The objective of sustainable development is to increase well-being—e.g., health, employment and environmental quality—eco-efficiently and equitably. A central role is given to long-term development within the limits of the earth and the carrying capacity of its ecosystem.
Total impact indicator	The result of the impact assessment model, which indicates the total impacts to the environment.
Total material consumption (TMC)	Total material consumption (TMC) refers to the total utilisation of natural resources required by the domestic / regional end use of the products of an economy. It can also be calculated by subtracting the utilisation of natural resources required by exports from the total material requirement (TMR).
Total material input (TMI)	Direct material inputs plus the region's hidden flows.
Total material requirement (TMR)	Total material requirement (TMR) expresses the amount (mass) of the direct material inputs and the hidden flows therein as utilised by an economic unit. TMR thus represents the overall amount of natural resource utilisation which the operations of the economic unit have required.
Value added	Value added (gross) refers to the value produced by a production unit. It is obtained by subtracting the intermediate products (goods and services) used in the production process from the output of the unit.

Annex 1. The ECOREG project group and steering group

Project group

Research Professor Matti Melanen, Finnish Environment Institute (project manager)
Division Manager Alec Estlander, Finnish Environment Institute [a]
University Trainee Marja-Riitta Hiltunen, Finnish Environment Institute
Senior Researcher Sirkka Koskela, Finnish Environment Institute [b]
Environmental Planner Lasse Liljeqvist, Regional Council of Kymenlaakso [c]
Senior Scientist Per Mickwitz, Finnish Environment Institute [d]
Research Engineer Tuuli Myllymaa, Finnish Environment Institute [e]
Docent Ilmo Mäenpää, University of Oulu, Thule Institute [f]
Researcher Esa Mänty, University of Oulu, Thule Institute
Senior Engineer Juha Pesari, Southeast Finland Regional Environment Centre [g]
Senior Researcher Ulla Rosenström, Finnish Environment Institute [h]
Research Manager Jyri Seppälä, Finnish Environment Institute [i]
Research Engineer Jyrki Tenhunen, Finnish Environment Institute [j]
Researcher Mika Toikka, Southeast Finland Regional Environment Centre

[a] In charge of the mechanism for eco-efficiency monitoring and evaluation (together with Tuuli Myllymaa)
[b] In charge of the regional environmental analysis
[c] The person in charge in the Regional Council of Kymenlaakso
[d] In charge of the analysis of socio-cultural factors (together with Ulla Rosenström)
[e] In charge of the mechanism for eco-efficiency monitoring and evaluation (together with Alec Estlander)
[f] In charge of the economic and material flow analyses, the person in charge at the University of Oulu
[g] The person in charge at the Southeast Finland Regional Environment Centre
[h] In charge of the analysis of socio-cultural factors (together with Per Mickwitz)
[i] In charge of the development of the eco-efficiency indicators
[j] In charge of the life cycle impact assessment as part of the regional environmental analysis

Steering group

Executive Director Tapio Välinoro, Regional Council of Kymenlaakso (Chairperson)
Director Leena Gunnar, Southeast Finland Regional Environment Centre (Vice Chairperson)
Project Manager Frank Hering, Kymenlaakso Regional Organisation of the Finnish Association for Nature Conservation
Managing Director Vesa Junttila, LCA Engineering Oy
Director General Lea Kauppi, Finnish Environment Institute
Director, Social Affairs, Sakari Laari, City of Kouvola
Managing Director Kimmo Naski, Port of Kotka Ltd
Senior Advisor Jyrki Pitkänen, Employment and Economic Development Centre Southeastern Finland
Vice President, Environmental Affairs, Tuija Suur-Hamari, Stora Enso

Annex 2. Programmes of the Kymenlaakso workshops held by the ECOREG project

(LIFE02 ENV/FIN/000331)

The Eco-efficiency of Regions – Case Kymenlaakso (ECOREG)

The first regional ECOREG workshop, 21 May 2003, Kouvola House, Varuskuntakatu 11, Kouvola

---

MORNING PROGRAMME,
Chairperson Executive Director Tapio Välinoro, Regional Council of Kymenlaakso

09:30	*Registration*	
10:00	Opening of the workshop	Executive Director *Tapio Välinoro*
10:10	Introductory lectures:	
	• The concept of eco-efficiency and the aims of the ECOREG project	Research Professor *Matti Melanen*
	• The regional economy of Kymenlaakso	Docent *Ilmo Mäenpää*
	• The environmental burden in Kymenlaakso 2000	Senior Researcher *Sirkka Koskela*
11:00	Valuation tasks:	
	• The key environmental issues of Kymenlaakso [a]	Research Engineer *Jyrki Tenhunen*
	• The key social and cultural issues of Kymenlaakso: joint valuation [b]	Senior Researcher *Ulla Rosenström*
11:45	*Lunch*	

AFTERNOON PROGRAMME,
Chairperson Director General Lea Kauppi (SYKE)

12:45	Introduction to group assignments [c]	Senior Scientist *Per Mickwitz*
13:00	Implementation of the assignments [c]	
14:30	*Coffee break*	
15:00	Closing session: Results of the valuation task on the social and cultural issues of Kymenlaakso Results of the group assignments	
16:00	*The workshop ends*	

[a] A valuation task on environmental issues, conducted by the participants later after the workshop

[b] A valuation task carried out at the workshop

[c] The main themes of the group assignments:

1. *What are the typical decision-making situations in which various bodies of the Kymenlaakso region need information on eco-efficiency?*
2. *What kind of information is then especially needed?*

The second regional ECOREG workshop, 1 December 2003, CT Centre, Metsontie 41, Kotka

Chairperson Executive Director Tapio Välinoro, Regional Council of Kymenlaakso

11:30	*Registration and lunch*	
12:30	Opening of the workshop	Executive Director *Tapio Välinoro*
12:40	With what indicators could the environmental, economic and social and cultural development of Kymenlaakso be measured?	
	The environmental dimension:	
	• The results of the valuation task introduced at the Kouvola workshop and results of impact assessment	Research Engineer *Jyrki Tenhunen*
	• Environmental indicators	Senior Researcher *Sirkka Koskela*
	The economic dimension and indicators	Docent *Ilmo Mäenpää*
	The socio-cultural dimension: • The results of the valuation task performed at the Kouvola workshop • Socio-cultural indicators	Senior Researcher *Ulla Rosenström*
14:00	*Coffee break*	
14:30	How should the eco-efficiency of Kymenlaakso be measured and monitored?	
	The results of the group assignments performed at the Kouvola workshop	Senior Scientist *Per Mickwitz*
	Regional eco-efficiency and its indicators	Research Manager *Jyri Seppälä*
	Monitoring and evaluation mechanism	Unit Manager *Alec Estlander*
16:30	*The workshop ends*	

The third regional ECOREG Workshop, 5 October 2004, Kuusankoski House, Kymenlaaksonkatu 1, Kuusankoski

Chairperson Executive Director Tapio Välinoro, Regional Council of Kymenlaakso

11:30	*Registration and lunch*	
12:30	Opening of the workshop	Executive Director *Tapio Välinoro*
12:40	Development of the eco-efficiency of the Kymenlaakso region	Research Manager *Jyri Seppälä*
	Eco-efficiency monitoring mechanism for Kymenlaakso (mechanism for updated evaluation and action prioritisation)	Division Manager *Alec Estlander*
	Instructions for the group assignments	*Jyri Seppälä* and *Alec Estlander*
13:30	Group assignments:	

Group assignment I – What opportunities are there for enhancing Kymenlaakso's eco-efficiency?

1. What are the priorities – where should action be taken?
2. What are then the tools and who should use them?

Group assignment II – How can various actors benefit from the mechanism for monitoring regional eco-efficiency?

1. Regional planning
   - Plans and programmes which can have benefit of the mechanism?
2. Activities of economic and other actors
   - Concrete examples of benefiting business sectors that will benefit and how they will benefit?

14:45	*Coffee break*	
15:15	Results of the group assignments and conclusions	
16:30	*The workshop ends*	

Annex 3. Monetary input-output table and import utilisation table, Kymenlaakso 2000

Reference:

Mäenpää, I. & Mänty, E. 2004. Economic and material flow indicators for the Kymenlaakso region. Documentation report 2 of the ECOREG project. The Finnish Environment 698en. Helsinki, Finnish Environment Institute.

The sums of the row and the column for each industry are equal, designating the value of the output of the industry. The columns for the industries indicate the inputs which each industry has used in terms of products from the region or imports. The intermediate use and the value added together add up to the value of the output of the industry. On the row for each industry in the table, we can see the use of the products of this industry as intermediate products, for final use within the region – in private or public consumption or for investments – or for exports to other regions of Finland or abroad.

Input-output table, Kymenlaakso in 2000, million euro

	INDUSTRIES															FINAL USE						Total
																Private	Public	Invest-	Exports		**Total**	
INDUSTRIES	1	2	3	4	5	6	7	8	9	10	11	12	13	Fis[a]	**Total**	consumption	consumption	ments	Domestic	Abroad		
1 Agriculture, hunting & fishing	23	0	0	71	0	0	0	0	0	1	0	2	0	0	**99**	16	0	1	29	0	**46**	**144**
2 Forestry and logging	0	3	0	0	80	0	0	0	0	0	0	0	0	0	**83**	1	0	1	19	0	**20**	**103**
3 Mining and quarrying	0	0	0	0	3	1	0	1	1	2	0	0	0	0	**7**	0	0	1	5	3	**9**	**16**
4 Manufacture of food products	8	0	0	60	31	6	3	1	1	2	3	24	3	0	**142**	84	1	0	100	15	**199**	**342**
5 Forest industry	2	1	0	11	801	18	8	4	5	24	8	33	9	0	**923**	28	14	6	418	2 388	**2 855**	**3 778**
6 Chemical industry	2	0	0	3	65	16	3	1	0	8	1	7	1	0	**107**	8	2	1	117	171	**298**	**405**
7 Metal industry	0	0	0	2	16	3	19	2	1	38	1	5	2	0	**91**	7	2	22	191	182	**403**	**494**
8 Other manufacturing	0	0	0	1	6	2	2	8	0	32	0	4	1	0	**57**	6	1	2	21	55	**85**	**142**
9 Electricity, gas & water supply	2	0	0	2	66	8	1	1	2	3	3	30	4	0	**122**	14	0	1	9	0	**23**	**145**
10 Construction	3	0	0	0	2	0	0	0	0	33	12	68	2	0	**121**	2	4	491	11	2	**510**	**631**
11 Transport and communication	1	1	2	18	285	25	12	7	8	14	51	67	15	0	**507**	121	145	2	114	39	**422**	**928**
12 Other services	10	3	1	19	147	25	24	6	7	47	59	177	68	63	**656**	1 034	411	76	6	0	**1 526**	**2 183**
13 Public administration	0	0	0	2	17	3	3	1	1	2	6	15	5	0	**57**	24	351	6	2	0	**382**	**440**
Use of products from the region	53	9	4	190	1 518	107	73	32	27	206	145	433	111	63	**2 971**	1 344	930	610	1 041	2 855	**6 779**	**9 750**
Imports from Finland	23	11	3	55	726	65	112	19	23	117	80	161	45	54	**1 494**	310	2	173	0	0	**485**	**1 979**
Imports from abroad	8	2	2	42	396	139	108	21	25	50	59	102	33	0	**984**	173	9	143	0	9	**334**	**1 318**
Cif/fob-adjustment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	-51	**-51**	**-51**
Finns' purchases abroad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	47	0	0	0	0	**47**	**47**
Foreigners' purchases in Finland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	-53	0	0	0	87	**34**	**34**
Product taxes and product subsidies	-2	0	0	-24	20	11	1	1	4	11	30	54	29	0	**136**	408	3	57	0	-12	**456**	**592**
Intermediate use/ Final use	81	22	8	263	2 660	322	295	72	80	384	313	751	217	117	**5 584**	2 230	944	983	1 041	2 887	**8 085**	**13 669**
Compensations to employees	17	10	4	38	424	42	137	40	24	166	212	838	199	0	**2 153**							
Other production taxes, net	-37	0	0	-1	-1	-1	-1	0	0	0	0	-2	0	0	**-43**							
Depreciation of fixed capital	23	15	1	19	297	22	15	8	40	11	131	260	37	0	**880**							
Operating surplus, net	60	56	3	22	399	20	48	22	1	69	271	336	-14	-117	**1 176**							
Value added at basic prices	63	81	8	79	1 118	83	199	70	65	247	615	1 432	222	-117	**4 166**							
Output at basic prices	144	103	16	342	3 778	405	494	142	145	631	928	2 183	440	0	**9 750**							

[a] Fis = financial intermediation services

Import utilisation table, Kymenlaakso in 2000, million euro

	PRODUCTS	INDUSTRIES 1	2	3	4	5	6	7	8	9	10	11	12	13	Fis[a]	**Total**	FINAL USE Private consumption	Public consumption	Invest-ments	Exports Domestic	Exports Abroad	**Total**	**Total**
1	Agriculture, hunting & fishing	10	0	0	34	0	0	0	0	0	0	0	1	0	0	**46**	13	0	0	0	0	**14**	**60**
2	Forestry and logging	0	9	0	0	304	0	0	0	0	0	0	0	0	0	**313**	3	0	2	0	0	**6**	**319**
3	Mining and quarrying	0	0	1	0	72	31	1	4	20	7	0	0	0	0	**137**	0	0	0	0	0	**0**	**137**
4	Manufacture of food products	2	0	0	26	20	2	1	0	0	0	1	10	1	0	**63**	31	0	0	0	0	**31**	**94**
5	Forest industry	0	0	0	1	145	2	1	3	2	25	3	23	4	0	**208**	27	0	0	0	1	**28**	**236**
6	Chemical industry	5	1	1	8	218	124	8	8	6	17	27	33	2	0	**458**	34	10	0	0	0	**44**	**502**
7	Metal industry	1	0	2	7	116	12	180	8	8	47	16	38	19	0	**453**	72	1	246	0	8	**327**	**780**
8	Other manufacturing	0	0	0	1	10	3	3	10	0	19	2	15	2	0	**66**	53	0	6	0	0	**60**	**126**
9	Electricity, gas & water supply	1	0	0	1	37	4	1	0	1	1	1	11	2	0	**61**	6	0	0	0	0	**6**	**67**
10	Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	**0**	**0**
11	Transport and communication	0	0	0	2	28	4	3	1	2	2	53	26	8	0	**129**	39	0	0	0	0	**39**	**168**
12	Other services	11	2	1	17	172	22	22	5	8	49	36	106	39	54	**543**	204	1	61	0	0	**266**	**808**
13	Public administration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	**0**	**0**
	Total	31	13	5	97	1 123	204	220	39	48	167	138	263	77	54	**2 478**	483	12	316	0	9	**820**	**3 297**

[a] Fis = financial intermediation services

Annex 4. Descriptions of the environmental impact (problem) categories

Environmental problem category	Description
Climate change	Climate change refers to the warming of the climate as a consequence of an increase in greenhouse gases. The greenhouse gases (e.g., carbon dioxide, CO_2, nitrous oxide, N_2O and methane, CH_4) admit the incoming short-wave radiation from the sun, but retain the long-wave heat radiation from the surface of the earth. Atmospheric warming occurs unevenly in different geographical areas. The impact is more visible in the northern continental region, in which the winters are predicted to warm up most. Climate change reinforces the ongoing changes in habitat, and threatens to eradicate entire habitats.
Stratospheric ozone depletion	Stratospheric ozone depletion refers to the depletion of ozone (O_3) and the thinning of the ozone layer in the stratosphere. Ozone serves to remove the most harmful element in the ultraviolet radiation penetrating the earth. Ozone depletion is a consequence of the transport of persistent compounds containing chlorine (Cl) or bromine (Br) into the upper atmosphere. Increased ultraviolet radiation leads to, for example, harmful impacts on health. It increases the susceptibility to sunburns and the risk of skin cancer. The radiation has increased more in the southern hemisphere than in the north, and the most near the polar areas.
Tropospheric ozone formation	Photo-oxidants, the most harmful of which is ozone (O_3), are created from hydrocarbons and nitrogen oxides in bright sunlight. Ozone and the gases forming it are conveyed by air currents and increase the concentrations of ozone over wide areas. Ozone is a powerful oxidant, and also a gas that cleans the atmosphere, but high concentrations in the troposphere are harmful. When inhaled, ozone paralyses the lungs and causes, for example, coughing and shortness of breath. As a powerful oxidant, ozone damages the cell tissues of plants and weakens the growth of trees and cultivated plants.
Acidification	Acidification refers to a decrease in the resistance of nature to acidifying depositions. The buffering capacity of the soil varies, for example, according to the geological conditions in the area. Acidification influences forest growth and the pH level of aquatic ecosystems. Forest lakes, organisms in headwater streams and the vegetation in forests with poor soils are especially susceptible to acidification. Acid rain causes damage to materials and the built environment.
Eutrophication of waters	The eutrophication of waters refers to the increased growth rate of aquatic organisms and the increase in phytoplankton and water plants due to an imbalance in the aquatic ecosystem. Due to the eutrophication of the aquatic ecosystem, more oxygen is required to decompose dead organisms (see "Aquatic oxygen depletion"). The ecosystem impacts of eutrophication are harmful for the recreational use of watercourses (sliming of fishing nets, degradation of swimming waters) and for the household and commercial use of surface waters.
Aquatic oxygen depletion	As a consequence of human activities, organic matter and ammonium nitrogen (NH_4^+), are leached into watercourses, where they consume the oxygen in the water. In this connection, oxygen depletion refers to the decreased oxygen levels in waters caused by these compounds. Oxygen depletion influences the entire aquatic ecosystem by causing, for example, the death of fish.
Ecotoxicity	In this connection, ecotoxicity refers to the toxic effects of continuous emissions caused by environmentally hazardous chemicals in ecosystems. The toxic effects may be acute (accidents) or chronic. The concentrations of toxic substances in so-called continuous emissions are not high enough to cause acute toxic effects. In the current context, the damage caused by pesticide use is left outside the scope of this impact category (cf. "Contamination of soil and water resources").

Environmental problem category	Description
Environmental accidents	Environmental accidents refer to unexpected disasters and accidents, which result in the release of harmful or toxic substances into the environment.
Contamination of soil and water resources	As a consequence of human activity, harmful substances are released into the soil, and can also make their way into groundwaters and surface waters. Harmful substances in the soil and water resources can pose a local threat to human health. Vegetation and animal life may also suffer from the contamination of soil and water. The damage caused by pesticide use is taken into account in this context.
Deterioration of local air quality	In order to safeguard human health, limit values and guideline values have been set for air quality in urban areas. Deterioration of the local air quality also results in nuisance and direct damages to vegetation caused by sulphur and nitrogen compounds.
Depletion of non-renewable resources	Natural resource use is considered as a stock factor in sustainable development, according to which the natural resources of the earth should be used in a manner that fulfils the needs of current generations without decreasing the possibilities of future generations from fulfilling their own needs.
Odour	Odour refers to unpleasant smells experienced by human beings. The so-called olfactory threshold level, i.e., the lowest concentration level at which olfactory sensations are perceived, varies considerably among different people.
Noise	Noise refers to sound levels or corresponding vibration levels that are harmful to health or significantly reduce environmental amenity. Guideline values have been set for average noise levels for both daytime and night-time activities.
Loss of biodiversity	Biodiversity refers to the diversity occurring on all levels of living nature. Ecological functions are an essential part of biodiversity. The impact of human activity on biodiversity is related to land use activities, in particular. The direct and indirect impacts of emissions on biodiversity are significantly smaller. Climate change, however, which is a result of greenhouse gas emissions, constitutes a growing threat to biodiversity in Finland. In the present context, only changes due to land use are included in the problem-area of biodiversity loss.
Degradation of land-scapes and cultural environments	The aesthetic values of the landscape may be disturbed by, e.g., buildings, structures, roads, land resource extraction, construction on shorelines, water constructions, changes in agricultural practices and forestry operations.
Loss of recreational values	Recreational values refer to people's opportunities to enjoy the conditions and experiences provided by their living and leisure-time environments, and nature. Outdoor activities, hiking, picking berries, gathering mushrooms and hunting are recreational activities. Amenity refers to the health and aesthetic qualities of the living and leisure-time environment.

Reference:

Tenhunen, J., Seppälä, J., Koskela, S., Hiltunen, M.-R. & Melanen, M. 2004. Regional environmental impact assessment. In: Koskela, S. (ed.). Environmental analysis and indicators for the Kymenlaakso region. Documentation report 1 of the ECOREG project. The Finnish Environment 697en. Helsinki, Finnish Environment Institute. Part 2, pp. 87–112.

Annex 5. Valuation task on environmental issues introduced at the Kouvola workshop

ECOREG workshop, 21 May 2003, Kouvola
J. Tenhunen/SYKE

Name of respondent:	____________________	Affiliation:	_________________
E-mail:	____________________	Telephone:	_________________

QUESTIONNAIRE
The questionnaire and the descriptions of the environmental problem categories are also available at the web-address http://www.ymparisto.fi/tutkimus/eu/ecoreg/ecoreg.htm

Please return the form by e-mail to jyrki.tenhunen@ymparisto.fi
or by post to Jyrki Tenhunen, SYKE, P.O. BOX 140, 00251 Helsinki.

TASK
Please select the environmental problems on the list below which you consider to be relevant in Kymenlaakso. You may also choose all the environmental problems listed below. The descriptions of the problem categories can be found in the attachment. Place the environmental problems that you selected in rank order of importance.

Tropospheric ozone formation [1)]
Ecotoxicity
Odour
Acidification
Aquatic oxygen depletion
Climate change
Loss of biodiversity
Contamination of soil and water resources
Degradation of landscapes and cultural environments
Noise
Deterioration of local air quality
Aquatic eutrophication
Depletion of non-renewable natural resources
Loss of recreational values and amenity
Stratospheric ozone depletion
Other problem category, please elaborate: ______________________________

Environmental problem category
1. __________________________ (Most important)
2. __________________________ (Second-most important)
3. __________________________ etc.
4. __________________________
5. __________________________
6. __________________________
7. __________________________
8. __________________________
9. __________________________
10. __________________________
… __________________________

Reference:

Tenhunen, J., Seppälä, J., Koskela, S., Hiltunen, M.-R. & Melanen, M. 2004. Regional environmental impact assessment. In: Koskela, S. (ed.). Environmental analysis and indicators for the Kymenlaakso region. Documentation report 1 of the ECOREG project. The Finnish Environment 697en. Helsinki, Finnish Environment Institute. Part 2, pp. 87–112.

[1)] Follows the order used in the Finnish source text, which was alphabetical.

Annex 6. The characterisation factors used in the environmental impact assessment model of Kymenlaakso

The environmental interventions were made commensurable within each impact category by means of characterisation factors. For example, the different greenhouse gas emissions can be denoted in terms of CO_2 equivalents by using global warming potential coefficients (GWP).

The characterisation factors used

Impact category (unit of impact category indicator)	Intervention	Characterisation factor
Climate change	CO_2	1
(CO_2-equivalence)	N_2O	310
	CH_4	21
Tropospheric	NO_x (as NO_2)	0.727
ozone formation	NMVOC	0.209
(POCP)	CO	0.064
Acidification	SO_x (as SO_2)	0.01635
(H^+-equivalence)	NO_x (as NO_2)	0.00639
	NH_y (as NH_3)	0.02646
Eutrophication	NO_x (as NO_2)	0.015
(NP)	NH_y (as NH_3)	0.041
	P-tot(W)	3.06 * adjustment [a]
	N-tot(W)	0.42 * adjustment [a]
Aquatic oxygen depletion	BOD_7(W)	1
(O_2-equivalence)	NH_4^+(W)	4.57

Abbreviations used: POCP = Photochemical Ozone Creation Potential, NP = Nutriphication Potential, W = emissions to water, CO_2 = carbon dioxide (fossil), N_2O = nitrous oxide, CH_4 = methane, SO_2 = sulphur dioxide, NO_x = nitrogen oxides, NO_2 = nitrogen dioxide, NH_y = reduced nitrogen compounds, NH_3 = ammonia, NMVOC = non-methane organic hydrocarbons, CO = carbon monoxide, P-tot(W) = total phosphorus load to waters, N-tot(W) = total nitrogen load to waters, BOD_7 = biological oxygen demand, NH_4^+(W) = ammonium nitrogen load to waters.

[a] The adjustment is presented in the next table.

Characterisation factors for direct phosphorus (P-tot(W)) and nitrogen (N-tot(W)) emissions to water were obtained by adjusting the customary equivalency factors (P: 3.06 PO_4 equivalent, N: 0.42 PO_4 equivalent) used in life cycle assessments (LCAs) by means of utilising the coefficients presented in the next table.

Share of phosphorus and nitrogen available for algae in the total emission to waters by activity sector

Activity sector	Share of total phosphorus available for algae	Share of total nitrogen available for algae
Agriculture	0.47	0.67
Forestry	0.30	0.20
Communities	0.40	0.90
Rural and holiday homes	0.80	0.80
Industry	0.31	0.53

Reference:

Tenhunen, J., Seppälä, J., Koskela, S., Hiltunen, M.-R. & Melanen, M. 2004. Regional environmental impact assessment. In: Koskela, S. (ed.). Environmental analysis and indicators for the Kymenlaakso region. Documentation report 1 of the ECOREG project. The Finnish Environment 697en. Helsinki, Finnish Environment Institute. Part 2, pp. 87–112.

Annex 7. Physical input-output table for product flows, and import utilisation table, Kymenlaakso 2000

Reference:

Mäenpää, I. & Mänty, E. 2004. Economic and material flow indicators for the Kymenlaakso region. Documentation report 2 of the ECOREG project. The Finnish Environment 698en. Helsinki, Finnish Environment Institute.

In the physical input-output table, the sums of rows and the sums of columns for the industries are not equal, because the product flows do not encompass all the material flows included in production. The physical input-output tables were used in the ECOREG project to estimate the amount of natural resources – from the region itself and included in imports – that are used by the industries in Kymenlaakso. At the same time, the tables provide an overview of the relative sizes of the product flow volumes in the regional economy.

Physical input-output table for product flows in Kymenlaakso in 2000, 1 000 tons

		INDUSTRIES														FINAL USE					Total
																Private	Invest-	Exports		Total	
INDUSTRIES		1	2	3	4	5	6	7	8	9	10	11	12	13	Total	consumption	ments	Domestic	Abroad		
1	Agriculture, hunting & fishing	321	0	0	140	0	0	0	0	0	0	0	3	0	463	12	0	88	0	99	563
2	Forestry and logging	12	0	0	0	1 163	0	0	0	4	0	0	2	0	1 181	138	0	286	0	423	1 604
3	Mining and quarrying	1	0	12	0	72	0	0	14	5	2 445	3	5	2	2 558	1	0	42	23	66	2 624
4	Manufacture of food products	1	0	0	22	68	2	0	3	0	0	0	7	0	102	46	0	252	47	345	447
5	Forest industry	0	0	0	0	2 336	1	0	3	1	61	0	1	1	2 403	9	0	379	3 129	3 517	5 920
6	Chemical industry	0	0	0	3	267	79	2	30	0	0	0	0	0	382	3	0	241	429	673	1 055
7	Metal industry	0	0	0	0	0	0	0	3	0	13	0	0	0	17	0	5	9	10	24	41
8	Other manufacturing	0	0	0	0	0	0	3	190	0	232	0	1	0	426	2	0	61	130	194	620
9	Electricity, gas & water supply	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Construction	0	0	0	0	0	0	0	0	0	0	51	0	0	51	0	4 313	0	0	4 313	4 364
11	Transport and communication	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Other services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	22	22
13	Public administration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Use of products from the region		334	0	12	165	3 906	82	5	242	10	2 752	54	20	3	7 584	232	4 318	1 357	3 768	9 676	17 260
	Imports from Finland	16	1	4	109	6 559	176	26	187	5	1 255	29	64	18	8 448	113	5	0	0	118	8 567
	Imports from abroad	43	2	5	151	2 033	342	19	150	253	373	48	56	7	3 482	82	62	0	0	144	3 626
Total of products		394	3	21	424	12 498	600	50	578	268	4 380	131	140	28	19 515	428	4 385	1 357	3 768	9 938	29 453

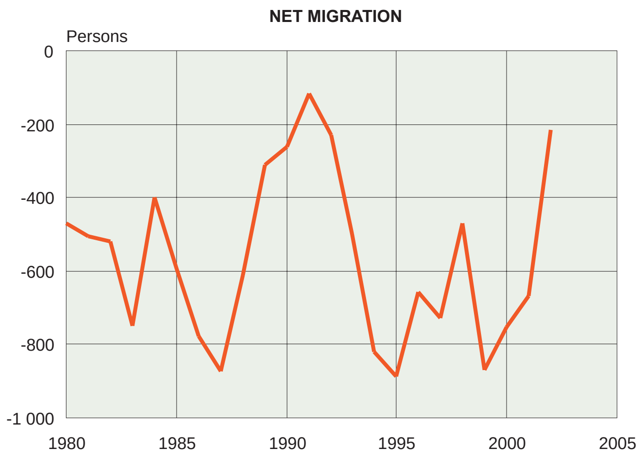
Import utilisation table, Kymenlaakso 2000, 1 000 tons, imports from Finland and abroad combined

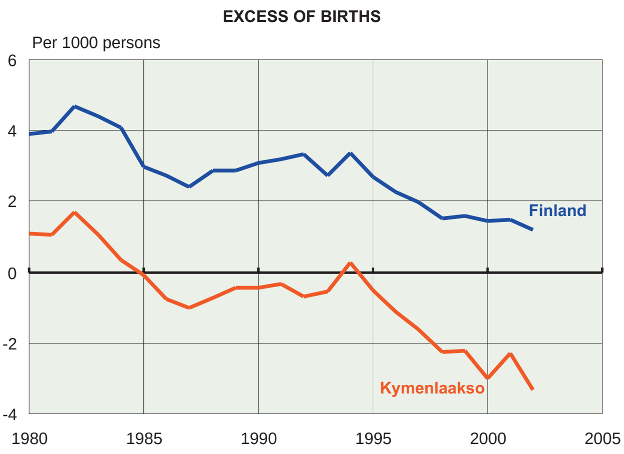
		INDUSTRIES														FINAL USE					**Total**
																Private	Invest-	Exports		**Total**	
	INDUSTRIES	1	2	3	4	5	6	7	8	9	10	11	12	13	**Total**	consumption	ments	Domestic	Abroad		
1	Agriculture, hunting & fishing	1	0	0	75	0	0	0	0	0	0	0	2	0	**78**	19	0	0	0	**19**	**97**
2	Forestry and logging	0	0	0	0	5 417	0	0	0	0	0	0	0	0	**5 417**	0	0	0	0	**0**	**5 417**
3	Mining and quarrying	26	0	7	9	992	164	8	240	253	1 345	1	6	0	**3 050**	1	0	0	0	**1**	**3 050**
4	Manufacture of food products	0	0	0	172	35	25	0	1	0	0	0	12	0	**246**	53	0	0	0	**53**	**298**
5	Forest industry	0	0	0	0	2 059	0	0	28	4	20	0	3	1	**2 115**	1	0	0	0	**1**	**2 117**
6	Chemical industry	33	3	2	4	80	214	3	3	1	34	73	95	24	**568**	110	0	0	0	**110**	**678**
7	Metal industry	0	0	0	0	0	0	32	2	0	89	3	1	0	**128**	7	16	0	0	**23**	**151**
8	Other manufacturing	0	0	0	0	9	115	1	64	0	138	0	1	0	**328**	6	0	0	0	**6**	**334**
9	Electricity, gas & water supply	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	**0**	**0**
10	Construction	0	0	0	0	0	0	0	0	0	0	1	0	0	**1**	0	51	0	0	**51**	**51**
11	Transport and communication	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	**0**	**0**
12	Other services	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	**0**	**0**
13	Public administration	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	**0**	**0**
	Total	60	3	8	260	8 592	518	44	337	258	1 628	78	120	25	**11 930**	195	67	0	0	**263**	**12 193**

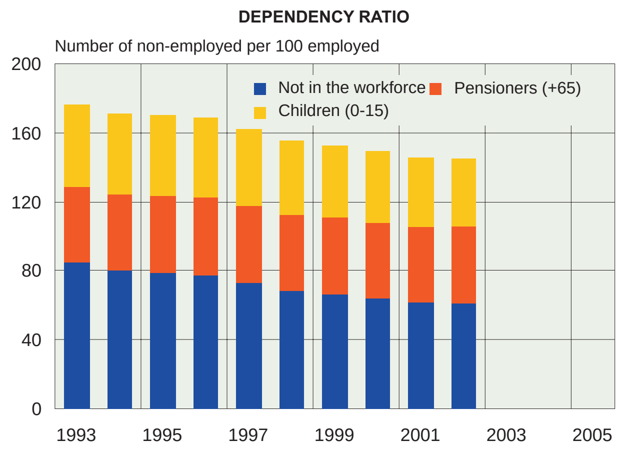
Annex 8. Time-series of socio-cultural indicators supporting the eco-efficiency measuring in Kymenlaakso

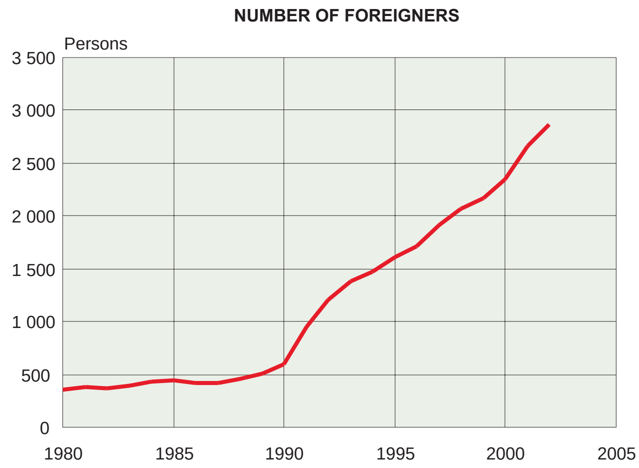
Reference:

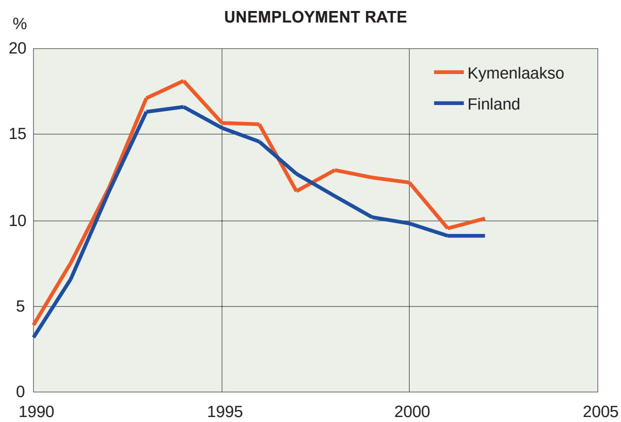
Rosenström, U. & Mickwitz, P. 2004. Social and cultural indicators supporting the measurement of eco-efficiency in the Kymenlaakso region. Documentation report 3 of the ECOREG project. The Finnish Environment 699en. Helsinki, Finnish Environment Institute.

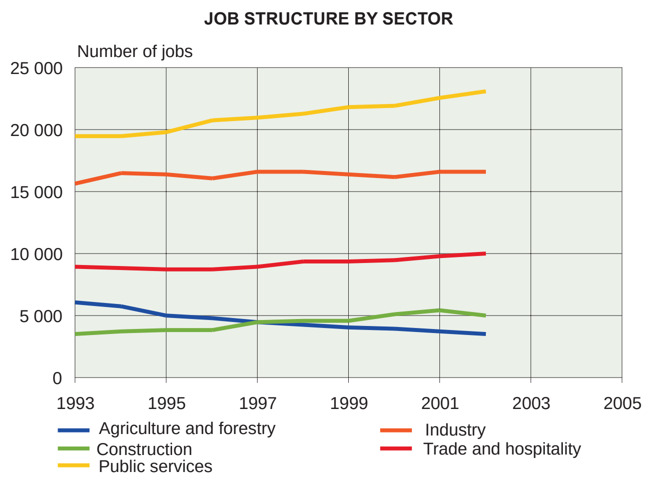




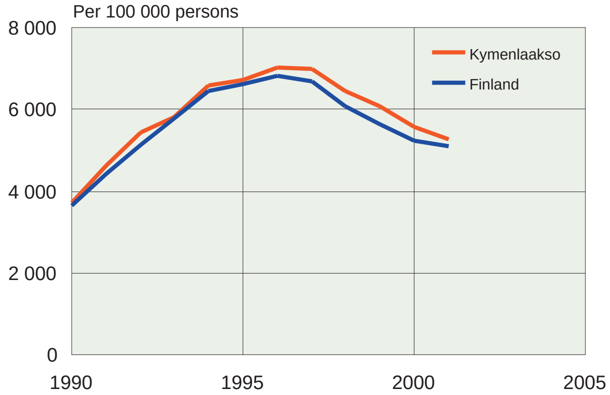




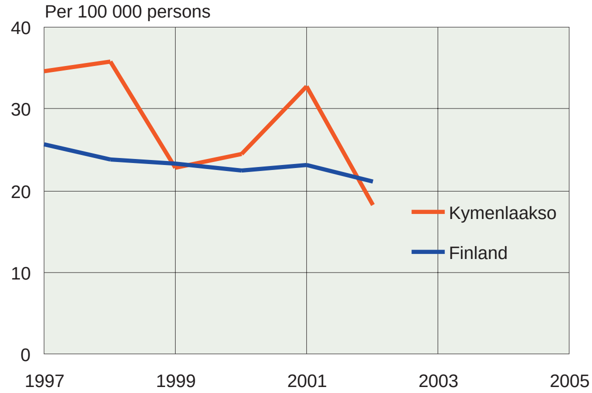




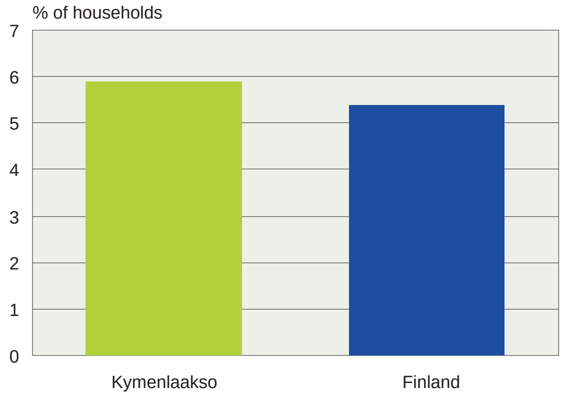
HOUSEHOLDS RECEIVING SOCIAL ASSISTANCE



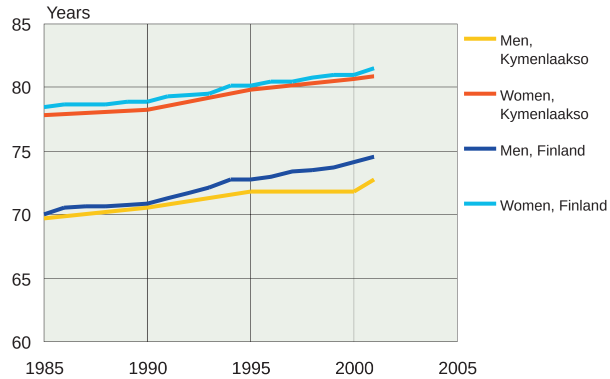
NUMBER OF SUICIDES



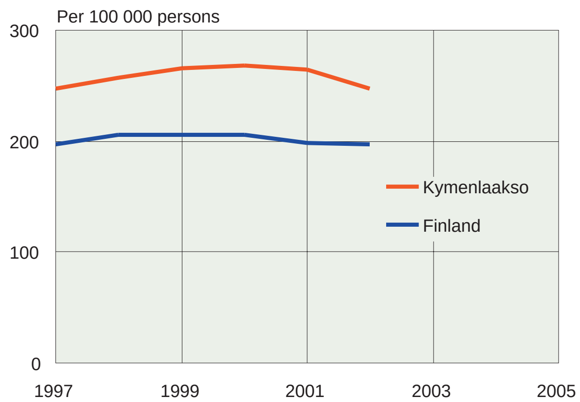
POVERTY RATE



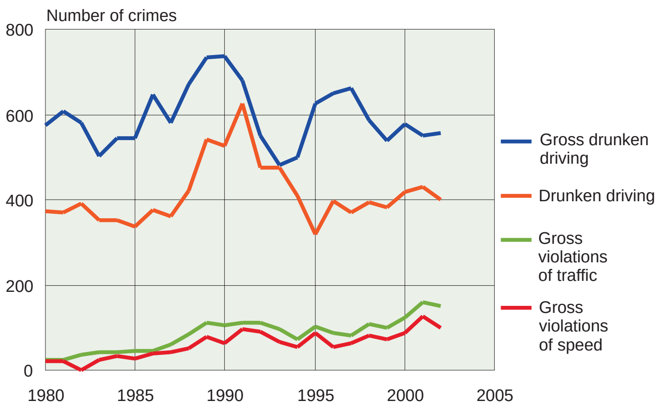
LIFE EXPECTANCY OF NEWBORNS



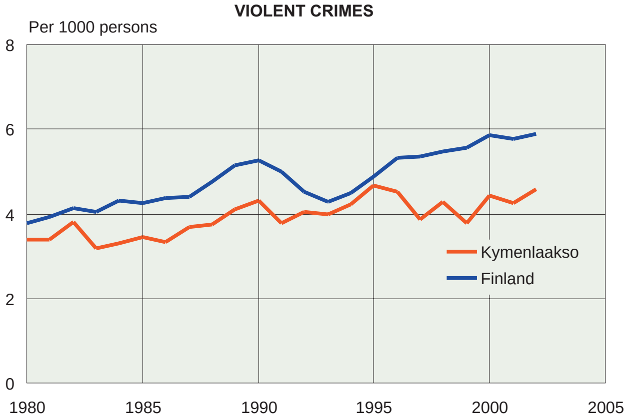
DEATHS BEFORE AGE 65



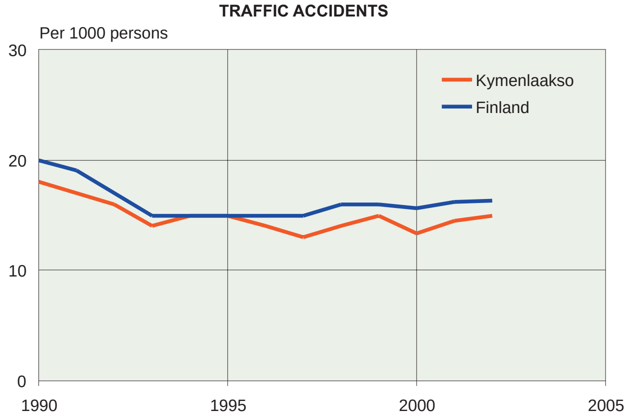
DEVELOPMENT OF TRAFFIC SAFETY



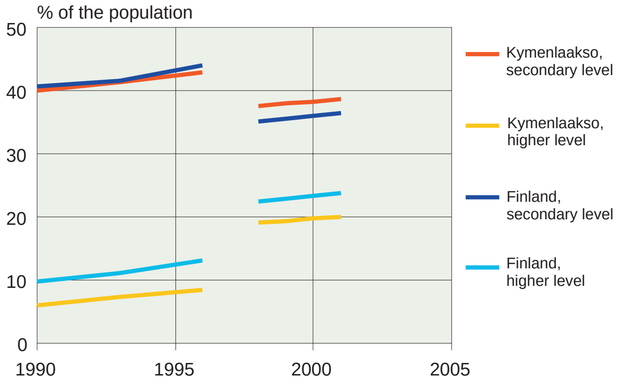
VIOLENT CRIMES



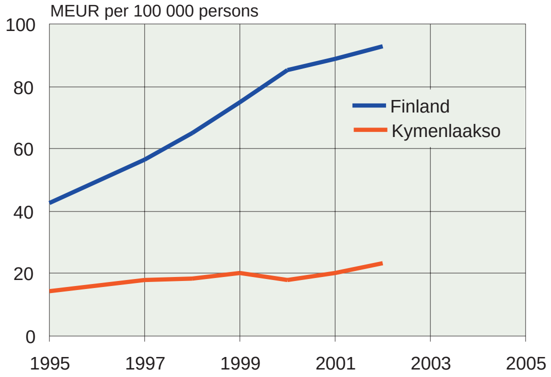
TRAFFIC ACCIDENTS



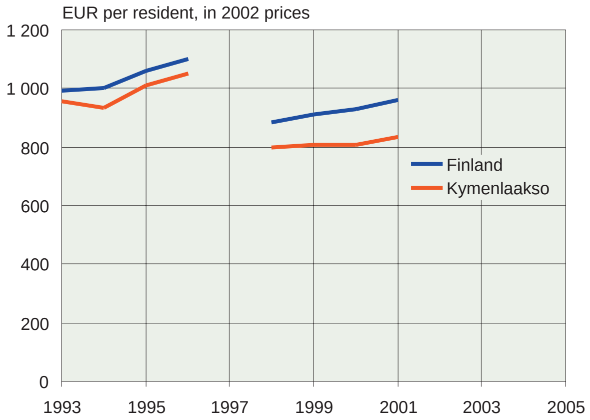
EDUCATIONAL LEVEL



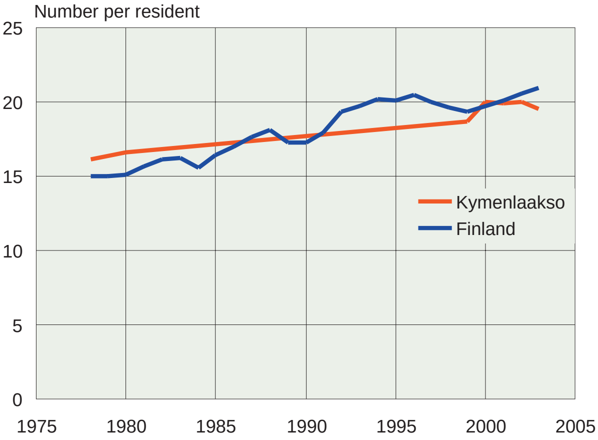
RESEARCH AND DEVELOPMENT EXPENDITURES



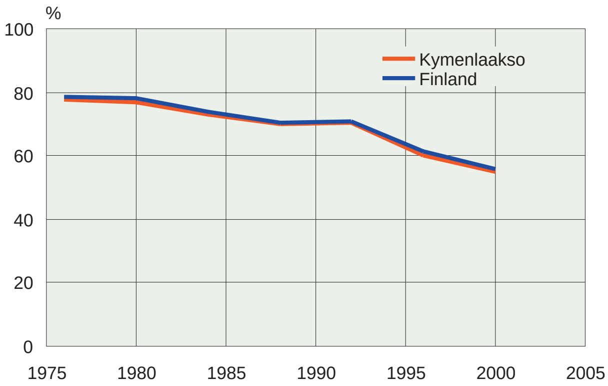
NET PUBLIC EXPENDITURES ON EDUCATION AND CULTURE



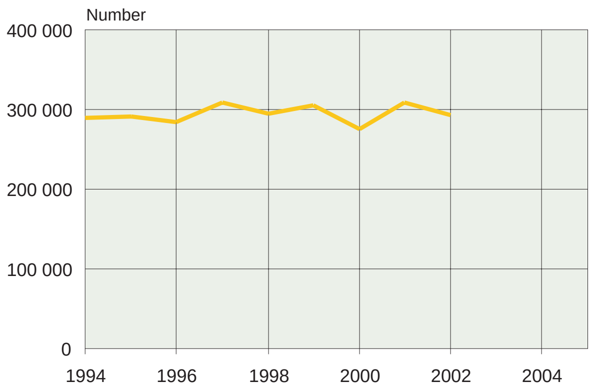
NUMBER OF LOANS FROM PUBLIC LIBRARIES



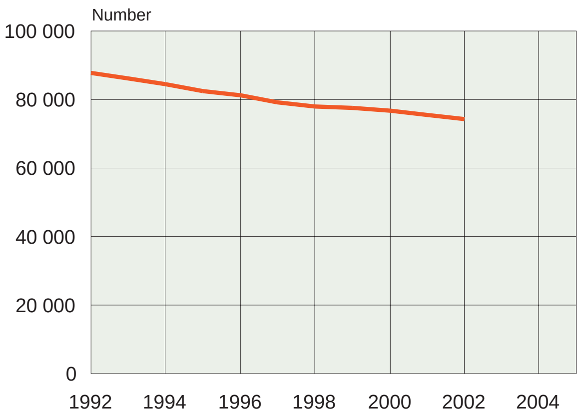
VOTING RATE IN MUNICIPAL ELECTIONS



NIGHTS SPENT IN HOTELS



CIRCULATION OF NEWSPAPERS



Documentation page

Publisher	Finnish Environment Institute — Date: December 2004
Author(s)	Matti Melanen, Jyri Seppälä, Tuuli Myllymaa, Per Mickwitz, Ulla Rosenström, Sirkka Koskela, Jyrki Tenhunen, Ilmo Mäenpää, Frank Hering, Alec Estlander, Marja-Riitta Hiltunen, Mika Toikka, Esa Mänty, Lasse Liljeqvist and Juha Pesari
Title of publication	Measuring regional eco-efficiency – case Kymenlaakso. Key results of the ECOREG project
Parts of publication/ other project publications	This publication is also available in the Internet www.environment.fi/publications
Abstract	Eco-efficiency is one of the means by which sustainable development is sought to be implemented. In the last few years the focus has been, in many ways, placed on the European "regions", and hence the promotion of their competitiveness – and, by this means, their eco-efficiency – has become a central issue in the regions concerned. The Finnish Environment Institute (SYKE), the Southeast Finland Regional Environment Centre, the Regional Council of Kymenlaakso and the Thule Institute at the University of Oulu conducted (1 September 2002 – 31 December 2004) a LIFE project named "The Eco-efficiency of Regions – Case Kymenlaakso (ECOREG)". The project was financed by the European Community's LIFE programme (support obtained from LIFE-Environment) and the Finnish Ministry of the Environment. The goal of this project was to demonstrate the concept of eco-efficiency and eco-efficiency evaluation on a regional scale, taking the Kymenlaakso region located in Southeast Finland as an example. This current report presents the key results of the ECOREG project particularly focusing on the indicators and measuring of regional eco-efficiency (monitoring and evaluation mechanism), the processes and methods utilised in the project as well as reproducibility and transferability of the ECOREG results in other parts of Finland and Europe. The ECOREG project has a website in Finnish and English at http://www.ymparisto.fi/syke/ecoreg, http://www.environment.fi/syke/ecoreg.
Keywords	Eco-efficiency, region, indicator, monitoring
Publication series and number	The Finnish Environment 735en
Theme of publication	Environmental Protection
Project name and number	ECOREG project (LIFE02 ENV/FIN/000331)
Financier/ commissioner	EU LIFE-Environment Programme, Finnish Ministry of the Environment
Project organization	Finnish Environment Institute, Southeast Finland Regional Environment Centre, Regional Council of Kymenlaakso, Thule Institute at the University of Oulu
	ISSN: 1238-7312 — ISBN: 952-11-1900-4, 952-11-1901-2 (PDF)
	No. of pages: 110 — Language: English
	Restrictions: Public — Price:
For sale at/ distributor	Edita Publishing Ltd., P.O. Box 800, FIN-00043 Edita, Finland, Phone +358 20 450 00 Mail orders: Phone +358 20 450 05, telefax +358 20 450 2380, Internet: http://www.edita.fi/netmarket
Financier of publication	Finnish Environment Institute, P.O.Box 140, FIN-00251 Helsinki, Finland
Printing place and year	Edita Prima Oy, Helsinki 2004

Kuvailulehti

Julkaisija	Suomen ympäristökeskus	Julkaisuaika Joulukuu 2004
Tekijä(t)	Matti Melanen, Jyri Seppälä, Tuuli Myllymaa, Per Mickwitz, Ulla Rosenström, Sirkka Koskela, Jyrki Tenhunen, Ilmo Mäenpää, Frank Hering, Alec Estlander, Marja-Riitta Hiltunen, Mika Toikka, Esa Mänty, Lasse Liljeqvist ja Juha Pesari	
Julkaisun nimi	Alueellisen ekotehokkuuden mittaaminen – mallina Kymenlaakson maakunta. ECOREG-hankkeen päätulokset	
Julkaisun osat/ muut saman projektin tuottamat julkaisut	Julkaisu on saatavana myös internetistä: www.environment.fi/publications	
Tiivistelmä	Ekotehokkuus on yksi keinoista, joilla pyritään kestävään kehitykseen. Kun huomio on viime vuosina monin tavoin kääntynyt Euroopan "alueisiin", on niiden kilpailukyvyn – ja tätä kautta myös ekotehokkuuden – edistämisestä tullut tärkeä kysymys alueilla. Suomen ympäristökeskus (SYKE), Kaakkois-Suomen ympäristökeskus, Kymenlaakson Liitto ja Oulun yliopiston Thule-instituutti toteuttivat 1.9.2002–31.12.2004 Life-hankkeen nimeltä "Alueellinen ekotehokkuus – esimerkkinä Kymenlaakso (ECOREG)". Työtä rahoittivat Euroopan yhteisöjen LIFE-ohjelma (ympäristön LIFE-tuki) ja Suomen ympäristöministeriö. Hankkeessa demonstroitiin ekotehokkuuskäsitettä ja ekotehokkuuden arviointia alueellisessa mittakaavassa esimerkkinä Kymenlaakson maakunta Kaakkois-Suomessa. Raportissa esitetään ECOREG-hankkeen päätulokset keskittyen erityisesti alueellisen ekotehokkuuden indikaattoreihin ja mittaamiseen (seuranta- ja arviointijärjestelmä), työssä käytettyihin prosesseihin ja menetelmiin sekä kehitettyjen menettelyjen käyttömahdollisuuksiin muualla Suomessa ja Euroopassa. Hankkeella on sekä suomen- että englanninkieliset www-sivut: http://www.ymparisto.fi/syke/ecoreg, http://www.environment.fi/syke/ecoreg.	
Asiasanat	Ekotehokkuus, alue, indikaattori, seuranta	
Julkaisusarjan nimi ja numero	Suomen ympäristö 735en	
Julkaisun teema	Ympäristönsuojelu	
Projektihankkeen nimi	ECOREG-hanke (LIFE02 ENV/FIN/000331	
Rahoittaja/ toimeksiantaja	EY:n Life-Environment-ohjelma, ympäristöministeriö	
Projektiryhmään kuuluvat organisaatiot	Suomen ympäristökeskus, Kaakkois-Suomen ympäristökeskus, Kymenlaakson Liitto, Oulun yliopiston Thule-instituutti	
	ISSN 1238-7312	ISBN 952-11-1900-4, 952-11- 1901-2 (PDF)
	Sivuja 110	Kieli Englanti
	Luottamuksellisuus Julkinen	Hinta
Julkaisun myynti/ jakaja	Edita Publishing Oy, PL 800, 00043 Edita, vaihde 020 450 00 Asiakaspalvelu: puh. 020 450 05, telefax 020 450 2380, Sähköposti: asiakaspalvelu@edita.fi, www.edita.fi/netmarket	
Julkaisun kustantaja	Suomen ympäristökeskus, PL 140, 00251 Helsinki	
Painopaikka ja -aika	Edita Prima Oy, 2004	

Presentationsblad

Utgivare	Finlands miljöcentral Datum: December 2004
Författare	Matti Melanen, Jyri Seppälä, Tuuli Myllymaa, Per Mickwitz, Ulla Rosenström, Sirkka Koskela, Jyrki Tenhunen, Ilmo Mäenpää, Frank Hering, Alec Estlander, Marja-Riitta Hiltunen, Mika Toikka, Esa Mänty, Lasse Liljeqvist och Juha Pesari
Publikationens titel	Att mäta regional ekoeffektivitet – erfarenheter från Kymmenedalen. ECOREG-projektets viktigaste slutsatser
Publikationens delar/ andra publikationer inom samma projekt	Publikationen finns tillgänglig också på internet www.environment.fi/publications
Sammandrag	Ekoeffektivitet är ett verktyg som används i strävandena att nå en hållbar utveckling. När de europeiska ”regionerna” under de senaste åren på många sätt har blivit föremål för uppmärksamhet, har också frågan om deras konkurrensförmåga – och därmed också deras ekoeffektivitet – blivit viktig i regionerna. Finlands miljöcentral (SYKE), Sydöstra Finlands miljöcentral, Kymmenedalens förbund och Thule-Institutet vid Uleåborgs universitet genomförde under tiden 1.9.2002-31.12.2004 Life-projektet ”Regional ekoeffektivitet – fallet Kymmenedalen (ECOREG)” Målet för projektet ECOREG var att ge en demonstration av begreppet ekoeffektivitet och mätning av ekoeffektivitet i regional skala. Till fallstudieregion valdes landskapet Kymmenedalen i sydöstra Finland. Den här rapporten presenterar projektets viktigaste resultat med särskild betoning på indikatorer för och mätning av regional ekoeffektivitet (uppföljnings- och bedömningssystemet), på de processer och metoder som användes i projektet samt på möjligheterna att tillämpa dessa förfaranden i andra delar av Finland och Europa. Projektet har www-sidor på finska och engelska: http://www.ymparisto.fi/syke/ecoreg, http://www.environment.fi/syke/ecoreg.
Nyckelord	Ekoeffektivitet, region, indikator, uppföljning
Publikationsserie och nummer	Miljön i Finland 735en
Publikationens tema	Miljövård
Projektets namn	ECOREG-projektet (LIFE02 ENV/FIN/000331
Finansiär/ uppdragsgivare	EG:s Life-Environment-program, miljöministeriet
Organisationer i projektgruppen	Finlands miljöcentral, Sydöstra Finlands miljöcentral, Kymmenedalens förbund, Thule-institutet vid Uleåborgs universitet
	ISSN: 1238-7312 ISBN: 952-11-1900-4, 952-11-1901-2 (PDF)
	Sidantal: 110 Språk: Engelska
	Offentlighet: Offentlig Pris:
Beställningar/ distribution	Edita Publishing Ab, PB 800, FIN-00043 Edita, Finland, växel +358 20 450 00 Postförsäljningen: Telefon +358 20 450 05, telefax +358 20 450 2380 Internet: www.edita.fi/netmarket
Förläggare	Finlands miljöcentral, PB 140, 00251 Helsingfors, Finland
Tryckeri/ tryckningsort och -år	Edita Prima Oy, Helsingfors 2004

ENVIRONMENTAL PROTECTION

Measuring regional eco-efficiency – case Kymenlaakso
Key results of the ECOREG project

The Finnish Environment Institute (SYKE), the Southeast Finland Regional Environment Centre, the Regional Council of Kymenlaakso and the Thule Institute at the University of Oulu conducted (1 September 2002 – 31 December 2004) a LIFE project named "The Eco-efficiency of Regions – Case Kymenlaakso (ECOREG)" (LIFE02 ENV/FIN/000331).

This current report presents the key results of the ECOREG project particularly focusing on the indicators of regional eco-efficiency and its measuring (monitoring and evaluation mechanism), the processes and methods used and the reproducibility and transferability of the ECOREG results in other parts of Finland and Europe.

Produced with the contribution of the LIFE financial instrument of the European Community.

The publication is also available in the Internet:
www.environment.fi/publications

ISBN 952-11-1900-4
ISBN 952-11-1901-2 (PDF)
ISSN 1238-7312

Edita Publishing Ltd.
PO Box 800, FIN-00043 EDITA
Phone +358 20 450 00
Mail orders:
Phone +358 20 450 05, fax +358 20 450 2380
Edita-bookshop in Helsinki:
Annankatu 44, phone +358 20 450 2566
www.edita.fi