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Summary

1 Objectives of the project

RAMEA is one of the 16 Projects financed by the INTERREG III C Program 2005-2007 under GROW, the Regional Framework Operation (RFO) whose main topic is to help Regions in adopting strategies coherent with the Lisbon & Gothenburg Agendas goals. Engaging citizens and integrating environmental systems is key to achieving balanced sustainable regional growth; this encapsulates the aim of the GROW partners who all come from high growth regions but share the ambition of "growth, but not at any cost".

The Regions involved are located at the four corners of the European Union: the nord Europe is represented by the South East England with its Development Agency (SEEDA) - the RFO Lead Partner - and the Hollandaise Province of Brabant; the East Europe is represented by Maloposka Region in Poland, while the West and South involve the Spanish Andalusia and the Italian Emilia-Romagna. The GROW projects activities all together aim to "green" economic growth (GREEN GROWTH); increase innovation and competition (BUSINESS GROWTH) while maximising the social potential of society (INCLUSIVE GROWTH). In so doing the GROW partners aim to integrate this "3 pillar (Planet, People, Profit)"sustainable development framework into their regional policies and strategies. The GROW partnership Regions have high performing economies but also a common vision for adopting measures in order to limit as far as possible the undesirable effects connected with high production and consumer society: the increasing pollution of all environmental media and the excessive use of natural resources. At this stage a question arises. What is the most effective way to limit these effects? At first some suitable knowledge tool are needed to help in setting up "sustainable" targets. Toward this specific topic the GREEN GROWTH as well as the other two strands has identified sub-themes and technical specifications used for helping in setting up the project proposal in 2 call for proposal rounds. The relevant sub-theme in our case is the "Resource Management" that includes amongst others the following project outlines: The Economy-wide tools that allows to assess the impacts of economic sectors on the environment and the material flows (environmental accounting)

On this specific sub-theme was then submitted on the second round, positively assessed and financed, the RAMEA project that involves 4 of the 5 GROW Regions: the South East England (UK) with 4 partner Organisations (SEE Development Agency, the SEE Regional Assembly, the Environmental Agency and Cambridge Econometrics), the Noord Brabant (NL) with Telos (the Regional Sustainable Development Institute), the Malopolska (PL) with MEERI (the Polish Academy of Sciences Mineral and Energy Economy-Division of Strategic Research) and the Emilia-Romagna Region (IT) with ARPA (the Regional Environmental Agency) that is the project lead partner. The project timeline is from May 2006 until October 2007.

As argued also from technical specifications the Environmental Accounting tools are identified as the reference framework for RAMEA project. In fact the main project output foreseen is the prototype at regional level of one of the most meaningful and powerful tools that help to bridging the Economy and Environment: the National Accounting Matrix with Environmental Account (NAM-EA). This is a table recording monetary and physical flows, developed since 1993 by CBS (Dutch Statistical Institute) and now currently updated in many EU Member States, at least at national level. Actually the extended project's title Regionalized nAMEA-type matrix maybe deserves a better explanation. The NAM is the "matrix version" of the national economic aggregates based on the European System of National Accounts (ESA 95), the standard code used at European level for the value added and other relevant indexes (i.e. Gross Domestic Products, Gross National Income etc.) comparable at global level because it's fully consistent with the revised world-wide guidelines on national accounting, the System of National Accounts (SNA 93) used for

code of measuring and compare the national macro-economy performances. In so far the national accounts is a central framework for the presentation and measurement of the economic stocks and flows within the Economy, that can be represented also in a table or matrix version.

For example the production processes can be described by the Supply and Use tables that are two matrices by industry and product describing with great detail the production processes (supply table) and the transactions in products (use table). A symmetric input-output table is a product-by-product or industry-by-industry matrix. It rearranges both supply and use in a single table with identical classification of products (or industries respectively) applied for both rows and columns. The matrix way to represent national accounts is recently even more stressed when the national accounting system was revised again on 2005 in order to reach a complete coherence between all the economic aggregates and the Supply and Use table via a fully integrated calculation approach. Whatever the version of ESA-data were available, the National Accounting Matrix represents the bulk information of an Economy more suitable to be used for economic analysis and for bridging the economy with the environment.

Nevertheless in order to take into account also the undesirable by-products of the Economy, namely the associated emissions and waste, these have to be recorded by physical units together with the monetary one used in the traditional economic measures. In that case the Environmental Accounts (EA) have to be adjusted to NAM defining an hybrid matrix that is commonly identified as a NAMEA-type matrix. This is one of the additional accounts, that has an international standard in the System of integrated Environmental and Economic Accounting (SEEA) Handbook, updated to 2003, at present the world-wide recognized conceptual reference on EA. Actually the developing process starts from the fundamental concepts of one of the SNA Chapter where possible environment and social “satellite accounts” adjusted to the main economic ones were established. Fulfilling the Rio declaration the United Nation Statistical Office with the United Nation Division for Sustainable Development and other International Institutes (OECD, World Bank, EUROSTAT) have been working on this line since 1993 and after a continuous revising process via internet consultation also, SEEA should be elevated by 2010 to an international statistical standard, firmly aligned with the SNA. Until now many pilot applications in a growing number of EU Member States, had regularly up-dated environmental statistics in EA framework. Moreover under EUROSTAT coordination some methodological reference guides have been defined. The most experienced one across the EU Countries is the "NAMEA for air emissions - compilation guide". And this one has been chosen as a common guide line for the RAMEA project output following the arising awareness on the global warming issues. Nevertheless the NAMEA-Air pilots are mainly referred to the national level, so that the project partnership work will be mainly directed to set up the better way to “regionalise” this method.

This “regionalization process” leaves some degrees of freedom to the project development from one partner Region to the other, depending on the characteristic of the national economic module and the environmental data available. This definition excluded only a pure “bottom-up” construction method of the regional modules. It means that no additional data collection has been planned and only the officially available data are used in order to maintain as far as possible a mutual interregional comparison opportunity both at international and interregional level. The common standard on which the data were collected should guarantee a mutual coherence amongst the 4 European Regions for a possible economic and environmental performance analysis at macro-level. Then by means of their own “tailor made” regionalization processes, the four RAMEAs–Air emissions prototypes where finally completed. In so far the slight unavoidable differences in building up methodology amongst partner Regions have not prevented Regions from benchmarking their results.

The benefit at EU level is self-evident: the improved statistical framework could be also the most effective analytical base to derive the structural indicators, used at EU level to measure the state of the art of European development strategy implementation, especially after the Spring Council in March 2005 when the Lisbon & Gothenburg Strategy has been revised and the Member States are asked to prepare National Plans after wide-ranging consultations with their Parliaments, social partners and local and regional governments. Moreover during this period of decreasing financial resources the Commission will be more careful to guarantee the coherence between the various institutional levels to increase the resources efficiency and this needs multilevel assessments. The measures must be, as far as possible, done by "quality certified" data and by methodologies to be shared between all UE Member States, including the new Members by the 25-EU enlargement. The best way to succeed in this challenge is to set up a coherent statistical framework like that used for measuring the economic aggregates (i.e. the Gross Domestic Product – GDP) and socio-economic indicators (i.e. employment rate) adjusting the environmental related impacts. This is the NAMEA structure.

Every Regional Partner has baseline experiences carried out before the beginning of the project, each of which with a specific excellence in complementary topics. Starting from the strong know-how of Nederland Region whose Dutch Statistical Institute (CBS) developed the first NAMEA since 1993; to the UK partner that is currently using an econometric model that allows to identify alternative scenarios for a conscious help to decision making processes; to the Polish partner that gives particular attention to the integration with the life cycle analysis of products as an additional criteria for the building-up methodology and the result interpretations; to the Italian one that has just some experienced Regional NAMEA pilots at regional level in two other Italian Regions to be capitalized in the new prototyping exercise for the Emilia-Romagna.

The RAMEAs potential applications are quite promising. They are suggested from one side by the experiences carried on by the partner Region that has forecasting econometric model (UK Region) tightly related with RAMEA tool because of the similar set of data involved. The NAMEA-type framework both at national and regional level allows to getting insight an economy-wide context that the policy/decision maker should try to modify. To highlight the specific sectors that have a key role in generating desirable or undesirable effects (in terms of economic or environmental performances) is the main model utility. This could be easily done by comparing the economic and environmental efficiency profiles of the productive sectors in a cross-section analysis at different geographical levels in order to detect what is due to the common national structure and viceversa what is a regional–specific one. In addition if more then one year description is available, it's possible to identify trends in time-series either for monitoring purpose or for determining factors of changes and their respective contribution (i.e. by decomposition analysis). Environmental Accounts are mainly production oriented in that the environmental pressures are allocated to industries or to private consumption of energy for heating and transportation only. Nevertheless if the accounts are linked to the Use, Supply or symmetric Input-Output tables of the economic accounts, the environmental pressures of the demand side is also calculated, in terms of embedded emissions in the final consumes. These emissions are traced through the production chain - the successive intermediate consumption of industries - thanks to the input-output account data and the Leontief approach. In fact the household consumption is also indirectly responsible for other air emissions that are attributed to the producers of the products they consume. Then the role of the consumers should be emphasized by promoting changing behaviour and by the introduction of environmental labelling schemes and a general interest in a more environmentally friendly life style. This could be part of an implementing strategy design in term of financial tools (taxes/incentives) or other motivational strategies in order to succeed in reaching some specific targets. As a complement to that *a latere* it should be analysed the sensitiveness of an economy to that specific award/penalties mechanism. In so far this model vocation is to inform policy/decision makers in

defining alternative scenarios after having identified the main responsible economic sectors in producing an undesirable pollution substances e.g. CO2 emissions or other Green House Effect gases; then to identify different goals for different actions enabling to reduce emissions, while disclosing e.g. the trade-off between the decrease in environmental pressures and possible impacts on income, employment etc.

The new programming period 2007/2013 of EU structural Funds should be a promising field for RAMEA prototype application in providing indications for the fine-tuning of the parameters of intervention or decision for the resources allocation by the Regional Managing Authority of Funds. An example in Italy (similarly in the other involved countries): it is worthwhile that the Public Investment Evaluation Unit of the National Department of Development Policies explicitly suggested the widespread use of Environmental Accounting tools including NAMEA at regional level to better allocate funds by means of a transparent and well informed decision process It will be encouraged also by the bill on Central and Local Government Environmental Accounting currently under discussion in Parliament and in Emilia-Romagna Legislative Assembly.

Summing up the potential of RAMEAs in supporting policies is twofold:

- from one side at macro level e.g. for Strategic Environmental Assessment of the Regional Operative Programs of the Competitiveness or Cohesion Funds and any other Regional Development Strategy ;
- from the other side at micro-level where every individual projects concurring in implementing the above strategy must be on line with the desirable target set-up at macro-level

For example in the case of low-carbon targets for the Structural Fund implementation process, RAMEA should help in defining the expected eco-efficiency of an economic sector and the balance with the others in terms of total CO2 emissions and eventually linked Emission Trading calculations. At the end of the project the reactions on the methodological results described above are very encouraging witnessed by the explicit recognition in a variety of dissemination events as a good practice to be wider diffuse in Europe.

In so far there are enough reasons for stating that RAMEA project results would deserve to be capitalised in a more robust way inside the promoting Regions at first in order to be successfully widespread into the other ones. The INTERREG IV C Program represents an opportunity on this line because of the capitalisation issue inspiring the whole program.

Nevertheless the just finalized RAMEA prototypes represent only one of the Environmental Accounting tools useful for orienting policy/decision makers in moving toward the Lisbon & Gothenburg targets in a more environment-friendly way. At a further step it should be explored the potential for an integration of this Regional NAMEA-type matrix with the intake of natural resources and energy, with new environmental themes (water, waste) and with social issues too. Meanwhile other complementary tools should be defined on the side of public responses quantification in terms of financial and non financial resources used by all institutional actors coping with natural resources degradation and depletion. This should be done in the view of setting up of all the valuable at regional (and local) level tools promoted by United Nation and EUROSTAT and systematized in SEEA 2003. The building activities for the 3 Sustainable Development pillars integrated knowledge is now started but it must be a continuous process with a tight link with the decision/policy makers in order to avoid an inevitable self-reference with no tangible results.

2 Review of past experiences

2.1 Report on Italian case studies of environmental accounting and NAMEA applications

According to the SEEA - System of Economic and Environmental Accounts (United Nations et al. 2003), the term “hybrid flow accounts” is used to denote a single matrix presentation containing both national accounts in monetary terms and physical flow accounts showing the absorption of natural resources and ecosystem inputs and the generation of residuals: the acronym NAMEA has become a generic term for this type of tables. It stands for “National Accounting Matrix with Environmental Accounts” and can find its roots in the analysis of “physical economy” by Leontief in 1970 (cited in SEEA 2003, 12) and in the work developed throughout the 1990’s by Statistics Netherlands (CBS - Centraal Bureau voor de Statistiek).

In 1994 the European Union, with its Communication COM (94) 670[1], identified NAMEA as a relevant part of the framework for environmental satellite accounts of the national accounts. Since that date, the 15 founding member states and some new EU member states have drawn up NAMEA tables to analyse interrelationship between the economy end the environment. The most advanced projects regard matrices on atmospheric pollutants (as for the environmental module), given the fact that Eurostat coordinated pilot projects in the period 1999-2001 (Eurostat 2001) and prepared standard tables for air emissions in the following four years (Eurostat 2004). Some countries have also carried out successful pilot projects regarding the possibility of extending the accounts of the environmental module to water extractions and discharge, to polluting emissions in water and to wastes (Cervigni et al. 2005).

The development of the NAMEA in Italy began, as regards the environmental module, with the description of atmospheric emissions and of resources’ intake. The Italian National Institute of Statistics, ISTAT, has developed the NAMEA aggregates starting with the 1990 matrix; the latest version refers to year 2002.

The following pages describe the work by ISTAT in introducing the NAMEA for the Italian context. In addition to that, waste accounts are under study for the national matrix. Table 1 shows the situation for NAMEA-type accounts developed in Italy at 2005. In 2006 two regional NAMEA projects, for Toscana and Lazio Region, are being implemented and are briefly presented in the following paragraphs.

[1] Directions for the EU on environmental Indicators and Green National Accounting - Integration of Environmental and Economic Information Systems.

Table 1 - Current situation of NAMEA-type accounts developed in Italy (adapted from Cervigni et al. 2005)

ENVIRONMENTAL ACCOUNTS		MAIN STATISTICAL INFORMATION PRODUCTS	TERRITORIAL SCALE	
			National	Regional
NAMEA-type accounts broken down by economic sector	Flow accounts (current or potential) of pollutants	Atmospheric emission accounts		
		Waste accounts		
		Wastewater accounts		
	Flow accounts of extraction of natural resources	Fossil fuel extraction accounts		
		Mineral extraction accounts		
		Biomass extraction accounts		
		Water extraction accounts		
		Endogenic vapour extraction accounts		

Produced regularly (for all or part of the field of observation): historical series updated annually or under production

Work in progress for the implementation of the first applications

Under study to start-up works or to define application after the development phase

2.1.1 Italian NAMEA 1990-2002

Objectives

The construction of a set of consistent air emissions account concerns the period 1990–2002 (Tudini et al. 2004). The work is carried by ISTAT, the Italian National Institute of Statistics, in collaboration with APAT, the Italian Agency for the protection of the environment and technical services.

The main objective of the work is to collect a consistent dataset, in order to link economic aggregates to the emission of atmospheric pollutants and to the intake of natural resources, based on a breakdown per economic activity and household consumption coherent with the classification proposed at European level.

The NAMEA tables take into consideration ten atmospheric pollutants and the intake of four natural resources[2].

Process

Italian NAMEA builds on three previous works done by ISTAT in the field of environmental accounting:

- the 1990 Italian NAMEA (Battellini et al. 1999, cited in Tudini et al. 2004), a first pilot NAMEA matrix comprising an Input-Output (I/O) based economic module, environmental accounts for six air pollutants - CO_2, SO_X, NO_X, N_2O, NH_3, CH_4 - as well as the direct intake from nature of virgin materials – endogenous steam, wood and fossil fuels, minerals, biotic materials - by economic activity;
- the 1991 and 1992 NAMEA matrices and the revised 1990 NAMEA (Coli et al. 2001, cited in Tudini et al. 2004), where the NAM module was enlarged, the range of

[2] Intake of natural resources are not calculated for year 2002.

pollutants included CO and NMVOC, and data on resources' intake where revised according to the European guidelines on material flows accounting (MFA);
- the 1999 NAMEA air emission accounts (Tudini et al. 2003, cited in Tudini et al. 2004), including two additional air pollutants, Pb and PM_{10}.

Methodology

NAMEA air emission accounts produced by ISTAT are prepared using as input the Italian CORINAIR[3] air emission data classified according to the process-based SNAP 97[4] nomenclature; input data are supplied by APAT. The matrices for the period 1990-2001 use the 2003 CORINAIR time series, while the NAMEA 2002 uses data from the 2005 APAT Air Emission Inventory[5].

The methodology mainly deals with the activities carried out to shift from the CORINAIR process-oriented source nomenclature (SNAP 97 codes) to the NAMEA socio-economic nomenclature (which includes economic activities described by NACE[6] codes plus household consumption), and in particular:

- the analysis of the qualitative link between each SNAP 97 process and NAMEA economic activities;
- the quantitative allocation of the emissions of each SNAP 97 process to the related NAMEA activities.

Since there is no standard connection between SNAP and NACE categories, the attribution of SNAP-based emission data to NACE-based accounts depends on the economic structure of the countries. In addition to that, only emission whose source is anthropic is taken into account, excluding all emissions related to natural phenomena. Table 1 shows the link used by ISTAT to match each SNAP 97 code taken into consideration for Italy to the related NAMEA activities. The first column reports the six-digit SNAP 97 codes, while the second one reports the NAMEA activities codes for which air emission is estimated.

Table 2 – Qualitative link between SNAP 97 codes included in the Italian NAMEA and NAMEA activities (Tudini et al. 2004)

SNAP 97 codes	NAMEA activities
010100	40
010200	40
010301	40
010302	40
010303	40

[3] CORe INventory of AIR emissions is a project performed since 1995 by the European Topic Centre on Air Emissions under contract to the European Environment Agency. The aim is to collect, maintain, manage and publish information on emissions into the air, by means of a European air emission inventory and database system. This concerns air emissions from all sources relevant to the environmental problems of climate change, acidification, eutrophication, tropospheric ozone, air quality and dispersion of hazardous substances (EEA 2005).

[4] Selected Nomenclature for sources of Air Pollution - developed as part of the CORINAIR project for distinguishing emission source sectors, sub-sectors and activities (EEA 2005).

[5] The main databases produced by APAT, using the CORINAIR methodology, are: database on national air emissions, database on provincial air emission, database on emission factors (APAT 2004).

[6] NACE is the acronym (from the French 'Nomenclature statistique des Activites economiques dans la Communaute Europeenne'-Statistical classification of economic activities in the European Community) used to designate various statistical classifications of economic activities developed since 1970 by the European Union; it is designed to categorise data relating to 'statistical units', in this case a unit of activity, for example an individual plant or group of plants constituting an economic entity such as an enterprise. It provides the basis for preparing a large range of statistics (output, inputs to the production process, capital formation and financial transactions) of such units. (EEA 2006)

SNAP 97 codes	NAMEA activities
010306	23
010401	40
010403	40
010406	23, 27
010500	60.2-60.3
020100	10, 95
020200	102
020300	01, 02, 05
030100	35, 40
030203	27
030204	26.2-26.8
030301	27
030302	27
030303	27
030304	27
030305	27
030307	27
030308	27
030309	27
030310	27
030311	26.2-26.8
030312	26.2-26.8, 27
030313	23
030314	26.1
030315	26.1
030317	26.1
030319	26.2-26.8
030320	26.2-26.8
030321	21
030322	27
040100	23
040200	23, 27
040300	27
040400	24
040500	24
040601	20
040603	21
040604	21
040605	15
040606	15
040607	15
040608	15
040610	45
040611	45
040612	26.2-26.8
040613	26.1
040614	26.2-26.8
040615	31
050101	10
050102	10
050103	23, 24, 26.2-26.8, 27, 40
050200	11-12

SNAP 97 codes	NAMEA activities
050300	11-12
050401	23
050402	60.2-60.3
050501	23
050502	23
050503	50-52
050600	40
050700	40
060101	34, 35
060102	50-52
060103	45
060104	103
060105	28
060106	35
060107	20, 36
060108	28, 29, 30-35
060201	28
060202	93
060301	25
060302	25
060303	25
060304	25
060305	25
060306	24
060307	24
060308	24
060309	24
060312	17
060313	19
060314	19
060401	26.1
060403	22
060404	15
060405	19, 20, 35, 36, 50-52
060408	103
060409	50-52
070100	01-95, 101
070200	01-95, 101
070300	01-95, 101
070400	01-95, 101
070500	01-95, 101
070600	01-95, 101
070700	01-95, 101
080100	75
080200	60.1
080300	61
080402	61, 101
080403	05
080404	61
080500	62
080600	01
080700	02

SNAP 97 codes	NAMEA activities
080800	10-37, 45
080900	101
090201	90
090202	24, 90
090203	23
090205	24, 90
090207	90
090208	90
090400	90
090700	01
091001	15, 17, 21, 23, 24, 27
091002	90
091003	90
091005	90
100100	01
100200	01
100300	01
100400	01
100500	01
100900	01

Once the link is defined, it is necessary to allocate the emission reported for each process to the related activities. If the process is linked to only one activity[7], all the emission from the process can be directly allocated to the activity. The process is more complex if the process is linked to more than one activity[8]. Different methods are used to distribute the emissions[9]:

- on the basis of energy use data by activity;
- on the basis of CORINAIR background data (point source data);
- on the basis of the number of full time jobs by economic activity.

Table 2 shows what methods are applied to SNAP 97 codes linked to multiple NAMEA activities.

[7] For instance SNAP 97 “010401” is linked to NAMEA activity “40”
[8] For instance SNAP 97 “010406” is linked to NAMEA activities “23” and “27”
[9] see Tudini et al. 2004, 13-17

Table 3 – methods used to distribute the emissions of SNAP 97 processes with multiple NACE associations (Tudini et al. 2004)

Type of process	SNAP 97 code	Corresponding NAMEA activities	Method (*)
Coke oven furnaces	010406	23, 27	CB
Combustion in commercial and institutional plants	020100	10-95	E
Combustion plants in agriculture, forestry and aquaculture	020300	01, 02, 05	E
Combustion in boilers, gas turbines and stationary engines	030100	35, 40	CB
Lime (combustion processes)	030312	26.2-26.8 for area emissions; 27 for point source emissions	CB
Coke oven (door leakage and extinction)	040201	23, 27	CB
Storage of solid fuel	050103	23, 24, 26.2-26.8, 27, 40	E
Paint application: manifacture of automobiles	060101	34, 35	CB
Paint application : wood	060107	20, 36	FTE
Other industrial paint application	060108	28, 29	CB
Application of glues and adhesives	060405	19, 20, 35, 36, 50-52	FTE
Passenger cars	070100	01-95, 101	E
Light duty vehicles < 3.5 t	070200	01-95, 101	E
Heavy duty vehicles > 3.5 t and buses	070300	01-95, 101	E
Mopeds and Motorcycles <50 cm3	070400	01-95, 101	E
Mopeds >50 cm3	070500	01-95, 101	E
Gasoline evaporation from vehicles	070600	01-95, 101	E
Automobile tyre and brake wear	070700	01-95, 101	E
National sea traffic within EMEP area	080402	61, 101	CB
Industry (off-road transport)	080800	10-37, 45	E
Incineration of industrial wastes (except flaring)	090202	1/3 of emissions to NACE 24 and 2/3 to NACE 90	CB
Incineration of sludges from waste water treatment	090205	1/3 of emissions to NACE 24 and 2/3 to NACE 90	CB
Waste water treatment in industry	091001	15, 17, 21, 23, 24, 27	CB

(*) CB: process whose emissions were distributed on the basis of CORINAIR background data;
E: process whose emissions were distributed on the basis of energy use data by activity;
FTE: process whose emissions were distributed on the basis of the number of full time employees by economic activity.

Results

NAMEA aggregates are realised for the period 1990-2002. The format is consistent to the Eurostat NAMEA air set of standard tables[10]. Economic and emissions data are filled in according to the most disaggregated level for which both of them are available.

NAMEA tables link economic aggregates (related to production, added value, intermediate consumption, employment and final consumption) to the emissions of ten atmospheric pollutants:

- Carbon Dioxide (CO_2)[11]
- Nitrous Oxide (N_2O)
- Methane (CH_4)
- Nitrogen Oxides (NO_X)
- Sulphur Oxides (SO_X)
- Ammonia (NH_3)
- Non-Methane Volatile Organic Compounds (NMVOC)
- Carbon Monoxide (CO)
- Particulate Matter (PM_{10})

[10] see Eurostat (2004), Annex 5.
[11] Including CO_2 from biomass combustion.

- Lead (Pb)

and the intake of four natural resources:

- endogenous steam
- fossil fuels
- minerals
- biomasses

SWOT analysis

The SWOT analysis of this case study is showed in the following Table.

Table 4 – SWOT Analysis for Italian NAMEA

Strengths • coherence of the methodology with Eurostat Guidelines • use of CORINAIR and APAT datasets • great detail in the emission allocation methodology • 12 years time series (1990-2002)	**Weaknesses** • no accounts on wastewater • no accounts on water extraction • not effective dissemination of the results • no synthetic indexes on environmental performance
Opportunities • waste accounts under study • creation of NAMEA-type tables for all Italian regions	**Threats** • tool not well known to decision-makers

2.1.2 A NAMEA for Toscana Region

Objectives

The first pilot project of regional NAMEA in Italy has been realized by IRPET, the Regional Institute for Economic Planning in Tuscany, in close collaboration with ISTAT. The main objectives of the study are:

- to link the wide knowledge on the interrelationships between regional economic sectors (that IRPET has been carrying on since for several years), with the pressures exerted on the environment;
- to build a tool useful for reports, studies, regional planning.

Process

IRPET regularly realizes studies and reports on the economic situation of Toscana Region. These analyses imply the use of economic input/output matrices, that IRPET builds by means of a multi-sector and multiregional econometric model. This model gives IRPET the possibility to produce economic accounting matrices, coherent with national accounting ones, for all Italian regions.

The awareness that the GDP is not sufficient to deep analyse the regional situation and the subsequent need of extend the study of economic indicators to the pressures that the economic sectors exert on the environment, led to the collaboration with ISTAT and to the first pilot project on a regional NAMEA matrix.

The matrix links the regional economic data with those of the regional inventory on air emission (IRSE). The work, which took a year and a half, is under publication and refers to year 2000.

Methodology

Input data on atmospheric pollutants are based on the regional inventory on air emission (IRSE), that refers to the year 2000. IRSE takes into consideration the following pollutants:

- Sulphur Oxides (SO_X)
- Nitrogen Oxides (NO_X)
- Non-Methane Volatile Organic Compounds (NMVOC)
- Carbon Monoxide (CO)
- Particulate Matter (PM_{10})
- Ammonia (NH_3)

The approach used for the inventory follows both the bottom-up and the top-down methodologies[12]. The classification adopted is coherent with the CORINAIR methodology, even if the SNAP 97 nomenclature has been partially modified in order to better adapt to the economic structure of Toscana region (Romanelli et al. 2004). The economic accounting is based on IRPET work on economic indicators and multi-sector econometric model.

A team of experts from ISTAT and IRPET was created to shift from the modified SNAP97 of IRSE to the NACE codes that apply to the Tuscan economy, in order to build a matrix which is coherent with both the national one and the Eurostat guidelines. However, because the IRSE data differs from the APAT data at provincial level (APAT 2004) the two matrices (national and regional) are not completely coherent[13]. By reason of input data, the NAMEA built for Toscana is not comparable to the pilot matrix built for Lazio Region (see Section 3).

Results

The realised NAMEA refers to year 2000. The matrix links atmospheric emissions and intake of natural resources with interrelationship between economic sectors.

The tool may help in the description of economic and environmental context of regional plans and programmes, and in particular the next Regional Energy Plan is going to use the results of the work. However its use in the definition of regional policies and strategies is not foreseen yet.

SWOT analysis

The SWOT analysis of this case study is showed in the following Table.

Table 5 – SWOT Analysis for NAMEA for Toscana Region

Strengths	Weaknesses

[12] Two methodologies are commonly used to realize an air emission inventory:

- bottom-up
- top-down

The first approach starts from data at local level and/or the direct knowledge of the emission source, while the second implies the use of input data at a national level and their allocation at local level using proxy variables. The bottom-up methodology need a great amount of input data, but gives more precise and accurate results. The top-down approach is quicker, but usually have a little level of accuracy. The combined use of the two methods is usually the most convenient for the building of a regional inventory.

[13] IRPET and ISTAT are taking into consideration the possibility of build a new matrix based on APAT data, in order to standardise the regionalisation process of the Italian NAMEA. This will allow to compare regional matrices and national one.

• coherence of the methodology with Eurostat Guidelines and Italian NAMEA • close collaboration with ISTAT • great accuracy in the economic part (NAM)	• input data on air emissions not coherent with national data (even if coherent with CORINAIR methodology) • no synthetic indexes on environmental performance
Opportunities • use of APAT data and comparison with other regional and national matrices	**Threats** • not used in the definition of regional policies/strategies • tool not well known to decision-makers

2.1.3 A NAMEA for Lazio Region

Objectives

The construction of a set of data on economic and air emission accounts for Lazio Region is the first application of a NAMEA matrix released by ISTAT at regional level. Data are produced for the project "Contabilità ambientale e sviluppo", developed by ISTAT and the Italian Ministry of Economy and Finance, with the aim of strengthening regional environmental accounts for the planning and the assessment of local development policies.

Process

As described in Section 1, ISTAT built national NAMEA accounts (regarding the emission of ten atmospheric pollutants and the intake of four natural resources) for the period 1990-2002. Moreover ISTAT, in collaboration with IRPET, realised a first pilot project of air emission accounts at regional level focussing on Toscana Region (see Section 2).

Following these two main experiences, ISTAT released the first NAMEA matrix for Lazio region, which refers to year 2000 (ISTAT 2006a). The matrix links the regional economic data with the emission of ten pollutants, using APAT data at provincial level (APAT 2004).

Methodology

The regional NAMEA is built coherently with the national one and thus the results are comparable. As for the contents, the regional NAMEA includes in the economic part (NAM) added value and employment but not production, because these data are not available at local level; in the environment part (EA) only air emission are taken into account, while the national matrix considers also intake of natural resources.

Air emission accounts are prepared using as input data APAT database at provincial level, while economic accounts at regional level are developed by ISTAT itself. Like the national matrix, the methodology deals with the problem of shifting from the SNAP 97 process-nomenclature to the NAMEA activity-classification. Regarding this process, some differences between the two level of analysis can be highlighted:

- some processes calculate emission only at a national level, thus these emissions can not be allocated to any Province[14];
- the analysis of emission from transport activities do not take into consideration the differences between emission from residents outside the national territory and emission from non-residents inside the national territory;
- emission data at regional level do not include CO_2 from biomass combustion;

[14] It is the case of processes "050202 Extraction, 1st treatment and loading of liquid fossil fuels – Off-shore activities" and "050303 Extraction, 1st treatment and loading of gaseous fossil fuels – Off-shore activities" (EEA 2005)

- the lower level of disaggregation of regional economic data in comparison with national ones, and the consequent differences as for the atmospheric emissions (see Table 6)
- the different level of aggregation for household consumption (transport, heating, other) at regional and national level, regarding COICOP classification[15].

The methodology adopted can be applied as a standard one, in order to obtain air emission accounts, coherent and comparable with national accounting, for all Italian Regions.

Results

NAMEA aggregates are realised for the year 2000. Economic aggregates (added value and employment) are linked to the emissions of ten atmospheric pollutants:

- Carbon Dioxide (CO_2)
- Nitrous Oxide (N_2O)
- Methane (CH_4)
- Nitrogen Oxides (NO_X)
- Sulphur Oxides (SO_X)
- Ammonia (NH_3)
- Non-Methane Volatile Organic Compounds (NMVOC)
- Carbon Monoxide (CO)
- Particulate Matter (PM_{10})
- Lead (Pb)

The collection of data obtained applying the methodology above to Lazio region led to:

- an analysis of air emissions in the region;
- a disaggregation of air emissions by economic sector;
- environmental profiles[16] by groups of economic activities;
- a disaggregation of air emissions by household consumptions (transport, heating, other).

[15] Classification of Individual Consumption According to Purpose (United Nations Statistic Division 2006). In particular, as for transport the regional data refer to "COICOP CP07 Transport", while the national data to "COICOP CP072 Operation of personal transport equipment". As for heating and cooking, the regional data refer to "COICOP CP04 Housing, water, electricity, gas and other fuels", while the national data to "COICOP CP045 Electricity, gas and other fuels". These differences imply that also the voice "other" is not comparable at regional and national level (ISTAT 2006b).

[16] The environmental profile of a given sector "allows […] for a comparison between the contribution provided to the national economy by the sector under examination (in terms of added value, employment, etc.) with the corresponding contribution to environmental pressures (measured by the relative share of total emissions of the different pollutants) (Cervigni et al. 2005: 10).

Table 6 – Disaggregation of economic activities for NAMEA Lazio (1st column) and Italian NAMEA (2nd column) (ISTAT 2006b)

Attività economiche nella NAMEA per il Lazio	Attività economiche nella NAMEA nazionale
01-02	01
	02
05	05
10-11-12-13-14	10
	11-12
	13
	14
15-16	15-16
17-18	17
	18
19	19
20-25-36-37	20
	25
	36
	37
21-22	21
	22
23-24	23
	24
26	26.1
	26.2-26.8
27-28	27
	28
29-30-31-32-33-34-35	29
	30
	31
	32
	33
	34
	35
40-41	40
	41
45	45
50--52	50-52
55	55
60-61-62-63-64	60.1
	60.2-60.3
	61
	62
	63
	64
65-67	65-67
70-74	70-74
75	75
80	80
85	85
90-93	90
	91
	92
	93
95	95

SWOT analysis

The SWOT analysis of this case study is showed in the following Table.

Table 7 – SWOT Analysis for NAMEA for Lazio Region

Strengths • part of a wider project, with the aim of strengthening regional environmental accounts • standard methodology, coherent with Eurostat Guidelines • coherent and comparable with the Italian NAMEA • analysis of data (environmental profiles of economic sectors, disaggregation of air emissions)	**Weaknesses** • top-down approach for air emissions is not well linked to regional context • first regional NAMEA matrix, not calibrated with other regional examples • no synthetic indexes on environmental performance
Opportunities • the methodology can be applied to other Italian Regions	**Threats** • not used as a decision support system • tool not well known to decision makers

2.1.4 Conclusion

We have discussed three case studies of the application of NAMEA-type matrices to the Italian context. The first describes the building of the Italian NAMEA, while the others relate to the application of the methodology to two regional contexts, Lazio region and Toscana region. Two main aspects can be highlighted starting from this analysis.

The first aspect is linked with the building of the matrix and can be broken down in the following issues:

- the environmental part of the matrix (EA);
- the input data used;
- the methodology followed to fill in the matrix;
- the reliability of the results.

As for the environmental accounts, all studies link the economic part with the analysis of related emissions in air. Natural resources are taken into account in the Italian matrix from 1990 to 2001 (but no more for the year 2002) and in the NAMEA for Toscana region. However, like the main NAMEA projects in Europe, the study of atmospheric pollutants is the most advanced. Waste accounts are under study only at national level, but no work has been done to introduce waste and water accounts at regional level.

The issues taken into account in the EA part are linked with the problem of input data which, as regards to atmospheric pollutants, are the air emission inventories built following the CORINAIR methodology. Italy and Lazio use data from APAT inventory (the regional data are actually disaggregated at local level using proxy variables), while NAMEA for Toscana is based on IRSE, the regional inventory on air emission. APAT data can be obtained for all Italian regions (that allows the comparison of the matrices and the benchmarking between regional and national situations), but emissions from regional inventories are often more tailored to the local context, thus for some aspects more precise.

All studies adopted a methodology coherent with Eurostat Guidelines on air emission accounts. Toscana region developed its study in close collaboration with ISTAT, even if the final results can not be compared to other two studies because of the difference in the input data. Actually, the only methodology recognised as standard by ISTAT is based on APAT datasets.

This lead to the last point: no project deals with reliability analysis. In our opinion, a comparison between results obtained with APAT data and those obtained using regional inventories, may highlight the main differences between the two methods and lead to some considerations on the reliability of the results.

The second aspect is connected to the communication of the results and the use of the matrix as a decision support tool. From the analysis of the case studies, we can see that the NAMEA-type matrix, even if identified as fundamental tools for environmental accounting by European Union, are not well known to decision makers, thus not used in the definition of national/regional policies and strategies. It is fundamental to build an easy-to-use matrix, in order to analyse the results obtained with reports and graphs. To obtain the maximum benefit, it is recommended to build synthetic indexes in order to highlight the environmental performance of an economic sector (like GDP does for the economic part) and give decision makers a useful tool for development strategies.

2.2 Report on Dutch case study of environmental accounting and NAMEA applications[17]

In the Netherlands two kinds of methodologies have been proposed to extend the national accounts regarding environmental problems. On the one hand there are the supporters of the idea that environmental damages and the use of the environment could be measured in monetary terms with the help of estimations and assumptions. Given the monetary values of environmental damages, these costs should be subtracted from the conventional Net National Income (NNI). The supporters of this idea have developed many different approaches to calculate an indicator, like the "Green National Income" (GNI) (Lange2003).

On the other hand, some scientists, especially coming from national accounting, reject this idea, because of the fact that strong assumptions must be made to estimate the monetary value of an environmental damage and that in general no market prices for environmental goods exist. These scientists propose just another approach, the so called "National Accounting Matrix including Environmental Accounts" (NAMEA). The NAMEA was developed and pioneered in the Netherlands and has therefore also been widely discussed. We will limit our discussion here towards the experiences of the Dutch NAMEA. However since the Dutch NAMEA has become somewhat of a standard, we will also discuss it's strengths and weaknesses on a more theoretical level.

2.2.1 The Dutch National NAMEA from 1993 – 2004

Objectives

The Dutch NAMEA combines national accounts and environmental accounts in a single matrix. It is a hybrid accounting system. The NAMEA is a so-called satellite accounting matrix (SAM), as it is described in the SNA 93 (Chapter XXI). The NAMEA system contains no economic assumptions; it is only descriptive. It maintains a strict borderline between the economic and the environmental aspects. It is represented in monetary units on the one hand and in physical units on the other hand. Therefore, the resulting indicators are measured in physical units. The interrelationship between the economy and the environment has two perspectives, an economic one and an environmental one. The economic perspective contains the physical requirements in the economic processes, like energy and material and spatial requirements. The environmental perspective puts forward the consequences of these requirements with respect to the availability of the natural environment. Consequently, the optimal allocation of natural resources requires the consideration of both perspectives.

The conception of the NAMEA system in the Netherlands is based on the work of Keuning (1992, 1993) de Haan & Keuning (1996) and de Boo, Bosch, Gorter & Keuning (1991, 1993). The origin of their work is the input-output approach of Leontief (1970).

The objective of the NAMEA has been to provide national policy makers with an instrument to help analyse the impact of certain environmental measures, in all the various stages of the policy cycle.

Process

Following the NAMEA's conceptual design by Keuning (1993), in co-operation with others, the first 'pilot' NAMEA for the Netherlands was compiled in 1993. This pilot greatly benefited

[17] This report is based on the paper ' Input-Output Based Environmental Modeling and Accounting; International Discussions as Reflected in Developments in the Netherlands' by Peter J. Stauvermann and Albert E. Steenge.

from the work carried out on environmental indicators at the Ministry of the Environment (Adriaanse 1993). Subsequently, the Dutch National Accounts Advisory Committee, a sub-committee of the Central Statistical Committee that decides upon the CBS[18] work programme, advised a regular compilation of this framework. Since 1994, the National Accounts Department and the Environment Statistics Department at the CBS jointly compile a NAMEA every year.

The Dutch NAMEA extends the conventional national accounting matrix with two additional accounts. One additional account is the account for environmental problems like the greenhouse effect or the ozone layer depletion. The second additional account is for environmental substances, like carbon dioxide or sulfur dioxide, where these substances are expressed in physical quantities, like kilogram, tons et cetera. The selection of themes and substances follows those environmental themes which were most important in the view of the Netherlands Ministry of Housing, Spatial Planning and the Environment (1989, 1990, 1992, 1993) and with an approval of the Dutch parliament (Tweede Kamer 1996)). The ministry had designed a single indicator each of the environmental themes, by weighing together the emissions that contributed to each theme.[19] It can be said, that the Dutch NAMEA generates consistent summary indicators for those environmental problems, which are considered to be most pressing at the political level in the Netherlands.

Methodology

The first additional account is the account for environmental problems like the greenhouse effect or the ozone layer depletion. The selected environmental themes are partly global environmental problems and partly national and local environmental problems. The selected themes and substances are (Keuning, van Dalen & De Haan 1999, p.18-22):

1. Greenhouse effect
2. Ozone layer depletion
3. Acidification
4. Eutrophication
5. Waste
6. Waste water
7. Fossil fuels

The second additional account is for environmental substances, like carbon dioxide or sulfur dioxide, where these substances are expressed in physical quantities, like kilogram, tons et cetera. The selected environmental substances are:

1. CO_2
2. N_2O
3. CH_4
4. $CFC's$ and halons
5. NO_x

[18] CBS: Centraal Bureau voor de Statistiek; nowadays called Statistics Netherlands

[19] The indicators refer to Adriaanse (1993). The numbers for the environmental themes are aggregated with the help of the IPCC conventions. This means e.g. that one kg of CO_2 emissions equals one global warming potential, one kg of N_2O emissions equals 270 global warming potentials, and one kg of CH_4 equals 11 global warming potentials. An extended explanation about the aggregation of different environmental substances is given in the Annex B of de Haan, Keuning & Bosch (1994). The authors agree with the view that the kind of aggregation can be doubted, because the connections of chemical substances and their implications to a specific environmental theme are not really known in natural science. We will come back to this issue in the SWOT analysis.

6. SO_2
7. NH_3
8. P
9. N

The NAMEA is centered around a set of tables, which give an overview of relevant relations between the flow accounts and data on environmental changes. De Haan (2001, p. 12) gives a figure about the scope of the NAMEA system:

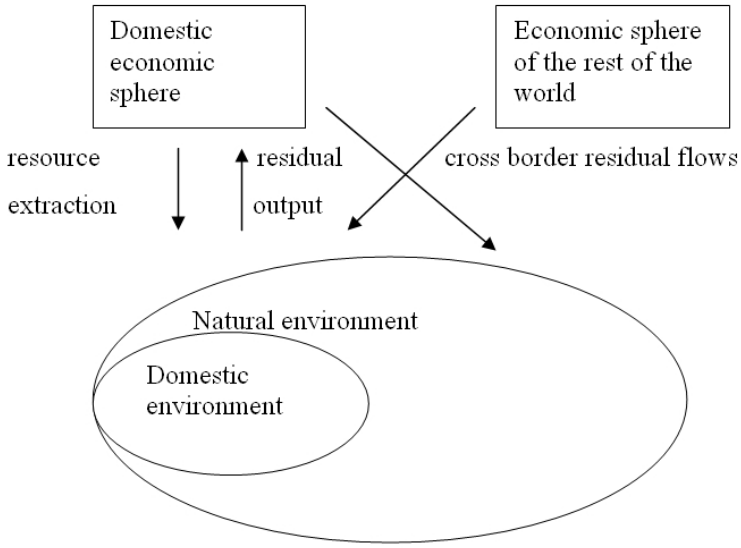

Figure 1 - Scope of the NAMEA system

The NAMEA distinguishes two main groups of activities, households and industries including public services. The production account is classified by branches of industry (SBI-93, comparable to NACE).

Emission totals in regular emission statistics are usually bounded from a geographical perspective. The Dutch Emission Register records the emissions from all sources on Dutch territory. The economic actors in the national accounts include all households, corporations and government units that have their centre of economic interest in the economic territory in a country (this includes besides domestic territory also airspace, territorial waters etc.) All land and buildings are by definition owned by resident entities.

Emission data from the Dutch Emission register are largely consistent with the national accounts with the exception of international transport. The transport of goods and people from one country to another (as an economic activity) is recorded in the national accounts of the country of the resident carrying out the transport service. The same holds for total energy consumption of these transport services. Therefore mobile pollution sources related to international transport carried out by planes, ships, and cars belonging to the national economy may result in pollution outside the domestic or economic territory.

Results

The NAMEA contains besides the conventional economic aggregates, a summary of environmental indicators. As a result it could be recognized how much a specific economic activity contributes to the GDP, employment, exports et cetera and how much it contributes to the major environmental problems, like the greenhouse effect, ozone layer depletion et cetera. For example, in the Dutch NAMEA 1994 tables it can be seen that the production of electricity in the Netherlands contributes only 1% to employment, but it contributes 25 % to the total emission of CO_2. NAMEA tables for different years are now available, which makes it also possible to recognize how the profiles of economic activities changed over time. For specific periods, as is explained in De Haan & Keuning (1995) or Keuning & de Haan (1996, 1997), it is possible to decompose the changes in emissions by industry into several effects:

1. Demand composition shift effects
2. Output growth effects
3. Eco-efficiency change effects

The first effect can be positive or negative in the sense that the claims to use the natural environment are reduced. The second effect is negative, because more output means in general an increased use of the natural environment, because of the laws of thermodynamics. The third effect is positive, because of technological progress. De Haan (1996) for example has connected the NAMEA with data on estimated costs and emissions reductions of a range of potential energy-saving measures by industry in the Netherlands. He came to the conclusion that the Dutch economy would be better off to some extend, if the most efficiency measures are applied first. However, if the norms for CO_2 emissions set by the government were too restrictive the result would be the reverse.

The NAMEA has also been used to predict the possible outcomes of a specific policy. To give an example de Boer, de Haan & Voogt (1994) make use of a model with the data from the NAMEA to estimate the consequences of reducing the pollution levels to norms set by the Dutch parliament. Other examples of the use of information gathered in the NAMEA include for instance an analysis of the possible effects of a shift in tax incidence, from labour to energy use, and a study for the introduction of catalytic converters into cars.

SWOT analysis

We have reviewed the Dutch NAMEA from two perspectives. First we have looked at it from a theoretical perspective. Since the Dutch NAMEA can be considered as a very advanced example, its advantages and drawbacks have a very high theoretical content. Furthermore we have thought about applying the methodology in a the regional context. This has added some more arguments to the analysis.

Strengths

The first major strengths of the NAMEA approach is a theoretical one: the NAMEA system contains no economic assumptions; it is only descriptive. It maintains a strict borderline between the economic and the environmental aspects. It is represented in monetary units on the one hand and in physical units on the other hand and environmental damages are not defined in monetary terms.

A second, more practical strength is that it is no problem to extend the NAMEA system with additional environmental themes and substances. The selection which kind of environmental problems should be represented depends on local circumstances and it can be a political decisions and not on the decisions of scientists.

Weaknesses

A weakness in the system is the aggregation of the environmental substances to the different environmental themes. This helps policy makers to better understand the different indicators, however the conversion factors are sometimes a bit crude. The NAMEA only incorporates environmental pressure indicators. When these are aggregated into the environmental themes, the indicators give only the potential contribution to a theme: Global Warming Potential (GWP), Acidification Potential (AP). The actual effects of the emissions depends on geographical circumstances, weather influences, like temperatures and so on and are not incorporated in the NAMEA.

Opportunities

It is no problem to integrate social accounts into the NAMEA system. This is done in the so-called System of Economic and Social Accounting Matrices Extensions (SESAME). [6] This way it becomes possible to get new insights for the question who should pay for the environmental damages. Telos has developed a provincial Sustainability Balance Sheet, based on the triple bottom line ‘ people’ ‘planet’ ‘profit’ and such a regional SESAME approach will very nicely supplement the information in our sustainability balance sheet. See also De Haan & Kee (2004), for an discussion of the use of a NAMEA in accounting for sustainable development.

Threats

A more practical threat regarding this specific RAMEA project might be the availability of data. Although environmental data will be relatively easy to obtain on a regional (provincial) level, the construction of an Input – Output matrix on a regional level might prove to be problematic. At the moment we are still investigating the availability of data and we will be talking to CBS about this problem. Next week, during the kick-off meeting in Guilford we hope to be able to give some indications on this topic. In a worst case scenario it will always be possible to use the national NAMEA and regionalise it based on some assumptions. A shift-and-share analysis of the industrial sector of Brabant compared to the national average might be a good solution for some of the problems.

Table 8 - Summary of SWOT Analysis

Strengths	Weaknesses
• A consistent and objective way of presenting national economic and environmental accounts • Strict borderline between economy and the environment • No monetary valuation of the environment • Environmental themes and substances accounts can be easily extended or adapted	• Aggregation of environmental themes
Opportunities	**Threats**
• Extending NAMEA with social accounts into a SESAME • Incorporating information into the Telos' Sustainability Balance Sheet	• Data availability

2.2.2 Conclusion

It can be concluded, that over the last decade Dutch NAMEA has been a multi-purpose information system, which has been able to inform the public and policy-makers about the status quo of the environmental assets and environmental pollution in The Netherlands. The NAMEA has provided policy-makers with a data-framework, which can be used to sketch the trade-off between prevention of environmental damages and macro-economic policy objectives, both from an ex-post and ex-ante perspective.

There is no experience in the Netherlands with regional NAMEA's, although regional accounting matrices for regional accounts have been constructed in the past. There is sufficient interest among the provincial authorities into questions of trade-offs and geographical scales to warrant an investigation about the possibilities of a RAMEA.

2.3 Report on Polish case studies of environmental accounting and NAMEA applications

The concept of NAMEA matrix was created in Holland at the beginning of the nineties. The purpose of the matrix creation was the assessment of the pollution indicators on the macro and meso level. The indicators are organized into the environmental themes, eg. global warming potential, ozone depletion, acidification, eutrophication, etc. The NAMEA matrices are used as information database, and in analysing, modelling and forecasting of changes in the economy and environment.

NAMEA is a statistical system, which means that it does not contain and modelling and the accounts and indicators are expresses in the natural units—the regular National Accounting Matrix is extended with two additional accounts: for environmental substances and for environmental themes.

The environmental information in Poland are gathered by the Statistical Office and include the data regarding:

- Use and protection of land and soil. useful minerals
- Resources, use, pollution and protection of waters
- Resources, use, pollution and protection of air
- Nature and biodiversity protection
- Wastes
- Radiation, noise
- Inspective activity and evaluation of environment degradation effects
- Economic aspects of environment protection
- International comparisons

The NAMEA matrix for Poland was designed as the pilot project under the title "Environmental Protection Expenditure Account in Poland" and was completed in 2005 by Polish Statistical Office and Foundation of Environmental and Natural Resources Economists.

2.3.1 Polish pilot study

Objective

The general objectives of the pilot project under the title "Environmental Protection Expenditure Account in Poland" were:

- preparation of EPEA account tables (A – Use of environmental protection services; B – Supply of environmental protection services; C – Financing),
- integration of the available data on environmental protection expenditure with national accounts resulting in the creation of the national economic account system in the domain concerned,
- creation of expertise and procedures necessary for the systematic preparation of environmental protection expenditure accounts,
- development of methodology of calculation of sustainable development indicators for the needs of national economy.

EPEA – Environmental Protection Expenditure Account

According to the project report, "the Environmental Protection Expenditure Account (EPEA) is the module of SERIEE (European System for the Collection of Information on the

Environment). The accounts in SERIEE focus in particular on accounting for the expenditures incurred by economic units to pursue activities and measures to safeguard the environment against degradation and depletion of resources, whether those activities and measures are to prevent these phenomena or to restore conditions prior to the onset of the phenomena. The main objective of these accounts is to achieve the following objectives:

- to quantify the financial contribution of the various institutional sectors to the individual fields of action on the environment;
- to evaluate the outcome of the activities and measures deployed in terms of contribution to reducing the pressures of the socio-economic system on the environment."

The EPEA is prepared to make the evidence of the data pertaining to the economic and monetary transaction in the economy sectors with the regard to the environmental protection.

The final report states that the objectives of EPEA include:

- "quantifying the total expenditure borne by the economy to protect the environment;
- quantifying how these expenditures are distributed among individual institutional sectors of the economy;
- quantifying resources of the productive system which, in particular, are used for pursuit of economic activities
- specifically created because of the need to protect the environment (i.e. quantifying the output from such activities)."

The EPEA project data was organised into five thematic tables:

- Table A— National expenditures on environmental protection
  - final consumption,
  - intermediate consumption,
  - gross capital formation for the purpose of performing characteristic activities and the form of purchase of specific products,
  - specific transfers,
  - financing received by resident units from rest of the world.
- Table B—output from environmental protection services
  - specialised and non-specialised characteristic producers in their position as producers: production costs and earnings from the sale of environmental-protection services,
  - specialised and non-specialised characteristic producers in their position as beneficiaries of specific transfers (investment subsidies and other current and capital transfers).
- Table B1—supply and demand for environmental protection services
  - users of characteristic services: purchases on the internal market; imports; self-supplies, in respect of characteristic services produced on an ancillary basis; or
  - specialised and non-specialised characteristic producers: sales on the internal market; exports; output of characteristic services intended for self-supply in the case of characteristic activities performed on an ancillary basis.
- Table C— Flows of financing in environmental protection expenditures
  - market transactions taking place between various institutional sectors and between these and the rest of the world,
  - specific transfers taking place between various institutional sectors and between these and the rest of the world,
  - expenditure self-financed by each institutional sector.

- Table C1—financial burden of environmental protection
  - expenditures on environmental protection incurred by various units as financers,
  - environment-related taxes collected by the government as beneficiary,
  - the net operating surplus earned by corporations as specialised characteristic producers,
  - profits earned by corporations and households as non-specialised characteristic producers,
  - expenditures on payment of interest on fixed capital incurred by the various units as financers.

Table 9 - Summary of SWOT Analysis

Strengths • All sectors of the economy as well as the said domains of environment protection seem to be of a high quality • Prepared within the SERIEE (European System for the Collection of Information on the Environment) framework	**Weaknesses** • The value of expenditures for connected and adapted products is available only for household sector. The expenditures for environment protection of other sectors also include expenditures for connected and adapted products, however they are not separated, • data concerning other then subsidies variables of foreign sector are not available • data concerning the value of fixed assets for environment protection are not available in Poland – therefore filling up the Table C1 was not possible
Opportunities • The developed methodology can be applied to the regional level	**Threats** • The outcomes are too complex to be used as a decision making tool

2.4 Report on United Kingdom case studies of environmental accounting and NAMEA applications

The purpose of this study is to assess the environmental accounting in the UK at a national and sub-national level. The national UK Environmental Accounts (NAMEA) provide a full scope of statistical analysis for environmental and sustainability indicators at the national level. Currently these accounts are not replicated with the same authority at the regional level, though some information is available.

This study focuses on three closely linked but very different regional tools, to assess how well they act as RAMEA type accounts, by determining the scope of the data sets, the depth, in terms of both time series and geographical disaggregation, and the usefulness of the statistics in terms of comparison, scenario analysis and policy recommendation.

Specifically this study will outline the UK Environmental Accounts and then the various regional tools, Environmental Footprints, Regional Economy-Environment Input Output Model (REEIO) and Resource and Energy Analysis Programme (REAP). The aim of this study is to provide a SWOT analysis of the various tools, with a combined in depth look at the methodologies behind each tool, to provide insight as to:

- What already exists in terms of RAMEA type accounts
- How could RAMEA accounts best be constructed in the UK

2.4.1 UK Environmental Accounts

Objectives

The UK Environmental Accounts are “satellite accounts” to the main National Accounts. They are designed to facilitate analysis of the wider impact of economic change and use similar concepts and classifications of industry as the National Accounts. The classifications reflect the framework by the European Union and United Nations for developing such accounts.

The UK Environmental Accounts provide information on the demands that UK economic activity places on the environment and on the importance of natural resources in the economy. The information in the UK Environmental Accounts is separated into three dimensions in order to assess the various environmental effects.

- Natural Resources
- Physical Flows
- Monetary

Natural Resources include oil and gas extraction and reserves, land cover, forestry and fishing. Physical flows include fossil fuel and energy consumption, atmospheric emissions, material flows, waste and water. The monetary part of the accounts focus on environmental taxes and environmental protection expenditure.

Process

The UK Environmental Accounts are published in the spring and autumn of every year by the Office of National Statistics, who also collect and publish the National Accounts.

Methodology

The UK Environmental Accounts have three separate dimensions.

- Natural Resources
- Physical Flows

- Monetary

Natural Resource Accounts include oil and gas extraction, land cover, forestry and fishing. Oil reserves include both oil and liquefied products obtained from gas fields, gas condensate fields and associated gas in oil fields. Gas reserves are the quantity of gas expected to be available for sale from dry gas fields, gas-condensate fields and oil fields with associated gas. The descriptions are based on the terminology introduced by the Department for Trade and Industry (DTI) in order to improve the general understanding and to move the accounts in line with those used in the gas and oil industry. Reserves are grouped into the categories of reserves, potential additional reserves and undiscovered resources. Simulation models using Monte Carlo techniques are used each year by the DTI to assess the likely existence of undiscovered oil and gas fields in the UK Continental Shelf. The assessments are presented as a range. Monetary assessments of oil and gas are made using the present value method.

Land cover estimates are based on the Countryside Survey 2000 (CS2000) a stratified sample survey that used detailed field recording and mapping to provide information on the stock and condition of habitats and landscaped in Great Britain. The results of CS2000 are compared to the results of a 1990 survey and then changes in land cover are estimated over the period.

Physical flows include energy consumption, atmospheric emissions, material flows, waste and water. The energy consumption dataset provides estimated of total energy used by each of the 93 industries and further estimates broken down into the different fuel types. The data unit is tonne of oil equivalent (toe) to enable different fuels to be compared to each other. The energy consumption dataset is broadly consistent with the Digest of UK Energy Statistics (DUKES) published by the DTI.

The UK is required to publish emissions data under different international agreements for key air pollutants. The emissions data comes from the National Atmospheric Emissions Inventory (NAEI) maintained by the National Environment Technology Centre (Netcen). Each year the Environmental Accounts present estimates of pollutants directly emitted to the atmosphere by each industrial sector. The figures are on a national accounts basis and include emissions from UK households and UK residents transport and travel abroad, and are therefore different to the data published by the Department for Environment, Food and Rural Affairs (DEFRA) which are based on the Kyoto Protocol obligations and therefore cover emissions on UK territory only.

Results

The frequent publishing of the UK Environmental Accounts has raised the profile of environmental and sustainable policy development, yet more than this, it has allowed, albeit at a national level, measured analysis on UK environmental policy.

The UK Environmental Accounts cover annual data for 1990-2004 in most cases, however for some variables data are available from 1970.

The accounts take into account:

- natural resource stocks (land cover, fuels, timber)
- energy use in terms of tonnes of oil equivalent, greenhouse gas emissions (CO_2, CH_4, N_2O, HFC, PFCs and SF_6)
- acid rain precursor emissions (SO_2, NOx, NH_3[4])
- material flows (biomass, minerals, fossil fuels), total waste arisings (by types and sector)
- radioactive waste
- consumption of water resources (by industrial sector)
- environmental taxes (revenues)
- environmental expenditure

There is also a bridging table which explains the differences between the UK Environmental Accounts and the IPCC measure of emissions.

Table 10 - UK Environmental Accounts - Summary of SWOT Analysis

Strengths	**Weaknesses**
• coherence of the methodology with Eurostat and UN Guidelines • full scope of data • 14 years time series (1990-2004)	• not effective dissemination of the results • no synthetic indexes on environmental performance
Opportunities	**Threats**
• creation of equivalent tables for all UK regions	• too aggregated for effective regional policy

2.4.2 The Ecological Footprint Accounts

Objectives

The Ecological Footprint Accounts are designed to compare the resources we use and the resources nature provides us. The accounts can be used to assess resource use between different geographical areas as the unit used to measure the Ecological Footprint of any particular geographical area is standardised.

Process

Ecological Footprint Accounts are developed by various organisations including Stockholm Environmental Institute (SEI) and Best Foot Forward.

Methodology

The Ecological Footprint is a calculation that estimates the demand of human activities on nature. It measures the resources consumed by population and nature's supply. It is possible to calculate the current Ecological Footprint for the UK as a whole, at the regional and devolved county level or for every local authority.

The Ecological Footprint calculates how much productive land and sea is needed to provide the energy, food and materials we use in our everyday lives, and how much land is required to absorb our waste. It also calculates emissions generated from burning oil, coal and gas and how much land is required to absorb this.

Ecological Footprints are standardised into global hectares, in order that they can be compared between different regions and countries, regardless of where on the globe their resources are harvested. This is an important feature of the Ecological Footprint as it allows comparison between different UK local authorities, regions, devolved countries and national results. A global hectare is one hectare of biologically productive space with world-average productivity.

Results

The accounts are being used by individuals, business managers, government administrators and sustainability practitioners around the world, in an attempt to better manage ecological assets and move towards sustainability. The accounts have certainly raised the profile of sustainability because they allow a single indicator snapshot of resource use to be compared globally.

A report by SEI "The Ecological Footprint of Greater Nottingham and Nottinghamshire" investigated the composition of The Ecological Footprint in the Nottingham area. The food sector was the largest contributor to The Ecological Footprint accounting for 22%, and the report suggests that this could be addressed by localising food production and through healthy eating campaigns. Households energy consumption accounted for 20% of The Ecological Footprint, despite the fact that there is potential for almost zero energy buildings to exist. The results also showed that in total The Ecological Footprint for Greater Nottingham in total was lower than the UK average.

Table 11 - UK Ecological Footprint Accounts - Summary of SWOT Analysis

Strengths • ease of comparison between geographical areas • visible composition of indicator • well known by policy makers • allows scenario projections	**Weaknesses** • not intrinsically clear what an ecological footprint is • too simplified an indicator for effective policy
Opportunities • integration with other indicators and statistics	**Threats** • not comprehensive enough in terms of outcomes

2.4.3 Regional Economy-Environment Input-Output Model (REEIO)

Objectives

The objective for Regional Economy-Environment Input-Output Model (REEIO) was to provide policy makers with a tool that would assist them in analysing regional policies and programmes with regard to the economy and environment. By doing this is would provide a firm basis for sustainability appraisal, strategic environmental assessment and benchmarks for the resource productivity of businesses and sectors.

REEIO is a custom built computer software package that developed by Cambridge Econometrics originally as part of the Reward project. REEIO builds on the established strength and reputation of an existing model, the Local Economy Forecasting Model (LEFM), which has been developed jointly by Cambridge Econometrics and the Institute for Employment Research. It enables the user to consider the potential impact of the economy on a number of key environmental pressures, waste, energy, emissions and demand for water, given various alternative assumptions.

Process

REEIO was originally developed by Cambridge Econometrics as part of the Reward project, a partnership led by the Environment Agency (EA) with the participation of Regional Development Agencies and the National Assembly for Wales. It has since been supported by SCPnet (see http://www.wwflearning.org.uk/scpnet/ for more information).

REEIO utilises the **Region Resource Use and Emissions Database** which was commissioned by SCPnet, which in turn draws on data from the Environment Agency Commercial and Industrial Waste Survey 2002/2003 and data on energy use and emissions to air provided by Netcen (who maintain the National Atmospheric Emissions Inventory).

The database includes data for the following indicators[20]:

- Commercial and industrial waste arisings, by English region and sector, for 2002/03
- Commercial and industrial waste arisings by English region and management route, for 2002/03

[20] See Cambridge Econometrics "Assessing the Performance of England's Regions in Promoting Sustainable Consumption and Production" for more details.

- Energy use in English region, sector and fuel in 2003
- Air emissions related to energy use by English region, sector and emissions type in 2003

The database also holds descriptive information on key strategies and projects supported by RDAs to promote resource productivity under certain themes:

- Business efficiency
- Environmental technology
- Waste management
- Energy management
- Sustainability

Methodology

The general purpose of REEIO is to model the links between the economy and the environment.

The environment is considered as providing four main functions:

1. The provision of natural resources used in economic activity (source functions)
2. The absorption and recycling of wastes from activities (sink functions)
3. The maintenance of human health and the provision of other services, from climate stability to amenities for recreation (human health and welfare functions)
4. Ecosystem function on which the other functions depend.

The links between the economy and the environment are vast and too complex. REEIO is tightly focused on the links between the economy and source and sink functions of the environment. Furthermore REEIO is focused in which of these links it encompasses. REEIO models the links between a region's economy and selected key environmental pressures; currently waste, energy, emissions to air and water demand.

REEIO analyses the extent to which regional output and employment depend on spending within the local area, or on markets outside the local area. The model follows the conventional System of National Accounts structure, distinguishing consumers' expenditure, investment, government consumption, intermediate purchases by industries and trade flows on the basis of information available locally and regionally. In terms of detail, REEIO distinguishes 41 employing activities, six types of unemployment, and 25 occupations.

The impact on the key environmental pressures being considered is modelled using economic inputs;

- Waste. Production of industrial and commercial waste is projected on the basis of each industry's purchases of input products. Household waste is projected on the basis of population growth and the rate of growth in per capita household waste arising.
- Energy Use. The use of energy by fuel type is determined on the basis of the scale of activity of the user and the relative price of fuels. The energy demand from power generation in the region is considered by explicit assumptions regarding specific plant capacities and utilisation
- Air Emissions. Energy related air emissions are determined on the basis of energy use by user and fuel type. Emissions that are not-energy related are determined by and appropriate activity indicator.
- Water Use. Water use is determined by modelling different components of overall demand separately. Non-household demand is determined by levels of economic

activity, whereas household demand for water is determined using per capita assumptions for metered and non-metered households.

Results

The policy use of REEIO and the Region Resource Use and Emissions Database has been varied. In general, REEIO can be used as a policy tool by Regional Development Agencies (RDAs) and others to assess the environmental impacts of regional policy using regional economic projections. Specific examples include:

- SEEDA: Assessing the potential implications of alternative growth scenarios developed to inform the Regional Economic Strategy (RES) on key environmental pressures under alternative assumptions for the strength and sectoral focus of trends in energy efficiency and the efficient use of other resources.
- NWDA: The Agency undertook a review of its Waste Strategy, with particular reference to the Commercial & Industrial waste stream. Alternative scenarios for were prepared in REEIO. While the existing strategy contained an objective for virtually no increases in waste arisings, presumably to be met by a continued shift in economic structure away from material intensive industries the work using REEIO identified the potential scale of the task.
- EMDA: As part of the Strategic Environmental Assessment of the RES REEIO was used to illustrate the potential impact of alternative patterns of economic development on waste arisings, demand for energy and associated emissions to air and to quantify the effects that alternative mitigation strategies could.
- SWRDA: The Agency and other regional partners have used REEIO to assess the environmental implications of business energy efficiency, such as what might be required from different sectors to achieve a 20% reduction in CO2. Issues relating to the energy efficiency of, and general use of, freight transport have also been examined.

Table 12 - UK REEIO model - Summary of SWOT Analysis

Strengths	**Weaknesses**
• coherence of the methodology with Eurostat and UN Guidelines • full scope of data • highly disaggregated industry breakdown • scenario projections and policy analysis	• only disaggregated to Government Office Region • no synthetic indexes on environmental performance • concerned with environmental impact of production in the region, rather than the entire environmental burden of production and consumption in the reigon
Opportunities	**Threats**
• creation of REEIO analysis for unitary authorities • development of REEIO in synergy with REAP	• concerned only with production

2.4.4 Resource and Energy Analysis Program (REAP)

Objectives

The Resource and Energy Analysis Program (REAP) is being developed by the Stockholm Environment Institution (SEI), in collaboration with the Centre for Urban and Regional. REAP is an integrated resource-environment modelling tool based on policy scenarios and considers consumption by households and, public and commercial services.

The objective of REAP is to capture the associated key environmental impacts of consumption in a certain geographical location. REAP uses a Material Flows Analysis to provide a

comprehensive picture of apparent and hidden physical flows of materials and energy carriers through the economy. The environmental impacts are measured through greenhouse gas emissions and ecological footprints.

Process

REAP is a tool designed and used to inform policy at a local or regional level regarding sustainability in consumption. REAP is available to all development agencies and local authorities and can be used at any time to provide scenario analysis on local or regional policies.

Methodology

The basic methodology underpinning REAP combines existing Material Flow Accounts (MFA), the National Environmental Accounts and National Footprint Accounts (NFA) with input-output analysis. Environmental input output analysis makes it possible to track and assign intermediate resource flows to consumption categories. Specifically REAP allocates Material Flows (MF), Greenhouse Gases and Ecological Footprints to detailed household consumption activities using the United Nations COICOP classification system and detailed household expenditure data.

The main data sources for REAP are PRODCOM, which provides detailed trade data and expenditure statistics. Final consumption patterns follow both SIC and COICOP classifications and are organised around key policy components such as:

- Food
- Energy
- Housing
- Infrastructure
- Consumer Goods
- Transport; and
- Waste

Spatial disaggregation of national data is possible down to the local authority level, although typically is used for district as opposed to local authorities.

REAP can be used to measure all greenhouse gases associated with consumption activities throughout the supply chain, predominantly REAP is used to measure CO_2 as CO_2 is the largest contributor to global warming.

REAP also takes into account The Ecological Footprint of consumption. The Ecological Footprint is a calculation that estimates the demand of human activities on nature. It measures the resources consumed by population and nature's supply. REAP can calculate the current and potential Ecological Footprint for the UK as a whole, at the regional and devolved county level or for every local authority.

The Ecological Footprint calculates how much productive land and sea is needed to provide the energy, food and materials we use in our everyday lives, and how much land is required to absorb our waste. It also calculates emissions generated from burning oil, coal and gas and how much land is required to absorb this.

Ecological Footprints are standardised into global hectares, in order that they can be compared between different regions and countries, regardless of where on the globe their resources are harvested. This is an important feature of REAP as it allows comparison between different U.K. local authorities, regions, devolved countries and national results. A global hectare is one hectare of biologically productive space with world-average productivity.

Results

REAP provides a simplification of the complex interactions that take place in an economy. The potential strength of REAP is that it provides strong methods and applies them at a greater level of detail than has been done before.

This means that it is possible for REAP to calculate projections of Ecological Footprints and greenhouse gas emissions by:

- Economic sector
- Final demand category
- Consumption Category by household
- National, regional and local area
- Socioeconomic group

A recent study by the Stockholm Environment Institute used REAP as a tool to analyse Leeds city region housing policy, "Using REAP for an Environmental Assessment of the Leeds City Region RSS Housing Policy". The study examined how 15 different policy scenarios will effect the carbon dioxide emissions associated with housing between 2003 and 2026. The "business as usual" scenario was taken to be in line with policies in the draft Regional Spatial Strategies, following this policy suggested an 8% rise in emissions from housing by 2026. The report showed that retrofitting the existing housing stock is the single most important housing policy with regard to CO_2 emissions.

The study demonstrated how REAP can provide the necessary evidence to inform better policy options towards reducing energy use, reducing emissions, and for using renewable energy sources.

Table 13 - UK REAP model - Summary of SWOT Analysis

Strengths • full scope of data • highly disaggregated industry breakdown • scenario projections and policy analysis	**Weaknesses** • all Materials Flow Analysis is only covered by The Ecological Footprint
Opportunities • development of REEIO in synergy with REAP	**Threats** • concerned only with consumption

2.4.5 Conclusion

The UK Environmental Accounts, essentially NAMEA, act as a fairly comprehensive statistical review of sustainability factors in the UK as a whole. The UK accounts are not however broken down by region; they are therefore unable to provide strong analysis on policy in the UK and a sub-national level.

Conversely the Ecological Footprint provides a single statistic, in terms of global hectares per capita, which can provide a comparison over many different geographical locations, local authorities, districts, regions and countries. However, in the case of the Ecological Footprint, the single synthetic statistic is limiting in policy analysis as it does not provide a comprehensive breakdown of the various factors which effect the environment, rather, by the nature of the tool it standardises the effects.

REAP goes one step further than the Ecological Footprint in that it aims to provide a more comprehensive range of analysis, by covering material flows through the ecological footprint but also measuring greenhouse gases individually. REAP also provides a breakdown over smaller geographical locations, down to the unitary authority.

In terms of providing a RAMEA type matrix similar to the UK Environmental Accounts or NAMEA, the Region Resource Use and Emissions Database used by REEIO provides a great deal of the data required at a regional level. The advantage of using this RAMEA type database alongside REEIO is that REEIO will act as a helpful policy tool to provide scenario driven policy analysis. One weakness of this database is that it doesn't provide water accounts; furthermore the accounts are only disaggregated at the regional level, and not sub-regional level.

2.5 RAMEA: a Regional NAMEA for air emissions

The review of past experiences and the related SWOT analyses lead to the agreement that the Regionalized NAMEA-type matrix (RAMEA) should focus on air emissions, as these data are available to some degree in all partner regions/countries. Moreover this is the more advanced area in terms of EUROSTAT implementation guides. It was also agreed that the matrix should be based on the NACE aggregated industrial sectors identified in the Eurostat manual "Namea for air emissions - compilation guide" that is also coherent with the SEEA Guidelines.

3 Data Availability

3.1 Regional Data Sources in Italy in implementing RAMEA

The following notes list the relevant regional data sources available in Italy to implement the proposed RAMEA for air emissions.

3.1.1 Economic data

Economic data for the Emilia-Romagna Region could be obtained using a multi-sector and multiregional econometric model developed by IRPET[21]: by means of this tool ARPA will have the possibility to have economic input/output accounting matrices (for at least 2 years) coherent with national accounting ones prepared by ISTAT[22].

The matrix for Emilia-Romagna Region can thus include the following indicators:

- Output
- Value added
- Intermediate Consumption
- Employment

for 30 economic sectors of the NACE rev. 1.1 classification:

- A: Agriculture, hunting and forestry
- B: Fishing
- CA: Mining and Quarrying of Energy Producing Materials
- CB: Mining and Quarrying Except Energy Producing Materials
- DA: Manufacture of Food Products; Beverage and Tobacco
- DB: Manufacture of Textiles and Textile Products
- DC: Manufacture of Leather and Leather Products
- DD: Manufacture of Wood and Wood Products
- DE: Manufacture of Pulp, Paper and Paper Products Publishing and Printing
- DF: Manufacture of Coke, Refined Petroleum and Nuclear Fuels
- DG: Manufacture of Chemicals, Chemical Products and Man-made Fibre
- DH: Manufacture of Rubber and Plastic Products
- DI: Manufacture of other Non-metallic products
- DJ: Manufacture of Basic Metals and Fabricated Metal Products
- DK: Manufacture of Machinery and equipments not elsewhere classified
- DL: Manufacture of Electrical and Optical Equipment
- DM: Manufacture of Transport Equipment
- DN: Manufacture not elsewhere classified
- E: Electricity, Gas and Water Supply
- F: Construction
- G: Wholesale and Retail Trade; Repair of Motor Vehicles, Motorcycles and Personal and Household Goods
- H: Hotels and Restaurants
- I: Transport, Storage and Communication

[21] Regional Institute for Economic Planning in Tuscany
[22] Italian National Institute of Statistics

- J: Financial Intermediation
- K70-71: Real Estate and Renting of machinery and equipment without operator and of personal and household goods
- K72-74: Computer and related activities, Research and development and Other business activities
- L: Public Administration and Defence; Compulsory Social Security
- M: Education
- N: Health and Social Work
- O+P+Q: Other Services

Monetary data are in millions of euro (both current and constant price), while data on employment are in thousands.

As for household expenditure, the following level of disaggregation (based on COICOP[23] classification) can be achieved:

- Food & non-alcoholic drinks
- Alcoholic drink, tobacco & narcotics
- Clothing & footwear
- Housing (net), fuel & power
- Household goods & services
- Health
- Transport
- Communication
- Recreation & culture
- Education
- Restaurants & hotels
- Miscellaneous goods & services
- Other expenditure items

Also for these types of indicators, monetary data are in millions of euro, both current and constant prices. Time period for economic data should be decided in order to match the available data on air emissions.

3.1.2 Environmental data

The main source of air emission data at regional level is the database on air emissions built by APAT[24] (by means of a disaggregation of national data at provincial level), which covers the following pollutants:

- Carbon dioxide (CO_2)
- Nitrous oxide (N_2O)
- Methane (CH_4)
- Nitrogen oxides (NO_X)
- Sulphur oxides (SO_X)
- Ammonia (NH_3)
- Non-Methane Volatile Organic Compounds (NMVOC)
- Carbon monoxide (CO)

[23] Classification of Individual Consumption According to Purpose
[24] Italian Agency for the protection of the environment and technical services

- Particulate Matter (PM)
- Heavy metals (As, Hg, Pb, Zn, Cd, Cr, Se, Cu, Ni)

Data are classified according to SNAP97 nomenclature and are available for three years: 1990, 1995, 2000. More recent data (up to year 2004) are available only at national level[25] and covers also the other three greenhouse gases (HFCs, PFCs, SF6).

Since there is no standard connection between SNAP97 and NACE categories, the attribution of SNAP-based emission data to NACE-based accounts will depend on the analysis of the economic structure of the Emilia-Romagna Region. A qualitative and quantitative link should then be defined. In addition to that, only emission whose source is anthropic will be taken into account, excluding all emissions related to natural phenomena.

3.2 Regional Data Sources in the Netherlands in implementing RAMEA

The following notes list the relevant regional data sources available in the Netherlands to implement the proposed RAMEA for air emissions. For the most part of the work, we will make use of the data that was edited by Statistics Netherlands (CBS), so that results are compatible with the official data.[26]

3.2.1 Economic data

The regional economic data edited by Statistics Netherlands (CBS) consists of five main economic indicators or variables, which we take into account:[27]

- Output (basic prices)[28]
- Gross value added (GVA)[29]
- Compensation of employees[30]
- Gross operating surplus[31]

[25] APAT 2006, Annuario dei dati ambientali

[26] See www.statline.cbs.nl for the available data in detail. Here we ignore the intermediate input of production, taxes and subsidies, because all these numbers are considered in the GVA and we do not take the numbers of employees into account.

[27] The definitions are taken from the CBS.

[28] Output covers the value of all goods produced for sale, including unsold goods, and all receipts for services rendered. Output furthermore covers the market equivalent of goods and services produced for own use, such as own account capital formation, services of owner-occupied dwellings and agricultural products produced by farmers for own consumption. The output of such goods is estimated by valuing the quantities produced against the price that the producer would have received if these goods had been sold. Output is valued at basic prices, defined as the price received by the producer excluding trade and transport margins and the balance of taxes and subsidies on products. This is the price the producer is ultimately left with.

[29] Value added at basic prices by industry is equal to the difference between output basic prices and intermediate consumption (purchasers' prices).

[30] Compensation of employees is the total remuneration paid by employers to their employees in return for work done. Employees are all residents and non-residents working in a paid job. Managing directors of limited companies are considered to be employees; therefore their salaries are also included in the compensation of employees. The same holds for people working in sheltered workshops. Compensation of employees is distinguished between wages and salaries and employers' social contributions.

[31] The gross operating surplus by industry is the balance that remains after deducting from the value added (basic prices) the compensation of employees and the balance of not product-related taxes and not product-related subsidies on production. The operating surplus of family enterprises is called mixed income, because it also contains compensation for work by the owners and their family members. On the level of the total economy operating surplus is computed by adding to the total of the industries the difference imputed and paid VAT.

- Labour input of employed persons[32]

We have divided up the economy of NB into 27 sectors following the NACE classification and distinguish between two consumer activities private traffic and all other consumer activities. Let us define first the different sectors:

- A+B Agriculture hunting forestry fishing
- C Mining and quarrying
- DA Food, beverages and tobacco
- DB+DC Textile and leather products
- Paper and paper products
- Publishing and printing
- DF Coke, refined petroleum, nuclear fuel
- DG Chemical products
- DH Rubber and plastic products
- Manufacture of basic metals
- Manufacture of metal products
- DK Machinery and equipment
- DL Electrical and optical equipment
- DM Manufacture of transport equipment
- Manufacturing n.e.c.
- E Electricity, gas and water supply
- F Construction
- Wholesale trade
- Retail trade, cars, repair, hotels
- Land transport
- Air transport, water transport
- Auxiliary transport activities
- Post and telecommunications, Banking, Insurance, Auxiliary financial activities, real estate activities, Commercial services
- L Pub. admin., defence, social security
- M Education
- N Health and social work
- Environmental services
- Culture, sports and recreation and other services

Beside this kind of aggregation, we have aggregated in a different so that the data will be comparable to the data of the RAMEA project partners. Here are the 22 different sectors:

- A+B Agriculture hunting forestry fishing
- C Mining and quarrying
- DA Food, beverages and tobacco
- DB+DC Textile and leather products
- DE manufacture of pulp, paper and paper products
- DF Coke, refined petroleum, nuclear fuel

[32] Labour input of employed persons is defined as the number of full-time equivalent jobs. Part-time jobs are converted to full-time jobs. For employees a full-time equivalent job is the annual contractual hours considered full-time in that branch of industry. For self-employed a full-time equivalent job is the quotient of the usual weekly work hours of that job and the average weekly work hours of self-employed with 37 or more normal weekly hours in the same branch of industry.

- DG Chemical products
- DH Rubber and plastic products
- DJ manufacture metals
- DK Machinery and equipment
- DL Electrical and optical equipment
- DM Manufacture of transport equipment
- DI+DD+DN (incl. 20+36+37) Manufacturing n.e.c.
- E Electricity, gas and water supply
- F Construction
- G+H wholesale trade, retail trade and hotels
- I Transport
- J+K Financial, business services and communication
- L Pub. admin., defence, social security
- M Education
- N Health and social work
- O+P+Q Sewage, refuse disposal, private households with employees, extra-territorial organizations

Now we have summarized what kind of data are available for the RAMEA regarding production. At least we have to different categories of consumption:

1. private car and motor bike traffic;[33]
2. all other consumption activities;[34]

3.2.2 Environmental data

In the next step, we give an overview about all environmental relevant substances, which we could divide to the production and consumption sectors;[35]

- CO_2 (Carbon dioxide): Greenhouse gas (causes the temperature of the earth's atmosphere to rise gradually).
- CH_4 (Methane): Greenhouse gas (causes the temperature of the earth's atmosphere to rise gradually).
- SO_2 (Sulphur dioxide - SO_2 and SO_3, calculated as SO_2): Causes acidification.
- N_2O (Laughing gas/dinitrogen oxide): Greenhouse gas (causes the temperature of the earth's atmosphere to rise gradually).
- NO_X (Nitrogen oxides - NO and NO_2, calculated as NO_2): Cause acidification and generates smog.
- NH_3 (Ammonia): Causes acidification.
- P (Phosphorus): Causes eutrophication
- N (Nitrogen): Causes eutrophication
- CFC's and halons (chlorofluorocarbons and halons): Cause the depletion of stratospheric ozone.
- waste

[33] Please note, that the emissions stemming from public transport, taxis, airplanes etc. are included in the production sector

[34] These activities are for the main part stemming from heating and cooking with gas, oil and coal. The emissions of power plants are not included in the consumption sector but in the production sector.

[35] The explanations are taken from the Statline (www.statline.cbs.nl) and De Haan (2003).

3.3 Regional Data Sources in Poland in implementing RAMEA

This note lists the relevant regional data sources available in Poland to implement the proposed RAMEA for air emissions.

3.3.1 Economic data

Economic data for the Małopolska region could be obtained using the data from the Central Statistical Office (GUS) and Regional Statistical Office. The data are available for the years up to the year 2004. Monetary data are in millions of PLN (in current prices). The data include gross output, gross value added (incl. the compensation of employees), intermediate consumption for 16 economic sectors of the NACE rev. 1.1 classification:

- A: Agriculture, hunting and forestry
- B: Fishing
- C: Mining and Quarrying
- D: Manufacture
- E: Electricity, Gas and Water Supply
- F: Construction
- G: Wholesale and Retail Trade; Repair of Motor Vehicles, Motorcycles and Personal and Household Goods
- H: Hotels and Restaurants
- I: Transport, Storage and Communication
- J: Financial Intermediation
- K: Real estate, renting and business activities
- L: Public Administration and Defence; Compulsory Social Security
- M: Education
- N: Health and Social Work
- O: Other community, social and personal service activities
- P: Private households with employed persons

The data on employment are in number of persons and include division into 15 sectors (the sectors O, P and Q are treated together), the mining and quarrying (C) is subdivided in 2 sections, manufacturing (D) is subdivided into 23 sections.

Average monthly data for household expenditure are available on the per month per capita basis in PLN. The household expenditures are divided into:

- Food and non-alcoholic beverages
- Alcoholic beverages and tobacco
- Clothing and footwear
- Housing, water, electricity, gas and other fuels
- Furnishings, household equipment and routine maintenance of the house
- Health
- Transport
- Communication
- Recreation and culture
- Education
- Restaurants and hotels
- Miscellaneous goods and services

3.3.2 Environmental data

The main source of air emission data at regional level is the Marshal Office database on emissions which covers all the emissions that are subject to the environmental charges for using the environment (Environmental Protection Act from 27.04.2001 with later changes, Government Order from 18.03.2003). The database is created by the Marshal Office for recording the reports from the companies about the fees for using the environment. The reporting is based on the standardised forms. The reporting duty is compulsory for every entity that conducts the activities that lead to emissions. The database consists of information divided into 4 modules:

1. emissions to air
2. water drawing
3. sewer emissions to water and soil
4. landfilled wastes

Due to the fact that it was decided that RAMEA will focus on the emissions to the air, the database content pertaining to this emissions is presented in more detail:

1. Air emissions by source
    a. Source of the emission
        i. Type, e.g. furnace, installation
        ii. Source capacity
        iii. Type of protection device
    b. The emission volume
        i. Type of fuel/substance, eg SO2, NO2, CO, CO2, dust, etc.
        ii. The effectiveness of protection device
        iii. The emission volume
    c. The place of emission, i.e. commune name
2. Air emissions from the engine fuels handling is specified separately and it includes:
    a. The volume of fuel handled
    b. The effectiveness of protection device
    c. The place of emission, i.e. commune name
3. Air emissions from boilers are another type of emissions reported and it includes:
    a. Boilers of capacity smaller than 5MW
    b. Fuelled by coal, coke, wood, oil or gas
    c. Boilers for which the IPPC is not required
    d. Number of boilers
    e. Volume of fuel used
4. Air emissions from combustion engines
    a. Cars
    b. Trucks
    c. The type of fuel
    d. Volume of fuel used

The emission that are accounted for in the Marshal Office database include 62 substances, among others: arsenic, ammonia, asbestos, benzene, vinyl chloride, chromium, tin, zinc, sulphur dioxide, carbon dioxide, methane, nickel, lead, dusts, mercury, carbon monoxide, nitrogen oxides, metallic elements and its compounds, etc.

The emission source in the database is identified by the statistical number, not the NACE. So this could have been a problem, but the assignments of NACE to statistical number will be done by Statistical Office in Malopolska. Another problem that arises is that the complete environmental

data are available electronically only for 2005, for other years are on paper only and are systematically inputted into electronic database.

To match the economic and environmental data the estimation of some data will be needed, or alternatively the disaggregation of national data.

3.4 Regional Data Sources in UK in implementing RAMEA

This note lists the sources of regional information available in the UK to implement the proposed RAMEA for air emissions.

3.4.1 Economic Data

The UK Regional Accounts provides an overview of the economic performance of the United Kingdom at a regional level. The variables covered are:

- Gross value added (GVA)
- household income
- consumption expenditure
- capital expenditure

The GVA are published in current prices for 15 industry groups:

- Agriculture, hunting, forestry & fishing
- Mining and quarrying of energy producing materials
- Other mining and quarrying
- Manufacturing
- Electricity, gas and water supply
- Construction
- Wholesale and retail trade (including motor trade)
- Hotels and restaurants
- Transport, storage and communication
- Financial intermediation
- Real estate, renting and business activities
- Public administration and defence
- Education
- Health and social work
- Other services

Cambridge Econometrics (CE) routinely receives more disaggregated data (for 30 sectors). The sectors are defined in terms of SIC2003 (which is identical to NACE classifications down to and including the 4-digit (Class) level).

Data in REEIO

REEIO contains the data/forecasts for the regional economy produced by CE. The GVA data/forecasts are reported for 42 sectors of the economy, and in constant prices. This is achieved first by:

- attributing the Regional Accounts data in current prices for the 30 sectors to each of CE's 42 sectors (using other information such as UK data and regional employment data)

- producing estimates of output in chained volume measure (cvm), similar in concept to constant price estimates, by applying national industry deflators to the estimates of regional output in current prices

The industry detail can be aggregated to form the industry definitions proposed for the RAMEA application in this project.

3.4.2 Environmental data

SCPnet database

The SCPnet resource use database contains estimates of energy use and associated emissions by region, fuel user (similar concept to industries), fuel and emission. Data are available for 1999 and 2003[36]. The particular application of interest in this study is that of emissions to air. The database covers the following air emissions:

- Carbon dioxide (CO_2)
- Sulphur dioxide (SO_2)
- Nitrogen oxides (NO_X)
- Carbon monoxide (CO)
- Methane (CH_4)
- PM10 (black smoke)
- Volatile organic compounds (VOCs)
- Nuclear emissions to air
- Lead emissions to air
- Nitrous Oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur Hexafluoride (SF_6)

The data are constructed from the National Atmospheric Emissions Inventory (NAEI) by Netcen, who prepare the UK emissions estimates for Defra. The framework in which the data are constructed is that used to monitor progress towards the Kyoto targets (and used for IPCC).

DTI

The DTI publish a range of regional energy consumption data[37] which is based on the NAEI data. These data include:

- gas consumption (for domestic and commercial & industrial users separately)
- electricity consumption (for domestic and commercial & industrial users separately)
- road transport energy consumption
- use of other fuels by broad fuel user group
- total final energy consumption by fuel (for domestic and commercial & industrial users separately)

[36] Improvements have been made to the method of calculation over the period which means that the two data sets are not directly comparable.
[37] see http://www.dti.gov.uk/energy/statistics/regional/index.html

DEFRA

Defra have published experimental 2003 estimates of regional (NUTS1) CO_2 emissions by sector (also produced by Netcen, using much of the DTI regional energy consumption statistics).

4 RAMEA framework

year	YYYY	Current Prices (Millions of euros)				ftes/n. jobs	GHG emissions (Mg)				Acidification (Mg)				Local air quality (Mg)		
NACE	**Industries**	**Output**	**Value Added**	**Intermediate Consumption**	**Final Consumption**	**Employment**	**CO_2**	**N_2O**	**CH_4**	**CO2 eq**	**NO_X**	**SO_x**	**NH_3**	**H+ eq**	**NMVOC**	**CO**	**PM**
A+B	Agriculture, hunting, forestry & fishing																
CA	Mining and quarrying of energy producing materials																
CB	Mining and quarrying, non energy producing materials																
DA	Manufacture of Food Products; Beverage and Tobacco																
DB+DC	Textiles and textile products, Leather and leather products																
DD	Wood and wood products																
DE	Pulp, paper and paper products																
DF	Coke, refined petroleum products and nuclear fuel																
DG	Chemicals, chemical products and man-made fibres																
DH	Rubber and plastic products																
DI	Other non-metallic mineral products																
DJ	Basic metals and fabricated metal products																
DK	Machinery and equipment n.e.c.																
DL	Electrical and optical equipment																
DM	Transport equipment																
DN	Manufacturing n.e.c.																
E	Electricity, gas and water supply																
F	Construction																
G	Wholesale and retail trade																
H	Hotels and restaurants																
I	Transport, storage and communication																
J	Financial intermediation																
K	Real Estate, Renting and Business Activities																
L	Public administration																
M	Education																
N	Health and social work																
O+P+Q	Other community, social and personal service activities																
COICOP	**Households**																
07	Transport																
	Other consumptions																
	Total - Industries	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-
	Total - Households				-		-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Conversion factors	**CO2**	**N2O**	**CH4**	**NOX**	**SOx**	**NH3**
GWP Conversion factors (CO2 eq)	1	310	21			
Acidification Conversion factors (H+ eq)				0,02174	0,03125	0,05882

5 Methodologies

5.1 Emilia-Romagna

5.1.1 Introduction

The economic accountability and the environmental accountability are integrated in Ramea model[38]. Let us have a look at this accountability system. The economic form is constructed according to the System of National Accounts and supporting tables (SNA), SEC 95 and carries flows and principal aggregates entered by the regional accountability, measured by monetary values. It allows to correlate the available resources, equal to the Production Value added to Imports value, with final investments, given by Investments and Exports demand value. The environmental form describes some pressures placed on the environment by the productive and consumer activities expresses by physical units of measurement. We took into accounts local industries activities, with regional localization. The classification of economic activities according to the regional accountability is constituted of 30 productive sectors according to ATECO 2002. As to final family consumers we took into account people present in Emilia-Romagna, among which there are residents and tourists. Family consumers are distinguished by charge functions. The most relevant are transports and heating ones.In order to qualitative correlation between pollutants processes and economic activities it is important to know how the production activities, practiced as secondary and auxiliary, are recorded in the Ramea economic form. Therefore the secondary activities are calculated separately from the main economic activities of the enterprise; but the activities practiced as auxiliary are recorded together with the principal or secondary activities which are referred to. A relevant exception of this rule is the electric power production that is calculated in correspondence to the economic power, gas and water production and engineering, even if these productions are practiced as auxiliary.The main reference of atmospheric emissions data is the national list on the emissions sources edited by APAT. APAT itself territorialized atmospheric emissions up to district-wide. For each pollutants the emissions are ranked by process, according to SNAP97. In the following table we read the 11 macro-fields that correspond to the more general clustering of the classification.

Table 14 - SNAP 97 classification of emission process for each macro-field

Macro-field ID Number	Macro-field features
01	Energy production combustion
02	Farming and services combustion
03	Industries combustion
04	Productive process
05	Mining and fossil fuels supply
06	Uses of solvents and other products
07	Road transport
08	Other mobile sources
09	Treatment and disposal waste
10	Farming
11	Nature

The main point, building Namea Matrix, for E-R is to correlate the atmospheric pollution emissions to a specific sector production or to a specific family consumer function. The focal point therefore is to translate each air emission according to SNAP97 by processes classification into

[38] Data references: Economic and power sources data next to 1995 – 2000 years of reference; regional Power Budget ENEA (1995 and 2000); Power sources consumption in Manufacturing sector ISTAT 2002; number of operators ISTAT (1996 and 2001); Production Value IRPET (1995 and 2000)

Namea classification by activities. Before going on with the emissions allocation to Namea activities, we need the total of emissions in coherence with Namea approach that consider only the emissions directly attributable or to the economic activities or to the family consumers. All the SNAP97 macro-fields emissions are coherent with this approach with the exception of the 11th sector that reports about emissions produced by natural resources, rivers, lakes and ground; these emissions are not attributable directly to economic activities or to family consumers and so do not find a collocation in Namea. If we subtract the regional emissions, contained in the macro-field 11 "Nature", from the total regional emissions inside IRSE, the net results, classified by processes or by Namea activities, should be equal.

Table 15 - Emissions for each SNAP 97 process

Process ID Number	Process overview	Emission
010100	Electric power production	Process emission 010100
...	...	...
Process *p*	Process overview *p*	Process emission *p*
...	...	...
100900	Cattle breeding	Process emission 100900
Emilia-Romagna Total		***Total emissions list (after Nature)***

Table 16 - Emissions classification for each NAMEA activity

NAMEA activities Number ID	Overview of activities	Emission
01	Farming, Hunting, Fishing and Forestry	Emission of NAMEA 01activity
...	...	...
i	NAMEA *i* overview	Emission of NAMEA *i* activity
...	...	...
33	Family consumptions - other	Emission of NAMEA 33 activity
Emilia-Romagna Total		***Total Emissions NAMEA Emilia-Romagna***

The parity between total emissions classified by polluting process (without macrofield 11) and the total emissions classified by economic activities can be formalized so (Bertini, Tudini, Vetrella, 2007)

$$\sum_{p=010100}^{100900} EMI(p) = EMI\_ER = \sum_{i=1}^{33} EMI_i$$

for each pollutant:
EMI(p) are the *p* process emissions
EMIi are the *i* emissions which Namea activity is responsible for
EMI_ER are the regional total anthropic emissions

5.1.2 Qualitative correlation

The connection between SNAP97 processes and Namea activities are made at first by a qualitative correlation; therefore we can progress with the emissions allocation for Namea activities.

Table 17 - Qualitative correlations between SNAP97 process and NAMEA activities

SNAP ID	SNAP process description	NAMEA ID	NAMEA activity description
010100	Combustion in energy and transformation industries	19	Electricity, gas and water supply
010300	Petroleum refining plants	19	Electricity, gas and water supply
010400	Solid fuel transformation plants	19	Electricity, gas and water supply
010506	Pipeline compressors	19	Electricity, gas and water supply
020100	Commercial and institutional plants	21	Wholesale and retail trade
020100	Commercial and institutional plants	22	Hotel and Restaurants
020100	Commercial and institutional plants	23	Transport, storage and communication
020100	Commercial and institutional plants	24	Financial intermediation
020100	Commercial and institutional plants	25	Business activities, R&D and IT
020100	Commercial and institutional plants	26	Public administration
020100	Commercial and institutional plants	27	Education
020100	Commercial and institutional plants	28	Health and social work
020100	Commercial and institutional plants	29	Other community, social and personal service activities
020100	Commercial and institutional plants	30	Real estate and renting
020200	Residential plants	32	Consumption and heating
020300	Processes with contact	1	Agriculture, hunting and forestry
020300	Processes with contact	2	Fishing
030100	Processes with contact	3	Mining and quarrying of energy producing materials
030100	Processes with contact	4	Mining and quarrying, non energy producing materials
030100	Processes with contact	5	Food products, beverages and tobacco
030100	Processes with contact	6	Textiles and textile products
030100	Processes with contact	7	Leather and leather products
030100	Processes with contact	8	Wood and wood products
030100	Processes with contact	9	Pulp, paper and paper products
030100	Processes with contact	11	Chemicals, chemical products and man-made fibres
030100	Processes with contact	12	Rubber and plastic products
030100	Processes with contact	13	Other non-metallic mineral products
030100	Processes with contact	14	Basic metals and fabricated metal products
030100	Processes with contact	15	Machinery and equipment n.e.c.
030100	Processes with contact	16	Electrical and optical equipment
030100	Processes with contact	17	Transport equipment
030100	Processes with contact	18	Manufacturing n.e.c.
030100	Processes with contact	20	Construction
030203	Blast furnace cowpers	14	Basic metals and fabricated metal products
030204	Plaster furnaces	13	Other non-metallic mineral products
030301	Sinter and pelletizing plants	14	Basic metals and fabricated metal products
030302	Reheating furnaces steel and iron	14	Basic metals and fabricated metal products
030303	Gray iron foundries	14	Basic metals and fabricated metal products
030304	Primary lead production	14	Basic metals and fabricated metal products
030305	Primary zinc production	14	Basic metals and fabricated metal products
030307	Secondary lead production	14	Basic metals and fabricated metal products
030308	Secondary zinc production	14	Basic metals and fabricated metal products
030309	Secondary copper production	14	Basic metals and fabricated metal products
030310	Secondary aluminium production	14	Basic metals and fabricated metal products
030311	Cement	13	Other non-metallic mineral products
030312	Lime (includ. iron and steel and paper pulp industr.)	13	Other non-metallic mineral products

030313	Asphalt concrete plants	10	Coke, oil refineries, treatment of nuclear fuels
030314	Flat glass	13	Other non-metallic mineral products
030315	Container glass	13	Other non-metallic mineral products
030316	Glass wool (except binding)	13	Other non-metallic mineral products
030317	Other glass	13	Other non-metallic mineral products
030319	Bricks and tiles	13	Other non-metallic mineral products
030320	Fine ceramic materials	13	Other non-metallic mineral products
030321	Paper-mill industry (drying processes)	9	Pulp, paper and paper products
030322	Alumina production	11	Chemicals, chemical products and man-made fibres
040100	Processes in petroleum industries	10	Coke, oil refineries, treatment of nuclear fuels
040201	Coke oven (door leakage and extinction)	10	Coke, oil refineries, treatment of nuclear fuels
040202	Blast furnace charging	14	Basic metals and fabricated metal products
040203	Pig iron tapping	14	Basic metals and fabricated metal products
040206	Basic oxygen furnace steel plant	14	Basic metals and fabricated metal products
040207	Electric furnace steel plant	14	Basic metals and fabricated metal products
040208	Rolling mills	14	Basic metals and fabricated metal products
040209	Sinter and pelletizing plant (except comb. 03.03.01)	14	Basic metals and fabricated metal products
040301	Aluminium production (electrolysis)	14	Basic metals and fabricated metal products
040302	Ferro alloys	14	Basic metals and fabricated metal products
040303	Silicium production	14	Basic metals and fabricated metal products
040401	Sulfuric acid	11	Chemicals, chemical products and man-made fibres
040402	Nitric acid	11	Chemicals, chemical products and man-made fibres
040403	Ammonia	11	Chemicals, chemical products and man-made fibres
040404	Ammonium sulphate	11	Chemicals, chemical products and man-made fibres
040405	Ammonium nitrate	11	Chemicals, chemical products and man-made fibres
040407	NPK fertilisers	11	Chemicals, chemical products and man-made fibres
040408	Urea	11	Chemicals, chemical products and man-made fibres
040409	Carbon black	11	Chemicals, chemical products and man-made fibres
040410	Titanium dioxide	11	Chemicals, chemical products and man-made fibres
040413	Chlorine production	11	Chemicals, chemical products and man-made fibres
040414	Phosphate fertilizers	11	Chemicals, chemical products and man-made fibres
040501	Ethylene	11	Chemicals, chemical products and man-made fibres
040502	Propylene	11	Chemicals, chemical products and man-made fibres
040503	1,2 dichloroethane (except 04.05.05)	11	Chemicals, chemical products and man-made fibres
040505	1,2 dichloroethane + vinylchloride (balanced process)	11	Chemicals, chemical products and man-made fibres
040506	Polyethylene Low Density	11	Chemicals, chemical products and man-made fibres
040507	Polyethylene High Density	11	Chemicals, chemical products and man-made fibres
040508	Polyvinylchloride	11	Chemicals, chemical products and man-made fibres

040509	Polypropylene	11	Chemicals, chemical products and man-made fibres
040510	Styrene	11	Chemicals, chemical products and man-made fibres
040511	Polystyrene	11	Chemicals, chemical products and man-made fibres
040513	Styrene-butadiene latex	11	Chemicals, chemical products and man-made fibres
040514	Styrene-butadiene rubber (SBR)	12	Rubber and plastic products
040515	Acrylonitrile Butadiene Styrene (ABS) resins	11	Chemicals, chemical products and man-made fibres
040516	Ethylene oxide	11	Chemicals, chemical products and man-made fibres
040517	Formaldehyde	11	Chemicals, chemical products and man-made fibres
040518	Ethylbenzene	11	Chemicals, chemical products and man-made fibres
040519	Phtalic anhydride	11	Chemicals, chemical products and man-made fibres
040520	Acrylonitrile	11	Chemicals, chemical products and man-made fibres
040521	Adipic Acid	11	Chemicals, chemical products and man-made fibres
040527	Other (phytosanitary,...)	11	Chemicals, chemical products and man-made fibres
040601	Chipboard	8	Wood and wood products
040603	Paper pulp (acid sulfite process)	9	Pulp, paper and paper products
040604	Paper pulp (Neutral Sulphite Semi-Chemical process)	9	Paper, print and publishing
040605	Bread	5	Food products, beverages and tobacco
040606	Wine	1	Agriculture, hunting and forestry
040607	Bear	5	Food products, beverages and tobacco
040608	Alcoholic	5	Food products, beverages and tobacco
040610	Roof covering with asphalt materials	20	Construction
040611	Road paving with asphalt	20	Construction
040612	Cement (decarbonising)	13	Other non-metallic mineral products
040613	Glass (decarbonising)	13	Other non-metallic mineral products
040614	Lime (decarbonising)	13	Other non-metallic mineral products
040615	Batteries manufacturing	16	Electrical and optical equipment
040618	Limestone and dolomite use	13	Other non-metallic mineral products
040619	Soda ash production and use	11	Chemicals, chemical products and man-made fibres
050101	Open cast mining	3	Mining and quarrying of energy producing materials
050102	Underground mining	3	Mining and quarrying of energy producing materials
050103	Storage of solid fuel	10	Coke, oil refineries, treatment of nuclear fuels
050201	Land-based activities	3	Mining and quarrying of energy producing materials
050302	Land-based activities (other than desulfuration)	10	Coke, oil refineries, treatment of nuclear fuels
050401	Marine terminals (tankers, handling and storage)	10	Coke, oil refineries, treatment of nuclear fuels
050402	Other handling and storage (including pipeline)	10	Coke, oil refineries, treatment of nuclear fuels
050501	Refinery dispatch station	10	Coke, oil refineries, treatment of nuclear fuels
050502	Transport and depots (except 050503)	10	Coke, oil refineries, treatment of nuclear fuels
050503	Transport and depots (except 05.05.03)	21	Wholesale and retail trade

050601	Pipelines	23	Transport, storage and communication
050603	Distribution networks	19	Electricity, gas and water supply
060101	Paint application : manufacture of automobiles	17	Transport equipment
060102	Paint application : car repairing	21	Wholesale and retail trade
060103	Paint application : construction and buildings	20	Construction
060104	Paint application : domestic use (except 06.01.07)	33	Consumption; other
060105	Paint application : coil coating	14	Basic metals and fabricated metal products
060106	Paint application : boat building	17	Transport equipment
060107	Paint application : wood	8	Wood and wood products
060107	Paint application : wood	18	Manufacturing n.e.c.
060108	Other industrial paint application	14	Basic metals and fabricated metal products
060108	Other industrial paint application	15	Machinery and equipment n.e.c.
060108	Other industrial paint application	16	Electrical and optical equipment
060201	Metal degreasing	14	Basic metals and fabricated metal products
060201	Metal degreasing	15	Machinery and equipment n.e.c.
060201	Metal degreasing	17	Transport equipment
060202	Dry cleaning	29	Other community, social and personal service activities
060301	Polyester processing	11	Chemicals, chemical products and man-made fibres
060302	Polyvinylchloride processing	11	Chemicals, chemical products and man-made fibres
060303	Polyurethane processing	11	Chemicals, chemical products and man-made fibres
060304	Polystyrene foam processing	11	Chemicals, chemical products and man-made fibres
060305	Rubber processing	12	Rubber and plastic products
060306	Pharmaceutical products manufacturing	11	Chemicals, chemical products and man-made fibres
060307	Paints manufacturing	11	Chemicals, chemical products and man-made fibres
060308	Inks manufacturing	11	Chemicals, chemical products and man-made fibres
060309	Glues manufacturing	11	Chemicals, chemical products and man-made fibres
060312	Textile finishing	6	Textile and clothing
060313	Leather tanning	7	Leather and leather products
060401	Glass wool enduction	13	Other non-metallic mineral products
060403	Printing industry	9	Paper, print and publishing
060404	Fat, edible and non edible oil extraction	5	Food, drink and tobacco
060405	Application of glues and adhesives	33	Consumption. Other
060406	Preservation of wood	8	Wood and wood products
060408	Domestic solvent use (other than paint application)	33	Consumption. Other
060409	Vehicles dewaxing	17	Transport equipment
070101	Highway driving	31	Consumption and transports
070102	Rural driving	31	Consumption and transports
070103	Urban driving	31	Consumption and transports
070201	Highway driving<3,5t	23	Transport, storage and communication
070202	Rural driving<3,5t -	23	Transport, storage and communication
070203	Urban driving<3,5t	1	Agriculture, hunting and forestry
070203	Urban driving<3,5t	2	Fishing
070203	Urban driving<3,5t	3	Mining and quarrying of energy producing materials

070203	Urban driving<3,5t	4	Mining and quarrying, non energy producing materials
070203	Urban driving<3,5t	5	Food products, beverages and tobacco
070203	Urban driving<3,5t	6	Textiles and textile products
070203	Urban driving<3,5t	7	Leather and leather products
070203	Urban driving<3,5t	8	Wood and wood products
070203	Urban driving<3,5t	9	Pulp, paper and paper products
070203	Urban driving<3,5t	10	Coke, oil refineries, treatment of nuclear fuels
070203	Urban driving<3,5t	11	Chemicals, chemical products and man-made fibres
070203	Urban driving<3,5t	12	Rubber and plastic products
070203	Urban driving<3,5t	13	Other non-metallic mineral products
070203	Urban driving<3,5t	14	Basic metals and fabricated metal products
070203	Urban driving<3,5t	15	Machinery and equipment n.e.c.
070203	Urban driving<3,5t	16	Electrical and optical equipment
070203	Urban driving<3,5t	17	Transport equipment
070203	Urban driving<3,5t	18	Manufacturing n.e.c.
070203	Urban driving<3,5t	19	Electricity, gas and water supply
070203	Urban driving<3,5t	20	Construction
070203	Urban driving<3,5t	21	Wholesale and retail trade
070203	Urban driving<3,5t	22	Hotels and restaurants
070203	Urban driving<3,5t	24	Financial intermediation
070203	Urban driving<3,5t	25	Business activities, R&D and IT
070203	Urban driving<3,5t	26	Public administration
070203	Urban driving<3,5t	27	Education
070203	Urban driving<3,5t	28	Health and social work
070203	Urban driving<3,5t	29	Other community, social and personal service activities
070203	Urban driving<3,5t	30	Real estate and renting
070301	Highway driving >3,5t	23	Transport, storage and communication
070302	Rural driving>3,5t	23	Transport, storage and communication
070303	Urban driving>3,5t	1	Agriculture, hunting and forestry
070303	Urban driving>3,5t	2	Fishing
070303	Urban driving>3,5t	3	Mining and quarrying of energy producing materials
070303	Urban driving>3,5t	4	Mining and quarrying, non energy producing materials
070303	Urban driving>3,5t	5	Food products, beverages and tobacco
070303	Urban driving>3,5t	6	Textiles and textile products
070303	Urban driving>3,5t	7	Leather and leather products
070303	Urban driving>3,5t	8	Wood and wood products
070303	Urban driving>3,5t	9	Pulp, paper and paper products
070303	Urban driving>3,5t	10	Coke, oil refineries, treatment of nuclear fuels
070303	Urban driving>3,5t	11	Chemicals, chemical products and man-made fibres
070303	Urban driving>3,5t	12	Rubber and plastic products
070303	Urban driving>3,5t	13	Other non-metallic mineral products
070303	Urban driving>3,5t	14	Basic metals and fabricated metal products
070303	Urban driving>3,5t	15	Machinery and equipment n.e.c.
070303	Urban driving>3,5t	16	Electrical and optical equipment
070303	Urban driving>3,5t	17	Transport equipment
070303	Urban driving>3,5t	18	Manufacturing n.e.c.
070303	Urban driving>3,5t	19	Electricity, gas and water supply
070303	Urban driving>3,5t	20	Construction
070303	Urban driving>3,5t	21	Wholesale and retails trade

070303	Urban driving>3,5t	22	Hotels and Restaurants
070303	Urban driving>3,5t	24	Financial intermediation
070303	Urban driving>3,5t	25	Informatics, research and other activities
070303	Urban driving>3,5t	26	Public administration
070303	Urban driving>3,5t	27	Education
070303	Urban driving>3,5t	28	Health and social work
070303	Urban driving>3,5t	29	Other community, social and personal service activities
070303	Urban driving>3,5t	30	Real estate activities and rental
070400	Mopeds and Motorcycles < 50 cm3	31	Consumption. Transport
070501	Highway driving > 50 cm3	31	Consumption. Transport
070502	Rural driving> 50 cm3	31	Consumption. Transport
070503	Urban driving> 50 cm3	31	Consumption. Transport
070600	Gasoline evaporation from vehicles	1	Farming, hunting and forestry
070600	Gasoline evaporation from vehicles	2	Fishing
070600	Gasoline evaporation from vehicles	3	Mining and quarrying of energy producing materials
070600	Gasoline evaporation from vehicles	4	Mining and quarrying, non energy producing materials
070600	Gasoline evaporation from vehicles	5	Food products, beverages and tobacco
070600	Gasoline evaporation from vehicles	6	Textiles and textile products
070600	Gasoline evaporation from vehicles	7	Leather and leather products
070600	Gasoline evaporation from vehicles	8	Wood and wood products
070600	Gasoline evaporation from vehicles	9	Paper, print and editing
070600	Gasoline evaporation from vehicles	10	Coke, oil refineries, treatment of nuclear fuels
070600	Gasoline evaporation from vehicles	11	Chemicals, chemical products and man-made fibres
070600	Gasoline evaporation from vehicles	12	Rubber and plastic products
070600	Gasoline evaporation from vehicles	13	Other non-metallic mineral products
070600	Gasoline evaporation from vehicles	14	Basic metals and fabricated metal products
070600	Gasoline evaporation from vehicles	15	Machinery and equipment n.e.c.
070600	Gasoline evaporation from vehicles	16	Electrical and optical equipment
070600	Gasoline evaporation from vehicles	17	Transport equipment
070600	Gasoline evaporation from vehicles	18	Manufacturing n.e.c.
070600	Gasoline evaporation from vehicles	19	Electricity, gas and water supply
070600	Gasoline evaporation from vehicles	20	Construction
070600	Gasoline evaporation from vehicles	21	Wholesale and retail trade
070600	Gasoline evaporation from vehicles	22	Hotels and Restaurants
070600	Gasoline evaporation from vehicles	23	Transport, storage and communication
070600	Gasoline evaporation from vehicles	24	Financial intermediation
070600	Gasoline evaporation from vehicles	25	Business activities, R&D and IT
070600	Gasoline evaporation from vehicles	26	Public administration
070600	Gasoline evaporation from vehicles	27	Education
070600	Gasoline evaporation from vehicles	28	Health and social work
070600	Gasoline evaporation from vehicles	29	Other community, social and personal service activities
070600	Gasoline evaporation from vehicles	30	Real estate and renting
070600	Gasoline evaporation from vehicles	31	Consumption. Transport
080100	Military	26	Public administration
080200	Railways	23	Transport, storage and communication
080300	Inland waterways	23	Transport, storage and communication
080402	National sea traffic within EMEP area	23	Transport, storage and communication
080403	National fishing	2	Fishing
080501	Domestic airport traffic (LTO cycles - <1000 m)	23	Transport, storage and communication
080502	International airport traffic (LTO cycles -	23	Transport, storage and communication

	<1000 m)		
080503	Domestic cruise traffic (>1000 m)	23	Transport, storage and communication
080600	Agriculture	1	Agriculture, hunting and forestry
080700	Forestry	1	Agriculture, hunting and forestry
080800	Industry	3	Mining and quarrying of energy producing materials
080800	Industry	4	Mining and quarrying, non energy producing materials
080800	Industry	5	Food products, beverages and tobacco
080800	Industry	6	Textiles and textile products
080800	Industry	7	Leather and leather products
080800	Industry	8	Wood and wood products
080800	Industry	9	Paper, print and editing
080800	Industry	10	Coke, oil refineries, treatment of nuclear fuels
080800	Industry	11	Chemicals, chemical products and man-made fibres
080800	Industry	12	Rubber and plastic products
080800	Industry	13	Other non-metallic mineral products
080800	Industry	14	Basic metals and fabricated metal products
080800	Industry	15	Machinery and equipment n.e.c.
080800	Industry	16	Electrical and optical equipment
080800	Industry	17	Transport equipment
080800	Industry	18	Manufacturing n.e.c.
080800	Industry	20	Construction
080900	Household and gardening	33	Consumption. Other
090201	Incineration of domestic or municipal wastes	29	Other community, social and personal service activities
090202	Incineration of industrial wastes (except flaring)	29	Other community, social and personal service activities
090203	Flaring in oil refinery	10	Coke, oil refineries, treatment of nuclear fuels
090205	Incineration of sludges from waste water treatment	29	Other community, social and personal service activities
090207	Incineration of hospital wastes	29	Other community, social and personal service activities
090208	Incineration of waste oil	29	Other community, social and personal service activities
090401	Managed Waste Disposal on Land	29	Other community, social and personal service activities
090402	Unmanaged Waste Disposal Sites	29	Other community, social and personal service activities
090700	Open burning of agricultural wastes (except 10.03)	1	Farming, hunting and forestry
091001	Waste water treatment in industry	29	Other community, social and personal service activities
091002	Waste water treatment in residential/commercial sect.	29	Other community, social and personal service activities
091003	Sludge spreading	29	Other community, social and personal service activities
091005	Compost production	29	Other community, social and personal service activities
100100	Cultures with fertilizers	1	Agriculture, hunting and forestry
100103	Rice field	1	Agriculture, hunting and forestry
100200	Cultures without fertilizers	1	Agriculture, hunting and forestry
100300	On-field burning of stubble, straw,...	1	Agriculture, hunting and forestry
100401	Dairy cows	1	Agriculture, hunting and forestry
100402	Other cattle	1	Agriculture, hunting and forestry
100403	Ovines	1	Agriculture, hunting and forestry

100404	Fattening pigs	1	Agriculture, hunting and forestry
100405	Horses	1	Agriculture, hunting and forestry
100406	Mules and asses	1	Agriculture, hunting and forestry
100407	Goats	1	Agriculture, hunting and forestry
100412	Sows	1	Agriculture, hunting and forestry
100414	Buffalo	1	Agriculture, hunting and forestry
100415	Other	1	Agriculture, hunting and forestry
100501	Dairy cows	1	Agriculture, hunting and forestry
100502	Other cattle	1	Agriculture, hunting and forestry
100503	Fattening pigs	1	Agriculture, hunting and forestry
100504	Sows	1	Agriculture, hunting and forestry
100505	Ovines	1	Agriculture, hunting and forestry
100506	Horses	1	Agriculture, hunting and forestry
100507	Laying hens	1	Agriculture, hunting and forestry
100508	Broilers	1	Agriculture, hunting and forestry
100509	Other poultry (ducks,gooses,etc.)	1	Agriculture, hunting and forestry
100511	Goats	1	Agriculture, hunting and forestry
100512	Mules and asses	1	Agriculture, hunting and forestry
100514	Buffalo	1	Agriculture, hunting and forestry
100515	Other	1	Agriculture, hunting and forestry
100900	Manure management regarding nitrogen compounds	1	Agriculture, hunting and forestry

The process of macro-field1 concerns the combustion of power production by means of public electric industries and cogeneration systems. The emissions caused by these processes have been correlated in an unique way to the power, gas and water production and engineering activities. The macro-field 2 concerns the process that pertains to the emissions deriving from heating combustion system in the service, residential sector, and hunting, forestry, fishing and water culture sector. The macro-field 3 concerns processes that refer to industries combustion plants. The emissions referred to processes classified inside the macro-field 4 are all univocally interrelated to the economic activities. They are Manufacturing and Construction emissions. About Manufacturing we consider: chemistry products, synthetic fibres, plastic matters, metallurgy, metallic and not metallic products. We can find also emissions deriving from food and tobacco industries. The emissions counted inside macro-field 5 derive from Mining, treatment and burden of raw materials mined from underground: they are attributable univocally to the considered economic sectors. Also inside the macro-field 6 the connection of the emissions are referred to the use of solvents and are easily linkable to the Namea activities. The emissions relative to Road transports are disaggregated by means of carrying and by different kind of covered roads, but they cannot give further ideas for a correct and immediately assigning to the Namea activities. We have to consider some hypothesis: first of all the emissions produced outside a region by the road transport of the regional residents are equal to the emissions produced inside the region by the road transports of non residents. A further hypothesis concerns the assignment of the car and motorcycles transports emissions to the family activities, and the extra-urban lorries emissions are connected to the consigners and auto-carriers industries, but the urban traffic of the same means is to allocate to other economic sectors. The vaporized emissions are attributed to people who use some engine-driven means. The emissions referred to the macro-field 8 concern off road transports. Only the industry off road transport is to allocate to industries sectors themselves.

5.1.3 Quantitative correlation

In the most cases the processes are correlated with one Namea activity only, but in other cases the correlations are multiple, they concern more than one Namea activity. For these cases we should define an Indicator aimed at attributing the emissions quotes to several activities outlined while we were making the qualitative correlations.

Particularly the multiple correlation concerns the following processes:

- Farming, Industry and Service combustion
- Using solvents for the paint application and preservation of the wood and for the paint application in metal-mechanics, electro-mechanics sectors and for the means of transports, as well as in the metal – greasing sector
- Road transport
- Off-road transport in Industry

To allocate the emissions deriving from not linkable processes to a unique Namea activity only, we use different approaches for different processes.

Table 18 - Methodology of partition of emissions deriving from SNAP process related not univocally to the Namea actiivities

SNAP 97 process overview	SNAP97	NAMEA activities ID	Approach used for the distribution
Combustion in commercial and institutional plants	020100	21-30	Production Value
Combustion in farming, forestry and fishing plants	020300	01; 02	Production Value
Combustion in hot water heater, turbines and in fixed internal combustion engine	030100	04;05;06;07;08; 09;11;12;13;14; 15;16;17;18;20	Regional Energy Budget (ENEA)
Paint application industry wood-furnitures	060107	08; 18	Number of operators
Paint application- other industrial activities	060108	14;15;16	Production Value
Metal greasing	060201	14;15;17	Production Value
Light duty vehicles < 3.5 t (r) - Urban driving	070203	1-22; 24-30	Production Value
Heavy duty vehicles > 3.5 t and buses (r) - Urban driving	070303	1-22; 24-30	Production Value
Vaporized emissions from vehicles	070600	1-31	Road transport emissions
Off-road transport in Industry	08080000	03 - 20	Regional Energy Budget (ENEA)

The emissions deriving from 020100 and 020300 processes are correlated to the associated sectors in the first qualitative phase using Production Value.

The emissions deriving from the 030100 process are ascribed considering a plurality of informative sources concerning power product consumer by the economic sectors and the regional economic accountability. A first difficulty is that the power sources consumption cannot be considered in the emission distribution directly. To build a weight system to use for the distribution of the emissions, the quantity of the power sources consumed has been considered for their contents of carbon, as a proxy of quantity of dioxide carbon emissions. As a first step, thanks to the regional Energy Balance data edited by ENEA for E-R, we decided the right quota to attribute to the

Construction sector and to sharing out between the single sectors of Manufacturing. Inside Manufacturing the partition among the sectors has been made by distributing the Italian power sources consumption proportioned to E-R by means of Production Value. The emissions of the 060107 sector have been attributed by means of the number of operators of the wood manufacturing and supplies production sector. The emissions deriving from the 060108 and 060201 processes have been attributed to correlated sectors of the first qualitative phase using the Production Value. The emissions of road transport sector have found a first solution in the qualitative correlation phase, often attributed in a unique way. For the distribution of the emissions correlated to multiply association of processes 070203 and 070303 we used the Production Value. For the emission of the process 070600 we calculated a weighted average of the emissions correlated to the sectors and to the family during the qualitative and quantitative correlations. The attribution of the 080800 process followed a similar approach as the 030100 process: the allocation considered the quota of fuels used in the Industry to assign the Construction sector, the power products consumption for transport by manufacturing sector and their carbon content, and the proportion between the regional sector Production Value and Italian one.

5.2 Noord-Brabant

5.2.1 Introduction

Mostly, in all European regions exist different approaches to take environmental sustainability into account, but often these approaches are different and hence not comparable. E.g. the region South-East England prefers the foot-print approach, contrary to this Noord-Brabant has developed the Telos balance. Both approaches are incomparable, and that is not desirable.

To overcome this problem the only solution is to make use of an approach which is widely accepted all over Europe. The RAMEA is the only candidate which fulfills this pre-condition, because it is only a regionalized version of the National Accounting Matrix including environmental accounts (NAMEA). The NAMEA is a hybrid accounting system, which relates economic variables measured in monetary terms to environmental variables measured in physical units. It is a so-called satellite accounting system.

Furthermore, the NAMEA is part of the national accounts which is based on the System of National Accounts (SNA 1993), the System of Economic and Environmental Accounts (SEEA 2003) and the European System of Accounts (ESA 1995). In so far the approach can not be taken into question. An additional advantage of a RAMEA is that the costs to construct a RAMEA are relatively low in comparison to other environmental accounting or monitoring systems. E.g. the yearly costs of a National Accounting Matrix including environmental accounts are estimated by CBS (Statistics Netherlands) workers to 1,5-2 mill. EUR per year. Given the national accounting matrices and regional accounting matrices by the national statistical offices and EUROSTAT the construction and compilation of a RAMEA should only cost just around 100.000 EUR at maximum per year, if the instrument is fully established in all regions within the EU. Beforehand some additional discussions should take place between more than four regions about the themes and compilation methodology.

A further advantage of the satellite approach is, that social accounting matrices could be added, so that we will get a fully overview about all elements, which are part of the 3P- (plant, people, profit) approach, including social accounts, economic accounts and environmental accounts

Why is it an advantage to rely on the numbers of statistical offices? To answer this question, we should remember that at the national level the main important origin of information for policy-making and the general public are the national accounts, which are based on the “System of National Accounts 1993” (SNA 93) and the European System of National Accounts 1995 (ESA

1995).[39] The main advantage of this accounting system is that it is used all over the world, so that it is possible to compare the economic performance of different countries. In addition to this core of the national accounts, there exists an additional international accepted accounting system to take the environment into account; the "System of Economic and Environmental Accounts 2003" (SEEA 2003). These additional accounts are called satellite accounts, because they are not part of the core accounts of the SNA. The introduction of such satellite accounts was demanded by national governments in the 1990ies, because of increasing environmental problems like global warming, acidification, eutrophication, ozone layer depletion etc.. One main advantage of the satellite accounts is that each country is free to decide what kind of environmental problems should be considered. This is caused by the fact that not all countries are confronted with the same environmental problems, especially if we think about local environmental problems.

The general idea behind the satellite accounts is to build up a hybrid accounting system which relates economic variables, measured in monetary units, to environmental variables, measured in physical units.

Because of its importance for administrative use, this statistical estimate and the requirements for the quality of these figures are very strict and laid down in an European guideline. In so far the general approach of a NAMEA is standardized[40], so that international and intertemporal comparisons are within the EU are always possible.

Regarding European regions such a tool like the NAMEA is missing at the regional level, although it seems to be necessary for regional policy-making. As a result it was the main objective of the RAMEA project to derive such a regional accounting tool.

One main advantage of following the NAMEA methodology is, that the resulting regional accounts will be consistent with the national accounts and the resulting numbers of different regions are international, national and intertemporal comparable. At least the regional accounts should be able to give an insight of the economic and ecological state of a region.

It should be noted that a RAMEA is only a descriptive tool, which does not inform us about in how far a region is sustainable or not, as long as the term "sustainability" is not well-defined. The problem with the term "sustainability" is, that there exists no well accepted definition of what it is. Regarding that problem the NAMEA delivers information which can be used for all different kind of sustainability concepts and definitions. It can be stated that national account numbers are value free and objective.

Here we restrict ourselves only to the economic and environmental aspects of a region.

Before we will do that, we will investigate into the general advantages of the approach and how it can be used for descriptive and analytical purposes. Additionally, we will explain the used methodology to construct a RAMEA.

5.2.2 The NAMEA as an Environmental Accounting Tool[41]

Since the 1990's, it was discussed in policy and science how to extend the national accounts regarding environmental problems. The discussion in economic science on this subject is much older and goes back to the beginning 1970's.[42] However, in principle two different strands of methodologies have been developed to integrate a kind of environmental accounting system of national accounts. On the one hand there are the supporters of the idea that environmental damages and the use of the environment could be measured in monetary terms with the help of estimations and assumptions. Given the monetary values of environmental damages, these costs should be

[39] Of course, partly the national accounts are unfortunately manipulated because of different reasons, see e.g. Stauvermann (2007) for details.
[40] The use of a standard involves always increasing returns to scale
[41] This chapter is partly based on Stauvermann & Steenge (2006) and Stauvermann (2007).
[42] See Hueting (1974, 1980).

subtracted from the conventional Net National Income (NNI). The supporters of this idea have developed many different approaches to calculate an indicator, which we will call "Green National Income" (GNI).[43]

On the other hand, many scholars, especially coming from national accounting, reject this idea, because of the fact that strong assumptions must be made to estimate the monetary value of environmental damages. At least there exist no market prices for environmental goods. These scholars propose another approach, the so called "National Accounting Matrix including Environmental Accounts" (NAMEA)[44]. Both approaches were comprehensively and widely discussed in the Netherlands. Here we try to give reasons why in the end the NAMEA is preferred.

Here we want to give a short description of the NAMEA system as in use in the Netherlands. We abstain from explaining the details and how the numbers of the NAMEA are compiled. We only want to give a brief overview about the NAMEA, so that it should be possible to understand, what kind of information the NAMEA can provide for policy-makers and economists.

The NAMEA is a statistical information system to combine national accounts and environmental accounts in a single matrix. It is a so-called satellite accounting matrix (SAM), as it is described in the SNA 1993 (Chapter XXI).[45] The conception of the NAMEA system is based on the work of Keuning (1992, 1993) de Haan & Keuning (1996) and de Boo, Bosch, Gorter & Keuning (1991, 1993). The origin of their work is the input-output approach[46] of Leontief (1970).[47]

The NAMEA system is only a descriptive system in which the economy is divided into its economic sectors and the contributions of these sectors to economic and environmental indicators. It maintains a strict borderline between the economic and the environmental aspects. It is represented in monetary units on the one hand and in *physical* units on the other hand, that is the reason why it is called a hybrid accounting system.

To get a clear understanding of the interrelationships between the natural environment and the economy, we should use a physical representation for the pollutants. If the NAMEA system would contain monetary values about environmental problems, two problems would occur. Firstly, the environment must be valued in monetary units and secondly it is very delicate task to differentiate between prize changes and quantity changes. Therefore, the resulting indicators are measured in physical units. The interrelationship between the economy and the environment has two perspectives, an economic one and an environmental one. The economic perspective contains the physical requirements in the economic processes, like energy and material and spatial requirements. The environmental perspective puts forward the consequences of these requirements with respect to the availability of the natural environment. Consequently, the optimal allocation of natural resources requires the consideration of both perspectives.

The fundamental idea of the NAMEA is to extend the conventional national accounting matrix with two additional accounts. One additional account is the account for environmental problems like the greenhouse effect or the ozone layer depletion.[48] The selected environmental

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[43] See for example Lange (2003).

[44] The NAMEA was developed by De Boo, Bosch, Gorter & Keuning (1991). See also De Haan, Keuning & Bosch (1994) or De Haan (2004).

[45] The original idea behind the SAM's (Satellite Accounting Matrix) was to incorporate concerns of inequality and poverty within the national accounts and input-output tables. An introduction to the SAM approach is given in Keuning & de Ruijter (1988), Pyatt & Thorbecke (1976) and Pyatt & Round (1986).

[46] Duchin & Steenge (1999) give a technical overview about input-output analysis with respect to environmental problems. Additionally, Duchin (1998) has presented a structural approach of different I-O models. See also Duchin & Lange (1994).

[47] Leontief´s (1970) analysis of the physical economy "can be regarded as the first prototype NAMEA since both systems are characterized by a hybrid structure including both physical as well monetary data" (de Haan (2001), p.5).

[48] The numbers for the environmental themes are aggregated with the help of the IPCC conventions. This means e.g. that one kg of CO2 emissions equals one global warming potential, one kg of N2O emissions equals 270 global warming potentials, and one kg of CH4 equals 21 global warming potentials.

themes are partly global environmental problems and partly national and local environmental problems. The selected themes are:[49]

1. Greenhouse effect
2. Ozone layer depletion
3. Acidification
4. Eutrophication
5. Waste
6. Waste water
7. Fossil fuels

The second additional account is for environmental substances, like carbon dioxide or sulfur dioxide, where these substances are expressed in physical quantities, like kilogram, tons et cetera. The selected environmental substances are: [50]

1. CO_2
2. N_2O
3. CH_4
4. $CFC's$ and halons
5. NO_x
6. SO_2
7. NH_3
8. P
9. N

The selection of themes and substances follows those environmental themes which were most important in the view of the Netherlands Ministry of Housing, Spatial Planning and the Environment (1989, 1990, 1992, 1993)[51] and with an approval of the Dutch parliament (Tweede Kamer (1996)). The ministry had designed a single indicator each of the environmental themes, by weighing together the emissions that contributed to each theme.[52]

It can be said, that the NAMEA generates consistent summary indicators for those environmental problems, which are considered to be most pressing at the political level in the Netherlands.

The NAMEA is centered around a set of tables, which give an overview of relevant relations between the flow accounts and data on environmental changes. De Haan (2001, p. 12) presents a picture of the scope of the NAMEA system.

[49] See for example the NAMEA table in Keuning, van Dalen & de Haan (1999, p.18-22).
[50] See e.g. the NAMEA table in Keuning, van Dalen & de Haan (1999, p.18-22).
[51] The pilot NAMEA in 1993 benefited much from the work done on environmental indicators at the Ministry of Housing, Spatial Planning and the Environment (Adriaanse (1993)).
[52] The indicators refer to Adriaanse (1993). An extended discussion of the aggregation of different environmental substances is given in the Annex B of de Haan, Keuning & Bosch (1994).

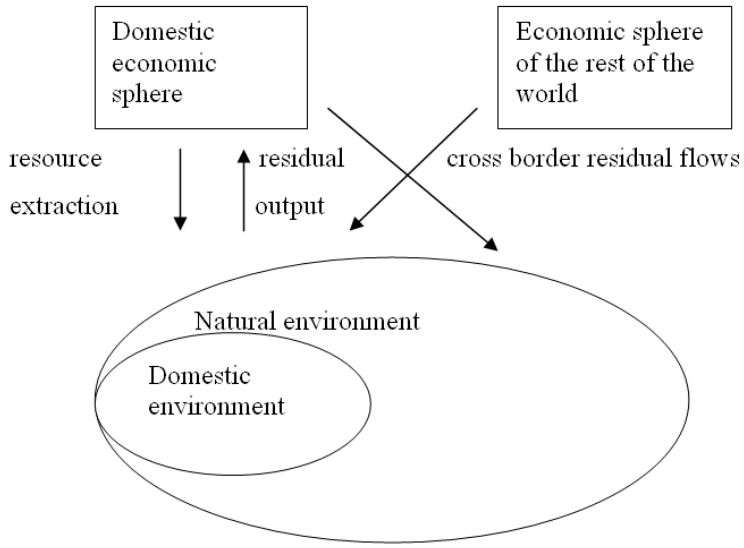

Figure 2 - Scope of the NAMEA system

Keuning (1992) presents the national accounts in a matrix format to get a coherent, generally applicable system, where specific tables for each relevant substance can easily be related to aggregate ecological and economic flows. As a result, the whole system can be mirrored on a few sheets of paper. Additionally, the matrix format reveals which entities and which accounts are involved at both ends of each set of monetary and physical flows. This especially, is advantageous for the I-O modeling practice.

In the NAMEA system, a strict borderline is maintained between the economy and the environment. For example, the environmental accounts are denominated in different physical units tons, kilo-joules, cubic-meters et cetera, but not in monetary units. In some sense, the NAMEA tables show the boundaries of the core national accounts. The physical accounts of the NAMEA expand these boundaries. The NAMEA makes the connection between the environment and the economy more clear and with its help, it is possible to receive a picture where the environmental hot spots are in the national accounts. In addition, it distinguishes between households and industries including public services. These are the main groups of activities.

Because the compilation of the NAMEA is explained in Keuning (1992) and Keuning, van Dalen & de Haan (1999), De Haan (2004) in detail, we refer to that literature.[53]

The NAMEA contains next to the conventional economic aggregates, a summary of environmental indicators. As a result it could be recognized how much a specific economic activity contributes to the GDP, employment, exports et cetera and how much it contributes to the major environmental problems, like the greenhouse effect, ozone layer depletion et cetera.

For example, in the RAMEA of Noord-Brabant 2003 tables (table 1) it can be seen that the production of electricity in the Noord-Brabant contributes only 0.42 % to employment, but it contributes 46.31 % to the total emission of CO_2 and 39.32 % to the GHG theme.

Similar observations can be made for each industry to get a profile about each industry. With the help of such profiles it will be become clear that the aggregate environmental damage of a country or region does not only depends of the country's (region's) size and development stage but also on its structure of economic activities.

For example, a region with a relative less developed service sector and high shares of the manufacturing and agrarian sector will relative more pollute the environment than a region where

[53] The NAMEA 1995 is given in the appendix of de Haan & Keuning (2000).

the share of the service sector is relative high. Of course this is the case in Noord-Brabant, because the manufacturing sector is over proportional huge in relation to the whole Netherlands.[54]

NAMEA tables for different years are now available, which makes it possible to recognize how the profiles of economic activities changed within time. These aspects are highly relevant to policy-makers and for future estimations.

To give an example de Boer, de Haan & Voogt (1994) make use of a model with the data from the NAMEA to estimate the consequences of reducing the pollution levels to norms set by the Dutch parliament.

Without doubt, the results of these model estimates depend on the assumptions about the behavior of the rest of the world and the assumptions about the technical progress to improve Eco-efficiency.[55]

Let us look at the following tables, which are based on the RAMEA 2003 of the Dutch region Noord-Brabant. For didactical reasons we restrict ourselves to the production sector.

Table 19 - Contribution of Production to output, gross value added, employment and some environmental themes according to the 2003 RAMEA for Noord-Brabant (NL)

2003	output Noord-Brabant	GVA Noord-Brabant	labor input of employed persons Noord-Brabant	CO2 Noord-Brabant	GHG theme Noord-Brabant
SIC '93	*%*				
Total economic activities	100	100	100	100	100
A+B Agriculture hunting forestry fishing	2,8451956	1,8752803	3,62699535	6,4277943	15,445963
C Mining and quarrying	0,0950348	0,1233105	0,03030915	0,09169091	0,1100969
DA Food, beverages and tobacco	8,3572139	5,4272628	2,82885431	4,28336964	3,7328166
DB+DC Textile and leather products	0,8874788	0,6469797	0,69711053	0,37273219	0,3313695
21 Paper and paper products	0,6184572	0,4516046	0,4344312	0,79566378	0,6873272
22 Publishing and printing	1,1221416	1,0057011	1,08102647	0,1131193	0,1245987
DF Coke, refined petroleum, nuclear fuel	0,0921106	0,0768689	0,05051526	0,3737413	0,3169605
DG Chemical products	5,4184455	3,4815194	1,62659123	12,400156	14,754596
DH Rubber and plastic products	0,9211065	0,6501826	0,70721358	0,18629269	0,1795252
27 Manufacture of basic metals	0,7186093	0,3763372	0,33340069	4,76075447	4,0544384
28 Manufacture of metal products	2,0637172	1,5197617	2,06102243	0,41872642	0,4101715
DK Machinery and equipment	3,5104392	1,9585549	2,12164074	0,38543425	0,4079259
DL Electrical and optical equipment	4,7159191	1,3532125	2,74802991	0,51993615	0,5438237
DM Manufacture of transport equipment	2,5213463	1,4525014	1,17195393	0,22133766	0,2270775

[54] See the case study below.

[55] Eco-efficiency is defined as the relation between emissions (measured in physical units) per unit of output (measured in money). See for example Filatova & Stauvermann (2006).

Manufacturing n.e.c.	2,5366981	2,4469925	3,60678925	2,25168887	1,998441
E Electricity, gas and water supply	3,9673373	2,6119403	0,42432815	46,3105319	39,32536
F Construction	7,8564536	6,3737108	7,78945241	0,94228646	0,8012386
51 Wholesale trade	5,9075092	8,0600218	7,2135785	0,99088343	0,8439223
50+52+55 Retail trade, cars, repair, hotels	6,3607521	7,7877778	12,2752071	1,95984189	1,6650491
60 Land transport	2,1338967	2,6679905	3,03091534	5,29427607	4,4986475
61+62 Air transport, water transport	0,0935727	0,0960861	0,13133966	0,71965937	0,6110459
63 Auxiliary transport activities	0,9181823	0,9576581	0,9294807	0,19502688	0,1665047
64+65+66+67+K Financial, business services and communication	20,644482	26,446096	18,4986866	2,32634938	1,9864886
L Pub. admin., defence, social security	4,8855196	6,2792262	5,92038796	1,57564402	1,3405124
M Education	2,3612492	4,0916661	4,62719741	0,59330979	0,5041581
N Health and social work	5,0616995	8,2233681	10,9517074	1,22475804	1,0632583
90 Environmental services	0,6922919	0,5765166	0,34350374	3,28558134	3,036113
92 + 93 culture, sports, others and recreation	2,6924089	2,975466	4,72822792	0,97941349	0,8325702

Table 2.1

(Source: CBS (2007) and own calculations)

Table 2.1 represents the relation of different production sectors to different economic indicators (regional GDP and regional employment) and environmental themes (greenhouse gas effect, ozone layer depletion, acidification, eutrophication and waste). The total regional production is normalized to 100. The table tells us how much a specific production sector contributes to the economic indicators and to the environmental themes relative to the aggregate contribution of the aggregate production. For instance, if we look at the fourth row, we can read how much the agriculture, fishing and forestry sector contributes to regional GDP of Noord-Brabant in relation to the total output of the regional production sector. Obviously, 2.84 % of the total output of the regional production sector is produced in the agrarian sector. Although, the contribution share of the agrarian sector to employment is only 3.62 %, the contribution share to the regional gross value added is only 1.87 %, but the contribution to the GHG theme is 15.44 % .

To get a better insight into these numbers an additional table can be constructed from the RAMEA.

Table 20 - Cumulative pollution per unit of final demand relative to the aggregate cumulative pollution per unit final demand (2003) in Noord-Brabant[56]

2003	GHG Noord-Brabant	Acidification Noord-Brabant	Eutrophication Noord-Brabant
SIC '93			
Total economic activities	1	1	1
A+B Agriculture hunting forestry fishing	5,4287877	18,181108	23,185751

[56] Source own calculations.

C Mining and quarrying	1,1584899	0,3422143	0,0548618
DA Food, beverages and tobacco	0,446658	0,1486727	0,6608444
DB+DC Textile and leather products	0,373383	0,1525512	0,3929392
21 Paper and paper products	1,1113577	0,4830701	1,220905
22 Publishing and printing	0,1110365	0,0395281	0,0069697
DF Coke, refined petroleum, nuclear fuel	3,4410838	3,9054804	0,213284
DG Chemical products	2,7230312	0,797261	1,0155975
DH Rubber and plastic products	0,1949017	0,0594027	0,0441871
27 Manufacture of basic metals	5,6420625	3,2490208	0,3427966
28 Manufacture of metal products	0,1987538	0,0728873	0,049436
DK Machinery and equipment	0,1162037	0,0629604	0,0111746
DL Electrical and optical equipment	0,1153166	0,0358442	0,0395165
DM Manufacture of transport equipment	0,090062	0,0295159	0,0312908
Manufacturing n.e.c.	0,7878119	0,7553768	0,1727095
E Electricity, gas and water supply	9,9122804	3,005134	0,3979182
F Construction	0,1019848	0,2228911	0,4174527
51 Wholesale trade	0,1428559	0,2833225	0,0541097
50+52+55 Retail trade, cars,repair, hotels	0,2617692	0,0632821	0,0115697
60 Land transport	2,1081843	5,6520155	0,9929036
61+62 Air transport, water transport	6,5301716	25,338993	2,9710862
63 Auxiliary transport activities	0,1813416	0,3361803	0,061069
64+65+66+67+K post,telecomunication, banking comercial services	0,0962237	0,107557	0,025732
L Pub. admin., defence, social security	0,2743848	0,5302236	0,0756114
M Education	0,2135133	0,0900705	0,0157311
N Health and social work	0,2100596	0,070907	0,0136227
90 Environmental services	4,3855963	1,057577	17,294375
92+93 other service activities	0,3092287	0,1160896	0,020113

The entries in the table give an impression for specific industries of the deviation of cumulated pollution per unit of final demand in relation to the average over all industries. The average pollution per unit of final output is standardized to one. Let us look for example at the agricultural sector in Noord-Brabant, in last column is the number 23.18 (4,4). This means that the relative contribution of this sector to eutrophication is 23.18 times higher than its relative contribution to the GDP.

Given these kinds of tables for specific periods, as is explained in De Haan & Keuning (1995) or Keuning & de Haan (1996, 1997), it is possible to decompose the changes in emissions by industry into several effects:[57]

[57] An explanation how to do this is given in de Haan & Kee (2004) and De Haan (2000).

1. Demand composition shift effects
2. Output growth effects
3. Eco-efficiency change effects

The first effect can be positive or negative in the sense that the claims to use the natural environment are reduced. The second effect is negative, because more output means in general an increased use of the natural environment, because of the laws of thermodynamics. The third effect is positive, because of technological progress. De Haan (1996) for example has connected the NAMEA with data on estimated costs and emissions reductions of a range of potential energy-saving measures by industry in the Netherlands. He came to the conclusion that the Dutch economy would be better off to some extend, if the most efficiency measures are applied first. However, if the norms for CO_2 emissions set by the government were too restrictive the result would be the reverse.

In principle, the NAMEA system has much in common with the SEEA 2003 system. Both systems are similar with respect to the use of a matrix format, to the kind how environmental protection expenditures are treated and how to deal and incorporate social issues. However, there exist some differences.[58]

1. The SEEA 2003 focuses on an extension of the standard asset accounts with accounts for environmental assets like rivers, sea, air et cetera. Contrary to this the NAMEA begins with an extension to the complete national accounting system with environmental substances accounts and environmental themes accounts.

2. The NAMEA does not contain a SNI, or a Green National Income, or an Eco-Domestic Product, as the SEEA 2003 does.[59]

3. The NAMEA system aggregates pollutants by environmental problems, but the SEEA system does not contain such an aggregation.

4. The NAMEA system can be used for analytical applications based on a Leontief model. For example, with the help of the NAMEA system it is possible to estimate the total pollution which is generated by one unit of final demand for each product group. (E.g., the electricity supply contributes 4.84 more to the green house effect per unit of final demand than the average product group of the economy, see the previous table.) Such type of accounting is not included in the SEEA system.

5. The methodology of the present version of the SEEA is, to view the degradation of natural resources in the same way as the consumption of fixed capital in national accounts. This is not the case in the present Dutch NAMEA system.

It can be conclude, that the NAMEA is a multi-purpose information system, which is able to inform the public and policy-makers about the status quo of the environmental assets and environmental pollution. Especially, the NAMEA provides policy-makers with a data-framework, which can be used to sketch the trade-off between prevention of environmental damages and macro-economic policy objectives. It is no problem to extend the NAMEA system with additional environmental themes and substances. The selection which kind of environmental problems should be represented depends on the political decisions and not on the decisions of scientists. This is the

[58] See Keuning & Steenge (1999) and especially Kee & De Haan (2004) who discuss the differences between SEEA and the NAMEA approach.
[59] Later on we will come back to this.

reason, why the NAMEA's of different countries are different. (The British NAMEA contains 15 environmental substances and only 3 environmental themes (Vaze 1999), the Japanese one contains 16 substances and 6 themes (Ike 1999), the German one contains 8 substances and 2 themes (Tjahjadi, Schaefer, Radermacher & Hoeh 1999) and the Swedish NAMEA contains 5 substances (Hellsten, Ribacke & Wickbom 1999).[60] Without any doubt, it would be useful to standardize the NAMEA's of all Countries, because of the global environmental problems. The data from the NAMEA can be used for calculating, e.g. the effects of a shift in tax incidence, from labor to energy use, say, on environmental and economic indicators in the NAMEA system. Additionally, the data can be used for modeling a general equilibrium model to estimate the consequences of a change in the tax system. With the help of the NAMEA, it is possible to calculate the consequences of specific political decisions. For example, let us look at the introduction of catalytic converters into cars. As a consequence, the burden of the ozone layer depletion decreased by nearly 12.3 % in the Netherlands. Further, it is no problem to integrate social accounts into the NAMEA system. This is done in the so-called System of Economic and Social Accounting Matrices Extensions (SESAME).[61] In addition, it is possible to get new insights for the question who should pay for the environmental damages[62]. At least it can be said that the NAMEA is a tool or an instrument to account for environmental problems and it combines the data from the environment with the economic data from the core of the SNA. However, no specific economic assumptions are used to compile a NAMEA. Policy-makers are free to decide which kinds of environmental themes and environmental substances should be regarded and policy-makers must decide how they want to resolve the environmental problems. As a result, the NAMEA does not only serve to derive aggregate indicators from a consistent meso-level information system, it also provides data in the required format for all kinds of I-O analyses and others.

5.2.3 Applications of the NAMEA

Some what contrary to the GNI approach, the NAMEA becomes more and more an important tool to analyze environmental policy measures. An indicator for this thesis could be the release of the recent published introductionary text book of Common & Stagl (2005) or the textbook edited by Proops & Safonov (2004), the article from Duchin & Steenge (1999) in a handbook on environmental economics edited by van den Bergh (1999) or the text of ten Raa (2005). The field of applications within I-O models framework is much broader than possible applications of the SNI approach. Here we shall not go into the formal methods which were used, because they are well-known. We only will survey the results of different investigations regarding what kind of information could be received. Obviously, the NAMEA is directly useable for I-O modeling, because of its matrix representation. The idea, to incorporate environmental aspects in I-O models is not new and goes back to Leontief (1970), Leontief & Ford (1972), Cumberland (1966) and others.[63] A general overview how I-O models could be applied regarding environmental problems is given in Miller and Blair (1985). It is well known, that I-O models provide a theoretical framework for specific questions about the relationships between different sectors of an economy and observable transactions between the sectors of the economy. To investigate what kind of questions could be resolved with the help of the NAMEA we give an overview about possible applications. It should be noted that most of the used I-O models are explained in detail by Duchin & Steenge (1999), Proops & Safonov (2005), Duchin & Lange (1995), ten Raa (2005) and De Haan (2004). The first I-O model, where the NAMEA was used, was developed by Steenge & Voogt

[60] For a comparison of the different approaches, see de Haan (1999).
[61] See e.g. Keuning (1997), Keuning (1998), Van de Ven, Kazemier & Keuning (1999), Keuning & de Haan (1996).
[62] See Steenge (1997, 1999).
[63] See e.g. Duchin & Steenge (1999).

(1995). They make use of a standard I-O model, where the sectoral outputs are functions of the final demand.

5.2.4 An I-O Model

Here we want to give an example to show how the NAMEA can be used with respect to normative judgments about political objectives. That means, given specific political objectives like the Kyoto-protocol we are able to calculate the outcomes with the help of I-O analysis. To do that, we represent the NAMEA system in a reduced form. This model is based on Steenge & Voogt (1995). Maybe, the introduction of account 2 is surprising, but the background is that consumers also produce emissions by consuming energy for heating, energy for private car use, waste etc... In so far consumption is defined according to consumption purposes in order to combine consumption expenditures with the quantity of emissions, caused by consumption. It should also be noted that we take only the domestic emissions (incl. the environmental the deficit/surplus) into account.

<table>
<tr><td colspan="2" rowspan="2"></td><td>Goods and services</td><td>consumption</td><td>Production</td><td>Income gene Ration</td><td>Income distribution And use</td><td>others</td><td>total</td><td>Emissions</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td></td><td></td></tr>
<tr><td>Goods and services</td><td>1</td><td colspan="5" rowspan="5">D</td><td rowspan="5">F</td><td rowspan="5">Z</td><td rowspan="5">R</td></tr>
<tr><td>Consumption</td><td>2</td></tr>
<tr><td>Production</td><td>3</td></tr>
<tr><td>Income generation</td><td>4</td></tr>
<tr><td>Income distribution and use</td><td>5</td></tr>
<tr><td>Others</td><td>6</td><td colspan="5">W</td><td>t</td><td>Zt</td><td>G</td></tr>
<tr><td>Total</td><td></td><td colspan="5">Z’</td><td>Zt’</td><td></td><td>T’</td></tr>
</table>

Explanation of variables

Variable	**Definition**	**Dimension**
D	Matrix of intermediates	n x n
F	Vector of final demand	n x 1
W	Vector of inputs	n x 1
T	Total transactions between others	
R	Matrix of domestically generated emissions	n x p
G	Vector of foreign emissions flowing to the home country	p x 1
Z	Vector of totals of accounts	n x 1
Zt	Total of accounts	
T	Vector of total pollutants in the home country	p x 1

5.2.5 A Linear-Programming Model

In this section we want to show how something like a Green national income can be calculated. To do that we take the NAMEA table to define a linear model. The basic idea goes back to the standard I-O model approach, where the sectoral outputs are written as a function of the final demand. At first we make use of the matrix ***A***, which represents the technical coefficients;

(2.1) $a_{ij} = \frac{d_{ij}}{Z_j}$.

In a next step we can write the vector of outputs ***Z*** as

(2.2) $Z = (I - A)^{-1} F$.

In equation (2.2) the matrix ***I*** represents the unit matrix.

Our objective in this model is to maximize the net domestic product or the aggregated net value added (NVA). The NVA is represented in the sub-matrix (4,3) in table 2.4. The elements of this matrix describe the NVA of all production activities j for all primary income category $\boldsymbol{f}$. Because of the assumption that these elements are linearly related to the output, we maximize the following objective function;

(2.3) $\max \sum_j \sum_f a_{jf} Z_j$,

where a_{fj} are elements of the sub-matrix (4,3) of A. The elements a_{fj} of must be interpreted as technical coefficients. Additionally to the objective function we introduce two restrictions.[64]

(2.4) $EZ \leq T - G$

and

(2.5) $F = (I - A)Z$.

Equation (2.5) is obviously the standard Input-Output restriction, which shall guarantee that the economic part of the model is consistent. The additional restriction takes the environmental part into account. To derive really a green national income, we introduce the condition that the quantity of each pollutant is always below its maximal acceptable level. In the model we treat the quantity of emissions as by product of the production output. Consequently, we assume, that the elements of the matrix R are linearly related to the output

(2.6) $R' = E\overline{Z}$

In equation (2.6) the matrix $\overline{Z}$ represents the diagonal matrix of ***Z*** and the matrix ***E*** is nothing else than the emission coefficient matrix, with the elements $e_{kj} = \frac{r_{jk}}{Z_j}$, what means that the coefficients of ***E*** and consequently ***E*** itself depend on the original values of the matrices ***Z*** and ***R.*** In inequality (2.4) the matrix ***G*** denotes the matrix of emissions from foreign countries. For simplicity we assume that these emissions from abroad are exogenously given. Then the interpretation of restriction (2.4) is nothing else than the statement that the quantities of domestic emissions are lower or equal to the original values, which are also the maximal acceptable levels of emissions.

[64] It should be noted that we could also introduce more restrictions than two. Of course, the additional restrictions must be fulfilled by an inequality or equality.

As noted before it would be no problem to take some additional constraints into account, this of course depends on the specific policy objectives. But it should be noted that we must take care about the feasibility of the model. If this will be ignored it could be possible that the different policy objectives are incompatible and not all objectives will be realizable.

It should be clear that sustainability is determined on the one hand by the maximal acceptable levels of emissions and on the other hand by minimal levels of economic variables like final outputs, investments, exports etc. Let us now denote the original vector of outputs as F_O. Then we can restrict the elements of ***F***, which are related to the final outputs of the economic variables to some minimum levels;

(2.7) $\alpha F_O \leq F$,

where $1 > \alpha \geq 0$ for account 1. Then we take care about the trade balance, where we assume that the imports do not exceed the exports, which are assumed to be exogenous in this model. So for accounts 4 and 5, the elements of ***F*** represent the income received from foreign countries. So we get the following equation;

(2.8) $F = F_O$, for accounts 4 and 5.

Because of the fact that for accounts 2 and 3 no economic interpretation of the corresponding elements of F exist, they are zero by definition;

(2.9) $F = 0$, for accounts 2 and 3.

Additionally we assume that the exports are a fixed share θ_i of the total final output of good *i*. Imports can be written as a fixed share of total other inputs, which at least means that the imports are also a fixed share of the total inputs. this restriction can be written in the following way;

(2.10) $\sum_i \beta_i Z_i = \sum_i \theta_i F_i$.

Now the whole model is well defined. To summarize the model again, we are maximizing the objective function (2.3) with respect to inequality (2.4), the standard I-O equality constraint (2.5), inequality (2.7), equation (2.8), equation (2.9) and equation (2.10).

Now we are able to perform model simulations and to optimize.

Given a certain level of domestic emissions, we are able to calculate unique levels of output totals and total final out. The changes in total output will change the net value added and household consumption, because both variables depend only on output totals.

At first Steenge & Voogt (1995) assume that $\alpha = 0.95$, which means that we want to realize at minimum 95% of the original final output or in other words we only restrict the decrease of final output to maximal 5% of its original value. The optimization will lead to an 1.4% increase of the NDP, which is mainly caused by an 2.5% increase of the net value added. of the sector services and other activities. However, let us look at the following table for the changes of the net value added (economic sectors) and changes of emissions (substances).

Table 21 - Changes of the net value added (economic sectors) and changes of emissions (substances)

Economic sectors	Changes of net value added in %
Agriculture	-1.6
Refineries	-1.6

Economic sectors	Changes of net value added in %
Chemical industry	-2.4
Basic metals	-2.3
Other manufacturing	-1.3
Electricity	0.4
Construction	2.7
Transport	-1.1
Services and other activities	2.5
Substances	**Changes of emissions in %**
CO2	-0.1
N2O	0.0
CH4	-0.4
CFC's and halons	0
NOx	0
SO2	-0.6
NH3	-1.5
P	-1.2
N	-1.3
Waste	-1.2

Secondly, the authors have simulate what will happen if we would change the parameter α, or in other words if we would shift the minimum level of final output of goods and services. If we now compare the results with the optimal situation, a decrease of all emissions by 1% leads to a decrease of 1.7 % of the Net domestic product and of a decrease of consumption of 1.1 %.

Just in another calculation, the authors have assumed that all emissions should be reduced by 5%, we got the result that the NDP will be decreased by 9.1% and the consumption by 6.1 %.

A different step was to calculate the reduction not by pollutant but by environmental themes. The government concentrate on three environmental themes; green house gases, ozone layer depletion, acidification and eutrophication.

Additionally, the authors calculated that a 1% reduction of emissions and assuming a restriction a minimum level of production of 90% compared to the actual one, the NNI would decreased by 1% in relation to the actual value. Similar simulations are made for environmental themes and they come to the conclusion that there exists a nearly linear relation between emissions and NNI.

5.2.6 Some other Examples

Steenge (1997) linked the I-O model including the NAMEA directly to certain institutional aspects of environmental policy. He showed that different liability rules could be introduced, so that the polluter-pay principle is not the only possible institutional rule which could be implied.

Another example where the data of the NAMEA was used in an I-O model was created by De Haan (2001), where he analyzed the effects, which influence the quantity of pollution. The change in of pollution is caused by different reasons:

-changes of eco-efficiency
-changes of production structure
-changes in pollution per money unit of output
-changes in the composition of final demand

With the help of I-O analysis he is able to calculate, what the main reasons for changes in pollution are. In his article he analyzes the time period between 1987-1998 to explain the changes of CO_2 emissions. Besides more detail results, De Haan (2004)[65] get the following results:

The change of CO_2 -emissions in the period 1987-1998 was caused by:

-12.1% eco-efficiency gains,
-0.2 % change of production structure,
-2.6 % change of demand structure,
+35.1% change of demand volume.

These different effects results in a 20.1% increase of CO_2 emissions in the observed period.

Of course, it is also be possible to restrict the I-O analysis to specific inputs like energy, like Schoenau and Delahaye (2006) have done with respect to the Dutch energy use in 2003. The authors calculated that 64 % of the Dutch energy use is caused by exports, 23 % by private consumption, 6 % by public consumption and 7 % by investment activities.[66]

5.2.7 Some General Problems and Restrictions to construct a RAMEA

However, the problem to construct a RAMEA is that much regional environmental data is not available, additionally

"*Apart from other problems, the absence of data on interregional trade is the biggest bottleneck. Because of the lack of a complete accounting framework, there is no consistency check by means of balancing items*".[67]

At least it means that we are not able to use bottom-up methods to construct regional environmental accounts. So we are compelled to make use of top-down methods as long as no regional data on emissions is available. Regarding regional accounts, Kruger (2006, p.5) proposed;

"*Top-down methods should be based on regional distribution keys that are as closely related to gross value added as possible.*"

Regarding economic policy proposals, the gross value added seems to be a relevant indicator, because it indicates the amount of the regional income. Regarding environmental policy proposals, it looks like more adequate to use a factor, which is closely related to the output, because mostly the quantity of emissions are positively related to the production level within an industrial sector. Because of the fact that the regional economic accounts of the Netherlands are very well elaborated (40 COROP areas and 38 economic activities), we have only to resolve the problem how to distribute the aggregate emission data of the Netherlands to the specific regions.

Therefore, in this report we want to describe how a Regional Accounting Matrix including Environmental Accounts (RAMEA) could be derived. It is clear that a RAMEA must be based on the methodology of the NAMEA (National Accounting Matrix including Environmental Accounts) which was developed by Steven Keuning and Mark de Haan.[68] The general idea is to develop a hybrid accounting system, where economic variables like GDP, value added etc. are expressed in

[65] Please note, there is a small error in the calculations of de Haan (2004,, p. 180, table 8.2 .). The total change regarding agriculture (first row) is not 0.8% but instead 0.7%, in so far the total change is not 20.2% but 20.1%.
[66] The analysis here was also made in other countries like Germany (see e.g. Stahmer (2000)).
[67] See Nijmeijer (2006, p.6).
[68] See e.g. De Haan (2003), Keuning & Steenge (1999), Keuning, van Dalen & de Haan (1999) and the cited literature there.

monetary terms and where the environmental variables are expressed in physical units like kg, joule etc. The big advantage of this approach is that a reader will get deep insights into the economic and environmental state of a country or region. Given this approach most of the methodology is determined and laid down in the SEEA 2003, the remaining problem is then to get adequate regional data. In principle, a RAMEA should provide information about the inter-linkages between the physical surrounding of the ecological system and the economy at a regional scale. This involves not only linking environmental data to economic data, but also presenting these data at the relevant geographical scale through up scaling or downscaling. It is an issue of matching available data across the various scales, which has proven to be one of the major challenges in the compilation of a new integrated regional accounting system. To make the analysis as easy as possible and to highlight the problems of data collection we restrict ourselves to emissions, which are taken into account in the Dutch NAMEA. The reference years of this study are 2001 and 2003, because that is first and the last year for what we have enough consistent and comparable data.

Regional economic data exist for each of all European provinces, but of course, these data are not as much elaborated as in the NAMEA. Especially it is be impossible to derive the value or quantity of interregional exports and imports from other provinces. Because of that, it will be impossible without estimations to derive use and supply Input-Output tables. However, we will use bottom-up methods if sufficient data is available. This approach is also used in the literature of national accounting; see e.g. Van der Veren, Brouwer, Schenau & van der Stegen (2004). A general approach how to derive a regional NAM is explained in detail in Eding, de Vet & Walrave (1999), Eding, Oosterhaven & Nijmeijer (1997) or CBS (1999). Van de Steeg & Steenge (2006) resolved some similar problems.

Additionally, it should be noted that the national accounts have some restrictions, e.g. goods and services are only part of the economic accounts if a market price exists. The only exception are the services of the public sector, in this case it is assumed that the prices of these services are equal to the costs of supplying these services. Of course, this assumption has strong implications, e.g. the economic contribution to the Gross Domestic Product (GDP) of a professor is equal to his gross compensation[69], if we ignore for simplicity the costs of his working place. Consequently, an increase of the salaries in the public sector looks like as an increase of production and hence as an increase of national income, although it is not really the case.

Also it should be noted that “economic sector” does not mean that the firms within an sector are only producing typical goods of this sector. To decide to which sector a specific firm belongs depends on the main activity of the firm. That means that it is possible that a firm which produces mainly electronic parts and delivers the parts with the help of a truck fleet, is accounted then in the sector of the electronic part producing sector, although that maybe 40% of the production value was contributed by the truck fleet.

Another problem arises, if a firm sources out a part of its production, there could be shift from one sector to just another. E.g. taking the example from above, if the firm sources out its truck fleet, the production value of the sector transport will increase and the production value of the electronic parts producing sector will decrease, although a real change of the economy has never taken place.

5.2.8 Concluding Remarks

As noted above there was a long discussion in the Netherlands about the question which kind of environmental accounts should be used. After a long discussion, the NAMEA approach became the preferred one. The reasoning was based on the argument that a GNI is rather a model than an accounting tool because of the strong underlying assumptions. Contrary to a GNI, the

[69] Gross compensation is defined as the sum of labor costs including all social security contributions paid by the employer.

NAMEA is more useful in concentrating on specific environmental themes or pollutants. It is easier for policy makers to decide on institutional changes to reduce the quantity of pollutants. Empirical investigations based on the NAMEA makes clear that small changes could increase the status of the environment combined with little harm for the average person. A GNI in contrast, is not able to deliver an insight of what is going wrong within an economy regarding to the environment, it only informs us and policy makers that the status is bad, but without information about the 'hotspots' or any other detailed information.

On the international level the question of selecting an environmental accounting system was delegated to the so called 'London Group', which consisted of national accountants from different countries, and representatives from the World Bank, OECD, UNSD and Eurostat, where they also decided to prefer satellite accounts instead of revising the NNI. This is laid down in the SEEA 2003, where de Haan has written the chapter on the NAMEA. After reading this part of this report, it should be clear that a RAMEA is also a very important statistical tool to derive possible policy measures regarding regional environmental policy. In the following figure the Eurostat methodology will become clearer.

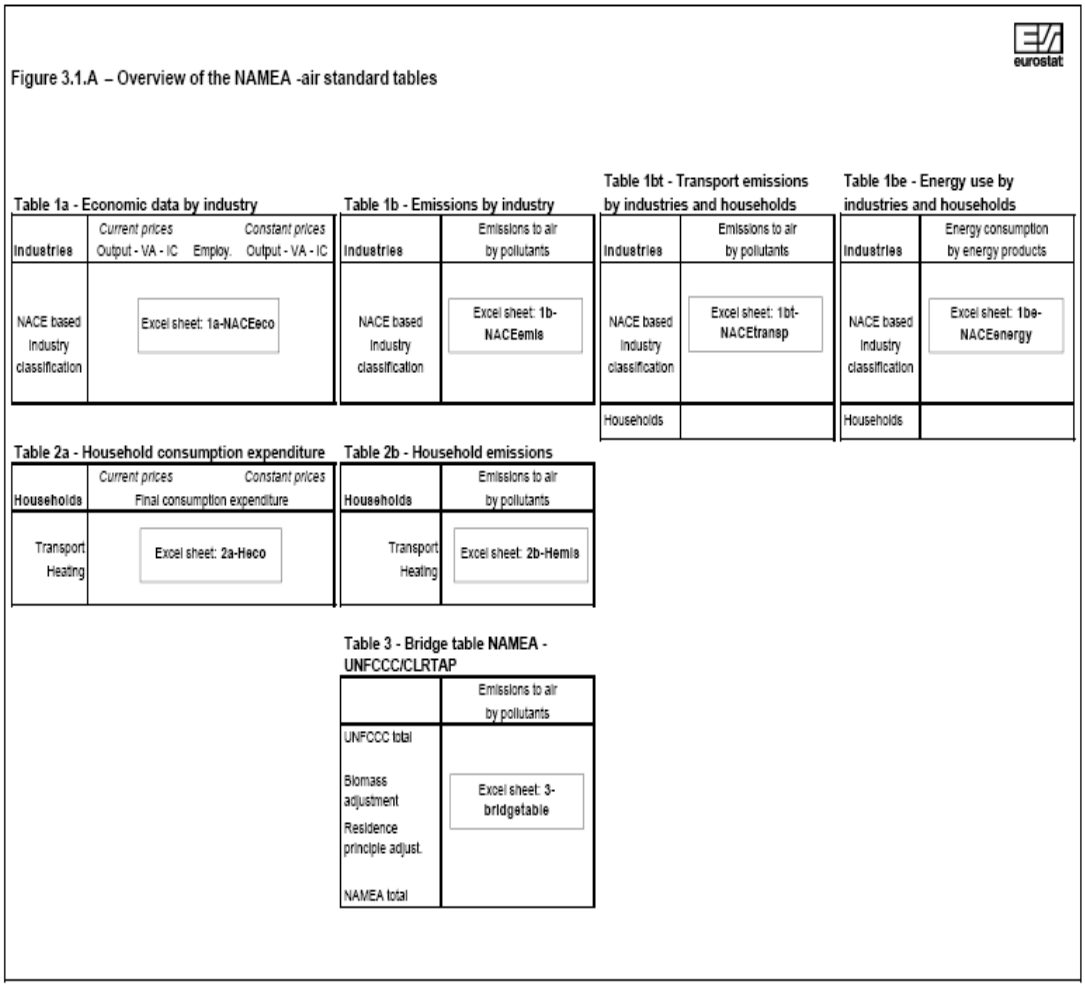

Figure 3 - Overview of the NAMEA air standard tables[70]

Because of the fact that regions and countries differ only regarding their political power it should be clear that the usefulness of the approach for regions could not be taken into question.

[70] See Eurostat (2005, p.50).

5.3 Malopolska

RAMEA for Małopolska was prepared for the year 2003. The chosen results are presented in the Table 22. The output data, gross value added and intermediate consumption with the division into sectors is regional data from Statistical Office. The allocation of output of sector D is estimated on the basis of distribution of production sold in industries in Poland, as more detailed information is not gathered. The employment data covering the number of employees is the average employment in the sectors. The data regarding the full time jobs are the data from regional database in Statistical Office (available online). For the sector D the full-time jobs are estimated on the basis of average employment in the medium size enterprises. Output within manufacturing sector is allocated on the basis of the production sold. Moreover the results are restricted to the emissions from the plants generating substantial air pollution as these are monitored on the level of sectors and regions. These emissions represent almost 70% of total CO2 emissions recorded for Poland. The Małopolska share of CO2 emissions from the plants generating substantial air pollution is equal to approximately 6.39%, which is slightly lower than share the production sold of the industry (sector C, D and E) of 6.41%. The share of Małopolska output is equal to 7.11%, and this of GVA is observed at the level of 7.30%. The biggest contributor to both the output and CO2 emissions is the manufacturing sector (29.46% to the output, 25.51% to the labour input and 27.07% to the emissions) and within this sector the biggest share of CO2 is attributed to manufacture of basic metals, although it represents only 5.51% of the total production sold in the industry. On the other hand there are two divisions: food, beverages and tobacco and manufacturing of electrical and optical equipment – both of them represent around 15% of the total production sold in the industry while their environmental impact remains relatively low at the level below 0.5%. Sector of electricity, gas and water supply contributes only 2.95% to the output, 2.85% to the labour input, but as much as 64.15% to the emissions of CO2.

Table 22 - Contribution of production to output, gross value added, employment and CO_2 emissions according to the 2003 RAMEA for Małopolska (PL).

2003		Output Małopolska %	Production sold Małopolska %	Labour input Małopolska %	GVA Małopolska %	CO_2 emissions Małopolska %
Total economic activities		100	100	100	100	100
A+B	Agriculture hunting forestry fishing	3.50		0.68	2.84	
C	Mining and quarrying	0.89	1.11	0.48	1.05	0.29
D	Manufacturing	29.46	90.09	25.51	18.03	27.08
DA	Food, beverages and tobacco		15.37	5.21		0.45
DB+DC	Textile and leather products		3.30	2.69		0.05
DE	21 Paper and paper products		1.23	0.28		0.08
	22 Publishing and printing		4.34	0.87		
DF	Coke, refined petroleum, nuclear fuel		3.42	0.17		0.34
DG	Chemical products		8.79	1.60		7.88
DH	Rubber and plastic products		4.31	1.19		
DJ	27 Manufacture of basic metals		5.51	0.96		15.45
	28 Manufacture of metal products		8.08	2.49		
DK	Machinery and equipment		3.96	2.13		0.40
DL	Electrical and optical equipment		14.21	2.90		0.09
DM	Manufacture of transport equipment		3.89	1.23		0.31

2003		Output Małopolska %	Production sold Małopolska %	Labour input Małopolska %	GVA Małopolska %	CO_2 emissions Małopolska %
DN	Manufacturing n.e.c.		2.36	1.03		
E	Electricity, gas and water supply	2.95	8.79	2.86	2.77	64.15
F	Construction	7.87		5.49	6.35	8.27
G+H	Trade and repair, hotels	20.47		16.17	23.71	
I	Transport, storage and communication	6.18		4.62	6.04	
J	Financial intermediation	2.51		2.69	3.34	
K	Real estate, renting and business activities	11.46		6.82	13.39	
L	Pub. admin., defence, social security	4.00		6.70	6.36	
M	Education	3.57		15.58	6.32	
N	Health and social work	3.29		9.54	4.95	
O	Other community, social and personal service activities	3.47		2.87	4.15	0.20

The RAMEA for Małopolska was prepared in cooperation with regional Marshal Office, which is the body responsible for the recording and collection of environmental charges. The main source of air emission data at regional level is the Marshal Office database on emissions which covers all the emissions that are subject to the environmental charges for using the environment (Environmental Protection Act from 27.04.2001 with later changes). The database is created by the Marshal Office for recording the reports from the companies about the fees for using the environment. The reporting is based on the standardised forms. The reporting duty is compulsory for every entity that conducts the activities that lead to emissions. The database consists of information divided into four modules:

- emissions to the air,
- water drawing,
- sewer emissions to the water and soil,
- landfilled wastes.

Since RAMEA was dealing with the emissions to the air, the database content pertaining to these emissions is presented in more detail:

5. Air emissions by source
    a. Source of the emission
        i. Type, e.g. furnace, installation
        ii. Source capacity
        iii. Type of protection device
    b. The emission volume
        i. Type of fuel/substance, eg SO_2, NO_2, CO, CO_2, dust, etc.
        ii. The effectiveness of protection device
        iii. The emission volume
    c. The place of emission, i.e. commune name
6. Air emissions from the engine fuels handling is specified separately and it includes:
    a. The volume of fuel handled
    b. The effectiveness of protection device
    c. The place of emission, i.e. commune name
7. Air emissions from boilers are another type of emissions reported and it includes:
    a. Boilers of capacity smaller than 5MW
    b. Fuelled by coal, coke, wood, oil or gas

c. Boilers for which the IPPC is not required
d. Number of boilers
e. Volume of fuel used

8. Air emissions from combustion engines
    a. Cars
    b. Trucks
    c. The type of fuel
    d. Volume of fuel used

The emission that are accounted for in the Marshal Office database include 62 substances, among others: arsenic, ammonia, asbestos, benzene, vinyl chloride, chromium, tin, zinc, sulphur dioxide, carbon dioxide, methane, nickel, lead, dusts, mercury, carbon monoxide, nitrogen oxides, metallic elements and its compounds, etc. The analysis of Marshal Office database was performed for the year 2005 since these data are available in the electronic format; the results are presented in the Table 23. It can clearly seen that the results from RAMEA analysis in terms of the sectors contributing most to the emission e.g. of CO_2 are the same that report the most emissions to the Marshal Office. For CO_2 emissions these sectors include among others electricity, gas and water supply (E), chemical products (DG), manufacture of metals (DJ). The difference however is in the amount reported, but this can be due to the fact that the statistical information on which RAMEA is based cover the most polluting plants.

Table 23 - Emissions results from Marshal Office database [t]

Sectors	**CO_2**	**CH_4**	**NH_3**	**SO_2**	**CO**
Section AB	2 605	–	0.06	59	8
Section C (CA)	0	51 170	–	0	2
Section C (CB)	70	–	–	1	32
Section D (DA)	65 991	132	3.23	614	347
Section D (DB+DC)	5 945	–	0.84	75	109
Section D (DD)	1 352	–	–	0	26
Section D (DE)	16 246	–	0.18	91	77
Section D (DF)	3 291	–	–	18	0
Section D (DG)	377 023	6	181	4 750	146
Section D (DH)	227	–	2.87	3	1
Section D (DI)	9 050 168	80 166	0.12	260	1 559
Section D (DJ)	65 322	–	0.34	701	259
Section D (DK)	21 636	0	0.40	114	98
Section D (DL)	6 846	–	0.01	1	2
Section D (DM)	39 230	–	–	91	242
Section D (DN)	14 540	–	–	822	74
Section E	5 134 635	111	0.01	37 298	1 573
Section F	8 289	–	–	39	79
Section G	5 264	–	0.03	27	44
Section H	909	–	–	2	0
Section I	0	4	–	0	0
Section K	24 171	–	3.76	102	181
Section L	2 962	–	–	9	32
Section M	0	–	–	1	1
Section N	24 197	–	–	66	57

Section OPQ	7 512	–	–	14	8
Not allocated	3 203 228	732	20.69	11 791	39 015
Total	18 081 659	132 320	214	56 950	43 973

5.4 South East England

This chapter describes the process used to create the RAMEA for South East England (SEE). Although the RAMEA presented here for South East England focuses on air emissions, tables were also produced for energy use. The tables were developed using data from the Regional Economy Environment Input Output Model (REEIO) for the South East.

5.4.1 The REEIO Model

REEIO was originally developed by Cambridge Econometrics (CE) as part of the Reward project, a partnership led by the UK's Environment Agency (EA) with the participation of Regional Development Agencies and the National Assembly for Wales. More recently, REEIO has been supported by SCPnet (see http://www.wwflearning.org.uk/scpnet/ for more information).

The majority of the baseline energy use and air emissions data (2003) in REEIO are constructed by Netcen, and draw on the UK National Atmospheric Emissions Inventory (NAEI) maintained by Netcen for the Department for Environment, Food and Rural Affairs (DEFRA). A brief overview of the methodology used to produce this data is given in Section 3 below[71].

The REEIO model is a forecasting model that links economic policy and environmental impacts. As well as allowing us to develop a RAMEA for a baseline year (2003), it also allows us to estimate the level of energy use and air emissions, and thus a RAMEA, for a forecast year.

5.4.2 The Data

Economic

The economic data (employment, output, value added) in the SEE RAMEAs presented here come from databases developed by CE for the Regional Economic Model of the UK Economy. This model breaks down the UK economy into 41 separate industries[72], in each of twelve administrative areas (the nine Government Office Regions (GORs) of England, and Wales Scotland and Northern Ireland).

The historical data in CE's databases are based on official data from the UK Office for National Statistics (ONS), such as employment data from the Annual Business Inquiry (ABI) and value added data from the Regional Accounts. The forecast data (ie for 2015) are from CE's UK Regional Forecast as published in *Regional Economic Prospects, July 2005*[73].

As discussed above, the economic data in the RAMEA for South East England are based on official data from the ONS. The data are used and recognised by many public agencies, including

[71] See '*Regional and Welsh Appraisal of Resource Productivity Development: Key Industrial Environmental Pressures – Air Emissions and Energy Use'*, REWARD, XXXX, for a detailed description of the methodology used to produce the data for 1999. A similar methodology was used to produce the data for 2003.
[72] See Annex for a definition of CE's 41 industries.
[73] CE has published more recent forecasts which could be incorporated within REEIO.

Regional Development Agencies (RDAs) and central government departments including DEFRA and DTI, and as such are the best available data. Where there is a need to estimate data that are not directly published (eg identify output in banking separately from insurance) then the methods adopted also make use of other authoritative data in order to provide estimates consistent with a published 'control total'. In this way there is a clear audit trail from official published data to that used and published by CE.

Energy Use/ Emissions

As discussed above, the energy use and emissions data for South East England were developed by Netcen, and draw on the UK National Atmospheric Emissions Inventory (NAEI) maintained by Netcen for the Department for Environment, Food and Rural Affairs (DEFRA).

The data provided from this source include:

- energy use by fuel and fuel users
- generation of power by power stations using fossil fuels
- energy use by fuel and power stations using fossil fuels
- emissions associated with each type of fuel and fuel user
- non-energy related emissions by fuel user
- direct emissions associated with each type of fuel and fuel user

In addition to these data, estimates were also made for the following indicators:

- The level of generation at power stations using nuclear or renewable fuels was obtained from the Digest of UK Energy Statistics (DUKES)
- The capacity of each power station (including those using renewable energy sources) was obtained from DUKES

Briefly, the data for UK regions/countries was developed from UK-level NAEI data using the following method.

1. UK data was allocated to Standard Industrial Classification (SIC, based on NACE) categories using a converter from NAEI sectors to SIC.
2. The SIC-based data was then allocated to 1x1 km grid squares across the UK, using one of three methods:

    - Point source mapping
      These are specific emission sources that can be individually spatially- or geo-referenced. They include large industrial installations, transport hubs or public facilities (eg hospital or crematoria), and other, smaller, point sources such as petrol stations.

    - Area source mapping
      Proxy variables (such as employment by sector, household spending on heating, or gas consumption data) were used to allocate emissions for a particular sector or domestic category to a particular location.

    - Road transport mapping
      A map of the UK major road transport network, and traffic counts, were used to allocate road transport emissions to each GOR

The data were then aggregated up from the 1x1 km squares to regional level.

In REEIO, the energy use and emissions data are stored for 44 'Fuel Users'[74], which are similar to industries, and are also based on the SIC classification. The allocation of these 44 fuel users to the 25 RAMEA sectors is shown in the Appendix.

The energy use and air emissions data in the RAMEA for South East England are based on official data from the National Air Emissions Inventory. Where estimates have to be made these are based on widely used methods using proxy variables.

5.4.3 Differences between NAMEA concepts and the RAMEA for South East England

The following discussion highlights areas where there are differences between the REEIO and RAMEA/NAMEA definitions of certain concepts. These issues should be borne in mind when comparing RAMEAs between regions, or using them for policy analysis.

Transport – allocation to sectors

In REEIO, all energy use and emissions from transport (ie including a retail company that operates its own distribution fleet) are allocated to the transport Fuel Users (Road, Rail, Air, Water). Under the NAMEA concept, the emissions from transport are allocated to the economic agents carrying out the activity (ie the relevant industrial sector, or households).

However, within REEIO, energy use by transport is split into freight and passenger transport, mode (ie road, rail, air, water), and type of fuel (14 fuels[75]). Further, passenger transport energy use for road transport is split into motorcycle, car and bus transport. These disaggregations of energy use allow us to estimate emissions based on emission rates by fuel type and user, and allow some more detailed analysis of emissions due to transport.

If we need to allocate freight transport activity back to the source industry, we could make use of the UK input-output tables, that show the amount of 'transport' commodity produced by each industry alongside its 'principal product'.

Transport – emissions associated with domestic economic activity

In REEIO, transport emissions are those that occur within the 'regional territory' only, no matter whether or not they are generated by an agent resident in the region. No consideration is given to emissions from residents associated with their activities overseas or outside the region. Under the NAMEA concept, emissions should be those associated with all domestic economic activity (ie net effects of international transport of freight and passengers, including personal use on holidays, should be included).

For air and water transport, we could make use of the 'bridging tables', published by the ONS within the Environmental Accounts for the UK, that show adjustments that reconcile the NAMEA estimates of emissions of, say, CO2, with the IPCC-reported data published by DEFRA (on which the REEIO data is based). These include 'bunker emissions', which account for the differences due to international aviation and international shipping. A proxy indicator (eg employment in an appropriate industry, or passenger numbers) could be used to calculate SEE's

[74] See Appendix for a list of the REEIO fuel users.
[75] See Appendix for a list of REEIO Fuel Types.

share of the UK total. Ideally we would be able to calculate the adjustment for air transport separately from sea transport.

Adjustments to other sectors, including domestic, could be made based on the 'cross-boundary' adjustments figure given in the bridging tables. Various data could be used to allocate the UK figure to SEE. These could include tourist visits to SEE, SEE household spending on overseas holidays to allocate UK tourism adjustments. For freight, other proxy variables would need to be found. The main question to answer first is whether this is necessary.

Production of electricity - emissions associated with domestic economic activity

As under the NAMEA concept, emissions relating to production of electricity are allocated to the electricity sector. However, in REEIO, emissions relating to the production of electricity are those from the production of electricity in the region, and not the production of energy *used* in the region.

CO2 from biomass

REEIO does not distinguish CO2 emissions generated from combustion of biomass fuels for energy production.

The bridging tables discussed above also include an adjustment for CO2 from biomass, and this could be allocated to SEE based on the region's share of electricity generation from this source

6 Annex

6.1 Cambridge Econometrics Industries

Cambridge Econometrics Industries defined in terms of the UK Standard Industrial Classification (SIC)		
	CE Industry	**SIC2003**
1	Agriculture etc	01, 02, 05
2	Coal	10
3	Oil & Gas etc	11, 12
4	Other Mining	13, 14
5	Food, Drink & Tobacco	15, 16
6	Textiles, Clothing & Leather	17, 18, 19
7	Wood & Paper	20, 21
8	Printing & Publishing	22
9	Manufactured Fuels	23
10	Pharmaceuticals	24.4
11	Chemicals nes	24 (ex24.4)
12	Rubber & Plastics	25
13	Non-Metallic Mineral Products	26
14	Basic Metals	27
15	Metal Goods	28
16	Mechanical Engineering	29
17	Electronics	30, 32
18	Electrical Engineering & Instruments	31, 33
19	Motor Vehicles	34
20	Other Transport Equipment	35
21	Manufacturing nes	36, 37
22	Electricity	40.1
23	Gas Supply	40.2, 40.3
24	Water Supply	41
25	Construction	45
26	Distribution	50, 51
27	Retailing	52
28	Hotels & Catering	55
29	Land Transport etc	60, 63
30	Water Transport	61
31	Air Transport	62
32	Communications	64
33	Banking & Finance	65, 67
34	Insurance	66
35	Computing Services	72
36	Professional Services	70, 71, 73, 74.1-74.4
37	Other Business Services	74.5-74.8
38	Public Administration & Defence	75
39	Education	80
40	Health & Social Work	85
41	Miscellaneous Services	90 - 99

6.2 REEIO Fuel Users

REEIO Fuel Users	
1	Power generation
2	Other energy transformation
3	Energy industries' own use: electricity generation
4	Energy industries' own use: other
5	Basic metals
6	Mineral products
7	Chemicals
8	Pharmaceuticuals
9	Mechanical engineering
10	Metal goods
11	Electronics
12	Electrical engineering & Instruments
13	Motor vehicles
14	Other Transport Equipment
15	Food, Drink & Tobacco
16	Textiles, clothing & leather
17	Paper, printing & publishing
18	Other mining
19	Wood & wood products
20	Rubber & plastics
21	Manufacturing nes & recycling
22	Water supply
23	Construction
24	Air transport
25	Rail transport
26	Road transport
27	National navigation and pipelines
28	Domestic use (households)
29	Public administration & defence
30	Education
31	Health & social work
32	Retailing
33	Distribution nes
34	Hotels & catering
35	Other transport services
36	Communications
37	Banking & finance
38	Insurance
39	Computing services
40	Professional services
41	Other business services
42	Agriculture
43	Miscellaneous services
44	Miscellaneous

6.3 RAMEA Sectors for South East England

RAMEA Sectors		
1	A+B	Agriculture, hunting, forestry & fishing
2	C	Mining & quarrying
3	DA	Manufacture of food products, beverages and tobacco
4	DB+DC	Manufacture of textiles and textile products and Manufacture of leather and leather products
5	DD+DE	Manufacture of wood and wood products, Manufacture of pulp, paper and paper products; publishing and printing
6	DF	Manufacture of coke, refined petroleum products and nuclear fuel
7	DG	Manufacture of chemicals, chemical products and man-made fibres
8	DH	Manufacture of rubber and plastic products
9	DI	Manufacture of other non-metallic mineral products
10	DJ	Manufacture of basic metals and fabricated metal products
11	DK	Manufacture of machinery and equipment not elsewhere classified
12	DL	Manufacture of electrical and optical equipment
13	DM	Manufacture of transport equipment
14	DN	Manufacturing not elsewhere classified
15	E	Electricity, gas and water supply
16	F	Construction
17	G	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods
18	H	Hotels and restaurants
19	I	Transport, storage and communication
20	J	Financial intermediation
21	K	Real estate, renting and business activities
22	L	Public administration and defence; compulsory social security
23	M	Education
24	N	Health and social work
25	O+P+Q	Other community, social and personal service activities, Private households employing staff and undifferentiated, Extra-territorial organisations and bodies

6.4 REEIO Fuels

REEIO Fuel Types	
1	Coal and coke
2	Motor spirit
3	Derv
4	Gas oil
5	Fuel oil
6	Other refined oil
7	Gas (natural gas, coke oven gas and town gas)
8	Electricity
9	Nuclear electricity
10	Landfill gas (renewable-obligation)
11	Waste (Renewable-obligation)
12	Other Renewable-obligation renewables
13	Other renewables
14	Heat sold

6.5 REEIO Air Emissions Types

REEIO Air Emissions	
1	Carbon dioxide (CO2)
2	Sulphur dioxide (SO2)
3	Nitrogen oxides (NOx)
4	Carbon monoxide (CO)
5	Methane, (CH4)
6	PM10 (black smoke)
7	Volatile organic compounds (VOCs)
8	Nuclear emissions to air
9	Lead emissions to air
10	Nitrous Oxide (N2O)
11	Hydrofluorocarbons (HFCs)
12	Perfluorocarbons (PFCs)
13	Sulphur Hexafluoride (SF6)

6.6 REEIO Transport Modes

REEIO Transport Modes			
Freight Transport Modes		**Passenger Transport Modes**	
1	Road	1	Motorcycles
2	Rail	2	Cars
3	Air	3	Buses
4	Water	4	Rail
		5	Light rail
		6	Air
		7	Water

6.7 Allocation of CE Industries and REEIO Fuel Users to RAMEA Sectors

Allocation of CE Industries and REEIO Fuel Users to RAMEA Sectors			
RAMEA Sector		**CE Industry**	**REEIO Fuel User**
1	A+B	1	42
2	C	2, 3, 4	18
3	DA	5	15
4	DB+DC	6	16
5	DD+DE	7, 8	17, 19
6	DF	9	2
7	DG	10, 11	7, 8
8	DH	12	20
9	DI	13	6
10	DJ	14, 15	5, 10
11	DK	16	9
12	DL	17, 18	11, 12
13	DM	19, 20	13, 14
14	DN	21	21
15	E	22, 23, 24	1, 3, 4, 22
16	F	25	23
17	G	26, 27	32, 33
18	H	28	34
19	I*	29, 30, 31, 32	35, 36
20	J	33, 34	37, 38
21	K	35, 36, 37	39, 40, 41
22	L	38	29
23	M	39	30
24	N	40	31
25	O+P+Q	41	43, 44
	Transport		24, 25, 26, 27
	Domestic		28
Note(s) : * Data for energy use and emissions for 'I. Transport, storage and communication', excludes road, rail, air and water transport, which is allocated to separate transport categories.			

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