Statistiska centralbyrån
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Land use by industry 2000

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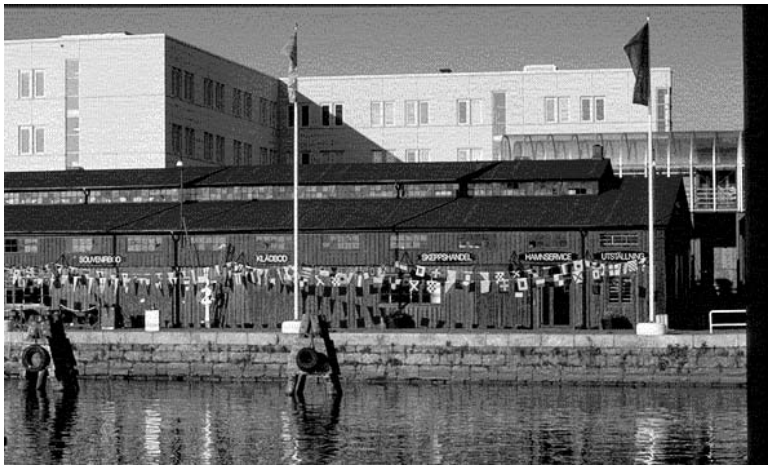

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Preface

Statistics Sweden has developed physical environmental accounts since 1993. Accounts for the use of energy and emissions to air are now regularly compiled. This report presents the results of a second Swedish pilot study in the area of land accounting.

In a framework for land accounts, it is important to include regional and qualitative aspects in supplementary tables. In a previous study made in 2002[1] we included tables regarding:

- land use in urban areas, 1980 and 1995
- built-up areas in coastal zones
- areas undisturbed by noise

In this study the information on land use in urban areas for the year 2000 will be further developed.

The report is prepared on commission from EUROSTAT, which supports and co-ordinates development of environmental statistics in the EU member states. The European Commission (DG Environment) has contributed financially to the project. The report is prepared by Marianne Eriksson, Annika Mårtensson and Viveka Palm.

[1] Eriksson et al, (2002), *Land accounting*

Contents

Summary

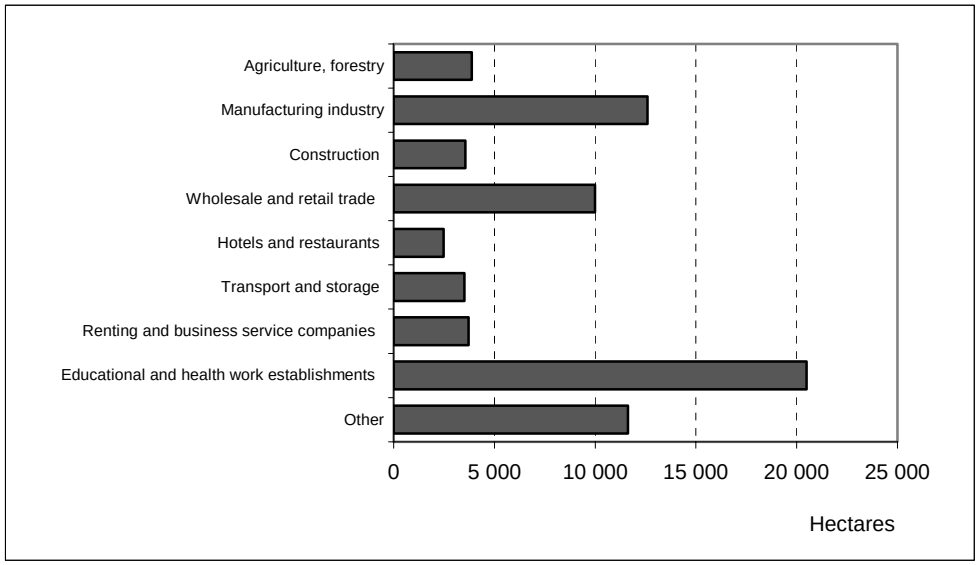
The major objective of this study is to develop methods to improve the physical data on land use by industry in urban areas. Urban areas correspond to 1.3 percent of total land area in Sweden. Population and workplaces are mostly concentrated to urban areas, 84 percent of the population live in and 86 percent work in urban areas.

The two main data sources are the Register of Real Estate Assessment (FTR) and Labour Statistics based on administrative sources (RAMS). Statistics on land use in urban areas based on aerial photos is used as a reference.

The compilation method to allocate area to industry consist of mainly two steps. In the first step workplaces are linked to a real estate. The address from the RAMS register is matched with an address in the geo reference register. This address is connected to a real estate in the FTR. From the FTR information on coordinates and area is transferred to the RAMS register. In the second step the area utilized by workplaces are estimated. This is done in different ways depending on whether there are inhabitants or not in the real estate. In both estimations the identity of the real estate is used as linking identity. In the case of multiple use, the number of employed is used as a distribution key to allocate area to a single workplace.

Combining the real estate register with the workplace register has made it possible to improve the statistics on land use in urban areas with special attention to land use by industry. Industry has been aggregated to 35 NACE groups. This aggregation follows, with a minor exception, the standard aggregation used in the Swedish environmental accounts. Of the total 71 900 hectares used by industries, 20 500 hectares or 29 per cent is allocated to Education and health (see figure below).

Built-up land used by industry in urban areas 2000.



A comparison between countries with experience in land accounting (Canada, Germany, Netherlands and Norway) showed that similar data sources have been used in all of the countries. The methods used are to some extent similar, but the applied distribution keys differ.

In the end of 2003 the Swedish data set Corine Land cover was completed. This information will give new possibilities in developing land cover and land use statistics.

Analyses like industry-specific area productivity or intensity rate may be of interest for issues in environmental policies in the future. Other analysis possible to make from the land accounts, once there are time series available, is decomposition analysis.

1. Background

1.1 Objective of the study

The major objective of the project is to develop methods to use a combination of the real estate register, supplemented with the population register and the central enterprise and work place register to improve the physical data on land use by industry.

The study will concentrate on land use by industry in localities/urban areas mainly because:

- the majority of workplaces and population is to be found in urban areas
- there are more problems connected to competition and conflicts of land use in urban areas than in rural areas
- in urban areas the possibilities to link the real estate register with the workplace register by address is quite good but there are still some problems linking the real estate register with the workplace register in rural areas (see section 2 Data sources)

The results from the project can contribute to calculations and analyses of the Indicators for Sustainable Development concerning Growth of built-up land.

1.2 Land use and land accounts

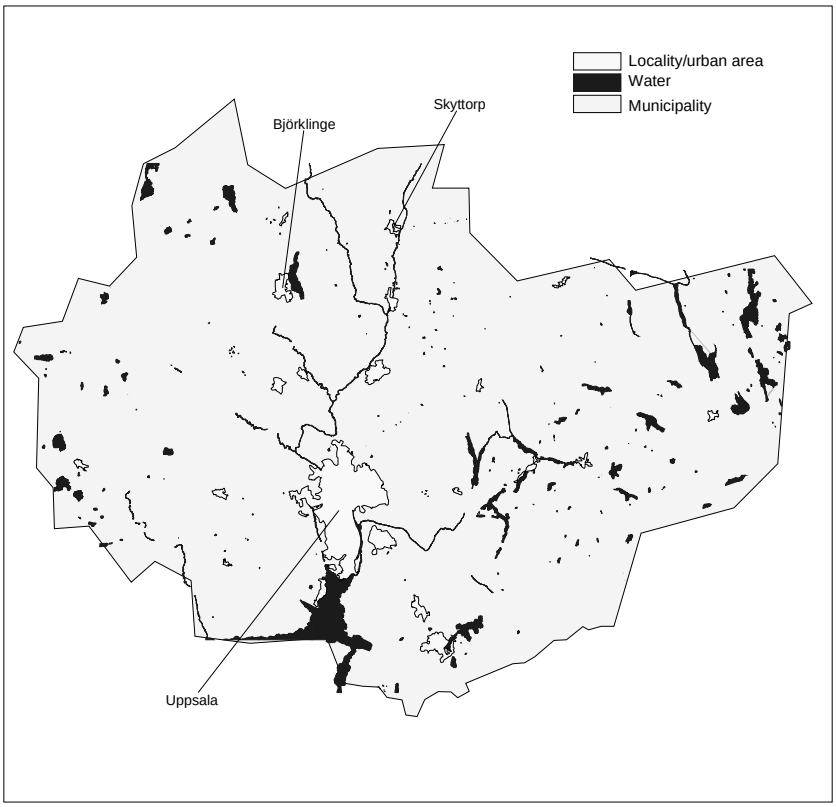
Land is in general not a scarce resource in Sweden, but in densely populated areas or in areas of major importance for biodiversity or recreation there can be conflicts in the use of land. Of the total population in Sweden, which is 8.9 million people, around 84 per cent of the population lived in urban areas in the year 2000. These areas correspond to 1.3 per cent of the total land area. About 86 per cent of the employed work in urban areas.

Urban areas or localities is defined as a group of buildings normally not more than 200 meters apart from each other. There is also a minimum criterion of at least 200 inhabitants which must be fulfilled. In Sweden localities are defined as urban and all area outside the locality as rural (see example in map 1). In the year 2000 there were 1936 localities or urban areas in Sweden.

The total area within the coastline of Sweden is about 450 000 $km^{2,}$ [2], where the area of land is 410 000 km^2. Forest land is the dominant type of landscape with 52 per cent of the total area of Sweden. Mountains and swamps amount to 29 per cent, inland water to 9 per cent and farming land to 8 per cent.

[2] 1 km^2 = 100 hectares

Map 1: Example from the municipality of Uppsala with localities



In 2002, Statistics Sweden made a study on 'Land accounts for Sweden'[3]. The objective was to contribute to the development of the framework for Land Accounts set up by Eurostat. The study was a first attempt to coordinate all the different data sources for land use and land cover applied for compiling land accounting for Sweden. One of the problems that time was to classify land use according to the NACE-classification. The databases we used had no information linking land use to workplaces. Since then, a new database is set up by Statistics Sweden linking workplaces with the real estate register. The real estate register also contains, information on area.

[3] Eriksson et al, (2002), *Land accounting*

2. Data Sources

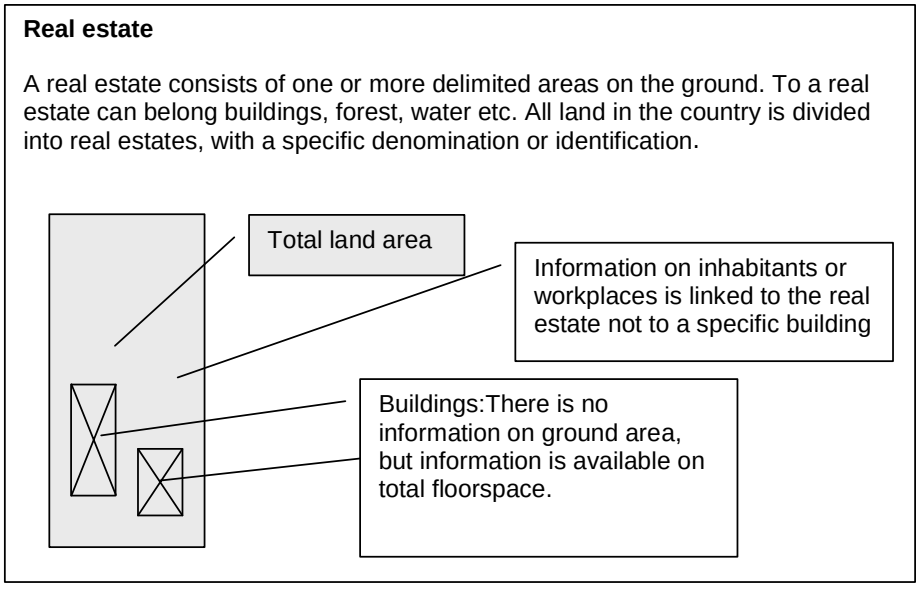
The two main databases applied in this project are the Register of Real Estate Assessment (FTR)[4] and Labour Statistics based on administrative sources (RAMS)[5]. Statistics on land use in urban areas based on aerial photos is used as a reference.

2.1 Register of Real Estate Assessment (FTR)

All land in Sweden is divided into real estates, which include buildings and constructions of different kinds (see figure 1). In the Register of Real Estate Assessment (FTR), each real estate receives a tax assessment value, which is the main basis for the tax assessment.

The central government has commissioned Statistics Sweden to produce statistics on real estate assessment and due to that Statistics Sweden has access to FTR. There is the General and Special Assessments of Real Estate, which form the FTR. The primary data are obtained from the National Tax Board. The FTR is used for statistical purposes, such as a description of the stock of real estate and buildings, as sample frames for statistical surveys and for different types of statistical processing for customers. By an agreement with Lantmäteriet (the Swedish National Land survey) Statistics Sweden also has access to coordinates and addresses for each real estate. FTR is linked with the total population register and for each real estate there is information on the total number of inhabitants.

Figure 1: Real estate, area and buildings



[4] **F**astighets **T**axerings **R**egistret, Statistics from real estate assessement have been published since 1970 by Statistics Sweden. Databases are easily available since 1996.
Further information: http://www.scb.se/templates/Product 30240.asp

[5] **R**egisterbaserad **A**rbets **M**arknads **S**tatistik, Statistics from RAMS have been published from 1985. Comparable databases are available from 1993.
Further information www.scb.se/templates/Product 7892.asp

The FTR contains hundreds of variables describing taxable real estate. The most important variables used in this project are listed below:

- county
- municipality
- real estate, name and number, (identification)
- category/type
- number of inhabitants
- coordinates, a central point for the buildings belonging to the real estate or the geographical centre for real estates without buildings
- area, total area of the real estate (there is no information on area under-laying buildings or structures)
- link to a geo reference register with one or several addresses linked to a real estate (not all real estates have an address)

As a total there are 3.1 million real estates in Sweden, of which 53 per cent in urban areas. In general, real estates in urban areas include buildings with surrounding areas while in rural areas real estates can include some buildings and extensive forests or agricultural land.

The main division in the FTR is by categories/type of Real Estate:

1. Units for agriculture and forestry
2. Units for one- or two-dwelling buildings
3. Units for multi-dwelling and commercial buildings
4. Industrial units
5. Extraction units
6. Electrical generating units
7. Special units

This classification is very useful in many aspects, but to be able to classify land by NACE-code further information is needed.

2.2 Register of workplaces derived from labour statistics based on administrative sources (RAMS)

A database containing information on all employed people is set up yearly at Statistics Sweden. The objective is to classify a person's employment status in November. This is done by the use of information from the statement of earnings and tax deductions filed by employers. A person is classified as employed if he or she has an income corresponding to four hours work or if he or she is temporarily absent in November. By the employment the person is linked to a workplace by a local unit number.

A local unit number of the workplace is registered on the statement of earnings and tax deductions filed by the employer. If a person has had several employments a main workplace is assigned, usually the employment with the highest income under November. Self-employed persons are assigned to their own workplace.

The special register (RAMS) is set up, as a sub-register to Statistics Sweden's Business Register, which contains all workplaces with at least one employed person. The total Business Register contains about 933 000 local units and 857 000 enterprises.

The Business register contains all legal persons. The register also contains natural persons who fulfill at least one of the following criteria, and estates of deceased persons fulfilling at least one of the first two of following criteria:

- registered for VAT
- registered as employer
- having a registered firm
- registered for F-tax (business tax) in a VAT exempt activity

All active enterprises have at least one local unit. A local unit is defined as each address, building or group of buildings where the enterprise has some kind of activity.

For this project we decided to use the Register of workplaces, RAMS, derived from labour statistics in order to best allocate land to the number of employed. In the Business register not all enterprises have employed people, but are set up for e.g. financial reasons. These types of enterprises do not always occupy any physical land area.

From the Business Register information on address to the workplace and NACE-group is transferred to the RAMS register.

The most important variables in the RAMS register, used in this project are listed below:

- identity of the workplace
- name of the work place
- address
- county
- municipality
- NACE 5 digit level
- number of employed by sex

In the RAMS database there are 466 200 workplaces and the number of employed amounts to 3.9 million.

2.3 Land use in urban areas based on aerial photos

In the previous study on Land accounts, the statistics on land use in urban areas was based on studies made by Statistics Sweden using interpretation of aerial photos. The results from those studies are used as a reference in this study. From aerial photos it is quite easy to separate built up land from other types of land cover such as parks, agricultural land, forests and other open land. In this study the main objective was to study the use of built up land by

industries. Information on total land use in urban areas was useful as a reference since the use of built up land in this study is estimated by methods using GIS system together with databases.

Statistics Sweden has been in charge of the delimitation of localities since the year 1960. From 1980, land use within urban areas has been examined. The latest study concerns land use in the year 2000 and changes 1995-2000. The study was based on aerial photographs and economic maps mostly in the scale 1:10 000 for a random sample of 42 urban areas. The area in the 42 urban settlements represents 20 per cent of the total urban settlement area in Sweden. About 36 per cent of the population lives in the examined urban settlements.

Table 1: Sample size distribution by size class of the localities

	2000			
	Localities< 10 000 inhabitants	Localities > 10 000 inhabitants excl. big cities	Big cities	Total
Number of localities in the sample	24	15	3	42
Total number of localities	1828	105	3	1936
Sample area as % of total urban area	2.5	19.5	100	20,3

On the basis of the results from the 42 urban areas, corresponding figures for all urban areas in Sweden have been calculated (see table 4).

The study of changes was directed towards changes inside the locality and changes in the surroundings of the localities (the expansion area). In the study of changes, information from new aerial photos is used together with supplementary information from the real estate register and maps.

3. Methods for compiling land use by industry in urban areas

The two databases described above (in section 2.1 and 2.2) are linked by address. The main element of the address is mostly street and number. In rural areas the addresses can consist of only the name of the village or post office box, which makes it more difficult to assign a real estate to the address. In urban areas with more precise addresses by street and number, the possibilities to link addresses to real estates is better. In urban areas most addresses can be linked to a real estate and one real estate can be linked to several addresses.

Statistics Sweden makes delimitations of localities/urban areas every fifth year. The delimitation is made by GIS technique using digital maps and register of real estates and buildings with coordinates. By GIS technique all real estates in an urban area can be specified. (See example in map 2)

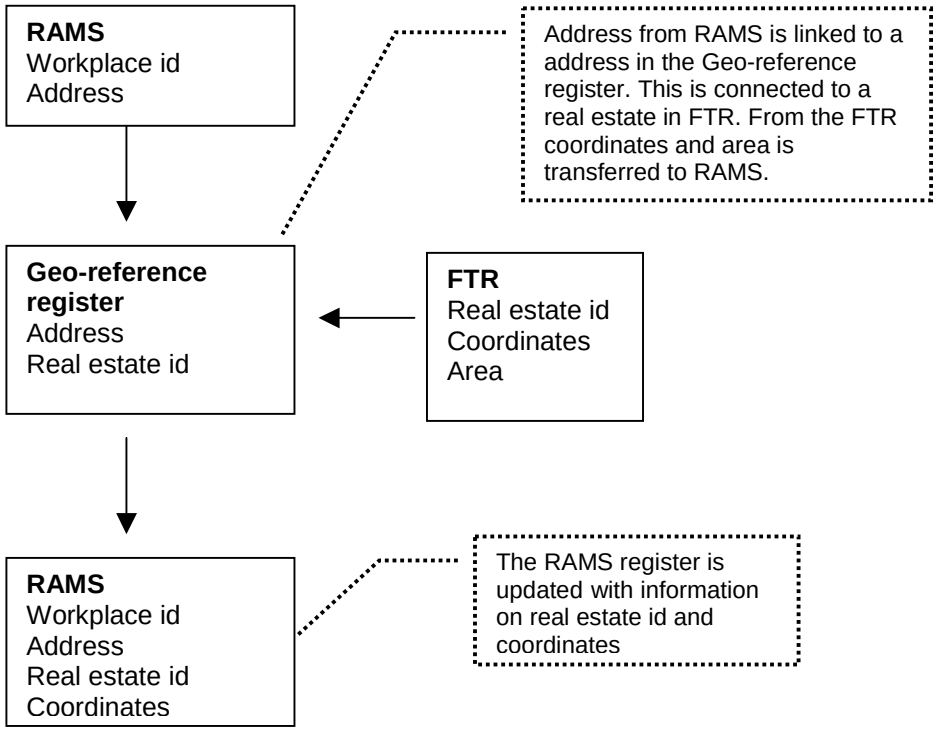
Map 2: Map of a locality with real estates and workplaces

The following part of this section contains a step by step description of the compilation method to allocate area to industries.

3.1 Linking workplaces to a real estate

In the basic RAMS register there is originally no information on the linkage to a real estate. To obtain information on the geographical location (coordinates) and estimates on used area for the single workplace it is a prerequisite to establish a link to the real estate (see figure 2). This is done with help of a special geo-reference register containing information on the link between address and real estate id. One real estate can be linked to several addresses. The coordinates is then used to link workplaces to a locality. This is done by combining digital maps of localities with coordinates for the workplace (see map 2).

Figure 2: Linking workplace to a real estate



In the RAMS database there are 466 000 workplaces. By using addresses it was possible to link 77 per cent of the workplaces to a real estate. In urban areas 84 per cent of the workplaces are linked to a real estate and 55 per cent in rural areas (see table 2, figure 3 and 4). For urban areas incomplete addresses in the workplace register is the main reason for failures in linking workplaces with real estates.

Another 57 000 workplaces has been possible to allocate to a locality but not to a specific real estate. This allocation to locality has been done by mainly three methods:

1. Some workplaces have incomplete addresses, sometimes it is only a street but no number. Using this information it has been possible to allocate the workplace to a locality but not to a specific real estate.

2. As the planning process at local government level often calls for a more detailed geographical breakdown than that provided by the official statistics, Statistics Sweden has developed the Key-Code system. The Key-Code system (in Swedish “NYKO”) is designed for generating statistics on sub-areas within a municipality. In many cases the municipality have been able to allocate a work-place to a Key-Code area but not to a specific real estate. Using GIS technique it is possible to combine digital maps of Key-Code areas with digital maps of localities and decide which Key-Cod area that are inside a locality and by that which workplace that is inside a locality.

3. Statistics Sweden has manually been able to assign larger workplaces to a locality, this was done by the use of e.g. internet, digital maps, yellow pages.

Table 2: Number of workplaces linked to a real estate

	Urban areas			Outside urban areas			Total
	Assigned to a real estate	Not possible to link to a real estate	Total	Assigned to a real estate	Not possible to link to a real estate	Total	
Number of workplaces	297 368	57 522	354 890	61 170	50 096	111 266	466 156
Number of employed	2 746 888	730 052	3 476 940	177 731	211 455	389 186	3 866 126

Figure3: Number of workplaces linked to a real estate

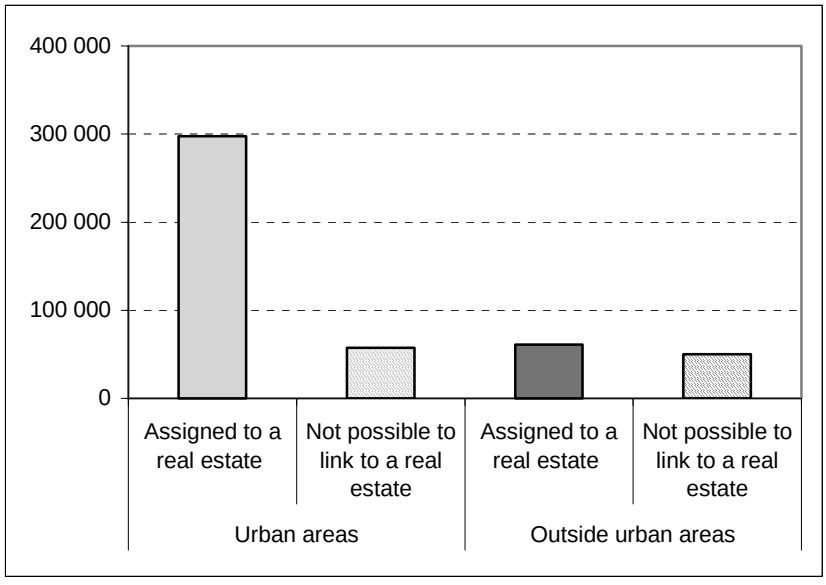
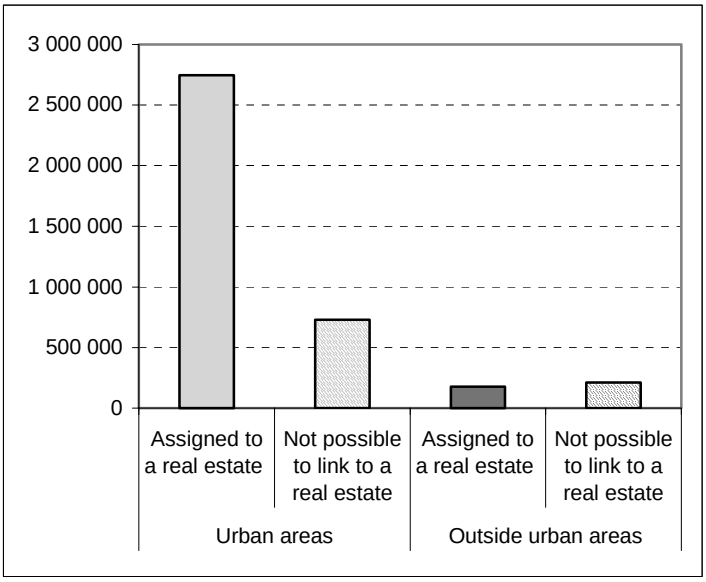


Figure 4: Number of employed linked to a real estate



3.2 Estimation of area utilized by workplaces

Information on area is found in the real estate register (FTR). Area refers to the total area of the real estate (see figure 1).

One real estate can house one or several workplaces together with inhabitants. So the problem of multiple use can consist of either several workplaces in the same real estate or workplaces together with inhabitants in the same real estate. The estimations on area used by workplaces are made in different ways depending on whether there are inhabitants or not in the real estate.

3.2.1 Estimation of area for workplaces in real estates without inhabitants

When several workplaces are located at the same real estate different distribution keys can be used to allocate area to a single workplace. Distribution keys can be e.g. number of employed, the main activity of the real estate, production value, or special distribution keys linked to NACE codes in combination with production value or number of employed.

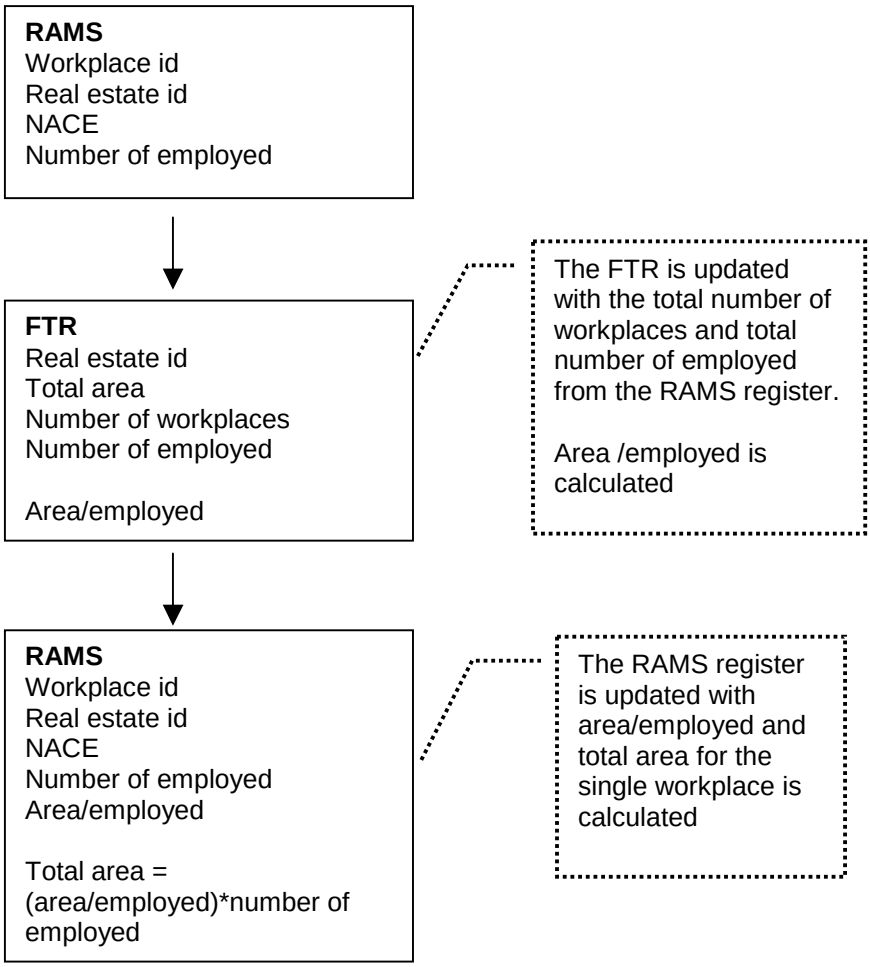
In this study the number of employed is used as distribution key for mainly two reasons:

1. A real estate can house rather many workplaces which can cause difficulties in deciding the main activity (in our project there were real estates with more than 150 workplaces). If one main activity is chosen there will be an underestimation of land used by other activities.

2. There is nearly always information of number of employed connected to the workplace. If a company consists of several workplaces there is not always enough information to allocate production values to a single workplace.

By first counting the total number of employed by each real estate, the area per employed in a single real estate could be determined. Area/employed was then inserted in the RAMS register. For each workplace the total area used was estimated by number of employed*area/employed. The linking identity is the real estate id.

Figure 5: Estimation on area for workplaces in real estates without inhabitants



3.2.2 Estimation of area for workplaces in real estates with inhabitants

The next step was to allocate area to workplaces situated in real estates with inhabitants.

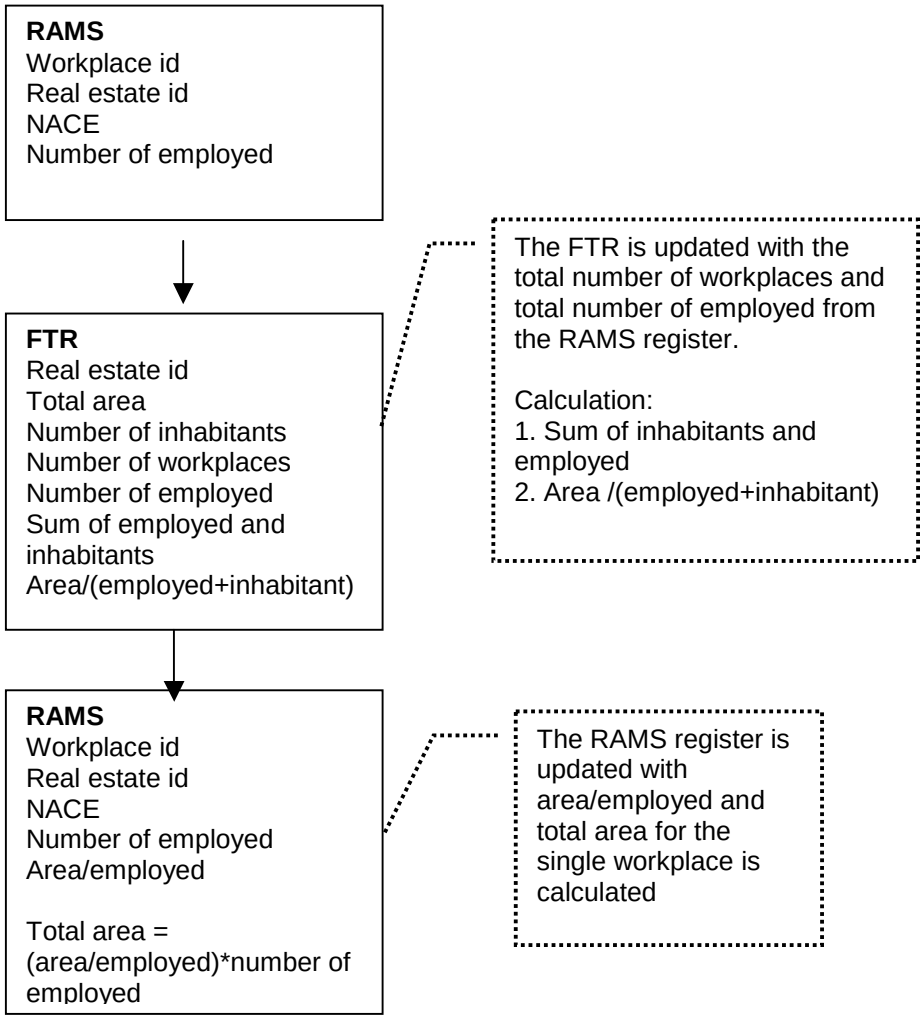
The combination of workplaces and inhabitants in a single real estate can consist of a huge variety of combinations, for example: a one person workplace can be situated in a private house, one or two inhabitants can live in a real estate which is dominated by one or several large workplaces or a real estate can have hundreds of inhabitants and only a single small

workplace. In urban areas 69 per cent of the total real estates with workplaces also had inhabitants.

The manifold of combinations of workplaces and real estate give possibilities for different types of distribution keys to split the utilised area between workplaces and inhabitants. In this study the sum of inhabitants and employed divided by total area is used, meaning all inhabitants and employed get equal shares. By that, real estates with mainly workplaces will get the main part of area and for real estates with mainly inhabitants, only a minor part of the area will be assigned to a workplace. Other type of distribution keys can be e.g. the main activity of the real estate, fixed area per inhabitant and the remaining area distributed by numbers of employed or equal shares for inhabitants and employed.

By first counting the total number of employed by each real estate and then adding it up with the total number of inhabitants, the area/(employed+inhabitant) in a single real estate could be determined. Area/employed was then inserted in the RAMS register. For each workplace the total area used was estimated by number of employed*(area/employed). The linking identities are the real estate id.

Figure 6: Estimation on area for workplaces in real estates with inhabitants



3.3 Estimation for missing values

As described earlier it was not possible to link all workplaces with real estates mostly depending on incomplete addresses for workplaces. As a total 57 500 workplaces was located to a locality but not to a specific real estate, which correspond to 16 per cent of the workplaces and 21 per cent of the employed. These workplaces was assigned an area/employed using the average per employed in the same NACE (2 digit). The estimated area amounted to 22 per cent of total area used by workplaces.

4. Results

4.1 Total land use in urban areas

Every fifth year since 1980 Statistics Sweden has carried out studies on land use in urban areas using aerial photos (se further information in section 2 Data Sources). The total land area of localities/urban areas amounted in the year 2000 to 521 040 hectares, thereof about 60 per cent was built-up or under-laying structures.

The result from the study of land use in urban areas 2000 based on aerial photos is shown in table 3.

Table 3: Land use in urban areas based on aerial photos in 2000

Land use	Hectares	Per cent
Residential area	184 150	35.3
Commercial land, industrial land and land used for technical installations	59 350	11.4
of which land not used at the moment	12 600	2.4
Land used for public services and facilities	23 800	4.6
Land used for transport and communication facilities	61 250	11.8
Land used for recreation facilities and the like	8 600	1.7
Agricultural land	30 250	5.8
Forest and other wooded land, public park	73 950	14.2
Open land such as bare rocks and grassland not used for any special purpose	78 400	15.0
Land not possible to classify	1 150	0.2
Total land area	521 040	100.0

By aerial photos it is not possible to get information on land use by industry or trace multiple use of buildings. The interpretation of photos is on a more aggregated level with regard to land use categories but it has an advantage in better estimating built-up land, land used for transports and green areas, especially when a real estate consists of some buildings and a rather vast un-built area.

4.2 Land use by industry

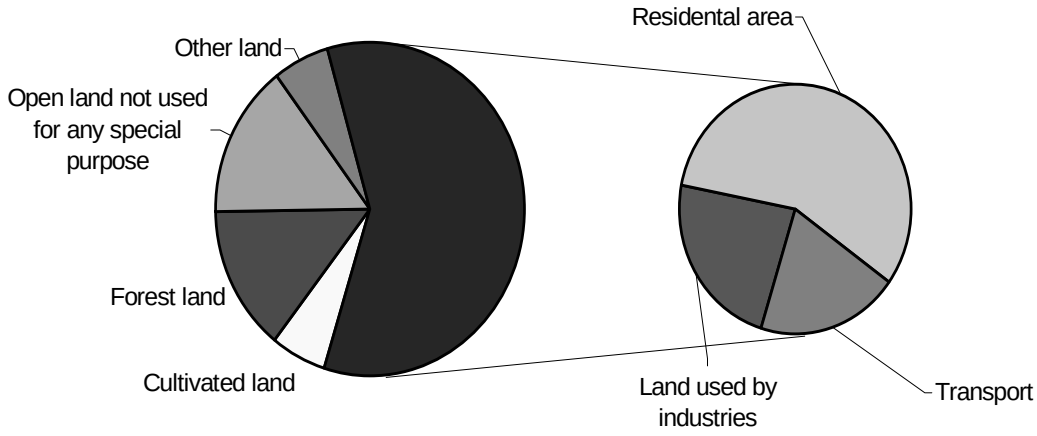
Combining the real estate register with the workplace register has made it possible to improve the statistics on land use in urban areas with special attention to land use by industry.

The total area of built-up land will sum up equally by the two methods but the distribution between residential land and land use by industry has changed. Residential land has now been estimated to 175 500 hectares and land used by industries to 71 900 hectares.

Table 4: Land use in urban areas based on real estate register and aerial photos in 2000

Land use	Data source	Hectares	Per cent
Built-up land			
Residental area	Aerial photos, FTR and RAMS	175 505	34%
Land used by industries	FTR and RAMS	71 845	14%
Transport	Aerial photos	61 250	12%
Other land			
Cultivated land	Aerial photos	30 250	6%
Forest land	Aerial photos	73 950	14%
Open land not used for any special purpose	Aerial photos	78 400	15%
Other land	Aerial photos	29 838	6%
Total	Digital maps	521 038	100%

Figure 7: Land use in urban areas by category in 2000



In table 5 land use by industry is shown. Industry is aggregated to 35 NACE groups. This aggregation follows, with a minor exception[6], the standard aggregation used in the Swedish environmental accounts.

[6]Here the public sector is not shown separately but disaggregated to the different activities. In the Swedish environmental accounts NACE 41 (Collection, purification and distribution of water) includes NACE 90.001 (sewage disposal), here NACE 90.001 is included in NACE 90 (Sewage and refuse disposal)

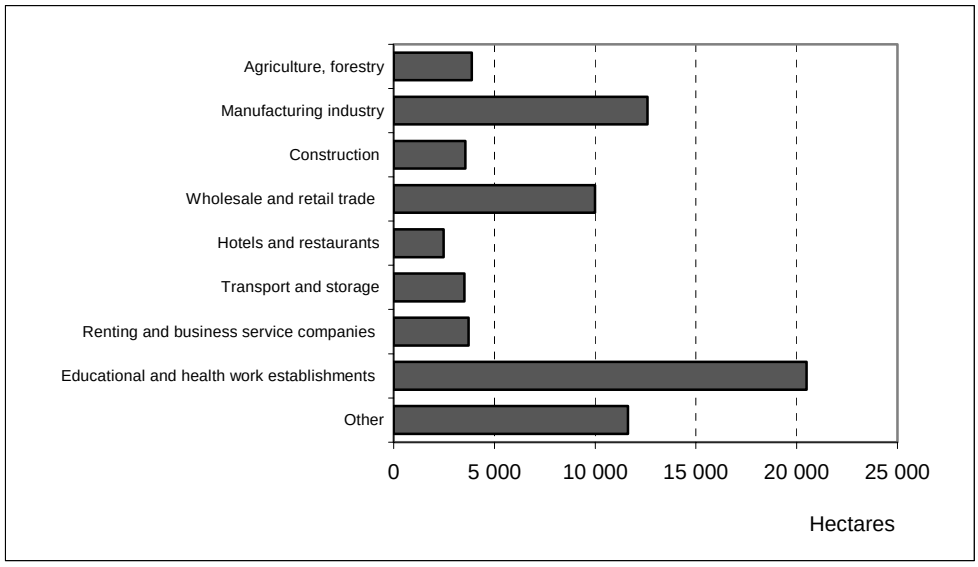
Table 5: Land use by industry in urban areas 2000

NACE	Industry	Number of work-places	Number of employed	Built-up land, hectares	Other urban land, hectares
01	Agriculture	4 691	12 373	2 987	30 250[7]
02	Forestry	1 951	7 616	866	73 950[8]
05	Fishery	429	701	21	
10-14	Mining and quarrying	164	4 467	37	
15-37	*Manufacturing industry*	*28 436*	*689 142*	*12 592*	
15-16	Food products, beverages and tobacco ind	2 000	60 693	848	
17-19	Textiles, clothing and leather	1 597	13 590	335	
20	Wood and wood products	2 240	29 186	1 232	
21	Pulp and paper	393	40 408	498	
22	Publishing and printing	4486	49 921	533	
23	Coke and petroleum products	32	1 417	11	
24	Chemicals and chemical products	586	37 236	376	
25	Rubber and plastic products	1 041	25 185	693	
26	Other non-metallic mineral products	813	13 905	468	
27	Basic metals	282	32 149	349	
28	Fabricated metal products	5633	74902	2 365	
29	Machinery and equipment	3104	87 950	2 053	
30	Office machinery and computers	188	3 524	54	
31	Electrical machinery and apparatus	887	27 797	424	
32	Telecommunications	404	43 097	174	
33	Medical and optical instruments, watches	1 327	24 800	207	
34-35	Transport equipment	1 085	96 095	1 184	
36-37	Manufacturing industry n.e.c.	2 338	27 287	788	
40	Electricity, gas, steam and hot water supply	749	17 930	428	
41	Water purification and sewage plant	155	1 426	367	
45	Construction	30 209	170 566	3 557	
50-52	Wholesale and retail trade	68 950	446 798	9 988	
55	Hotels and restaurants	13 992	85 282	2 483	
60-63	Transport and storage	19 732	146 120	3 514	61 250
64	Post and telecommunications	2 942	71 229	530	
65-67	Financial intermediation	4 826	81 596	327	
70	Real estate activities	10 628	55 057	727	
71-74	Renting and business service companies	59 992	388 188	3 720	
75	Public administration	4 273	19 8731	1503	
80-85	Educational and health work	39 854	919 556	20 487	
90-95	Other community and personal service	35 375	149757	6 817	
	Unknown	27 542	30405	897	
	Total industry	354 890	3 476 940	71 845	
	Households			175 505	
	Other land				108 238
	Total			247 350	273 688

[7] Total agricultural land amounted to 3 200 000 hectares
[8] Incl public parks, total forest land amounted to 23 500 000 hectares

Of the total 71 900 hectares used by industries, 20 500 hectares or 29 per cent is allocated to Education and health, thereof roughly half is for education and half for health work. The manufacturing industry covers 21 600 hectares or 18 per cent and Wholesale and retail trade covers 10 000 hectares or 14 per cent.

Figure 8: Built-up land used by industry in urban areas 2000



The main objective of this study was to develop methods to allocate land use to industries and to present data for one year. The calculations have been made for the year 2000. Since the results are based on registers that are yearly updated, there are good possibilities for regular and timely production on land use statistics and changes in land use.

This study only covered land use in urban areas due to, among others, difficulties with geographical references for workplaces outside urban areas. In Statistics Sweden there are on-going projects for improvement of the addresses for workplaces, which will facilitate possibilities of linking workplaces with real estates outside urban areas. This will open up for the possibility to cover the whole country.

5. International outlook

Land accounts has yet not been produced in many countries. We have however found four countries that have experience in land accounting; Canada, Germany, Netherlands and Norway. This chapter provides an overview of the accounting structures used in those countries. The following questions will be answered:

- what sources and methods are used?
- how are the accounts presented and used?

5.1 Sources and Methods

5.1.1 Canada[9]

The purpose of the Canadian Land account is to provide information to address the issues of four land use categories: agriculture, forestry, shore zone/coastal zone and urban.

The Land Account of Canada forms a large, spatially-referenced database with five layers or components:

1. Physical foundation – a spatial frame used for the estimation of all other components of the account. This layer involves the assembly, estimation and validation of physical data from various sources at an ecoregion[10] level. Data from many of Statistics Canada's surveys are used. To include demographic, social and economic data, geo-statistical units are used. Geographical Information System (GIS) is used.
2. Land cover – the physical nature of the land's surface (e.g. urban built-up areas, mature forest). Initial land-cover information has been taken from satellite imagery. Satellite imagery and GIS are used to determine the surface properties.
3. Land use – a description of how land is used for commerce (e.g. agriculture), non-commercial activities (e.g. recreation) and ecological purposes (e.g. wildlife breeding). Information on agri-cultural land use comes from the *Census of Agriculture*. Forest information comes from *Canada Vegetation Cover- Digital Satellite Image* (Natural Resources Canada and Forestry Canada) and from the Canadian Forest Inventory. Urban and rural information is based on urban area figures from Statistics Canada's 1991 *Digital Enume-ration Area Polygon File.* Currently a macro land-use classification is employed. Land use by ecozone for all of Canada (217 eco-regions) for seven land use classes are estimated.

[9] The following section is, when nothing else mentioned, based on Statistics Canada, (1997), *Econnections – Linking the Environment and the Economy "Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts"* .

[10] Ecoregions are large natural units delineated by distinctive sets of non-living (abiotic) and living (biotic) resources that are ecologically related (Statistics Canada, 1997).

4. Land potential – the biophysical properties of land (e.g. climate, geology, topography and soil characteristics). The basis for land potential in the accounts are *Canada Land Inventory (CLI).*
5. Land value – Estimates are made for the value of direct-uses. Residential values are derived from Canada Mortgage and Housing Corporation building-permit data. The value of land under non-residential buildings is derived from capital stock information. Values for agricultural land are taken from farm real estate values reported to the *Census of Agriculture*. The data on land use and land potential from layers 3 and 4 is used as the basis for the estimates.

The residual category (other land) is very high. This category is assigned when not able to define a dominant use. [11]

5.1.2 Germany

The German Statistical office has developed special accounts on built-up and traffic area which link the area use with the causing economic activity. The German land accounts can be used as a source of information for estimating and checking the impact of economic instruments whose purpose is to reduce the land area used in this way.[12]

There is no survey available in Germany that directly provides data fitting to the already existing economic data, so data on built-up and traffic area has been created. For calculating those figures the *Federal Statistical Office´s* land use survey was used as principal source, but this was supplemented by various other data. [13]

The land use survey is an evaluation of land register information (that means: no satellite data or any geo-referenced information). Distribution keys are used for breakdown of the figures by economic branches and private households. Different data are used according to availability and what can be assumed to be correlated with the use of the land category in question by economic branches. This might for example be[14]:

- the number of employees to break down the built-up area used for trade purposes
- information drawn from regular samples on income and consumption for the breakdown of the built-up area for housing purposes
- km driven or fuel consumption for the breakdown of traffic area

Built up area is assigned to branches in two stages. Firstly, the area to be classed as "built up" is determined from the land use survey by use, and secondly it is assigned to a branch on the basis of percent age share of use.

[11] Trant, (2003), Statistics Canada
[12] Schäfer et al, (2002), *Results of the German Environmental Accounting on the use of land for economic activities*
[13] Schoer et al, (2003), *Development of built-up and traffic area in Germany 1993 to 2001 – approaches to an environmental economic analysis*
[14] Seibel, (2003), Federal Statistical Office Germany

Around 80 per cent of the area is allocated by means of keys based on statistics, and 15 per cent is assigned directly to branches and households (100 per cent allocation). For the branch allocation of built up area as a whole, approximately 100 allocation keys were derived.[15]

Land used for traffic is also assigned to branches in two stages. The total area is broken down according to the type of use, with the area used for roads further divided by category of road on account to the different structures of use (federal motorways, main roads, local roads, municipal roads, footpaths and cycle tracks). An estimation method is developed for road area by category of road which mainly use information on road length as basis for estimation.[16]

5.1.3 Netherlands[17]

For the economic activities as distinguished in the NAMEA[18], land use is estimated for three different regions according to type of use in Netherlands. These regions are Northeast of the Netherlands, the Conurbation of Western Holland and the rest of the Netherlands.

In Netherlands four options in allocation has been recognized. Where possible the option of allocating with supplementary data will be used. This additional data can either be economic or otherwise relevant to the use of land by different activities (time spent on particular area of land by a particular activity).

The source data used are taken from the land use statistics. There are 8 groups of land use distinguished, with a sub-classification into 33 groups in total. When multiple uses take place within the groups, distribution keys are used. The 8 groups of land use are:

- *Agriculture*, all agricultural ground is allocated to the economic activity agriculture.
- *Fforests*, 38 per cent of total forest area is used by forestry, 42 per cent is allocated to nature and landscape preservation, 10 per cent to recreational use, 1 per cent to hunting, 2 per cent to military drill-grounds and 6 per cent has no specific main objective
- *Built-up areas*, subsections: residential areas, minerals yielding, industrial areas, costumer services and office parks, other public services, social and cultural and medical services, traffic, railroads, paved roads, unpaved roads, airfields
- *Recreation*, subsections: parks, sports fields, non-residential recreation, allotments, residential recreation

[15] Schäfer et al, (2002), *Results of the German Environmental Accounting on the use of land for economic activities*
[16] Ibid.
[17] The following section is based on Leuers et al, (1998), *Land use accounting.*
[18] National Accounting Matrix including Environmental Accounts (NAMEA) links the national accounts and environmental statistics. The NAMEA shows the interrelation between macro-indicators for the economy and the environment. (Leuers et al, 1998)

- *Natural areas*, are not used by any economic activity and will thus not be allocated to any of them.
- *Dumping grounds and wreckage yards*, the land used is allocated to them separately.
- *Cemeteries*, is allocated to the economic activity that provides the service of arranging the funeral.
- *Building sites for industry, building sites for other purposes and other areas*, this category is used when there is no clear purpose for the land at the time being and the land is currently transformed.
- *Water bodies*, different water bodies are allocated to different economic activities depending on function of use such as fishery, natural function as habitat for birds and fish, recreation and water transport.

In the case of multiple use, all activities are allocated to their most likely respective share. In cases where no further information is available land is allocated to all potential uses and these activities will then use the same amount of land. Another option is to allocate the land so that total use of land equals total potential use. If the other options not are possible, the total amount of land will be allocated to the economic activity which is the main user of the land. A criterion is however needed to decide which activity uses the most of the land.

5.1.4 Norway[19]

At the moment a so-called ”land-take-by industry” project is carried out in Norway. Specifically, the land-use by buildings and related surrounding, technical construction and flanking areas (such as storage areas, harbors, parking lots, etc.) are to be calculated. This means that the enterprise's use of common infrastructure, such as the road and rail networks, will be excluded.

The following data sources will be examined in the Norwegian project:

- geo-referenced buildings and ground properties from the Official Ground property-, Address- and Building Register (GAB)
- stock of industries from the Central Enterprise and Establishment Register (CBR)
- land use statistics as developed by Statistics Norway
- land cover information from thematic digital maps in the scale 1:50 000. Source used is the Norwegian mapping Authority.
- agricultural and forestry statistics from Statistics Norway

Households will not be included in the initial estimations since the applicable register is not yet fully established.

In the ongoing project in Norway potential data sources, including administrative registers, sampled statistical information and digital maps will

[19] The following section is based on e-mail correspondence with Bloch, (2003) Statistics Norway

be identified and evaluated. Based on this methodological work, estimates at the national level for the different NACE divisions (2-digit NACE level) will be made.

5.2 Presentation and use

5.2.1 Canada[20]

The land accounts presents beginning-of-period stock estimates by land category. The land account is updated on a multi-year cycle instead of an annual time series of stock estimates. Some components are updated every two to three years, major revisions are made every five years following the release of new information from the censuses of population and agriculture.

An important role of the Land account is to provide extended estimates of the value of Canada's land for inclusion on the Canadian National Balance Sheet Accounts (CNBSA). Currently, the land included is treated as a tangible, non-produced asset and is recorded as "commercial land".

The national resource stock accounts serve as the basis for environment-economy indicators in the area of land-use, national wealth and physical measures of resource stocks. The Land-use indicators estimated are *Share of prime agricultural land under cultivation* and *Urban-rural land use change*. These indicators show how land-use patterns have changed since the early 1900's. They provide broad measures of the pressure placed on land resources by economic activity, addressing questions like:

- how quickly is rural land being converted to urban land?
- of Canada's total urban land area, what share is occupying prime agricultural land?
- what percentage of total prime agricultural land is being cultivated over time?

5.2.2 Germany[21]

The constant increase of built-up and traffic area is viewed as an environmental problem in Germany, and therefore observation and control of the development of area use play a pivotal role in the National Strategy for Sustainable Development of the German Government passed in 2002. The respective headline indicator in the strategy is the average daily increase of built-up and traffic area. This indicator is fully embedded into the data set of the German Environmental Accounting and therefore analyses of this is possible to make.

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[20] The following section is based on Statistics Canada, (1997), *Econnections – Linking the Environment and the Economy - "Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts"*

[21] The following section is, when nothing else mentioned, based on Schoer et al, (2003), *Development of built-up and traffic area in Germany 1993 to 2001 – approaches to an environmental economic analysis*

The breakdown of land use categories by economic users has been used as input in two projects for macroeconomic modeling. One project was executed by the Federal Environmental Agency and the Helmholtz Society. In that project only data of a precursor version with a classification much simpler than in the last version was used. In the other project a researcher estimated scenarios for political instruments (taxes) on land use and taxes on "soil sealing" (by buildings or streets for example). This showed that it will be rather difficult to meet the target of the German Sustainability strategy saying only 30 ha new land use per day in the year of 2020.[22]

The available differentiation of the built-up and traffic area by economic activities enables secondary analyses. Some of them are listed below.

Area Productivity
The relationship between economic growth and area use can be described by the term of area productivity, defined as the quotient of Gross Domestic Product (in prices of 1995) and built-up and traffic area. To calculate branch-specific area productivity or intensity rate, the branch-specific area-use data is linked with the gross value added of the production branches or with the consumption expenditures.

Structure of area use by products of final use
The direct area use can be shown by production branches and private households. The area can also be assigned to the goods of final use as they are shown in the National Accounts. This can be obtained by linking data on direct area use differentiated by economic activities with the identically structured monetary input-output tables in the National Accounts. The results obtained from the input-output model can be differentiated by final use categories as well as by product groups.

Intensity of area use by products of final use
Specific ratios expressing the area intensity of product groups can be calculated. This can be measured by following ratio: built-up and traffic area to expenditure for final uses.

Decomposition of change in area use by influencing factors
The data on built-up and traffic area in a detailed break down by economic activities can be utilized to estimate the influence of different factors on the overall development of the area use. A tool that can be used for this purpose is the decomposition analysis. The result shows the change of area use due to effects of the individual influencing factors. This describes how area would have developed if only the factor under consideration would have changed.

Land use by various branches in the context of national accounts is in Germany believed to be useful for[24]:

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[22] Hoffmann-Müller, (2003), Federal Statistical Office Germany
[23] Hoffmann-Müller, (2003), Federal Statistical Office Germany
[24] Schäfer et al, (2002), *Results of the German Environmental Accounting on the use of land for economic activities*

- input-output analyses
- decomposition analyses
- more extensive reporting on economic aspects within environmental economic accounting, in particular adding to the material and energy flow account.
- analysis of the area productivity of individual branches
- analysis of the "consumption" of land for use in the manufacture of the individual groups of goods, taking into account the total intermediate consumption chain (indirect land use)
- structural pressure indicators for problem areas
- scenarios connected with multi-sectoring modeling approaches

5.2.3 Netherlands

The NAMEA-classification is used at a more or less 2-digit presentation of NACE. Extensions are however made to the prevailing classification. Household is expanded with a subdivision of "own transport" and "recreational use" instead of the earlier "other expenditure. Another extension is the addition of the category "no direct use". Parts allocated to this category are natural areas that never (or hardly ever) are visited, building sites and unoccupied houses.[25]

5.2.4 Norway

The objectives of the Norwegian project are to develop measures for statistical expressions for land take by NACE 2-digit level. It is also to calculate a first estimate for statistics at the national level for the year 2002 using the manufacturing industry as the major focus with service industries as a second focus. Tables based on the Norwegian NAMEA will be used as the data presentation approach. The action will provide valuable methodology development for NAMEA in general which will be useful in improving comparability across countries.[26]

5.3 Discussion

Similar data sources have been used in all of the countries above. There is however need for improvement of the quality in the data. The methods used are to some extent similar but the distribution keys applied differ. It would be of interest to make comparisons between countries in order to understand the importance of distribution keys and data sources. Presentation and use is likely to become harmonized between the countries as the land accounts are standardized.

[25] Leuers et al, (1998), *Land use accounting*
[26] Bloch, (2003), Statistics Norway

6 Future work

6.1 Land accounts

Land accounting is in many parts closely connected to statistics on land use and land cover. Land use in the accounting system is linked to economic activities. This will give opportunities to further analyse land use and changes in land use due to economic activities or households.

6.1.1 Improving methods and data quality

In this project we have developed a method to allocate built-up land to industries. As seen in other countries there are different methods to allocate land use for transport systems or un-built up land to economic activities or households. There is need for further discussions on how this shall be done together with how the result shall be used.

In Statistics Sweden, Land use and Land cover statistics have so far been based on administrative register such as National Forest inventories, Agricultural surveys and Register of Real Estate Assessments. In the end of 2003 the Swedish data set Corine Land cover or the Swedish Land Cover was completed. The data set contains information down to units of 1 hectare, and covers the whole country. Combining information from these databases will in the future give us new possibilities in developing land cover and land use statistics. The time period for updating of the Swedish Land Cover has yet not been decided.

6.1.2 Develop supplementary accounts

Another important area for Land accounts is to develop supplementary accounts with regard to qualitative aspects or areas with potential conflicts for land use. Example of important supplementary accounts can be coastal areas or areas undisturbed by noise.

Other aspects for the environmental accounts can be to include the total floor space used by the industries or the households. An increase in floor space will probably be in conflict with the goal to reduce emissions from heating.

6.1.3 Develop analyses, indicators

Industry-specific area productivity or intensity rate are analyses, which should be of interest for environmental policies in the future. Productivity rates can be used to make decoupling analyses in different branches to see how the area of land use has developed relative the economic development. This may be of interest for evaluation of the Swedish environmental objectives.

Another analysis possible, is to assign the area to the goods of final use. This can be done by the use of input-output tables. The results obtained from the input-output model can then be differentiated by final use categories as well

as by product groups. An extension of this is to calculate ratios expressing the area intensity of product groups. Results like this can be used in analyses of consumption patterns and to direct information on such issues.

Another analysis which is possible to make, once there are time series available, from the land accounts is to estimate the influence of different factors on the overall development of the area use. The tool used for this is decomposition analysis. Data on land area is used as a product of the observed influencing values.

All of the analyses above should be of interest for governmental decisions concerning the environment, production, consumption and economic policy instruments such as subsidies and taxes. They can also be used as an indicator if the environmental objectives will be meet. Indicators can be used to show how land use patterns have changed. Such indicators may be of interest for policy analyses and spatial planning in Sweden.

6.2 Resource accounts

6.2.1 Presenting an overview of the resource account

Sweden has now tested the recommended methods in several different types of resource accounts. For example, there has been reports with fishing accounts[27], forest accounts[28], land accounts[29], sand and gravel[30] and water accounts[31]. We are interested in merging these different accounts into a common reporting form, where all resources are presented together. This would be a way of increasing the value of doing the accounts in several ways:

- firstly, it would give an overview of the resources used in general, viewed with regards to the coupling between physical, environmental and economic data
- secondly, it would avoid doing double work with those institutions who already have the responsibility of looking at the resources in a more thorough way, such as the national forest board and the national board of fisheries
- thirdly it has been expressed from other countries that they would be interested in a 'lighter' version of the resource accounts, which could be produced with available data

Out of this overview of resources it is possible to see economic data as well as resource use data of different branches. This would be interesting for analyses of for example sustainable development. One way of making

[27] Austbo et al, (1995), *Nordic Natural Resources and Environmental Accounting*
[28] Eriksson M.et al, (1999), *Skogsräkenskaper – en delstudie avseende fysiska räkenskaper*
Eriksson H. et al,(2001), *Environmental accounts for forest, – test of a proposed framework for Non ESA/SNA-functions*
Eriksson M. et al, (1997), *Forest Economic and Environmental accounting- a pilot study of a first implementation*
[29] Eriksson M. et al, (2002), *Land accounting for Sweden*
[30] Bergstedt et al, (1999), *Material flow study on sand and gravel*
[31] Brånvall et al, (2003), *Water accounts 2000 - with disaggregation to Sea Basins*

interesting analyses is decoupling analyses with for example the use of resources and value added.

6.2.1 Renewable energy

To make the accounting of the resources more complete there would also be new areas that could be included. The renewable energy forms such as bio-fuels, hydro power, wind power and solar power, together with new forms for generating heat and cooling such as bed rock and heating pump would also be of interest.

6.2.2 Quality of resource use

Other new data to add to the overview of resources could be information on the environmentally motivated parts of activities or products such as:

- ecological farming
- purchases of wood which is fsc-labelled
- fish labeled as catched with ecologically approved methods
- green electricity

If this data is linked to the resource in concern an indicator can be created of the environmental consideration within the branch or category of resource.

6.2.3 Environmentally motivated subsidies

Environmentally motivated subsidies in Sweden are given to either land or renewable resources. It is of interest to make these distributions clear via a compilation of the subsidies allocated on different land categories or resources. Out of this compilation it is possible to see the priorities made in subsidies. Analyses can then be made with connections made to the development of use patterns of different renewable resources and so on.

6.2.4 Cultural heritage

There is an interest to include indicators for cultural heritage as a part of the available resources. This because there is some on-going work on this in Sweden, as a part of the sustainable development strategy. Here maps of areas with historical values and of areas where the preservation of building types or e.g. farming practices are of interest and could perhaps be added. Subsidies are paid for certain activities of this form, which would perhaps give input to the economic data on this subject.

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