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Transport and the Environment in Finland

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Statistics Finland

Tel. +358 0 17 341
Telefax +358 0 1734 3264

Address P.O.B. 770
SF-00101 Helsinki
Finland

Sale of publications

Tel. +358 0 1734 2011
Telefax +358 0 1734 2274
Address P.O.B. 770
SF-00101 HELSINKI
Finland

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Preface

The connections between transport and the environment play an increasingly important role in the discussion and decision making on transport policy. To support decision making, information is needed, not least statistics.

The environmental issues of traffic are very topical in Finland, mainly because of plans for extensive public road and railway construction projects, problems associated with built-up areas, and ecological issues. In 1991, on commission from the Ministry of Transport and Communications, Statistics Finland set out to compile a report on transport and the environment. The main objective of the report, *Liikenne ja ympäristö*, was to give a comprehensive picture of the relationship between transport and environmental issues.

As well as statistics, the report contains estimates and projections, research results, and information on aspects of transport policy and legislation. The most important bodies in the field have participated in the compilation of the report.

This publication is a translated, abridged version of the detailed, more comprehensive Finnish report.

Heikki Salmi
Statistics Finland

For more information, please contact

Merja Jantunen
Senior Researcher
Environment Statistics
Statistics Finland
P.O.Box 770
SF-00101 HELSINKI
Finland

Contents

Finland at a glance

Area

338 thousand sq.km, of which:
8 per cent cultivated land
55 per cent forest land
10 per cent inland waters (198 thousand lakes)
27 per cent other

Climate

- Distinct change of seasons
- Highest average temperature in July, $+17^{\circ}$ - $+14^{\circ}$ C, lowest in January/February, -3° - -14° C
- Days with precipitation: 10 per month on average; annual precipitation: 600-700 mm
- Lasting snow cover settles on the south coast around Christmas and in Lapland in late October/early November; snow cover disappears between mid-April and end-May; winters with little snow not unusual on the south coast
- In all of Finland, winds are usually from the south-west and rarely from the north-east, with an even distribution of winds from the other directions

Soil and waters

- Soil usually composed of hard, erosion-resistant rocks, such as granite; one-third of the area covered with peatlands
- Mean depth of lakes approx. 7 m; lakes of 10 km^2 or more make up 64 per cent of the lake area; lakes of 1 hectare or more number 56 000
- Humus content of waters often high
- Theoretically, the water stays in the lakes for 2.3 years; in shallow lake systems for a considerably shorter time; in deep lakes with different temperature layers considerably longer

Population

- Total population 5 million; 60 per cent of it accounted for by urban areas
- Population of Helsinki, the capital, half a million; of Greater Helsinki 800 thousand
- Population density 15.7 per sq.m

Regional structures

- Growth has focused on regional centres, which have spread out over larger areas, thus increasing the volume of both passenger and goods transport;
- The growth in production, the trend towards larger units, and the international division of labour have increased the transport volumes of raw materials and finished products
- The area of the labour market has expanded, centring increasingly in the southernmost area of the country; the way to work has lengthened; opportunities for consumption and for free-time activities have improved; and the supply of services has decentralized

Automobiles in 1990

- 385 passenger cars per 1 000 inhabitants
- Total of passenger cars 1.9 million
- Average number of automobile kilometres per year 17 500, compared with 12 000 to 15 000 in Central Europe

Domestic passenger transport in 1990

billion person-kilometres

Road transport	55.3
Railway transport	3.3
Air transport	1.0
Water transport	0.1

Domestic goods transport in 1990

billion tonne-kilometres

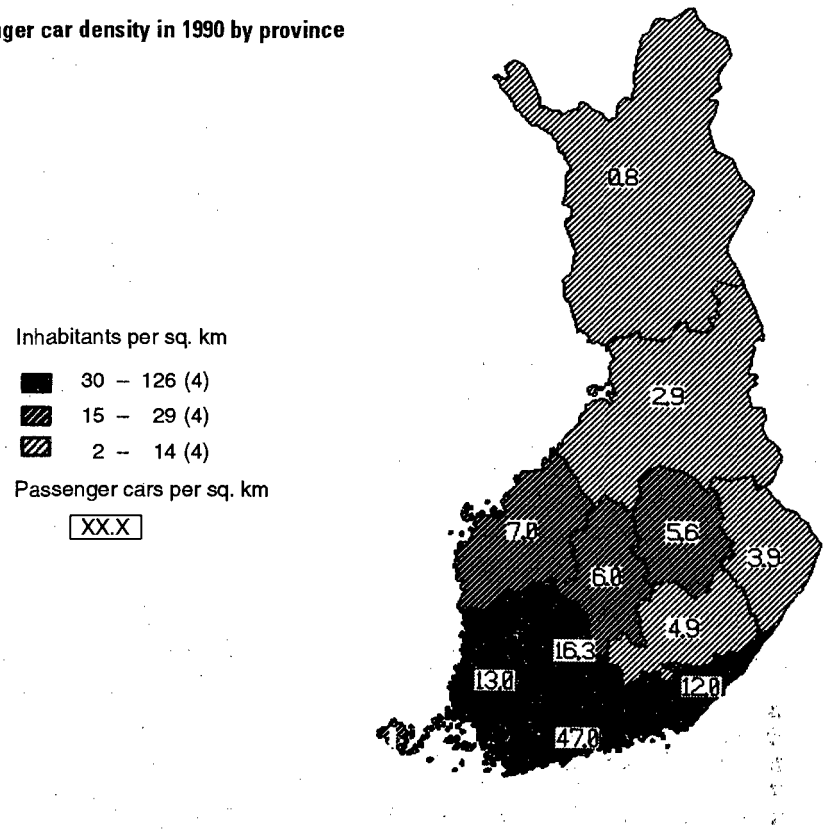
Road transport	25.4
Railway transport	8.4
Water transport	4.0

The high proportion of road transport is largely explained by transports of wood raw materials and processed wood products; the wood-processing industry accounting for 39 per cent of exports in 1990

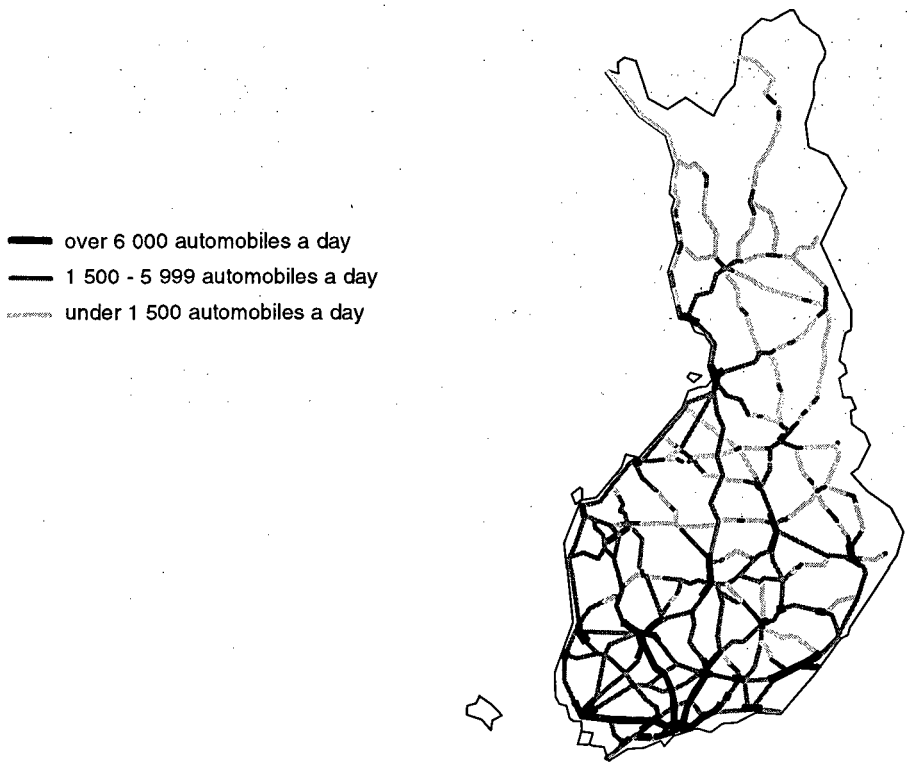
Contribution of transport to GDP in 1990

- FIM 29.6 billion (excl. communications and transports by trade and industry; preliminary figure), or
- 6.2 per cent of GDP

Population and passenger car density in 1990 by province



Traffic volumes on main highways in 1991



1. Exhaust emissions

General reduction targets for emissions

Finland aims to reduce sulphur emissions by 80 per cent by 2000 and nitrogen oxide emissions by approx. 30 per cent by 1998 (Table 3.1). The base year is 1980, when sulphur emissions amounted to 584 000 t of SO_2 and nitrogen oxide emissions to 264 000 t of NO_2. As a halfway goal set for 1994, Finland aims to freeze NO_x emissions and their trans-boundary fluxes to the level of the year 1987.

The earlier goal of Finland was to reduce sulphur oxide emissions by 50 per cent from 1980 to 1995. By 1990, these emissions had already been reduced by 60 per cent as a result of process and raw material changes in pulp mills and metal and engineering plants, changes in oil refineries, reductions in the consumption and the sulphur content of heavy fuel oil, and a more widespread use of district heat.

A further reduction in sulphur emissions will require the introduction of efficient pollution control technologies and the use of low-sulphur fuels in energy production and transport, as well as process-technological improvements in industry.

Nitrogen oxide emissions, on the other hand, increased in the course of the 1980s because of the steady increase in traffic volumes and in energy consumption. Traffic emissions peaked in 1991, due to both economic recession and the effect of emission standards. As well as technical measures, other measures - on which no detailed decisions have yet been made - will need to be taken in order to reach the 30 per cent reduction target. The current measures to limit traffic and energy production emissions will enable the freezing of emissions to the level of 1987, i.e. to 270 000 tonnes of NO_2 a year.

At the Geneva international conference in November of 1991, Finland committed itself to reducing the emissions of volatile organic compounds (VOCs) by at least 30 per cent by 1999. The base year is 1988, when the emissions of non-methane volatile organic compounds (NMVOCs) in Finland amounted to 210 000 tonnes. A strategy on VOCs has been adopted in order to reduce emissions, with a significant proportion of it to be carried out by limiting VOC emissions from transport sources (Table 3.7).

Trends in exhaust emissions

Exhaust emissions from traffic sources are calculated in Finland from estimates which are based on traffic volumes or, for industrial, agricultural and forest equipment, operating hours and on specific emission coefficients.

Road traffic accounts for 70 to 90 per cent of traffic emissions and automobile traffic for the bulk of road traffic emissions (Table 3.4). For automobile traffic, estimates have been made concerning generation of emissions in 1980-2010 (Figure 3.2):

Automotive carbon monoxide emissions increased more slowly than traffic volumes in the 1980s, which was a consequence of emission standards introduced in the 1960s. However, the standards were based on engine modifications, causing an increase in nitrogen oxide emissions - an increase exceeding the increase in traffic volumes in the 1980s. Hydrocarbon emissions followed the overall trend in traffic volumes.

As a result of the introduction of cars equipped with catalytic converters, the CO, NO_x and HC emissions of gasoline-fuelled passenger cars are

projected to fall by 2010 - quite rapidly at first - despite the steady increase in traffic volumes. Simultaneously, the proportion of CO and NO_x emissions accounted for by engine start-up and warm-up will increase substantially, barring a market introduction of converters with a shorter warm-up time before reaching the level of effective operation. Apart from catalytic converters, advanced engine technology will contribute to the fall in hydrocarbon emissions and in the nitrogen oxide emissions of diesel-fuelled vehicles.

Converter operation control as part of car inspections will begin in 1993. The emissions of old cars without a converter will be reduced through changes in fuel quality, for instance. 1991 saw the market introduction of a new grade of gasoline (known as City gasoline) which reduces old-car carbon monoxide emissions by 10 to 20 per cent, hydrocarbon exhaust emissions by 5 to 10 per cent, and volatile organic compound emissions by 13 to 17 per cent.

Exhaust gas particulate emissions increased at the same pace as traffic volumes. The reduction of particulate emissions will largely be effected by enforcing the new standards for heavy diesel vehicles (Table 3.2). The tighter EC'95 standard to be enforced in Finland from 1995 and 1996 will probably require - in addition to more advanced engine technology - the use of cleaner fuels and particulate emission control devices.

The level of sulphur oxide emissions fell rapidly during the 1980s as a result of the continuous lowering of the sulphur content of liquid fuels. In 1980, the sulphur content (measured value) of gasoline was 0.45 g and of diesel oil 3.0 g per litre, compared with 0.18 g and 0.81 g per litre, respectively, in 1990. The sulphur content of diesel oil will continue to fall for a few more years, after which emission levels will rise in proportion to the consumption of liquid fuels. By 2010, sulphur oxide emissions will have regained their present level unless the sulphur content of fuels is reduced further.

Lead emissions increased in proportion to the increase in traffic volumes until 1985, when their level began to fall as a result of the rapid lowering of the lead content of gasoline. Until 1980 the lead content of gasoline was 0.7 g per litre, from which it first fell to 0.4 g and then to 0.15 g per litre. As a result of the widespread introduction of unleaded gasoline in 1990, lead emissions fell in 1990 to a quarter of their level in 1985. Lead emissions from traffic sources have been forecast to end almost completely by the year 2000.

2. Acidification

The sulphur emissions of industrial and energy production plants in Finland have the greatest potentially acidifying effect on the environment (Figure 4.1). The potentially acidifying effect of nitrogen oxide emissions from traffic and energy production sources and of ammonia emissions from agriculture is, however, also significant.

Total acid deposition has been estimated with respect to 1988, when sulphur deposition was approx. 200 kt and nitrogen deposition approx. 130 kt, 70 kt of which was due to nitrogen oxide emissions and 60 kt to ammonia emissions (Table 4.1).

The nitrogen deposition originating from nitrogen oxide emissions from domestic road traffic and other mobile sources is greatest in southern Finland, where emission density is also greatest. Calculated at the level of 1990, deposition in southern Finland is approx. 25 $mg(N)/m^2/a$ (Figure 4.2). If account is also taken of emissions from domestic stationary sources, i.e., mainly emissions from energy production and industrial plants, the estimated level of deposition for southern Finland in 1990 is approx. 40 mg $(N)/m^2/a$.

In 1990, the maximum total deposition originating from nitrogen oxide emissions - covering both domestic and foreign emissions and background deposition - amounted to over 200 $mg(N)/m^2/a$ in southern and in south-eastern Finland. Approx. 20 per cent of the deposition came from domestic sources. Of the deposition originating from foreign sources, approx. half was accounted for by traffic.

Of the nitrogen deposition originating from ammonia emissions in Finland, more than 30 per cent comes from domestic sources. The level of deposition originating from ammonia emissions in Finland and the rest of Europe ranged from 20 to 400 $mg(N)/m^2/a$ in 1986.

Of sulphur deposition, the greater part is accounted for by foreign emissions. Total deposition in the southernmost part of Finland in 1987 was approx. 1 $g(S)/m^2/a$. Of this, approx. 0.2 $g(S)/m^2$ was accounted for by domestic emissions and 0.1 $g(S)/m^2$ by background deposition.

It is held today that the level of acid deposition in northern Europe should be reduced by some 70 per cent in order not to exceed the critical load of ecosystems. In Finland, the critical load is exceeded for approx. a third of the lakes. Exceedances are smaller for woodland but more frequent than in the case of lakes. The proportion of nitrogen in the acid load has not yet been established, and the development of a method for calculating the critical load of nitrogen began only recently (Henriksen et al. 1990, Kämäri et al. 1991; see also Kauppi, Anttila and Kenttämies 1990).

3. Health effects

Air quality in built-up areas

Of the most important pollutants in exhaust emissions, carbon monoxide and nitrogen oxide are subject to air quality limit values in Finland. In addition, the maximum level of particulate matter is subject to the limit value of total suspended particulates (TSP). The limit values have been in force since September of 1984 and are going to be revised shortly.

In the late 1980s in Finland, a number of local authority districts and the Finnish Meteorological Institute have started monitoring the air quality in built-up areas with special reference to traffic. The initial phase only covers regions of the greatest importance for air quality.

The highest measurements of hourly carbon monoxide concentrations in built-up areas have been only a few mg/m^3 short of the limit value (30 mg/m^3). Exceedances of the eight-hour limit value for carbon monoxide (10 mg/m^3) have been measured in or off busy streets in several built-up areas. The exceedances have not, however, been permanent; they have only occurred during peak hours of congestion.

Exceedances of the 1-hour and 24-hour limit values of nitrogen dioxide (300 and 150 $\mu g/m^3$) in built-up areas are rare. The 24-hour averages of nitrogen dioxide concentrations range from 20 to 100 $\mu g/m^3$ even in areas with heavy traffic, while 1-hour averages may rise to 150 to 250 $\mu g/m^3$.

In or off busy streets, where measurements are often made, the depletion of ozone hampers the formation of nitrogen dioxide. The level of nitrogen dioxide concentrations falls relatively slowly, however, as you move upwards from street level. Farther away from streets, nitrogen dioxide concentrations originating from traffic emissions have been measured which are even higher than those measured in the immediate vicinity of streets.

The usual device for TSP measurements allows particle sizes of several micrometres. Thus, most of the measured TSP is dust originating from roads and streets. In inner cities, and even in the centres of small built-up areas, concentrations often exceed the limit values of particles, the 24-hour limit value being 150 $\mu g/m^3$ and the annual limit value 60 $\mu g/m^3$. For several months in spring, depending on the weather, concentrations in central areas may be several times as high as the annual average and up to seven times as high as the 24-hour limit value. Outside built-up areas, the level of concentrations is usually appreciably lower, although spring dust occurs there, too, bringing concentrations close to the limit values.

Concentrations of inhaled dust (PM_{10}, particle size < 10 μm) are also greatest in the centres of built-up areas. In the centre of Helsinki in 1990, for example, concentrations averaged 22 to 35 $\mu g/m^3$/a and 69 to 93 $\mu g/m^3$/day, and were 1.5 times as high as in suburban residential areas on average.

Ozone measurements in built-up areas have only been made in Greater Helsinki, where ozone concentrations are relatively high on average. Because of the inner-city ozone depletion, ozone is not, however, an urban problem in Finland.

The background concentrations of ozone are also rather high, exceeding the 7-hour limit value of 50 $\mu g/m^3$ which the ECE has proposed on the basis of tolerance limits for susceptible vegetation. The greater part of the ozone observed at background stations is attributable to remote transfer.

Health effects of air pollution

According to a survey, 60 per cent of the people in Finland are concerned about the air quality in their own locality (Tulokas 1990). Air pollution is thought to be a more serious environmental problem than traffic noise, for instance.

The body of data on the actual effects of traffic exhaust gases and particulate emissions is modest but indicative. For example, there is adequate international proof that diesel exhaust gases increase the risk of lung cancer. The exact number of those exposed to diesel exhaust gases in Finland is not known.

Two studies conducted in Oulu and in Helsinki (Paunio et al. 1987, Pönkä 1990) suggest that increases in the level of air pollution increase the incidence of upper respiratory system infections, especially among infants. It has also been established that there exists a statistically significant connection between slightly increased levels of nitrogen dioxide concentrations and the incidence of acute asthmatic attacks in Helsinki (Pönkä 1991). However, there is no explicit information on the specific substances involved. A cold climate appears to strengthen the harmful effects of air pollution on health.

Exposure to noise

More than half the population of Finland are concerned about traffic noise in their own locality. Traffic noise is thought to be a more serious problem than other kinds of environment noise (Tulokas 1990).

Taking all environment noise areas into account, it has been estimated that in 1986 in Finland approx. 1.8 million people lived in areas exposed to noise (L_{Aeq} > 55 dB). Of people in Finland, 17 per cent (840 000) are exposed to road traffic noise in excess of 55 dB and 5 per cent (250 000) to road traffic noise in excess of 65 dB (Ministry of Transport and Communications 1988). Approx. 350 000 people in Finland live in areas of public-road noise exceeding 55 dB (Finnish National Road Administration, 1992b).

Under the provisions of the Noise Abatement Act effective since 1988, the Finnish Council of State may issue, for the purpose of noise abatement, instructions and orders concerning outdoor and indoor noise levels. In the autumn of 1992, the Council of State will take a decision on noise levels with reference to traffic and land use planning. Until then, a National Board of Health letter of instructions, based on the Public Health Act and decree, will serve as the general recommendation on noise levels.

4. Economic control

Pricing the damage

One development objective for the next few years concerns the pricing of environmental damage attributable to traffic (Parliamentary Transport Committee 1991). An economic survey should be undertaken of all the development projects on the various modes of transport, with estimates made of the benefits and costs of each project, including the costs of environmental damage.

To date, the burden on the economy has only been assessed with respect to road traffic emissions and accidents (Finnish National Road Administration 1922, Helsinki Research Institute for Business Administration 1990). It is intended that these environmental costs be taken into account - as well as construction and maintenance costs and the operating costs of vehicles - when assessing individual road projects.

Economic incentives

Regarding gasoline-fuelled passenger cars meeting catalyst-level requirements, the assessed value is reduced by FIM 4 500 before calculating the motor-car tax. This results in a tax cut of some FIM 6 700 in the car's selling price. To prevent unreasonable increases in transport costs, Government subsidies may also be needed to support and expedite the acquisition of buses and lorries which meet the existing low-emission requirements.

The Finnish Government subsidizes collective transport in order to ensure the provision of basic services in areas where it otherwise would not be possible. In 1992, the Ministry of Transport and Communications will support bus, motor-coach and taxi transport with FIM 293 million. Of this, FIM 148 million will be used to buy basic services for rural areas, which - combined with FIM 30 million supplied by local authorities - will buy a transport volume totalling 40 million vehicle kilometres. A total of FIM 135 will be used to reduce bus and motor-coach fares on a transport volume of approx. 400 million vehicle kilometres. Approx. FIM 330 million of subsidies will go for passenger transport on the unprofitable lines of the State Railways, for reducing train fares, and for granting welfare discounts. Government subsidies for collective transport in 1992 will amount to FIM 623 million. (Hakala 1992).

Local authorities, too, subsidize collective transport. In the three largest urban areas, subsidies for providing bus and rail transport services and for lowering fares amount to nearly FIM 1 billion. In the rest of the country, local authority subsidies for urban collective transport total approx. FIM 25 million.

As regards Government subsidies for goods transport, there is a development area transport subsidy and a transport subsidy for newspapers. Although questionable from the point of view of the environment, the cost of work travel may be deducted from taxes. The longer the commuting distance, the greater the deduction. Taxation of company cars also favours private motoring.

There are no Government subsidies for combined goods transport. Because of the small flows of goods and a railway network far less dense than in Central Europe, the potential market for combined transport is small. The potential for combined transport is further weakened by the relative incompatibility of Finnish road transport vehicles and railway rolling stock.

Because of the limitations of tracks and rolling stock, it is hardly possible to transfer goods road transport to the railways in the foreseeablefuture.

On the other hand, railway transport offers a practical alternative in only some 2 per cent of road transports, a transfer of which to the railways over the long term would, however, increase the State Railways' present transport volume by 27 per cent.

Taxation

The total tax revenue yielded by road traffic in 1991 (1990) amounted to FIM 9.7 (10.5) billion, FIM 6.5 (5.5) billion of which was accountd for by fuel tax and FIM 3.2 (5.0) billion by vehicle taxes.

Taxation of traffic in Finland focuses on the taxation of passenger cars. The proportion of taxes in the cars consumer price (approx. 50 per cent) is about the same as at the beginning of the 1980s despite a significant reduction in the motor-car tax between 1982 and 1992. This is due to, among other things, the increased turnover tax. At approx. FIM 0.30 per vehicle kilometre, the real value of the road traffic taxes proper (excl. turnover tax) in proportion to traffic volumes has remained virtually unchanged, although taxation of road traffic has not been used as an instrument of controlling traffic volumes (Kuitunen 1992). On the other hand, the real price of fuels fell in the late 1980s, contributing to the increase in traffic volumes.

There is discussion in Finland about shifting the focus of traffic taxation from the taxation of vehicle acquisition and ownership to the taxation of vehicle operation, which would make causing of damage the prime object of traffic taxation.

For passenger cars, this could be done by lowering the motor-car tax based on the price of the car (currently approx. 30 per cent of the car's consumer price) and by increasing the fuel tax. This would not affect people's average transport costs or the income of the state. However, a rise in variable costs would influence people's travel decisions. On the other hand, there is the risk - at least in the short term - that easing the acquisition of cars will increase traffic volumes and lead to the use of larger cars.

As regards heavy goods transport, an increase in the real price of fuel would probably influence - over the long term - the location and the choice of transport modes of companies needing raw material and product transport services in that an effort would be made to cut down on road transport, which would have become more expensive. In the short term, there is little or no price elasticity in heavy goods transport.

There is already a surtax, or pollution tax, on transport fuels, except on unleaded gasoline. The pollution tax - FIM 0.45 per litre on leaded gasoline and FIM 0.225 per litre on gasoline blends - is added to the basic tax on gasoline, FIM 1.68 per litre. The basic tax on diesel oil is FIM 0.77 per litre and the pollution tax FIM 0.27 per litre. On heavy and light fuel oil, there is only the pollution tax: FIM 0.021 per litre on light and FIM 0.021 per kilogram on heavy fuel oil. The same applies to natural gas, the pollution tax on which is FIM 0.0105 per norm. m^3. A new proposal for the taxation of transport fuels with reference to the tax benefits of the new grades of gasoline and of sulphurless diesel fuel is under preparation.

Within the next few years, value added tax will be adopted in Finland. Its size will determine the competitiveness of collective transport and thus, in part, the magnitude of the harmful effects of transport on the environment.

5. Environmental impact assessment (EIA)

In Finland, assessment of the impact of transport on the environment is a procedure associated mainly with road projects. The aim of EIA is to recognize environmental effects in the initial phase of a project and to review the assessment as work proceeds on the project.

EIA will be extended to all major transport projects. EIA legislation is under preparation, with the bill scheduled to be introduced in the autumn of 1992. The extent to which EIA will be extended to the policy level will be decided on the basis of the EC directive under preparation.

EIA is aimed at increasing co-operation between citizens and authorities in the course of different planning and design phases. The participation of citizens is likely to be facilitated by the integration of individual hearings, for instance, making it possible to assess a project as a whole.

To take into account the impact of the entire life span of a project or an activity is a key principle of the EIA process. This is also a key objective for developing the production of environmental information.

Figures and Tables

1. Traffic and transport

1.1 Volumes by means of transport

Table 1.1 Traffic volumes in 1970–90

Year	*Road traffic:* whole country (public roads, private roads, streets)					*Railway traffic*				
	Total	Pass. cars	Buses, coaches	Vans[1]	Lorries, road tract.	Trains	Pass. coaches	Freight wagons	Other railw.veh.	Total
	Mill. vehicle-km					Mill. train-km	Mill. wagon-axle km			
1970	..	..	..	..	..	43	419	1 436	14	1 869
1975	24 370	19 880	640	1 470	2 380	45	507	1 432	10	1 949
1980	26 760	22 180	640	1 550	2 390	45	520	1 622	8	2 149
1985	31 150	25 970	670	2 050	2 460	44	478	1 571	7	2 057
86	32 350	26 840	670	2 260	2 580	38	452	1 352	5	1 810
87	34 250	28 640	670	2 400	2 540	43	522	1 461	6	1 989
88	36 510	30 730	670	2 520	2 590	42	515	1 533	6	2 054
89[2]	38 710	32 680	670	2 680	2 680	39	551	1 465	6	2 022
1990	39 750	33 430	680	2 860	2 780	..	549	1 532	5	2 085

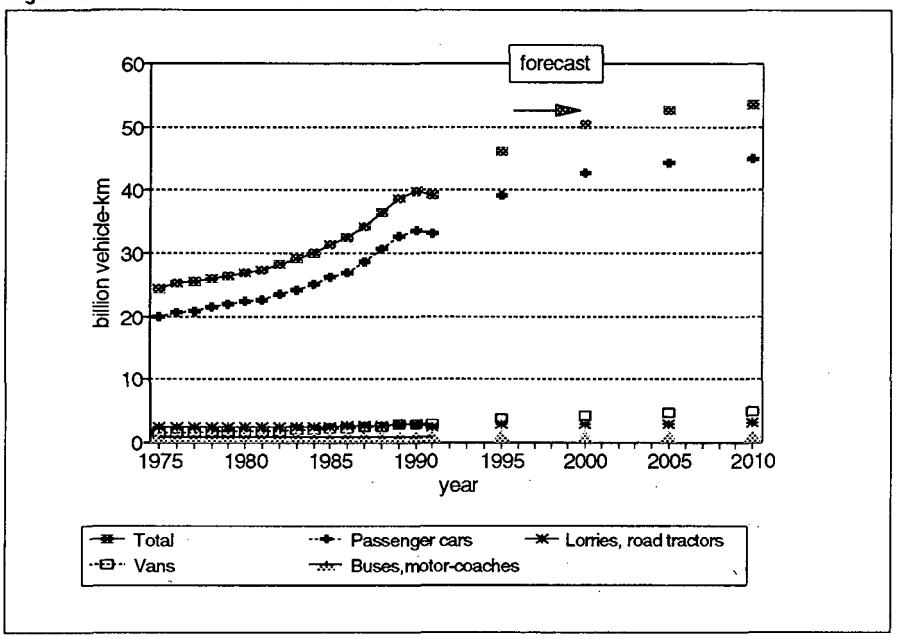
Year	*Air traffic:* domestic carriers				*Airport traffic* (scheduled and charter): landings					
	Total	Inland	International		Total		Inland		International	
		Sched-uled	Sched-uled	Charter	Helsinki–Vantaa Airport	All airports	Helsinki–Vantaa Airport	All airports	Helsinki–Vantaa Airport	All airports
	Mill. flight-km				Number					
1970	25.3	5.6	14.0	5.7	..	44 997	..	34 464	..	10 533
1975	43.1	10.5	19.8	12.8	26 305	60 974	12 703	45 025	13 602	15 949
1980	46.6	11.9	23.6	11.1	27 259	64 727	13 013	48 017	14 246	16 710
1985	49.4	12.6	25.8	10.9	30 569	67 982	14 716	49 838	15 853	18 144
86	52.1	11.6	26.5	14.0	28 832	66 415	13 735	47 468	15 097	18 947
87	60.2	14.1	29.3	16.8	36 140	77 536	17 522	55 750	18 618	21 786
88	69.2	16.5	32.1	20.6	42 900	87 567	21 331	62 410	21 569	25 157
89	77.2	17.5	37.9	21.8	49 052	94 883	23 885	65 498	25 167	29 385
1990	83.5	18.7	41.9	22.9	54 890	107 433	25 458	72 815	29 432	34 618

Year	*Waterway traffic:* port calls		
	Domestic coastal traffic	International traffic	
		Direct[3]	Total[4]
	Number		
1970	..	36 090	..
1975	..	34 568	..
1980	..	34 167	..
81	6 563	32 625	45 565
1985	5 003	30 121	42 212
86	5 114	30 730	42 984
87	6 021	31 573	44 196
88	5 039	35 076	48 216
89	5 212	37 690	51 603
1990	4 144	39 662	53 049

1) Less than 3 500 kg.
2) The data on railway traffic are not fully comparable with earlier data because of a revised calculation method.
3) Direct traffic overseas, no calls at domestic ports.
4) From 1981, the whole traffic; earlier, only vessels with cargo.

Sources: Finnish National Road Administration, Finnish State Railways, Civil Aviation Administration, National Board of Navigation

Figure 1.1 Road traffic volumes in 1975 – 2010



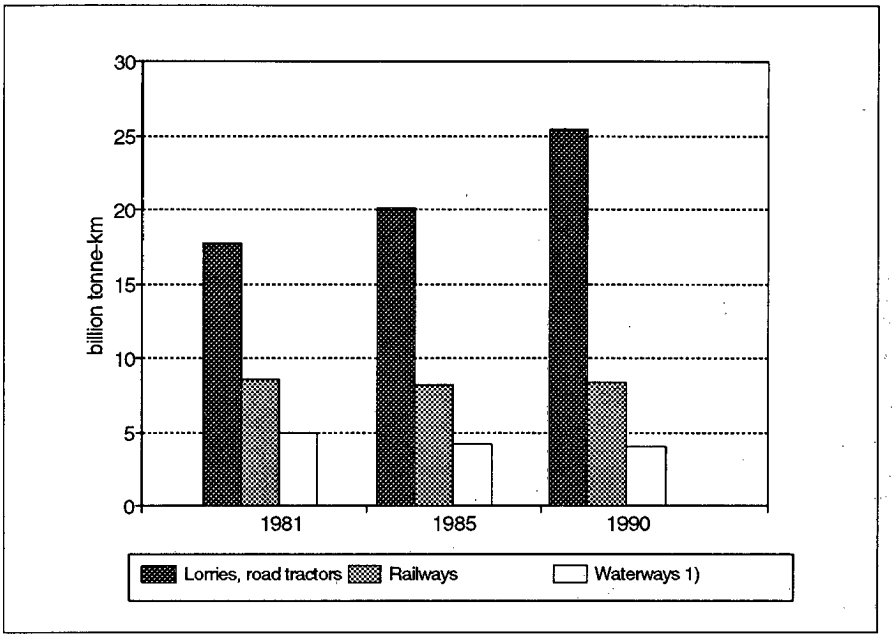
Source: Finnish National Road Administration

Table 1.2 Road traffic volumes in 1975 – 2010

Year	*Whole country:* public roads, private roads, streets					On public roads
	Pass. cars	Buses, coaches	Vans	Lorries, tract.	Total	
	Mill. vehicle-km					
	Realized					
1975	19 880	640	1 470	2 380	24 370	16 710
1976	20 580	640	1 490	2 380	25 090	17 220
1977	20 870	640	1 500	2 380	25 390	17 330
1978	21 380	640	1 520	2 380	25 920	17 650
1979	21 870	640	1 530	2 380	26 420	17 960
1980	22 180	640	1 550	2 390	26 760	18 100
1981	22 600	650	1 620	2 400	27 270	18 390
1982	23 410	660	1 730	2 400	28 200	19 100
1983	24 170	670	1 850	2 390	29 080	19 800
1984	24 940	670	1 930	2 400	29 940	20 570
1985	25 970	670	2 050	2 460	31 150	21 610
1986	26 840	670	2 260	2 580	32 350	22 520
1987	28 640	670	2 400	2 540	34 250	23 880
1988	30 730	670	2 520	2 590	36 510	25 570
1989	32 680	670	2 680	2 680	38 710	27 150
1990	33 430	680	2 860	2 780	39 750	27 890
1991	33 130	650	2 860	2 530	39 170	27 450
	Forecast					
1990	33 330	670	2 900	2 600	39 500	27 650
1995	39 100	670	3 600	2 700	46 070	32 250
2000	42 700	670	4 150	2 800	50 300	35 250
2005	44 400	670	4 500	2 900	52 500	37 000
2010	45 000	670	4 800	3 000	53 500	37 700

Source: Finnish National Road Administration 1989

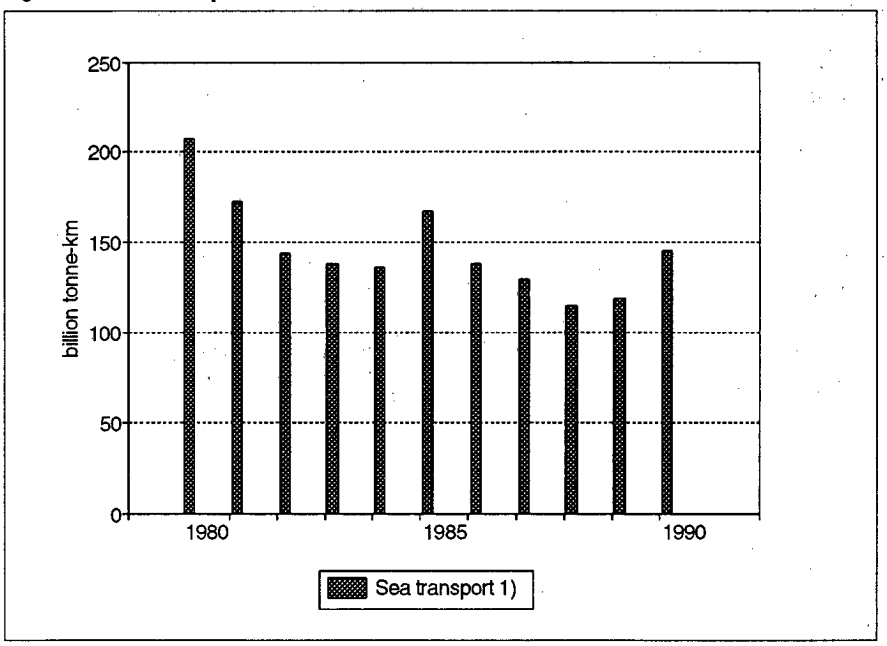
Figure 1.2 Domestic goods transport volumes in 1981, 1985 and 1990



1) Inland waterway and coastal traffic

Sources: Finnish National Road Administration, Finnish State Railways, National Board of Navigation

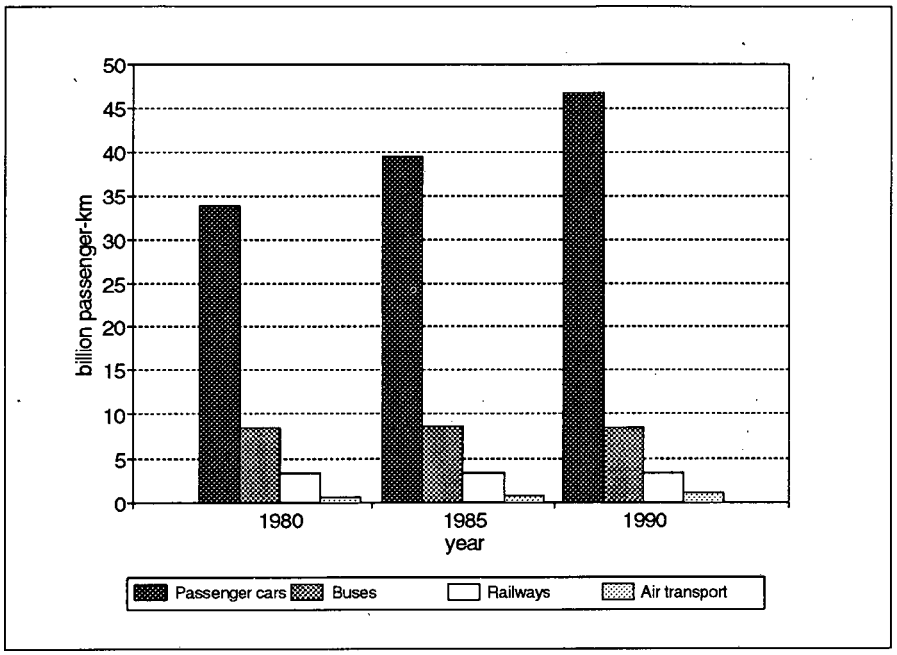
Figure 1.3 Sea transport volumes in 1980 – 1990



1) International traffic

Source: Finnish National Board of Navigation

Figure 1.4 Domestic passenger transport volumes in 1980, 1985 and 1990



Sources: Finnish National Road Administration, Finnish State Railways, Civil Aviation Administration

Table 1.3 Goods transport volumes in 1970–1990

Year	*Lorries, road tractors* [1]	*Railways*			*Waterways*						*Air transport* [4]				
		Total	Commercial transports	Transports of own goods	Total	Domestic transports [2]			International tr.		Domestic, scheduled		International, scheduled		Charter flights
						Total	Vessels	Floating	Total	Finnish vessels [3]	Total [5]	Passengers	Total [5]	Passengers	
	Mill. tonne-km														
1970	..	6 407	6 270	137	..	4 349	2 359	1 990	..	..	21	20	72	49	..
1975	..	6 620	6 438	182	129 329	4 435	2 635	1 800	124 894	56 510	41	39	102	72	167
1980	..	8 491	8 335	156	212 495	5 184	3 395	1 789	207 311	79 923	48	46	194	144	138
81	17 700	8 522	8 391	131	177 553	4 963	3 123	1 840	172 590	89 352	53	51	227	173	124
1985	20 100	8 148	8 067	81	171 785	4 171	2 692	1 479	167 614	59 715	62	60	283	201	217
86	..	7 033	6 951	82	142 741	4 491	2 972	1 519	138 250	42 105	58	55	296	205	265
87	21 900	7 480	7 403	77	134 403	4 188	2 897	1 291	130 215	33 452	69	66	347	252	320
88	..	7 893	7 815	78	119 213	4 065	2 745	1 320	115 148	25 959	77	74	389	284	384
89	25 000	8 058	7 958	99	122 534	3 884	2 727	1 157	118 650	25 670	81	79	467	332	440
1990	25 400	8 427	8 357	70	149 637	4 030	2 980	1 050	145 607	24 084	86	84	489	347	441

1) Lorries of 3.5 tonnes or more, registered in Finland.
2) Inland and coastal transports.
3) Vessels registered in Finland.
4) By Finnish carriers.
5) Passengers, goods, post.

Sources: Finnish National Road Administration, Finnish State Railways, National Board of Navigation, Civil Aviation Administration.

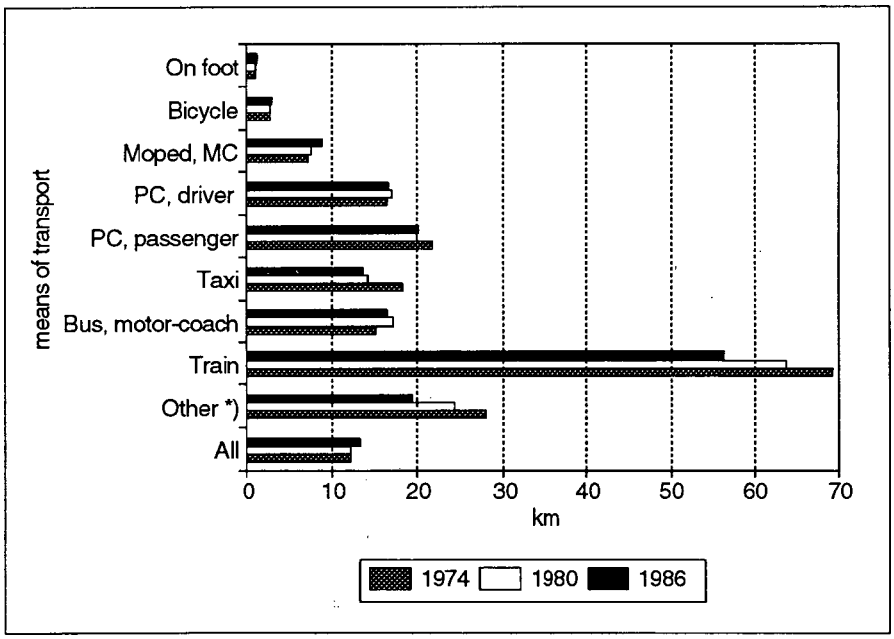
Table 1.4 Daily trips: average distances in 1986, 1980 and 1974 according to destination and means of transport

Destination or purpose	Means of transport									
	On foot	Bicycle	Moped, MC	PC, driver[1]	PC, pass.[2]	Taxi	Bus, motor coach[3]	Train	Other[4]	All means
	Km									
Home	1.5	3.2	9.9	16.5	21.1	11.9	13.0	33.9	17.5	12.5
Workplace	1.1	3.3	8.2	15.0	14.8	7.2	12.7	25.4	25.7	11.8
Business	1.1	5.4	34.2	23.5	38.8	3.2	28.7	27.8	32.8	24.7
School	1.0	2.6	8.5	22.0	9.7	20.0	14.4	109.8	15.0	11.3
Shopping, daily	0.8	1.8	5.6	7.1	7.1	5.1	9.8	91.2	4.4	4.7
Shopping, other	1.2	2.7	8.2	12.1	13.3	38.3	13.4	12.5	12.4	9.6
Errands	0.8	2.6	4.6	12.8	15.0	45.8	12.2	53.9	8.8	10.7
Entert., hobbies	1.5	4.1	8.4	17.9	21.9	4.8	19.7	28.5	15.1	13.6
Visit	1.6	3.4	7.2	24.8	25.5	7.9	23.3	208.3	34.0	21.2
Other	1.6	4.5	7.0	18.5	26.1	6.0	38.7	90.2	6.0	22.8
Total 1986	**1.3**	**3.1**	**8.9**	**16.6**	**20.2**	**13.7**	**16.4**	**56.4**	**19.4**	**13.3**
Total 1980	**1.2**	**2.9**	**7.6**	**17.0**	**19.9**	**14.2**	**17.2**	**63.7**	**24.3**	**12.2**
Total 1974	**1.2**	**2.8**	**7.2**	**16.4**	**21.8**	**18.3**	**15.2**	**69.3**	**27.9**	**12.2**

1) As driver of a car.
2) As passenger in a car.
3) The figures for 1980 and 1974 also include transport by tram.
4) Snowmobile, water and air transport, etc.

Source: Finnish National Road Administration 1977, 1982, 1988

Figure 1.5 Daily trips: average distances travelled in 1974, 1980 and 1986 according to means of transport



*) Snowmobile, water and air transport, etc.

Source: Finnish National Road Administration 1977, 1982, 1988.

Table1.5 Daily trips by means of transport and distances travelled in 1986

Means of transport	Distance travelled (km)											All trips
	< 0.5	0.5–1.0	1.0–3.0	3.0–6.0	6.0–10	10–15	15–30	30–50	50–100	100–150	> 150	
	%											
On foot	68	40	18	6	2	1	0	0				18
Bicycle	15	21	22	13	7	3	1	0	0	1		12
Moped, MC	0	2	1	1	2	2	1	0	0			1
PC, driver[1]	12	27	39	49	51	57	57	57	59	57	49	43
PC, passenger[2]	3	7	12	15	17	14	20	24	25	26	20	13
Taxi	0	0	1	0	1	0	1	1	1	0	0	1
Bus, motor-coach	0	1	5	14	17	16	14	10	8	6	12	9
Train	0	0	0	1	3	4	4	4	4	5	14	2
By air	0				0	0			1	1	1	0
Other	1	1	1	2	1	2	2	2	1	4	4	2
All means	100	100	100	100	100	100	100	100	100	100	100	100

1) As driver of a car
2) As passenger in a car

Source: Finnish National Road Administration 1988

Table 1.6 Passenger traffic: average distances travelled in 1974 – 1990

Year	*Road traffic*[1]			*Railway traffic*		*Waterway traffic*			*Air traffic*[5]	
	Pass. car, driver	Pass. car, pass.	Bus, motor-coach[2]	Long-distance[3]	Local[4]	Domestic		International	Domestic	International
						Inland	Coastal			
	Km									
74	16.4	21.8	15.2	273.5	..	62.2	18.3	..	..	..
1975	..	..	..	270.8	22.5	92.5	17.1	..	329.8	1 204.6
1980	17.0	19.9	17.2	277.3	23.2	36.9	23.4	..	347.5	1 654.3
1985	..	..	..	279.0	22.4	34.1	29.9	..	368.6	1 765.3
86	16.6	20.2	16.4	281.0	21.6	32.0	28.7	..	375.7	1 801.3
87	..	..	..	278.6	17.3	29.2	30.6	..	371.1	1 824.4
88	..	..	..	269.4	17.8	31.4	30.3	..	374.3	1 866.3
89	..	..	..	236.3	17.2	32.8	26.3	287.4	283.3	1 960.8
1990	..	..	..	239.0	17.0	33.0	29.0	280.7	396.6	1 969.5

The distances travelled on Helsinki City Transport underground trains and trams averaged approx. 7 km and 2 km, respectively.
1) Finnish National Road Administration 1977, 1982, 1988.
2) The figures for 1980 and 1974 also include transport by tram.
3) Over 75 km.
4) Commuter traffic in Greater Helsinki.
5) Scheduled service by Finnish carriers.

Sources: Finnish National Road Administration, Finnish State Railways, National Board of Navigation, Civil Aviation Administration

1.2 Stock of vehicles

Table 1.7 Road motor vehicles, trailers and motorcycles in 1970 – 1990

Year	Passenger cars		Buses, motor-coaches	Vans[1]		Special auto-mobiles	Lorries, road tractors	
	All	Gasoline fuelled		All	Diesel fuelled		All	Capacity > 10 t
	Number							
1970	711 968	698 625	8 116	56 707	6 737	5 024	46 195	1 939
1975	996 284	969 770	8 651	77 546	19 025	6 581	50 905	10542
1980	1 225 931	1 163 652	8 963	96 624	39 905	8 782	52 527	17 559
1985	1 546 094	1 418 518	9 017	127 618	83 234	11 867	52 019	20 086
86	1 619 848	1 482 709	9 166	135 718	93 051	12 470	51 747	22 020
87	1 698 671	1 554 117	9 233	146 219	104 109	13 640	51 956	21 625
88	1 795 908	1 645 685	9 229	160 901	117 272	15 392	52 736	23 475
89	1 896 895	..	9 268	187 827	..	18 067	53 818	..
1990	1 926 326	1 771 325	9 287	207 226	146 714	20 621	54 269	25 716

Year	Trailers[2]			Motorcycles		Mopeds
	All	Capacity		All	> 125 cm^3	
		10,0 – –14.9 t[3]	> 15 t			
	Number					
1970	15 844	1 843	..	44 139	24 555	281 620
1975	43 394	10 059	..	49 085	22 651	197 052
1980	115 776	15 722	..	43 377	19 753	167 763
1985	225 003	19 348	..	50 738	26 188	145 167
86	243 174	7 158	12 723	48 147	26 429	137 014
87	271 001	6 914	13 534	50 909	28 545	130 846
88	294 438	6 688	14 437	51 998	29 844	121 395
89	..	..	..	55 052	..	114 537
1990	345 015	6 143	17 825	59 716	34 821	..

1) Less than 3 500 kg
2) Excl. caravans
3) 1973–1983 ≥ 10 t, 1984–1985 ≥ 12 t

Lähteet: Statistics Finland; Finnish Motor Insurers' Association, Green Card Bureau and Guarantee Fund

Table 1.8 Stock of road motor vehicles: renewal in 1980 – 1990

Year	First registrations			Registrations terminated[1]			Terminations relative to stock[2]		
	Pass. cars	Vans	Lorries, tractors	Pass. cars	Vans	Lorries, tractors	Pass. cars	Vans	Lorries, tractors
	Number						%		
1980	103 760	11 594	5 069	47 330	6 309	4 298	3.9	6.5	8.2
1985	138 976	13 931	3 676	66 857	7 475	4 279	4.3	5.9	8.2
86	144 021	15 266	3 772	70 267	7 166	4 044	4.3	5.3	7.8
87	152 327	17 442	4 096	73 504	6 941	3 887	4.3	4.8	7.5
88	174 479	21 602	4 252	77 242	6 920	3 472	4.3	4.3	6.6
89	177 610	30 480	4 904	76 623	3 554	3 822	4.0	1.9	7.1
1990	139 041	24 988	4 184	109 610	5 589	3 733	5.7	2.7	6.9

1) Registrations terminated in year N =
stock in register in year N-1 –
stock in register in year N +
first registrations in year N

2) Registrations terminted in year N
as a percentage of stock in year N

Source: Statistics Finland

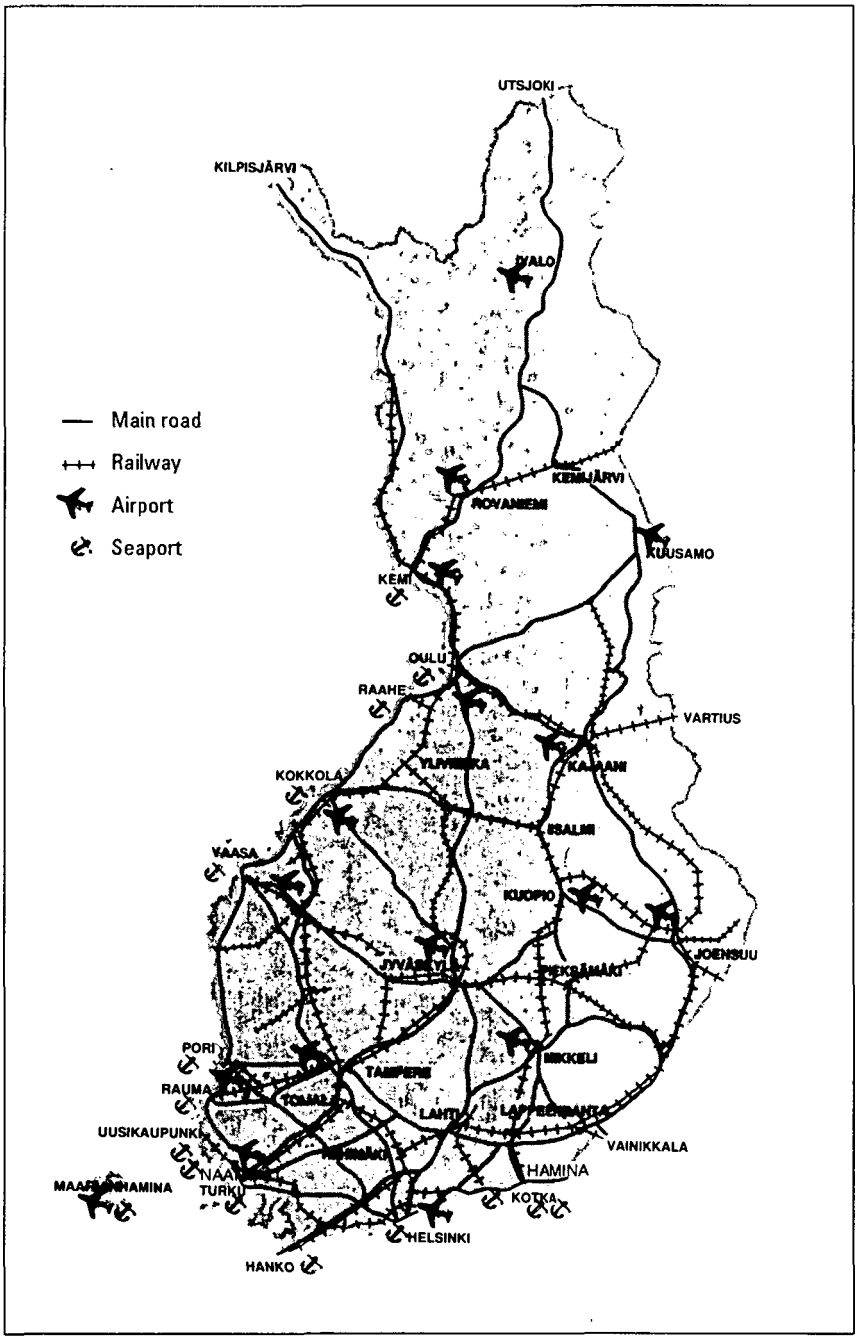
Table 1.9 Stocks of road motor vehicles in 1990 – 2010

Year	Passenger cars		Buses, coaches	Vans	Special autom.	Lorries, tract.	Total	
	1 000	Growth, % per yr, forecast	1 000					Growth, % per yr, forecast
1990	1 940	3	Ei ennakoituja muutoksia	180	18	53	2 200	3
1995	2 250	2		220	25	53	2 557	2
2000	2 500	1.4		250	30	54	2 843	1.4
2005	2 670	0.4		280	33	55	3 047	0.5
2010	2 730		9	300	35	55	3 130	

Source: Finnish National Road Administration 1989

1.3 Network

Figure 1.6 Main traffic network



Main seaports

Sköldvik (oil port) ...	13.2
Helsinki	8.4
Kotka	6.8
Hamina	5.0
Raahe Rautaruukki ..	4.3
Naantali	4.2
Rauma	3.4
Kokkola	2.7
Turku	2.5
Pori	2.1

Unloading plus loading in 1990, mill. weight tonnes

Source:
National Board of Navigation

Main airports

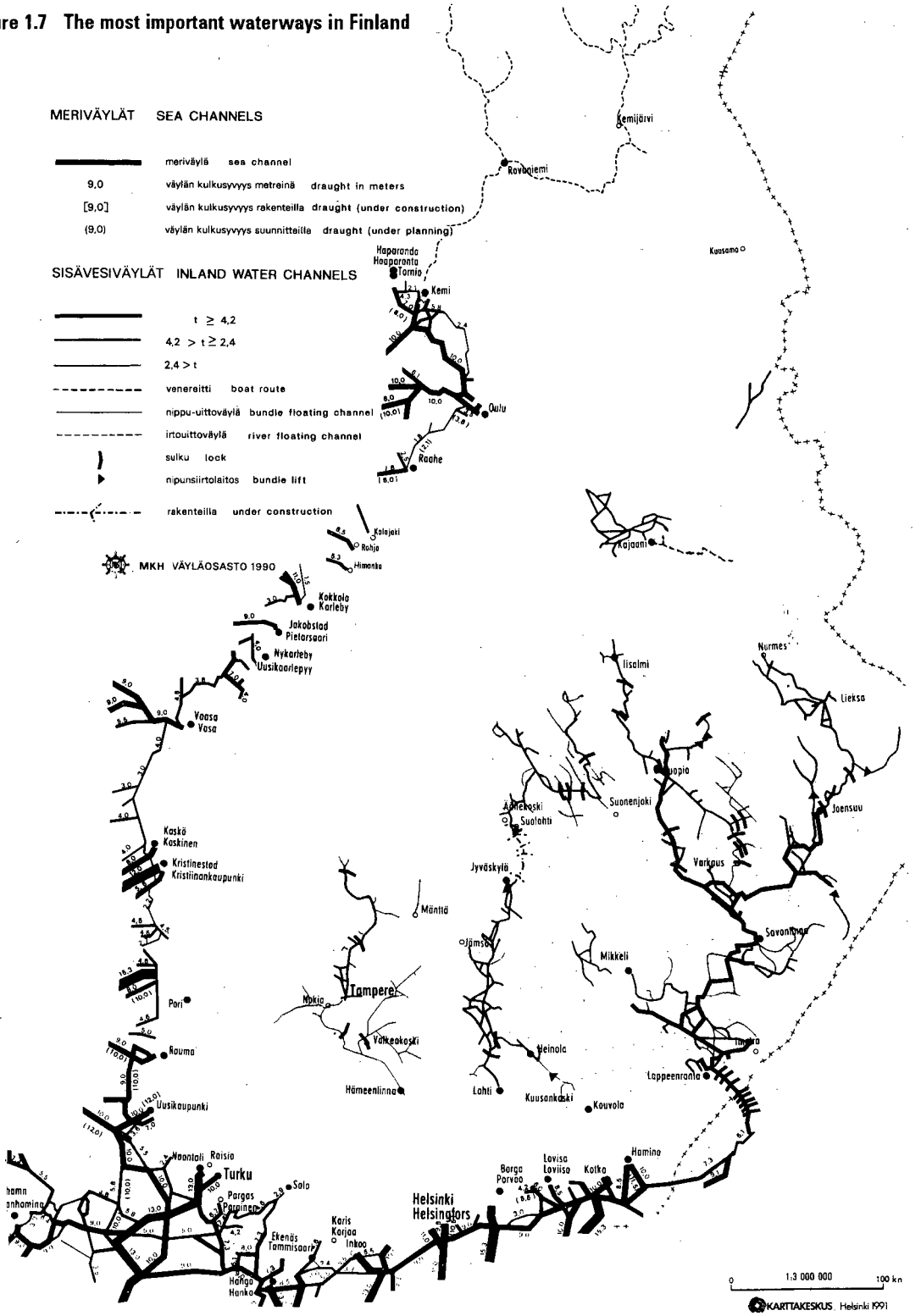
Helsinki-Vantaa ...	54 890
Oulu	7 221
Turku	6 704
Kuopio	4 061
Jyväskylä	3 914
Rovaniemi	3 795
Tampere-Pirkkala .	3 404
Vaasa	3 320
Maarianhamina ...	2 792
Joensuu	1 946

Landings in scheduled and charter traffic in 1990

Source:
Civil Aviation Administration

Source: Finnish National Road Administration 1991

Figure 1.7 The most important waterways in Finland

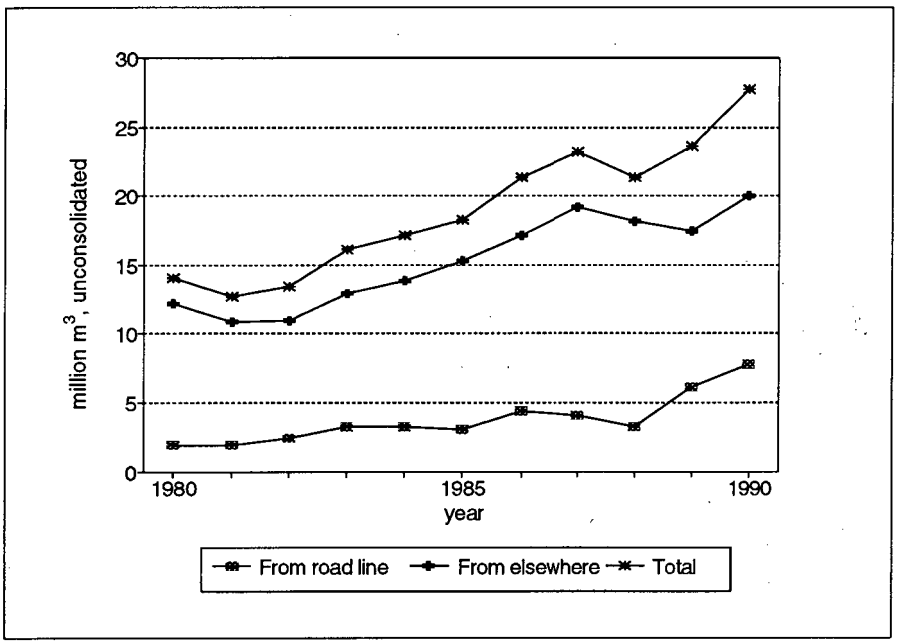


Source: National Board of Navigation

2. Use of natural resources

2.1 Soil materials use

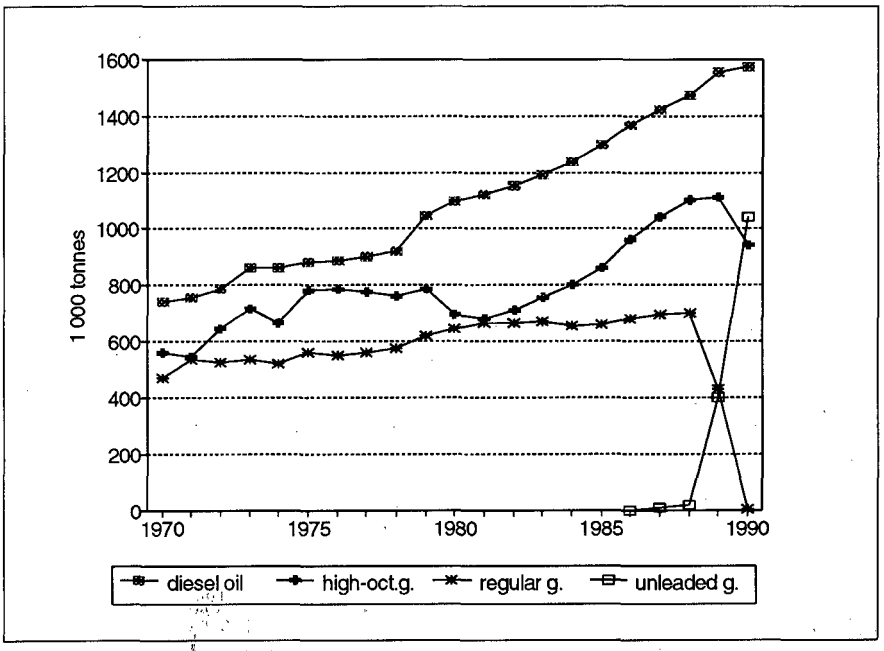
Figure 2.1 Stone materials use by the Finnish National Road Administration in 1980 – 1990[1)]



1) Construction and maintenance of public roads

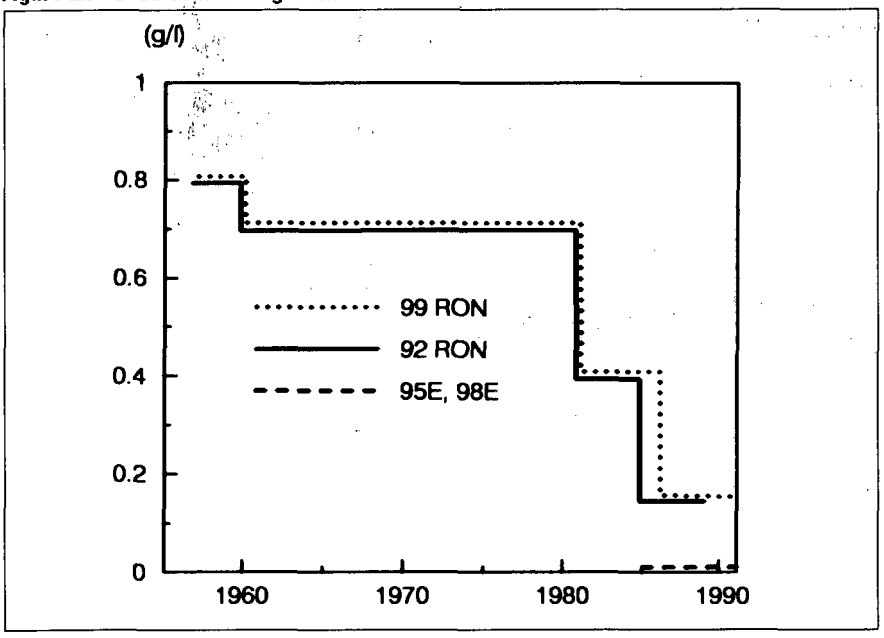
Source: Finnish National Road Administration

Figure 2.2 Road traffic fuel sales in 1970– 1990



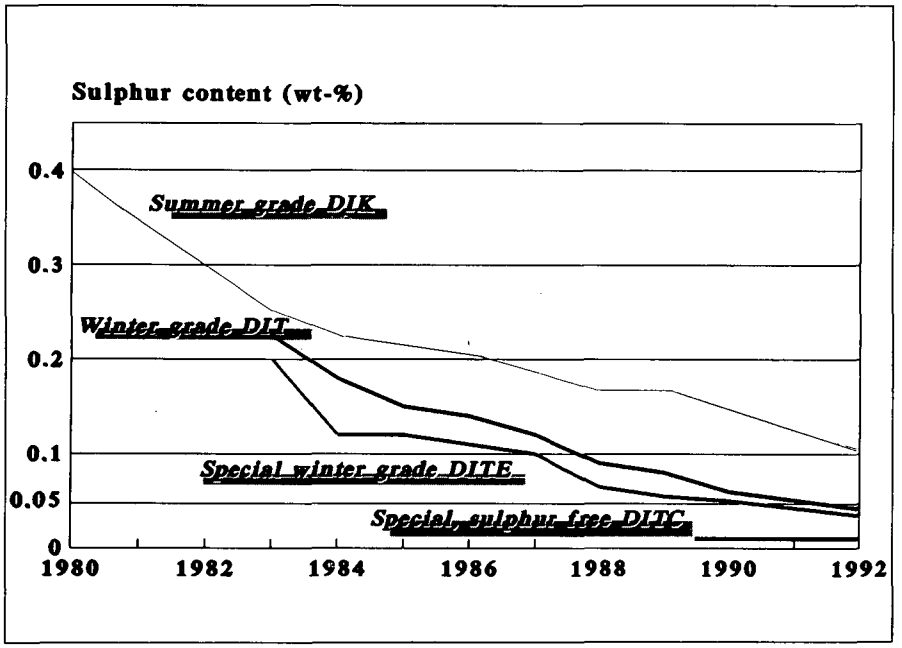
Source: Finnish Petroleum Federation

Figure 2.3 Lead content of gasoline in 1970 – 1990



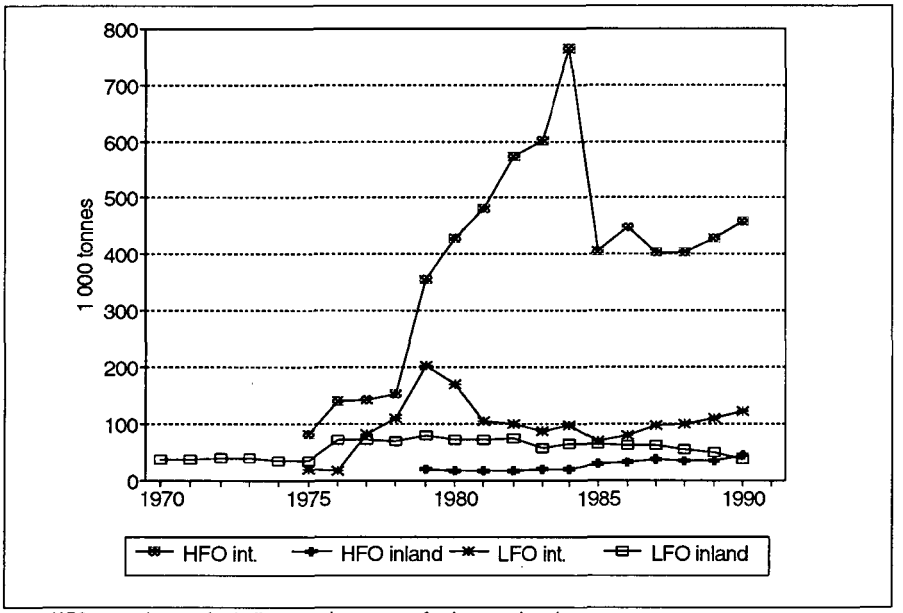
Source: Neste Oy

Figure 2.4 Sulphur content of Neste diesel fuels in 1980 – 1992



Source: Neste Oy

Figure 2.5 Water transport fuel sales in 1970 – 1990



HFO = heavy fuel oil
LFO = light fuel oil
int. = for international transport
inland = for inland transport

Source: Finnish Petroleum Federation

Table 2.1 Fuels and electricity used for traffic in 1970–1990

Year	*Road traffic*					*State railways*			*Air traffic*			
	Sales to consumers[1]					Locomotives			Inland			International[3]
	Gasoline			Diesel oil	Total	Diesel oil	Electricity[2]	Total	Jet fuel	Aviation gas.	Total	
	Regular and high-oct.	Unleaded	Total									
	1 000 tonnes						GWh		1 000 tonnes			
1970	1 026	–	1 026	742	1 768	97	7	–	32	17	49	47
1975	1 341	–	1 341	880	2 221	94	66	–	80	12	92	130
1980	1 336	–	1 336	1 099	2 435	86	191	–	80	8	88	152
1985	1 521	–	1 521	1 299	2 820	74	290	–	87	4	91	157
86	1 647	–	1 647	1 366	3 013	65	260	–	89	5	94	161
87	1 732	4	1 736	1 427	3 163	70	291	–	97	5	102	186
88	1 804	14	1 818	1 473	3 291	68	308	–	113	4	117	236
89	1 543	398	1 941	1 557	3 498	62	316	–	116	3	119	276
1990	943	1 043	1 986	1 542	3 528	57	340	–	127	4	131	320
Year	Petajoules (10^{15} joules)											
1970	44.2	–	44.2	31.5	75.7	4.1	0.0	4.1	1.4	0.7	2.1	2.0
1975	57.8	–	57.8	37.4	95.2	4.0	0.2	4.2	3.5	0.5	4.0	5.6
1980	57.6	–	57.6	46.7	104.3	3.7	0.7	4.3	3.5	0.3	3.8	6.5
1985	65.5	–	65.5	55.2	120.7	3.1	1.0	4.2	3.7	0.2	3.9	6.8
86	71.0	–	71.0	58.1	129.0	2.8	0.9	3.7	3.8	0.2	4.0	6.9
87	74.6	0.2	74.8	60.6	135.5	3.0	1.0	4.0	4.2	0.2	4.4	8.0
88	77.7	0.6	78.3	62.6	140.9	2.9	1.1	4.0	4.9	0.2	5.0	10.2
89	66.5	17.1	83.6	66.1	149.7	2.6	1.1	3.8	5.0	0.1	5.1	11.9
1990	40.6	44.9	85.6	65.5	151.1	2.4	1.2	3.6	5.5	0.2	5.6	13.8

1) Virtually the whole amount sold is used for road traffic.

2) The amounts of electricity used for electric locomotives and trains and for heating of rolling stock.

3) The figures include fuel sales to foreign aircraft, but exclude the amounts of fuel that Finnish aircraft purchase abroad.

Lähteet: Finnish Petroleum Federation, Finnish State Railways, Ministry of Trade and Industry 1991

Table 2.1 (cont.)

Year	*Waterway traffic*										
	Inland			International[1]			Finnish merchant vessels[2]				
	Light fuel oil[3]	Heavy fuel oil	Total	Light fuel oil	Heavy fuel oil	Total	Heavy fuel oil	Diesel oil	Light fuel oil, marine diesel oil	Total	Purchased in Finland
	1 000 tonnes										
1970	37	..	..	..	..	..	664	220	–	884	63
1975	35	..	..	17	82	99	716	199	–	916	76
1980	70	17	87	169	429	598	798	231	–	1 029	406
1985	64	28	92	68	405	473	635	–	128	763	423
86	61	31	92	78	448	526	534	–	101	635	423
87	61	36	97	96	402	498	409	–	107	516	343
88	53	35	88	98	404	502	356	–	111	467	323
89	48	35	83	108	427	535	374	–	103	477	328
1990	36	43	79	121	458	579	..	–	..	..	..
Year	Petajoules (10^{15} joules)										
1970	1.6	..	..	..	..	..	27.0	9.4	–	36.3	2.6
1975	1.5	..	..	0.7	3.3	4.0	29.1	8.5	–	37.6	3.2
1980	3.0	0.7	3.7	7.1	17.4	24.6	32.4	9.8	–	42.2	16.7
1985	2.7	1.1	3.9	2.9	16.4	19.3	25.8	–	5.4	31.2	17.3
86	2.6	1.3	3.9	3.3	18.2	21.5	21.7	–	4.3	26.0	17.3
87	2.6	1.5	4.0	4.1	16.3	20.4	16.6	–	4.5	21.1	14.1
88	2.2	1.4	3.7	4.2	16.4	20.6	14.5	–	4.7	19.1	13.3
89	2.0	1.4	3.5	4.6	17.4	22.0	15.2	–	4.4	19.5	13.4
1990	1.5	1.7	3.2	5.1	18.6	23.7	..	–	..	..	..

1) The figures include fuel sales to foreign vessels, but exclude the amounts of fuel that Finnish vessels purchase abroad.

2) Vessels registered in Finland.

3) From 1976, the figures are derived from an ad hoc survey by the Ministry of Trade and Industry.

Sources: Ministry of Trade and Industry 1991, National Board of Navigation.

Table 2.2 Total primary energy consumption in Finland by user sector in 1970–1990

Year	User sector						
	Inland traffic[1]	Industry[2]	Energy production[3]	Heating of buildings[4]	Other[5]	Total	Int. traffic[6]
	Petajoules (10^{15} joules)						
1970	83.1	233.2	204.7	215.3	34.6	770.9	5.2
1971	86.4	237.6	236.0	208.8	35.8	804.6	5.7
1972	91.5	268.1	259.5	204.2	36.1	859.5	5.3
1973	98.8	292.4	284.1	214.5	37.5	927.4	7.3
1974	96.5	276.9	281.8	177.7	35.9	868.7	6.9
1975	103.8	240.6	294.1	187.4	35.2	861.1	9.7
1976	104.7	257.2	325.3	184.4	37.2	908.9	11.7
1977	105.5	251.9	331.7	189.4	38.3	916.6	14.5
1978	106.8	265.9	353.8	187.3	39.2	953.0	16.2
1979	115.7	287.1	375.1	179.0	38.3	995.2	28.9
1980	114.8	286.5	399.4	163.3	36.5	1000.6	31.1
1981	116.4	288.5	433.3	143.0	35.9	1017.1	30.1
1982	119.2	273.1	441.1	128.4	36.5	998.4	33.8
1983	122.0	270.9	480.5	126.9	34.2	1034.4	34.3
1984	125.6	281.6	507.6	113.9	35.8	1064.5	41.3
1985	131.1	289.1	549.4	114.9	37.9	1122.4	26.1
1986	139.2	284.2	547.3	111.1	37.5	1119.3	28.5
1987	146.2	293.6	590.5	117.2	39.1	1186.6	28.4
1988	151.2	296.9	603.1	113.9	40.2	1205.2	30.7
1989	159.7	321.4	593.1	103.0	41.7	1218.9	33.8
1990	162.2	317.9	617.0	109.2	41.7	1248.0	37.5

1) Excl. the amounts of oil supplied for ships and aircraft operated in international service.

2) The amounts of fuel used for the generation of heating and of counterpressure and process condensation power.

3) The amounts of fuel used for the generation of regular condensation power, gas turbine power, and district heat and power; the equivalent amounts of fuel used for the generation of hydropower, net imports of electricity, and nuclear power; refineries' own use and losses.

4) The amounts of fuel used for the heating of residential, commercial and public buildings, excl. district heat and electric heating.

5) The amounts of fuel used in agriculture and forestry, construction, and households.

6) The figures include fuel sales to foreign ships and aircraft, but exclude the amounts of fuel that Finnish ships and aircraft purchase abroad.

Source: Ministry of Trade and Industry 1991

Table 2.3 Transport and storage: direct and indirect energy use[1] in 1985

Transport and storage (Standard Industrial Classification 71)[2]	Energy use				
	Fuels	Heat	Electricity	Total	Percentage
	Petajoules (10^{15} joules)				
Railway transport[3]	3.36	0.01	1.25	4.62	0.06
Other land transport	27.30	1.34	0.73	29.37	0.36
Traffic[4]	25.82	1.20	0.58	27.61	0.34
Support functions[5]	1.48	0.13	0.15	1.76	0.02
Waterway transport, incl. support funct.[6]	32.60	0.16	0.24	32.99	0.41
Air transport, incl. support functions[7]	14.09	0.10	0.09	14.28	0.18
Total	**77.35**	**1.60**	**2.32**	**81.26**	**1.00**

1) The amounts of energy consumed by the use of buildings and by the operation of transport, industrial and other equipment in the transport and storage sector.
2) Of the total consumption of gasoline and diesel oil, for instance, only about 30 per cent is accounted for by this sector, with 47 per cent accounted for by households and 23 per cent by other sectors.
3) Finnish State Railways.
4) Professional lorry and van traffic, private bus and motor-coach traffic and travel service, taxi traffic, municipal transport services (incl. light rail traffic).
5) Forwarding, travel agency and car rental services.
6) Offshore and coastal traffic, stevedoring, ports.
7) Domestic airlines.

Source: Statistics Finland

Table 2.4 Inland transport: direct[1] and indirect[2] energy use in 1988

Type of transport	Purpose of energy use			
	Contruction and maintenance of transport network	Manufacture and maintenance of vehicle stock	Traffic	Total
	Petajoules (10^{15} joules)			
ENERGY USE				
Passenger transport				
Passenger car	7.31	17.87	89.34	114.52
Bus, motor-coach	0.27	2.11	7.72	10.10
Train	0.15	0.85	1.50	2.51
Air	0.15	0.01	3.25	3.41
Total	**7.88**	**20.84**	**101.81**	**130.53**
Goods transport				
Lorry, road tractor	0.89	5.69	33.71	40.29
Van	0.65	3.57	10.15	14.38
Train	0.45	0.28	3.21	3.94
Waterway, incl. floating	0.27	0.14	1.34	1.75
Total	**2.26**	**9.68**	**48.41**	**60.35**
Total	**10.14**	**30.52**	**150.21**	**190.88**

1) Fuels and electricity used for the operation of transport equipment and energy losses occurring in the production and distribution of fuels and electricity.
2) Energy used for building and maintaining transport networks, for manufacturing and maintaining equipment, and for producing and distributing fuels and electricity.

Sources: Pasi 1992;. coefficients of energy use derived from Kordi and Schjelderup 1979 and Kordi et al. 1979.

3. Emissions

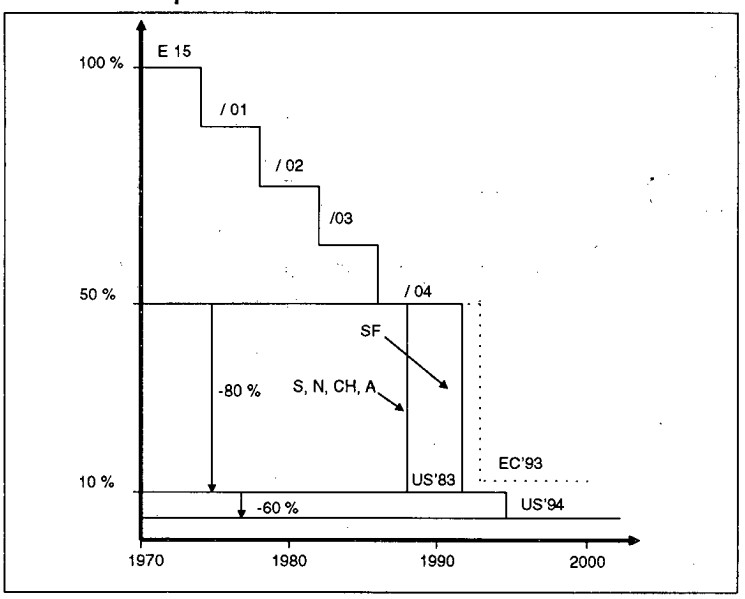
3.1 Emission standards

Table 3.1 Commitments and objectives concerning reduction of emissions in Finland

Agreement, decision			Base year, emission	Target year
SO_2	Helsinki'85	protocol – 30 %	1980 584 000 t SO_2	1993
	Helsinki'85	objective – 50 %	"	1995
	National decision	objective – 80 %	"	2000 120 000 t SO_2
NO_2	Sofia'88	protocol	1987 270 000 t NO_2	1994 270 000 t NO_2
	Sofia'88	declaration – 30 %	1980 264 000 t NO_2	1998
VOC	Geneva'91	protocol – 30 %	1988 210 000 t NMVOC[1)]	1999

1) Emissions due to human activities.

Figure 3.1 Specific emissions of gasoline-fuelled cars: relative developments in response to the revised standards on emissions.



Like some other countries, Finland has switched from the prevailing European line to the more stringent US standard. The application of the US'83 limit was introduced in stages: on 1 January 1990 for all car models to be inspected and on 1 January 1992 for all new cars to be operated.

S = Sweden CH = Switzerland
N = Norway A = Austria

Table 3.2 Development of emission standards for heavy motor vehicles

Regulation	CO	HC	NO_x	Particulate matter
	g/kWh			
ECE R49				
1 Jan. 1989	14	3.5	18	ECE R24
ECE R49/01				
1 Jan. 1991	11.2	2.4	14.4	ECE R24
"EC'92"				
1 July 1992	4.5	1.1	8.0	0.36
"EC'95"				
1 Jan. 1995	4.0	1.1	7.0	0.15

Table 3.3 Motor vehicle noise pollution: limit values applied in Finland

Vehicle type	Weight/ power output	Limit value (dBA)	
		Previous	From 1 Oct. 1991
Passenger cars		80	77
Vans, buses and motor-coaches, lorries .	< 3.5 t	81	79
Buses and motorcoaches	> 3.5 t	82	80
	> 147 kW	85	83
Lorries, road tractors	> 3.5 t	86	83
	> 147 kW	88	84

3.2 Exhaust emissions

Table 3.4 Exhaust emissions from transport sources in 1990

	CO	HC	NO_2	Part. matter	SO_2	Pb	CO_2
	Tonnes						
Passenger cars	324 000	30 500	68 200	4 200	1 430	184	7 080 000
Vans	14 300	3 050	5 150	1 340	406	5	786 000
Buses, coaches	3 670	2 110	15 100	1 340	335	0	546 000
Lorries, road tractors	16 400	5 960	36 200	4 170	1 650	0	2 690 000
Road traffic, total[1]	**359 000**	**41 700**	**125 000**	**11 000**	**3 820**	**189**	**11 100 000**
Trains[2]	500	700	5 000	700	300	0	278 000
Ships[3]							
domestic traffic	300	300	5 900	200	2 500	0	306 000
Aircraft	2 000	500	1 100	50	50	0	321 000
Self-propelled industrial, agricultural and forest equipment	22 200	7 540	38 900	3 550	2 560	6	2 080 000
Inland traffic, total	**383 000**	**50 700**	**176 000**	**15 500**	**9 200**	**195**	**14 100 000**
Road traffic %	94	82	71	71	42	97	79
International waterway traffic[2]	200	200	38 800	100	18 000	0	–

1) For total emissions of volatile organic compounds in road traffic, see Table 3.7.

2) Includes electricity production.

3) The data on ships' nitrogen dioxide and sulphur dioxide emissions are derived from a Ministry of the Environment draft report.

Sources: Technical Research Centre of Finland: Road, Traffic and Geotechnical Laboratory; Ministry of the Environment (draft report); Puranen 1992

Table 3.5 Estimated exhaust emissions per person-kilometre

	CO	HC	NO_2	Particulate matter
	g per person-km			
Passenger car, no cat. converter.	1.8–7.5	0.2–0.6	1.5–1.9	0.06–0.08
Passenger car with cat. converter	0.6–2.2	0.06–0.2	0.4–0.6	0.06–0.08
Passenger car, diesel	0.05	0.1–0.4	0.4–0.6	0.1–0.5
Bus, motor-coach	0.1–0.2	0.04–0.1	1.0–0.5	0.2–0.1
Electric train	0.0	0.0	0.04	0.01
Aircraft	2.1	0.5	1.1	0.05

For automobile traffic, the first figure relates to traffic on highways and country roads, the second to traffic in city streets. For cars, the average load (i.e. the average number of persons per vehicle) is estimated at 1.33 in city traffic and 1.7 on roads; for buses and motor-coaches, at 17 in city traffic and 10 on roads. For trains and aircraft, the totals of person-kilometres are used instead of average loads.

Source: Alppivuori 1990

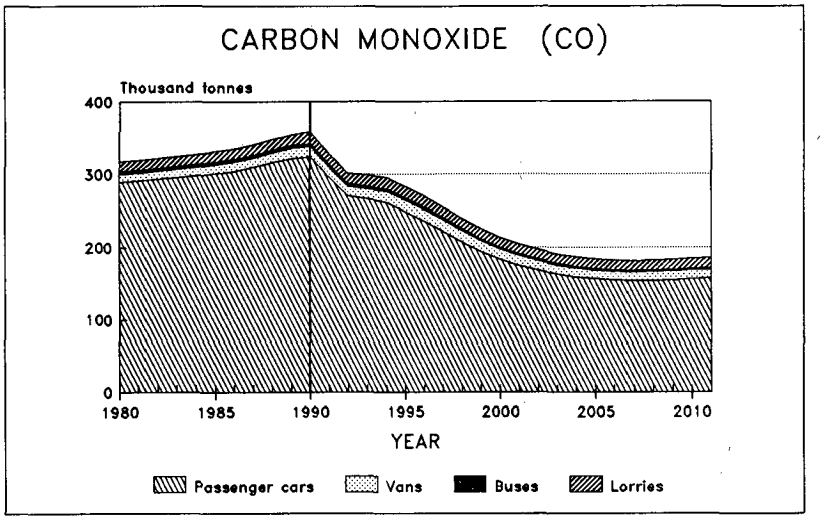
Table 3.6 Estimated exhaust emissions per tonne of goods transported per kilometre

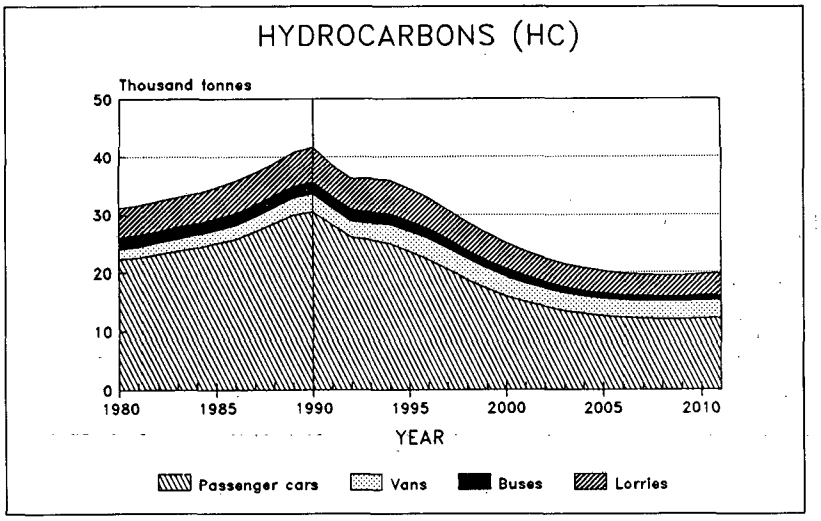
	CO	HC	NO_2	Particulate matter
	g per tonne-km			
Light lorry	0.1–0.3	0.05–0.1	1.0	0.08–0.1
Heavy lorry, road tractor	0.03	0.01	0.5–1.0	0.04
Train, diesel	0.1	0.01	0.8	0.05
Train, electric	0.0	0.0	0.05	0.01

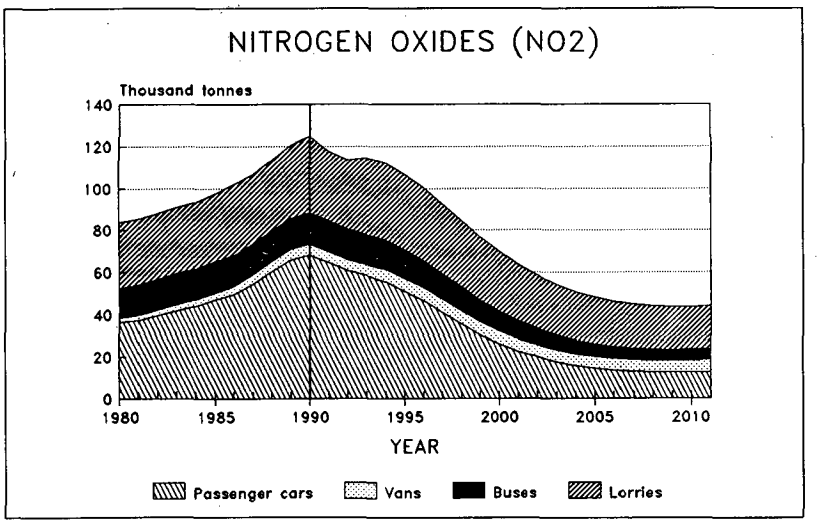
For goods road vehicles, the first figure relates to operation as fully loaded and the second to operation as empty or nearly empty. For trains, the totals of tonne-kilometres are used instead of average loads.

Source: Technical Research Centre of Finland: Road, Traffic and Geotechnical Laboratory

Figure 3.2 Road traffic emissions: estimated amounts in 1980–2010

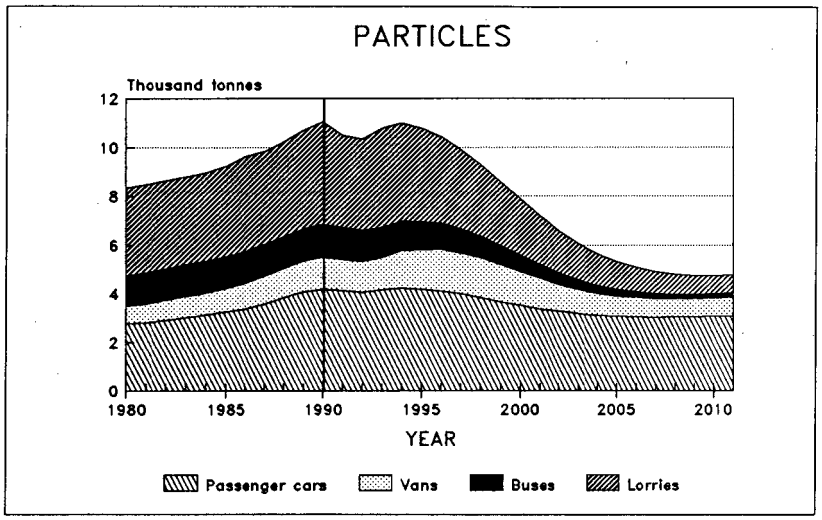


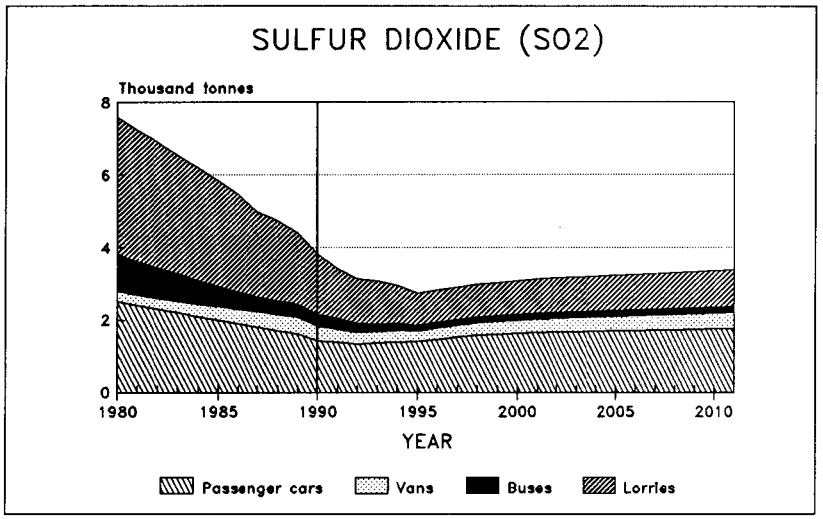


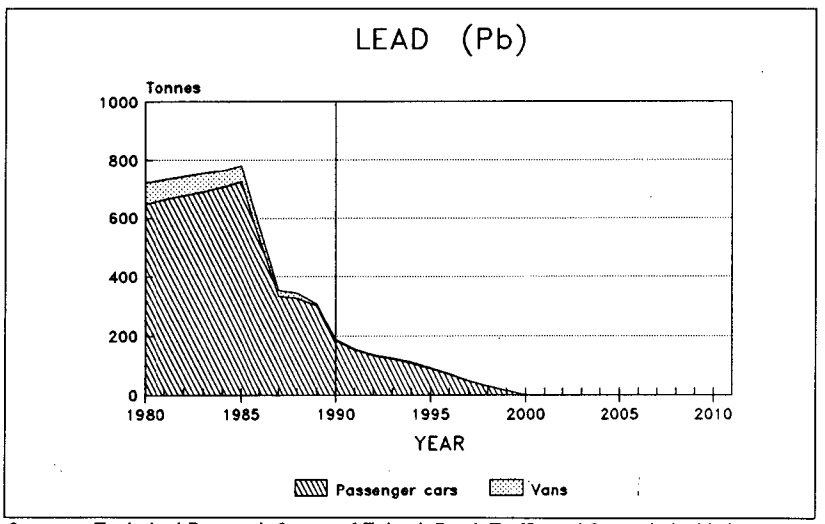


Source: Technical Research Centre of Finland: Road, Traffic and Geotechnical Laboratory

Figure 3.2 (cont.)

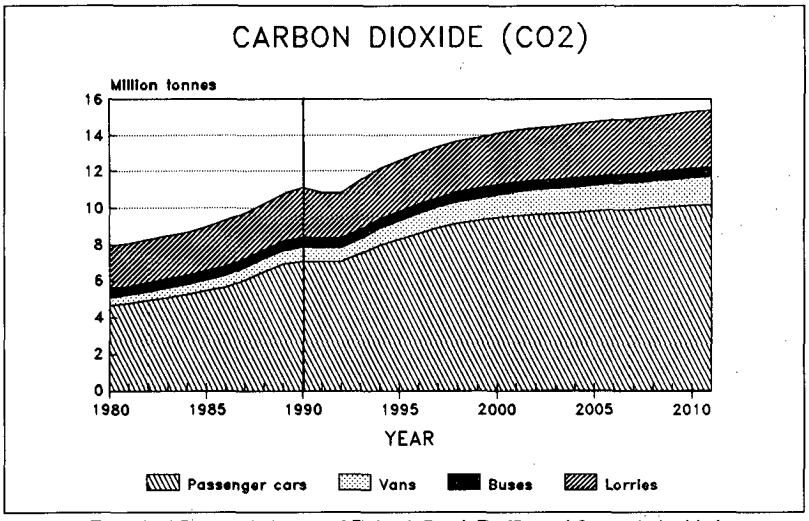






Source: Technical Research Centre of Finland: Road, Traffic and Geotechnical Laboratory

Figure 3.2 (cont.)



Source: Technical Research Centre of Finland: Road, Traffic and Geotechnical Laboratory

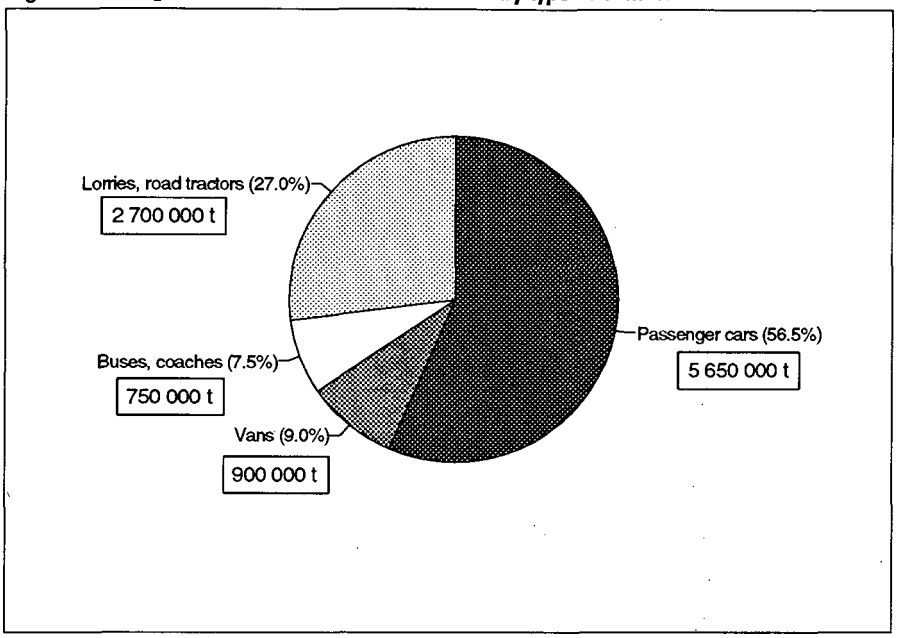
Table 3.7 Emissions into the air in Finland[1)]

	NO_x	SO_2	HC/VOC	Pb	CO
	1 000 tonnes				
Energy production	95	142	35[2)]	0.021	110
Industry	17	109	67[3)]	0.087	10
Industrial, agricultural and forest equipment[4)]	41	2.7	11.5	0.010	32
Traffic (exhaust), excl. int. waterway traffic	138	6.9	48[5)]	0.189	362
Road traffic, volatile	–	–	26	–	–
Taking on fuel, vehicle maintenance, road surfacing	–	–	17	–	–
Total, excl. int. waterway traffic	291	260.6	204.5	0.307	514
Traffic %	47	3	44	62	70
Int. waterway traffic	39	17.8	0.2	0.0	0.2

1) Data from different years between 1987 and 1990.
2) Does not include the methane emissions of energy production, totalling 38 000 tonnes.
3) The figure also includes the emissions of solvent use, oil refining and chemicals ports.
4) Self-propelled and movable combined.
5) In addition to the emissions presented in Table 3.4, the figure includes 4 800 tonnes of moped and motorcycle exhaust emissions.

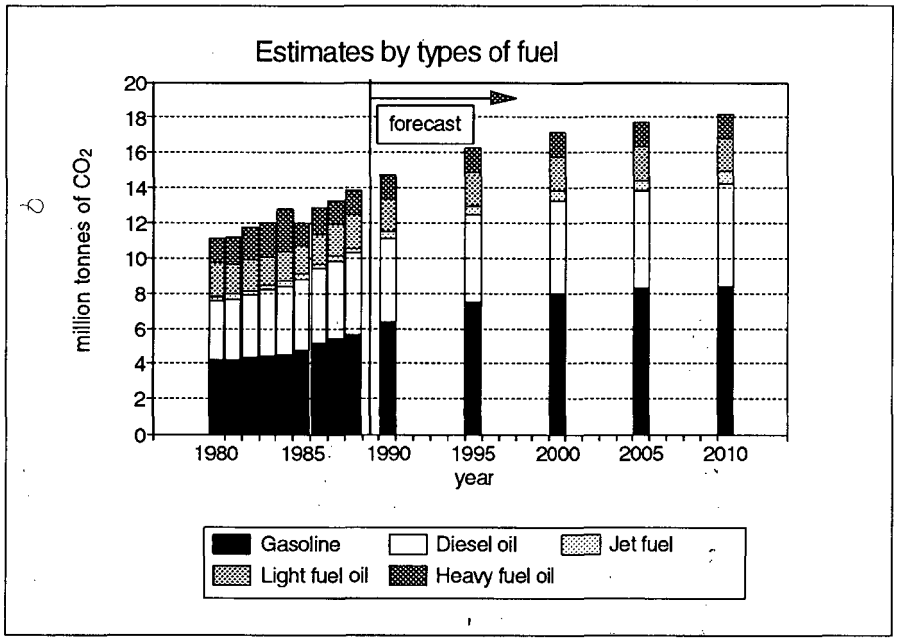
Source: Ministry of the Environment

Figure 3.3 CO_2 emissions of road traffic in 1988 by type of vehicle



Source: Laurikko 1990

Figure 3.4 CO_2 emissions of traffic in 1980–2010



Source: Laurikko 1990

Table 3.8 Carbon dioxide emissions of oil-fuelled motor vehicles in 1988

Emission	Fuel							
	Gasoline	Diesel oil	Light fuel oil	Heavy fuel oil	Aviation gasoline	Jet fuel	Vaporizing oil	Total
	1 000 tonnes							
Carbon dioxide (CO_2)	5 695	4 633	1 927	1 373	13	354	13	14 008

Based on Ministry of Trade and Industry data on fuel sales in Finland.

Source: Laurikko 1990

Table 3.9 Measured street noise levels in selected areas

Area; town	Equivalent continuous sound level dB(A)		Year
	Day, 7 am–10 pm	Night, 10 pm – 7 am	
Street			
Kuopio	63–76	53–66	1980
Lahti[1)]	60–74	58–72	1979
Lappeenranta	57–68	49–62	1981
Anjalankoski	55–68	50–58	1983
City centre, balcony giving onto an open court, 80 m from intersection			
Kuopio	53–60	44–51	1991
Main artery for inbound traffic, measurement at 10 m from road			
Kuopio	68–70	..	1991

1) Heavy traffic, transit traffic.

Source: University of Kuopio, Department of Environmental Hygienicks (Erkki Björk)

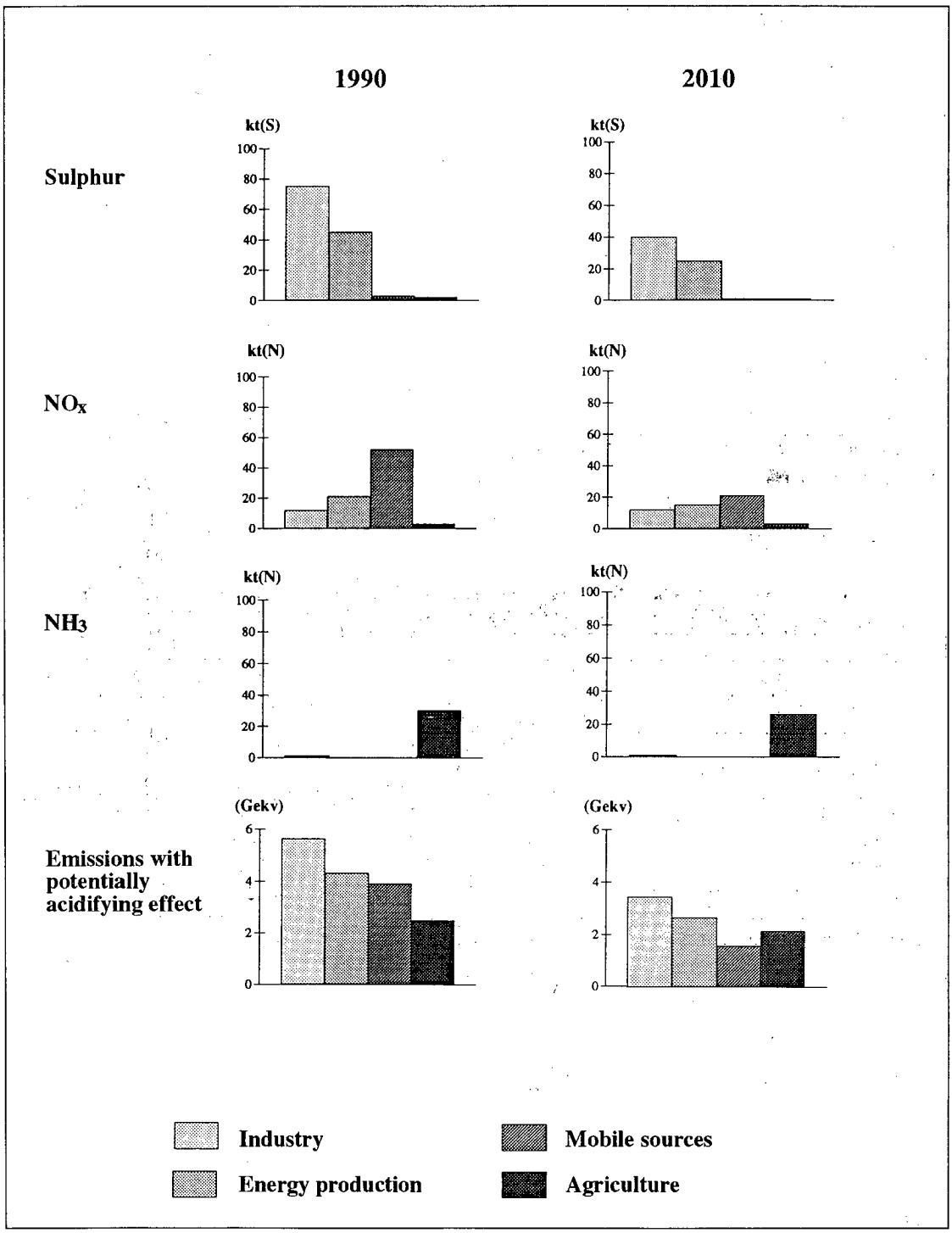
Table 3.10 Measured noise levels in areas affected by Helsinki-Vantaa Airport in 1990

Area	Distance from runway (km)	Equivalent continuous sound level dB(A)		Max. sound level dB(A)
		Day, 7 am–10 pm	Night, 10 pm – 7 am	
Koivuhaka	1	33–68	51–64	100
Viertola	2.5	50–66	38–45	90
Piispankylä	4	49–62	35–62	90
Vierumäki	4.5	50–62	36–43	90
Martinlaakso	5	63–68	52–64	90
Myyrmäki	6	60–67	34–53	90

Source: University of Kuopio, Department of Environmental Hygienicks

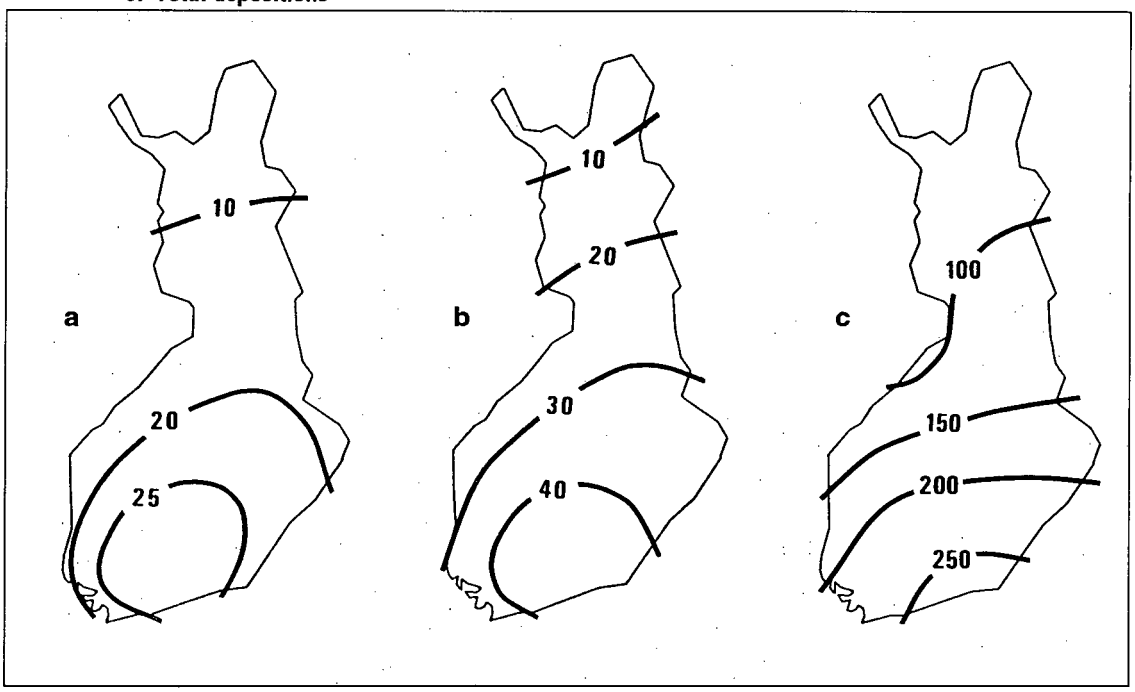
4. Acidification

Figure 4.1 Potentially acidifying emissions in Finland by type of source: data for 1990 and a projection for 2010



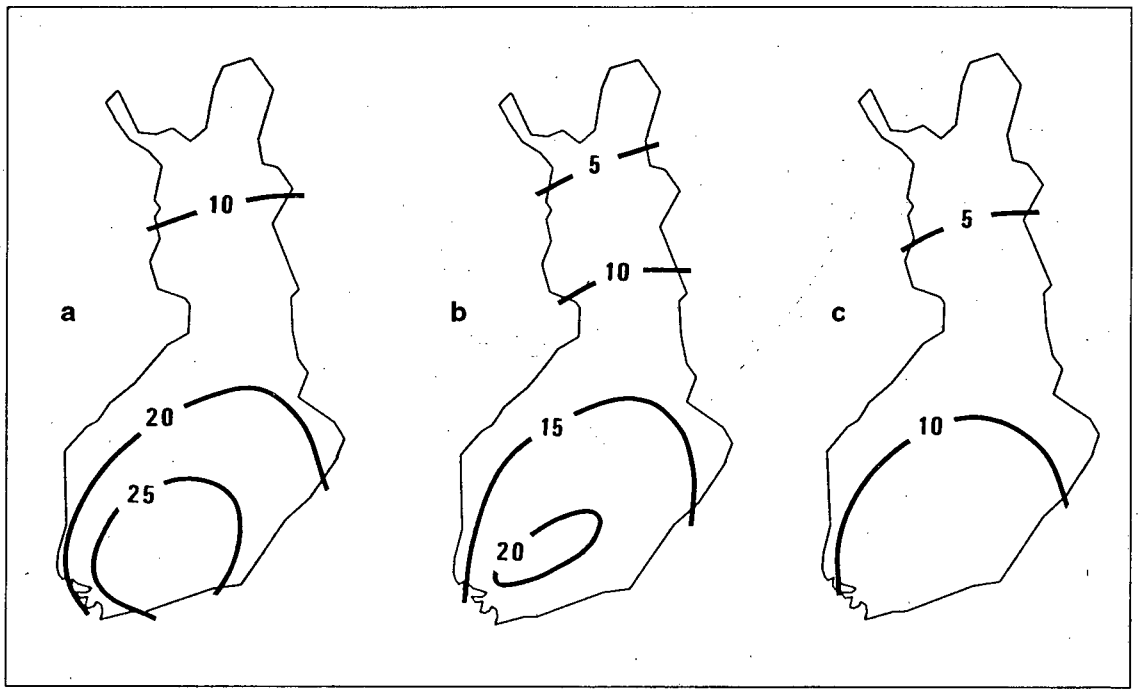
kt = 1 000 tonnes
The nitrogen oxide emissions of agricultural tractors and other mobile equipment are included in the data on the agricultural sector.
Source: Kangas et al. 1991

Figure 4.2 Nitrogen depositions (mg(N)/m^2/a) in Finland in 1990 as calculated from nitrogen oxide emissions.
a. Deposition due to domestic road traffic and other mobile sources
b. Deposition due to domestic emissions
c. Total depositions



Source: Kangas et al. 1991

Figure 4.3 Nitrogen depositions (mg(N)/m^2/a) in Finland as calculated from nitrogen oxide emissions from domestic road traffic and other mobile sources: data and projections for 1990 (a), 2000 (b) and 2010 (c)



Source: Kangas et al. 1991

Table 4.1 Acidifying emissions and depositions in Finland in 1988

Nitrogen oxides	Emission	Deposition in Finland
	1000 t (N) / a	
Finland		
– industry	10	
– energy production	20	
– traffic	50	
Total	**80**	**10**
Rest of Europe	6 700	50
Background		10
Total		**70**

Ammonia	Emission	Deposition in Finland
	1000 t (N) / a	
Finland	30	20
Rest of Europe	7 500	30
Background		10
Total		**60**

Sulphur	Emission	Deposition in Finland
	1000 t (S) / a	
Finland		
– industry	100	
– energy production	50	
– traffic	3	
Total	**n. 150**	**50**
Rest of Europe	20 000	110
Background[1]		40
Total		**200**

1) Background deposition from natural and human sources.

Source: Kangas et al. 1991

5. Scrap tyres and vehicles

Table 5.1 Generation of scrap tyres in 1984 – 1991

Year	Passenger cars, vans	Lorries, road tractors; buses, coaches	Other tyres
	tonnes		
84	12 300	8 800	4 600
1985	11 600	9 100	4 800
86	12 000	8 900	4 700
87	14 300	9 400	4 900
88	13 800	9 300	4 900
89	14 700	9 600	5 100
1990	15 100	9 900	5 200
91	15 000	9 100	4 800

Source: Ministry of the Environment.
The data for the years 1988–1991 have been updated on the basis of traffic volumes; the data on other scrapped tyres have been updated using a coefficient based on the variations in lorry traffic volumes and in bus and motor-coach traffic volumes.

Table 5.2 Scrap vehicles: generation and treatment in demolition centres in 1972–1991

Year	Generation [1]				Treatment in demolition centres [2]			
	Pass. cars	Vans	Number		Total		Pass. cars	Vans
	Number	Number	Number	t [3]	Number	t [3]	%	%
1972	36 269	3 936	40 205	24 123	12 800	7 680	36	32
1973	42 589	3 972	46 561	27 937	22 300	13 380	53	48
1974	54 056	3 938	57 994	34 796	29 400	17 640	55	51
1975	58 016	4 081	62 097	37 258	54 600	32 760	94	88
1976	56 107	3 995	60 102	36 061	40 600	24 360	73	68
1977	48 031	4 133	52 164	31 298	38 500	23 100	80	74
1978	41 309	4 183	45 492	27 295	38 600	23 160	94	85
1979	45 896	5 502	51 398	30 839	38 600	23 160	84	75
1980	47 330	6 309	53 639	32 183	39 000	23 400	83	73
1981	52 367	7 219	59 586	35 752	36 700	22 020	70	62
1982	55 898	7 117	63 015	37 809	31 800	19 080	57	51
1983	61 791	7 372	69 163	41 498	47 500	28 500	77	69
1984	64 118	7 439	71 557	42 934	50 800	30 480	80	71
1985	66 857	7 475	74 332	44 599	55 700	33 420	84	75
1986	70 267	7 166	77 433	46 460	70 300	42 180	100	91
1987	73 504	6 941	80 445	48 267	71 800	43 080	98	90
1988	77 242	6 920	84 162	50 497	..	..	..	..
1989	76 623	3 554	80 177	48 106	..	..	..	..
1990	109 610	5 589	115 199	69 119	..	..	..	..
1991	109 024	9 817	118 841	71 305	..	..	..	..

1991: excl. the Autonomous Territory of the Åland Islands
Source:
1) Ministry of the Environment 1989; updated by Statistics Finland in 1992.
2) Committee report, KM 1980:19.
3) Amounts calculated on the basis of car weight (600 kg).

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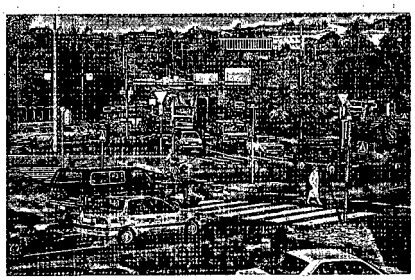

This report describes the connection between transport and the environment from the point of view of materials and energy use, various emissions and their effects, and efforts to reduce the harmful effects of transport. It is an abridged version of a book in Finnish and is based on statistics and research data.

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