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FACTS AND FIGURES ON EVIRONMENTAL EFFECTS OF FREIGHT TRANSPORT IN THE NETHERLANDS

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Abstract
Without discussing the need of a good freight transport system, it is obvious that freight transport threats the environment in many ways. The present study investigates these threats to the environment in the Netherlands as complete as pssible, in order to find solutions for a less polluting and less disturbing freight transport.
The aim of the study was to analyse what kinds of threats to the environment are caused by what transport modes, to what extend. A difference is made between types of air pollution and other aspects concerning the quality of life such as unsafety and noise. Other differences are made between transport by road, inland wayerway and rail, between different types of road transport vehicles and between the different commodity categories. Moreover the caused threats are related to the different kinds of origin-destination patterns in transport and to different kinds of areas in which transport takes place. Finally attention is given to ways of of the problems.

CONTENTS

INTRODUCTION

It is obvious that our transport system not only offers benefits like accessibility and mobility, but also causes a very serious problem with regard to a growing impact on the environment. Particulary the consequences of the emissions are alarming; the results of acid rain are already visible on the quality of the forests. Another aspect of the problem is the growing traffic nuisance.

The share of the freight transport in this threat to the environment is considerable. On the field of characteristic emissions of diesel engines it can be more than half of the total emissions caused by traffic.
It is also a fact that the increase of the freight traffic as a result of the the used logistic conceptions is bigger than the growth of the freight production. When tendencies continue in this way it can be expected that the emissions of the freight transport alone will exceed the Dutch limits on air pollution. In other words, when the present-day development does not change, some targets with regard to limit the emissions of the total traffic will be spend only by the freight traffic within one or two decades.

The lack of a sufficient capacity on the road network is another problem. An increase of the freight traffic means a continuing growth of traffic flows with added problems. Freight traffic troubles other traffic, but threats also the environment directly. For instance, the share of the freight transport in the noise by traffic is disproportinately high. Also from this point of view it is necessary to think about a new approach of the freight transport.

The problems above mentioned were the reason for a study concerning an analysis of all kinds of threats to the environment by freight transport, that is carried out by order of the Ministry of Housing, Physical Planning and Environment and the Ministry of Transport and Public Works. In this study the Duch inland and international freight transport is taken into consideration. With regard to air pollution a difference is made between the total air pollution by freight transport and air pollution within build-up areas and in inner towns. Also attention is paid to the other effects on the quality of life, mainly caused by road transport.
The latest complete data-set on the freight transport of CBS (Netherlands Central Bureau of Statistics) was from 1985. Because this CBS-data-set is the most important data source, 1985 is used as starting year. In cases where more recent data were aivalable, from a point of uniformity also 1985 is used.

Next point is the definition of the studied problem. After that a specification of the used approach will be given. Most attention will be given to the study-results, after which recommendations are given for ways out of the problems.

DELIMITATION OF THE PROBLEM

The threats to the environment by passenger and freight transport can be divided into two main categories:
- The impact on the environment by the existence of infrastructure;
- The impact on the environment by the use of this infrastructure.

These categories can be divided into several specific threats to the environment as indicated in figure 1.

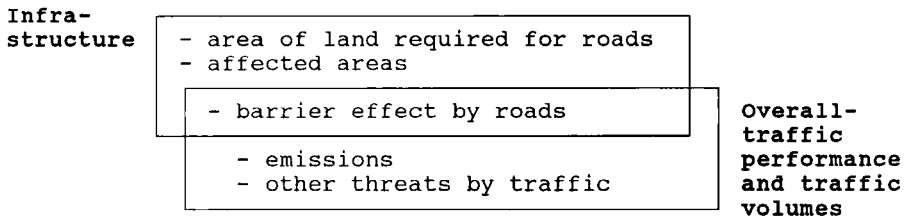

Figure 1: Subdivision threats to the environment

The aspects "area of land required for roads" and "affected areas" are directly related to the existance of infrastructure. In the case of the required area of land the surface that is really needed is of interest. In the case of affected areas it is of interest that distuiguished areas are used for traffic purposes. The traverse of a road through a country-side of great value can be an example.

The barrier or segregation effect of a road has two sides. On the one side there is the spacial threat to the environment. On the other side the vehicles-flow on the the road cause a functional threat; so it is as a result of higher traffic volumes more difficult to cross a road.

In the case of threats to the environment related to the infrastructure it is difficult to distinguish the impact of the passenger transport and the impact of the freight transport. Therefore this study is limited to that kind of threats by freight transport which can be set apart and which can be quantified. These are emissions and other threats, related to overall-traffic performance and traffic volumes.

With regard to the impact on the environment it is not only needed to make a difference between emissions and the other effects on the quality of life, but also between source and receiver and between time- and site bound or otherwise. The coherence between these aspects is given in figure 2.

Problems related to receivers	Other threats by vehicles - numbers of loading and unloading vehicles - traffic volumes on roads	Time- and site-bound impact on the environment
Problems related to sources	Emissions of vehicles - overall-traffic performance	Not time- and site-bound impact on the environment

Figure 2: Subdivision impact on the environment by freight transport

In this figure can be seen that the division into emissions and the other threats to the quality of life does not exactly coincide with the division into time- and site-bound effects and not time- and site-bound effects. The difference between these two divisions is caused by the locally produced emissions, which are considered as emissions, but also cause time- and site-bound effects.

On the field of air pollution attention is paid as well to the polluting emissions of
- carbon monoxide (CO),
- (volatile) hydrocarbons (HC),
- nitrogen oxides (NO_x),
- sulphur dioxide (SO_2),
- aerolsols (airborne particles),

as to the emissions of
- carbon dioxide (CO_2),

which is related close to the energy consumption.

On the field of the other effects on the quality of life a difference is made between:
- physical inconvenience,
- noise,
- bad smell,
- unsafety.

Otherwise, these kinds of threats to the environment are mainly caused by road transport.

As far as not time- and site-bound impact on the environment concerned we investigated the emissions which are spread on the whole country and for which the effects are lasting. As far as time- and site-bound impact on the environment concerned we investigated local concentrations of emissions and the other effects on the quality of life, which are characterized by a limited spread and which are of short duration.

FRAMEWORK OF THE STUDY

The chosen scope of the study is broad. In the following the main lines of the used approach are indicated. Here above all the successive steps to get results are important. The referred framework of the study is showed in figure 3.

An inventory of the transported goods in the Netherlands is made first, by which a difference is made between inland transport and international transport (inward cargo, outward cargo and transit cargo). Beside that a difference is made to the classification of goods, the shape and appearance of goods, transport distances and transport modes.
Moreover an inventory is made of the existing infrastructure for road transport, railway transport, inland waterweay transport and also the totally used vehicles/vessels for the different modes.

The overall traffic performance and the overall freight volumes are expressed in vehicle-kilometres for the different modes and in ton-kilometres for the different categories of goods (commodity flows).
In order to get hold on the impact on the environment by emissions, emission-factors are determined for all kind of vehicles and all sorts of emissions, expressed in gram per vehicle-kilometre.
Also the energy-factors are determined for all kinds of vehicles, that is to say the energy consumption per vehicle-kilometre with the connected emission carbon dioxide.
Based on the emission-factors on the one side and the overall traffic performance on the other side the overall-emissions for the different categories of vehicles/vessels are determined.

Untill now the determined emissions are related to the transport modes. A further subdivision of the emissions is made for the different categories of goods (NSTR commodity flows), transported by the different categories of road-vehicles.
A subdivision of the emissions is also made for different sorts of areas.

The relation between infrastructure and overall traffic performance, which gives traffic volumes in specific cases, is important for the effects on the other threats to the environment.
While these kinds of threats to the environment mainly are caused by road transport, in the study work only is done for road-vehicles.

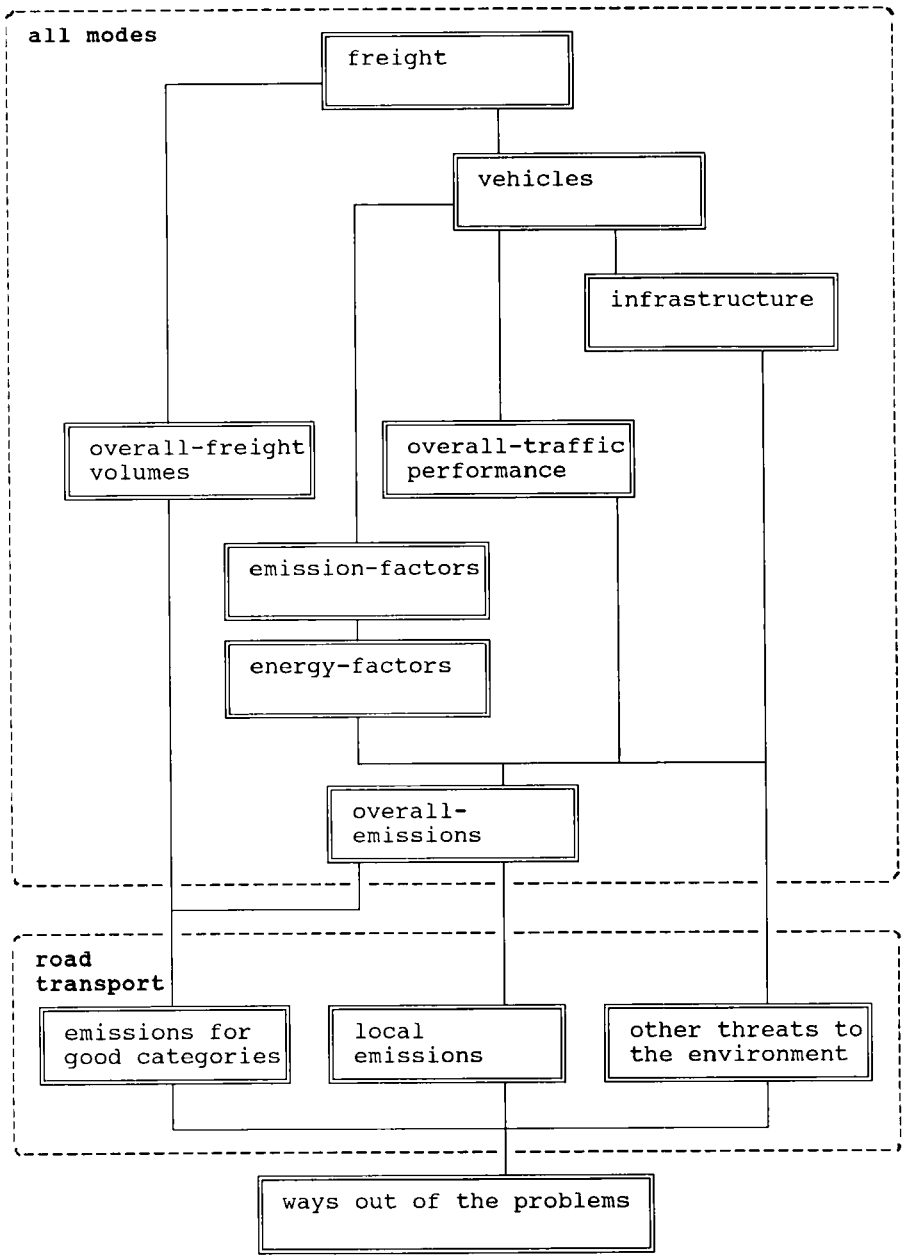

Figure 3: Framework of the study

RESULTS OF THE STUDY

As already mentioned at the delimitation of the problem, a difference is made between the emissions and the other threats to the environment by the freight transport. In both cases attention is given to the problems caused by the use of freight vehicles.
By emissions the different chemical components of air pollution and the directly to energy consumption related exhaust of carbondioxide are meaned. It is possible to calculate with nation-wide emissions in first instance, although there are in some areas and at some times more concentrated emissions.
As far as the other threats to the environment physical inconvenience, noise, bad smell and unsafety are distinguished. In contrast with emissions these threats are time- and site-bound. This fact in combination with the less availability of data obliged us to a more qualitative approach in some cases.

EMISSIONS

As far as the used modes for the freight transport concerned difference is made between road transport, rail transport and inland waterway transport. The shares of these modes in the inland and international transport are given in table 1. International transport consists of inward cargo, outward cargo and transit cargo.

Table 1: Transported freight in tons, 1985

	International 1,000 ton	Inland 1,000 ton
Road transport	90,885	343,560
Inland waterway transport	213,408	76,390
Rail transport	17,591	5,528

Source: CBS (revised)

The produced overall-traffic performance by the different transport modes is given in table 2. The overall-traffic performance by railway and inland waterway transport is disproportionately small, because of the use of big transport units. By these units big volumes are transported per trip.

Table 2: Overall-traffic performance (vehicle/vessel-km) by freight transport, 1985

	Internat. mln km	Inland mln km	Total mln km
Road transport	1,077	3,048	4,125
Inland waterway transport	40	21	61
Rail transport			12

For road transport the most essential difference can be made between:
- trucks and trailers, mostly provided with diesel engines,
- (delivery) vans, mostly provided with petrol engines.

This division is not complete, because on the one side passenger cars are also used for freight transport, and on the other side trucks are used for other purposes than freight transport.
In the first case an example is the use of passenger cars for the provision of shops. In the second case examples are the use of vans at maintenance services and the use of trucks as fire-engines, break-down lorries, a.s.o.
Finally foreign trucks are distinguished as a separate category of vehicles.

The figures in table 1 and 2 of the road transport concern only the (freight volumes and traffic performance of) the (inland and international) transport by trucks and trailers.

Considering the overall-traffic performance by all commercial vehicles (all vehicles used for other purposes than the transport of passengers), we see the following figure:

- trucks and trailers (intern. and inl. transp.	4,125 mln km
- foreign trucks and trailers	329 mln km
- vehicles for special purposes	410 mln km
- (delivery) vans	4,756 mln km
total	9,530 mln km

Because of the size of the used vehicles and vessels railway and inland waterway transport are characterized by low emissions per vehicle-kilometre. One thing and another lead to the overall-emission as given in table 3. The overall-emission by passenger cars is also given in table 3 as a comparison.

Table 3: Overall-emissions by freight transport, 1985

	Emissions in mln kg					
	CO_2	CO	HC	NO_x	Aer	SO_2
Road transport	7668	85.62	34.24	96.85	14.37	6.51
Inland waterw. tr.	1077	3,59	1,49	8,44	0,60	1,16
Railway transport	333	0,08	0,03	0,35	0,02	0,22
Passenger car		673,00	144,00	162,00	8,49	3,57

Source: CBS (revised)

Table 3 shows in a clear way that most of the emissions (84 to 96 %) by freight transport are caused by road transport. Therefore it is necessary to give special attention to road transport.
It also will be clear, that the emissions produced by the

freight transport have not to be neglected in comparison with the emissions produced by the passenger transport. The emissions of NO_x, aerosols and SO_2 are about half, respectively higher, than the passenger-car emissions. This is caused by the fact that the diesel-engine dominates in the freight transport by trucks and trailers.

As distinct from the tables 1 and 2 the emissions by road transport in table 3 concern all kinds of commmercial vehicles. Table 4 gives a division of the emissions by road transport into the different categories commercial vehicles,

Table 4: Emissions by commercial road-vehicles, 1985

	Emissions in mln kg					
	CO_2	CO	HC	NO_x	Aer	SO_2
Trucks in inland tr.	3886	16.67	12.61	54.79	7.21	3.63
Trucks in intern. tr.	1409	5.37	5.37	21.69	2.48	1.27
Foreign vehicles		1.11	0.98	5.23	0.54	0.10
Special vehicles	410	8.86	3.20	5.41	1.23	0.39
(Delivery) vans	1963	53.52	12.13	9.73	2.91	1.12

Source: CBS (revised)

The emissions by international freight transport by road and the emissions of foreign trucks together cause only a relative small part of the overall-emissions by commercial vehicles; maximum 28 % in the case of NO_x and minimum 8 % in the case of CO.

By far most of the emissions of commercial road vehicles are caused within the inland transport. With regard to the inland freight transport trucks and trailers have to be distinguished from (delivery) vans. Vans cause 63 % of the CO-emission and trucks 57 % of the NO_x-emission of the overall emission of freight transport by road, respectively typical emissions of petrol-engines and diesel-engines.
The share of the emissions of special vehicles indicates that vans are a substancial part of this category vehicles.

The freight volume in tons mentioned in table 1, transported by trucks and trailers, are to divide according to the by CBS used NSTR commodity categories. This division for international and inland transport is given in table 5. Also the share of the road transport for each commodity category is given in this table.

The share of road transport in the international transport is only very high in the case of commodity category 9. This category concerns many kinds of piece goods, among which a lot of consumer goods.
In case of other commodity categories, where the share of piece goods is relatively high, maximum half of these goods

are transported by road transport. In the case of typical goods loaded in bulk the share of road transport is very low. In the case of inland transport the share of road transport is high to very high for almost all commodity categories. Only for goods loaded in bulk this share is about a half.

Table 5: Transported volumes by road per commodity category

Commodity category	International 1,000 t	share of road tr. in %	Inland 1,000 t	share of road tr. in %
0. agricultural produce	11,931	51	36,481	92
1. other food products	17,838	51	78,174	88
2. solid mineral fuels	1,718	12	834	52
3. mineral oil and minreal oil pruducts	1,475	4	16,540	52
4. ores, scrap-iron, pyrites	1,451	2	2,061	77
5. iron, steel, non-ferro metals incl. semi-man. articles	6,830	44	6,416	91
6. raw minerals and manu-factures, building mat.	16,207	28	119,514	74
7. fertilizers	1,297	15	5,655	68
8. chemical products	16,268	51	24,133	90
9. vehicles, engines and remaining goods	15,871	87	53,772	95

Source: CBS (revised)

Besides of the fact that the volume of freight by inland road transport is more than three times the volume by international road transport, there also is the fact that the inland transported goods for three fourths consists of the following three commodity categories:
- tons commodity category 1 23 %,
- tons commodity category 6 35 %,
- tons commodity category 9 16 %.

Looking at the overall-traffic volume, related to the different kinds of goods, the role of commodity category 6 is only very small. Only 6 % of the truck-kilometres are related to this category. For this an explanation can be the fact that also sand belongs to this category, which mostly is transported at short distances.

It is obvious that the commodity categories 1 and 9 cause a disproportionate part of the overall-traffic performance. Besides that also trips of empty vehicles causes a substancial part of the overall-traffic performance.
The overall truck kilometres in the inland transport concerns more than three quarters of the commodity categories 1 and 9 and empty trips together:

- overall traffic volume empty trips 28 %,
- overall traffic performance commodity category 1 19 %,
- overall traffic performance commodity category 9 30 %.

The strongly disproportionate overall traffic performance by commodity category 9 (related to the transported volume in tons) could be explained by the very low loading-rate; 4.9 tons in this case and a overall weight mean of 9.4 tons.

If we regard the relation between the different goods transported by truck and the emissions, it can be seen that empty trips, commodity category 1 and commodity category 9 give (about) the same shares in the emissions as the mentioned shares in the overall traffic performance.

When looking at (delivery) vans, there are neither data about empty trips, nor about volumes and kinds of transported goods. However it can be expected, that the freight transport by vans will be the same as commodity category 9.

Although the emissions by truck are computed for the whole country in the first instance, it is appropriate to distinguish emissions within build-up areas and rural areas, as given in table 6. An important matter of fact is that (delivery) vans produce the biggest part of their emissions within build-up areas. For trucks this is only half of the emissions.

Table 6: Emissions by commercial vehicles distinguished to kinds of areas

	Emissions in %				
	CO	HC	NO_x	Aer	SO_2
In rural areas					
i.e. on highways	22	40	77	48	67
In build-up areas	78	60	23	52	33

Source: CBS (revised)

City centers are within the build-up areas the areas where a lot of freight transport has a destination on the one side, and where the threats by freight traffic are the worst because of the high concentrations of activities. Table 7 gives the share of the emissions within city centres drawn from the overall emissions within build-up areas.

Table 7: Local emissions of commercial vehicles

	Emissions in %				
	CO	HC	NO_x	Aer	SO_2
In city centres	39	36	26	35	25
In other urban areas	61	64	74	65	75

Source: CBS (revised)

OTHER THREATS TO THE ENVIRONMENT BY FREIGHT TRAFFIC

Besides emissions attention is given to the other threats to the environment by freight traffic. In doing so a distinction is made between physical inconvenience, noise, bad smell and unsafety.
To make it possible to compute the results of this kinds of threats, it is needed to start at the side of the receivers, not at the side of the source like in the case of the emissions. Traffic-consumers, in particular pedestrians and neighbours can be seen as receivers.

The density of the road network, compared to the railway and inland waterway network, causes that the other threats to the environment are to be related to the road traffic. Finally not only traffic by road vehicles, but also parked vehicles, contribute to some kinds of threats.

Physical inconvience means the fact that freight vehicles block the passage or hinder the view of other road users and/or neighbours. The problem is of particulair interest in the case of the threat by loading and unloading vehicles to pedestrians in shopping streets. Table 8 gives the ratios of this threats, caused by vans and trucks in different kinds of shopping streets.

Table 8: Physical inconvience by vans and trucks in different kinds of shopping streets

	Ratios Delivery vans	Trucks
Neighbourhood shoppingstreet	1	1
District shopping street	1 - 4	1 - 5
City centre shopping street cat. 3	3 - 9	3 - 10
City centre shopping street cat. 2	7 - 19	7 - 20
City centre shopping street cat. 1	> 16	> 16

The results show in a clear way that problems do not only exist in the main shopping streets, but also in shopping streets of lower interest. It can also be seen that the problems are more serious if it is a shopping street in a more urbanized area.
The shares given in table 8 for vans and trucks can be seen independent to each other, however the vans cause an overall threat equal to the threat of trucks.

The noise caused by the freight road vehicles is above all important for neighbours. In contradiction to pedestrians it is for neighbours not possible to run away from the noise. About 900,000 inhabitants are threatened by noise of freight vehicles. This is a quarter of the 3.7 million inhabitants, that are threatened by noise of road traffic (by passenger and freight traffic together).

A further impression of the noise caused by freight vehicles can be obtained by a subdivision into different noise-categories. It is also possible make a distribution between vans and trucks on the one side, and between streets with a stronger residential function and streets with a stronger traffic function on the other side. The results of these divisions are given in tables 9 and 10.

Table 9: Number of inhabitants threatened by noise of vans and trucks

	Threatened inhabitants in % Noise category db (A)				
	50-55	56-60	61-65	66-70	total
Vans	9	31	20	9	69
Trucks	2	12	10	7	31

Source: Min. VROM

Table 10: Number of inhabitants threatened by noise of different kinds of streets

	Threatened inhabitants in % Noise category db (A)				
	50-55	56-60	61-65	66-70	total
Streets with a stronger traffic function	1	12	14	15	42
Streets with a stronger residential function	11	31	15	1	58

Source: Min. VROM

Table 9 shows us that the inhabitants are threatened twice as much by noise of vans than by noise of trucks, whereas in the lowest noise category this ratio is four.
Table 10 let us see that one and a half the number of inhabitants, which are threatened by noise of freight traffic, are living in streets with a residential function than in streets with a strong traffic function.

Bad smell is characterized by the smell concentrations of distinct materials for pedestrians and neighbours. Not only high traffic volumes are playing a role, but also characteristics of the build-up area and weather conditions.

From the emissions of road vehicles bad smell is caused by the aldehieds out of hydrocarbons and aerosols. In case of the last soot is most important. Tables 11 and 12 show see where the emissions of hydrocarbons and aerosols of different kinds of vehicles will be found.

Table 11: Hydrocarbons emissions by commercial vehicles in different kinds of areas

	Emission in %		
	Rural areas	Build-up areas inner cities	other areas
Vans	6	12	18
Trucks, foreign trucks incl.	33	7	15
Special vehicles	1	3	5

Source: CBS (revised)

Table 12: Aerosol emission by commercial vehicles in different areas

	Emission in %		
	Rural areas	Build-up areas city centres	other areas
Vans	3	8	10
Trucks, foreign trucks incl.	44	8	19
Special vehicles	2	2	4

Source: CBS (revised)

From the overall emission of hydrocarbons more than one third is caused by (delivery) vans. Within build-up areas and particulary within inner cities this share is half to more than half.
From the overall emission of aerosols one fifth is caused by (delivery) vans. Within build-up areas this share is one third and within inner cities about half.

The unsafety caused by commercial vehicles is a problem for the (other) road users. Hereby is supposed that unsafety can be expressed in the real number of accidents. Looking at the risk of all kinds of vehicles for the other road users as well as for passenger, then the following is obvious:
- Trucks and vans cause (except busses) most deaths among other road users per vehicle kilometre, at least five times more than passenger cars;
- For truck and van drivers (except busdrivers) this risk is the smallest, only about half of that of passengers of passenger cars.

Looking at accidents with hospital injuries the number of accidents in relation with vans is about the same as the number of accidents in relation with trucks. On the other hand trucks cause as twice mortal accidents as vans. Table 13 gives a more detailed information about the ratio between accidents with injuries and mortal accidents per kind of vehicle.

Table 13: Accidents related to different kind of vehicles per vehicle kilometre, 1984 - 1986

	Ratio Mortal accidents	Mortal and hospital injuries accidents
Passenger cars	1.0	10.0
Vans	0.9	8.8
Trucks	2.6	11.8
Trailers	1.9	7.0

Source: SWOV

From accident figures (from 1981, 1982 and 1983) appears that in the case of mortal accidents and accidents with hospital injuries 56 % of the victims are pedestrians and cyclists.

In contrast to emissions the other threats to the environment are directly founded problems. The negative effects of these threats to the environment are significant within build-up areas, the more if there are mostly pedestrians and neighbours. Further it is clear that bigger vehicles cause disproportionately more serious threats than smaller vehicles.

Briefly and summerized to the point the analysis led to the following results.

1 With regard to the different transport modes:
By far most of the air pollution, in relation with the freight transport, is caused by the road transport.

2 With regard to the difference between inland and international transport:
Within the road transport by far most of the air pollution is caused by the inland transport.

3 With regard to the transported goods (or otherwise):
From the emissions by trucks three fourths are in connection with the transport of food products, other goods (for a considerable portion consumer goods) and empty trips.

4 With regard to different areas:
The share of the generated emissions in urban areas varies from one fourth to three fourths of the total emissions. About one third of these emissions is generated in inner towns.

5 With regard to the difference between delivery vans and trucks:
The share of the delivery vans in the threats to the environment is considerable:

- From emissions of petrol-engines this can be more than half of the total freight transport emissions'
- A disproportionate share of these emissions is generated in urban areas and a comparative bigger proportion in inner towns;
- The physical inconvenience caused by delivery vans is not less than that by trucks;
- The same applies to the bad smell;
- Twice as much inhabitants are threated by noise of vans as by noise of trucks.

By trucks twice as much mortal accidents are caused as by vans.

Compared with the threat to the environment by passenger traffic the threat to the environment of freight traffic is not to be neglected, but requires on the contrary special attention.

WAYS OUT OF THE PROBLEMS

To set bounds to the threat to the environment by freight transport, it is necessary to make a distinction between the overall traffic performance and the traffic volumes, in particular in sensitive areas.

To reduce emissions by freight transport the overall traffic performance has to be reduced. This is possible in different ways. The most obvious possibilities are:
- To stimulate the development and use of less polluting road vehicles;
- Improvement of the ratio full load and empty kms;
- To use bigger road vehicles outside urban areas.

Which of these solutions will be preferred in certain cases is not only to decide by the realisable reduction of emissions per tonkm, but also by the area where the freight traffic pass through. This because also the threats such as noise and unsafety are important.

Naturally the use of less polluting (road) vehicles is a good sake. However, this can not be the final solution. For this, their are several reasons. First the possibilities to get cleaner engines are limited. Particularly this counts for diesel engines. Besides that, freight traffic is increasing as a result of the increase of goods production and as a result of a shift from rail to road transport. At last there is a growing tendency to cut down the acceptable limits of the different overall emissions.

An improvement of the ratio full load and empty kms can give a contribution to reduce emissions, but also results of this possiblity will be limited. Indeed a quarter of the inland overall traffic performance by trucks is related to trips of

empty vehicles. However, it is not realistic to expect that it will be possible to reduce trips of empty vehicles completely.

The use of bigger (road) vehicles is also mentioned as a possibility to reduce emissions. Table 14 shows us see that there is a remarkable difference between the emissions of trucks on the one side and the emissions of trucks and trailers and truck-tractors and semi-trailers on the other side.

Table 14: Emissions per tonkm by trucks, 1985

	Emissions in gr per tonkm					
	CO_2	CO	HC	NO_x	Aer	SO_2
Trucks	451	2.24	1.57	5.65	0.90	0.43
Trucks and trailers	109	0.54	0.38	1.37	0.22	0.10
Truck-tractors and semi-trailers	127	0.34	0.34	2.30	0.19	0.11

Source: CBS (revised)

The figures in table 14 concern the inland freight transport by truck. Figures concerning commodity categories 1 and 9 (not given here) show the same picture: three times to four times less emissions per tonkm in the case of trucks and trailers and truck-tractors and semi-trailers.
Naturally these figures are influenced by the fact that on longer distances outside build-up areas trucks and trailers and truck-tractors and semi-trailers are used more than single trucks. Yet it can be asserted that the use of road vehicles as big as possible really can reduce emissions.

Far more better for a decrease of the emissions than the use of bigger road vehicles is the use of railway or inland waterway transport. In table 15 the emissions per tonkm of the different modes are given.

Table 15: Emissions per tonkm of different modes, 1985

	Emissions in gr per tonkm					
	CO_2	CO	HC	NO_x	Aer	SO_2
Road transport	211	0.90	0.68	2.97	0.39	0.20
Inland waterway	33	0.11	0.05	0.26	0.02	0.04
Railway	102	0.02	0.01	1.01	0.01	0.07

Source: CBS (revised)

The figures of road transport concern all kinds of trucks; are to be considered as a weighted average of the figures in table 14. The figures of inland waterway and railway transport are based on inland and international transport together.
The above mentioned shows strongly to search for possibilities to increase the use of inland waterway and railway transport within international and inland transport.

For a long time railways had a strong position in the transport of bulk cargo by the so-called trainload transport, but the transport of this kind of freight is diminishing (in the western world). Only the combined rail-road transport of containers, swapbodies and trailers on international long distance trips is increasing. This increase is concerned with the transport on a few number of important international links.

However, the real problem is the much higher emissions of the inland road transport. As an alternative for the more disperced inland transport pattern only the wagonload railway transport system exist. For this type of railway transport many shunting operations are needed. By that, railway transport by the wagonload system is expensive, slow and causes much damage. Competing with the road transport is therefore very difficult.

Yet a better railway system conception for inland freight transport is needed from a point of view of protection of the environment. For the development of such a system a new approach is necessary; that is to say a system without the need of shunting operations.Further characteristics of the system have to be regularly scheduled freight trains of a fixed composition, which serve a sufficient number of transhipment terminals.
It will be clear that such a railway transport system only can exist by using containers, swapbodies and trailers. As a matter of fact shunting of railway wagons is replaced by the transhipment of containers, a.s.o. between trucks and wagons and eventually between two wagons.

In the case of the aimed enlargement of the share of the railways in the inland freight transport the road transport industry has not to be seen as a competitor of the railway company, but as a customer. This has to be seen in relation with the development of the integration of the activities of transporters and shippers. Freight transport is getting more and more custom-made, where quality is more important than price. Therefore the road transporter has to conform to the logistical processes of the shipper. This can not be a job for the large scale railways. The railways has to offer transport services to the road transporters. So it is possible for the road transporter in any particular case to make a choise between using road transport for the whole journey or to use combined road-rail transport.

Further research is needed to develop a nationwide network for freight transport by rail and the determination of new tran shipment terminals. Naturally use of railway transport is only possible on relatively long distances also within inland transport. An earlier study proved that combined road-rail transport will be possible from distances of 150 km, if shunting operations are abondoned.
In table 16 shows that the volume of freight transport on

distances over 150 km is relatively small, but more than half of the tonkms.

Table 16: Distance distribution of freight traffic

	Share in %	
	Tons	Tonkms
0 - 150 km	81	45
> 150 km	19	55

Source: CBS (revised)

Maybe rail services are needed on different relations where rail links do not exist. In such cases it is thinkable to introduce truck services as an interim solution. The use of as big road vehicles on these links wil be preferred. Perhaps it is possible to make arrangements for the use of trucks with too trailers.

Besides rail transport the inland waterway transport is favourable from a point of view of the environment. But the inland waterway transport is yet in a stronger way related to the transport of bulk cargo. The best possibilities of the inland waterway transport concern the transport of containers. Nevertheless research has to be done to a possibility of using inland waterways in a network for combined transport. Inland waterway transport is slow, but unlike the railway system inland waterways has no capacity problems. However, a problem can be the fact that there are a lot of inland waterway transporters whereas there is only one railway transport company.

In the foregoing attention is given to the need of the enlargement of scale in the interlocal transport in order to set bounds to the emissions. In this case it is important to reduce the vehicle kms by the use of as big vehicles as possible. However for the reduction of the other threats to the environment it is necessary to reduce traffic volumes in build-up areas and particulary in inner towns.

The present day optimalization within each firm has as a result that many trucks has to deliver goods on a lot of adresses. In this way a disproportionate number of vehicle trips are generated for the provision of shopping centres. It must possible by an optimalization on a higher scale to get to such physical distribution processes, that perhaps the overall traffic performance will not change but indeed traffic volumes will decrease in sensitive (vulnerable) areas. The contemplated reduction of the number of trucks in above all inner towns can be realized by using the principle that a fully loaded vehicle will not deliver this load in many (inner) towns, but that a vehicle will be loaded by more shippers and will unload the total load only in one inner town.

An other possiblity is the building of consolidation terminals at the fringe of a town. So it will be possible to provide a town from one distinct terminal. In this case the accent lies on the logistic chain integral good flows control.
This transport chain can be combined with the mentioned inland railway transport system. The transhipment terminals corporated in this system can be combined with depots. Within this scope also the development of typical city-bound mini containers is thinkable.

Limiting the number of trucks particulary in inner towns can not be the final solution to reduce the (other) threats to the environment in a sufficient way. Also attention has to be given to the extensive use of vans. Although it is better possible to reduce emissions of the petrol engines of vans than the emissions of the diesel engines of trucks, this will not be a sufficient solution of all the problems caused by vans. Therefore it will be appropriate to research the use of electric traction for vans.

Two options are to distinguish for the electric traction of cars. In the first case we can think about cars only for short distances, thus driving only relatively few kms a day, so that batteries can be charged at night. In the second case easy interchangable packets of batteries are used. For this service stations will be needed all along roads. Herewith the problem of the limited range of action of electric cars will be solved. As yet the first mentioned type of electric cars has the best opportunity to be used on a larger scale, because special service facilities for battery loading are not necessary.

A study to the use of electric vans for the provision of inner town shopping centres will be prefered. It is thinkable that pedestrian areas only may be entered by electric vans, together with realizing freight transfer facilities at the fringe of a pedestrian area. Such a transfer facility can be combined with a warehouse, that has to be exploited by the shopholders.

Also research has to be done to solve the problems of the inner city freight transport by physical infrastructure. A matter of fact is the limited space within inner towns, a space that is used for many purposes. It is only possible to realize added space by building a second level, that is to say by constructing tunnels (mostly elevated roads are not acceptable from a point of view of towenscape).
It may be wondered why in most cases tunnels are being built for passenger transport. A better solution should be to bring the freight transport in city centres underground. Perhaps it will be possible to build underground freight tunnels for smaller piece goods similar to the pneumatic post system. In this case tunnels are needed with a smaller diameter than for passerger transport tunnels.
Naturally building of such an underground system will not be simple. As an example the access points to the system can br mentioned. Nevertheless a pilot study will be appropriate.

FREIGHT TRANSPORT POLICY

The different mentioned ways out of the problems require an increasing interference of the the government with regard to the freight transport. At present the role of the government is twofold. On the one hand the government is building infrastructure such as roads, ports, etc., whether special for the freight transport or not. On the other hand the government imposes restrictions to the freight transport, set bounds to the dimensions of trucks, close streets to trucks at distinct times, etc. Mostly this kind of measures are issued by local authorities. An extra problem is the lack of coordination between the different local authorities by preparing these measures.

The seriousness of the from this study appearing problems ask for a more structural approach on a strategic level. In the future the government has to fulfil a more initiating and stimulating role to get to a more environment friendly freight transport. Naturally the government has to create conditions to make things possible, but also a task of the government has to be to bring the different actors in the transportation scene together not only to get to freight transport chains from a point of view of economics but also from a point of view of environment.

Also the best division among the different authorities of the work to be done and the responsibilities have to be studied. At present only the central government and the local authorities mind the freight transport. However, it is necessary to study what could be the task of the provinces and the to develop transport regions on the field of freight transport.

Physical planning is a task exclusively of the public authorities. The broad use of road transport has resulted in a sprawl all over the country of industrial zones without any connection with railways or inland waterways. Particularly many local authorities has developed industrial zones which are not always situated at the best places.
A better prognosis of the traffic volumes as a result of the planning of industrial zones and the kind of industry there is needed. The contribution to the threat to the environment has to be a criterion for the decision to realize an industrial zone or not.
This has not to be the picture for a decision to a complete industrial zone, but also to make decisions about separate undertakings. Just as it has not to be tolerated to realize an industrial zone that can only be reached by passing through a residential quarter, it has not to be tolerated to build a big supermarket which attract a lot of freight vehicles in the middle of a historic inner city.

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