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Transport, Environment and Health in Central and Eastern Europe

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COWI Consulting Engineers and Planners AS
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It should be noted that findings and conclusions expressed in this report are those of the consultants and should not necessarily be attributed to the Danish Ministry of Environment and Energy.

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Foreword

The current level of transport in the Central and Eastern European region is not yet on a scale which is comparable to the EU. Nevertheless, CEE countries face serious and growing problems of traffic congestion, fatal accidents, noise and heavy air pollution, especially in urban areas. This is a result, among other things, of inadequate safety regulations, poor fuel qualities and a high share of old, polluting vehicles. Furthermore, the economic growth already seen in some countries of the region and expected for the whole region in the near future will induce massive and steady growth in transport volumes (especially road traffic) which in turn is expected to intensify the pressure on peoples health and the environment.

This report is intended to assist countries in Central and Eastern Europe in their efforts to control the negative health and environmental effects from transport and to facilitate and promote a pro-active approach in addressing these problems. It provides an overview of the current state of affairs with regard to traffic volumes, transport infrastructure, modal split, age and composition of the vehicle fleet, accidents, air pollution and noise, and it describes the likely future trends, challenges and options for policy response.

Important policy initiatives have recently been taken by most CEE countries to counteract some of the negative effects from transport. Examples include strategies to phase out the use of leaded petrol, requirements for catalysts on new cars and efforts to comply with relevant EU directives. However, implementation of these initiatives requires enhanced co-ordination among different stakeholders as well as increased institutional, regulatory and economic capacity. As an example, data concerning actual road traffic volumes are scarce, implying that it is difficult, if not impossible, to monitor and evaluate the development and impact of regulation.

The report has been prepared over a period of only three months and it has been undertaken primarily as a desk study supplemented by two case studies from the Czech Republic and Bulgaria. Considerable difficulties have been encountered in gathering reliable data in this short period of time. Readily available data are often not up to date and the case studies have revealed that international statistics in many cases lag behind national data. Furthermore, differences in estimation methods make comparisons between countries difficult.

I believe, however, that the report does a good job in capturing the direction of the recent development and the likely future trends in the CEE transport sector and implications hereof. At the start, the intention was to include both CEE and CIS countries in the survey but we soon realised that this was not possible due to the lack of time and data. Nevertheless, it is my hope that the report will serve as a useful tool for planners and policy makers working in this field, and that it will be of interest not only in the CEE region but also in countries of the former Soviet Union and in the international community in general. I regard the report as a working document which can be up-dated and extended as new information becomes available but also a document which at this point provides a useful contribution to the on-going process of integrating environmental and health aspects in transport policies by highlighting the special challenges that face CEE countries.

As to the details of the report, I refer to the Executive Summary. I would like to emphasise that I find the results interesting and worth studying in detail. Transport systems and infrastructure are major investment items, and to achieve the best long term result one has to take into account the external costs of transport, i.e. the negative as well as the positive health and environmental effects, when calculating the economic rate of return. Often the positive effects of promoting health and environmentally friendly modes of transport like walking, cycling and electric cars and trains are overlooked in investment decisions.

It is pointed out in the report that most CEE countries have had good public transport and rail systems with large market shares until recently, where these modes of transport have lost market share to private passenger cars and lorries. One of the big challenges to the CEE countries, as in many European countries, is to reverse this trend. But this can only be done if due attention is given to this issue and resources are allocated to upgrading public transport and rail systems, in order to achieve environmentally sound and efficient public transport and rail systems. In this respect, the CEE countries have possibilities and advantages compared to Western Europe where tram and light rail systems are now being rebuilt and re-established in many cities. It would be a shame if these opportunities are not taken advantage of.

Leo Bjørnskov
Deputy Permanent Undersecretary

Executive Summary

Increasing transport problems in CEE

The process of transition from centrally planned to market economies in Central and Eastern Europe has involved rapid economic changes and new structural requirements. In order to support and accelerate this process it is essential that these countries provide the necessary transport infrastructure to facilitate the effective movement of passengers and goods. At the same time they must wrestle with modality shifts in transport demand brought on by the economic recovery and liberalisation in markets for private vehicles that will exacerbate transport's negative impacts on health and environment and engender a new set of policy challenges.

The emerging transport problems for CEE countries relate to rapid growth in the number of private vehicles, many of them purchased second hand in the West and lacking effective emission controls, anticipated growth in the volume of transport and fuel consumption, deficiencies in road infrastructure that contribute to accidents and congestion, and declining demand for public transportation services that threatens to erode the revenue base necessary to sustain and improve these services in the future. Some key transport trends in the CEE countries are as follows:

Vehicle fleet

During the first half of the 1990s, the number of vehicles increased by 10% in most EU countries while the increase in the CEE countries was on the order of 30-80%. Nevertheless, the number of vehicles per 1,000 inhabitants in EU countries ranges between 400-500 while typical vehicle numbers for the CEE countries are 200-300.

Passenger cars are considerably older in most CEE countries than in Western Europe. The average age of the vehicle fleet in CEE is 10-15 years, compared to 6-10 years in Western Europe. The age of the vehicle fleet has important implications for health and the environment since the technical standards with regard to safety, emissions and noise are generally lower for older cars.

Increases in car transport

In many countries, the sharp increase in car ownership has not been matched by an increase in vehicle use of the same magnitude. This is due to periods of economic recession and high vehicle operational costs. But growth in the volume of car transport is expected with economic recovery. For example, in the Czech Republic, the volume of private transport is expected to increase by 70% by 2015.

Decline in public transport

Public transport volumes have dropped since the beginning of the transition period. There are variations between CEE countries, but in general, passenger transport by rail, busses and coaches, which had increased steadily in the years before transition, has declined 40-50% in the period 1990-96. Subsidies for public transport have decreased and public transport systems have deteriorated.

The main challenges

As a result of these trends, the CEE region faces serious and growing problems of traffic congestion, accidents, air pollution and noise; especially in urban areas. Although the timing and severity of these emerging problems vary across the region, all of these countries must address a similar set of issues: Old technical equipment (cars, public transport vehicles and infrastructure), poor fuel quality and a lack of the necessary institutional and economic capacity to solve the problems.

Accidents

Road transport is a significant cause of accidents resulting in injury or death. Because of lower traffic volumes in CEE compared to the EU, the total number of injuries caused by traffic accidents is lower. However, the average fatality rate caused by road accidents - which according to WHO are more reliable than data on morbidity - has been higher during the first half of the 1990s in CEE compared to the EU. The fatality rates in CEE and the EU have been converging, but the rates remain alarmingly high in the CEE countries compared to the level of traffic. Within the CEE region there are significant differences in the number of accidents, injuries and deaths since the beginning of the transition process. In Hungary, the trend in fatalities and injuries has been declining during the first half of the 1990s, while the opposite trend is observed in the Czech Republic. Fatalities in the three Baltic countries have declined. Still, the Baltic countries have had the highest mortality rates in the region due to road traffic accidents. In most other CEE countries, fatalities have fluctuated from year to year.

The case studies in the Czech Republic and Bulgaria provide data for more recent years. The number of accidents in the Czech Republic causing death, serious injury and slight injury increased from 1990 to 1998 by 6%, 34% and 23%, respectively. This increase mainly occurred during the first half of the 1990s, whereas decreases in accidents in the Czech Republic in general and especially in Prague were seen in the period from around 1995 to 1998. In Bulgaria, the total number of fatalities caused by road traffic was reduced by 40% from 1990 to 1997, whereas the number of injuries increased from 1990 to 1997.

There is reason to fear that the expected increase in road traffic volumes and continued widespread use of old, unsafe cars, will lead to increases in the already high fatality rates in the CEE countries, if no further steps are taken. An important measure is obligatory use of seat belts.

Air pollution

The transport sector is a major source of air pollution and has serious impact on human health, acidification and climate change. Important emissions from traffic are particles, NO_x, HC, CO, VOCs, lead and CO_2. Photochemical oxidation of some of these emissions further lead to secondary pollution such as ozone. In CEE, the transport sector accounts for 25%-35% of total air emissions of NO_x, NMVOC and CO, compared to EU transport sector shares for the same pollutants of 35%-70%. The higher share of traffic emissions in the EU is due to a combination of higher traffic volumes and greater progress in controlling air emissions in the energy and industry sectors.

Air pollution levels in CEE are higher than in Western Europe, in spite of much lower levels of traffic. For example, mean values for NO_2 show that although WHO air quality guidelines are exceeded in most European cities, NO_2 concentrations are 20% higher in the CEE cities, measured in average mean annual values. Furthermore, ambient air lead concentrations are alarmingly high in several CEE cities, where leaded petrol still dominates the petrol market.

Emissions of NO_2, the most common form of NO_x, cause respiratory irritation such as breathing difficulties and coughing, and cause serious problems for people with asthma and bronchitis. Emissions of NO_x contribute to acidification, a leading cause of forest damage, declining fish stocks and changes in soil chemistry. Acidification has severely damaged more than one third of the forest cover in CEE.

Furthermore, NO_2 is one of the most important precursors of *ozone*. Even low levels of ozone cause changes in lung function and higher levels have

serious effects on health. Experiments have shown that human beings exposed to levels of 200 $\mu g/m^3$ over a 6-hour period - a level, which regularly occurs in Europe during the summer months - experience inflammation of airways, coughing and pain during deep breathing.

The effects of *particles* on human health depend on the size of the particles, with smaller or finer particles more risky because they penetrate further into the lungs. A common indicator for particles is the total suspended particles or TSP, which includes particles of all sizes. Monitoring results indicate that only a few cities in Europe exceed the TSP level of 120 $\mu g/m^3$ (annual mean). However, since fine particles have little weight compared to coarse particles, TSP levels are an imperfect measure of the health risks from particles. Air quality limit values for finer fractions of particles (PM_{10}) are on the way for EU member countries, as part of the framework directive on Ambient Air Quality and related daughter directives. The directive will also require monitoring of $PM_{2.5}$. According to WHO, it is not possible to define a clear threshold level below which health effects from particles are no longer observed.

Exposure to *lead* is another very important health problem in CEE. Lead emissions have serious adverse effects on human health. Studies have found a statistically significant connection between the exposure of people to lead and reductions in their intellectual performance measured by IQ. Thus, a 10 microgram per deciliter increase in the blood lead level has been found to cause an approximately 2.5 point decrease in the IQ of exposed children. Additionally, the exposure of adults to atmospheric lead has been connected to elevated blood pressure causing hypertension, heart attacks, and premature deaths. No lower threshold of exposure exists under which the adverse effects of lead on children and adults cannot be detected.

Although the CEE countries are all in the process of phasing out lead, the market shares of unleaded petrol varies from a low percentage of only 5-6% in Romania and Bulgaria up to 98% in Lithuania and 100% in Slovakia. Slovakia's phase-out was accomplished in only three years during which time unleaded petrol share increased from 6% to 100%. Slovakia managed to phase out lead even though a substantial share of the vehicle fleet consists of cars whose performance required lead as a valve lubricant. The problem was solved by substituting alternative additives for lead at the refinery.

Emissions of CO_2 contribute to the problem of global warming. Currently, average emissions of CO_2 per capita in CEE are only one third of emissions per capita in the EU. However, CO_2 has become an increasing problem in the transport sector in the EU due to increased fuel demand that has negated improvements in fuel efficiency. Correspondingly, economic growth in CEE can be expected to lead to increases in transport activities and CO_2 emissions in CEE.

General emission trends in the region are difficult to assess because of data problems. However, the case studies in the Czech Republic and Bulgaria provide some insights into the emission trends.

In the Czech Republic, total air emissions from stationary and mobile sources have declined markedly. Since 1992 *total* emissions of particles have been reduced by a factor 4, emissions of SO_2 have been more than halved, and the total emissions of NO_x, CO, and HC have dropped 40%, 16%, and 12%, respectively.

Transport sector emissions, on the other hand, have increased sharply in the Czech Republic, both in absolute and relative terms. Emissions of particles have increased by 26% from 1994 to 1997, and from 1992 to 1997 emissions of NO_x, CO and HC have increased by 12%, 66% and 33% respectively. This development has resulted in increases in the transport sector's share of total emissions from 2% to 8% for particles, from 30% to 56% for NO_x, from 20% to 40% for CO and from 35% to 53% for HC.

Thus, transport sector emissions have indeed increased relative to stationary source emissions. Although air quality has generally improved in the Czech Republic, transport generated air pollution represents an emerging problem that is masked by the general trend in air quality.

Although catalytic converter requirements on new cars have been in force since 1993 in the Czech Republic, only 20% of cars were equipped with catalytic converters in 1997. There has been an improvement in this share since 1992, when the share was estimated at 6%. The future trend in transport-related air pollution will depend strongly on the retirement of old high emission vehicles and replacement with cars with catalytic converters.

In Bulgaria, total air emissions have dropped by 30-45% since 1990. Although this decline can be attributed partly to policies on reducing air pollution, a major factor is the economic recession experienced in the country in the 1990s. Transport sector emissions account for significant shares of total air pollution, which however are somewhat lower than in the Czech Republic. Emissions from the transport sector of NO_x, CO and VOC accounted for 37%, 40% and 15% of the total air emissions in 1997. In Bulgaria no figures are available on the share of cars with catalytic converters, but the estimated share is approximately 10%.

Noise

Traffic noise is perceived as a nuisance and causes a wide range of health effects in human beings. Traffic noise affects concentration, increases stress and results in high blood pressure, which can lead to more serious illness or death from health problems such as coronary hearth disease and hypertension. Sleep disturbance has a potential impact on human health after long term exposure. Children exposed to loud noise for longer periods of time experience increased learning disabilities.

WHO has set an outdoor limit value for human exposure to 55 dB(A), indicating that values above this level lead to unacceptable nuisance and deterioration of human health. The limit value is comparable to the sound level from normal speech in a room at a distance of one meter.

There is only limited data on the trends in traffic noise in the CEE countries. The proportions of people exposed to high levels of traffic noise are generally much higher in large cities compared to other areas. For some cities in CEE, data indicate that 45-50% of the urban population is exposed to more than 65 dB(A), a level well above the WHO limit value.

Building on the case studies of the Czech Republic and Bulgaria it appears that these countries deal with noise problems as part of the Environmental Impact Assessment carried out for new infrastructure. However, there is also a need to reduce noise problems associated with traffic on existing roads and public transport infrastructure, particularly in cities and urban areas. Noise pollution from vehicles is likely to increase in the future with the anticipated increases in traffic.

The condition of the vehicle fleet

The size, age and technological condition of the car fleet are important indicators of the environmental and health effects from road transport. Many of the present air pollution, safety and noise problems in CEE countries are caused by old polluting vehicles, combined with poor fuel quality. To a large extent, these problems stem from the economic conditions in the countries.

The age of the vehicle fleet and lack of emission controls present the CEE countries with a significant challenge to upgrade vehicles to EU emission standards. Low per capita incomes will limit the demand for newer cars, discourage retirement of older high polluting vehicles and may necessitate policy measures to discourage purchase of old vehicles and encourage retirement.

The case studies indicate that public transport vehicles also make a significant contribution to air pollution problems and that fleet replacement should be a vital concern from both an environmental and a quality of service perspective.

Cycling and walking

Transport does not have to be motorised. For short distances, cycling and walking may be attractive alternatives to motorised transport. Cycling and walking involve no air pollution, limited noise, and reduced risks of accidents relative to modes of transport such as the private car. Cycling and walking can substitute short trips, and short trips by car generate far more air pollution per km than longer trips.

Further, daily physical activity has a dramatic impact on people's health. According to WHO, 30 minutes of daily brisk walking or cycling - even in 2-3 sessions of 10-15 minutes each - will reduce the risk of serious diseases such as coronary heart diseases, adult diabetes, obesity, hypertension and high blood pressure by as much as 30-50%.

However, cycling is generally not regarded as a mode of transport in the CEE cities, but is primarily a sport or recreational activity. The reasons for the poor use of cycling options are lack of tradition, lack of appropriate road surfaces, mountain areas, safe infrastructure in terms on bicycle lanes, and insufficient traffic signals. Before the transition period, cycling was quite popular in rural areas for economic reasons and due to poor transport alternatives, but is now losing ground to other modes of transport.

Different transport traditions

The case studies revealed significant differences in transport traditions. The Czech Republic is a highly motorised country, especially in Prague, where the number of cars is 511 per 1,000 inhabitants. For several decades the Czech Republic has been a car-producing nation. Private car transport is generally high on the political agenda, even if much of the attention and financial resources are allocated to public transport in the Czech Republic.

Probably the most outstanding feature of Bulgarian transport policy, on the other hand, is the reliance on public transport, especially in the larger cities. In Sofia, public transport accounts for up to 80% of total transport volume. Moreover, there seems to be a consensus on transport priorities, as the Ministries of Health, Transport, and Environment all rate improvements in the public transport system as a high priority.

As the transport traditions and problems will vary between the CEE countries so will the strategies to combat transport generated problems. International donors, therefore, should be cautious not to apply a uniform approach, which implicitly assumes that the CEE countries have the same transport

objectives. In that regard, it should be noted that the Ministry of Transport in Bulgaria finds it more difficult to gain the necessary financial support from international donors for rail projects than for the development of motorways.

The influence of economic conditions

The increases in car ownership have taken place despite the economic recession that took place in the CEE countries in the early 1990s. Before the transition period, the CEE countries had restrictions on the importation of vehicles and minimal domestic car production, which limited private car ownership. Political changes gave way to liberalised trade in vehicles and increases in car ownership. The economic situation in the CEE countries now varies a great deal, but recovery is under way, and improvements in the economy are expected to result in further increases in car ownership and even larger increases in car transport, because of increased use of existing cars.

The economic recession has influenced the public transport in terms of decreasing subsidies, leading to lower service, poor maintenance and in some cases higher fares. Public transport has experienced declines both in absolute and relative terms. Still, the share of public transport is high compared to Western Europe.

Infrastructure

The density of the transport infrastructure is generally lower in the CEE countries compared to Western European countries. This is especially the case for motorways, where CEE countries typically have 0-5 km of motorways per 1000 km^2, compared to 15-55 km per 1000 km^2 for typical Western European countries. The density of the railway infrastructure is more or less at the same level in the CEE region and EU.

The case studies indicate that the CEE countries are very interested in the development of the transport infrastructure, both in terms of motorways and railways, but also in terms of city infrastructure (ring roads, subway networks, and renovation of tram networks). However, international financing is required in order to develop the infrastructure. The case studies indicate and some sources point to the problem, that international financing is too focused on (international) road transport and that it is quite difficult to obtain international financing of rail infrastructure and city infrastructure, which could have important environmental and health implications.

Policy considerations

The CEE countries face the large **challenge** of protecting human health and environmental quality under the pressure of a burgeoning transport sector. Inevitably, economic growth, which everybody is striving for, will also lead to transport growth, and without a remarkable effort to control and diminish the associated negative health and environmental effects, the CEE countries may face very serious problems in the future.

There are significant variations in both the state of transport and the types of policies needed to address transport issues in individual CEE countries. A great number of policy options are available and the mix of policies should be tailored to individual countries. Still, some general considerations are useful in structuring transport policies.

Transport policy decisions related to infrastructure, investments in public transport and spatial planning have long term implications for coping with the inevitable environment and health problems related to transport. The CEE countries need to take steps to establish the necessary institutional and legal framework to solve these problems through the integration and balancing of these concerns in transport policy. However, the process of integration will require effective **co-operation** between transport, environment, and health officials backed by the strong commitment of the government.

Analyses of the Czech Republic and Bulgaria reveal that the current level of integration of environment and health policies into transport policy differs between the countries. In both countries, however, the objectives of transport policy relate more to the mobility and supply of transport services than to the associated environmental and health problems. Therefore, both countries should increase their efforts on developing **integrated transport policies**. The prospects of EU membership and the associated requirements in the environment and transport areas should provide added impetus to integrate environmental and health concerns into transport policy.

In the 1990s most CEE countries have experienced, simultaneously, a sharp decline in the demand for public transport and substantial increases in car ownership rates. If governments respond to pressure from motorists for more roads, and shift resources from investments in public transportation to meet this demand, these trends will continue or worsen. On the contrary, public transport should be developed further and preferably in connection with encouragement of cycling and walking whenever possible.

Governments in Western Europe have attempted to reverse similar trends in public and private transport with recent efforts focused on resuscitating public transportation networks. For instance, many large cities in Western Europe including Paris, London, Stuttgart, Strassbourg and Grenoble have rebuilt and re-established tram and light rail systems in central city areas.

Thus, sustained **support for public transport in the CEE cities** is necessary in order to reap the benefits of existing public transport systems. Efforts should be focused on renewal of equipment and infrastructure, emphasising environmentally friendly development of these systems.

Present transport policies in CEE is not sufficiently directed towards coping with the challenge of rapidly increasing or potentially increasing car transport. **Monitoring of car transport volumes** is underdeveloped or lacking. **Implementation of economic instruments** - such as taxes and tax differentiation to regulate transport patterns, fuel quality, modal split and transport demand - do not seem to be high on the agenda. Environmental and health targets should be set and policy instruments identified. The CEE countries need to prevent problems now, rather than cure the problems later, most likely at much higher costs.

Although the widespread use of economic instruments is also a challenge to the EU countries, inspiration can be obtained from EU transport policy and EU experiences, and adapted to individual CEE countries. EU transport policy outlines principles for setting tariffs for infrastructure and for using market mechanisms to meet environmental targets. An important principle is to provide incentives for environmentally friendly behaviour by internalising environmental and health costs in the price of transport.

Gradual increases in road taxes should be considered, including mineral and oil taxes as well as registration and ownership taxes. Such taxes would have the double effect of curbing growth in car transport and at the same time providing financial resources. An important component in increasing transport volume is the increase in car ownership. Vehicle taxes should be deployed to curb car ownership and designed to encourage environmentally friendly and energy efficient vehicles.

Many of the environment and health implications from transport are due to old cars and poor fuel quality. For accession countries, but also other CEE

countries, there is a focus on **implementing EU directives**. Implementation of directives on emission standards, fuel standards, periodical inspection and type approval as well as seat belt legislation should be given great attention with respect to the health and environment aspects of transport. Likewise, **control and enforcement** of this regulation should be given high priority.

Measures to reduce accidents include improving car safety, such as seat belt requirements, improvement of infrastructure, safer traffic regulation, educational campaigns, reduce exposure to traffic hazards and changing the modal spilt of transport. Measures to reduce noise include separation of dwellings from transport infrastructure, reduction of traffic in residential areas, construction of noise screens, insulation of houses, emission limits for motor noise, low-noise asphalt and tires and lowering of speed limits.

Special attention should be given to spatial planning in order to secure dwelling patterns and localisation of industry, business and shopping that does not favour increased daily car transport. Instead, spatial planning should provide incentives for the use of public transport. Present localisation patterns, which support this development should be preserved. Traffic regulation is also an important instrument for reducing the impact of traffic nuisances.

Furthermore, it is recommended to make extensive use of information campaigns, designed to inform the public of the health and environmental dangers from the transport sector, and of what each individual can do to eliminate these dangers. Public participation, for example in connection with new infrastructure project, is also an important instrument to increase awareness and democracy.

External technical assistance and international financing are crucial elements in coping with the increasing environmental and health effects from transport in the CEE countries, and are absolutely necessary if the CEE countries are to meet EU directives and other international agreements and standards. Thus, bilateral and multilateral assistance have important roles to play in the process of framing new policies and not least of ensuring effective and timely implementation of already approved policies such as the phase out of leaded petrol, EU directives, international conventions, etc. It is crucial that the necessary technical assistance is being provided, including assistance for traffic monitoring, emission measurement, institutional strengthening, enforcement of new standards, and project preparation for international financing of investment projects.

International financing should be careful not to distort the modal split and weaken the favourable position for public transport by prioritising road infrastructure projects above rail and city infrastructure investments. The large health and environmental benefits associated with public transport should be important parts of the considerations on transport sector development for both national and international institutions.

The upcoming **Charter on Transport, Environment and Health**, to be adopted in London on 16 June, and the Programme of Joint Action of the Vienna Declaration from 1997 provide additional impetus for the development of transport policy. The charter is the first international document to direct attention to the positive health effects of physically active modes of transport, and the importance of considering these modes in transport policy. Policy makers should encourage bicycle transport by providing safe bicycle infrastructure and increasing awareness of the positive health effects of cycling.

1 General background

1.1 The CEE region

This paper provides an overview of the current state-of-affairs on transport[1], environment and health issues in Central and Eastern Europe (CEE) and discusses possible policy options to be employed. The study has been carried out primarily as a desk study, supplemented by two minor case studies, which were carried out for Prague/The Czech Republic and Sofia/Bulgaria.

15 countries

The 15 CEE countries covered by the study are:

Albania, Bosnia and Herzegovina, Bulgaria, Croatia, The Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia, The Former Yugoslavia Republic of Macedonia (FYROM) and Yugoslavia.

The transition process in CEE has varied greatly from country to country, depending on the political situation at the beginning of the transition, on the economic environment in which the changes have occurred and on the stage and nature of development and reform. Ten of the CEE countries are now applying for EU membership. These countries are:

Bulgaria; the Czech Republic; Estonia; Hungary; Latvia; Lithuania; Poland; Romania; Slovakia; Slovenia.

Environment and health issues

At the outset, there are at least three specific reasons for raising the transport-health-environment issue for Central and Eastern Europe (CEE):

1. In the CEE-countries, the efforts for improving environment and health conditions have focused on reducing emissions from stationary sources, which have so far been the primary contributor of pollution in many urban areas in the region. However, development trends indicate that the magnitude of the pollution from stationary sources will diminish in the future whereas transport's impact on environment and health is likely to increase as a result of increased transport volume.

2. Anticipated increases in transport volumes are expected to increase transport environment and health problems of transport very rapidly, especially because old polluting, noisy and unsafe vehicles still dominate the vehicle fleets. Increased car ownership and a dramatic drop in the use of public transport indicate a potentially environment and health damaging development of the transport sectors in CEE.

3. Even if the CEE countries benefit from taking a proactive approach, the institutional capacity to address the new complex of problems arising may be lacking. Recent studies have revealed a lack of consistency in environmental and transport policies in many of the CEE countries: for instance, the transport policies often contradict the aims of the environmental and health policies.

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1 In this report transport is defined as motorised and non-motorised transport of passengers and goods by road, rail, sea and air. Primary focus of the report is on road and rail transport. Pipeline transport is not included.

Order of presentation

The individual economic and political situations, as well as the aspirations for EU membership are of significant importance for the development of the transport sector and for the implications for environment and health in the individual CEE countries. The countries differ in these and many other aspects of relevance for this study, and it has not been possible to identify groups of countries with similar conditions for all aspects. Therefore, in the presentation, the CEE countries are listed according to the latest figures for GNP[2]. This measure is chosen, since the volume and character of transport activities normally correlate with GNP.

Data quality

Please note that most of the data presented in this paper are collected from international statistics due to the fact that international compilations present data from several countries in the same batch and because they provide the most reliable comparative data. However, the study revealed that international statistics are not always in accordance with national statistics. This means that some of the statistics in this report may deviate from figures in national yearbooks or other specific data from each country.

1.2 Political development

The changes in Central and Eastern Europe during the last 10 years penetrate all aspects of social, political, and economic life. New democracies are being built on the premises of responsiveness and participation. Administrations are re-organised and decentralised. Citizens and organisations, together with governments and enterprises, are faced with the task of implementing new legislation, and the citizens have to cope with not only a fundamental re-orientation of property rights but also fundamental changes in attitudes, expectations and norms.

The political transition in the region has shown progress and has, in many cases, demonstrated its resilience. This is in particular the case in Central Europe where several general elections have taken place and new governments have replaced the previous governments without that giving rise to significant turbulence[3]. It is in the midst of these fundamental changes that the countries in the CEE have to tackle the new transport-health-environment complex.

The environment was a high priority on the political agenda on the eve of the political breakthrough, and pressure from environmentalists contributed substantially to dismantling the previous political systems in most CEE countries. However, over time these movements seem to have lost some of their popularity.

The CEE countries now face the task of building appropriate institutional capacity to deal with the new challenges arising out of the market-economic system. In this respect, it may prove difficult to gain political acceptance for decisions, which in the short run are unfavourable for powerful segments in the population.

1.3 Economic development

The development in the volume of transport generally has a strong positive correlation with economic development. In order to get an impression of the

2 Unless no other specific order of presentation is given by the context.

3 See European Bank for Reconstruction and Development, "Transition Report 1998".

economic development in CEE countries the development and status for 1997 in Gross Domestic Product (GDP) is shown in Table 1.1.

Table 1.1
The development in the gross domestic product for CEE countries

	Index for GDP at constant 1990 prices (1990 = 100)							GDP per capita (US$)
	1990	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1997**
Slovenia	100	86	87	91	95	98	102	9,055
Czech Republic	100	80	80	82	85	89	92	5,050
Hungary	100	85	85	87	89	89	91	4,415
Croatia	100	71	69	69	70	74	78	4,268
Slovakia	100	82	79	82	89	95	99	3,615
Poland	100	95	99	104	111	118	124	3,512
Estonia	100	76	70	98	153	186	194	3,216
Lithuania	100	53	38	39	40	42	43	2,577
Latvia	100	58	50	50	49	50	52	2,237
FYROM	100	77	68	64	63	65	68	1,984*
Yugoslavia	100	68	49	52	-	-	-	1,711
Romania	100	75	76	79	84	88	85	1,544
Bulgaria	100	83	82	82	84	76	73	1,224
Albania	100	65	72	78	85	92	-	680
Bosnia and Herzegovina	100	77	68	60	-	-	-	502*
France	100	102	101	104	106	107	110	23,786
UK	100	98	99	103	106	108	112	21,823
Portugal	100	103	102	103	106	108	111	10,789

Sources: GDP at constant 1990 prices from EEA: Statistical Compendium for the Second Assessment
GDP per capita from UN/ECE: Trends in Europe and North America
* GDP per capita for 1996

It is a well-known fact, that by the end of the 1980s, living standard, reflected in the GDP, was very different in the West and in the East; GDP per capita was about 2.5 times higher in Western Europe as compared with CEE. Following the collapse of the centrally planned economies, the CEE region experienced a period of economic recession until the mid-1990s. For many of the countries in CEE the economies are not yet on scale with the level in 1990.

In recent years, economic growth rates have increased rapidly in Croatia, The Czech Republic. Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. Today, these countries have the highest GDP per capita in the region. Other countries, including Bulgaria and Romania, are still suffering from the transition and continue to experience declines in GDP. However, OECD trend analyses show that economic recovery is underway in all the countries under consideration, but, such forecasts are highly uncertain, given the fragility of the CEE economies.

As shown in the table, GDP per capita in the CEE region remains considerably below the average of the Western European countries. Future economic growth is likely to increase transport demand in terms of both passenger and goods transport.

The economic recession in the early 1990s strongly affected the transport sector in the region. Transport volumes decreased within all modes. However, a significant recovery has been experienced throughout the second half of the decade.

2 Transport, environment and health in CEE

Transport leads to a number of environment and health effects such as air pollution, noise, and accidents. Air pollution affects human health and causes damage to buildings and forests; noise is a nuisance and can cause health problems; accidents lead to injuries and loss of lives. Besides, infrastructure takes up land resources and can cause barrier effect for people and animals, thereby causing welfare loss and loss of bio diversity.

Current patterns of transport are dominated by motorised transport, that lead to the adverse environmental and health effects. However, other modes of transport such as cycling and walking induce physical activity that leads to health benefits.

Air pollution and the risk of accidents affect transport behaviour, in particular for the vulnerable groups (children, elderly people, disabled and people with weak health). The effect may be that the population becomes less inclined to use non-motorised modes of transport, the outcome being both less physical activity and increased motorised transport.

This section presents an overview of the development in transport activities and in environmental and health effects from transport activities in CEE countries.

2.1 Vehicle fleet, traffic volume and modal split

2.1.1 Vehicle fleet

The size and growth of the vehicle fleet as well as the average age of vehicles are important indicators for the development in car traffic and for the overall assessment of the adverse effects of transport. The technological stage of vehicles, which is reflected in the average age of the vehicles, is important for the effects of accidents, air pollution and noise.

Table 2.1
Vehicle Fleet in European Countries, 1994/1995/1996

Country	Number of Vehicles (1,000)	Average Age*) (Years)	No. of Vehicles per 1,000 Inhabit.
Slovenia [3]	851	6.5/7.3	426
The Czech Republic [2]	3,359	13.9/10.6	326
Hungary [2]	2,534	11.2/9.3	246
Croatia [2]	810	10/15	169
Slovakia [3]	1,217	14.8/13.0	230
Poland [3]	9,400	10/12	244
Estonia [3]	358		239
Lithuania [2]	860	12/10	231
Lativa [3]	470	10/10	188
Romania [3]	2,772	11.5/9.6	123
Bulgaria [2]	2,031	15	241
Albania [3]	112		35
Belgium [3]	4,741	7	484
Finland [3]	2,213	10/9.7	434
Germany [3]	45,871		564
Ireland [2]	1,262	7.3/6.4	351
Italy [3]	32,810	6/8.1	569
Portugal [1]	4,141		394
Spain [1]	16,606	10	427
Switzerland [1]	3,428	7.1/6.5	512

Source: UN/ECE Task Force to Phase out Leaded Petrol in Europe, main report. Table 5.2
1) Data are for 1994, 2) Data are for 1995. According to case study data, number of vehicles per 1000 is 458. It is an example of deviation between national and international statistics. 3) Data are for 1996, *) The first figure concerns passenger cars and light duty vehicles, and the second figure relates to heavy-duty vehicles and trucks. Note: Selected Western European countries.

Table 2.1 shows that the number of vehicles per 1,000 inhabitants in CEE is lower than the level in Western Europe, but it also shows a wide variation within the CEE. Albania (35), Croatia (169) and Romania (123) have the lowest rates of vehicles per 1,000 inhabitants whereas The Czech Republic (326), Hungary (246) and Slovenia (426) have the highest. With the exception of Croatia and Bulgaria the countries with the highest rates of vehicles generally coincide with the ones with the strongest economies and vice versa. This verifies what would be expected; that there exist a positive correlation between the strength of a country's economy and the number of passenger cars.

Passenger cars are considerably older in most CEE countries than in most countries in Western Europe, although there are individual differences. In Slovenia the average age is 6,5 years. The average age of passenger cars range between 10 years (Croatia, Latvia, and Poland) and 15 years (Bulgaria and Slovakia). The main reason for the old average age of the cars in CEE is the fact that a large share of cars purchased in CEE consists of second-hand vehicles from Western Europe. The average age of these cars is typically over 5 years. Another reason that vehicles are older on average in CEE is

that the older cars are not retired because of substantial demand for affordable cars.

Table 2.2
Number of vehicles in Europe, 1990-1996

	Change in Number of Vehicles. Index. 1990 = 100						
Country	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
The Czech Republic[1]	100	103	107	123	123	129	139
Hungary	100	102	106	108	113	116	
Croatia	100	95	89	60	67	65	
Slovakia	100	103	108	112	111	114	118
Poland	100	115	122	126	133	139	145
Latvia	100	114	120	122	118	120	130
Romania	100	110	121	135	152	164	179
Albania	100	124	272	450	538	619	631
Belgium	100	102	105	107	109	110	113
Denmark	100	100	101	102	102	107	111
Finland	100	99	100	97	96	98	100
France	100	102	103	104	106	108	109
Ireland	100	105	107	109	114	120	
Italy	100	110	107	108	109	110	110
UK	100	100	102	101	103	103	110

Source: UN/ECE Task Force to Phase Out Leaded Petrol in Europe. Main Report. Table 5.3 Note: Selected Western European countries
Note: Figures are for passenger cars. The index for all vehicles was 124 in 1996.

Table 2.2 shows that the size of the vehicle fleet is growing substantially in most CEE countries while the number of vehicles are growing only moderately in the Western European countries. In fact, Croatia is the only nation in CEE that is experiencing a diminishing number of vehicles. Under the centrally planned economies, the governments restricted the volume of private car sales and the demand for private vehicles was not satisfied. Immediately after the collapse of the planned economies, the number of vehicles per 1,000 population increased as a consequence of redemption of the smouldering demand for Western vehicles.

The pressures on the environment and health have most likely been intensified in the region, because of the increasing number of vehicles in CEE. However, the trend in traffic volume is a better indicator for the pressures on the environment and health.

2.1.2 Traffic volume and modal split

The political and economic development in CEE since 1989 entailed heavy implications on the transport patterns in CEE. Privatisation, demonopolisation, and new tax reforms as well as new legal and financial systems have caused a change in transport in CEE.

Passenger transport

The volume of traffic in the CEE has basically followed the economic development in the region. Soon after the beginning of the transition, the overall volume of traffic dropped sharply, just as the GDP in the region. The fares of public transport increased dramatically as a result of a cut in national subsidies and the supply of public transport deteriorated and, consequently, the demand for public transport declined.

At the same time, the number of vehicles increased, in spite of higher vehicle costs, higher fuel prices and higher operational costs. The market liberalisa-

tion introduced used vehicles from Western Europe to the CEE and the demand for private cars increased. Still, the growth in the size of the vehicle fleet did not result in a proportional growth in car usage because of the high and increasing vehicle running costs. Consequently, the growth in private transport did not counterbalance the drop in public transport and therefore the overall transport volume has declined.

Due to lack of statistics on private car use, it is not possible to obtain a complete overview of the development in the passenger transport volume in the CEE countries. However, ECMT provides data for the total passenger transport for rails, buses and coaches for the countries in CEE.

Table 2.3
The development in passenger transport volumes in CEE.

	Thousand million passenger- kilometres				
	1970	**1980**	**1990**	**1995**	**1996**
Railways	118.32	135.76	152.85	87.87	87.06
Buses and coaches	111.53	202.27	217.98	133.24	124.08
Total	229.85	338.03	370.83	221.11	211.14

Source: ECMT: Trends in the Transport Sector 1970-1996
Note: The table comprises the following CEE countries: BG, BIH, CZ, EST, H, HR, LT, LV, MK, PL, RO, SK, SLO

The overall passenger transport volume dropped from 1990 to 1996, due to the downward trend in the use of public transport. Since 1990 there has been a steady decline in rail passenger traffic in CEE in general, however, the rate of decline has slowed down in the recent years. The trend varies though, for instance Hungary and Latvia have had increasing levels of rail traffic while Estonia, Lithuania and Slovakia have had decreasing levels. In general, bus and coach traffic in CEE has also shown a constant drop in passenger-kilometres travelled since the beginning of the transition, but here the decline seems to be accelerating. The countries with the highest declining rates are Bulgaria, Lithuania, Latvia and The Czech Republic.

Road traffic volumes by private cars in the CEE and the EU
Statistics on private car use in CEE are scarce, and therefore it is not possible to provide an overview of the recent trends in the passenger transport volume in the CEE countries. The level of private car use in CEE compared to the level in the EU, could be illustrated by a few estimates on car traffic in Bulgaria, Hungary and The Czech Republic in 1990 and 1996.

In 1996, the passenger-kilometres travelled by private cars in The Czech Republic were estimated at 57,900 mill, which equals 5,600 km per capita per year. In Hungary, the private car use was at a level of 4,300 km per capita in 1996, while it was 4,700 km per capita in 1990. The Czech Republic and Hungary are probably representatives for the countries with the largest use of private cars in the region, since they are among the countries with the strongest economies. At the other end of the scale is Bulgaria and it is worth noting that the level of private car use was as low as 600 km per capita in 1990. Although no data are available for 1996, the level was probably not significantly different from the level in 1990, since it is reported that a family on average used 54 litres of petrol for private transport in 1996.

For comparison, the level of private car use in the EU countries was typically between 8,000 and 12,000 km per capita in 1996. This illustrates that the private car use in CEE is still not at a level comparable to the current standard levels in Western Europe. The road traffic volumes by private cars in CEE are far from the current levels in EU countries, in spite of the tremendous increase in the number of vehicles in CEE.

In general, the rate of mobility in CEE has declined significantly compared to the 1980s due to the economic situation. When the economies in CEE recover and begin to grow, it is expected that the passenger transport volume will increase. For instance, it is expected that passenger transport volumes will be more than doubled in The Czech Republic, Hungary, Poland and Slovakia over the period from 1990-2010.

Change in modal split

The political and economic transition in the CEE entailed a modal shift in passenger transport. Under the centrally planned regimes, restrictions on imports of vehicles together with minimal domestic car production limited private car use. When CEE began the transition into market economies the number of motor vehicles began to increase and the growth in private car traffic is an important reason for the decline in public transport. The development has caused a shift in the modal split of transport in which the percentage of public transport has declined. For instance, Budapest has experienced a decline from a share of 80% public transport in 1985 to 60% in 1996. Kilometres travelled by railways, buses and coaches have decreased while the kilometres travelled by private cars have most likely increased.

The modal split of transport in Polish cities[4]

Since the end of World War II, passenger transport in the major cities of Poland has relied heavily on public transport. The cities developed effective networks for mass transport using tramways, buses and railways. Through the 1970s the public means of transport worked effectively in the cities and mass transport carried about 80-90% of the non-pedestrian trips. Another reason for the success of public transport was very low fares, only about 20-30% of the total costs was covered through ticket sales.

The political reforms in the late 80s and early 90s changed the modal split of transport. The number of cars per 1,000 inhabitants grew rapidly in the cities and at the same time substantial economic pressure forced the municipal transport companies to raise the fares on public transport.

Below, examples from Polish cities of the changes in modal split are shown, illustrating the decrease in public transport and increase in car transport.

Table 2.4

Modal split for non-pedestrian passenger trips (%)

City	Year	Means of transport			
		Bus, tram or rail	Car	Taxi	Bike
Poznan	1968	87%	8%	3%	1.6%
	1986	72%	20%	6%	1.1%
	1990	69%	27%	3%	1.4%
	1993	60%	35%	3%	1.8%
Wroclaw	1986	76%	14%	9%	1.0%
	1990	77%	14%	9%	0.6%
	1992	74%	17%	8%	1.0%
Warsaw	1980	81%	18%	-	-
	1987	79%	21%	-	-
	1993	68%	31%	-	0.9%

Source: ECMT: Sustainable Transport in Central and Eastern European Cities. 1996

The Polish cities are struggling to cope with the substantive growth in the private road transport but up till now it has been without great success. Traffic congestion and lack of parking lots have been the immediate problems, but important problems are also that air pollution and noise are now exceptionally high in Poland.

[4] Source: OECD (ECMT): Sustainable Transport in Central and Eastern European Cities, 1996

By the end of the 1980s, the greater part of the region's public transport infrastructure was in a poor condition. The fleet and facilities were obsolete and users of public transport were met with frequent operational breakdowns and unreliable service. The public transport systems in CEE have continued to be in a poor and obsolete condition. The fleets are aged and use old technology (poor energy-efficiency, insufficient fuel consumption, and high vehicle emission) and, hence, continue to increase the pressure on environment and health in the region. Further, the poor conditions of public transport leads to fast increases in car transport, as soon as the economic conditions improve.

Freight Transport

The overall volume of freight transport has dropped since the transition began, but the volume has been growing since 1994 and it is expected to rise even further in the near future as a consequence of the closer relationship with the countries of the European Union. This development reflects the overall development in the CEE countries industrial outputs. However, the overall trend in CEE covers a wide variation from one country to another. In 1996 freight transport grew by 22.3% in Latvia and 8.8% in Estonia while it fell by 9.1% in the Slovakia and by 3.9% in The Czech Republic. The overall freight transport trends for the CEE are shown in Table 2.5.

Table 2.5
The development in freight transport in CEE

	Thousand million tonne-kilometres				
	1970	**1980**	**1990**	**1995**	**1996**
Rail	334.14	443.08	366.91	204.39	202.28
Road	65.61	148.58	150.66	122.83	125.72
Inland waterways	11.33	15.84	13.67	7.87	8.43
Total	411.08	607.50	531.24	335.09	336.43

Source: ECMT: Trends in the Transport Sector 1970-1996
Note: The table comprises the following CEE countries: BG, BIH, CZ, EST, H, HR, LT, LV, MK, PL, RO, SK, SLO.

Freight transport is dominated by railways in CEE, contrary to with the freight transport in Western Europe that is dominated by roads. However, as Table 2.6 shows the transformation of the economic and political structures in CEE have caused a major change in the modal split of freight transport.

Table 2.6
Modal split of freight transport in CEE

	Freight traffic						
	1970	**1975**	**1980**	**1985**	**1990**	**1995**	**1996**
Rail	81.3%	76.9%	72.9%	74.1%	69.1%	61%	60.1%
Road	16%	20.7%	24.5%	23.4%	28.3%	36.7%	37.4%
Inland waterways	2.7%	2.4%	2.6%	2.5%	2.6%	2.3%	2.5%
Total	100%	100%	100%	100%	100%	100%	100%

Source: ECMT: Trends in the Transport Sector 1970-1996
Note: The table comprises the following CEE countries: BG, BIH, CZ, EST, H, HR, LT, LV, MK, PL, RO, SK, SLO.

Before the transition, raw materials and heavy mass goods were dominant in CEE freight transport, and the transport network infrastructure was designed for transport and trade with the former Soviet Union. Restructuring of the industrial bases in the CEE have made freight transport less reliant on activities involving bulk transport, which have taken a heavy toll on the rail-

way transport. Previously large volumes of bulk transport via rail to and from the former Soviet Union have been reduced significantly. This is one of the prime reasons for the shift in market share. Furthermore, the replacement of the highly inflexible centrally planned transport sector with market economy rules has shifted a large share of the freight transport from rails to roads because road transport have proven faster and more flexible. Road transport was better able to adjust to the new economic structures and therefore it withstood the dramatic decline in freight transport relatively better than its competitors.

Air traffic

The CEE countries have experienced rapid growth of air traffic since the beginning of the 1990s. The growth is significantly greater than the growth in the EU, and it is especially due to a growth in passenger transport and only to a smaller extent due to increases in freight transport. For instance, for the airports of Prague, Budapest, Warsaw, Sofia and Tallinn[5] the number of passengers increased by between 8% to 47% from 1995 to 1997.

Air traffic is strongly positively correlated with the economic development and therefore air traffic in CEE is expected to continue to grow at a faster rate in the years to come.

2.1.3 **Projections of transport trends**

The OECD Environmental Policy Committee's Working Group on Transport has an ongoing project of *Environmentally Sustainable Transport* that aims at describing how an environmentally desirable future may be achieved. A study on *Environmentally Sustainable Transport* in CEE countries[6] in transition uses a similar approach and elaborates different scenarios for the future development of transport in CEE, that can meet a series of goals in 2030. For this purpose the Working Group has also analysed current and projected transport trends in CEE and a "business-as-usual" trend forecast scenario for transport in CEE has been constructed. The trend forecast will briefly be outlined below, which will provide a useful framework of reference for the policy discussions later in this report.

The assumption of "business-as-usual" is the basis for a reference scenario of future transport in CEE. The reference scenario analysis in the OECD study has been constructed in respect to trends in transport volume and modal split, and their impacts on the environment and health are comparable to the trends outlined in the previous sections of this report. These current trends in transport are the starting point for the projections but the future transport trends are also based on a few assumptions on economic and demographic developments as well as future transport patterns and the environmental performance of transport systems.

The study assumes moderate but steady increases in the GDP for the CEE countries. Another key assumption is that a shift in transport towards increased road traffic is anticipated. Moreover, it is assumed that in 2030 the transport patterns will be similar to those observed in the EU countries in 1990. Furthermore, technological progress especially for road vehicles is assumed in the trend projections.

The "business as usual" projections of transport trends in CEE include estimates for future transport volume and modal split as well as the emissions stemming from transport in CEE in year 2030. The results can be summarised as follows:

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[5] Source: EU: Transport in Figures, 1998.

[6] OECD: Joint Austria/UNEP/OECD Study on EST (Environmentally Sustainable Transport) in CEI Countries. Draft 1998.

- **Road traffic** for both passenger and freight transport will grow at a massive and steady rate. The passenger volume for road traffic will be doubled in 2010 and tripled in 2030 compared to the 1994 level. In 2030, the freight transport volume for road traffic will be more than 4 times the level in 1994.

- **Public transport** will stabilise at a level slightly higher than the level in 1994, but below the level of public transport before the collapse of the central planned economies.

- **Modal split**. Because of the development in public and private traffic, the share of private road transport will rise from 46% to 70% from 1994 to 2030 and freight transport by road will rise from 29% to 65%.

- The overall **passenger transport volume** will increase. The average distance travelled will increase from app. 5,000 km per capita per year to app. 10,200 km (the current standard level in OECD and EU countries) from 1994 to 2030.

- **Transport infrastructure**, primarily road infrastructure, in CEE will be widely extended to meet the assumed transport demand. For instance, the motorway network is assumed to increase from app. 4,000 km in 1994 to app. 17,500 km in 2030.

- **Transport emissions** will increase with respect to NO_x and CO2, but decrease with respect to particles and VOC. The development in emissions is a combined effect of anticipated technological progress and harmonisation with EU standards on the one hand, which leads to decreases in the emissions of NOx, CO, HC and particles; and on the other hand increases in transport volumes.

  The result is, that emissions of CO_2 will double from 1994 to 2030. NO_x-emissions will increase from 1994 to 2010 then decrease slightly, making the 2030 level approximately 50% higher than the 1994 level. VOC and particulate emissions will decrease steadily over the period and the level in 2030 will be less than 40% of the 1994 level. Nevertheless, the impacts on health and the environment of the development in transport related emissions by 2030 will still be considerable, especially for NO_x and CO_2-emissions.

The trend projections for the reference scenario do not include estimates for the development in noise and accidents. However, the adverse impacts of both noise and accidents are strongly correlated with the volume of transport (road traffic). Therefore, it is fair to assume that traffic related noise and accidents in CEE will increase, unless steps are taken to reduce the impact.

The trend projections demonstrate that the environmental costs of transport will likely be high if the existing trends towards rising motorization in CEE continue. Negative impacts from traffic, noticeable traffic accident, noise and air pollution will multiply and the impacts will be more difficult to address unless something is done to change the development.

2.1.4 Challenges

This and previous sections have demonstrated that the number of vehicles is increasing in most CEE countries, and it can be expected to increase even further in the future once the economic recovery and growth really commences throughout the region. This trend of increase will lead to increase of environmental and health pressures from traffic unless measures are taken to

control this development. Projections for the future traffic volume and modal split of transport in CEE confirm that the pressure will increase.

In general, the recent increase in the demand for mobility has not been met by an increase in public transport, rather is has been met by an increase in private car ownership and a rapidly declining share of public transport. However, the share of public transport is actually still high in CEE compared to the level in Western European countries.

Public mass transport offers clear advantages in terms of fuel efficiency, emissions per passenger, noise and safety. Therefore, an important challenge for the CEE is to maintain a high share of public transport in the future, since high this will be an effective mean of controlling the adverse effects of transport.
It is important to note that public transport systems in many CEE cities benefit from several important, positive features that could form the basis for long-term, sustainable urban transport development in the region. There is a strong tradition of public transport in the CEE cities; extensive (although old and outdated) public transport networks and furthermore the land use patterns in the region are conducive to public transport. The CEE can profit from these advantages in the long run. In order to do this however, it is essential to maintain the high demand for public transport. The key to constant high demand of public transport is rehabilitation and upgrading of existing transport systems as well as service improvements for mass transport and prevention against additional increases of fares.

When the economic recovery really gets underway in CEE, it is anticipated that not only the vehicle fleet but also the overall traffic volume will increase. CEE faces the challenge of coping with the growing driving force of transport, which will increase the environmental, and health pressure in the region.

2.2 Infrastructure density and barriers

Transport infrastructures exert pressures on the environment through the consumption of space, physical transformation of the environment and barrieres. The impacts of land-use include direct and indirect landscape and habitats losses. Transport infrastructure density can be used as an indicator of accessibility or transport supply as well as an indicator for the environmental pressure of infrastructure.

While additional infrastructure typically improves the mobility for people and/or goods in the society, it may also cause limitations on some people's freedom of movement. For instance, motorways divide the landscape creating physical barriers for the people living nearby and in addition it creates barriers within natural habitats where they impede the migration of animals.

The land used for transport networks (e.g. road density) can be used as an indirect indicator for the pressure on biodiversity and as an indicator for pressure of physical barriers that separate communities and limit the freedom of movement for people living near the transport infrastructure.

Table 2.7 presents the trends in the transport infrastructure networks distributed on motorways, main and national roads, railways and inland waterways in CEE countries and in selected Western European countries. Data on the transport infrastructure is scarce for the CEE, which is clearly reflected in the table, and therefore it is difficult to draw clear conclusions about the

development in transport infrastructure. However, a few important trends are presented in the table.

Table 2.7

Density of the transport infrastructure network in CEE

	Year 1994			
(km/1000 km^2)	**Motorways**	**Main and national roads**	**Railways**	**Inland waterways**
Slovenia	10	67	59	n.a.
Czech Republic	5	n.a.	119	n.a.
Hungary	4	69	82	15
Slovakia	4	63	75	49
Poland	1	141	75	12
Estonia	1	25	23	n.a.
Lithuania	6	69	31	6
Latvia	n.a.	n.a.	37	n.a.
FYROM	4	28	27	n.a.
Yugoslavia	4	63	39	14
Romania	0	62	n.a.	7
Bulgaria	2	26	39	4
Belgium	55	412	111	50
Denmark	18	87	55	0
Germany	31	117	116	19
France	15	52	59	11
UK	13	50	70	0

Source: EEA: Statistical Compendium for the Second Assessment

The density of motorways and main and national roads in CEE is generally lower in CEE compared with the selected EU countries (with the exception of Poland). This is especially true for motorways, which only comprises a small share in CEE.

The railway infrastructure comprises a large share of the total transport infrastructure in CEE in comparison with the selected EU countries. The table shows that railways are generally quite extensive in CEE, although significant variations exist within CEE. The Czech Republic has the highest density of railways and Estonia the lowest.

A well-functioning transport network is generally considered to be a necessity for a sound and blooming economic development in a region. This seems to be the perception in CEE as well. In general, the governments in CEE are currently seeking to expand the existing transport networks to meet the expected future needs for transport of goods and passengers. For instance, future accession to the European Union is a driving force for improving and building motorways connecting with the EU network throughout the region.

The construction of infrastructure in CEE is highly dependent on financial support and loans from international financial institutions. From an environment and health point of view, railway infrastructure and public transport in general should receive much attention from the international financing institutions, since public transport has important advantages in terms of environmental and social benefits.

2.3 Accidents

Transport involves certain risks of accidents with a direct adverse effect on people's health, since traffic accidents cause injuries and loss of lives. According to the WHO there are around 2 mill. road accidents with injuries per year, leading to 120,000 deaths and 2.5 mill. injured in Europe.

This section describes the development in transport accidents and safety in CEE countries. Most of the presentation will be concentrated on road traffic accidents, since these accidents account for the vast majority of transport related accidents, both in terms of absolute number of fatalities and death rates per kilometre travelled.

Table 2.8
Fatality rates in the EU (1994)

Mode	Persons killed	Passenger km travelled (billions passenger-km)	Fatalities per billion passenger-km
Road	45,258	3,935	11.4
Railway	1,115	270	4.1

Source: WHO: *An Overview of Environment and Health in Europe in the 1990s.*

Table 2.8 shows that railway fatalities in the EU in 1994 corresponded to only 2.5% of the deaths caused by road traffic accidents and it also shows that the number of fatalities per km were almost 3 times lower for rail than for road transport. This emphasises the significant and dominant role of road transport accidents.

Indicators

The risk of accident is usually expressed in terms of the number of victims per volume of traffic. More precisely it is expressed in the rate of accident, injury or death per-vehicle-kilometre or per passenger-kilometre. Sometimes the risk of accident is expressed as the number of victims per 1,000 vehicles or per 100,000 population due to lack of information on the kilometres travelled. Other indicators of relevance are the standardised death rates by road traffic accident per 100,000 population or simply the number of fatalities and injuries.

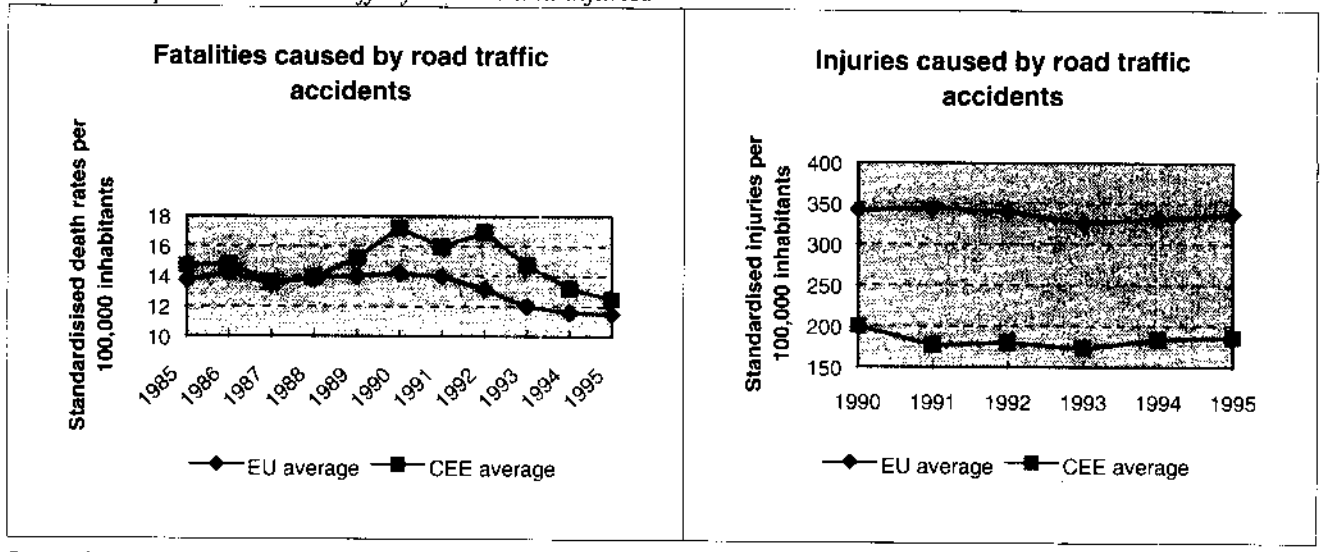
2.3.1 The overall trends in CEE

Through the last decades there has been an increasing awareness of the dangers of traffic and the need for implementation of preventive measures in Europe. In recent years this development has been reflected in number of road traffic fatalities. For the 29 ECMT countries[7] the number of fatalities dropped from 79,939 in 1992 to 73,709 in 1994 and the number of casualties (killed + injured) dropped from 2,120,726 to 2,056,843. Nevertheless traffic accidents still cause a disturbing number of death and injuries. According to the WHO[8] road traffic accidents account for 1.4% of all deaths and 20% of all accident deaths in the European region.

[7] Consist of A, B, BG, CH, CZ, D, DK, E, EST, F, FIN, GR, H, HR, IRL, I, L, LT, LV, N, NL, P, PL, RO, S, SK, SLO, TR, UK. Source: ECMT: *Statistical Report on Road Accidents 1993/1994.*

[8] WHO: *An Overview of Environment and Health in Europe in the 1990s.*

Figure 2.1
The development in road traffic fatalities and injuries



Source: EU98

Figure 2.1 immediately shows that the average fatality rate caused by road traffic is higher in CEE compared with the average rate in the EU even if traffic volumes are generally higher and there are more accidents in the EU than in the CEE. This is explained by the fact that more preventive measures have been implemented in the EU. Improvements in safety features for vehicles[9] and road infrastructure have been made in the EU, and these improvements tend to reduce the severity of an accident rather than prevent it from happening at all.

The figure also shows that the number of fatalities peaked in the CEE right after the collapse of the planned economies, which at first seems surprising since the number vehicles in CEE increased from the beginning of the 1990s. The explanations for the trend are many. Part of the reason is that the growth in the size of the vehicle fleet did not result in a proportional growth in traffic volume because of the high and increasing vehicle running costs. The reduction in the number of fatalities is also due to a reduction in the severity of accidents, since the reduction has not been paralleled by a proportional reduction in the number of injuries caused by road traffic accidents. Furthermore, the drop in the rate of mobility in CEE due to the economic recession has also been a contributory factor to the drop in the rate of accidents. In fact, declining accident rates would be expected due to the significant drop in mobility, but growth in car traffic have counteracted this effect and it should be noted that the reduction in the fatalities of road accidents in CEE now seems to be levelling off.

Although the above shows that the number of fatalities caused by traffic accidents is decreasing in CEE in general, this does not hold for all of the countries in CEE. In fact, the countries have had very varied trends.

2.3.2 The trends in selected CEE countries

For evaluation of the development within the CEE region, data for each country is needed. Unfortunately, the accessible and most reliable statistics[10] on road accidents do not account for all of the CEE countries and, therefore, the trends will only be outlined for a limited number of countries.

[9] The average age of the vehicles in CEE is generally higher than the average age in EU and therefore the safety of the vehicles is lower.
[10] ECMT: *Statistical Report on Road Accidents 1993/1994.*

Table 2.9

The number of fatalities and injured in road traffic accidents

	Fatalities					Injured				
	1990	**1991**	**1992**	**1993**	**1994**	**1990**	**1991**	**1992**	**1993**	**1994**
Slovenia	517	462	492	493	505	6,533	6,938	7,394	7,762	7,921
Czech Republic	1,307	1,355	1,545	1,504	1,637	27,756	27,478	31,987	32,297	35,667
Hungary	2,432	2,120	2,101	1,678	1,562	36,996	32,676	32,577	25,430	26,962
Croatia	-	-	-	855	804	-	-	-	15,596	17,679
Slovakia	-	-	697	478	595	-	-	10,930	11,524	11,032
Poland	7,333	7,901	6,946	6,341	6,744	59,611	65,242	61,046	58,812	64,573
Estonia	436	491	287	321	364	2,379	2,175	1,289	1,502	1,832
Lithuania	933	1,093	779	1,008	814	5,491	6,638	4,251	4,440	4,096
Latvia	946	997	787	724	774	4,646	4,469	3,708	3,667	4,323
Romania	3,782	3,078	2,816	2,826	2,877	8,137	7,789	6,960	8,302	8,198
Bulgaria	1,567	1,114	1,299	1,227	1,390	5,255	5,168	8,224	8,625	8,441
ECMT countries	85,485	84,213	79,939	75,179	73,709	2,080,074	2,044,012	2,040,787	1,972,845	1,983,134

Source: ECMT

Note: ECMT consist of the following 29 countries: Austria, Belarus, Belgium, Bosnia Herzegovina, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, the Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Moldova, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

The development in fatalities and injured for the CEE countries presented in Table 2.9 reflect the fluctuating trend in the region after the collapse of the planned economy. It is difficult to point out representatives for the wide-spread development in the region, however, the Baltic countries have all experienced declines in the number of fatalities and in the number of injuries since 1990, which is also the general trend. On the other hand, the Czech Republic, Bulgaria and Hungary have experienced somewhat different developments. The trend in the Czech Republic stands out from the general trend, by showing a constant rise in both the number of fatalities and the number injured. In Bulgaria, the development in fatalities reflects the wide-spread development in the region while the development in injured shows a tremendous increase from 1991 to 1992 then stabilising. In Hungary, both the number of fatalities and the number injuries from accidents have continuously been decreasing since the beginning of the transition.

Trend projections in Hungary

The number of road accident fatalities increased by 50% between 1980 and 1990 before it finally began to drop. Despite a constant drop in the number of fatalities and injuries, the number of accidents involving personal injuries is still higher in Hungary compared to other countries with a similar vehicle fleet size.

Trend projections for fatalities and injuries in Hungary 1980-2010

	1980	**1985**	**1990**	**1995***	**2000****	**2005****	**2010****
Fatalities	1,630	1,756	2,432	1,560	1,600	1,650	1,500
Injuries	25,457	26,596	39,596	29,400	31,500	33,650	35,500

Source: ECMT: Issues in Sustainable Transport: The Case of Hungary

Note: * preliminary figures, ** projections

The trend projections show increases in both the number of fatalities and the number of injuries. The Government of the Hungarian Republic recognises that the transport policy calls for efforts to reduce the number of accidents via improvements in the road network and vehicles, more stringent regulation and control, public information initiatives and improved emergency response operations.

Whereas Table 2.9 shows the development in the real number of fatalities and injured in accidents, standardised fatality and injury rates are more appropriate for comparison among countries. It should be stressed though, that interpretation of the figures for accidents across countries calls for precaution. Differences in the number of standardised fatalities do not necessarily mean that any given country's currefnt policy measures are better or worse than another's because the differences may be a consequence of factors outside of influence.

Factors affecting the risk

The risk of traffic accidents and the severity depend on a number of factors, including:

- The level of traffic
- The traffic mix, separation of traffic
- The age and safety features of vehicles
- The infrastructure
- The type of road
- The time of day and the climatic conditions
- Driving experience and the behaviour of drivers
- Speed
- Blood Alcohol Concentration

The risk of accident is influenced by each of the above factors and the relations are not always straightforward.

In CEE like in the rest of Europe, the vast majority of accidents happen in built-up areas and except for only very few motorway accidents, the rest of the accidents happen outside built-up areas. The areas with the highest risks are intersections, crossings, urban roads with high speed and roads with curb lane parking.

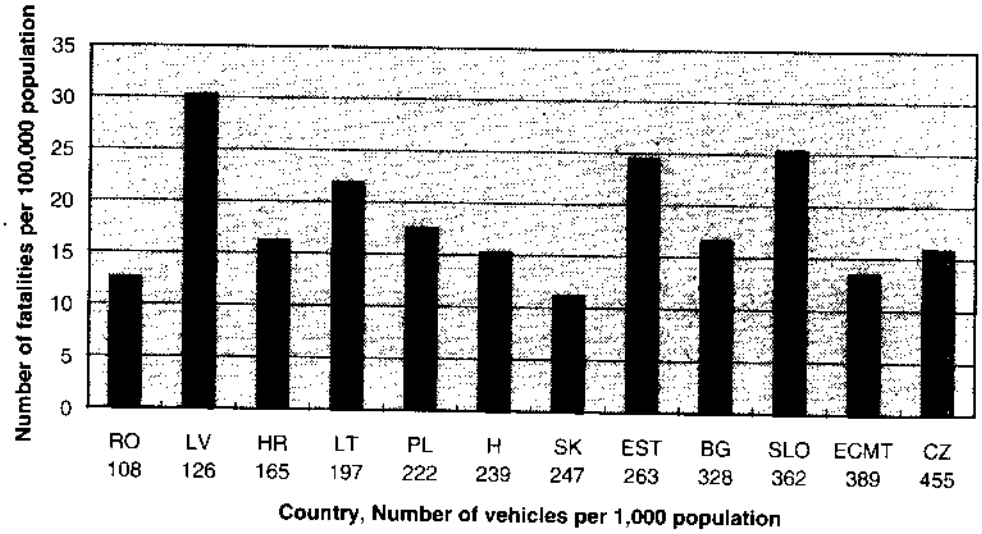
The number of fatalities falls disproportional among the population, thus death rates from traffic accidents are two times higher for people aged 15-24 compared to middle aged people. Among other things, this relation may reflect the experience of the driver.

The average driving speeds are positively correlated with the number and the severity of the traffic accidents which means that higher speeds lead not only to more accidents but it also increases the severity of the accidents. It has been documented that even small reductions of average speeds result in significant reductions of accidents.

Varied trends in CEE

The varied trends for the countries are of course partly due to differences in implemented preventive policy measures across the region. However, the variation is also due to geographical and socio-economic factors, as for instance the density and quality of road systems, population density, road-user behaviour, road vehicle population, traffic engineering, etc. Therefore, comparisons of the risk levels for the countries in CEE as well as for countries in other parts of Europe should be done with great care, and the interpretations of the figures should be done while bearing the above factors in mind.

Figure 2.2
Risk-level and vehicle ownership[11] ratios in 1994 for selected CEE



Source: ECMT: Statistical Report on Road Accidents 1993/1994

Despite the difficulties in comparison of country data for accidents, Figure 2.2 depicts the standardised fatalities and number of vehicles in use in respect to the size of the population for selected CEE countries. The number of fatalities might be expected to increase with the number of vehicles, but even though this thesis applies, not surprisingly it must be concluded that there are other factors that determine the number of fatalities as well.
The Czech Republic is the only nation with a larger share of vehicles per 1,000 population than the average of the 29 European countries (ECMT), but the Czech Republic also encountered more fatalities. On the other hand Romania and Slovakia are the only nations with lower standardised fatalities rates than the average of ECMT. However, especially Romania has a significantly lower fraction of vehicles, which is most likely a part of the reason for the moderate rate. The weighted indicator for all of the other nations could be said to be strictly dominated by the average in ECMT in the sense that the number of vehicles are lower and the fatalities are higher. Latvia stands out in the figure by having the largest level of fatalities per 100,000 inhabitants, while at the same time having a very low number of vehicles per 1,000 inhabitants.

2.3.3 Road safety measures in CEE and the rest of Europe

The trends in road safety in CEE in general have shown decreasing levels in the number of accidents, injured and deaths since the beginning of the transition process. The improvements in road safety could be connected with introduction of measures to reduce the number of accidents. However, downward trends in car use (despite more vehicles per 1,000 inhabitants) have most likely helped to improve road safety in CEE as well.

The policies for improvement of road safety and prevention of injuries and deaths due to traffic accidents are traditionally split in primary, secondary and tertiary measures. Primary measures aim at preventing accidents from occurring by improving infrastructure, implementing safer traffic rules, pro-

[11] Please note that the vehicle ownership ratios in the figure do not exactly match the figures in *Table 2.1*. The reason is that the different sources do not agree on figures. However, for the present purpose, the figures show a similar tendency.

moting educational campaigns etc. Secondary measures aim at mitigating the consequences of accidents by introducing restrain system, introducing safer cars etc. Tertiary measures aim at reducing the sequels of accidents by improving the treatment of traumas. However, it is important to stress that road safety could also be improved by intervening on the determinants of exposure to traffic hazards, i.e. managing the demand and need for transport and the reasons behind increased mobility. Changing the modal spilt of transport or reducing the relative personal travel demand by promoting accessibility rather than mobility could for instance reduce the exposure to traffic hazards.

Initiatives in the CEE and the EU

The EU Action Programme "Promoting Road Safety in the EU" requests for evaluation of road safety measures by cost-benefit analyses. The cost-benefit approach has identified a number of low cost measures (primary and secondary) that have brought significant safety gains in the EU and offered high rates of benefits to costs. In the EU countries some of these low cost measures include the following preventive strategies:

- Control of blood alcohol level while driving
- Speed reduction in residential areas
- Use of speed cameras
- Use of seat belts
- Introduction of day-running lights
- Requirements on technical specifications for transport means
- Periodic safety inspections
- Best practice for use of cycle and motorcycle helmets
- Best practice for vehicle design

Furthermore, EU harmonisation of transport safety has been made. The measures range from fitting of lorries with speed-limiting technique and fitting of coaches and buses with seat belts to harmonisation of conditions for issuing driving licenses.

In general, the extent of the initiatives undertaken in CEE to improve road safety at all levels (primary, secondary and tertiary) as well as the efforts of developing new measures and the speed of implementing policies are not at level with the standard in the EU. Nevertheless, in the last few years several initiatives have been taken in CEE countries to deal with road traffic safety. The main safety measures taken in CEE recently include the following components[12]:

- Programme launched for reducing accidents where they have been especially frequent (black spots)
- Traffic education and training of children
- Exchange of traffic signs with better and more logical signs
- Improvement of the legislative framework
- Training for drivers in international traffic
- Introduction of stricter speed limit in urban areas
- Introduction of rules for stricter use of safety belts
- Obligatory use of daylights

Some of the measures to improve road safety undertaken in CEE coincide with measures undertaken in the EU countries. However, CEE is halting one or two steps behind the EU, which can be illustrated by a case of implementation of stricter use of seat belts. In 1993 Hungary introduced a law that commands for obligatory use of safety belts installed in rear passenger car seats outside built-up areas. Yet, at the same time Denmark introduced an

[12] Source: ECMT: Statistical Report on Road Accidents 1993/1994.

even stricter regulation for the use of safety belt in passenger cars. It commands that safety belt shall be used by all drivers and passengers on all trips, including children (eventually using safety seats).

Not only are the recently undertaken measures in CEE generally at a lower stage than in the EU, but the overall level of road safety measures implemented are generally fewer and less strict. Still, it should be noted that the process of improving road safety in CEE as well as in the EU is a dynamic process that interacts closely with the trends and challenges in the region and the development of society in general, traffic, technology etc. Since the trend and challenges differ in the EU and CEE this explains at least some of the differences in the initiatives undertaken for improvement of road safety in the two regions.

2.3.4 **Challenges**

This section demonstrated that the number of fatalities caused by road accidents is decreasing in CEE in general. Still, the standardised death rates caused by road traffic are higher in CEE compared with the EU, despite the lower volume of traffic. Most countries in CEE have given the problem of road safety a rather low priority. In general, road safety legislation in CEE is not sufficient despite of the fact that a number of measures have been undertaken in the past few years.

Once the expected economic recovery and growth gets underway in the CEE it is likely that both the number of fatalities and injuries will grow in the region making the gap to EU even larger.

As mentioned above, a number of measures are available for reducing accidents and the severity of accidents. Actions need to be taken if the risk level of road accidents in CEE shall be brought to a level consistent with the level in the rest of Europe. This is, in particular, true if the traffic volume increases in CEE as anticipated and if the modal split continues to shift from public transport to private cars.

2.4 **Air pollution**

The transport sector is a major source of air pollution and contributes significantly to urban air pollution, acidification, photochemical pollution and climate change. Air pollution from traffic has strong adverse effects on human health in terms of increases in nuisances, morbidity and mortality, and in terms of psycho-social impacts.

The most important emissions from traffic are particles, nitrogen oxides (NO_x), hydrocarbon (HC), carbon monoxide (CO), volatile organic compounds (VOC), lead (Pb) and carbon dioxide (CO_2). Emissions of these pollutants have a direct impact on human health in terms of increases in respiratory diseases, cardiovascular diseases and cancer. Photochemical oxidation of pollutants such as nitrogen oxides and volatile organic compounds% in the troposphere results in the formation of a range of secondary pollutants known as photochemical oxidants, of which ozone (O_3) is the most abundant and toxic. Furthermore, air pollution from traffic damages forests, agriculture, buildings and the global climate in terms of the green house effect. In Appendix 1, an overview of health and environment effects of transport air emissions is presented.

The transboundary nature of air pollution

Given the transboundary nature of air pollution, a number of international environmental agreements have been introduced under the United Nations umbrella to curb air emissions.
The Convention on Long-Range Transboundary Air Pollution entered into force in 1983 to combat acidification in Europe. To date, it has been extended by seven protocols (targeting sulphur, nitrogen, volatile organic compounds, heavy metals and persistent organic pollutants).
The Framework Convention on Climate Change was established in 1992 to stabilise greenhouse gas emissions so as to limit anthropogenic interference with the climate system. Its 1997 Kyoto Protocol strengthened the emission targets for developed countries, which are to be achieved by the period 2008 - 2012.
The Committee on Environmental Policy of the United Nations Economic Commission for Europe established a "Task Force" for the phase out of leaded petrol in Europe in May 1996. A "Pan-European Strategy" has been framed to ban the marketing of leaded petrol in Europe as from January 2005.

2.4.1 Air quality

Although other emissions than traffic contribute to deterioration of the ambient air quality, the air quality in CEE cities gives an indication of the size of the problem related to traffic emissions. Below, the ambient air quality in CEE cities is described, and the health and environmental effects of a deterioration of air quality is illustrated. Next, transport sector emissions in CEE is compared to the EU.

Various sources on ambient air quality in Europe are available. The description here is based on a WHO report on exposure of urban population in Europe to air pollution[13]. The report summarises information on air quality in European cities collected by the WHO European Centre for Environment and Health, ECEH, in the period 1992-1996. The data on air quality is typically from 1989-1991. An impression of the air quality in CEE countries can be obtained from these data; however the data should be interpreted with great care, since the situation may have changed considerably[14]. Variations in location of monitoring stations and measurement methods may also cause differences. As can be seen from the table below, data is not available for all countries.

In the table below, two indicators on air quality have been chosen: NO_2 and particles (Total Suspended Particles, TSP). TSP refers to particles with diameters up to 25-50 μg and is measured in units of weight. Recent research indicates that fine particles in high numbers are particularly damaging to human health and TSP as indicator does not take this into account, since fine particles have little weight compared to coarse particles. Air quality limit values for finer fractions of particles (PM_{10}) are on its way for member countries of the European Union as part of the framework directive on Ambient Air Quality and related daughter directives for 13 individual compounds. The directive also requires monitoring of $PM_{2.5}$.[15]

[13] K. Huysmans and M. Krzyzanowski: "Exposure of urban population in the WHO European Region to major pollutants"
[14] See case studies for more up to date information for the two case examples.
[15] Examinations of the effect of human exposure to small particles ($PM_{2.5}$) in urban areas have shown that an increase in exposure of around 10 $\mu g/m^3$ resulted in increased mortality between 7-14%. (WHO, Air quality guideline for Europe 1996. Particulate matter, 1996. Background paper)

In the table below, air quality indicators on NO_2 and TSP is shown (annual mean value). The annual mean value gives an indication of the level of air pollution, although peak values, which do have important significance for health effects, are not captured in this kind of indicator.

Table 2.10

Air quality indicators in the CEE and the EU cities. Mean/median values

µg/m³	**NO_2**	**TSP**
WHO air quality guidelines 1996[2]	40-50 µg/m³ (annual)	120 µg/m³ (annual)[2]
EU air quality directives	50 µg/m³ (annual)[3]	150 µg/m³ (annual)[4]
CEE		
Ljubljana, Slovenia 1991/1992	-	-
Prague, Czech Republic. 1991[5]	56	84
Budapest, Hungary. 1992	44	62
Zagreb, Croatia. 1990	-	-
Bratislava, Slovakia. 1990	-	58
Warsaw, Poland 1992	54	-
Estonia[1]		
Vilnius, Lithuania. 1991	39	127
Riga Latvia. 1990	60	100
FYROM[1]		
Belgrade, Yugoslavia.1991	123	-
Bucharest, Romania. 1990	67	-
Bulgaria[1, 4]		
Tirana, Albania. 1990	-	-
Bosnia and Herzagovina[1]		
The EU:		
Copenhagen, Denmark. 1994	48	65
Brussels, Belgium. 1994	44	-
Berlin, Germany. 1989	41	99
Paris, France. 1991	-	43
Madrid, Spain. 1993	63	53
Athens, Greece. 1993	70	-

Note 1: Not included in the report

Note 2: WHO formerly had an air quality guideline for TSP from 1987 at 120 µg/m³ (24 hours). Recent WHO updates have not established air quality guidelines for TSP because according to WHO there is no evident safe low level threshold for effects on morbidity and mortality (meaning, that even very low levels may have an impact).

Note 3: Present EU directive. A proposed EU limit value states recommend NO_2 of 40 µg/m³ (annual) to be met in 2010.

Note 4: Former EU limit value on TSP. (See text above). Average of 24 hours values.

Note 5: Se also case study.

The air quality figures on NO_2 illustrate, that all cities in Europe for which data are available, are either just at or exceed the WHO air quality guideline of 40-50 µg/m³. On average, the cities in CEE have higher NO_2 concentrations than the EU cities mentioned. Prague, Riga, Belgrade and Bucharest are among the most polluted cities, especially Belgrade. In the EU, the Southern cities, Athens and Madrid, display the highest levels of NO_2 air pollution.

With respect to particles (TSP), Vilnius and Riga show air pollution levels close to or above of 120 µg/m³. In the EU, only Berlin has a similar high level. Other countries in CEE as well as the EU are well below the guidelines for mean values.

Data for selected CEE and Western European countries show that the share of diesel driven heavy duty vehicles in CEE varies between approximately 30% in Latvia and 90-100% in Poland, the Czech Republic, Slovakia and Slovenia. On average 75% of heavy duty vehicles in CEE are diesel driven compared to 94% in Western Europe. Similarly, the share of diesel driven passenger cars is only 7% in CEE compared to 16% in Western Europe[16]. Thus, the present share of diesel vehicles is generally lower in CEE than in Western Europe. The emission of particles is closely related to the share of diesel vehicles.

Dose response

Particles: Day-to-day variations in particle concentration have been documented to have an effect mortality and hospital admissions for respiratory and cardiovascular diseases.

The publication "Traffic, Air Pollution and Health" by Euro Citizens Action Service (ECAS) provides estimates of the effects of particulate exposure. It is estimated that a 10 $\mu g/m^3$ increase in average PM_{10} levels causes a 1.4% increase in cardiovascular deaths and a 3.4% increase in respiratory deaths. Furthermore, respiratory hospital admissions will increase by 0.8% and asthmatic attacks will increase by 3.0%.

ECAS also provides estimates for the effect of a 3-day pollution episode of particulate matter on a population of 1 million. The theoretical effect of exposure to 100 $\mu g/m^3$ of PM_{10} is estimated to 8 deaths and 12 hospital admissions for respiratory causes.

In should be noted that WHO has argued that on the basis of current evidence for dose-response, no guideline value can be derived that would be compatible with complete protection of the population from adverse health effects from particles. Moreover, it has not been possible to define a clear threshold level below which health effects are no longer observed.

NO_2: Air quality guidelines are expressed in terms of NO_2[17]. NO_2 leads to respiratory irritation that provokes a shortness of breath, difficulties in breathing and coughing. People with asthma or bronchitis might experience deterioration of lung function and an increase in respiratory diseases. Furthermore, nitrogen dioxide (NO_2) is one of the important precursors for ozone.

For short term exposure[18] of NO_2 for 2-14 hours there is decreasing lung function at 9,400 $\mu g/m^3$ for healthy humans and for asthmatics an adverse effects has been demonstrated for levels of only 560 $\mu g/m^3$.

Studies examining the dose-response relationship of NO_2 are typically linked with the examination of other pollutants which makes the risk estimation of health effects from NO_2 exposure somewhat difficult. However, in "Traffic, Air Pollution and Health" a study is quoted to have found that an increase of 30 $\mu g/m^3$ in long term exposure to NO_2 was associated with a 20% increase in respiratory tract infections for children in the age of 5 to 12 years. The studies that have examined the effects on adults have not resulted in sufficient evidence to provide exact dose-response figures but according to "Traf-

[16] Danish Environmental Protection Agency: UN/ECE Task Force to Phase Out Leaded Petrol in Europe. Country Assessment Report, 1998.
[17] Motor vehicles only emit small quantities of NO_2 (about 5%), but large quantities of NO. However, motor vehicles still account for large share of NO_2 levels because NO reacts with ozone in the air to produce NO_2.
[18] Danish Environmental Protection Agency, 1997.

fic, Air Pollution and Health" by ECAS there is a tendency across the studies for symptoms to increase as levels of NO_2 rise.

Ozone: Studies have shown that changes in lung function can be detected even at low ambient concentrations of ozone exposure. Moreover, there is evidence that ozone exposure both in short and long term can have serious effects on health.

WHO reports, that hourly ozone concentrations of 200 $\mu g/m^3$ can cause eye, nose and throat irritation, chest discomfort, cough and headache[19]. The most well investigated effect of ozone exposure is on lung function. Experiments have shown that human beings exposed to levels of 200 $\mu g/m^3$ over a 6-hour period (a level which regularly occurs in Europe during summer months) experience inflammation of airways, coughing and pain during deep breathing[20].

The relationship between levels of ozone and hospital admissions has been examined. In "Traffic, Air Pollution and Health" it is estimated that a 60 $\mu g/m^3$ increase in daily one-hour levels leads to a 10% increase in hospital admissions for respiratory conditions.

In should be noted that vulnerable groups such as asthmatics, active individuals and children are the most sensitive to decreases in lung function from ozone exposure. The lungs of asthmatics are more sensitive and active individuals and children are more exposed to ozone because they tend to spend more time outside.

Lead: Lead emissions lead to several adverse effects on people's health. Foetal exposure to lead may cause decreased gestational age, reduced birth weight, foetal death, and increased infant mortality. Children exposed to lead may suffer inferior reading and learning abilities, hearing loss and loss of concentration.

Studies have found a statistically significant connection between the exposure of people to lead and reductions in their intellectual performance measured by IQ: a 10 microgram per decilitre increase in the blood lead level has been found to cause an approximately 2.5 point decrease in the IQ of exposed children. Additionally, the exposure of adults to atmospheric lead has been connected to elevated blood pressure causing hypertension, heart attacks, and premature death. No lower threshold of exposure exists under which the adverse effects of lead on children and adults cannot be detected.

Exposure

The impact on humans of air pollution depends on the exposure to air pollution. As shown in the table below, the share of the population exposed to very high concentrations of NO_2 is higher in the CEE region than in Western Europe, whereas the share of the population exposed to NO_2 concentrations in the order of 60-100 $\mu g/m^3$ is higher in Western Europe.

[19] Exposure for about six hours to concentrations of 160 µg/m3 produces inflammation of the airways and changes in standard indices of lung function.

[20] ECAS: *Traffic, Air Pollution and Health, 1997.*

Table 2.11
Percentage of city population exposed to NO2 concentrations

	Annual mean concentration ($\mu g/m^3$)		
	< 60	60 - 100	> 100
Western countries	76.1	23.9	0.0
CEE countries	75.9	15.4	8.7

Note: The figures concern the percentage of city population exposed to elevated NO2 concentrations in cities with data after 1985.
Source: Urban Air Quality in Europe, EEA 1998.

Although there are major differences between individual countries, air pollution levels in CEE are generally higher than in Western Europe, in spite of lower levels of traffic. As shown in the next section, traffic is certainly not the only source of air pollution. However, since the air pollution problems are already significant, CEE countries should put great attention to the expected increases in transport, notably road traffic, in order to counteract the negative impacts.

2.4.2 **Acid depositions**

Anthropogenic emissions of nitrogen oxides (plus ammonia and sulphur dioxide) result in acid depositions (acidification) that ultimately lead to defoliation and reduced vitality of trees, declining fish stock and changes in soil chemistry.

NO_x accounts for most of the potentially acidifying depositions in Europe, since acidification by sulphur is becoming less important. Eutrophication of water bodies is to a large extent due to nitrate leaching from agricultural soils, although atmospheric emissions of NO_x have been estimated at around one third of the total nitrogen input to the Baltic Sea[21].

Exceedances of the critical load (5 percentile) of acidifying nitrogen are encountered in central Europe and southern Scandinavia, where they fluctuate between 500 - 1000 eq/ha/yr. A 1995 joint EC-UNECE survey on forest conditions in Europe revealed that acidification has severely damaged more than one third of the forest cover in CEE[22].

2.4.3 **Emissions from Transport**

Data availability

Emission inventories for particulate matter (PM) are not yet well developed (methodologies and emission factors are not yet harmonised and may differ between countries and research institutes) and therefore few comparable data exist. Work is under way to homogenise PM emission data under the framework of the European Commission's AIRBASE database (containing data supplied under the new Exchange of Information Decision and Air Quality Directives).

The CORINAIR inventory of air emissions records data on NO_x, non-methane volatile organic compounds (NMVOCs), CO, methane (CH_4), carbon dioxide (CO_2), nitrous oxide (N_2O), ammonia (NH_3) and sulphur dioxide (SO_2). To date only 1990 data has been validated for CEE, while 1994 figures exist for the EU. A joint initiative by UNECE and the Danish Environmental Protection Agency[23] provides comprehensive descriptions of fuel types and lead emissions in CEE.

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[21] EEA (1997): Air Pollution in Europe 1997. European Environment Agency. Copenhagen, Denmark.
[22] EEA (1997): Air Pollution in Europe 1997. European Environment Agency. Copenhagen, Denmark.
[23] DEPA (1998): UN/ECE Task Force to Phase Out Leaded Petrol in Europe. Danish Environmental Protection Agency. Copenhagen, Denmark

Transport Share of Air Pollution

Pollution by *particles* is dominated by stationary pollution sources. Traffic accounts for some 10-25% of total anthropogenic emissions[24] of primary particles, although its contribution to ground level concentrations and exposure is believed to be significantly higher.

The table below presents relative sector contributions to air emissions in Central and Eastern European (CEE) countries and the European Union (EU), respectively, for eight important air pollutants: NO_x, NMVOC, CO, CH_4, CO_2, N_2O, NH_3 and SO_2. The share of transport sector emissions is presented and for comparison emissions from energy, industry and a miscellaneous grouping (including emissions from agriculture, households, nature, and waste management).

Table 2.12

Sector contributions to air emissions (CEE, 1990)

CEE	*NOx*	*NMVOC*	*CO*	*CH4*	*CO2*	*N2O*	*NH3*	*SO2*
Transport	35%	23%	33%	0%	9%	1%	0%	3%
Energy	32%	0%	1%	0%	38%	9%	0%	59%
Industry	23%	9%	35%	1%	31%	10%	4%	21%
Other	9%	67%	31%	99%	22%	80%	96%	16%
Total (1000t per year)	3,925	3,438	15,104	12,457	1,041,373	455	1,602	10,711

SOURCE: EEA (1996): CORINAIR 1990 Summary Report 1. European Environment Agency. Copenhagen, Denmark

Table 2.13

Sector contributions to air emissions (The EU, 1994)

CEE	*NOx*	*NMVOC*	*CO*	*CH4*	*CO2*	*N2O*	*NH3*	*SO2*
Transport	63%	35%	69%	1%	25%	5%	1%	5%
Energy	19%	1%	1%	0%	33%	5%	0%	51%
Industry	11%	6%	11%	0%	23%	25%	3%	20%
Other	7%	58%	18%	99%	22%	65%	96%	24%
Total (1000t per year)	12,563	16,900	45,180	25,976	3,159,976	1,320	3,536	14,284

SOURCE: EEA (1997): *CORINAIR 1994 Inventory*. European Environment Agency. Copenhagen, Denmark

The tables illustrate, that in both CEE and in the EU, transport sector emissions account for significant shares of air emissions for NO_x, NMVOC and CO. In CEE, however, the shares are much lower, ranging from 23-35%, whereas the shares in the EU range from 35%-69%. The higher shares of traffic emissions in the EU is due to a combination of higher traffic volumes and increased emission control in the energy and industry sectors.

Furthermore, it is interesting to note that while CO_2 emissions from traffic accounts for 9% in CEE, they account for as much as 25% in the EU.

Transport accounts for the largest share of NO_x, with larger contributions from the energy and industry sectors in CEE (mostly due to the modest penetration of cleaner technologies in these sectors).

Emissions of NMVOCs cluster around the "other" grouping (where households and waste management are responsible for some 40% and 33% of the

[24] EEA (1997): Air Pollution in Europe 1997. European Environment Agency. Copenhagen, Denmark.

total loads in CEE and the EU, respectively). The transport sector accounts for some 23% of the total emissions in CEE and 35% in the EU.

While emissions of CO are distributed evenly among the transport, industry and "other" sectors in CEE, the share of the transport sector is much larger (69%) in the EU.

Lead in petrol is the main contributor to lead pollution in CEE, with a share of total 1996 emissions ranging from 39% in Poland to 79% in the Czech Republic[25].

Emissions in CEE

The table below summarise per capita emissions of NO_2, NMVOCs and CO from transport. Based on the data available, emissions per capita are generally lower in CEE that in the EU.

Table 2.14
Per capita emissions of NO_2, NMVOCs and CO from transport (the CEE and the EU, 1996)

	NO_2 kg of NO_2 per inhabitant	**NMVOC kg per inhabitant**	**CO kg per inhabitant**
CEE			
Bulgaria	12.80	7.64	36.80
Czech Republic	22.11	7.57	28.47
Estonia	:	:	:
Hungary	9.88	7.19	43.61
Latvia	7.10	9.88	38.43
Lithuania	10.46	10.19	58.48
Poland	10.81	7.37	30.31
Romania	:	:	:
Slovak Republic	8.23	7.11	28.80
Slovenia	25.42	:	46.62
Average	**13.35**	**8.14**	**38.94**
The EU			
Austria	11.24	6.80	38.39
Belgium	17.87	14.45	81.36
Denmark	25.81	13.91	79.24
Finland	33.48	16.87	59.13
France	:	:	:
Germany	13.99	7.28	45.92
Greece	16.40	21.83	87.32
Ireland	15.73	17.25	70.37
Italy	:	:	:
Luxembourg	26.92	23.14	105.42
Netherlands	19.36	9.39	33.57
Portugal	:	:	:
Spain	:	:	:
Sweden	26.19	19.16	96.95
United Kingdom	20.78	12.97	70.46
Average	**20.71**	**14.82**	**69.83**

SOURCE: UNECE-EMEP/MSC-W.

The table reveals considerable differences between the countries in CEE, as well as in the EU. In CEE, the Czech Republic and Slovenia have the highest levels of NO_2, which are higher than many EU countries. Other CEE countries have levels of NO_2, which are lower than most of the EU countries. The variations on emissions of NMVOC and CO in the countries are consider-

[25] DEPA (1998): *UNECE Task Force to Phase Out Leaded Petrol in Europe*. Danish Environmental Protection Agency. Copenhagen, Denmark.

able, but comparing CEE countries with the EU there is a clear tendency of lower levels in CEE.

Per capita *lead* emissions in CEE countries range from 0.5 grams in the Slovak Republic to 26.7 grams in Estonia (EU average levels around 7 grams)[26]. Poland was the largest absolute emitter of lead in CEE with 400 tonnes in 1996[27]. The contribution of motor vehicles to current lead levels in CEE is expected to decrease considerably with the phase out of leaded petrol. The table below shows the increasing market shares of unleaded petrol in CEE.

Table 2.15
Market share of unleaded petrol in CEE

Country	1990	1991	1992	1993	1994	1995	1996
Slovenia	3	9	20	29	36	45	54
Czech Republic					37	44	52
Hungary						49	64
Croatia	3		12	15	23	25	30
Slovakia	3	4	6	43	81	100	100
Poland					26	35	48
Estonia						77	81
Lithuania	76	74	69	64	41	78	98
Latvia							60
Romania						13	5
Bulgaria	<1	1	1	2	5	7	6

Source: UN/ECE: PAN-European strategy to phase out leaded petrol, 1998

The table illustrates a trend of increasing market shares of unleaded petrol in almost all CEE countries, which is a consequence of the measures that have been undertaken to phase out the lead. However, the table also shows that the market shares of unleaded petrol vary substantially among the CEE countries. On the one side of the scale, Slovakia and Lithuania that has almost achieved a complete phase out, and on the other side of the scale countries like Bulgaria and Romania display market shares of 5-6% of unleaded petrol.

Slovakia has achieved the complete phase-out in a very short period of time. In 1992 the market share was only 6% and three years later, lead was completely phased out of petrol. Slovakia managed to phase out the lead despite of the fact that a substantial share of the vehicle fleet consists of cars with soft valve seats. They solved this problem by using alternative additives produced and added at the refinery.

The table below shows the emissions of lead in terms of share of total emissions and emissions per capita.

[26] DEPA (1998): *UNECE Task Force to Phase Out Leaded Petrol in Europe*. Danish Environmental Protection Agency. Copenhagen, Denmark.
[27] DEPA (1998): *UNECE Task Force to Phase Out Leaded Petrol in Europe*. Danish Environmental Protection Agency. Copenhagen, Denmark.

Table 2.16
Lead pollution from transport (CEE, 1996)

	Emissions from Motor Vehicles		
	(tonnes)	***(share of total emissions)***	***(grams per capita)***
Bulgaria	136	54%	16.2
Czech Republic	227	79%	22
Estonia	40*	77%	26.7
Lithuania	10.1	59%	2.7
Poland	400	39%	10.4
Slovak Republic	2	:	0.5

* Data for 1995
SOURCE: DEPA (1998): *UN/ECE Task Force to Phase Out Leaded Petrol in Europe.* Danish Environmental Protection Agency. Copenhagen, Denmark.

Emissions of CO_2

Increasing anthropogenic emissions of gases, notably CO_2, that affect the absorption and emission of radiation in the atmosphere are believed to contribute strongly to global warming. As a result of climate change, global mean surface temperature has increased by between 0.3 and 0.6 °C since the late 19th century. Atmospheric concentrations of CO_2 increased from about 280 ppm to above 360 ppm over the same period[28].
The potential consequences of climate change include increases in sea level, more frequent and intense storms, floods and droughts, and changes in biota and food productivity. Climate change is also likely to affect human health through the shifts in the distribution of diseases, such as malaria and respiratory disorders[29].

The table below shows the development in CO_2 emissions per capita in the CEE and the EU.

[28] EEA (1998): *Europe's Environment: The Second Assessment. European Environment*
[29] IPCC (1996): *Second Assessment: Climate Change 1995.* Intergovernmental Panel on Climate Change. Geneva, Switzerland.

Table 2.17
Emissions of CO_2 from transport

	CO_2 (tonnes per inhabitant) 1990	1996	% change
CEE			
Bulgaria	1.20	:	:
Czech Republic	0.76	0.97	28%
Estonia	1.68	1.04	-38%
Hungary	0.73	0.66	-10%
Lithuania	1.55	:	:
Poland	0.74	0.73	-2%
Romania	0.34	:	:
Slovak Republic	:	0.78	:
Slovenia	1.63	:	:
The EU			
Austria	1.80	1.94	8%
Belgium	2.00	2.20	10%
Denmark	2.04	2.24	10%
Finland	2.39	2.15	-10%
France	2.17	2.32	7%
Germany	2.04	2.11	3%
Greece	1.50	1.64	9%
Ireland	1.39	1.84	32%
Italy	1.65	:	:

SOURCE: United Nations - Climate Change Secretariat (UNFCCC).

There are major differences between individual countries both with respect to the levels of CO_2 emissions per capita and the development trends. From the data available, the level of CO_2 emissions in CEE countries is only one third of the level in the EU. The levels in the EU are higher and also almost all display increases in emissions. Three of the CEE countries display decreases in CO_2, whereas the Czech Republic shows an increase of 28%. Decreases in CO_2 since 1990 can be explained by the economic recession seen in most CEE countries. Economic recovery would in most cases result in increases in CO_2 emissions.

2.5 Noise

Adverse health effects from noise

Traffic noise is a health problem because it is perceived as a nuisance and causes stress for human beings. Noise interferes with mental activities requiring attention, concentration and memory, and further, according to the WHO, exposure to transport noise can lead to serious annoyance, speech interference, increased blood pressure, stress and sleep disturbance. Children exposed to loud noise for a longer period of time has an increased probability of learning disabilities. However, sleep disturbance is probably the most serious effect in terms of its potential impact on human health after long term exposure.

The noise indicators

Data on health effects such as sleep disturbance, increase in blood pressure and physiological stress are normally not available. Hence, this section will primarily provide information on the percentage of people exposed to different levels of noise measured in L_{eq} dB(A)[30].

[30] The level of noise is measured in dB(A). The sound pressure level measured in dB is transformed into a so-called A weighted sound pressure level dB(A), which takes into account the frequency and fluctuation and reflecting the sound sensitivity of the human ear. The impact of noise on humans is measured in Equivalent Sound Pressure Level (L_{eq}), which is calculated as

The limit value for human exposure has been set to L_{eq} 55 dB(A) by the WHO, indicating that values above this level lead to unacceptable nuisance and deterioration of human health. The most common statistics on noise show the number or the percentage of population exposed to different levels of noise, measured in L_{eq} dB(A). This measurement is a simple method of estimating the overall nuisance of transport noise implicitly.

Unfortunately, only limited data on noise indicators are available. International standards for noise measurement and assessment have not been established, although reasonable national measurement methods exist, for example the Nordic model. The EU is underway with a standard noise measurement model, but so far data on the development trends and the comparability of data on noise pollution are generally poor. In EEA: *Europe's Environment* an overview of population exposed to noise from road, rail and air is presented. The overview is based on an OECD study from 1993 and a WHO study from 1994. According to EEA, these sources represent the most comprehensive survey in this area. Still, only few data on CEE countries are available.

Because of the above limitations, the following evaluation of the trends in transport related noise in CEE is only indicative.

2.5.1 **Road traffic noise**

Traffic noise is typically the largest contributor to noise in urban areas, and road traffic noise is by far the largest contributor to transport noise. However, the severity of the problem of road traffic noise varies across Europe.

Figure 2.3 shows the percentage of population exposed to traffic noise levels above the limit level 55 dB(A). The figure includes data for the Czech Republic[31], Slovakia, Poland and Hungary in 1990 -1992, which are the only CEE countries for which data are available in the EEA report. For comparison data is shown for selected Western European countries for the same period[32].

The percentages in the table are cumulative, which means that for example, the percentages of people exposed to 55 dB(A) includes the percentage of people exposed to >60 dB(A).

Although comparisons and interpretations of data should be made with great care, the figure shows that road traffic noise is apparently a major problem in Slovakia with more than 80% of the people exposed to noise levels above 55 dB(A), and 57% exposed to an "unacceptable"[33] level of noise (>65 dB(A)). The percentage of the population exposed to road traffic noise in Slovakia is significantly higher compared to percentages in Poland, Hungary and the Western European countries in the table.

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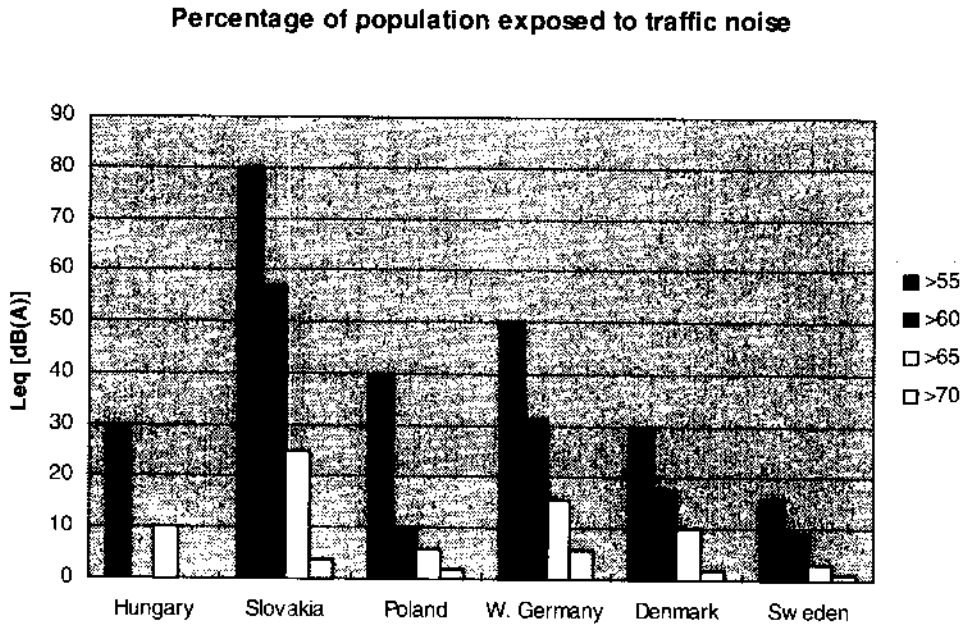
the mean value of sound intensity over time expressed in decibels. The measurement of noise is thoroughly described in EEA's: *Europe's Environment.*

[31] Please note that more recent data for noise exposure in the Czech Republic is presented in the case study.

[32] It should be noted, that noise abatement measures may have changed the share of population exposed to noise from 1990-92 till today. However, the data presented are the latest international data available.

[33] This is WHO's definition of the terms undesirable and unacceptable.

Figure 2.3
Noise exposure due to road traffic



Source: Europe's Environment. Statistical Compendium (OECD 1993, WHO 1994). The reference year is 1990 for Czech Republic, Slovakia, W. Germany and Denmark, 1991 for Hungary and Sweden and 1992 for Poland.
Note: Comparison of the data should be made with great care, since a variety of estimation methods have been used in the different countries and the time of collecting data is not matching.

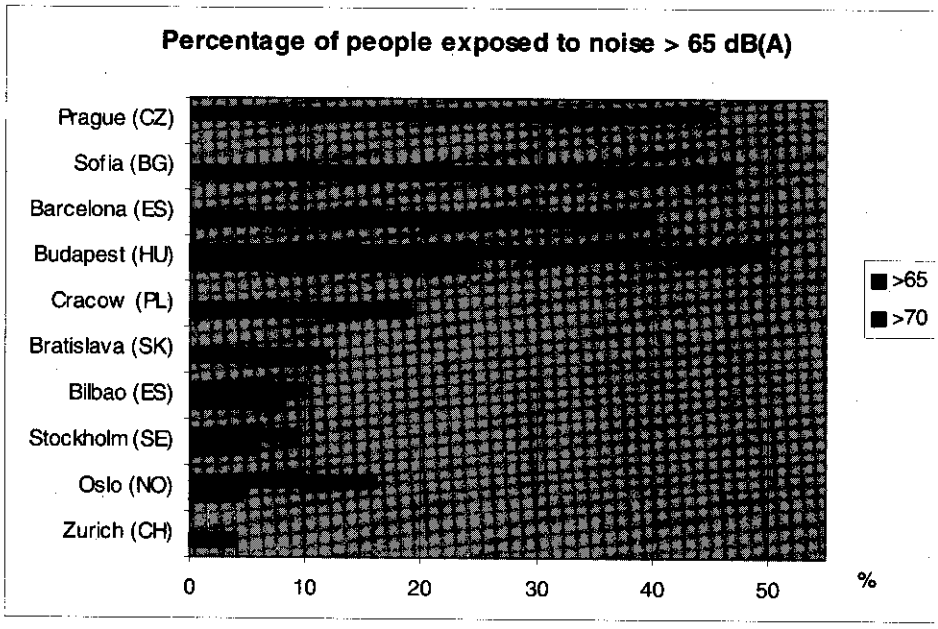
It is difficult to assess the overall trends for noise exposure due to road traffic in CEE from the limited data presented in the figure. However, the problem of traffic noise seems serious for the CEE countries presented in the table and the problem is likely to increase in the future due to increases in traffic volumes. For comparison, according to EEA about 50% of the European population are exposed to road traffic noise levels above 55 dB(A) and about 10% are exposed to levels above 65 dB(A).

2.5.2 Noise in urban areas

The share of the population exposed to unacceptable levels of noise is much higher in large cities compared with the national average. Thus, studies in the former West Germany have shown that the percentage of people annoyed by street noise increases with the number of inhabitants in a city[34].

[34] Source: EEA: Europe's Environment.

Figure 2.4
Noise in selected European Cities



Source: EEA: *Europe's Environment, Statistical Compendium*

Figure 2.4 shows the percentage of people in selected European cities exposed to noise levels above 65 dB(A). The CEE cities appear to be noisier than the Western European cities. 50% of the urban population in Budapest and about 45% of the urban population in Prague is exposed to more than 65 dB(A), which is well beyond the acceptable level of noise. In Sofia 47% and in Bratislava 12% are exposed to levels above 70 dB(A). Only few Western cities are included in the EEA report. However, many Western cities also have high noise levels.

2.5.3 **Rail and air traffic noise**

There are only few international statistics available for railway and aircraft noise. Therefore, only a few comments will be made on this development.

Railway noise

Railway noise is generally regarded as less disturbing than road noise[35]. A study on railway noise in Germany, France and the Netherlands estimated that around 10% of the EU population (EU-15) is exposed to railway noise greater than 55 dB(A)[36]. A similar figure for CEE countries is not available. The future trend in railway noise will depend on the future rail traffic volume, technological development and the implementation of noise abatement measures, such as noise screens.

Aircraft noise

The future trend on air traffic noise will depend on the technological level of new aeroplanes and on the development in air traffic. On the one hand, the technological development will entail use of quieter aeroplanes that will reduce the problem and on the other hand expected growth of air traffic will increase the problem. Within CEE rapid growth in air traffic is expected in the coming years and it is not likely that this increase will be counterbalanced by introduction of comparable noiseless planes. This indicates that the number of people exposed to air traffic noise will increase in CEE.

[35] Research show, that noise from railway traffic is perceived as less annoying, comparable to a difference of 5 dB(A).
[36] Lambert J. and Vallet M.: Study related to the preparation of a communication on a future EC noise policy, 1994.

2.5.4 **Noise abatement measures**

Factors affecting the noise impacts

The level of noise depends on the noise emitted, the conditions for spreading and the conditions for reception. The level of noise emitted depends on factors such as:

- The traffic volume
- The share of heavy vehicles
- The motor sound
- Speed
- The vehicle friction (types of asphalt and tires)

The conditions for spreading and reception depend on factors including:

- The conditions for spreading, including noise screens, buildings and natural barriers
- The 24-hours distribution
- The routes of traffic
- The spatial distribution of dwellings and infrastructure
- Insulation of buildings

The impact of noise can thus be reduced in various ways. First of all, noise depends on the volume of traffic, which therefore may be reduced by redirecting traffic from residential areas and by introducing petrol taxes and other economic instruments. Factors such as noise qualities of motors, tires, roads (asphalt types, age); the distribution of road traffic on heavy and light vehicles; speed limits; noise screens; traffic regulation; spatial planning; incorporation of noise considerations in infrastructure planning and insulation are other examples of measures to reduce noise.

At low speeds the sound from vehicle engines dominates the noise emitted, whereas at higher speeds the sound from friction between tires and road surfaces dominates the noise picture.

Urban and residential areas are the most noise sensitive areas, since many people live and work there.

In Western Europe measures to reduce traffic noise have been implemented in a number of countries. Stricter standards for noise from vehicles, traffic calming measures (reduced speed limits and traffic management), noise barriers and noise insulation are some of the measures used in reducing transport noise pollution.

A number of the CEE countries have also applied instruments for noise abatement[37].

2.5.5 **Challenges**

Because of limited data on the share of the populations exposed to transport noise, it is difficult to assess the trends in noise exposure during the last years in many of the European countries (including CEE). Nevertheless, in accordance with WHO, there is not only growing evidence that noise has become a concern for an increasing number of national authorities during the last decade, but there is also growing evidence that road traffic noise is the most widespread source of nuisance in European cities.

The challenges for CEE countries, as well as for other European countries, are to develop standardised noise measuring methods; to secure acceptable

[37] See Chapter 3 and 4 on case studies on the Czech Republic and Bulgaria.

noise levels when constructing new infrastructure and establishing new housing areas; and - most difficult - to establish programmes for reducing noise in existing buildings and by existing infrastructure. These existing noise problems are likely to increase as a result of the expected increases in road traffic in CEE countries.

2.6 Cycling

Cycling and walking beneficial to health

Not all means of transport are associated with external adverse effects on environment and health. Walking and cycling does not lead to noise and congestion nor does it contribute to the air pollution. Furthermore, means of transport such as cycling and walking lead to health benefits by providing physical activity. According to WHO, the benefits of physical activity comprise of a number of effects. Among other things physical activity dramatically reduces

- the risk of developing coronary heart diseases,
- the risk of developing adult diabetes,
- the risk of becoming obese,
- the risk of developing hypertension,
- Blood pressure among people with hypertension.

So, how much physical activity should be generated in order to provide effective and significant benefits? Again, according to WHO, a total of 30 minutes of cycling or brisk walking on most of the days of the week will reduce the risk of the above diseases with 30-50%. The exercise is sufficient even if it is carried out in episodes of 10 to 15 minutes.

Of course, using means of transport such as walking and cycling is not the only way to exercise and therefore it is not the only activity that promotes health, but nevertheless sedentary lifestyle have been found to be one of the largest risk factors for coronary heart disease and stroke. Hence, promoting walking and cycling will not only reduce the direct adverse environmental and health effects, but it would also prolong the average lifetime in the society, since coronary heart disease and stroke are the leading cause of death in Europe.

2.6.1 The overall trends in CEE

Lack of data

There are no cross-country quantitative data of the share of cycling and walking in the CEE countries, just as none of the CEE countries, according to information collected, have comprehensive nation-wide statistics on cycling. Therefore, it is only possible to indicate the trends based on qualitative information provided by various cycle experts in CEE and via the case studies of Sofia and Prague.

Cycling not widespread in CEE

Cycling is not a widespread transport mean in CEE, even if the level may deviate from country to country[38]. Overall the level of cycling in CEE is very low and cycling is not seen as a real transport mean but rather serving sports and recreation purposes. The social climate for cycling (and walking) is not very conducive because of their low status as transport modes.

38 There is for instance a great variation in the use of cycling throughout the EU-countries. Person-cycling-km per person per year ranges from 20 km in Spain to more than 850 km in Denmark and the Netherlands. There are no such enormous varieties in the CEE countries but of course they deviate from each other also in respect of cycling intensity. Such differences may not be accurately captured in this text du to lack of statistical information on cycling.

Decreasing cycle rates in rural areas

All information complied in the course of this project points to the following change in cycle patterns in the CEE countries during the 1990s: Cycling was quite popular in *rural areas* before the political and economic revolution. It was favoured of economic reasons and due to poor transport alternatives. This was e.g. the case in Hungary, Poland, Slovakia, Lithuania, Bulgaria, and the Czech Republic. Now the share of cycling is either constant or loosing ground in rural areas at the expense of private car transport.

Increasing cycle rates in urban areas

The reversed trends can be observed in *urban areas*. The city transport planning did not consider cycling as a transport means at all, and a bicycle in a city therefore used to be a very rare sight! Now cycling in cities is getting increasingly popular, albeit from a very low level. This popularising trend is backed-up by the following factors: 1) Mountain bikes are becoming fashionable among youngsters, 2) rising fares for using public transport and 3) increasing congestion problems. Still, cycling is not yet considered a "normal" transport means in any city in CEE.

2.6.2 The trends in selected CEE countries

Trends from four CEE countries are briefly presented below. The development has been pretty similar in all countries. According to various national experts and international cycle trend experts, the development in these countries is pretty much in line with the development in the whole region but it is of course not possible to draw clear-cut conclusions for the whole CEE region based on only four countries.

Poland

Cycling is quite popular in small towns. The cycle rate is low but increasing in larger cities where cycling used to be almost unknown. In general, cycle conditions are very poor with very few bicycle tracks and lanes (in Warsaw, Vroclaw, Gdansk, and Cracow), poor road maintenance, and poor enforcement of traffic rules. According to traffic research carried out by the municipality of Cracow 10% of adults say the cycle every day or often but only 1% of home-work trips are performed by bicycle. Cycling is promoted primarily by grass root organisations like "Cities for Bicycles Network". In 1997, the new traffic code was approved and it was favourable to the cyclists. [39]

The Czech Republic

The share of cycling in the overall transport pallet is negligible in the Czech Republic. A programme of marking and development of cycle routes is now in progress, according to which Prague should have some 180 km of bicycle routes. However, it would be unrealistic to expect cycling to gain a solid foothold in Prague. There are no tradition for cycling in the capital, it is perceived as a low status transport mean, and the road surface with cobble stone does not stimulate cycling nor does the intense and poorly regulated road traffic in Prague.[40]

Bulgaria

Like in other CEE countries, there is no tradition for bicycling in Bulgaria. The situation seem to be typical for the whole region as well: City planning has been carried out without integration of cycling; cycling is perceived as a low-status transport means; it is unsafe to go by bike in larger cities due to intense car transport and lack of compliance with traffic rules. The National Environmental Health Action Plan (1997) states that bike transport shall be promoted, e.g. by way of improvement and enlargement of the bike lane system. However, the plan does not endorse any specific action in regard of this.[41]

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[39] Source: Marcin Hyla from the network "Cities for Bicycles". See the web side http//www.bikenews.org/1997/08.htm for further information.
[40] Source: Information compiled as part of the case study of Czech Republic/Prague.
[41] Source: Information compiled as part of the case study of Bulgaria/Sofia.

Lithuania

Also Lithuania lacks updated statistics on cycling. However, it is clear that the situation for cycling has changed significantly the last 10 years. There was an increasing interest in bicycling during Soviet economic blockade in 1990 but since 1992 bicycle use has decreased because of drastic increased number of second hand cars brought from Western Europe. This is in particular the trend in smaller towns. Cyclists are treated badly in the traffic, probably because cycling since long time is perceived as transport means only for children and pensioners. In Lithuania, bicycle tourism is seen as a tool to promote bicycle transport infrastructure development.[42]

2.6.3 Barriers to cycling - and measures to overcome them

Physical barriers

As already mentioned there are several barriers to a more widespread use of cycling in CEE. Some of the obvious physical barriers are:

- The main barrier is that cycling is not integrated in the traffic (and in traffic planning), hence cyclists are seen as alien objects to other road-users.

Substantial increase of cycling requires investments in e.g. the structures that make cycling an advantageous transport alternative, that means: Construction of market cycle lanes, cycle tracks, and well-established bicycle network; integration of bicycles in all new road schemes (as a minimum); and rearrangement of traffic lights to include cyclists.

- Lack of cycle parking facilities in central origins in the cities. Therefore parking facilities should be improved.

- Poor integration of bicycling and public transport. Bicycles and trains (trams, trolley-buses) are complimentary by nature. The former are effective and flexible for shorter distances, the former are an energy efficient transport mode for longer distances. To achieve the synergy, public transport should be re-arranged as to be attractive to cyclists (parking facilities at rail stations, systems to allow the cycles as accompanied luggage.

Cultural and psychological barriers

Even if the physical barriers are enormous, the cultural and psychological barriers may be even bigger obstacles. They are, e.g. the following:

- In spite of the fact that cycling is perceived as a low status transport mean compared to "fashionable" individual car transport, cycling is becoming more and more accepted among young people primarily for sports and recreation.

- There is a lack of a reasonable "bicycle climate" resulting in cyclists being overlooked in the traffic. Non-compliance from the side of other road-users with existing traffic codes adds to the cyclist's troubles. Consequently many cyclists does not experience a reasonable "subjective" (experienced) safety.

  The attitudes to cyclists from the society must therefore be improved, especially from other road-users that should be aware of the cyclists and drive with a necessary caution towards them. The change of attitudes can not be achieved over-night, but will need a period of time and a significant campaign activity. Campaigns should be directed towards the actual road users with a three-fold aim: a) making the road users aware of the cyclists, their needs and their behaviour; b) making the public

[42] Source: Saulius Ruzinskas, head of the Bicycle Information Centre in Lithuania.

aware of the benefits of cycling; and c) converting the potential cyclists to active cyclists.

3 Case study: The Czech Republic

3.1 Introduction

This chapter presents the trends in the Czech transport development and describes transport generated health and environmental problems, focussing on the capital city of Prague. The chapter is based on official statistical and other documents, interviews with officials in central government agencies, and other expert assessments.

Highlights on the Czech Republic

Geography. The Czech Republic is a Central European state having borders with Germany, Austria, the Slovak Republic, and Poland. The population is 10.3 million of which 1.2 million live in the capital city of Prague. It occupies 79,000 sq. km ranking it among the smaller European countries.

Politics. The Czech Republic is a multiparty, parliamentary democracy. The Czech government (since June 1998) is formed by the Social Democratic CSSD headed by of Milos Zeman. It is a minority government. Main opposition party is the ODS (Vaclav Klaus). The first democratic parliamentary election in 42 years was held in 1990, marking the end of the communist era. In 1992 the former Czechoslovakia was separated, and the Czech and the Slovak Republics was established.

Economic development. Political and financial crises in 1997 shattered the Czech Republic's image as one of the most stable and prosperous of post-Communist states. The currency was forced out of its fluctuation band. After expending $3 billion in vain to support the currency, the central bank let it float. Czech difficulties in 1997 contrast with earlier achievements of strong GNP growth, a balanced budget, and inflation and unemployment that were among the lowest in the region. GDP was increasing in the period 1993-1998 after a drop in 1991 and 1992. Forecasts project economic growth the coming years.

Relation with the EU. The Czech Republic applied for membership of the European Union on 17 January 1996. Accession negotiations began on 31 March 1998. The Czech Republic expects to enter the EU in year 2003.

3.2 Transport development

Passenger transport volume and modal split

The overall passenger transport volume in the Czech Republic has been moderately increasing in the recent years to a level of approximately 95 billion-passenger km per year. The increase is due to a significant growth in passenger car transport (and air transport) whereas rail transport and public road transport have lost ground.

Table 3.1
Development in passenger transport volume by mode of transport (Million passenger km)

Means of Transport	1994	1995	1996	1997	1997-level in % of 1994 level
Rail transport	8,481	8,023	8,111	7,721	91%
Public road transport*	11,523	10,963	9,735	8,804	76%
Air transport	2,605	3,148	3,170	3,525	135%
Waterway transport	n.a.	8	8	8	n.a.
Car passenger transport**	51,700	54,500	57,900	59,000	114%
Mass urban transport***	15,463	15,565	15,789	15,933	103%
Total	*89,772*	*92,206*	*94,713*	*94,990*	*106%*

Source: Transport Yearbook 1997 (Ministry of Transport and Communications)
*) Excluding urban bus transport
**) Estimate
***) Urban bus, trams, trolley-bus and metro traffic. Originally given as seat km. Estimate of passenger km is based on expert assessments (seat km are are converted to passenger km by multiplying by 0.5)

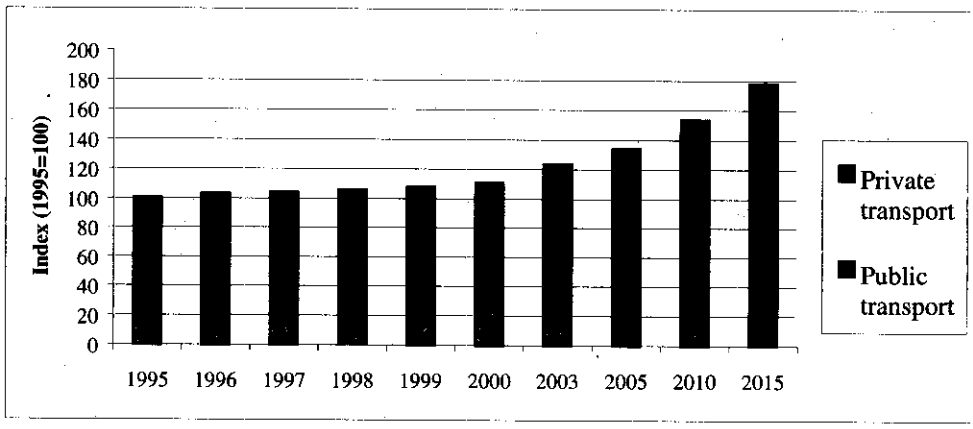
Comparison with the EU-countries

On average, every Czech travels 5,600 km per year on roads. The corresponding figures for Germany, Denmark, UK, and Portugal are in the range of 9,000 to 12,000; hence even if road transport has increased significantly in the Czech Republic it is not at a level of Western European countries.

Traffic growth in the future

In the period 1995-2005 overall transport volume is expected to increase with no less than 80%.

Figure 3.1
Prognosis for passenger transport (passenger km, public and private transport (1995=100)



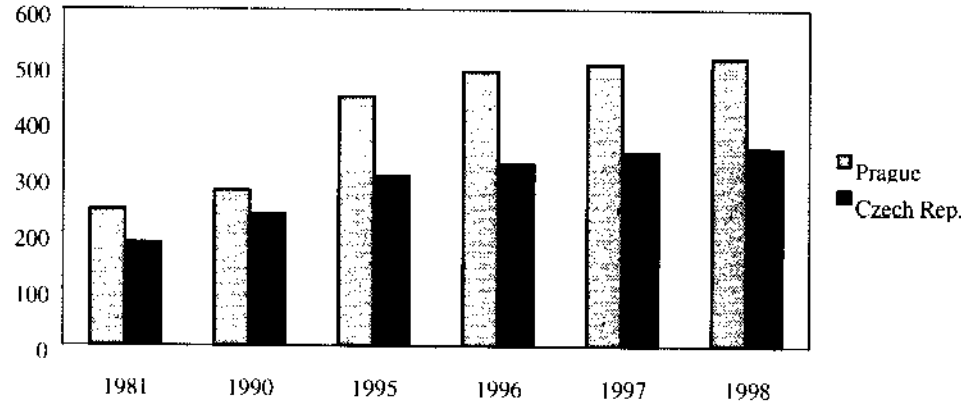
Source: The Ministry of Transport and the Czech Bureau of Statistics (1999).
Note: The prognosis does not contain Mass Urban Transport; hence the relative share of public transport is lower than in Table 3.1.

The volume of private transport is expected to increase by 70% by 2015, while the volume of public transport will double in that period.

Vehicle fleet

The increased share of car passenger transport is not surprising since the number of passenger cars in the republic has been constantly increasing during the last decades, and in particular since 1990.

Figure 3.2
1981 to 1998 Personal car motorization (cars per 1000 inhabitants).



Source: Transport Yearbook Prague 1998 (Institute of Transportation Engineering of the City of Prague, 1999).

In 1961, the number of passenger cars per 1,000 inhabitants in the Czech Republic was only 21 while in 1998 it was 352. Czech traffic experts assume that the saturation point for motorization in the Czech Republic will be around 500 vehicles per 1,000 inhabitants.

The increase has been even higher in Prague: since 1991 the number of cars as well as the volume of car traffic has had an explosive boost that is unprecedented in Europe, apart from the former East German cities. With its 511 cars per 1,000 inhabitants, Prague now ranks among the most motorised cities throughout the world. The passenger car volume has risen by 111% in the period 1990-1997 whereas the number of persons transported by way of public transport in Prague on an average workday has decreased with 20% during the 1990s.[43] It is therefore beyond doubt that the passenger car is the "winning" mean of transport in Prague. The growth rate for the passenger car transport has slowed down somewhat during the recent years.

The high increase of passenger car traffic in Prague has been caused by a number of factors. The most important are: A greater number of car owners; a modal shift of some commuters from the public transport system to using own cars; increased mobility of population; and an increased number of motorised visitors of Prague.

Cycling and walking

No statistics on cycling and walking is available but the share of cycling is negligible. Cycling is not considered a "normal" transport mode in most parts of the Czech Republic but is seen as having a recreation or sports character. Following the official transport policy[44] cycling should be encouraged as part of an environment friendly life-style. A programme of marking and development of cycle routes is now in progress, according to which Prague should have some 180 km of bicycle routes. However, it would be unrealis-

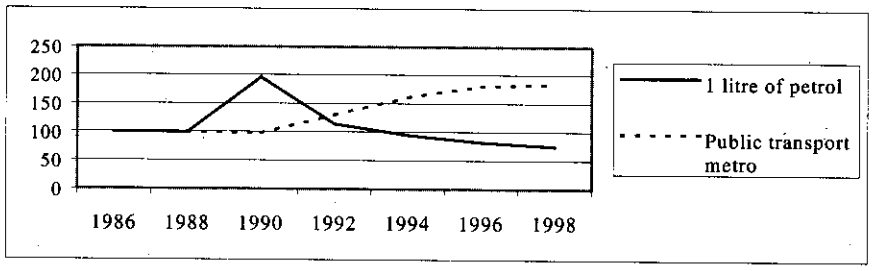
[43] Public transport in Prague consists of three main transport means, namely 1) the metro which in 1998 carried 39% of the total passengers using the municipal public transport, 2) the tramway network (31%) and 3) the buses (30%).
[44] See the document "Transport Policy of the Czech Republic" (Ministry of Transport and Communications)

tic to expect cycling to gain a solid foothold as a mode of transport in the near future, since there is no tradition for cycling. Further, cycling is regarded as a low status mode of transport, and the road surface with cobblestone does not invite cycling. On top of that is the safety aspect. The intense and poorly regulated traffic in Prague does not really give place to cycling.

Transport prices

In the figure below the development in transport prices is compared. The cost of 1 litre petrol and the price of a ticket to the Prague Metropolitan Railway is given for a number of years, with 1986 as the starting point (=100). The prices are corrected for inflation by using the consumer price index.

Figure 3.3
The relative price development for passenger car transport (petrol) and public transport in 1986-1998 (1986=100).



The figure demonstrates that public transport has become relatively more expensive compared to private transport (the price of petrol) in the recent years. The price of a ticket to the Prague Metro has almost doubled, in fixed prices. The economic incentive structure has thus developed in an unfavourable way for public transport.

Factors influencing modal split

To halt the decline in public transport and to avoid a threatening collapse of road transport in the Prague greater area, several measures are used, for example:

- Preference to public transport. 45% of Prague city council budget 1998 (equal to 12.4 billion CSK) is allocated to transport purposes, and 70% hereof are directed to the public transport sector. Subsidisation to public transport is expected to increase in the future.[1]
- Concerning investments in new infrastructure the same pattern prevails in Prague as 41% of capital costs in 1998 were allocated to roads, while 59% were allocated to the construction and reconstruction of the Underground railway and the electric tramway tracks.[2]
- Restriction of passenger car transport. Establishment of parking zones, stricter enforcement of traffic regulation, and use of traffic lights to steer amount of traffic in the city.

On the other hand it should not be overlooked that the transport authorities seek to improve the general road traffic infrastructure in Czech Republic. Building of new motorways, ring roads, and improvement of road quality, without seeking to promote public transport, bicycling and walking, may induce increases in car traffic, since it makes car transport relatively more attractive. Even if transport volumes may not primarily be determined by the

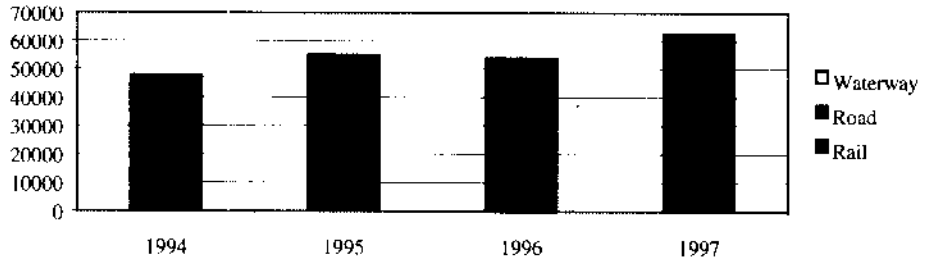
[1] Following the 1999-budget, public transport in Prague will be subsidised with 11,500 billion CSK. 8% hereof is allocated via the state budget.
[2] Source: Institute of Transportation Engineering of the City of Prague.

supply of infrastructure, the quality of the various transport means influences the modal split. For the country as a whole transport infrastructure building is already now focussed on road transport for. Total investments in rail network, airports, and waterways in 1997 were less than half of the amount, used on the road transport network. New road building schemes are in the pipeline. Road projects worth 150 billion CSK - intended for implementation the next 10-15 years - are already planned.

Goods transport

In spite of the recent slow economic development in the Czech Republic, in the period 1994-1997 the goods transport (measured as million tonne km) has increased by 30%.[1]

Figure 3.4
The development in goods transport - volume and modal split (million tonne km)



Source: Transport Research Centre, Prague. Note that 1997 was the first time using the Eurostat's methodology for collecting statistical data on goods transport, hence comparing between 1997 and the other years should be done with some caution.

The increase is not equally divided by transport modes. Less goods have been transported by rail and waterway transport since 1994, whereas the amount of goods transported on roads increased by almost 80%. The strong position of road transport vis-à-vis rail transport is expected to be further reinforced in the future.

3.3 Transport generated health and environmental problems

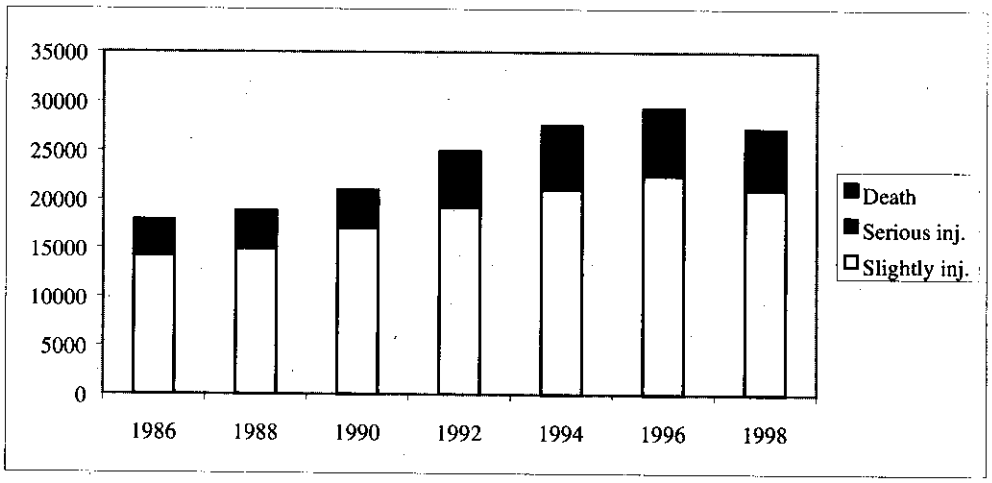
3.3.1 Accidents

Accidents in the Czech Republic

Close to 30,000 road accidents involving injury takes place every year in the Czech Republic. The number of people killed in road traffic accidents peaked in the mid 90s where close to 1,600 lost their lives every year. Recent years have seen a slight improvement; still, the number is higher than around 1990, when the road traffic was not as intense as now.

[1] 1994 is the first year where data is available for the Czech Republic. Other data concern the former Czechoslovakia.

Figure 3.5
The development in road traffic accidents in the Czech Republic, 1986-1998[48]



Note: The figure illustrates the number of accidents causing deaths or injuries (and not the number of deaths and injured).

Unfavourable trend in Prague

For Prague alone, since 1990 the basic trend has turned unfavourable as traffic accidents started to increase faster than traffic volume. Consequently, the accident risk rate also grew, which is expressed through a relative accident rate parameter (number of accidents per one million vehicle-kilometres covered).

Table 3.2
Traffic accidents, injuries and the relative accident rate in Prague, 1981-1998

Year	Total no. of accidents	Fatal injuries	Serious injuries	Slightly injuries	Relative accident rate
1981	13,064	81	401	2,572	7.1
1990	18,024	91	369	2,806	7.5
1995	33,898	123	679	4,044	7.9
1996	38,091	85	654	4,048	8.3
1997	39,473	90	539	3,720	8.0
1998	42,131	65	535	3,568	8.3

Source: Transport Yearbook Prague 1998 (Institute of Transportation Engineering of the City of Prague.

Low traffic discipline

One of the chief factors of this unfavourable development is a deterioration of traffic discipline with drivers as well as pedestrians, insufficient enforcement of the traffic rules and more of the easy-going, reckless and hazardous attitude. According to Prague traffic experts no further improvements in the number of road traffic accidents should be expected. Stabilisation at the present level or a mild decrease is the most likely development for the coming years.

Policy to reduce accidents

No objectives for the future level of accidents are formulated in the transport policy but two action plans have been launched for road safety increase. The following measures are suggested:[49]

- The human factor, e.g. better education, better control of taxi driver performance, adoption of rules to regulate behaviour of drivers and pedestrians at crossings, etc.

[48] Source: Transport Yearbooks (Ministry of Transport and Communications).
[49] Source: "Transport Policy of the Czech Republic" (Ministry of Transport and Communications, 1998).

- Vehicles. Stricter conditions for import of used cars, speed limits for lorries and buses, introduction of telematics into vehicles, etc.

- Transport infrastructure, e.g. adjustment at points of frequent accidents; adjustment of crossroads and pedestrian crossings, construction of by-passes around communities, calm zones in communities, introduce measure to force drivers to adhere to road traffic rules and speed limits, etc.

3.3.2 Air pollution

Total air pollution has been reduced

The Czech Republic is one of the countries worldwide, that have suffered most from air pollution. The levels of SO_2, and other atmospheric pollutants, have taken a serious toll on the health of the Czech population and have cased extensive damage to forests. Therefore it is encouraging that the total air pollution emissions in the Czech Republic have been significantly reduced. Since 1992 the emission of particles has been reduced by a factor 4, the emission of SO_2 has been more than halved, and the total emissions of NOx, CO, and HC have dropped 40%, 16%, and 12%, respectively.[50]

Negative trend for transport sector

For the transport sector, the trend is very different:

- The absolute level of transport generated air pollution is increasing

- The share of transport generated air pollution of total air pollution emission is increasing rapidly.

Table 3.3

Transport generated air pollution emission, 1992-1997

	Particles		SO_2		Nox		CO		HC	
	Ton/year	% total emission	Ton/year	% total emission	Ton/year	% total emission	Ton/year	% total emission	Ton/year	% total emission
1992					210,356	30.2	210,269	20.1	72,465	35.3
1993					210,356	36.6	210,269	21.8	72,465	35.5
1994	8,020	2.3	7,450	0.6	199,046	45.8	285,412	27.8	72,656	36.3
1995	6,766	3.4	7,478	0.7	193,494	46.9	266,427	30.5	72,349	44.1
1996	10,154	5.7	8,421	0.9	226,601	52.5	291,754	32.9	81,836	46.4
1997	10,085	7.9	9,581	1.4	235,743	55.7	348,153	39.7	96,455	53.4

Source: Statistical Environmental Yearbook of the Czech Republic (The Ministry of the Environment of the Czech Republic, 1998).

Note: No data available on transport generated CO_2-emission in the Environmental Statistics.

It appears that transport is a significant source of pollution for the following air pollutants: CO, NOx, and HC. This is also the case for lead (not included in *Table 3.3*). For lead, the problem is expected to be solved in the future when the unleaded petrol becomes the only accepted norm of petrol. Already now, 63% of all petrol consumed is unleaded.[51] Moreover, the transport generated share of particles pollution has increased rapidly the recent years.

Need for action

In the light of the expected transport growth until year 2015, *Table 3.3* demonstrates that e.g. the renewals of the rolling stock (increasing number of vehicles equipped with catalytic converters) is of importance to counter the development in transport generated emissions. Vehicles with catalytic converters made up more than 20% of the car fleet in 1997 compared to only 5.6

[50] Source: Statistical Environmental Yearbook of the Czech Republic 1998 (The Ministry of the Environment of the Czech Republic).

[51] Source: Prague Environment. Trends and Statistics (Institute of Municipal Informatics of the City of Prague, 1998).

in 1992.[52] An increase in the number of vehicles equipped with catalytic converters is anticipated.

Air quality assessment[53]

The table below gives the Czech air imission limits; in parenthesis WHO guidelines is mentioned. It appears that daily particles limit value is not as strict as WHO guidelines whereas the Czech CO limit values for CO are stricter than the WHO-guidelines.

Table 3.4
Imission Limits applying to air pollutants ($\mu g/m^3$)[54]

Pollutants	Yearly limit	Daily limit	Half-hour limit
Particles	60	150 (120)	500
SO_2	60	150	500 (500, 10 min.)
NO_2	80	100	200 (200, 1 hour)
CO		5 000 (10 000, 8 hours)	10 000 (60 000)
Lead	0.5		

Note: Numbers in parentheses are WHO guidelines.

Together with North Bohemia and the Ostrava region, Prague ranks among the regions of the country that are most affected by air pollution. This is e.g. the case for **particles pollution.** Even if the total yearly mean concentration has been halved since 1985 the imissions levels were dramatically exceeded in 1997 at several monitoring stations. Yearly mean concentrations ranging between 40 and 50 $\mu g/m^{-3}$ account for the largest part of the territory of Prague (54%).

Yearly **sulphur dioxide** concentrations did not exceed the annual limits and only in few cases were daily limits exceeded. Except for one monitoring station in Prague the yearly mean of the monitoring stations in the territory of Prague was below on half of the concentration limit. Yearly mean concentrations ranging from 20 to 30 $\mu g/m^{-3}$ thus account for 70% of the territory of Prague.

Prague and especially its central part shows the highest concentration of **nitrogen oxides** in the republic, with a slightly growing trend due to increasingly dense traffic. In 1997, all the air quality monitoring stations in Prague, except one, registered momentary exceeds of the NO_2 limits. The yearly limit was exceeded at no less than eight stations. Local air pollution experts expect that at best only a mild improvement in air quality in Prague in regards of nitrogen oxides should be expected for the next decade.

Carbon monoxide limit concentrations were exceeded very seldom in 1997. Compared to other atmospheric pollutants, CO thus remains the least problematic substance in Prague.

The concentration of **lead** has been close to halved at most monitoring stations since 1988. The highest lead concentrations are found in the centre along the business streets.

Overall, air quality in Prague has improved during the last decade; however particles and nitrogen dioxide remain pollutants which have not been

[52] Source: Statistical Environmental Yearbook 1998 (The Ministry of Environment, 1998).
[53] Source: The description is based solely on Prague Environment 1998 (Institute of Municipal Informatics of the City of Prague, 1999).
[54] Source: Prague Environment 1998 (Institute of Municipal Informatics of the City of Prague, 1999) and Urban Air Quality in Europe (European Environment Agency, 1998)

brought down to a level in concurrence with the unit values. The level of nitrogen dioxides even seems to be increasing due to traffic increases.

Policy to reduce air pollution

Main themes in the efforts to reduce transport air pollution are:[55]

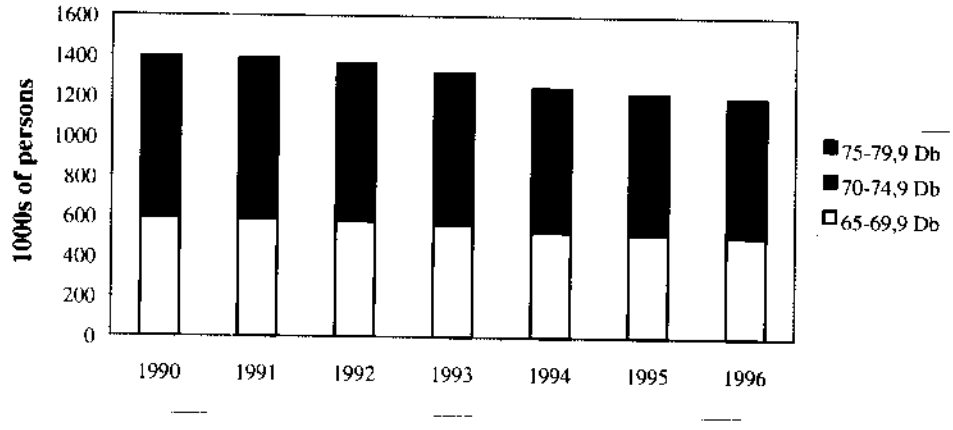
- Gradual shifting of passenger and goods transport from road to other more environmentally friendly modes of transport
- Introduction of economic instruments (internalisation of external costs)
- Development of non-motorised transport modes (cycling and walking)
- Integrated approach to transport infrastructure planning (including ecological and social aspects)
- Introduction of integrated public transport systems.

3.3.3 Noise

The Czech Republic in general

Close to 1.3 million people in the Czech Republic are disturbed by transport generated noise levels above 65 dB(A). Out of these 80,000 people are plagued by noise from transport in the magnitude of 75 dB(A)+. Since 1990 the number of transport noise plagued people throughout the country has been constantly decreasing, albeit at low speed.[56]

Figure 3.6
Development in the number of people in the Czech Republic disturbed by noise from transport

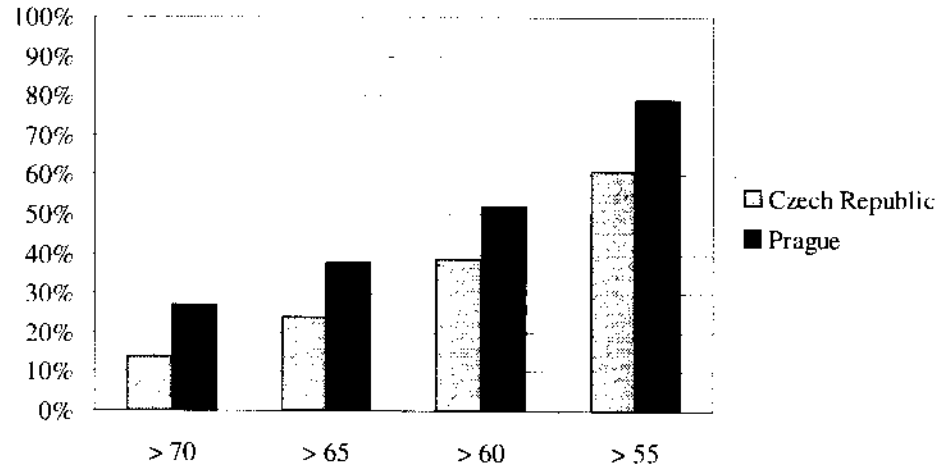


Noise problems in Prague

Noise is also a major health and environmental problem in Prague where no less than 27% of the inhabitants, equal to 326,000 inhabitants, are exposed to noise levels above 70 dB(A). Close to 80% of the inhabitants in the capital have to live with noise levels above 55 dB(A), see figure below.[57]

[55] Source: "Transport policy of the Czech Republic" (Ministry of Transport and Communications, 1998).
[56] Source: Transport Yearbook 1996 (Transport Research Centre & the Ministry of Transport and Communications).
[57] Noise is monitored in so-called test areas (totalling 29,526 persons).

Figure 3.7
Percentage of inhabitants exposed to various noise levels



Note: The numbers in the figure deviate slightly from noise figures previously presented due to different sources. The percentages in the table are cumulative, which means that for example, the percentages of people exposed to 55 dB(A) includes the percentage of people exposed to >60 dB(A).

The percentage of Prague's inhabitants affected by excessive noise is very high. The reasons are mainly: High concentration of people in a relatively small area; an increasing number of registered vehicles; an inadequate road system; transit traffic through Prague resulting from the absence of adequate ring roads; and the disrepair of roads which are not designed to cope with today's traffic load.

In the course of the past 15 years, however, the noise load has not worsened in most areas in Prague, despite increased transport. Until 1989, there were few but very noisy cars and trucks. No official prognosis for the future is available. Local noise experts assess that either a stabilisation or even a mild degradation of the current situation should be expected.

Comparison with other cities

The percentage of people in Prague exposed to noise above 65 dB(A) is high compared to other European cities. Sofia, Barcelona and Budapest are examples of other cities with high levels of noise, whereas the noise levels in many Western European cities are considerably lower. See Figure 2.13.

Policy to reduce noise problems

There are no overall quantitative targets for noise pollution in the Czech Republic but noise load reduction plans have been in existence for some 20 years. All new vehicles must comply with EU noise standards and new housing estates are designed in accordance with EU-standards. The construction of ring roads around Prague and other major cities may decrease the number of noise plagued citizens. All significant roads, particular in Prague, are provided with noise abatement measures without which the roads would not be accepted for construction. Moreover, there are plans for a more extensive use of noise screens along main roads.

3.4 Conclusions

This chapter has described the transport development in Prague and the status for the transport generated air pollution problems, noise problems, and accidents. The conclusions are:

Transport development

Overall transport volumes are increasing and are expected to increase significantly in the period until 2015. Car transport, in particular, gained ground at the expense of public transport, e.g. because public transport has become relatively more expensive compared to private transport in the 1990s.

The car fleet is large in the Czech Republic, even compared with West European standard but the car transport volume is not that high. In short: There are many cars but they are not used as much as cars in Western Europe.

Accidents

The road traffic discipline is not high, resulting in a correspondingly high number of accidents. In Prague, traffic accidents grow faster than traffic volumes, hence the relative accident rate is growing.

Air pollution

While air pollution emissions from stationary sources have decreased in recent years, emissions from vehicles have increased quite substantially. Consequently, the transport share of total air pollution has increased rapidly in Czech Republic in recent years. This trend is likely to continue.

Two developments will take place in the future: Increased (car) transport and improvement of the vehicle fleet. For the time being, only 20% of the passenger cars are equipped with catalytic converters. It is uncertain whether the improvement will take place at a speed that will counteract the growth in transport. In all cases, the transport generated CO_2-emission, which are not affected by a wider application of catalytic converters, will increase significantly. It may also be necessary to consider carefully the development in particles pollution from transport as this may constitute a growing health problem.

Noise

In general, noise levels have decreased slightly in the Czech Republic. Still, more than 25% of the Czech population are exposed to noise levels above 65 dB(A). Noise levels in Prague have remained almost constant over time despite intensified traffic.

4 Case Study: Bulgaria

4.1 Introduction

Bulgaria has undergone a harsh transition process, which has affected most sectors in the society, including the transport sector. This chapter presents the transport development during the 1990s and describes the transport-generated health and environmental problems in Bulgaria, with a view to the capital city of Sofia. The chapter is based on official statistical and other documents, interviews with officials in central government agencies, and other expert assessments.

Highlights on the Republic of Bulgaria

Geography. Bulgaria is a small country bestowed with a beautiful landscape. It is located in Southeastern Europe with borders to Greece, the former Yugoslav republic of Macedonia, Romania, Serbia, and Turkey. The country occupies 110,993.6 sq. km The number of inhabitants is 8.36 million (corresponding to 76 inhabitants per km^2). Sofia is the capital.

Politics. Parliamentary democracy. The present government (since 1997) is a coalition of parties called Unified Democratic Forces. It comprises the Union of Democratic Forces (CDC) the National Union (Naroden Sauz) and the Democratic and Rural Party (BZNC). The Socialist Party is the main opposition party.

Economic Development. One of the poorest countries of central Europe, Bulgaria has slowly been moving from its old command and control economy towards a market-oriented economy. The economy faced a major crisis in 1996, marked by a banking system in turmoil, a depreciating currency, inflation of 311%, and contracting production and foreign trade. The GNP for 1996 and 1997 showed decline in economic activity, whereas the activity increased in 1998. The expectations for the coming year are being adjusted in the light of the war in Yugoslavia that adversely affects Bulgaria.

Relation with EU. Bulgaria - as one of the so-called EU candidate countries - is determined to be part of the European Union and much effort is directed to fulfilment of that goal. When membership will be realised is uncertain but it may be within the first decade of the new millennium.

4.2 Transport development

Passenger transport volume and modal split

Due to the economic recession in Bulgaria the rate of mobility is significantly reduced compared to the 1980s. Table 4.1 demonstrates that the mobility has been more than halved since 1990.

Table 4.1

Development in passenger transport by mode of transport, excl. private car transport (mill. passenger km).

	1990	1992	1994	1996	1998
Rail (incl. Sofia metro)	7,793	5,393	5,059	5,065	n.a.
Public road transport	25,955	16,957	12,817	9,296	8,341
Private road transport*	n.a.	n.a.	n.a.	n.a.	3,928
Trolley-bus	1,046	795	699	708	n.a.
Tramway	586	524	250	296	n.a.
Other	3,782	3,010	3,613	3,152	n.a.
Total	*39,162*	*26,679*	*22,438*	*18,517*	*n.a.*

Note * Private road transport. Data for the passengers carried by private road transport companies are available only for 1998. All the companies were state property through 1990. The privatisation processes began in 1991 and the share of the private transport companies is continuously growing.

No information is available on the volume of private car transport in Bulgaria.

From Table 4.1 it appears that public road transport and tramway have experienced a decrease in transport volumes, whereas the position of rail and trolley-bus has remained more stable.

Public transport dominates in Sofia

Traffic experts assess that a very large share[58] of total passenger transport in Sofia is performed by public transport.[59] The main reason for the extensive development was social rather than environmental. Today, the quality of the rolling stock is low. Thus, 75% of all buses are older than 10 years. Therefore, a renewal of the rolling stock is given high priority, as it would reduce air pollution.

Low level of road transport

In the absence of statistical information on private car transport, the level hereof could tentatively be indicated by the consumption of fuel in households. Since 1992, average fuel consumption per household has dropped by a factor 3, from 165 litre/year to 54 litre/year. The decline has in particular been profound since 1995, thereby reflecting the economic crisis. Fuel consumption of 54 litre per year could be equated with a car transport volume per household in the range of 400-500 km per year. This is less than 10% of road transport volume in the Czech Republic and only 5% of the volume in many Western European countries. Although the data are scarce and only should be interpreted with caution, it indicates that the level of road transport today is very low in Bulgaria.

Traffic volume prognosis

The Ministry of Transport approved a traffic forecast in 1996.[60] It is based on the relation between the GDP and traffic growth considering also the development of socio-economic factors, such as population, vehicle fleet and consumption. Three scenarios - low, medium and high has been developed. According to the forecast, total passenger and goods transport volumes in 2010 will be 30-60% higher than in 1995. The forecast should be interpreted with great caution, because of uncertainties with regard to the present volume of passenger car transport as well as with regard to the economic development, especially in the light of new economic problems, due to the war in Yugoslavia.

[58] Experts estimate a share of 70-80%. However, since there are no data available for passenger car transport, this is only a very rough estimate.

[59] Public transport in Sofia consists of 100 bus routes, 10 trolley bus lines, 16 tram lines, and one metro line. An enlargement of the metro system has been projected but came to a halt due to financial problems.

[60] The forecasts have been prepared in 1996 under the Phare project "Preparation of Traffic Forecasts and Investment Programmes for the Years 2000 and 2010".

Vehicle fleet

It may be expected, based on the decline in road transport volumes, that the vehicle fleet is shrinking. However, the quite opposite trend can be observed: The number of passenger cars and trucks has increased significantly during the 1990s.

Table 4.2
The development of the vehicle fleet (number of vehicles)[61]

Vehicle types	1989	1991	1993	1995	1997	1997 level compared to 1989, %
Motorcycles	221,418	226,853	230,635	233,365	236,260	107%
Passenger cars	1,269,958	1,358,976	1,505,451	1,647,571	1,730,506	136%
Trucks	139,123	157,841	185,824	203,257	210,960	152%
Busses	32,899	35,561	39,280	41,019	40,422	122%
Other*	574,086	625,568	684,774	722,395	743,072	129%
Total	*2,237,484*	*2,404,799*	*2,645,964*	*2,847,607*	*2,961,220*	*132%*
Cars/1000 inhabitants**	*152*	*163*	*180*	*197*	*207*	

Note*: The category "other" covers ambulances, police cars, fire brigades, tractors, cranes, etc.
Note**: It should be stressed that these figures are only for passenger cars. Therefore the car ownership rate is lower than the vehicle ownership rate.

For Sofia, the car fleet has developed more rapidly than for Bulgaria as a whole: From 189 passenger cars per 1000 inhabitants in 1990 to 320 cars in 1997, i.e. quite close to a doubling in numbers. The explanation of this seemingly paradoxical situation - more cars, less passenger car transport - is as follow: In the years after the political changes it was popular to buy second-hand Western cars. As the economic situation worsened in the mid 90s fewer people could actually afford to drive their cars, hence today lots of cars are parked on a permanent basis and will be so until the economic situation improves.

Few cars with catalytic converters

The vehicle fleet is old - and polluting. The age of most cars in Bulgaria range between 10 and 18 years. There are no data available on percentage of passenger cars with catalytic converters but according to expert assessments the level may be as low as 10% for the whole country; 20% in Sofia. It is thus possible that the share of transport generated air pollution will be either constant or decreasing in spite of a possible increased car transport, provided the car fleet is modernised.

Cycling and walking

The use of bicycles as a transport mode for short distances has been well known in Bulgaria before and after the Second World War when motor vehicles were not allowed for personal use. By lifting the bans and following the growth in motor vehicles, the bicycles were gradually abandoned by the adults. In the 1970s and 80s there was a promotion for improvement of conditions for cycling in special areas. But the small number of parking lots at plants, enterprises, schools and state buildings have now been eliminated. There are thus no suitable conditions for bicycle transport in e.g. Sofia.

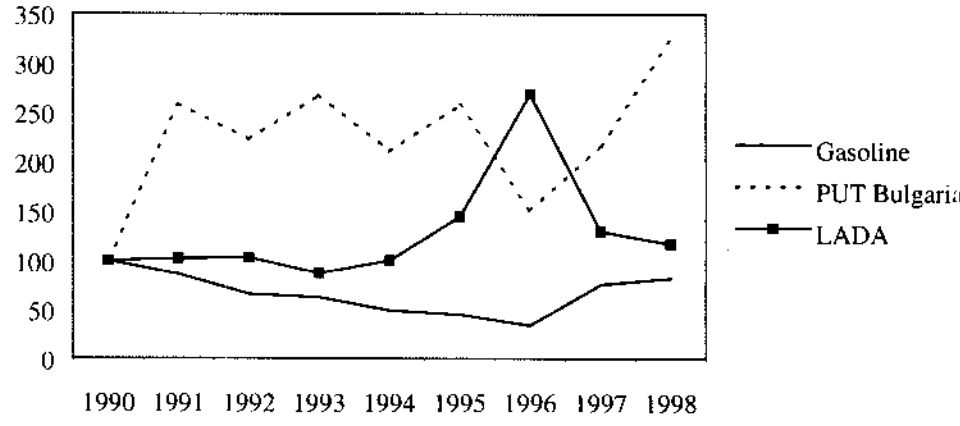
Regardless of the economic and health state of the Bulgarian population there is still no strategy for cycling promotion, and actual infrastructure development is not favourable to cycling. For instance, none of the reconstructed and newly constructed boulevards and streets in Sofia have bicycle lanes.

[61] Source: The Traffic Police within the Ministry of Interior (authority responsible for vehicles registration).

Transport prices

The transport prices have developed very unfavourable for public urban transport (PUT). In fixed prices the level trebled since 1990, whereas the petrol price level in 1998 is slightly below the level in 1990. The purchasing price for a Lada passenger car is likewise at the same level today as eight years ago.

Figure 4.1
The relative price development for car transport (petrol) and public transport in 1990-1998, fixed prices (1990=100).



In spite of the PUT price increase and the relatively constant price level for private motoring in real terms, public transportation remains the only transport mean affordable for the greater part of the population, not least because of the significant salary reductions that most Bulgarians have experienced the last decade.

Moreover, in absolute figures public transport is still cheap. A Public Urban Transport ticket costs an amount equal to 0.14 USD in 1998. This could be compared to 0.64 USD for 1 litre petrol; hence five tickets to the public urban transport can be purchased at the same cost as 1 litre of petrol. Such a ratio is not likely to be found in West European countries. Also cars are relatively expensive. The price of a LADA 2107 was 5,554 USD in 1998.

Subsidies to public transport in Sofia

The subsidy for the Sofia urban public transport (bus, tram, trolley bus and metro) have shown a steady decline during the 90s. Corrected for inflation, it appears that the subsidies in 1998 were only one third of the subsidies in 1990. The cut down in subsidies explains why it has been necessary to raise the fares significantly during recent years.

Goods transport

Railway and road goods transport in Bulgaria, measured as tonne km, has been reduced to one third compared to 1990.

Table 4.3
Development in domestic goods transport volume by mode of transport (Million tonnes km)

Transport mode	1990	1992	1994	1996	1997	1998	1998 level in % of the 1990 level
Railway	12,160	6,492	6,922	6,791	7,016	5,891	48
Road	6,871	2,258	1,839	751	484	1,188*	17
Total	19,031	8,261	8,761	7,542	7,500	7,079	37

Note: * Total for the public and private road transport companies. Data for the domestic goods carried by private road transport companies are available only for 1998.

The same paradox we observed for car transport - more cars, less traffic - appears also to apply for goods transport. The total goods transport has been reduced to almost one third during the 1990s, and in particular road goods transport has shrunk even if the number of trucks in Bulgaria is as high as ever.

Numerous small transport companies were established in the early 90s. In the beginning it was lucrative when there was still a reasonable economic activity but concurrently with the economic recession, the small companies came to a halt.

4.3 Transport generated health and environmental problems

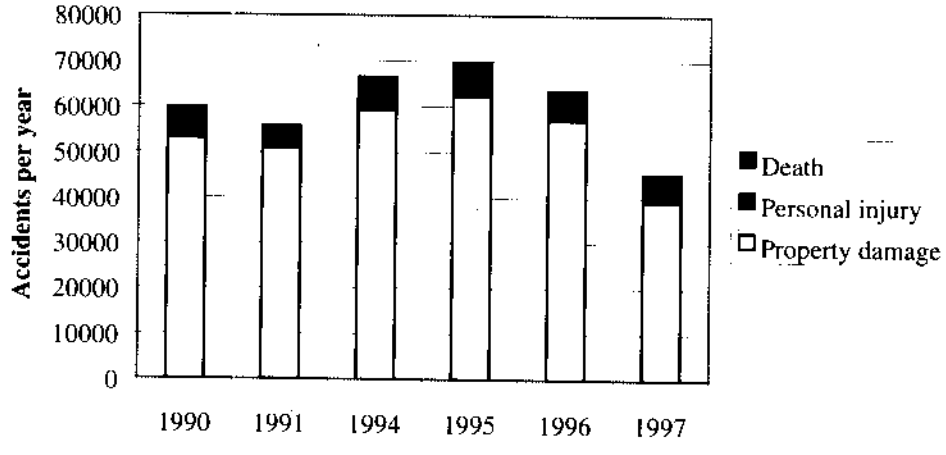
4.3.1 Accidents

Road accidents in focus

In recent years the number of railway related deaths is negligible compared to road transport deaths. For the whole period the total number of deaths in the railway transport is below 20 people of which most have been employees of the railway company. There have not been accidents in domestic air transport in the last 10 years.

The interest is therefore centred on road transport. After the change of the regime in 1989, a record number of fatalities -1567 - in road accidents was registered in 1990.

Figure 4.2
The development in road traffic accidents in Bulgaria, 1986-1998[62]



[62] The decrease of the traffic accidents involving property damage in 1997 partially is a result of the introducing of new insurance regulations. It means that if the drivers of the vehicles involved in the accident agree between them there is no need to inform the traffic Police.

Reduction in fatalities

The Bulgarian National Environmental Health Action Plan (1997) states that the number of road transport injuries and deaths should be reduced by 25% by year 2000 versus 1990. The number of killed was in fact "only" 915 in 1997 compared to 1567 in 1990; hence a 40% reduction has been achieved. The number of injuries has, conversely, increased slightly in the period 1990-97, so it is an urgent task to implement measures to reduce the road accidents if the objective is to be fulfilled. The development in road accidents does not look promising in the light of the reduced amount of road transport in the 90's. Indeed, Bulgaria is one of the countries where the number of fatalities per 100,000 inhabitants is high considering that the road transport is not very intense.

A major part of the accidents (70%) in 1998 is registered in residential areas. At the same time the number of fatalities in residential areas and non-residential areas is almost equal, which is an indication for greater severity of accidents outside settlements. In the residential areas there is one dead in 9 accidents, while in rural areas this ratio is one-to-four.

Pedestrians vulnerable

A majority of accidents are caused by the drivers (81% in 1997 and 83% in 1998). The most common type of accident is "hitting a pedestrian" - 41% of all accidents in 1997 and 39% in 1998. This is even more profound in Sofia: The main part (73%) of the traffic fatalities in Sofia are pedestrians. The reasons for the extremely high level of accidents with pedestrians in the Capital include:

- Lack of parking (cars are parked on the pavement and the pedestrians are forced to walk on the street lane)
- Lack of mutual respect between pedestrians and drivers
- Violations of speed limits
- The passenger underpasses are in bad condition (no lighting, insufficient maintenance, etc.). Therefore, many pedestrians cross the traffic lanes above the underpasses.

Policy to reduce accidents

Due to the present economic situation in Bulgaria traffic safety is not a high priority issue for the government and no radical changes should be anticipated in the near future. However, just recently the new Road Traffic Law was adopted by the parliament. It is harmonised with the European standards and norms including those on traffic safety. Some of the relevant traffic rules are: In residential areas the drivers of all vehicle categories cannot exceed 50 km/h.; blood alcohol concentration above 0.5 per thousand when driving is illegal; motor vehicles must pass a periodic test for checking technical order; there are no tax concessions for motor vehicles with particular safety equipment, like ABS brakes; seat belts are required only in vehicles which have them installed.

4.3.2 **Air pollution**

Total air emission in Bulgaria

The Bulgarian government is pursuing a policy towards emission reductions following the official signing and ratification of international protocols for reducing emissions of SO_2 and NO_x, and volatile organic compounds. The development in emissions indicates a successful implementation of this objective; however the decreasing levels are partly caused by the economic recession.

Table 4.4

Total emission levels, 1990-1997, for the following pollutants: SO_x NOx, VOC, CH_4, NH_3, and CO (1000 tonne per year)

	1990	1991	1992	1993	1994	1995	1996	1997	1997 level in % of 1990 level
SO_x	2,020	1,677	1,128	1,426	1,480	1.497	1,420	1,365	68%
NO_x	376	266	239	242	230	266	259	225	60%
VOC	393	354	355	384	348	355	309	282	72%
CH_4	759	582	624	664	528	511	500	538	71%
NH_3	144	-	-	13	19	99	83	77	53%
CO	901	608	768	830	858	846	623	517	57%

Source: The Ministry of Environment and Waters (1999).

The emissions have been declining for all six pollutants considered. The main reduction took place in the first half of the 1990s.

Emission from transport

In the table below the share of transport generated air pollution is compared to total air emission for 1997. It appears that transport contributes significantly to the total emission of NO_x, VOC and CO. Except for SO_2 the transport share of air pollution is, however, significantly lower for the pollutants considered than e.g. in the Czech Republic.

Table 4.5

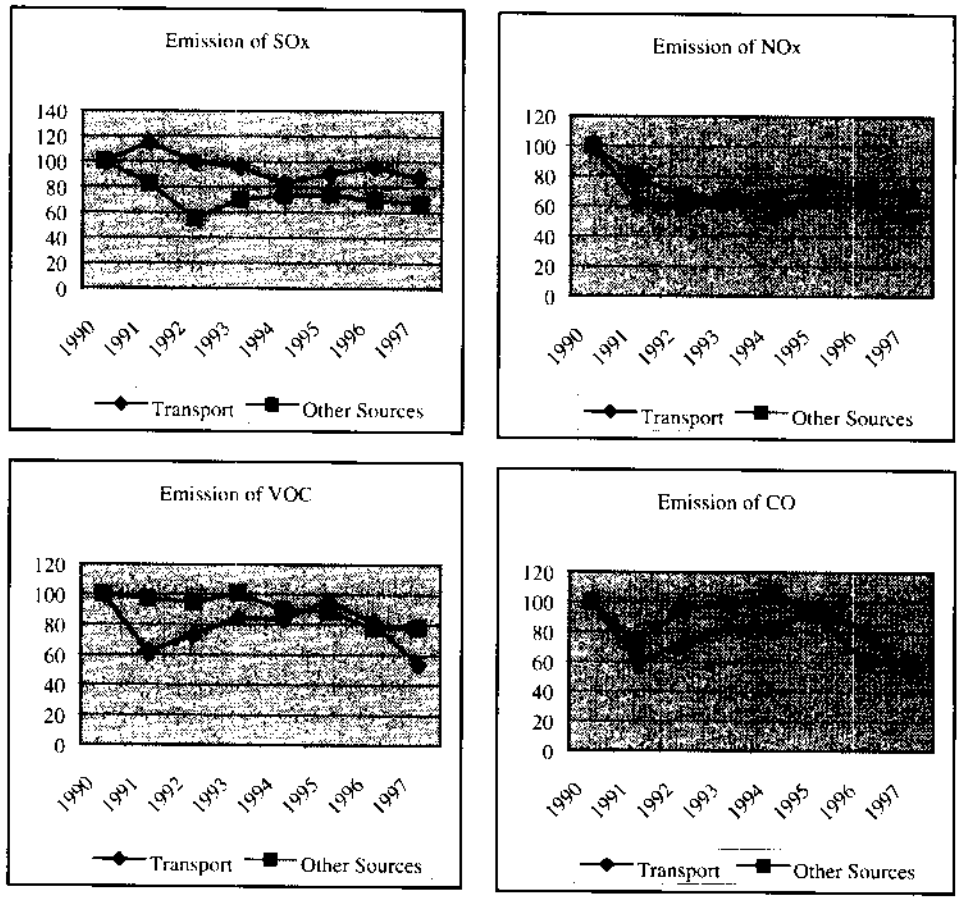
The share of transport generated air pollution compared to total air pollution emission in Bulgaria, in 1997 (1000 tonne)

	SOx	NOx	VOC	CH_4	NH_3	CO
Total emission	1,365	225	282	538	77	517
Transport	23	83	43	1	0	205
Transport (%)	2%	37%	15%	0%	0%	40%

Development over time in transport share of air pollution

The figures below compare the development in transport generated air pollution over time with all other sources. It should be noted that the data for vehicle emissions is very unreliable, because there is no Bulgarian emissionsmodel (calibrated) for the actual fleet condition.

Figure 4.3
The development in transport generated air pollution, compared to all other sources (1990=100).[63]



The figure demonstrates that the air pollution emission from transport and other sources has been declining for all pollutants considered. The transport-generated emission has decreased relatively more than other sources for VOC, CO and NO_x.

Lead emission an important issue

In 1996, the market share of unleaded petrol was 6% compared to only 1% in 1990. The share of unleaded petrol should be able to increase rapidly given the characteristics of the domestic refinery industry that has a potential of producing 45% of unleaded petrol. 136 tonnes of lead were emitted from vehicles in 1996 corresponding to 54% of the total lead emission. The lead emission from vehicles declined by 33% from 1990 to 1996 due to decreasing petrol consumption. 67 tonnes of lead were emitted from vehicles in Sofia corresponding to 56 kg per 1,000 inhabitants.[64] According to a national programme on lead phase-out, production and consumption of leaded petrol should end by January 1, 2004.

Air pollution emissions in the future

For the coming 10-15 years a general improvement in air quality level in the country is expected. But for the coming years the emissions may start to increase again along with the expected growth in the national economy (and the growth in consumption of energy). For transport air pollution, rather pessimistic assessments prevail. It is expected that it will at the most be possible to maintain the current level of pollution, due to:

[63] Source: Ministry of Environment and Waters. Data is based on fuels consumption. The ministry would like, in the future, to perform analysis of actual emission.
[64] Source: UN/ECE Task Force to Phase Out Leaded Petrol in Europe, Country Assessment Report (Danish Environmental Protection Agency, 1998).

- the slow rate of vehicle fleet replacement, especially for the private cars
- reduction in fuel prices;
- increase of tourist flows;
- increase of transit traffic

Air quality assessment

The ambient air quality indicators - particles, sulphur dioxide, nitrogen, ozone, carbon oxide and lead - are subject to obligatory monitoring, pursuant to Clean Air Act (1996) provisions. Ambient air quality is monitored by a national network of monitoring stations attached to the Ministry of Environment and Waters; a network comprising 109 measuring locations. The table below gives the Bulgarian ambient air quality values; in parenthesis WHO guidelines are mentioned.

Table 4.6

Ambient air quality limit values ($\mu g/m^3$)[65]

Pollutants	Yearly average	Daily average	Half-hour average
Particles	150	250 (120)	500
Sulphur dioxide	50	150	500 (500, 10 min.)
Nitrogen dioxide	50	100	200 (200, 1 hour)
Carbon monoxide		10 000 (10 000, 8 hours)	60 000 (60 000)
Lead		1.0	

The annual concentration limit for **particle** concentration is exceeded by a factor 2 at several monitoring stations. Based on six randomly selected monitoring stations the particle pollution situation does not seem to have improved in the period 1988-1997.

SO_2 levels at the 10 most polluting monitoring stations are significantly above limits values; at some stations extremely high concentrations have been measured (more than 3 times the limit value).

Sofia stands out as the area in Bulgaria having the highest concentration of **NO_2**. In 1997, annual average NO_x concentrations were almost five times higher than the annual limit. The concentration started to grow rapidly in Sofia in 1991 and is still growing. Based on NO_2 concentration the air quality in Sofia thus has worsened significantly during recent years.

The daily **lead** limit is only occasionally exceeded; still the ambient lead levels are quite high compared to other cities. For instance, in Sofia the 1996-level was approximately 0.6 $\mu g/m^3$.

Ozone is an increasing air pollution problem in Bulgaria, as it is in other CEE countries. Bulgaria has only 13 stations where ozone is measured, but limit values are already exceeded at six of them. Ozone does not appear in emission tables because it is a secondary air pollutant formed photochemically in the atmosphere from NOx and VOCs, downwind from the emission sources on sunny days. Ozone is a strong oxidant and respiratory irritant, and it damages crops and forests. Ozone levels increase generally from west to east, both across Europe, as well as across individual countries, with highest concentrations in the daytime "urban ozone plumes" that form in and downwind of cities like Sofia. While NOx emission reduction measures are being implemented at large point sources in Bulgaria (power plants and industries), increasing NOx and VOC emissions from traffic will increase the severity of the ozone problem. This will eventually lead to ozone episodes requiring public health alerts and emergency actions to temporarily cut precursor

[65] Source: "National Emission Report to the UN/ECE for 1997" (Ministry of Environment and Waters, 1998).

emissions (industry shutdowns, traffic restrictions), as has happened in other southern European cities.

To sum up, although many Central and Eastern European countries have experienced improved air quality during the 1990s, the situation is different for Bulgaria. The data available indicates that the air quality has not improved in recent years. For many monitoring stations the levels of particles, SO_2 and NO_2 are well above annual limit values and lead levels are quite high, e.g. in Sofia. The average NO_2 concentration in Sofia has been rising since 1991 and reached in 1997 a level five times higher than the annual limit value.

Policy to reduce air pollution

The focus in recent years has been to decrease emissions from stationary sources but the National Environmental and Health Action Programme (1997) also advances the following policy statements on transport:

- Promote environment friendly transport modes, like public transport
- Gradual renewal of the stock of buses (and other public transport modes)
- Lead phase-out program and programmes for reducing other forms of transport generated air pollution.

Various EU-directives on petrol and diesel fuel qualities, and ambient air quality will be implemented the coming years. A high duty is imposed on import of old cars thereby making it economically unacceptable to buy worn-down (polluting) cars from Western Europe. Vehicle inspections are performed to control e.g. the exhaust quality.

4.3.3 Noise

In 20 years, the Ministry of Health has performed monitoring of noise in residential areas and around noisy streets and enterprises. Monitoring in the large cities shows that the permissible noise limits are exceeded at 64 to 86% of the monitoring points.[66]

Slightly decreasing noise levels

Detailed surveys have been undertaken in the towns of Veliko Tarnovo, Gorna Oryahovitza and Svishtov in Northern Bulgaria. These cities have been chosen because of the lack of big industrial factories and a large share of the noise problem stemming from transport. The data display a tendency of increasing noise levels during the period 1992-1995 and decrease /stabilisation in 1995-1997.

No comprehensive information is available on the number of persons exposed to various noise levels, nor of the causes of noise; therefore it is difficult to assess the severity of the problem. It has been shown that up to approximately 50% of the inhabitants of Sofia suffer from noise levels above 70 dB(A).[67]

Noise in Sofia

Vibration is a major problem in Sofia and other main cities having heavy road and the rail transport (trucks, trams and metro). The problem with the trams has been partially solved by improvement of the rail track at some of the most critical sections of the street network. Vibrations from heavy trucks are being avoided by diverting traffic away from the city centre to ring roads.

A particular noise problem in Sofia is in the immediate neighbourhood of the Sofia Airport. The airport will be modernised. Based on the EIA prepared in

[66] Source: The National Environmental and Health Action Plan (1997).
[67] Source: "Europe's Environment, Statistical Compendium (EEA).

relation to this project, various measures will be implemented to achieve relief to the population of the air transport noise.

Policy to reduce noise pollution

The section on noise abatement in the Bulgarian National Environmental and Health Action Plan (1997) consists mainly of general policy statements and actions to be taken in order to generate more reliable data on noise exposure. Specific objectives are not advanced, nor is there a presentation of measures to apply to reduce noise levels. The proposed initiatives may be interpreted as a "first step" directed at proving a solid basis for subsequent specific noise regulation.

4.4 Conclusions

Bulgaria has gone through a turbulent decade, and this is reflected in traffic trends that at a first glance look paradoxical. The vehicle fleet has increased significantly during the 1990s, whereas the volume of road transport is decreasing. Bulgarians cannot afford to use their cars. Fortunately the public transport system is of relatively good standard, at least in major cities.

Focus on public transport

Probably the most outstanding feature of Bulgarian transport policy is its reliance on public transport, especially in larger cities. In Sofia, public transport still accounts for up to 80% of total transport volume, even though public transport fares have increased.

The Bulgarian transport authorities prefer to continue the tradition of public transport promotion and would therefore like to see international assistance being channelled to a "green" modernisation of the public transport. Improvement of the Sofia public transport vehicle fleet is one obvious possibility. This could include e.g. renewal of the rolling stock, implementation of GPS-type system for centralised traffic management, and realisation of the already planning metro infrastructure.

So even if the national and local transport authorities in Sofia in principle favour the construction of new motorways (and other major infrastructure projects), they would like to see international donors focus more on improvement of the existing public transport. This would lead to immediate environmental improvements and to support public transport would be in line with the Bulgarian tradition for providing cheap public transport on social grounds.

Accidents

For a country with relatively low road transport intensity, it poses a serious problem to have between 1000 and 1500 road-traffic deaths per year. Unfortunately, the problem is not high on the political agenda due to other pressing problems the country is confronted with. Therefore major progress should not be expected. On the contrary, when transport volumes start increasing the number of fatalities may follow. Specific action is, however, being taken e.g. to build fences around public schools to protect children from running onto neighbouring busy streets.

Air Pollution

Total air pollution emissions have gone down, in some cases almost halved due, primarily, to the economic recession. It may thus be feared that when the economy starts growing, the environmental problems will follow.

Therefore, efforts are needed to de-couple the relation between economic growth and environmental impact. Within the transport sector obvious possibilities are the renewal of the car fleet and an environmental modernisation of the public transport. Already now a replacement of the old buses is taking

place in the bigger cities, and the Bulgarian authorities would like to accelerate such a modernisation process.

Ambient air quality indicators indicate that the air quality is unsatisfactory and worsening in Bulgarian cities. Probably just as alarming is the fact that no overall improvement of air quality has taken place in recent years. The NO_2 concentration in Sofia has even been rapidly rising since 1991, exceeding annual limit value by five times.

Noise

There is a lack of up-dated observations and analyses of the noise exposure and the impact it has on the health of Bulgarians. Many traffic experts have stressed that noise should be treated as one of the main transport generated health problems in Bulgaria but lack of reliable data hamper a concerted effort.

Finally, it should be noted that some important data is lacking. For instance, in Bulgaria - like in many other CEE-countries - no precise information on private car transport is available.

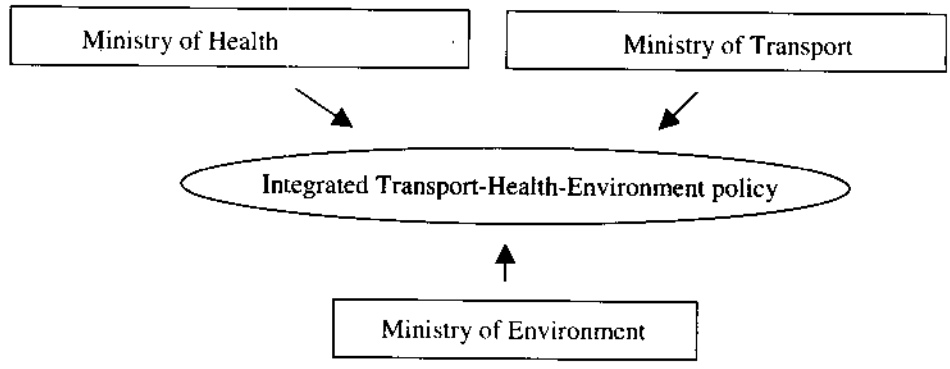
5 The challenge of integration and co-ordination

Purpose

To integrate environmental and health concerns into transport policy requires joint decisions and joint actions to be taken by a range of bodies. It also requires a strong co-ordination of policies at the various levels of the policy process: From initial planning, target-setting, selection of instruments, implementation of measures, to monitoring of compliance. A potential obstacle to achieve this relates to the actual willingness of the respective bodies to engage in the necessary co-ordinating activities.

This chapter is delimited to an analysis of the specific challenges it poses to formulate and co-ordinate an integrated transport-health-environmental policy at the level of the central governmental agencies.[68]

Figure 5.1
The Challenge: Three ministries involved in developing a transport policy in which health and environmental concerns are integrated



This section addresses the interplay between the various ministries and discusses impediments to co-ordination and how to overcome co-ordination problems. Based on that, two case studies, the Czech Republic and Bulgaria, will briefly be described.

5.1 Benefits and barriers to co-ordination

Benefits of co-ordination

In general, policy co-ordination is beneficial to society for a variety of reasons. First, co-ordination is a way to ensure efficient use of resources; a way to create decision-making opportunities, and a way to secure that actions taken in one area do not shift the burden to other policy areas. The Ministry of Taxation[69] may, for instance, loose revenue by lowering the tax on unleaded petrol but the effort to phase-out lead may on the other hand spare society for additional health care costs. Second, many public problems are characterised by a mismatch between the nature of the problems and the sectoral problem-solving structures in government as the problem stretches

[68] Several other institutional aspects would be relevant to include to get an overview of the *institutional capacity* to address the transport-health-environment complex; however, this is beyond the scope of this study.
[69] It should be noted that in Bulgaria - one of the case countries - there is not a Ministry of Taxation: instead the General Taxation Administration is subordinated the Ministry of Finance.

across bureaucratic borders. Environmental and health impacts of transport present an obvious example of this. Co-ordination is therefore necessary to solve such malevolent problems (See text box for examples).

Problems are different - two examples

Lead phase-out is a relatively benevolent problem. The negative health impact of lead is scientifically proved; and as everybody in principle favours lead phase-out solution the conflict level is rather low. Technical solutions are available in most countries (or are being prepared). Still, it requires co-operation between the health authorities, which produce knowledge of the negative impact of lead and have raised the issue; the authorities that are responsible for petrol quality and for privatisation of refineries; and the taxation authorities (in case unleaded petrol is imposed a lower tax).

Protection of valuable landscapes versus construction of a new motorway is a more difficult issue. The objective of landscape protection may conflict with the aim of improved mobility (as expressed by the extensive road- and rail building programmes that have been framed for many CEE countries.) A technical solution, which satisfies everybody, either does not exist or is expensive to implement; like constructing a motorway tunnel through a National Park to avoid deterioration of the area. Huge economic interests will often be on stake; some will benefit from the decision - others will loose; and the decision cannot be proved scientifically but must be grounded in political and ethical considerations. It all adds up to a malevolent issue which requires intensive dialogue between the national (and regional) environmental and transport authorities.

Barriers to co-ordination

Co-ordination between ministries does not always come easy. Below a brief description is given of some typical barriers to co-ordination.

Ministerial autonomy

The principle guiding the division of labour between governmental agencies is compartmentalisation and specialisation: Ministries are given certain tasks like "transport", "energy", or "defence". Only a few ministries are by nature co-ordinating ministries; probably the Ministry of Finance is the only one in most countries.

One of the consequences of this division of labour is that ministries develop a kind of ownership over a certain policy area. It may thus not be attractive for the ministry of transport to involve other ministries in setting objectives. However, to develop integrated approaches to transport policy basically requires that other ministries are invited to have a say on the future transport policy.

Different values and perceptions

As the ministries of transport, environment, and health have different formal objectives (see figure below) they are likely also to have different values and priorities, different perceptions of what are the most important societal problems, and different perceptions of what are the legitimate actors in society.

Therefore, ministries have interests, objectives, strategies, and agendas. They are deeply involved in solving particular problems and will therefore have their own agendas. These agendas will most likely not be totally in concurrence with other ministries.

Figure 5.2
Indication of different focus areas of the ministries of transport, health and environment.

Ministry of Transport	Ministry of Health	Ministry of Environment
Effective mobility e.g. by provision of good infrastructure	Secure the human health e.g. by preventing noise, air pollution and accidents	Protect ecological systems e.g. by preventing air pollution and deterioration of landscapes

How to achieve co-ordination across bureaucratic units which have different focal points?

Co-ordination is a public good

"To integrate" may be seen as a problem rather than an asset from the perspective of one single ministry. This has to do with the dilemma of co-ordination: It will serve the common good but will not necessarily be to the benefit of every involved actor. The question of whether and how intense policies should be integrated across sectors is of a political nature: The involved actors evaluate their interest in being involved in transverse co-ordination versus their interest in evading co-ordination. The benefits of co-ordination often have a public good character, i.e. benefits are equally distributed to all actors (ultimately to the society at large), whereas the benefits of omitting co-ordination often will be specific.

Co-ordination may change power structures

The extent and intensity of co-ordination between ministries can be characterised as an unstable game. The actors will constantly elaborate on whether to pursue short- or long run sector specific interests or whether to act in accordance with the common good. The willingness of the ministries to enter into a dialogue on transport-health-environment issues will therefore not be constant but will to a high degree depend on the current power position vis-à-vis other actors.

The strategy for weaker actors could be to strongly advocate co-ordination as a means to establish a platform to introduce new ideas and concepts. Powerful actors on the other hand will probably seek to avoid co-ordination unless they can get an even better grip of the policy in question.

To sum up; in spite of the societal benefits of co-ordination between ministries the actual level of integration may not be high. Possible barriers to co-ordination are among other things the high degree of ministerial autonomy, and the fact that co-ordination is a public good that does not necessarily benefit all the involved actors. The challenge is to recognise these natural (but often hidden) barriers and to create inventive institutions, which make possible fruitful dialogue and co-operation between ministries.

5.2 Case studies: The Czech Republic and Bulgaria

The case studies described previously showed that there are major differences between the two countries in regard of traffic development and transport priorities but there are also similarities.

Both countries have young Ministries of Environment established in the early 1990s, and old ministries of health and transport. Both countries are

actively seeking environmental improvements along with economic restructuring. Finally, even if both countries have been involved in developing overall policy plans e.g. for transport there are no specific health and environmental objectives for the transport sector in any of the two countries.

In the following a brief description is given of the position of the three ministries involved in Bulgaria and the Czech Republic and the level of co-ordination and integration is roughly indicated.

5.2.1 Bulgaria

The Ministry of Transport (MoT)

The Ministry of Transport gives top priority to modernisation of the public transport system. The reasons are both social and environmental. The ministry finds it therefore important that more funds are allocated to development of rail transport. However, the ministry finds it more difficult to gain the necessary financial support from international donors for rail projects compared to the development of for example Pan-European motorway network.

The Ministry is also planning new infrastructure. It has launched the report "National Investment Priorities" which describes transport infrastructure projects related to the Pan-European Transport Corridors with a total value of USD 4,449.50 million.

The Ministry of Health (MoH)

The Ministry of Health plays a key role in advancing the National Environmental and Health Action Plan, NEHAP, (1997, see text box below). The Plan was prepared in co-operation with the Ministry of Environment and Waters as well as other ministries, including the MoT. According to the Ministry of Health the process has been and still is successful. The implementation of the plan is being carefully monitored and its implementation is to a high degree the responsibility of the MoH.

The Ministry of Environment and Waters (MoEW)

The Ministry of Environment and Waters was also deeply involved in the preparation of the Bulgarian NEHAP. The MoEW and the MoH collaborate closely on monitoring and assessment of the ecological and health risks from air, water and soil pollution. The MoEW would like to see the public transport modernised, as the present standard is not satisfactory from an environmental point of view. This priority is fully in accordance with the priorities of the MoT and the MoH.

The main focus of the MoEW with respect to transport is the Environmental Impact Assessment of infrastructure projects and monitoring of air pollution. The EIA procedures - mandatory since 1993 - follows international standards.

The process of preparing, adopting and implementing the Bulgarian National Environmental and Health Action Plan, NEHAP

Background: The Second European Conference on Environment and Health, 1994, set priority to the development of national environmental health action plans. A pilot project was launched including six countries of which Bulgaria was included.
Planning process: The Bulgarian MoEW and MoH co-ordinated the process. All ministries were asked to contribute. NGOs and interest organisations were likewise encouraged to participate by submitting proposals and comments. In May 1998 a public hearing was arranged involving 45 organisations.
Adoption: The plan was approved by the Council of Ministers, along with recommendations on implementation of the plan.
Implementation: The ministries are responsible for developing a strategy for implementation of the NEHAP within their area; hence the plan is not only the responsibility of the MoE and MoH. Based on the NEHAP local and regional plans are being prepared.
Monitoring: A high level vice-minister committee monitors the implementation of the plan on a quarterly basis.

Factors influencing the level of co-ordination and integration

Bulgaria is likely to face transport problems when transport volumes start to grow again. From an institutional perspective the country seems to be rather well equipped to handle the challenge. It is the impression that there is a high level of co-ordination and willingness to co-ordinate between the three ministries. The three policies are not seen as conflicting; hence there are no major conflicts between the ministries that hamper everyday working relations.

Three factors are of relevance to this.

First, there has been a successful NEHAP-process in which all ministries have participated. As a result, the ministries are familiar with balancing objectives in a process that involves other ministries. Even if the plan is not specific on objectives it nevertheless outlines overall priorities and stresses the need to integrate environmental and health concern into transport decisions.

Second, and more important, there seems to be a consensus on transport priorities. All three ministries' first priority on transport is the improvement of the public transport. Consequently, neither mobility nor health and environmental concerns are conflicting with each other.

Third, due to the lack of economic growth, the transport demand has not increased; hence the traditional transport policy conflicts have not been exposed in Bulgaria. But when the transport volume starts growing it may lead to more pressure on existing infrastructure and claims for new roads/rails will be raised. This may give rise to conflicts on how to steer and respond to the transport growth; that means whether to invest even more in public transport or start a massive road building programme.

5.2.2 **The Czech Republic**

Ministry of Transport (MoT)

According to the document "Transport policy of the Czech Republic", prepared by the MoT, individual car traffic should be kept within acceptable environmental limits; public transport should be promoted, and transport volumes should gradually be shifted from road to more environmentally friendly transport modes. The document does not define what "acceptable limits" are.

The current road building programme, promoted by the MoT, will extend the motorway system from presently 450 km to 1100 km The environmental authorities have questioned the programme on the ground that its realisation will disturb valuable landscapes and lead to increasing traffic volumes.

Ministry of Health (MoH)

In many cases, the MoH and the MoT have identical positions. The health authorities perceive that many transport generated health problems can be improved by implementation of better road infrastructure. The planned completion of the Prague Ring Road system is an example. It is expected to improve the *noise* situation in the city and probably also to improve the *air quality*. A lot of traffic will be directed away from the city centre and the residential areas. Finally it may also result in fewer *accidents*. From the perspective of the MoH the ring road will improve the human health conditions while it will simultaneously improve mobility, thereby being in line with MoT-priorities. The Ministry of Environment - focussing on bio-diversity and landscape protection - have a critical stance on the issue as the ring road may affect a weekend house area close to Prague and deteriorate landscapes and rivers valleys.

Ministry of Environment (MoE)

Improvement of air quality is a high ranked objective according to the document "State Environmental Policy" (approved by the government, 1995). With regard to transport, focus is on reduction of NOx and VOC that will be promoted qua modernisation of the car fleet and the public transport. This objective appears in concurrence with the priorities of the MoH and the MoT. However, the MoE is reluctant to accept the rationale of road development as it finds that transport demand to some degree is determined by the supply of infrastructure; hence construction of new motorways is expected to lead to more traffic rather than solve transport problems. The ministry sees itself as having a control-function, in relation to the impact of transport on landscape protection, and this sometimes creates tension between the MoT and the MoE.

Factors influencing the level of co-ordination and integration

The integration of environmental and health concern into transport policies seems well underway, if assessed by the overall transport and environmental policy plans. Moreover, it appears that all three ministries attach a high priority to a modernisation of the vehicle fleet and the public transport as a means to reduce the emissions of air pollutants.

Considering road infrastructure projects, the MoT (focussing on inter-city mobility) and the MoE (focussing on landscape protection) seems to have very different priorities and this gives rise to conflicting positions. According to the *Prague Environment, Trends and Statistics* (1998) "conflicts between construction activities and developments and nature protection interests take place on a more or less permanent basis."[70]

There is no tradition for close co-operation between the MoT and the MoE. It is the impression that only few informal contacts are exchanged on the level of civil servants during everyday activities; and it is not a normal practice to establish inter-departmental working groups to solve particular problems. In short, the ministries seem to be somewhat isolated from each other, in spite of the fact that both have prepared policy plans that address the transport-health-environment complex.

The intensity and character of co-ordination may be influenced by the fact that the Parliament is relatively little involved in the transport policy-making in the Czech Republic. The parliament does not approve specific construction laws for new motorway or railway projects, and it does not determine the composition of the MoT-budget, only budget size is given. In the absence of parliamentary decisions on infrastructure projects, a lot of policy-making therefore is shifted "downwards" to the administrative level. Quite naturally this give rise to tensions between the ministries on specific issues.

In the light of this institutional setting for transport policy-making it might be very useful to explore the possibilities to create institutions on the administrative level which could facilitate the dialogue and co-ordination between the MoE and the MoT, see section 5.3 below.

5.3 Measures to improve co-ordination

The level of co-ordination between ministries is not static. If there is a determined will to engage in co-ordinating activities, new institutions can be designed and installed to facilitate it. Examples are given below.

[70] "Prague Environment, Trends and Statistics" (Institute of Municipal Informatics of the City of Prague, 1998).

At the parliamentary level, all new parliamentary bills may be required to include an explicit environmental and health assessment. The comments should go with the bill and be available to the public. Also the state budget could be subject to an environmental and health assessment.

At the macro-planning level a common measure is to develop environmental and health action plans which address how to secure integration of environmental and health concern into the transport policy and which establish (quantitative) environmental objectives. This is a method already used in Bulgaria and the Czech Republic.

At the administrative level several measures may be applied, depending on the local context:

- Create green offices ("Trojan horses") in ministries like transport, taxation, and finance; thereby securing that environmental issues will be dealt with also within the important sector- and economic ministries.
- Establish ad-hoc working groups with representatives from the MoT, MoH, and MoE to prepare new transport related legislation, and to discuss specific problems, etc. - thereby also establishing good informal working relations between the ministries.
- Establish co-ordinating committees at the level of (vice) ministers.

5.4 Conclusions

Based on the assumption that co-ordination between the transport, health, and environmental authorities is a prerequisite for integration of environmental and health objectives into the transport policy, this chapter has outlined the barriers to co-ordination. It has been stressed that co-ordination has a public good character; therefore healthy co-ordination patterns cannot a priori be expected to come smoothly. Co-ordination in itself should be seen as an objective to be achieved qua a deliberate process of designing and implementing institutions to facilitate co-ordination.

Further the chapter briefly analysed the situation in the Czech Republic and Bulgaria. In particular in Bulgaria, the level of co-ordination seems quite high. There is agreement between the three ministries on overall transport objectives; hence the co-ordination process is easy to maintain as no actor may fear to loose his position. The tradition for co-ordination seems to be a valuable asset for Bulgaria when addressing its current and future transport problems.

In the Czech Republic integration also has started to gain foothold; an example being the national Transport Policy Plan which addresses the environmental challenges of the transport sector. At the administrative level the co-ordinating activities appear to be quite few. The extent of daily interaction between ministries of transport and environment are sparse and there seems to be a lack of forums to facilitate the dialogue and the co-ordination.

6 Considerations for a policy response

The CEE countries face a big challenge of integrating environmental and health aspects in their transport policies. This challenge occurs in the midst of the transition period, where the CEE countries are striving to redirect their economies in the direction of modern market economies. The CEE countries should therefore exploit the possibilities for using market based instrument to regulate the transport sector in a more environmentally friendly and healthy way.

A wide range of policy instruments are available for regulating the transport sector in a more healthy and environmentally friendly way, but for the CEE countries special attention should perhaps be given to instruments, which take advantage of the market forces to obtain environmental and health targets. By using economic instruments, such as taxes, tax differentiation and subsidies, price incentives can be changed and market demand changes induced.

6.1 Targets and instruments

When framing an integrated transport, environment and health policy the following issues should be considered:

- the problem
- the target
- the strategies
- the instruments

In order to identify the *problem* attention must be given to the problem area, monitoring made where possible and political acceptance obtained for allocating resources to solve the problem. An example could be the identification of high accident rates to be a problem.

Next, realistic *targets* must be set, taking into consideration the political, economical and technical possibilities of reaching the target. Following the same example, the target could be to reduce the number of fatalities and injured to a given number before a given date.

The *strategies* identify the areas of action. In the example, strategies could include safer roads, lower speeds and safer vehicles. In order to identify strategies it is important to understand the relationship between traffic and the problem, e.g. the reasons why traffic leads to traffic accidents.

Finally, the specific political *instruments* must be considered. Instruments are legislation or other initiatives, which are implemented in order to reach the desired results. In the given example instruments could be investments in road infrastructure such as traffic regulation or separation of traffic, speed limits and speed control, requirements of safety belt and air bags and periodical inspection including safety checks.

As mentioned above, it is vital to understand the relationship between traffic and the problem in order to identify the environmental strategies. By identi-

fying the physical or behavioural steps by which traffic leads to nuisances, the possible areas for using policy instruments could at the same time identified. Below this will be schematically illustrated for air pollution, accidents and noise.

Air pollution

The damage of traffic emissions on environment and health depends on factors such as the emission level from individual vehicles, traffic patterns, meteorology, exposure and dose-response relations. Identification of strategies for reducing the impact from emissions from traffic take a starting point in these relations, schematically illustrated in Figure *6.1*:

Figure 6.1
The effect of transport-related air emissions

Traffic	Emissions	Air quality	Exposure	Dose	Effect
Size Distribution Speed Cold start	Substances Transformation Correlation	Chemistry Meteorology Topography	Demography Activity pattern	Physiology Activity level	Dose-response

Source: The Danish Environmental Protection Agency: *Health Assessment of air pollution from road traffic.* 1997.

From the figure, possible strategies for reducing the impact of air pollution could be identified. Examples could be: Reduce traffic speeds; avoid short trips (converting to walking and cycling); use catalytic converters; improve fuel qualities; separate dwellings and traffic; give special attention to exposure of children and people with respiratory diseases and generally improve the health of the population (reducing their vulnerability to air pollution). Many more strategies are available, these are just examples of how to use a systematic approach.

Accidents

Accidents should be viewed in terms of risk. The risk of accidents is a combined effect of the risk to become involved in an accident and the risk of being killed or injured, *if* the accident happens.

Figure 6.2
The risk of transport accidents

Traffic	Traffic behaviour	Infrastructure	Exposure	Dose	Effect
Traffic volume Mode split Speed Vehicle safety	Risky behaviour Alcohol	Mode segregation Signals Crash fences	Individual traffic activity	Passive safety Mode vulnerability	Rescue system Medical care Psychology

As mentioned above, possible strategies for reducing traffic accidents could include safer roads; lower speeds; higher vehicle safety, such as seat belts and air bags.

Noise

The impact of noise depends basically on the noise emitted and on the conditions for spreading and reception. *Figure 6.3* illustrates the relationships between traffic and noise nuisances:

Figure 6.3
The effect of transport noise

Traffic	Emissions	Spreading	Exposure	Dose	Effect
Traffic volume Heavy vehicles Speed Day/night	Road surface Tires Motors	Geography Meteorology Barriers Insulation	Activity pattern Localisation Traffic routes	Sensibility	Dose-response Expectations Information

Thus, examples of possible strategies for reducing the impact of traffic noise could be: Reduce traffic speeds; improve tires and road surfaces; reduce motor noise; establish noise screens; insulate houses in noisy areas; separate dwellings and traffic; redirect traffic; give information on noise changes. Noise abatement will typically be focused around:

- Construction of new infrastructure
- Building new housing areas
- Existing areas

When constructing new infrastructure or building new housing areas, localisation is an important factor for reducing the noise impact from traffic. Legislation on noise limits is often established for new infrastructure and new housing areas, whereas reduction of noise for existing areas and infrastructure typically present a more complex problem.

6.2 Choice of instruments

The CEE countries are presently redirecting their economies in a more marked based direction. Therefore, the economic benefits accruing from the use of economic instruments should be given special attention. In order to achieve an economically efficient use of resources, prices of goods should in general reflect the costs of producing those goods, including environmental and health costs. If this is not the case, economic efficiency will not be attained. Taxes and other economic instruments can be used to correct such market failure by making consumer prices reflect the full socio-economic costs.

However, all types of instruments should be considered. Instruments could according to OECD be grouped in three basic groups:

- Administrative instruments
- Economic instruments
- Information and planning

Administrative instruments are also known as standards or command and control policies and have a direct regulative effect. The administrative instruments are rules or regulations, and generally have to be supplemented with sanctions in case of non-compliance. Administrative instruments could also include spatial planning, if such planning is made compulsory.

Economic instruments regulate the activities indirectly. By adjusting prices and giving the right incentives, behaviour is affected.

Information and planning instruments are characterised by affecting the actions of individuals on a voluntary basis and include instruments such as planning, education, motivation, public information, voluntary agreements, hearings and declarations on political intentions. Spatial planning and other planning activities not regulated by law are included under this heading.

In Appendix 2 is presented an overview of administrative, economic and information instruments.

An integrated transport policy should take the various options for instruments into consideration and assess to which extent they enforce or contradict one another. For instance, a policy for reducing air pollution from cars points to increased use of catalytic converters, which however increases CO_2 emissions. This does not mean that catalytic converters should not have a high priority but only that the different effects of the instruments should be considered together. In many cases, instruments will have a positive effect on several environmental and health aspects. Petrol taxes thus have a negative effect on transport volumes and thereby a positive effect on most impacts from traffic.
The external costs of transport can be affected at multiple levels, e.g. the means of transport, the vehicles, the fuel used, or more generally the level of transport itself. Several policy options can respond to more than one strategy for addressing the three problems of noise, emissions and accidents. Some policy instruments can even be applied to address strategies for all of the adverse effects of transport.

For example, reducing the overall level of road transport by increasing the costs will reduce all of the adverse effects. Economical instruments such as fuel taxes and vehicle excise duties can be used to internalise the external costs by increasing the price of transport. Increased fuel taxes will increase the total costs of road transport, which will reduce the demand. Fuel taxes will also improve the energy efficiency of transport, because it will influence vehicle technology, life-styles, locational decisions, driver behaviour, choice of travel mode and length of trips. Car use and fuel consumption would be reduced, thereby reducing emissions, noise and accidents.

6.3 EU´s transport policy

EU transport policy outlines principles for using the market mechanism to obtain environmental targets. An important principle is to provide incentives for environmentally friendly behaviour by internalising environmental and health costs in the price of transport.

The EU Commission has launched several papers that describe the overall transport policy principles of EU[71]. A central concept is the concept of sustainable mobility, expressing the need for balancing the positive effects of mobility against the negative effects of infrastructure use, accidents and environmental damage (external costs).

The overall objective of the EU transport pricing policy states that external costs of transport should be internalised. This means that taxes should be imposed that reflects the external costs of transport, such as noise, air pollution and accident costs.[72]

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[71] Commission of the European Communities: "The Future Development of the Common Transport Policy - a Global Approach to the Construction of a Community Framework for Sustainable Mobility, COM(92) 494 final, December 2, 1992.
Commission of the European Communities: "Towards fair and efficient pricing in transport. Policy options for internalising the external costs of transport in the European Union. Green Paper". COM(95). 691 final. Luxembourg, 1996.
Commission of the European Communities: "Fair Payment for Use: A phased approach to transport infrastructure charging in the EU". 1998.

[72] "The future development of the common transport policy", COM(92) 494 final, December 2, 1992

As mentioned above, in a market economy, the best allocation of resources is only established if the costs facing the individual producers and consumers represent the true costs to society. This is often not the case with environmental and health costs associated with transport. Internalisation of these costs is a way to correct for such market failure.

Table 6.1 presents a breakdown of the total costs of transport in external and internal costs for the most important cost items.

Table 6.1
Classification of the costs of transport

Cost Categories	Social Costs	
	Internal/private costs	**External costs**
Transport expenditure	fuel and vehicle costs, tickets/fares	costs paid by others (e.g. free provision of parking spaces)
Infrastructure costs	user charges, vehicle taxes and fuel excises	uncovered infrastructure costs
Accident costs	costs covered by insurance, own accident costs	uncovered accident costs (e.g. pain and suffering imposed on others)
Environmental costs	own disbenefits	uncovered environmental costs (e.g. noise disturbance to others)
Congestion costs	own-time costs	delays/time costs imposed on others

Source: "Towards fair and efficient pricing in transport", COM(95) 691 final. Green Paper.

The existence of external costs has the effect that transport users respond to prices that are lower than the "true" costs, which again leads to a transport demand above what is economic efficient. The result is congestion, accidents, air pollution and noise above socially acceptable limits.

Whenever there are external costs on a market, the market price is too low compared to the socially optimal situation. A tax should therefore be imposed by the authorities in order to raise the market price to which the consumer responds.

6.4 Recommendations

In order to cope with the challenge of increasing or potentially increasing car transport, environmental and health targets should be set and policy instruments identified. Economic instruments such as taxes and subsidies to regulate transport patterns, modal split and transport demand should be emphasised.

Gradual increases in road taxes should be considered. Such taxes would have the double effect of curbing growth in car transport and at the same time providing financial resources. The advantages of tax differentiation for reaching environmental and health targets should be considered. The tax regimes should be shaped according to each individual country, with a view to the EU transport taxation principles.

Spatial planning should consider to preserve and promote localisation of dwelling areas, business and recreational areas, so that it is favourable with

respect to use of public transport for daily purposes such as commuting, shopping and leisure.

Important policy measures to consider in CEE countries include:

In general:

- To set overall objectives for reducing environmental and health implications from transport noise, accidents and air pollution.
- To establish the necessary institutional framework for integrating environment and health objectives in transport policies and to secure co-ordination between transport, environment and health interests.
- To closely consider the individual environmental and health problems (notably noise, air pollution and accidents) and policy objectives in order to identify appropriate administrative, economic and information instruments.
- To apply cost-effective measures for reducing various negative impact from transport.
- To strengthen enforcement and control.

More specifically:

- To preserve and support the market share of public transport by securing the necessary funding and keeping fares low. Road taxes represent a source of financing. International financing should support national initiatives for environmentally friendly transport modes, like rail and light rail infrastructure and rolling stock.
- To secure that spatial planning in regard to localisation of housing, business, industry and shopping support the use of public transport.
- To implement and accelerate implementation of important EU directives, such as the directives on emission standards, fuel standards, periodical inspection and type approval.
- To promote renewal of the vehicle fleet.
- To monitor car passenger traffic by implementing monitoring systems.
- To develop standardised noise measurement methods and programmes for more abatement both in relation to new infrastructure projects and to reduce problems along existing roads and railway lines.
- To enhance efforts to improve fuel qualities at refineries and to support demand for cleaner fuels by economic incentives.
- To provide incentives to increase bicycle transport as a transport mode by providing a safe bicycle infrastructure and by providing information about the positive health effects from cycling.
- To use market based instruments (taxes and tax differentiation) to influence traffic volumes and modal split , such as taxes on petrol, on car ownership and on car registration.

- To implement information campaigns aimed at drivers and car owners and designed to address various issues such as encouraging the use of seat belts, informing about the dangers of traffic accidents, informing about the applicability of unleaded petrol in different car models, informing about how to drive in order to minimise the use of petrol per kilometre driven. and about environmental and health effects from transport.

- To introduce smog alarms and warnings to vulnerable groups is also a recommended and commonly used instrument.

International co-operation and support:

External technical assistance and international financing are crucial elements in coping with the increasing environmental and health effects from transport in the CEE countries. and absolutely necessary if the CEE countries are to meet EU directives and other international agreements and standards. Thus bilateral and multilateral assistance have important roles to play in the process of framing new policies and not least of ensuring effective and timely implementation of already approved policies such as the phase out of leaded petrol, EU directives, international conventions, etc.

It is recommended:

- To provide technical assistance for setting up effective traffic monitoring and emission measurement systems.

- To provide external technical assistance in the framing of strategies and action plans and in terms of strengthening CEE institutions by transferring experience on practical implementation of EU laws and regulations.

- To implement training and institution building programmes to improve the ability to enforce new standards, such as petrol standards, vehicle safety standards, etc.

- To provide assistance in project preparation and documentation with the purpose of obtaining (partial) international financing of investment projects (infrastructure investments, refinery investments, etc.).

- To give access to concessional financing of certain transport investment projects such as investments in improved public transport systems.

Appendix 1: Health and environmental effects of transport emissions

Transport emissions are complex and include hundreds of compounds that are released into the atmosphere as gases, aerosols and particulate matter. The engines emit nitrogen oxides (NO_x), hydrocarbons (HC), carbon dioxides (CO_2), carbon monoxide (CO), sulphur dioxide (SO_2), volatile organic compounds (VOC), particulate matter (PM) and lead (Pb). Some of these emissions transform in the atmosphere and give rise to secondary pollution, such as photochemical oxidants, tropospheric ozone, acid aerosols and carcinogenic hydrocarbons.

The various emissions from transport cause several adverse effects on health, and it also damages forests and agriculture, damages and demolishes buildings and damages the global climate.

Health effects

Particulates that remain within the lungs lead to respiratory diseases, cardiovascular diseases and cancer. Moreover, several studies have shown that short and long-term increases in the particulate matter concentrations are associated with increases in mortality for cardiovascular causes and respiratory causes as well as with total mortality. Levels of hospital admissions increase for respiratory diseases such as bronchitis and for asthma. Children suffer higher levels of chronic cough and bronchitis and asthmatics have to use more medicine to control their symptoms. Particles also causes decreases in lung function. Furhtermore, particles may enhance the development of lung cancer. According to the WHO guidelines[73] there are no lower limit below which particles has no health effects. Large particulate matter causes irritation to the eyes, nose and throat, while finer particles remain within the lungs, provoking respiratory diseases and cancer. The effects of particulate matter on health (and especially the smaller diameter fractions) make it the most worrying pollutant present in urban air.

Nitrogen oxides (NO_x) react with oxygen in the air to produce NO_2. NO_2 may produce respiratory tract irritation, difficulties in breathing and coughing. Persons suffering from asthma or bronchitis are more vulnerable, and levels of 200-500 $\mu g/m^3$ may reduce the lung function and increase the sensitivity of the respiratory tract. Data from animal experiments suggest that exposure to NO_2 may alter the immunoresponse and lead to decreased resistance towards respiratory infections. Furthermore nitrogen dioxide is one of the important precursors for ozone.

Ozone. High dozes of the secondary pollutant ozone formed by photochemical reaction of NO_X and volatile organic compounds in the troposphere can lead to headaches and eye irritation. It is a major constituent of photochemical smog and one of the most common air pollutants, causing severe respiratory problems and increased allergic response and sensitivity. WHO reports that hourly ozone concentrations of 200 $\mu g/m^3$ can cause eye, nose and throat irritation, chest discomfort, cough and headache (exposure for about six hours to concentrations of 160 $\mu g/m^3$ produces inflammation of the air-

[73] WHO (1996): *Revised WHO Air Quality Guidelines*. World Health Organisation. Copenhagen. Denmark.

ways and changes in standard indices of lung function). Recent studies have shown, that levels of ozone commonly occurring in European cities cause hospital and emergency room visits for asthma and other respiratory problems, reduction in lung fuction and symptoms such as wheezing, coughing, and chest tightness in healthy adults and children. Increases in hospital admissions from respiratory diseases have been observed below 100 $\mu g/m^3$ ozone. In the update of the WHO air quality guidelines for Europe a ozone guidance value of 100 $\mu g/m^3$ as an 8-h mean is recommended, however, it is stated that this level may not adequately protect the most vulnerable from effects.

Hydrocarbons (HC) consist of unburned petrol and substances from the process of combustion. These volatile organic compounds are major precursors of photochemical pollutants and thereby contribute to ozone formation. Animal testing has shown that hydrocarbons can cause cancer. Several hydrocarbons e.g. benzene and 1,3-butadiene are considered carcinogenic. Benzene and 1,3-butadiene are typical volatile hydrocarbons from traffic emissions. Polyaromatic hydrocarbons, PAH are less volatile and emissions of these substances mainly occur in connection with combustion and emission of particles. PAH consists of a large group of different substances many of which e.g. benzo(a)pyrene are potent carcinogens.

Lead (Pb) in petrol leads to several adverse effects on people's health. Foetal exposure to lead may cause decreased gestational age, reduced birth weight, foetal death, and increased infant mortality. Children exposed to lead may suffer inferior reading and learning abilities, hearing loss and loss of concentration. Lead exposure in adults tends to raise blood pressure and high concentrations of lead in the blood may cause neurological and renal effect as well as cardiovascular effects, including heart attack, stroke, and mortality. No lower threshold of exposure exists under which the adverse effects of lead on children and adults cannot be detected.

Carbon monoxide (CO) has significant human health impacts, particularly inferring with absorption of oxygen. Carbon monoxide binds instead of oxygen to the haemoglobin in the blood and thus reduces the oxygen carrying capacity of the blood. In order to provide the essential oxygen, the heart must pump faster, which increases the risk of cardiovascular diseases. Critical levels may occur at places with heavy traffic and at places with low air exchange. People with heart diseases are especially vulnerable to carbon monoxide exposure, as reduced oxygen level in the blood increases the risk for symptoms and heart attack in more serious cases. The 1996 WHO air quality guidelines for Europe recommend a maximum 8 hr average concentration of 10 mg/m^3 of CO near roads.

Non-methane volatile organic compounds (NMVOCs) are major precursors of photochemical pollutants and thereby contribute to ozone formation. Benzene (C_6H_6) is the most commonly monitored NMVOC because of its genotoxic carcinogen potential (any exposure levels may result in increased risk of cancer). Most of the benzene is emitted through the exhausts of motor vehicles, although about 10% are due to evaporation losses. Benzene is a well-known human carcinogen, and may also depress the central nervous system after acute exposure. According to the WHO recommendations, there is no lower level below which health risk is negligible (WHO has set a lifetime leukaemia risk of $4x10^{-6}$ in a population with lifelong average exposure of 1 $\mu g/m^3$).

Environmental effects

The most important environmental effects of transport emissions are acid depositions (acidification) in soil, forests and water leading to soil acidifica-

tion, forest degradation and eutrophication. Emissions of nitrogen oxides, ammonia and sulphur dioxide are the main causes for the acidification.

The acidification contributes to the forest degradation that is observed in large parts of the world. Furthermore, exposure to ozone and eutrophication by excess nitrogen deposition has been found to contribute to the degradation. The degradation of forests can be seen as reduced growth and vitality of trees. A 1995 joint EC-UNECE survey on forest conditions in Europe revealed that acidification has severely damaged more than one third of the forest cover in CEE. However, the percent of forest in CEE suffering from acid deposition above the critical loads for acidification is expected to fall from 39.2% of the total forest cover in 1990 to 9.6% in 2010.

The acid deposition also plays a role in the damage of agriculture. Vegetation is also affected by reception of emissions directly through the leaves. A range of emissions has been found to affect the vegetation. The most significant are nitrogen oxides, sulphur dioxide and ozone.

The acidification further causes material effects in terms of corrosion and smudging of buildings. Corrosion of buildings is caused by the acid deposition from emissions of nitrogen oxides and sulphur dioxides. The acid attacks and demolishes stone, metal, paint and other building materials. The smudging of buildings is caused by emissions of particulate matter. The particles become attached to buildings affecting the visual impression and increasing the need for cleaning.

Eutrophication of water bodies is largely due to nitrate leached from agricultural soils, but atmospheric emissions of NO_x also play an important role for the total level of nitrogen input to lakes and seas. The eutrophication adversely affects the biodiversity and leads to declining fish stocks.

Damage to global climate

Damage to the global climate is an important category of the emission-related damages, and it is widely recognised, that the greenhouse gases has an adverse effect on the global climate. Transport is a major contributor to emissions of greenhouse gases. A wide variety of emissions contribute. The most important are carbon monoxide (CO_2), and, to a smaller extent, methane and nitrogen oxide.

The greenhouse gases contribute to global warming which has been found to affect a wide range of global systems and human activities. Lots of scientific studies have been undertaken, aiming at identifying the greenhouse effects by searching for trends in climatic and hydrological records.

The global warming is envisaged to melt mountain glaciers and inland ice caps, and expand seawaters, which will lead to a rise in the global mean sea level. Some of the environmental effects of the sea-level rise will be permanent inundation of low-lying land, increased frequency of temporary flooding and changes in rates of beach, dune or cliff erosion. Climate change is also likely to affect human health through the shifts in the distribution of diseases, such as malaria and respiratory disorders. Furthermore, in the long run the climatic change will adversely affect the hydrological cycle, agriculture, ecosystems and biodiversity. A major part of the concern is the uncertainty about the character and degree of the effects.

Appendix 2:
Overview of policy instruments

Administrative regulation	Economic instruments	Planning and information
Prohibitions *Commands* • Emission standards • Technical standards *Permissions* • Type authorisation • Registration *Control and sanctions* • Fines and imprisonment • Confiscation • Withdrawal of permissions *Guidelines*	*Taxes* • Emission taxes • Ownership tax or weight tax • User fees • Product charges • Administrative charges • Tax differentiation *Subsidies* • Grants • Soft loans • Tax deductions • Tax suspension *Infrastructure investments* *Recycling systems* *Tradable permits (quotas)*	*Planning* • Spatial planning • Long-term plans, scenario-building *Policy signals* • Declarations of intent • Pre-announcements *Information* • Education • Attitude adaptation • Public information • Eco-labelling *Dialogue* • Public hearings • Consensus *Environmental guidance* • Environmental audits • Energy consultations *Voluntary agreements*

Source: CO2-reductions in the transport sector. Danish Ministry of Transport, 1995.

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Resumé:
Rapporten beskriver udviklingstendenser inden for transportsektoren i de Central-og Østeuropæiske lande samt de resulterende miljø- og sundhedsmæssige effekter. Desuden beskrives mulige virkemidler over for trafikkens negative effekter, herunder anbefalinger til integration af miljø- og sundhedsaspekter i transportpolitikken. Rapporten er baseret på litteraturstudier samt interview med nøglepersoner i
2 udvalgte case-lande: Tjekkiet og Bulgarien.

Emneord:
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The report provides a review of the current state of affairs and development trends in the transport sector in Central and Eastern Europe including the associated environmental and health effects. Focus in the report is on the challenges and policy options for counteracting the negative effects from transport as well as integrating environmental and health aspects in transport policies. The report is undertaken as a desk study supplemented by two case studies in the Czech Republic and Bulgaria.

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