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EXTERNAL COSTS OF TRANSPORT IN CENTRAL AND EASTERN EUROPE

Final Report

27-28 May 2003

This report is the final version of the study on external costs of transport in Central and Eastern Europe. It has been prepared within the Environmentally Sustainable Transport (EST) outreach activity "EST goes East" to Central and Eastern Europe. A consortium of consultants mandated by the CEI Working Group on Transport and the Environment and the OECD Working Group on Transport has conducted the study.

A summary brochure of the study including the main results on current and projected future transport externalities has been issued jointly with the CEI and the Austrian government. These documents are also available on the OECD/ENV website www.oecd.org/env/transport.

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FOREWORD

Current and projected transport trends in Central and Eastern Europe are not sustainable and cause severe damage to human health and the environment. Transport-related accidents, air pollution, noise, climate change impacts, etc. generate large social costs. These costs are usually not covered by the users, but have to be borne by the whole society. Consequently, ignoring these externalities result in market inefficiencies that favour more harmful transport modes.

Knowing these external costs is a prerequisite to develop strategies for their internalisation, and thus for making progress towards sustainable transport - a key issue on the transport policy agenda. External costs of transport have not been assessed for Central and Eastern Europe, and thus, an important element of policy-making was missing. Following the CEI Ministerial Declaration “Towards Sustainable Transport in the CEI Countries” and the OECD/UNEP Initiative on Environmentally Sustainable Transport in the CEI region, the OECD Environment Directorate, supported by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, launched this pilot study on “External Costs of Transport in the CEI” under the auspices of the CEI Working Group on Environment and its Task Force on Environment and Transport. This initiative aims to facilitate sustainable transport policies by providing – for the first time – detailed data on external costs of different transport modes in the Central and Eastern European countries.

This report presents the detailed results of the study including current external costs by mode of transport and by country and as well as a number of conclusions and recommendations for policy. It also contains an estimate of projected future external costs of transport in 2010 for the CEI region as a whole. This study can serve as a basis for improving the assessment of externalities and developing strategies towards their internalisation and thus contributing to environmentally sustainable transport in the CEI region.

The study was elaborated by a consortium of consultants including Markus Maibach, Christoph Schreyer, Christian Schneider (INFRAS, Zurich); and Max Herry, Markus Schuster, Martin Russ, Stefan Wolf (HERRY Consulting, Vienna). The report was prepared by the OECD Secretariat under the auspices of the OECD Environmental Policy Working Group on Transport. The main responsibility for this work was with Peter Wiederkehr, assisted by Nadia Caïd, Environment Directorate. Secretariat support was ably provided by Adam Troman.

The OECD would like to acknowledge the financial contribution from the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management and the commitment and continuous support from Robert Thaler and his team from the Division of Mobility, Noise and Spatial Planning, especially Ms. Renate Nagy, who very much helped to complete this work.

This report is published on the responsibility of the Secretary-General of the OECD.

TABLE OF CONTENTS

SUMMARY

Aim of the study

This study is part of the joint OECD/UNEP initiative on Environmentally Sustainable Transport (EST) for CEI countries. It estimates total and average external accident and environmental costs per mode and country, in order to develop a quantitative monetary basis for internalisation strategies.

For reasons of comparison, it is based on the state of the art methodology developed for Western Europe, and adapted to the situation in CEI countries. The study provides results by country and individual models for 1995 (base year) as well as projections for 2010. It uses the most recent available transport data (OECD, ECMT, other sources)[1].

Methodology

The following table gives an overview of the cost components considered and the method used. Cost estimates are based on a value transfer method using results from the study in Western Europe (Infras/IWW, 2000). In order to transfer unit values of Western European to CEI countries, a specific value adjustment process, based on GDP per capita and Purchasing Power Parity adjustment was applied.

OVERVIEW OF EXTERNAL COSTS BEING CONSIDERED				
Type of effect	**Cost components**	**Method**	**Data basis**	**Type of Externality**
Accidents	Additional costs of - medical care - economic production losses - suffer and grief.	The value of human life is estimated by using studies for willingness to pay to reduce accident risks.	Accident rates per country (mainly ECMT statistics)	Partly external (part which is not covered by individual insurance)
Noise	Damages (opportunity costs of land value) and human health.	Willingness to pay for a noise reduction to 55 dB(A).	Population density in urban areas and noise exposure	Fully external.
Air pollution	Damages (opportunity costs) of - human health - material/buildings - biosphere/crop losses.	PM_{10} dose response functions are the basis for the repair and damage costs.	Emission level per transport mode (OECD).	Fully external.
Climate change	Damages (opportunity costs) of global warming.	Avoidance costs to reach Kyoto targets per country.	CO_2 Emissions per transport mode (OECD).	Fully external.
Nature and landscape, ground sealing	Additional cost to repair damages, compensation costs.	Costs based on unit types of repair measures (space indicators).	Length and width of transport infrastructure.	Fully external.

Table S-1 External cost categories considered in this study

1 Not considered were congestion costs and other indirect effects.

Results for the base year 1995

The cost estimates have shown that there are significant externalities due to accident fatalities and due to environmental nuisances of the transport sector. They result in external costs of nearly 40 billion of Euro for the base year 1995. Two cost categories are predominant: about half of this amount is external accident costs; more than 40% are air pollution costs. Noise costs are rather small due to a still relatively low population density and occur more locally (i.e. in urban areas). Climate change costs are less important, mainly due to the assumption, that avoidance costs of the CEI countries to reduce CO_2 emissions to meet Kyoto targets are rather low.

TOTAL COSTS IN 1995 BY COST CATEGORY & TRANSPORT MODE

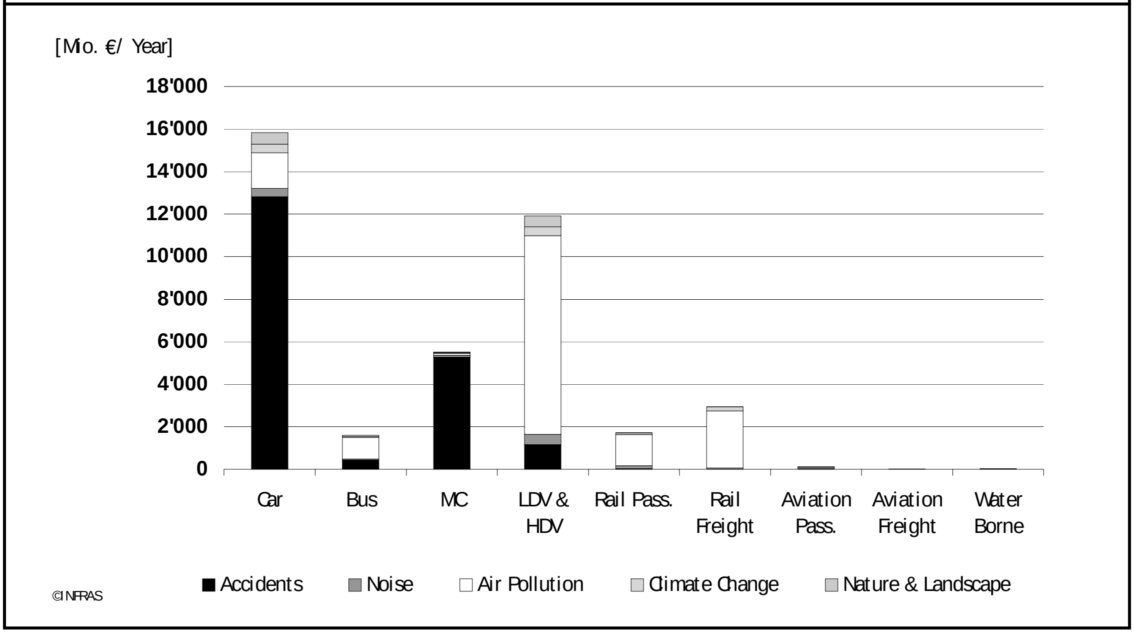

Figure S-1 Total costs in 1995 by cost category and transport mode. Passenger cars are responsible for around 40% of total costs, road freight transport (Light and heavy duty vehicles) for ca. 30%.

Road transport is predominant and accounts for 87% of total costs. While accidents costs are predominant for passenger cars, the PM_{10} emissions of diesel engines of trucks are mainly responsible for the high share of air pollution costs in road freight transport.

Air pollution health costs are also very relevant in the rail sector, due to the high share of diesel locomotives and the fossil fuel based production of electricity. The latter causes as well air pollutant emissions, although their effect might be somewhat less relevant for human health since they are close to the plant sites.

The costs from aviation are lower than road transport, but quite significant for air cargo. Costs have been estimated only for the LTO-cycle and not for cruising altitudes, where significant climate effects occur.

Total external costs amount to 14% of GDP of the CEI region. The levels differ from country to country, depending on GDP levels, population densities and traffic volumes in urban areas, and diesel shares in the rail sector.

The cost ratio between road and rail clearly indicates the lower costs incurred by railways. Also in the CEI countries, the railways perform significantly better, if one compares average costs in passenger and in freight transport. It has to be noted however, that the environmental performance of the railways is worse than in Western Europe, due to high diesel shares and due to fossil fuel based electricity production.

AVERAGE COSTS OF PASSENGER TRANSPORT IN 1995 BY COST CATEGORY & MODE

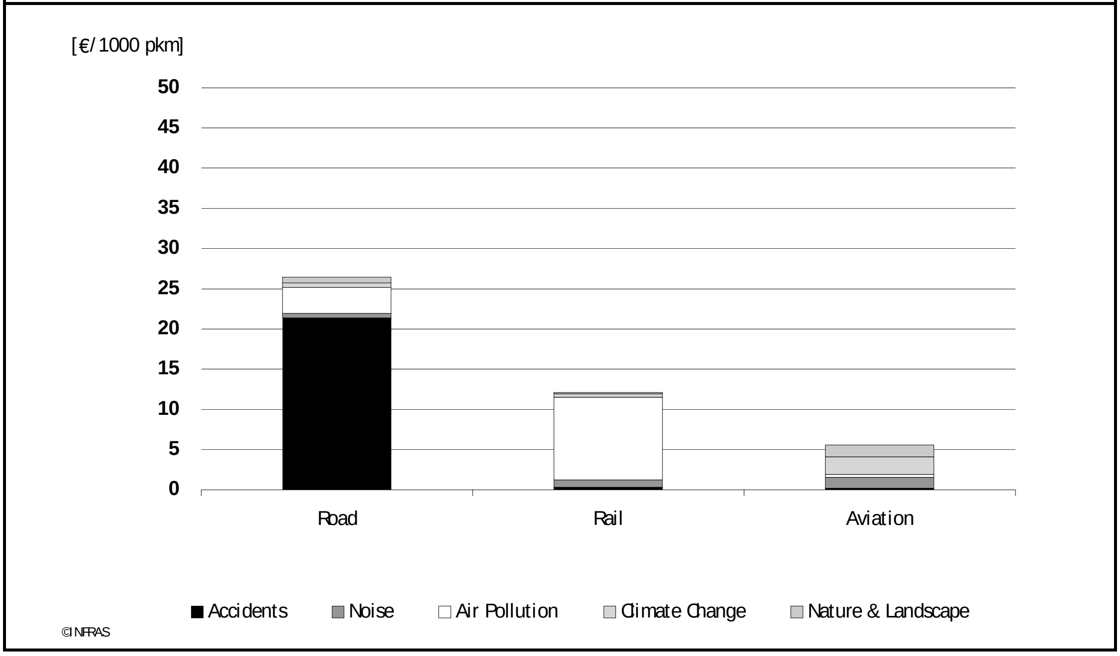

Figure S-2 Road transport has the highest level of average external costs per passenger km.

AVERAGE COSTS FOR FREIGHT TRANSPORT IN 1995 BY COST CATEGORY & MODE

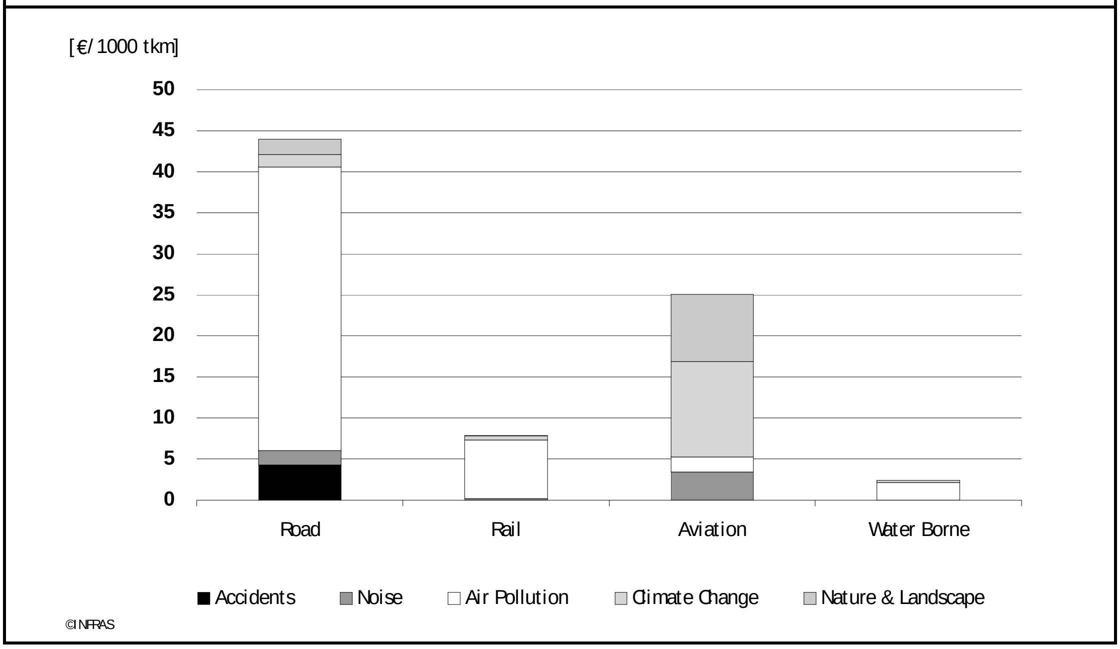

Figure S-3 Air pollution costs are predominant in freight transport.

Outlook to 2010

A rough **trend outlook for 2010** indicates, that external costs will rise significantly, due to economic growth (which is predominant for the increase of damage valuations) and traffic growth, especially in road transport and aviation. Total costs will increase by 58%. Average costs however decrease (mainly in the freight sector), due to the reduction of PM_{10} emissions for diesel engines.

If we consider a growth scenario with **environmentally sustainable scenario** with best available technology and improved modal shares towards rail (EST3 according to OECD 1999), the costs will increase only slightly (by 7%) compared to 1995 levels. This increase is not due to increased nuisances, but due to higher income levels which influence the willingness to pay.

TOTAL EXTERNAL COSTS OF THE TREND DEVELOPMENT AND EST3 AND 1995

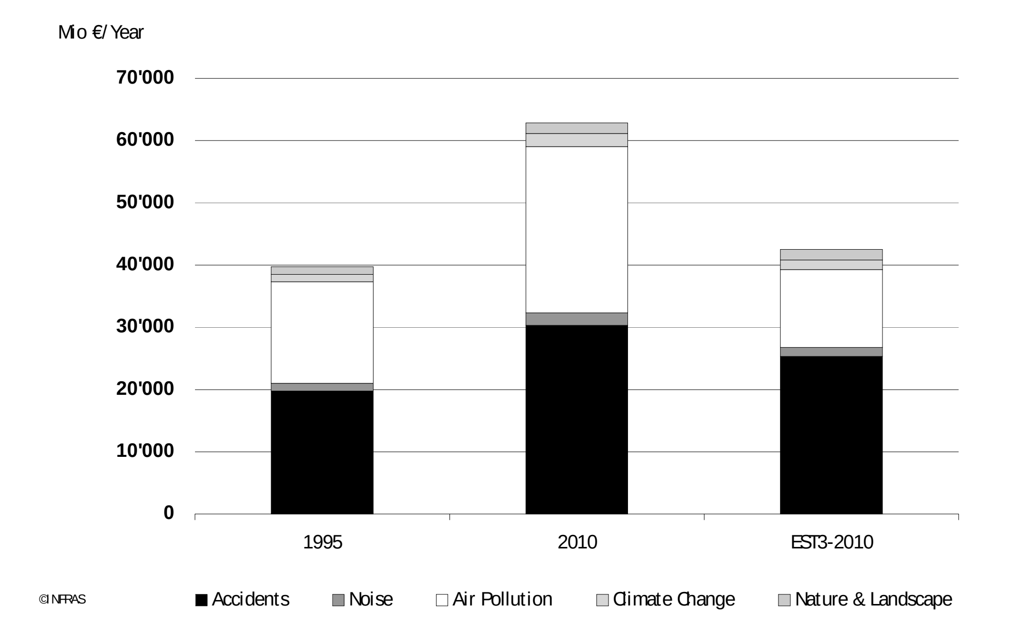

Figure S-4 The costs of the EST3-2010 scenario are significantly lower than in the trend scenario. The increase of GDP however leads to an increase of 7% compared to 1995 levels.

Range of uncertainty

The figures must be considered as pilot results for Eastern Europe. The sensitivity analysis has shown that the range of uncertainty is very high, especially if one would like to compare different countries and different cost elements of different transport modes. We recommend to use the results primarily at the aggregate level for the entire region. The uncertainty range per cost category varies approximately between -50% up to +100% of the values shown.

Comparison with Western Europe

There are many similarities between this study and those for Western Europe, especially with regard to the predominant role of the road sector and the comparison between road and rail. Some differences however can be highlighted:

- External costs per GDP are higher in the CEI countries (14% of GDP) than in Western Europe (8% of GDP). This indicates the higher relevance of safety and environmental problems in the CEI countries relative to other economic activities.

- The projected increase to 2010 rate of external costs in Eastern Europe (+58%) is higher than in Western Europe (+42%), due to higher economic and transport growth rates. On the other hand the reduction potential of improved technology is more significant in Eastern Europe.

Policy conclusions

Based on the **general cost structure**, the following policies can be recommended to reduce external costs:

- Specific safety programmes (improving road infrastructure) and improvements of the existing insurance system should and will improve the safety situation, which is the predominant cost category of road transport. From a pricing perspective point of view, the increase of liability amounts and the differentiation or insurance premium according to individual risk performance of car drivers might be most efficient measures.

- A fast introduction and implementation of EURO-norms and retrofitting of existing diesel engines would reduce road transport air pollution problems and related costs. Such a policy could be strengthened by introducing additional incentive schemes for the use of environmentally friendly cars (i.e. the differentiation of existing taxes according to environmental criteria).

- A programme for the revitalisation of the railways through targeted investments is essential in order to improve the share of railways and to make use of the better environmental performance (i.e. the lower average costs). Such a programme should improve the quality of railways (infrastructure and operation) and the environmental performance as well. The electrification of diesel tracks and the retrofitting of existing diesel locomotives (for example using particle filters and low-sulphur fuels) are possible strategies.

With respect to **pricing policies**, one has to consider that this study has not estimated all relevant cost elements. For pricing purposes, one should include other cost elements (such as congestion costs, infrastructure costs and related revenues) as well. Nevertheless the figures presented for accidents and for environmental costs can be used as proxies for an externality price which is able to internalise these costs elements. For road transport for example, appropriate average charges would be:

- 3.3 Eurocents per passenger and kilometre for <u>passenger cars</u>, and

- 4.4 Eurocents per tonne and kilometre for trucks and <u>light duty vehicles</u>. Expressed in costs per vehicle kilometres, there is a range of between 3.2 Eurocents (for light duty vehicles) up to 6.6 Eurocents (for heavy trucks). Expressed in tonne kilometres, light duty vehicles cause higher unit costs (due to low loading factors) than heavy trucks, ranging from 1.0 Eurocents to 9.7 Eurocents.

Economic theory suggests that the transport sector also generates a lot of economic benefits which are very relevant for the functioning of the economy, and especially for trade. This is however not an argument or justification to subsidise transport (see for example ECMT 2000). **External benefits** are therefore not relevant for efficient pricing solutions.

All types of costs and benefits however should be considered for the evaluation of transport investments, i.e. infrastructure investments for different modes. Most important are time savings for the transport users and additional regional benefits. In order to apply comprehensive **cost benefit analysis appraisals**, the external costs (accidents and environmental unit costs) should be considered as well. This study provides a basis with figures for each country of the CEI region.

EXTERNAL COSTS OF TRANSPORT IN THE CEI[2] COUNTRIES .

1. INTRODUCTION

Background

External costs of transport are important indicators revealing market inefficiencies in the transport sector. They express those costs which are not paid by the users, leading to suboptimal prices and traffic volumes (i.e. with prices usually too low, traffic volumes will be too high). Most important are external costs of accident risks, environmental nuisances and congestion.

The study commissioned by the UIC (Union internationale des chemins de fer; International Railway Union) has estimated these costs for Western Europe (INFRAS/IWW 2000). Total external costs (accidents and environmental costs) amount to 530 billion € for 1995, being 7.8% of the total GDP in EUR 17(EU countries, Norway, Switzerland). Accidents are the most important single cost category with 29% of total costs. Air pollution and climate change costs amount to 48%. Whereas the costs for nature and landscape and the urban effects considered are of minor importance, upstream effects (11%) are quite significant, especially due to the fact that they are strongly related to air pollution and climate change. The most important mode is road transport, causing 92% of total costs, followed by air transport, causing 6% of total external costs. Railways (2%) and waterways (0.5%) are of minor importance. Two thirds of the costs are caused by passenger transport and one third by freight transport.

The transport situation in Eastern and Central Europe experiences great changes. The growth of the economy has led and still leads to high growth rates of traffic volumes, especially in the road transport sector. This increases the need for improved capacity and leads to unwanted side effects such as safety problems and environmental nuisances.

The CEI countries have recognised these problems and initiated several projects related to sustainable transport solutions. The EST-CEI Report, a very important report in this respect (OECD 1999) compiled the basic transport and environmental figures for today’s state and future development.

[2] Countries of the CEI region include: Albania, Belarus, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, FYRO Macedonia, Hungary, Moldova, Poland, Romania, Slovak Republic, Slovenia, Ukraine.

Aim and output of the study

External cost compilations supplement national transport data and are an important (quantitative) basis for policy decisions. The level of external costs strongly suggests the need for internalisation strategies, i.e. investment priorities, improved pricing solutions in the transport sector.

Most relevant are accident and environmental costs, since these costs are usually not considered in pricing schemes. Thus the OECD and the Austrian Ministry for Agriculture and Forestry, Environment and Water Management have launched this study to provide quantitative figures for Eastern and Central Europe, i.e. the CEI countries.

This study follows the methodology of the UIC study mentioned above (INFRAS/IWWW 2000) and provides first estimates of accident and environmental costs for different modes and different countries. At the same time it is based on the OECD work on transport and environmental data and relates to the quantitative figures provided in the respective study (OECD 1999). With this approach it is possible to compare the results between Western and Eastern Europe.

The study produces the following results:

- <u>Cost categories</u>: Accidents (part which is not paid by insurance), noise, air pollution and health impacts, material damages, nature and landscape, climate change risks.[3]

- <u>Countries included</u>: Albania, Belarus, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, FYRO Macedonia, Hungary, Moldova, Poland, Romania, Slovak Republic, Slovenia, Ukraine. These countries were covered in the previous OECD reports and represent the CEI countries.[4]

- <u>Transport modes</u>:

  - Road transport: Private cars, light and heavy duty vehicles, buses and motorcycles
  - Rail transport: Passenger and freight
  - Waterborne freight transport: esp. inland water transport
  - Air transport: passenger and freight

- <u>Base year</u>: Values for 1995[5] and outlook for 2010.

- <u>Presentation of results</u>: Total costs per mode and per country and average costs per mode and per country. The study presents mean values. The range of uncertainties is discussed in a separate chapter.

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3 These categories are usually seen as the most important ones. Not considered are two types of other external costs:
- Minor environmental costs like risks from energy production or up- and downstream effects (discussed in the sensitivity analysis).
- Other type of externalities such as congestion and state subsidies for infrastructure provision or external benefits of the transport sector (discussed in the final chapter ‘interpretation of the results’).

4 Yugoslavia is not treated in this study, although it has also joined the CEI-Initiative in the mean time. This is due to lack of comparable transport and environmental data.

5 1995 was chosen in order to have a comprehensive data basis and for reasons of comparison with the study for Western Europe.

It is important to note that this study tries to calculate average figures per country based on top down approaches, using national data for transport volumes and related effects. Other studies on external costs also estimate marginal cost figures for specific traffic situations, in order to have detailed information for corridor comparisons or efficient pricing solutions.

Structure of the report

This report shows the methodology and the results of the total and average environmental costs for the CEI countries. Chapter 2 shows the most important methodological steps following the methodology of the UIC study. Chapter 3 presents the total and average costs in 1995. Uncertainties are discussed in a separate chapter, since the approach of external cost estimation has to deal with considerable uncertainties at different levels. Chapter 4 presents the results of the outlook for 2010, both for a trend scenario and a scenario considering environmentally sustainable transport solutions. Finally Chapter 5 interprets the figures with respect to policy conclusions, especially the design of improved pricing solutions. This chapter refers as well to the importance of other cost categories and examines the relevance of external benefits.

Detailed data and the description of methods are given in the Annexes.

2. METHODOLOGY

2.1 General methodological issues

Overview of costs considered

The following table gives an overview of the cost components, which are considered in this study:

OVERVIEW OF EXTERNAL COSTS BEING CONSIDERED				
Type of effect	**Cost components**	**Method**	**Leverage points and variability**	**Type of Externality**
Accidents	Additional costs of - medical care - economic production losses - suffer and grief.	The value of human life is estimated using studies for willingness to pay to reduce accident risks.	Depending on different factors (partly on vkm).	Partly external (part which is not covered by individual insurance), especially opportunity cost and suffer and grief.
Noise	Damages (opportunity costs of land value) and human health.	Willingness to pay for a noise reduction to 55 dB(A).	Depending on traffic volume and environmental performance.	Fully external.
Air pollution	Damages (opportunity costs) of - human health - material/buildings - biosphere/crop losses.	PM_{10} dose response functions are the basis for the repair and damage costs.	Depending on vkm, energy consumption and environmental performance.	Fully external.
Climate change	Damages (opportunity costs) of global warming.	Avoidance costs to reach Kyoto targets per country.	Depending on consumption of fossil fuels.	Fully external.
Nature and landscape, ground sealing	Additional cost to repair damages, compensation costs.	Costs are based on unit types of repair measures, based on space indicators.	Fixed costs	Fully external.

Table 1 External costs categories within this study

The methodology is based on the latest state of the art of estimating external accident and environmental costs. The approach is used as well within recent EU-research projects (UNITE)[6]. Details per cost component are shown in the Annex.

Value Transfer Procedure

Since there are no comprehensive studies for cost valuations in Eastern and Central Europe available, it is necessary to transfer the value results from studies carried out for Western Europe and to combine them with transport and emission data from Eastern and Central Europe. In order to transfer these unit values, it is necessary to use a comprehensive value transfer procedure considering different economic

6 (On-going) EU-Project UNITE (UNIfication of accounts and marginal costs for Transport Efficiency)

indicators. We assume that the willingness to pay for the decrease of specific damages is depending on income per capita and the purchasing power. We refer hereby to the same value transfer procedure as it is used within the most important European research project on this issue (UNITE):

In order to transfer unit values (e.g. value of statistical life), we use GDP/capita (Assumption: income elasticity of willingness to pay approach is close to one).

In order to transfer national currencies, we use the Purchase Power Parity (PPP) adjusted exchange rates.[7]

For accident unit costs for example, the risk value was adjusted to the CEI countries according to GDP/capita in each CEI-Country. The GDP/capita is measured at purchasing power parities (PPP).

2.2 Accidents

Cost components

The following cost components per casualty are added in order to estimate social accident costs. External costs are computed by subtracting transfers from liability insurance systems and gratification payments. The resulting external costs per casualty are multiplied with the number of fatalities and injuries. The total external costs are allocated to the modes according to the responsibility for the accident.

EXTERNAL ACCIDENT COST ELEMENTS		
Effect	**Fatalities**	**Injuries**
Risk value	Loss of utility of the victim, suffering of friends and relatives	Pain and suffering of victims, friends and relatives
Human Capital Losses	Net production losses due to reduced working time	
Medical Care	External costs for medical care before the victim deceased	External costs for medical care until the person completely recovers from his/her injury
Administrative costs	Costs for police, for the administration of justice and insurance, which are not carried by the transport users.	
Damage to property	Not included because material damages are paid by the traffic-participants through insurance premiums.	

Table 2 Source: INFRAS/IWW (2000): External Costs of Transport, p 17

Valuation of external accident costs

The valuation of accidents is a controversial matter. It is evident that life is too important for a valuation in monetary terms only, but changes in risks can be valued monetarily. No one would trade his life for a sum of money, but most people are prepared to express their willingness to pay for improved safety performance, by choosing between different situations of safety equipment and related costs.

7 **Purchasing power parities** (PPPs) are the rates of currency conversion that eliminate the differences in price levels between countries. Per capita volume indices based on PPP converted data reflect only differences in the volume of goods and services produced. Comparative price levels are defined as the ratios of PPPs to exchange rates. They provide measures of the differences in price levels between countries.

Nowadays there is a reasonable widespread agreement that monetary values of risk reductions in the transport sector are able to reflect individual preferences of the affected population. The value should be expressed as the collective **willingness to pay (WTP)** for safety improvements or **willingness to accept compensation (WTA)** for increased risk. The WTP or WTA can be estimated by asking a sample of the affected population about the amount they would be willing to pay or accept as a compensation for changes in the level of safety.

Risk value for fatalities

Accidents are not only the cause of pain and suffering: they often shorten the lifetime of their victims. This loss of welfare can be seen as external costs that can be expressed in monetary terms. The Risk Value, in some studies as well named "Human Value", tries to estimate monetary values for pain, grief and suffering of an average transport accident victim.

Based on limited number of well-designed studies (e.g. UNITE), we propose an average **EU Standard Risk Value of 1.5 million Euros per fatality**. This value was transferred to each CEI-country using the value transfer procedure described above.

Risk value for injuries

The Risk Value for injuries is estimated as a share of the Risk Value for fatalities. This study will use the ratios established by ECMT (1998), which estimates the Risk Value for severe injuries at 13% and for slight injuries at 1% of the Risk Value of fatalities. Both values are based on a study by O'Reilly et al. (1994) who used a standardised methodology to compare the three types of risks.

RISK VALUE			
	Fatalities	**Reported injuries**	
		severe injuries	slight injuries
in 1'000 Euro	1'500	200	15
% of Fatalities	100%	13%	1%

Table 3: EU Standard risk values per casualty for transfer to the CEI countries.
Data Source: INFRAS/IWW [2000]: External Costs of Transport, p 18.

Other external accident costs

The costs of net lost production, medical treatment and ambulance were added, in order to have the full social costs of a fatality. These additional costs are approximately 10% of the risk value.

2.3 Noise

Effects of transport noise

Transport noise not only imposes undesired social disturbances, but also influences the individual well being which can entail physical and psychological health damages. Health effects can be caused by noise levels above 85 dB(A), while lower levels (above 60 dB(A)) may cause nervous stress reactions, such as changes of heart beat frequency, increase of blood pressure and hormonal changes. Noise exposure increases the risk of cardiovascular diseases (heart and blood circulation).

Methodological steps for noise costs calculation

The general procedure to estimate noise costs is the following:

- Estimation of the exposure to noise of the population for each CEI country,
- Willingness to pay per decibel and person disturbed,
- Adjustment of the unit value of WTP for noise reduction for the CEI countries,
- Health costs caused by noise.

Unit values

The average willingness to pay value per dB(A) is based on the UIC study: 30 EURO per dB(A) average per household (exposed) - adjusted by GDP per capita (The GDP/capita is measured at purchasing power parities).

2.4 Air pollution

Cost categories

Total external air pollution costs are calculated for the following categories:

- Health costs (lung disease and respiration problems),
- Building damages (additional costs for restoration and cleaning),
- Crop losses (due to quality decrease).

Health costs

The estimations of the UIC study refer to findings of the project 'Health Costs due to Road Traffic-related Air Pollution, an impact assessment project of Austria, France and Switzerland' (WHO 1999), where population weighted PM_{10} average exposure levels were used to estimate morbidity and mortality cases for every country. PM_{10} is used as the basic indicator considering as well nuisances from other pollutants (such as NO_x, Ozone).

PM_{10} emissions for road transport were calculated based on vehicle fleet weighted emission factors for CEI countries taken from the recent study on environmentally sustainable transport in the CEI countries in transition (OECD 1999). Since these emission factors only cover tailpipe exhaust PM_{10} emissions, recent studies have been used to estimate total emissions which include also road, tyre and clutch abrasion as well as re-suspension (INFRAS 1999). Mileage data for every country are taken from the International Road Statistics 1998 (IRF 1998) and the OECD (1999), missing values for several countries have been estimated based on available data of comparable countries.

PM_{10} Emissions for rail transport are calculated using emission factors according to OECD (1999) and mileage and fuel consumption data based on UIC and OECD statistics (UIC 1996, OECD 2002).

Emission factors for aviation and inland waterways are taken from INFRAS/IWW (2000). Emission factors were adjusted according to different aircraft fleet characteristics in the CEI countries.

Using correlation analysis with PM_{10} emissions (including non-exhaust emissions) and PM_{10} exposition data for Austria, France and Switzerland, a relationship between emissions and population weighted average PM_{10} exposition was calculated. The same health effects (long-term mortality, respirator hospital admission, etc.) as in the WHO-study (WHO 1999) were assessed. The estimation of additional cases caused by transport PM_{10} emissions, a fixed baseline increase function from the WHO-study was used. For the valuation of air pollution health effects, the WTP-values as computed by the WHO study were used.

WILLINGNESS TO PAY VALUES FOR AIR POLLUTION HEALTH EFFECTS		
Incident	**Value [Euro]**	**unit**
Long-term mortality (adults >= 30 years)	915'000 (61% of 1.5 million.)	per life lost
Respiratory Hospital admission (all ages)	7'870	per admission
Cardiovascular Hospital admission (all ages)	7'870	per admission
Chronic Bronchitis incidence (adults >= 25 years)	209'000	per case
Bronchitis (children< 15 years)	131	per case
Restricted Activity Days (adults >= 20 years)	94	per day
Asthmatics: Asthma attacks (children < 15 years)	31	per attack
Asthmatics: Asthma attacks (adults >= 15 years)	31	per attack

Table 4 Willingness to pay: Values for the valuation of air pollution health costs.
Source: INFRAS/IWW (2000), WHO (1999)

As in the WHO study we corrected the risk value considering age. Because the mortality risks are increasing with age, the risk value is reduced to 61% of the total estimated value of 1.5 mio. € (see WHO 1999 for detailed argumentation).

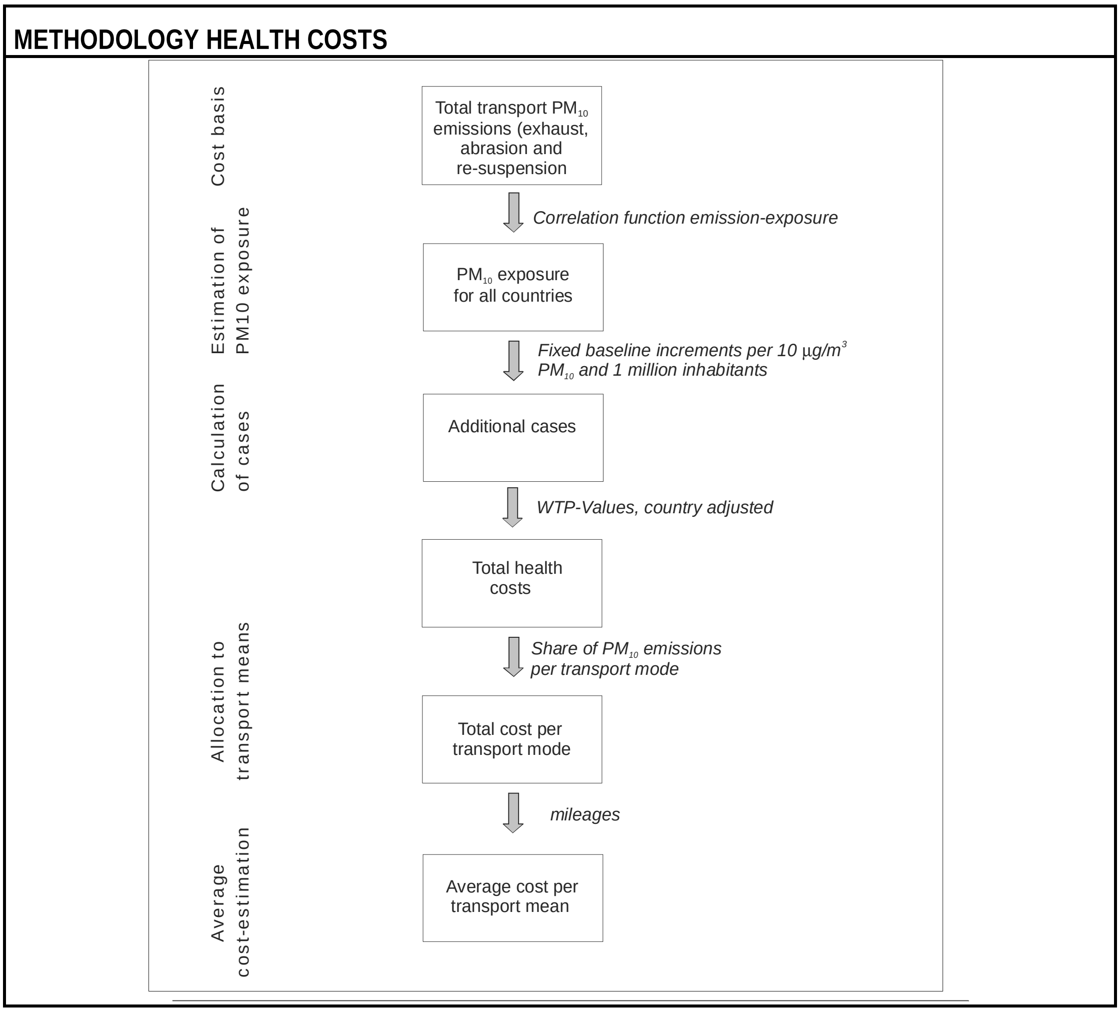


Figure 1 Methodology used for the estimation of health costs.

Building damages and crop losses

For these cost categories a rather simple methodology was applied which was already used in the UIC study (INFRAS/IWW 2000), using the CEI countries NO_x exposition and the value of agricultural production levels and building surface respectively.

The procedure used for the top down approach is based on recent Swiss studies in this field (INFRAS 1992). The basic figures for Switzerland are transferred to other European countries according to the NO_x-emissions, country size, agricultural production and population. The allocation to different transport means is based on their share of total transport NO_x -emissions.

The following Figure 2 shows the procedure for the allocation of these costs to all transport modes and countries. The most important driving factors are NO_x -emissions. These emissions can be used as a indicator component in order to allocate damages to the transport sector. Thus they serve as well as a proxy for other pollutants (like NMVOC, SO_2).

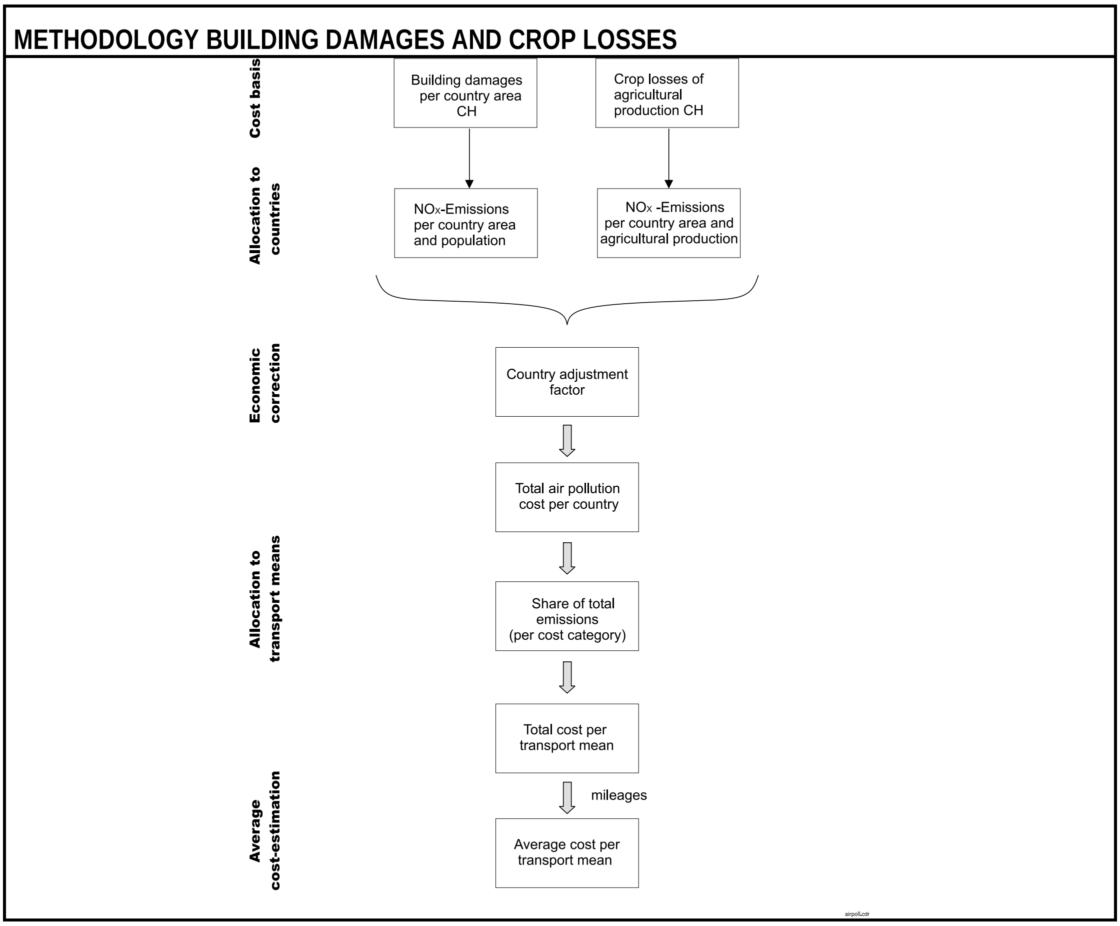


Figure 2 Methodology used for the estimation of building damages and crop losses.

2.5 Climate change

CO_2 emissions for all countries and means of transport are calculated using specific emission factors based on the OECD/CEI study.

Cost estimations are based on scientific studies which estimate the costs for several Eastern European countries. The figures are based on a survey done in the UIC study. They represent marginal avoidance costs to reach Kyoto targets. They are significantly lower than the values used in the UIC study. The following table indicates the different marginal abatement costs (MAC) for different Annex I countries (according to UN-terminology).

	Commitments Kyoto 97				Marginal Abatement Costs			
	Reduction commitments		Target 2010	Reduction from baseline	low	medium	high	Main scenario
countries/region	% 1990	% baseline	mil. t CO2	mil. t CO2	$ / t CO2	$ / t CO2	$ / t CO2	$ / t CO2
	1	2	3	4	5	6	7	8
ANNEX I	-6%	-21%	12898	-3520				
OECD	-7%	-21%	9557	-2500				
Western Europe	-8%	-12%	3088	-406	25 [2]		70 [5]	**48**
Austria	-13%	-16%	52	-9				
Belgium	-8%	-20%	105	-26	31 [1]	80 [4]	100 [3]	**70**
Denmark	-21%	-21%	41	-11	4 [1]			
Finland	0%	-15%	54	-10			40 [3]	
France	0%	-11%	367	-43	0 [1]			
Germany	-21%	-6%	801	-53	0 [3]		12 [1]	**6**
Greece	25%	-17%	103	-20			179 [1]	**179**
Ireland	13%	-15%	35	-6				
Italy	-7%	-17%	401	-85	170 [3]		331 [1]	**251**
Netherlands	-6%	-7%	158	-12	1 [3]	25 [4]	352 [1]	**126**
Norway	1%	-20%	36	-9	95 [3]		>170 [6]	**95**
Portugal	27%	-14%	54	-8				
Spain	15%	-10%	261	-30			1227 [1]	**800**
Sweden	4%	-1%	64	-1	110 [3]		170 [4]	**140**
Switzerland	-8%	-9%	41	-4	25 [3]		160 [4]	**93**
United Kingdom	-13%	-15%	505	-90		10 [1]		**10**
North America (NA)	-7%	-26%	5045	-1805				**62**
USA	-7%	-27%	4610	-1690	16 [2]		110 [3]	**63**
Canada	-6%	-21%	435	-115		40 [3]	140 [4]	**60**
Pacific (PAC)	-3%	-17%	1423	-289				
New Zealand	0%	-20%	25	-7				
Australia	8%	-16%	312	-58				
Japan	-6%	-17%	1086	-224	41 [2]			**55**
EIT	-2%	-23%	3342	-1021		6 [2]		**6**
Bulgaria	-8%		76			9 [6]		**9**
Czech Republic	-8%		153					
Estonia	-8%		35					
Hungary	-6%		67					
Latvia	-8%		21					
Poland	-6%		390			10 [6]		**10**
Romania	-8%		157					
Russian Federation	0%		2389					
Slovakia	-8%		54					

1 Crash Programme, CEC DG XII JOULE (1991): Cost effectiveness analysis of CO2-reduction options: Synthesis report, Brussels.
2 GREEN (OECD 1994)
3 Jepma 1997a
4 Krom et al. 1996 (ETSAP-study)
5 IEA (Econ 1996/58)
6 Econ 1996/58, corresponding reduction unknown
7 Jepma C. 1997b, in JIQ Vol. 3/4, Dec. 97
see also WRI 1997

Table 5: Kyoto commitments of Annex I countries: Marginal abatement costs (MAC) of CO_2 emissions reductions compared to 1990.

Generally, costs differ more between countries than between regions (INFRAS/IWW 2000).

Legend: MAC in column 8 = MAC for the last reduction of the reduction commitment of Kyoto, = average of the low, medium and high MAC figures in column 5+6+7 (or estimations)

The lower avoidance costs are reasonable, since the marginal costs to reduce one unit of CO_2 are lower in Eastern Europe than in Western Europe for all economic sectors. We have used an overall average shadow value for CO_2 of 8 € per tonne (no differentiation between countries), with a range of 6 to 12 €. Since the reduction of climate change risks is requesting a global strategy, no distinction between different situations within the countries considered will be made. For all transport means the same unit cost value (€ per tonne CO_2) will be used.

2.6 Nature and Landscape

Effects on nature and landscape are mostly related to transport infrastructure and do in general not depend on the level of infrastructure use. They depend very much on the individual perception of society and are usually difficult to measure. Thus within national estimates of external costs, these costs are usually not considered, firstly because they are fixed costs and mostly irreversible[8] secondly due to lack of detailed information of the perception of individuals.

The determination of the external effects of nature and landscape which includes the pollution of soil and groundwater due to transport is difficult. Up to now, it has not been feasible to quantify them in monetary terms as it has been done for other externalities like accidents, noise, air pollution and climate change. We distinguish two kinds of effects:

1) Effects which are caused by the **provision** of infrastructure (roads, rail tracks, dams, bridges, airports, etc.):

   - spatial separation effects/barrier effect (partly influenced by the traffic levels, i.e. utilisation of infrastructure),

   - reduction of the quality of landscapes,

   - loss of natural land area (loss of biotopes).

2) Effects which are caused by the **utilisation** of the infrastructure:

   - pollution of soils and surface/groundwater systems,

   - pollution caused by accidents.

From an economic point of view, the valuation of the damages (for instance based on a willingness to pay approach) would be most feasible. A direct valuation of transport related damages is however not available (see Infraconsult 1998). Thus we refer to a more pragmatic but consistent approach. In order to avoid double counting, we summarise all effects with regard to nature within one cost category.

Based on a network classification, we estimate those costs which are necessary to improve existing infrastructure to a level that is neutral (acceptable) from an environmental (nature and landscape) point of view. Most important is a set of unit costs based on the repair and compensation costs approach. This was done by transferring Western European unit cost per km^2 infrastructure. This rather simple approach has the advantage to be transparent, further it also considers other environmental costs like groundwater nuisances.

Steps for the estimation 1995

Figure 3 presents the detailed approach which is trying to determine the costs of the different repair and compensation measures.

[8] In regard to existing infrastructure, these costs are not really reparable. Thus the aspects of nature and landscape are usually very important aspects for the evaluation of new projects, e.g. within environmental impact analysis or cost benefit analysis.

Firstly we have to define an initial state of nature and landscape which is regarded to be ‘natural’ enough and worth aspiring after. The state of nature at the year 1950 is regarded as sustainable by experts (see Ökoskop 1998). In other words, its state at that time corresponds to an acceptable intervention in nature and landscape. Damages since then have to be compensated. This starting point is generally used to calculate the sealed area and additional impaired area (side effects) caused by transport infrastructure. It is applicable especially for road transport.

The allocation of the cost per transport mode to the vehicle categories is based on specific assumptions:

- The allocation of road transport is based on PCU (Passenger Car Unit):

- Passenger Car:	1
- Motorcycle:	0.5
- Bus:	3
- LDV & HDV:	2.5

- The allocation of rail transport is based on train kilometres.[9]
- The allocation of air transport is based on the aircraft movements.

9 A distinction between electrified and not electrified rail tracks has not been made, although the damages are different. Whereas the pollution of diesel tracks (due to air pollutants) is mainly causing soil and groundwater problems, electrified tracks are causing soil problems (due to abrasion) and visual intrusion due to electricity wires.

METHODOLOGY NATURE AND LANDSCAPE

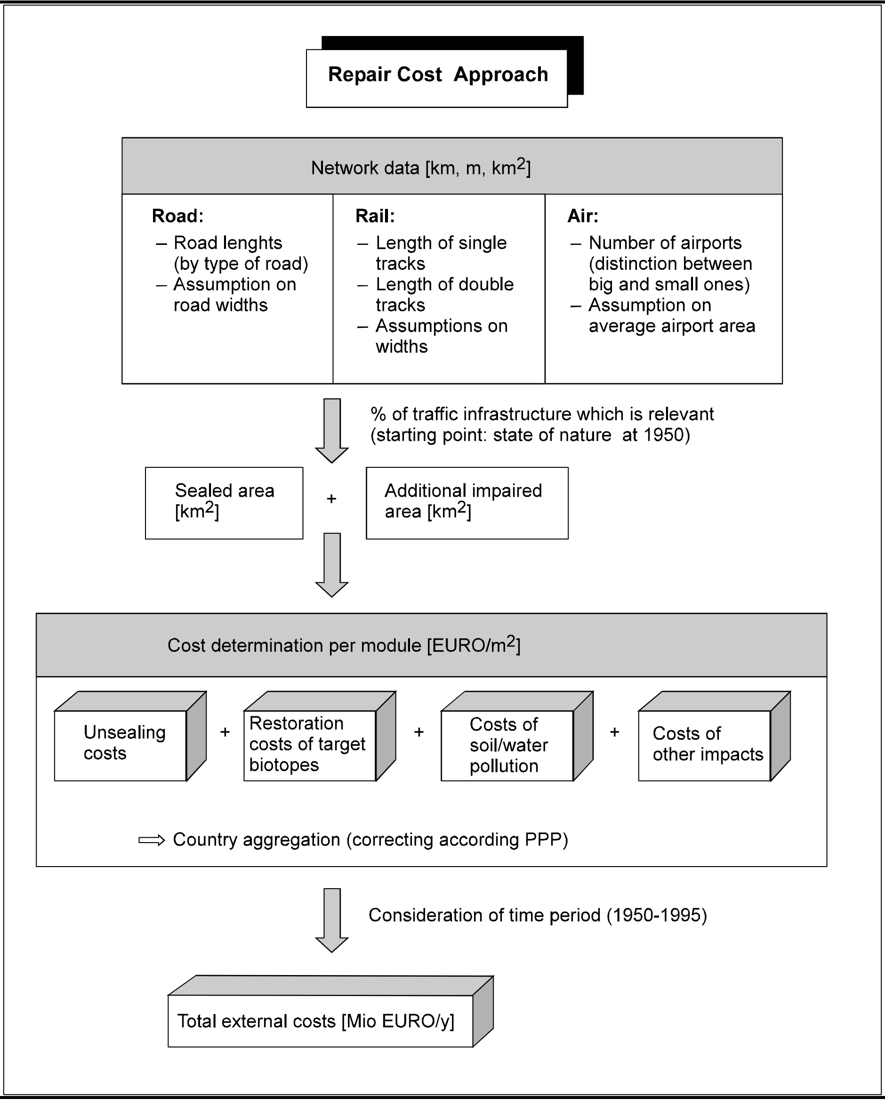


Figure 3 Methodology of the repair cost approach to value costs for nature and landscape.

3. TOTAL AND AVERAGE COSTS PER COUNTRY IN 1995

3.1 Total costs by cost category and transport mode

The following figures and tables present the results for total costs in the CEI countries in 1995. Total external costs amount to approx. 40 billion Euro for 1995, being almost 14% of total GDP in CEI countries. Accidents are by far the highest cost category, contributing 50% to total external costs of transport, followed by air pollution costs which have a share of around 41%. Noise, climate change and nature & landscape are of minor importance contributing each to ca. 3% of total costs.

Road transport contributes to almost 87% of total external costs, followed by rail transport (12%) and aviation (0.4%). Passenger transport causes around 63% of total costs, 37% are caused by freight transport.

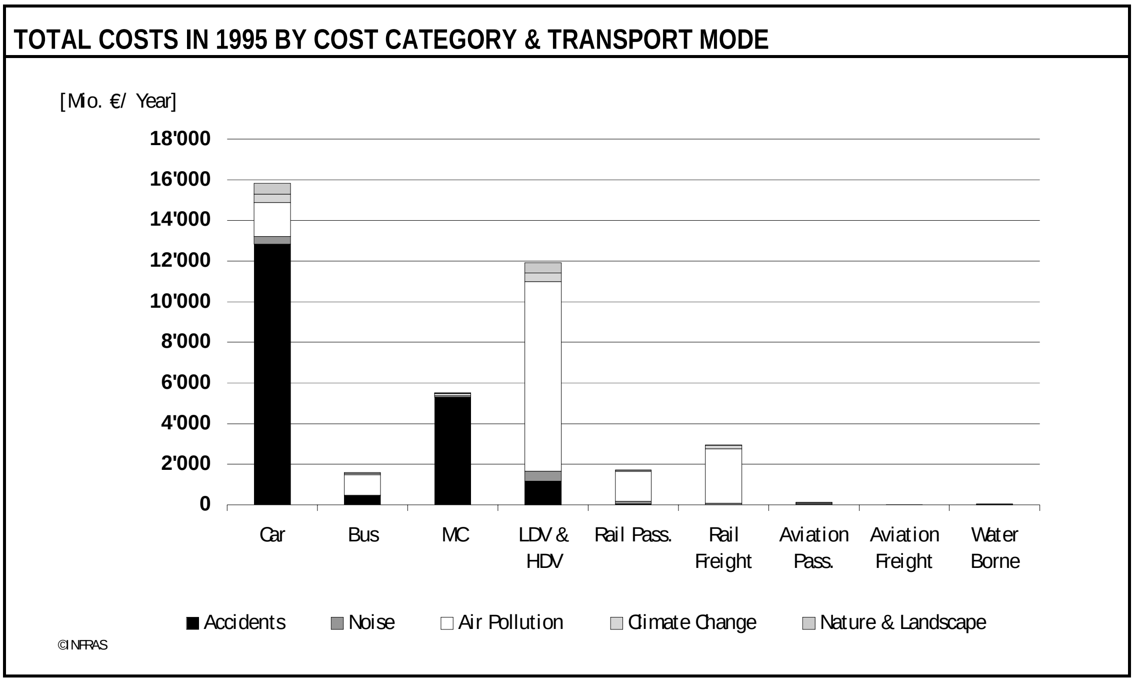


Figure 4 Total costs 1995 by cost category and transport mode.

Passenger cars are responsible for around 40% of total costs, road freight transport (LDV&HDV) for ca. 30% (exact values in **Table 6**).

TOTAL COSTS IN 1995 BY COST CATEGORY & TRANSPORT MODE													
			Road						**Rail**		**Aviation**		**Water-borne**
[million Euro/year]			Car	Bus	MC	LDV & HDV	Pass. total	Freight total	Pass.	Freight	Pass.	Freight	Freight
Accidents	19'752	50%	12'827	437	5'284	1'157	18'548	1'157	42	0	5	0	0
Noise	1'228	3%	389	39	82	486	510	486	133	68	29	2	0
Air Pollution	16'310	41%	1'664	1'014	96	9'355	2'775	9'355	1'457	2'682	8	1	32
Climate Change	1'208	3%	417	45	31	414	493	414	63	177	50	7	5
Nature & Landscape	1'199	3%	535	57	24	508	616	508	25	12	33	5	0
Total CEI	39'697	100%	15'833	1'594	5'516	11'919	22'942	11'919	1'719	2'940	124	15	37

Table 6 Total external costs of transport in the CEI countries amount to approx 40 billion EUR in 1995.

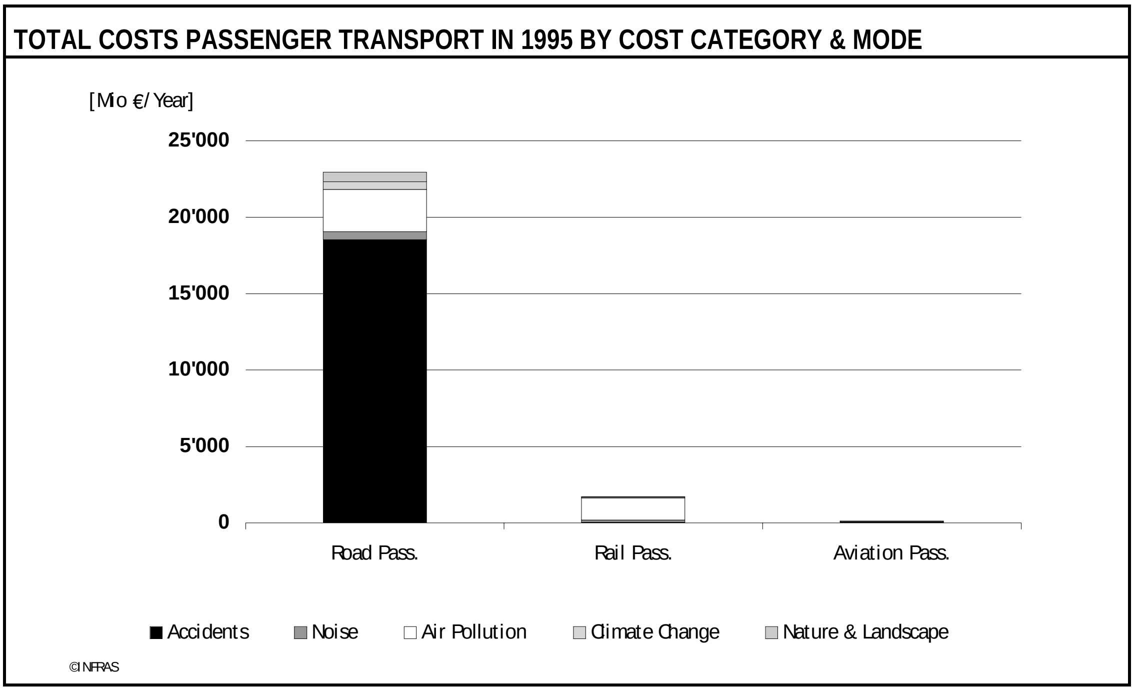


Figure 5 Accident costs are by far the most important cost category in passenger transport.

Accident costs are predominant. This is mainly due to the rather critical safety performance of road transport in the CEI countries. Air pollution costs are the next major cost category, mainly related to health costs due to high particle emissions. This is true for road and rail, since railways face a rather high diesel share and fossil fuel based electricity production. Figure 6 is showing the structure of the freight sector. Air pollution costs are predominant, due to the high level of diesel engines, once again for road (HGV) and rail (diesel locomotives). Due to rather low traffic and population density, noise exposure is rather a local problem. Climate change impacts will lead to rather low costs, since avoidance or abatement measures (e.g. the promotion of fuel saving cars) are not very costly in the CEI countries.

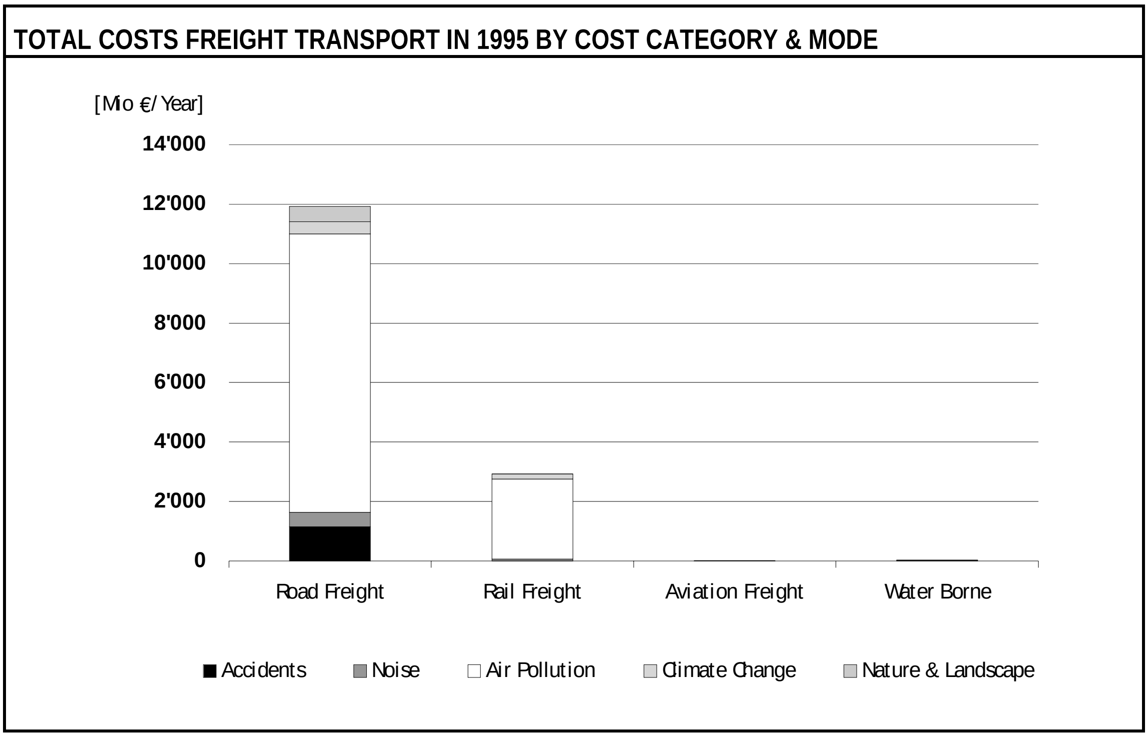


Figure 6 Air pollution costs of road and rail freight transport are the major cost element in freight transport.

Looking at the share of modes of different cost components, the share of road transport to total cost is interesting. Road passenger transport is responsible for 94% of accidents, whereas the share of air pollution costs is 17%. Noise, air pollution and climate change are the predominant cost elements of rail transport, whereas the costs of other transport modes are more or less negligible.

TOTAL EXTERNAL COSTS IN % BY TRANSPORT MODE & COST CATEGORY

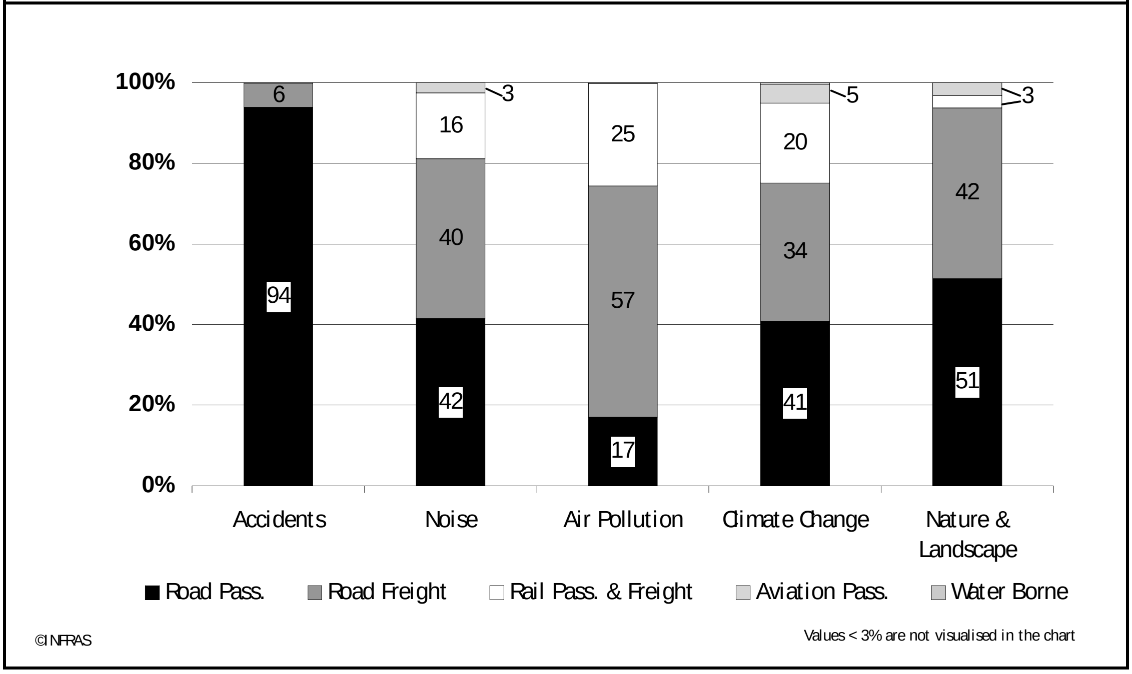


Figure 7 The share of road transport differs between different cost categories.

3.2 Average costs by cost categories and transport mode

The following tables and charts present average costs in Euro per 1'000 pkm and tkm. In **passenger transport**, motorcycles contribute the highest value with 166 € per 1'000 pkm. Passenger cars reach 33.3 €. Rail transport reaches approx. one third of the passenger car value (12 € per 1'000 pkm). While in road transport accident costs are the predominant cost factor, air pollution costs play a dominant role in rail transport. This is mainly due to the high share of diesel traction as well as a high share of low tech fossil fuel power plants in Eastern Europe. One has to consider however, that the PM_{10} Emissions of the railways electricity production might harm human health somewhat less than those pollutants which are emitted directly along the roads.

In **freight transport**, external costs of road freight transport are significantly higher than all other means of transport. The external costs for road freight transport amount to 44 € per 1000 tkm, which is 5.6 times higher than the costs of the railways.

AVERAGE COSTS IN 1995 BY COST CATEGORY & TRANSPORT MODE												
	Average Cost Passenger							Average Cost Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water-borne	Overall
	Car	Bus	MC	Pass. total								
	[Euro / 1000 pkm]							[Euro / 1000 tkm]				
Accidents	27.0	1.2	158.9	21.4	0.3	0.2	18.0	4.3	0.0	0.0	0.0	1.7
Noise	0.8	0.1	2.5	0.6	0.9	1.3	0.7	1.8	0.2	3.4	0.0	0.8
Air Pollution	3.5	2.8	2.9	3.2	10.3	0.4	4.1	34.5	7.2	1.9	2.1	18.2
Climate Change	0.9	0.1	0.9	0.6	0.4	2.2	0.6	1.5	0.5	11.6	0.3	0.9
Nature & Landscape	1.1	0.2	0.7	0.7	0.2	1.5	0.6	1.9	0.0	8.2	0.0	0.8
CEI 1995	33.3	4.4	165.9	26.4	12.1	5.5	24.0	44.0	7.8	25.1	2.4	22.5

Table 7 Road average costs are more than two times (passenger transport) and more then five times (freight transport) higher than rail costs.

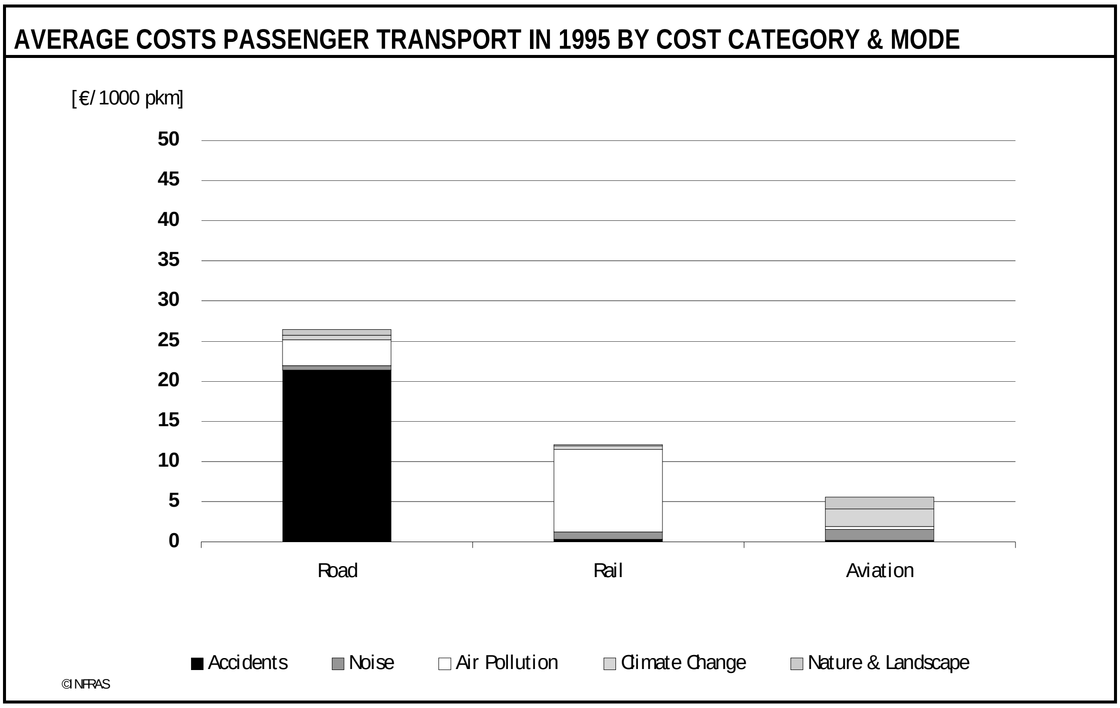


Figure 8 Road transport has the highest level of average external costs per passenger km.

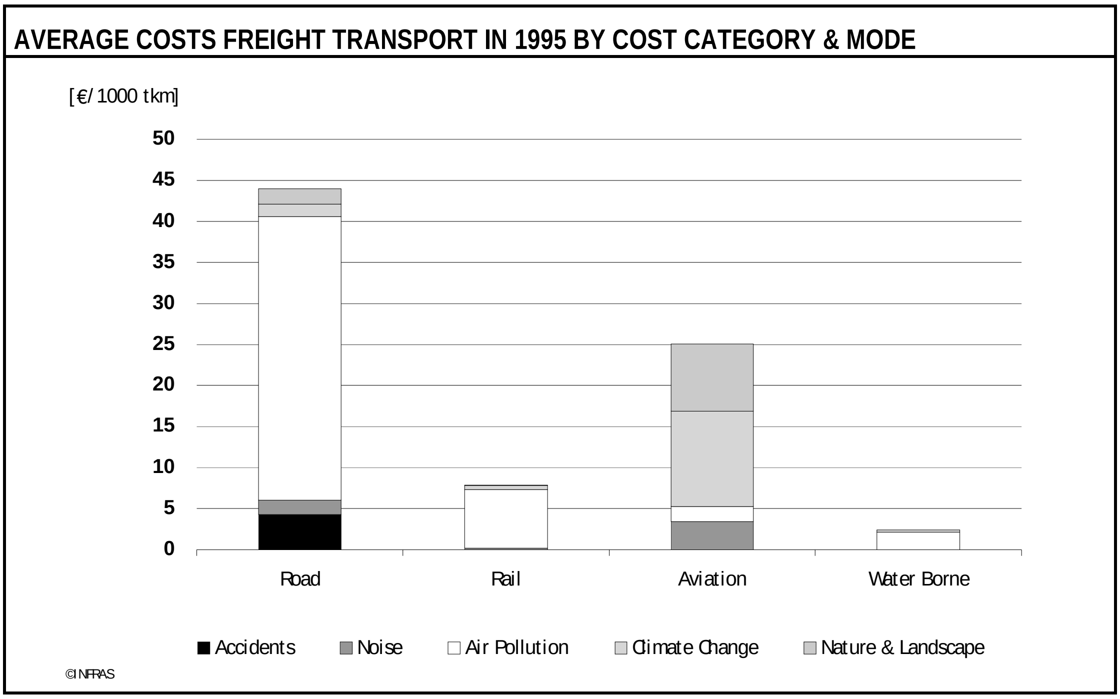


Figure 9 Air pollution costs are predominant in freight transport

It has to be considered, that these figures represent an average for rather disperse vehicle fleets. This is especially true for road freight transport, where all sorts of vehicles (light duty vehicles up to 3.5 tonnes up to heavy 40 tonne trucks) are included. If one wants to differentiate these costs, one has to consider the different environmental performance and the different loading factors. The following table is showing the relations for specific type of vehicles. The heavier the vehicle, the higher the costs per vehicle km. A 40 tonne truck is producing up to 5 times higher accident and environmental costs per vkm than a light duty vehicle (gasoline). The relations per tkm however is reverse, since heavy trucks are able to load much more freight (in tonnes) than light duty vehicles: A well loaded 40 tonne truck is producing 4 times lower costs per tkm than the average.

AVERAGE COSTS FOR DIFFERENT FREIGHT VEHICLES

Type of freight vehicle	Relations per vkm	Relations per tkm
Light duty vehicle (up to 3.5 tonnes, gasoline)	0.3	0.9
Light duty vehicle (up to 3.5 tonnes, diesel)	0.7	2.2
Mid size truck (10 tonnes)	1.2	1.2
Mid size truck (20 tonnes)	0.35	0.4
Mid size truck (40 tonnes)	1.45	0.25
Average	**1 (= 140 Euro per vkm)**	**1 (= 44 Euro per tkm)**

Table 8 Costs expressed per vehicle km and per tonne km, average (Road) = 1 (Basis: INFRAS/IWW 2000)

3.3 Total and average costs by country

The following tables and charts present the allocation of total external costs to the CEI countries considered. Detailed country tables are shown in the Annex. The highest share occurs for Poland (32%), followed by the Czech Republic (18%), Hungary (11%) and the Ukraine (11%).

TOTAL COSTS 1995 BY COUNTRY & TRANSPORT MODE												
		Road						**Rail**		**Aviation**		**Water-borne**
[million Euro / year]		Car	Bus	MC	LDV & HDV	Pass. Total	Freight total	Pass.	Freight	Pass.	Freight	Freight
Albania	284	71	64	12	132	147	132	4	1	0	0	0
Belarus	1'645	518	59	381	289	958	289	138	248	12	0	0
Bos.-Herceg.	121	39	38	n.a.	44	77	44	0	0	0	0	0
Bulgaria	1'440	568	51	238	421	856	421	63	84	12	2	2
Croatia	985	558	32	25	341	615	341	10	15	3	0	0
Czech Rep.	6'996	2'381	231	1'465	2'277	4'077	2'277	216	399	21	2	4
FYRO Maced.	267	140	16	2	100	157	100	5	3	2	0	0
Hungary	4'430	2'221	119	259	1'306	2'598	1'306	276	248	15	3	5
Moldova	255	54	44	8	117	107	117	4	5	1	0	0
Poland	12'609	5'213	415	1'693	4'394	7'320	4'394	265	602	23	2	3
Romania	3'134	1'272	134	209	885	1'615	885	300	311	13	1	10
Slovak Rep.	1'697	609	126	222	603	957	603	41	89	2	1	4
Slovenia	1'403	1'026	44	17	260	1'088	260	16	35	4	1	0
Ukraine	4'431	1'163	221	986	752	2'370	752	382	900	16	4	8
CEI 1995	39'697	15'833	1'594	5'516	11'919	22'942	11'919	1'720	2'940	124	15	37

Table 9 Total external costs CEI 1995 by country and transport mode.

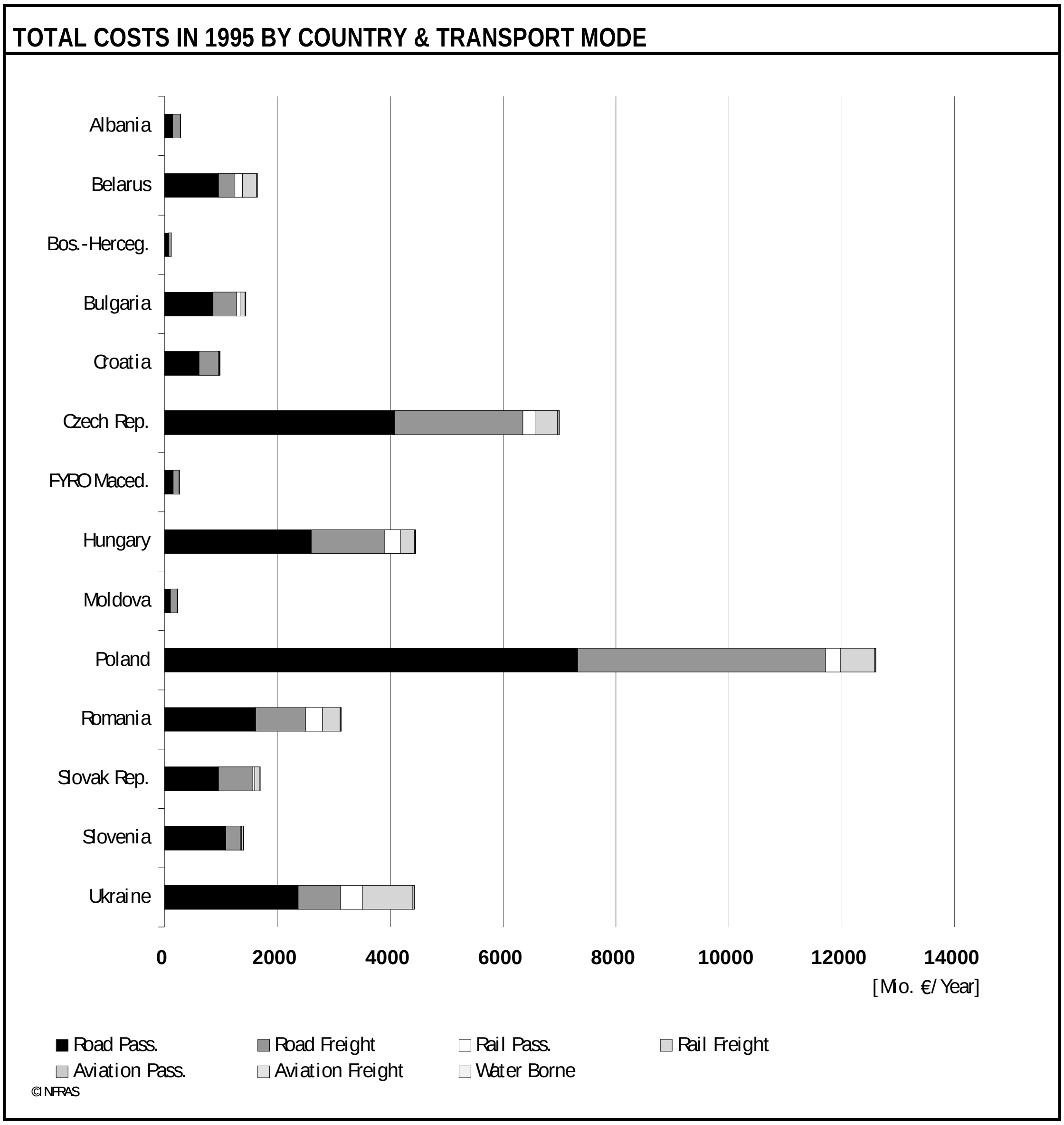


Figure 10 Road passenger transport contributes to more than 50% of total external costs in all CEI countries.

Total costs per capita show quite a high range between the countries. The most important driving factor is the economic performance and the population density. Therefore the costs of Czech Republic, Hungary, Poland, the Slovak Republic and Slovenia are up to three times higher than the CEI average. The performance according to cost per unit of GDP shows the strong influence of the economic situation. The differences between the countries are much smaller. The maximum is reached by Belarus and the Ukraine, both countries with a low GDP level compared to the traffic density (especially road freight transport).

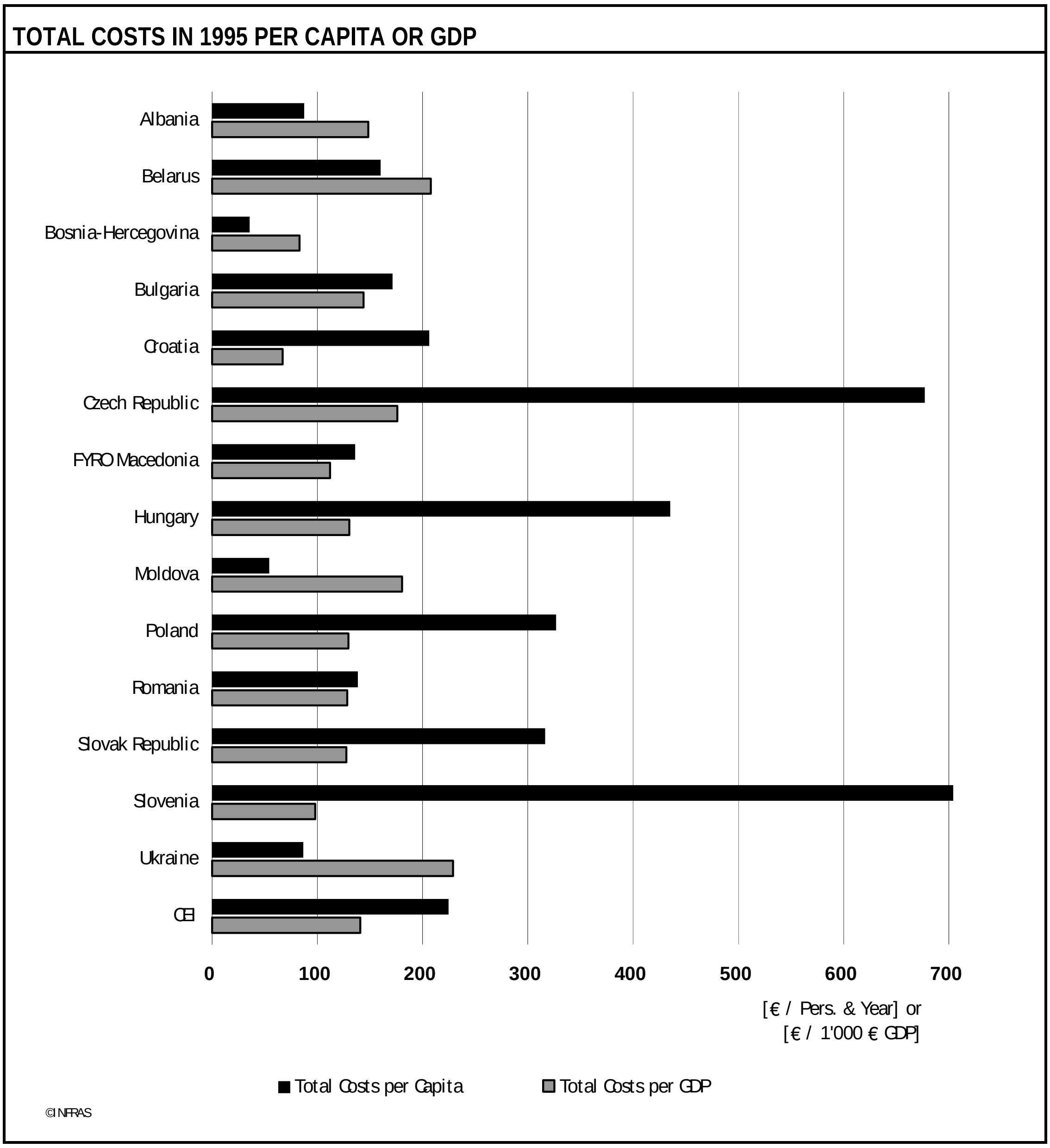


Figure 11 The range of the ratio per capita is significantly higher than the ratio per GDP: the richer the country, the higher the level of external costs.

The following table figures show the performance of average costs for road and rail according to countries. With respect to road transport, the population density, the vehicle performance and the GDP-level are the most important driving factors. The latter is influencing the level of level of accidents and health costs predominantly, since the values (i.e. value of statistical life) are varying according to GDP per capita.

Within rail transport, the differences occur mainly due to the different diesel shares and the fossil share for the production of electricity. The differences between the countries are quite significant based on these major influence factors.

AVERAGE COSTS IN 1995 BY COUNTRY & TRANSPORT MODE										
	Average Cost Passenger						Average Cost Freight			
	Road				Rail	Aviation	Road	Rail	Aviation	Water-borne
	Car	Bus	MC	Pass. total						
	Euro / 1000 pkm						Euro / 1000 tkm			
Albania	54.7	6.4	400.9	13.0	21.3	100.8	48.7	18.9	n.a.	n.a.
Belarus	27.4	5.2	180.5	29.6	11.1	4.6	48.0	9.7	21.1	2.9
Bos.-Herceg.	37.5	7.2	n.a.	12.2	n.a.	n.a.	65.5	n.a.	n.a.	n.a.
Bulgaria	17.4	4.0	109.2	18.1	13.4	3.7	38.8	9.8	17.5	2.5
Croatia	39.7	4.5	292.0	28.8	11.0	7.8	33.4	7.5	34.4	2.0
Czech Rep.	48.5	6.3	310.0	45.2	26.9	8.0	54.7	17.6	31.6	3.2
FYRO Maced.	24.3	5.1	158.0	17.8	72.0	4.3	47.6	19.9	19.1	n.a.
Hungary	61.3	7.6	386.9	49.5	44.3	6.4	62.6	29.5	26.9	3.7
Moldova	19.9	2.2	144.0	4.7	4.0	4.0	16.5	1.6	19.3	1.1
Poland	39.6	5.1	212.1	33.1	12.6	5.2	44.8	8.8	24.4	2.9
Romania	24.1	5.1	152.1	20.1	15.9	4.8	48.0	12.9	21.2	3.1
Slovak Rep.	33.6	5.3	230.7	22.2	9.7	13.5	46.3	6.5	60.6	2.9
Slovenia	78.9	12.5	493.7	65.6	26.5	6.7	110.4	12.0	30.4	n.a.
Ukraine	11.8	2.2	75.6	11.1	6.0	5.7	20.3	4.6	25.6	1.4
CEI 1995	33.3	4.4	165.9	26.4	12.1	5.5	44.0	7.8	25.1	2.4

Table 10 Differences in average costs per country are mainly due to differences in GDP per capita and differences in the average accident costs, which is the most important cost category.

AVERAGE COSTS ROAD IN 1995 BY COUNTRY

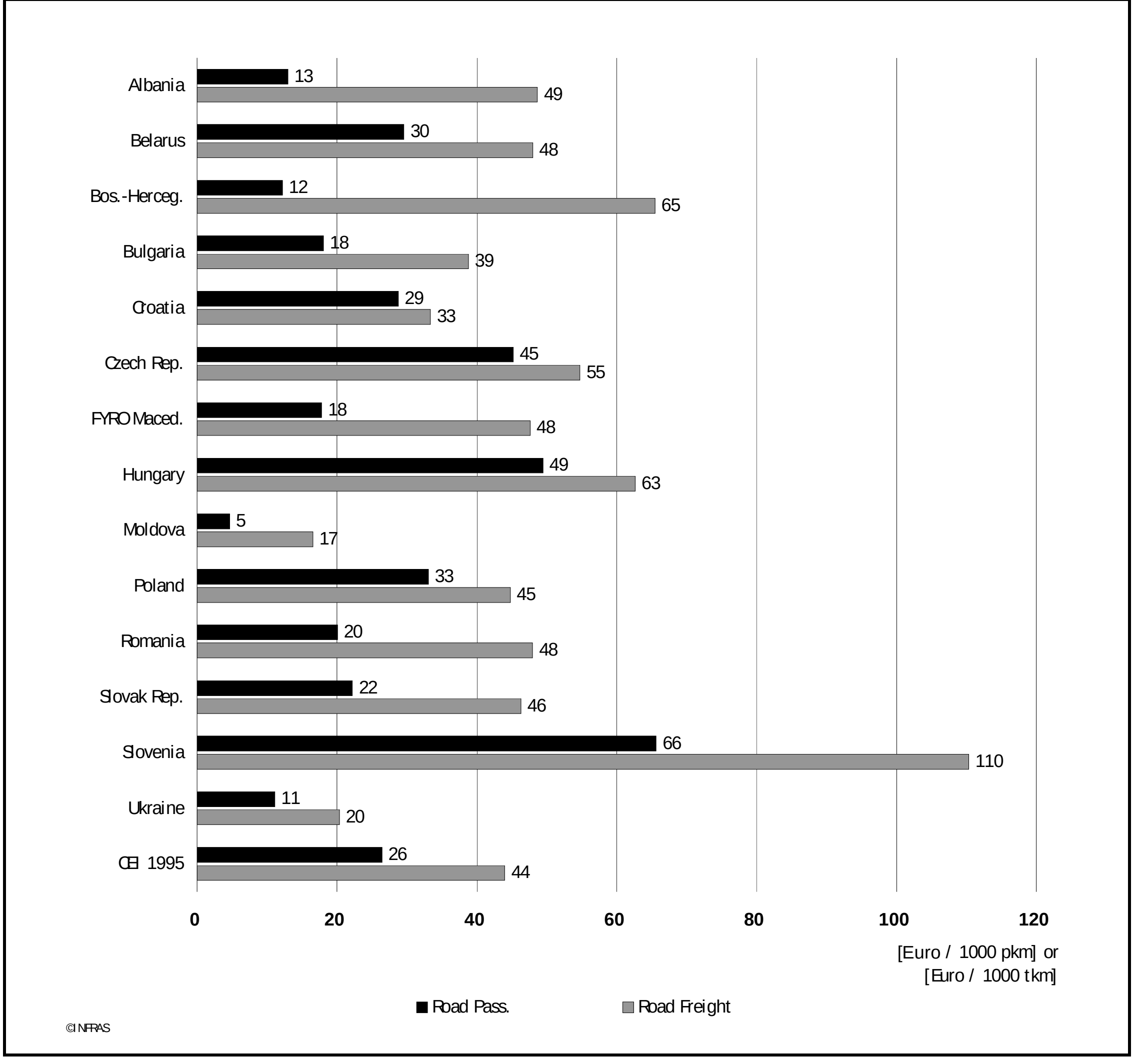


Figure 12 Differences of average costs in road transport are mainly caused by different GDP levels and differences of accident and air pollution costs in each country.

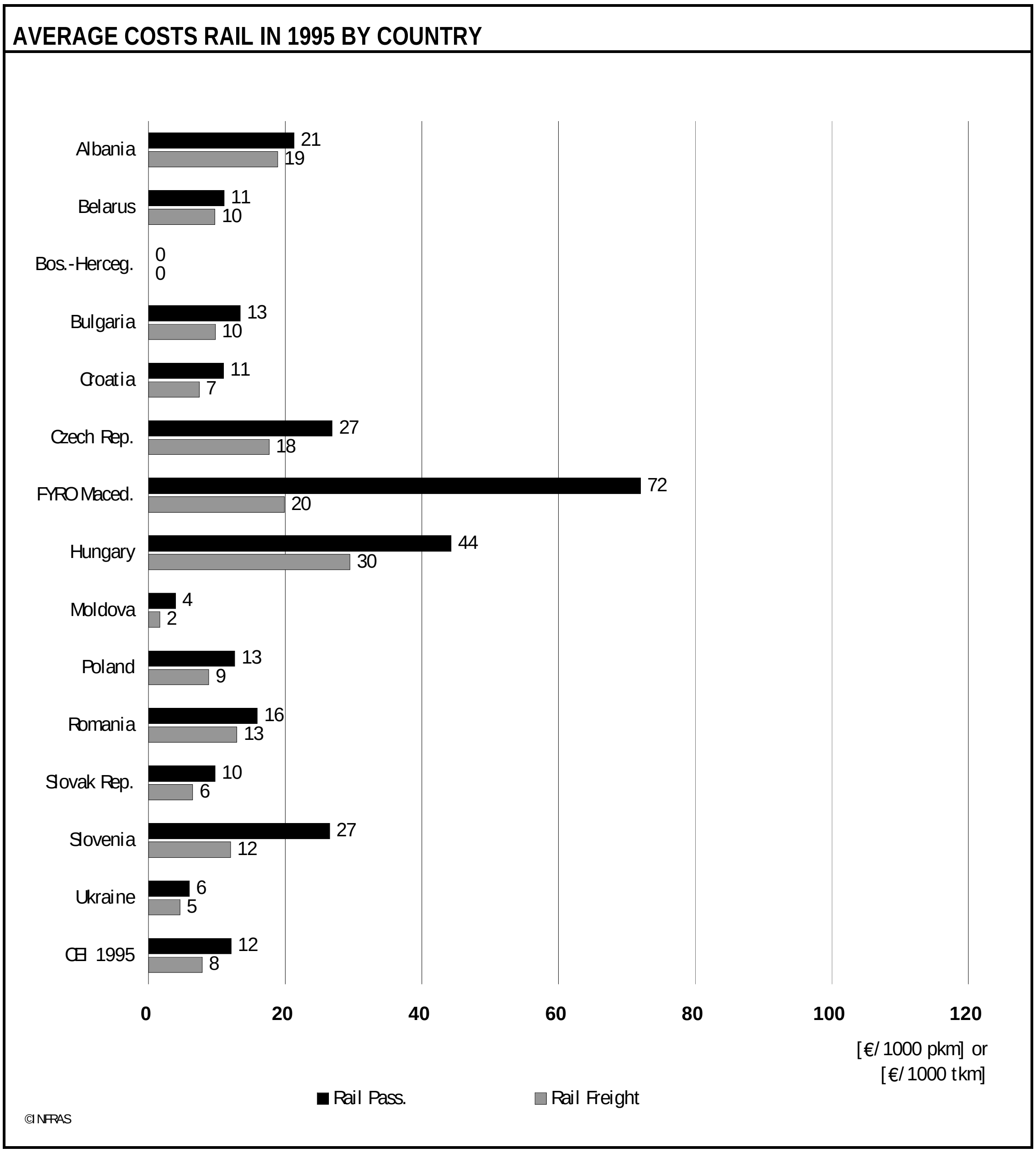


Figure 13 The share of diesel traction on one hand and the electricity mix on the other hand is the most important explanation factors for differences of average external costs of rail transport.

3.4 Analysis of uncertainties

External cost estimation has to deal with several uncertainties. The reasons are manifold:

- The data basis (population, traffic volumes, economic performance),
- The physical indicators for damages (accidents, noise exposure rates, emission estimates etc.),
- The unit values for the estimation of external costs (basic methodological uncertainties, value transfer procedures etc.).

Looking at the statistical basis and the fact, that many methods and indicators were transferred from Western Europe to CEI countries, the uncertainty ranges are definitely larger for CEI countries.

The following table shows the results of some sensitivity calculations of the valuations of individual cost categories. The sensitivities consider reasonable ranges of unit values.

SENSITIVITIES				
Cost category	**Share of total costs**	**Relevance for transport means**	**Sensitivities considered**	**Range of sensitivities**
Accident	50%	Road	Risk value (1,5 Mio €) was replaced by 1,0 Mio €, on the other hand by 2,0 Mio €.	-33% to +33%
Air pollution (Health Costs)	41%	Road and Rail	Long term mortality: 0.46 to 1.83 million Euro	-35% to +71%
Noise	3%	Road and Rail	WTP 15 and 45 €/dB(A), reference 30 €/dB(A)	-33% to +33%
Climate Change	3 %	All modes	Upper and lower bound for scientific shadow rate CO_2 (6 and 12 € per t CO_2).	-25% to +50%

Table 11 Overview of sensitivities of the most important cost categories with their uncertainty range.

Based on mathematical mechanisms, individual ranges cannot just be summed up in order to get an overall range of uncertainty. Some uncertainties can even outweigh themselves. Without carrying out a detailed analysis, we can provide the following thumb rules as a basis for the interpretation of the results:

- Considering all levels of uncertainty, plausible ranges of individual cost categories (for all CEI countries) are between around -50% and +100% of the values shown here. The same will be true for the total costs per transport mode.
- The overall value (total costs of CEI countries) will have a lower range of uncertainty. It might around +/- 33%.
- The ratios between countries are even more uncertain, since the ranges might cumulate. Thus a detailed interpretation of differences between countries is not very appropriate.

4. OUTLOOK 2010

4.1 Introduction

In order to get a broad idea of the future trends in the CEI region, a forecast for 2010 was developed. Two scenarios are distinguished:

- Trend development with likely changes in technologies and requirements

- Scenario Environmentally Sustainable Transport (EST3 according to OECD definition considering high economic growth, best available technology and modal split changes in favour of rail: i.e. a combination of improved technology and modal shift).

The outlook for the year 2010 is based on the results of the calculation for the year 1995 and the CEI-traffic and emission forecasts for both scenarios (OECD 1999). The most important driving factors are:

- the increase of the traffic levels,
- the change of the vehicle fleet (i.e. the development of the emissions),
- the economic development (change of GDP and the Purchasing Power Parity).

In addition, we work on the following assumptions (simplifications):

- no change of the individual travel behaviour,
- no change in transport legislation (with respect to increase traffic safety, e.g. reduction of alcohol limits, liability of using seatbelts, usage of lights during day, etc.)
- no change of the population between 1995 and 2010 (based on: Environmentally Sustainable Transport in the CEI Countries in Transition, OECD, 1999).

A detailed list of assumptions is provided in Annex 5.

It is evident that traffic growth and traffic structure in transition countries will differ within the CEI region. Given the high level of uncertainties of long term forecasts, the same growth assumptions for all CEI countries have been used, without further differentiation. Thus, the results for this outlook are valid on an aggregate level (the CEI region).

4.2 Trend scenario 2010

The following figures and tables present the results for the forecast until 2010. Total external costs will increase by 58% between 1995 and 2010. A major factor is the increase of the transport volume and the GDP per capita. The highest growth rates are assumed in road transport (Cars + 57%, HGV +107%), and in the aviation sector (+68%). The costs for rail passenger transport will increase much less (+19%). For rail freight transport, they even will decline due to the reduction of PM_{10} emissions. All cost categories will increase (between 45% and 70%). Most dominant is the increase of climate change and noise costs, since no significant technical progress can be expected.

TOTAL COSTS FORECAST FOR 2010 TREND BY COST CATEGORY & TRANSPORT MODE

[million Euro/year]			Road Car	Bus	MC	LDV & HDV	Pass. total	Freight total	Rail Pass.	Freight	Aviation Pass.	Freight	Water-borne Freight
Accidents	30'340	48%	19'245	655	7'736	2'645	27'635	2'645	49	0	11	0	0
Noise	1'984	3%	551	34	65	956	650	956	216	110	48	3	0
Air Pollution	26'656	42%	3'707	948	136	19'090	4'791	19'090	1'683	1'062	21	3	6
Climate Change	2'055	3%	648	51	31	1'022	730	1'022	63	131	91	13	4
Nature & Landscape	1'735	3%	684	47	17	902	747	902	28	14	38	6	0
Total CEI	62'769	100%	24'834	1'734	7'984	24'615	34'552	24'615	2'039	1'318	209	25	10

Table 12 The forecast for total external costs of transport in the CEI countries amount to approx 60 billion EUR in the year 2010.

TOTAL COSTS PASSENGER TRANSPORT FORECAST FOR 2010 TREND

BY COST CATEGORY & MODE

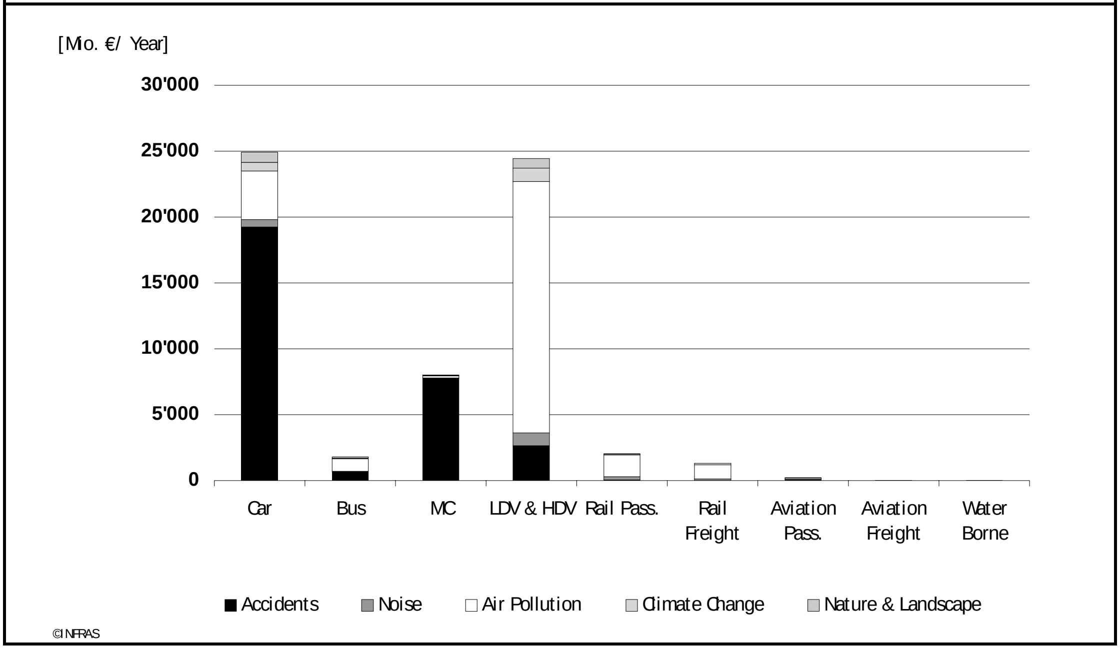


Figure 14 Total costs of passenger car and road freight transport nearly reach the same level. The structure (accident and air pollution costs) however differs significantly.

CHANGE OF TOTAL COSTS AND COST CATEGORIES IN % BETWEEN 1995 AND 2010

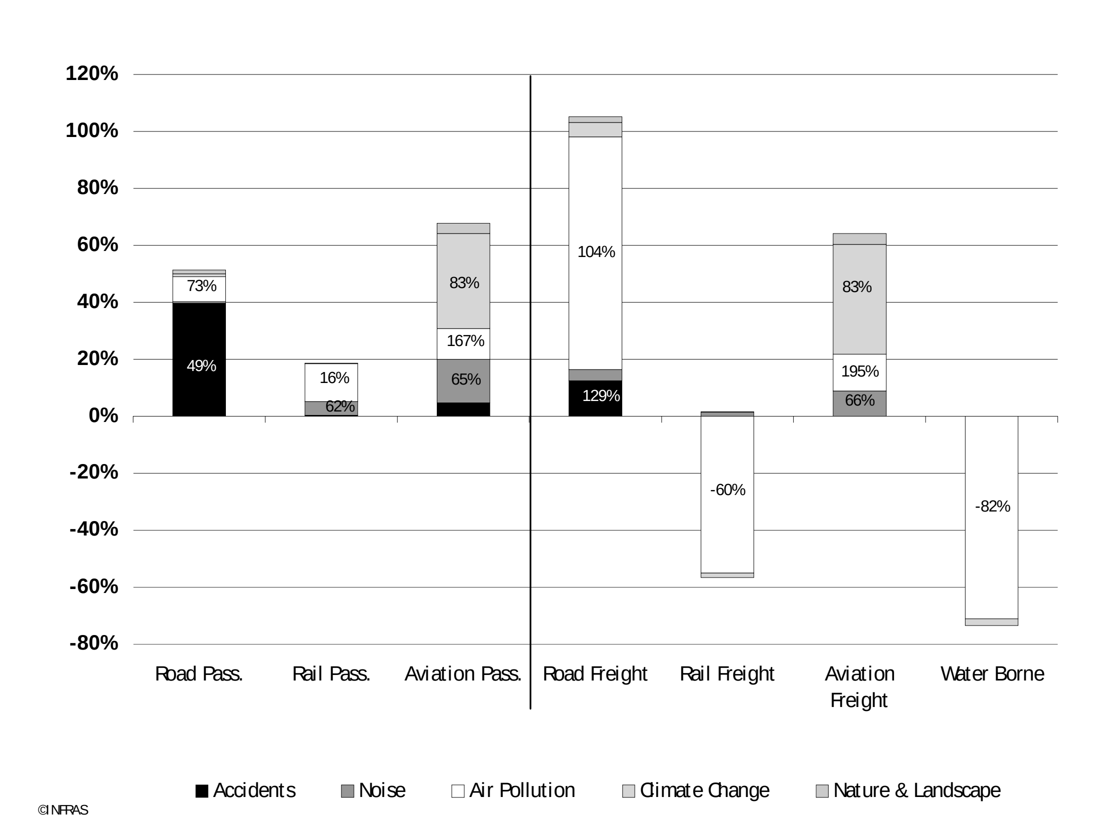


Figure 15 The bars refer to the change of total costs as a whole; the written percentages refer to the change of the individual cost components.

Average costs however mainly decrease, especially in the freight sector, where technical progress (mainly the decrease of PM_{10} emissions) outweighs the economic growth factors (income and traffic growth).

AVERAGE COSTS TREND FORECAST FOR 2010 BY COST CATEGORY & TRANSPORT MODE

	Average Cost Passenger							Average Cost Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water-borne	Overall
	Car	Bus	MC	Pass. total								
	[Euro / 1000 pkm]							[Euro / 1000 tkm]				
Accidents	23.9	1.6	228.4	22.3	0.3	0.2	19.4	3.4	0.0	0.0	0.0	2.3
Noise	0.7	0.1	1.9	0.5	1.5	1.0	0.6	1.2	0.3	2.7	0.0	0.9
Air Pollution	4.6	2.4	4.0	3.9	11.9	0.4	4.5	24.3	2.8	2.3	0.5	17.1
Climate Change	0.8	0.1	0.9	0.6	0.4	2.0	0.6	1.3	0.4	10.3	0.3	1.0
Nature & Landscape	0.8	0.1	0.5	0.6	0.2	0.8	0.6	1.2	0.0	4.5	0.0	0.8
CEI 2010	30.8	4.3	235.7	27.9	14.4	4.4	25.7	31.4	3.5	19.7	0.8	22.1

Table 13 Road average costs are more than two times (passenger transport) and more then seven times (freight transport) higher than rail costs.

CHANGE OF AVERAGE COSTS AND COST CATEGORIES IN % BETWEEN 1995 AND 2010

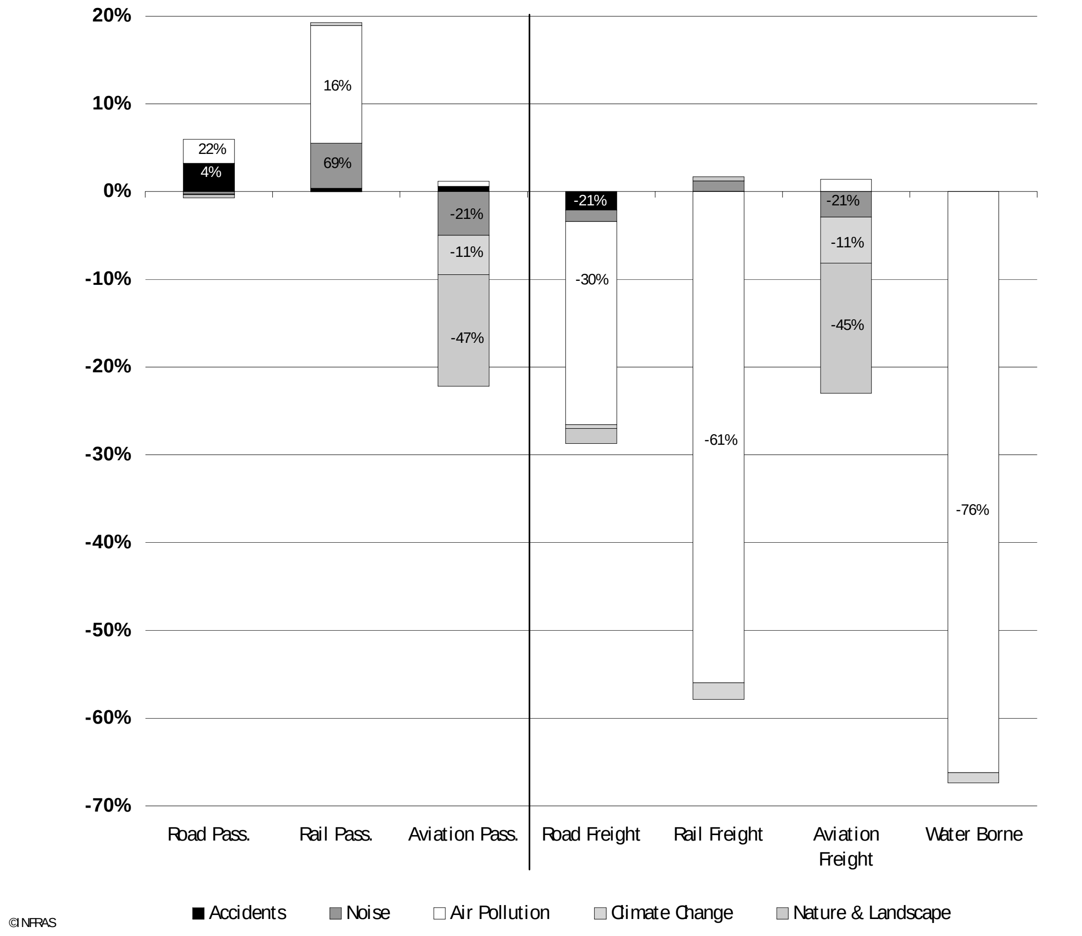


Figure 16 The bars refer to the change of average costs as a whole; the written percentages refer to the change of the individual cost components.

4.3 EST3 scenario

The following figures and tables present the results for the forecast until 2010 for the EST 3 scenario. Total external costs will increase by 7% between 1995 and 2010. As for the trend development, a major factor for this increase is growth of the transport volume and the GDP per capita. The technical progress however is outweighing the increased traffic volumes. The mode specific changes differ quite significantly. Road transport costs are increasing by 12% compared to 1995. Rail transport costs however are decreasing. The levels between the trend development and the EST scenario are similar: while the trend scenario has a lower modal share, the EST scenario has higher rail volumes with a better technology.

TOTAL COSTS FORECAST EST3 FOR 2010 BY COST CATEGORY & TRANSPORT MODE													
			Road						**Rail**		**Aviation**		**Water-borne**
[million Euro/year]			Car	Bus	MC	LDV & HDV	Pass. total	Freight total	Pass.	Freight	Pass.	Freight	Freight
Accidents	25'298	59%	15'970	568	6'498	2'191	23'037	2'191	59	0	11	0	0
Noise	1'452	3%	412	47	48	726	506	726	112	57	48	3	0
Air Pollution	12'486	29%	1'364	406	130	7'898	1'901	7'898	1'621	1'036	21	3	6
Climate Change	1'571	4%	383	68	16	736	466	736	108	152	91	13	5
Nature & Landscape	1'735	4%	664	83	16	886	763	886	28	14	38	6	0
Total CEI	42'542	100%	18'792	1'172	6'708	12'437	26'673	12'437	1'928	1'259	209	25	10

Table 14 The forecast for total external costs of transport for EST3 scenario in the CEI countries amount to approx 43 billion EUR in the year 2010.

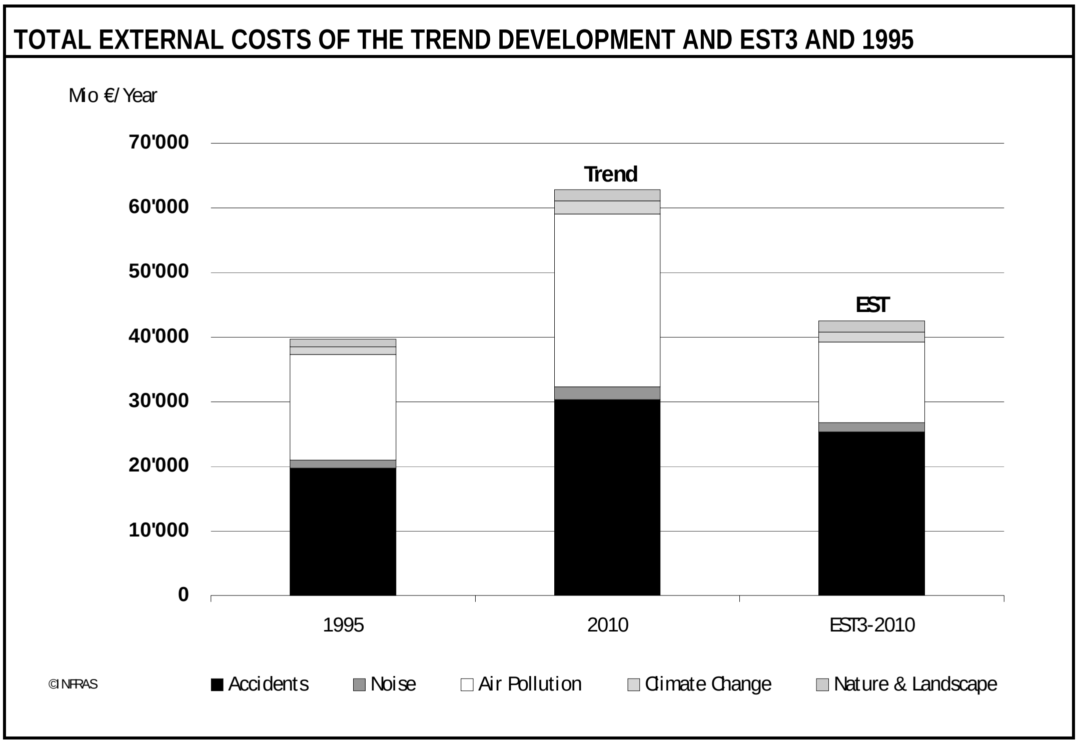


Figure 17 The costs of the EST3-2010 scenario are significantly lower than in the trend scenario. The increase of GDP however leads to an increase of 7% compared to 1995 levels.

TOTAL COSTS PASSENGER TRANSPORT (ROAD & RAIL) 1995 COMPARED TO THE TREND OUTLOOK 2010 AND SCENARIO EST3-2010

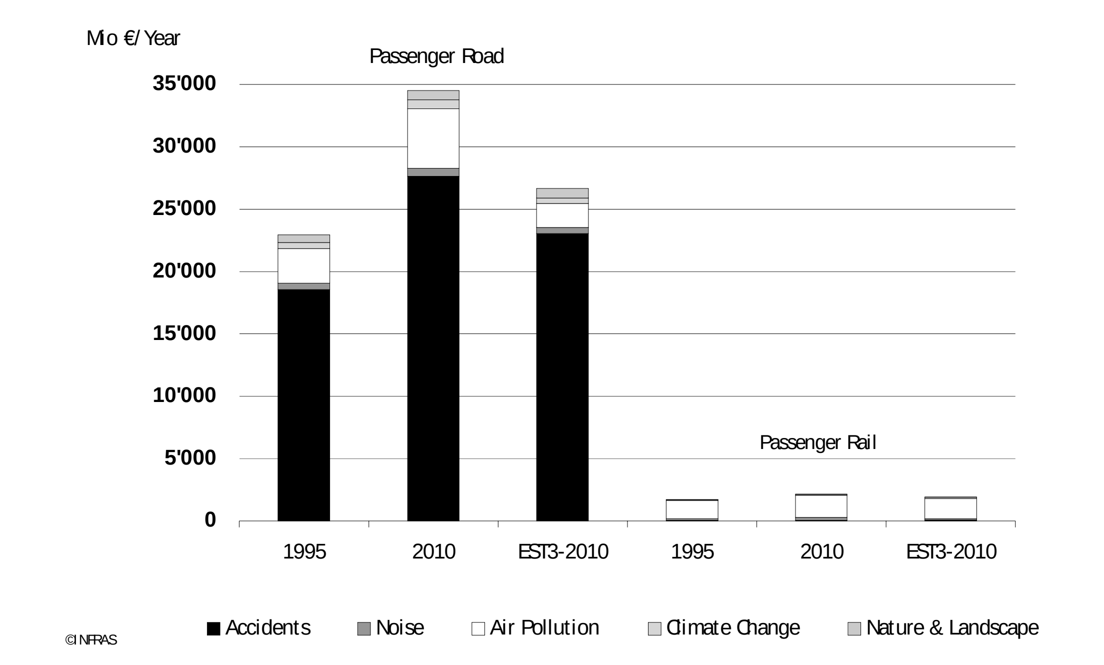


Figure 18 Total road passenger costs of the EST3 scenario 2010 are increasing by about 16% compared to 1995 levels. For rail, the level remains more or less stable.

TOTAL COSTS FREIGHT TRANSPORT (ROAD & RAIL) 1995 COMPARED TO THE TREND OUTLOOK FOR 2010 AND SCENARIO EST3-2010

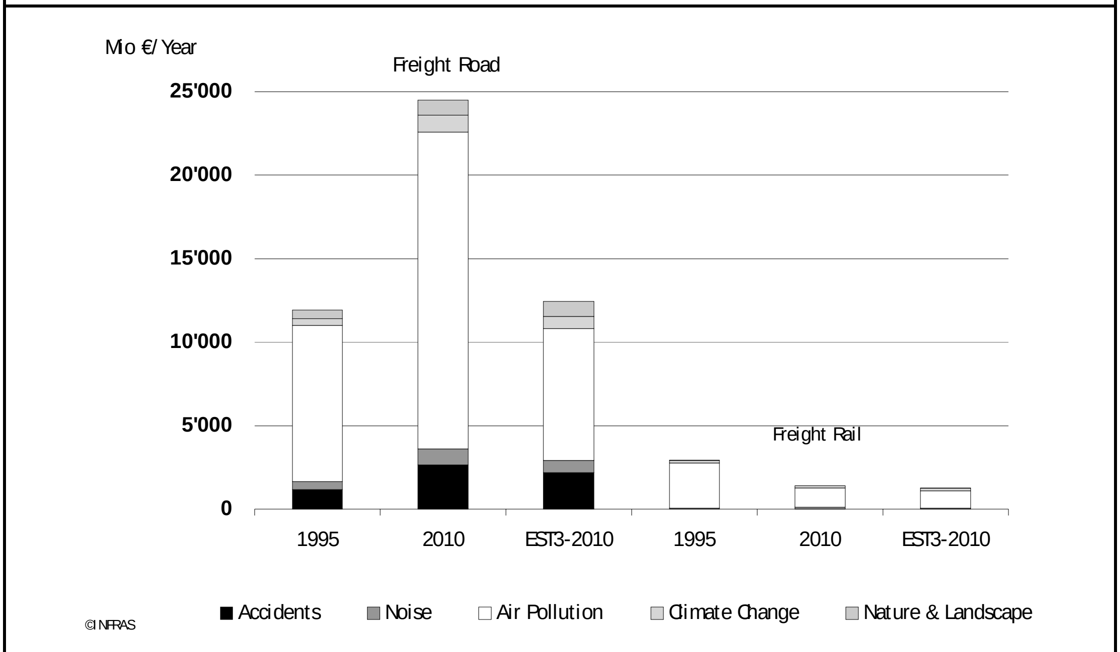


Figure 19 Total road freight costs of the EST3 scenario 2010 are increasing by about 4% compared to 1995 levels. For rail, the level is even decreasing, similar to 2010 trend levels.

Average costs are decreasing significantly compared to 1995 levels and 2010 trend levels. Most important is the technical progress in the field of air pollution.

AVERAGE COSTS FORECAST EST3 FOR 2010 BY COST CATEGORY & TRANSPORT MODE

	Average Cost Passenger							Average Cost Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water-borne	Overall
	Car	Bus	MC	Pass. total								
	[Euro / 1000 pkm]							[Euro / 1000 tkm]				
Accidents	27.7	1.1	228	20.3	0.2	0.2	16.2	3.9	0.0	0.0	0.0	2.1
Noise	0.7	0.1	2.0	0.4	0.5	1.0	0.5	1.3	0.1	2.7	0.0	0.8
Air Pollution	2.4	0.8	5.4	1.7	6.6	0.4	2.5	13.9	2.4	2.2	0.5	8.7
Climate Change	0.7	0.1	0.6	0.4	0.4	2.0	0.5	1.3	0.4	10.3	0.3	0.9
Nature & Landscape	1.1	0.2	0.7	0.7	0.1	0.8	0.6	1.6	0.0	4.5	0.0	0.9
CEI 2010	32.5	2.2	278.1	23.5	7.9	4.4	20.1	21.8	2.9	19.6	0.7	13.4

Table 15 The average costs are significantly lower compared to 1995. For accident and nature and landscape however, they are increasing (for freight transport), since it is assumed, that the change of number of accidents is not proportional to the change of traffic volumes (see Annex).

AVERAGE COSTS ROAD TRANSPORT IN 1995 COMPARED TO THE TREND OUTLOOK FOR 2010 AND SCENARIO EST3-2010

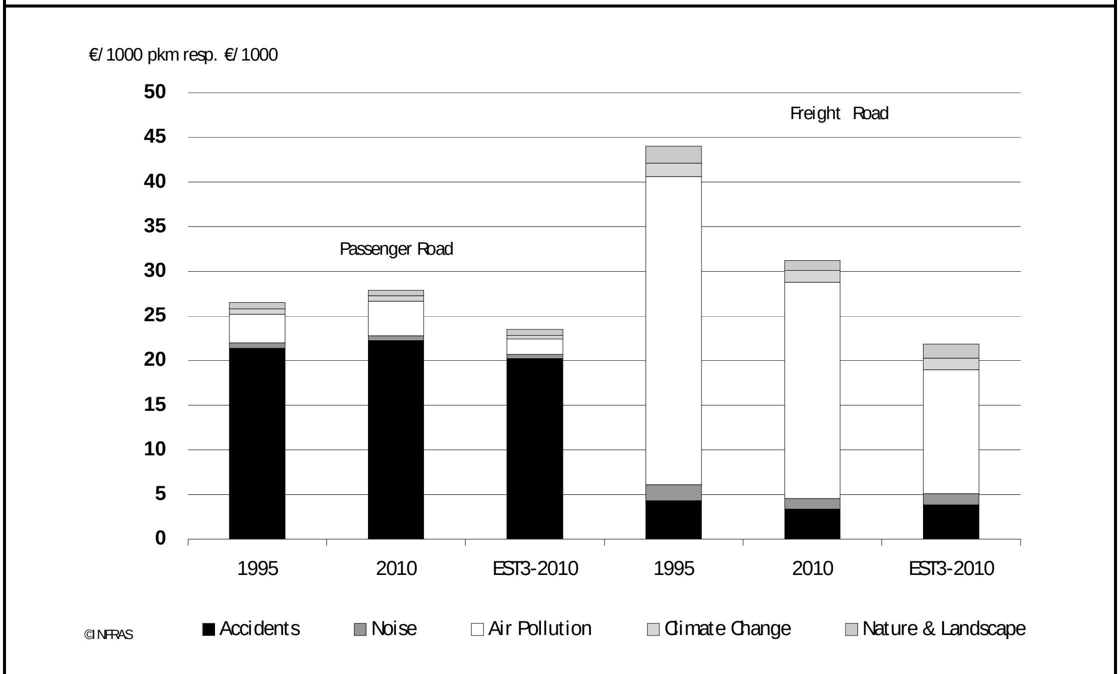


Figure 20 The average costs of the EST3-scenario are 11% lower compared to 1995 levels and 16% lower compared to trend (road passenger transport). For road freight the reduction is significantly larger (50% compared to 1995, 31% compared to 2010 trend).

AVERAGE COSTS RAIL TRANSPORT 1995 COMPARED TO THE TREND OUTLOOK 2010 AND SCENARIO EST3-2010

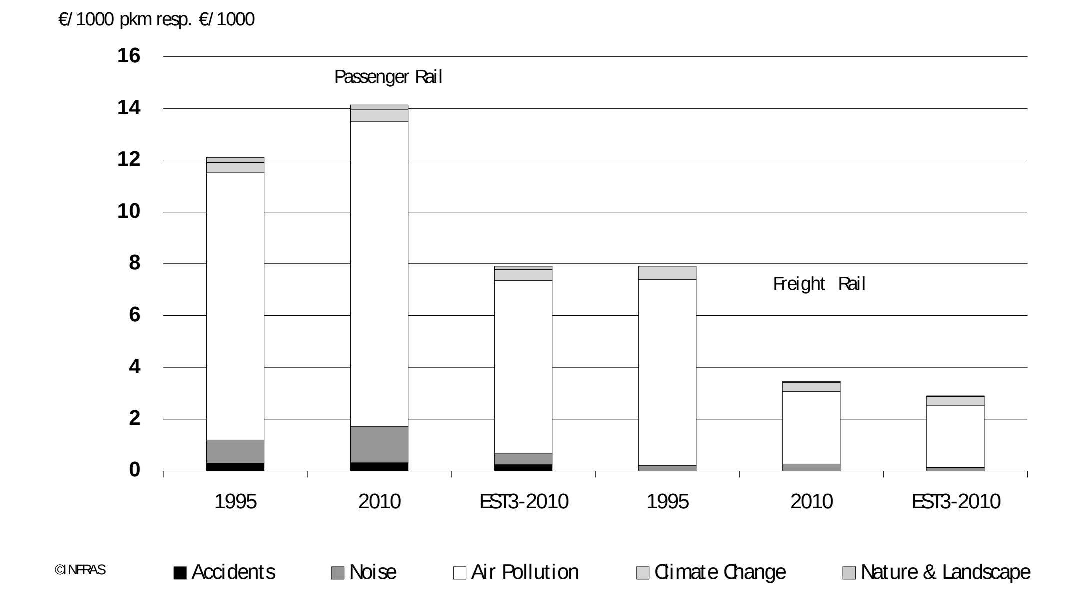


Figure 21 The average costs of the EST3-scenario are 24% lower compared to 1995 levels and 35% lower compared to trend (rail passenger transport). For rail freight the reduction is significantly larger (63% compared to 1995, 27% compared to 2010 trend).

5. INTERPRETATION OF THE RESULTS

5.1 General interpretation

The estimations have shown that there are significant externalities due to accident fatalities and due to environmental nuisances of the transport sector. They result in external costs of nearly 40 billion of Euro for the year 1995. Two cost categories are predominant: about half of the total amount is external accident costs; more than 40% are air pollution costs. Noise costs are rather small and are occurring more local (i.e. in urban areas), due to a rather low population density. Climate change costs are rather low, mainly due to the fact, that the avoidance costs of the CEI countries to reduce CO_2 emissions to meet Kyoto targets are rather low.

Road transport is absolutely predominant and accounts for 87% of total costs. While accidents costs of passenger cars are predominant, the PM_{10} emissions of the diesel engines of trucks are mainly responsible for the high share of HDV and LDV air pollution costs in road freight transport.

Air pollution health costs are also very relevant for the rail sector, due to high share of diesel locomotives and the fossil based production of electricity, which causes as well air pollutant emissions, although their effect might be somewhat less relevant for human health since it is concentrated along the plant sites.

The aviation sector is performing rather well, since the costs are very much concentrated around the airports. The low values used for climate change costs supports this results significantly.

Total external costs amount to 14% of GDP in CEI countries. The levels differ from country to country, based on different GDP-level (most relevant for the differences), different population densities and traffic volumes in urban areas, and different diesel shares in the rail sector.

A rough trend outlook for 2010 indicates, that external costs will rise, due to economic growth (which is predominant for the increase of damage valuations) and traffic growth, especially in road transport and aviation. Total costs will increase by 58%. It is interesting to see, that average costs will decrease strongly due to technical progress in PM_{10} emission rates. That means: Safety and environmental problems of the transport sector will increase dramatically in the future, as well due to the fact, that the railways won't be able to play a strong role as an environmentally friendly mode, as long there is no change in investment priorities.

If we consider a growth scenario with environmentally sustainable technology and improved modal shares towards rail (EST3 according to OECD 1999), the costs will increase only minor (by 7%) compared to 1995 levels. The increase is not due to increased nuisances, but due to higher income levels which influence the willingness to pay.

The figures must be considered as pilot results for Eastern Europe. The sensitivity analysis has shown that the **range of uncertainty** is very high, especially if one would like to compare different countries and different cost elements of different transport modes. We recommend to use the results primarily at the aggregate level for the entire region. The uncertainty range per cost category varies approximately between -50% up to +100% of the mean values shown.

5.2 Comparison with Western Europe

Since the methodology for the CEI countries is strongly based on the methodology applied for the UIC study for Western Europe (INFRAS/IWW 2000), it is possible to compare the results (especially some ratios) with Western Europe. The following observations are interesting:

- External costs per GDP are higher in the CEI countries (14% of GDP) than in Western Europe (8% of GDP). This indicates the higher relevance of safety and environmental problems in the CEI countries relative to other economic activities.
- Accident costs are much higher in the CEI countries than in Western Europe. This is an indication of the differences of the safety performance.
- The share of road freight transport costs is much higher than in Western Europe. This is due to high emission levels of diesel engines and related particle emissions.
- The cost ratio of road to rail in CEI countries is similar to that in Western Europe. Also in the CEI countries, the railways perform significantly better than road transport, if one compares average costs in passenger and in freight transport. It has to be considered however, that the environmental performance of the railways is worse than in Western Europe, due to high diesel shares and due to fossil based electricity production. The cost of rail freight are 5.6 times lower than for road freight and for passenger transport they are three times lower for rail than for road.
- The contribution of the aviation sector in Eastern Europe is smaller than in Western Europe. The reason for this is primarily the assumption of lower population density around airports and of lower unit costs for climate change emissions, since the CEI countries might have lower avoidance costs to reach Kyoto targets.
- The relative growth rate of external costs in the trend scenario in Eastern Europe (+58%) is higher than in Western Europe (+42%), due to higher economic and transport growth. The technical potential for improving environmental performance is more significant in Eastern Europe (esp. in regard to PM_{10} emissions). The performance of the EST3-scenario for instance is showing significantly reduced average costs.

5.3 Policy conclusions

Estimations of external costs can be used for policy conclusions, mainly for investment priorities and for pricing decisions.

a) Monetary evaluation of impacts and investment priorities

This study has estimated accident costs and environmental costs. Within these cost categories, it focused on the most relevant ones. Not considered were minor categories like urban scarcity costs (not very relevant in Eastern and Central Europe) and up- and downstream processes (also not relevant and lack of data). The study has not considered congestion costs and transport subsidies which are assumed to be also relevant in Eastern Europe.

Therefore the study is not able to present a complete picture of all external costs of the transport sector. For the improvement of the safety and the environmental situation however, the study suggests some important results, to be considered in future policy and investment development.

- Specific safety programmes and improvements of the existing insurance system should and will improve the safety situation, with a view to reducing the predominant cost category of road transport. From a pricing point of view, the increase of risk insurance premium and differentiation according to individual risk performance of car drivers might be most efficient measures.
- An accelerated introduction and implementation of EURO-norms as well as an improvement of existing diesel engines will be able to reduce air pollution problems of road transport. Such a policy could be strengthened by introducing additional incentive schemes for the use of environmentally friendly cars and lorries (i.e. the differentiation of existing taxes according to environmental criteria).
- A programme for the revitalisation of the railways is essential in order to increase the share of railways and to make use of the better environmental performance (i.e. the lower average costs). Such a programme should consider infrastructure investment priorities for rail and should envisage the quality of railways (infrastructure and operation) and the environmental performance as well. The electrification of diesel tracks and the replacement of existing diesel locomotives (for example using particle filters) are promising strategies.

b) Pricing of transport

An efficient pricing scheme – according to economic welfare theory – is based on social marginal costs, that means the prices should reflect all costs which occur due to additional use of infrastructure (costs per additional vehicle km). Most relevant are the external costs which are calculated within this study (accidents, environment) and the congestion costs. This theoretical concept is however difficult to estimate and implement, since a differentiated pricing scheme would be necessary. Considering improved road pricing technologies in the future however, such a concept might come true.

This study has estimated average costs. The figures (for accidents and for environmental costs) can be used as proxies for an externality price which enables to internalise these costs. For road transport for example, appropriate charges would be

- 3.3 Eurocents per passenger and kilometre for passenger cars, and
- 4.4 Eurocents per tonne and kilometre for trucks and light duty vehicles. Expressed in costs per vehicle kilometres, there is a range of between 3.2 Eurocents (for light duty vehicles) and up to 6.6 Eurocents (for heavy trucks). Expressed in tonne kilometres, light duty vehicles cause higher unit costs (due to low loading factors) than heavy trucks. There is range from 0.97 Eurocents up to 9.7 Eurocents.

One has to consider however, that these figures do not reflect whether today's prices (i.e. taxes) are too high or too low in the transport sector in comparison to an efficient pricing regime. For this purpose, one should include other cost elements (such as congestion costs, infrastructure costs and related revenues) as well.

c) External benefits?

The study has not considered specific external benefits of the transport sector. Economic theory suggests that the transport sector generates a lot of economic benefits which are very relevant for the functioning of the economy. There is however enough evidence, that there is no general reason to subsidise transport (see for example ECMT 2000). External benefits are therefore not relevant for efficient pricing solutions. One exception are public service obligations (from public transport), which should be operated and financed by the state in an efficient and transparent manner.

All type of costs and benefits however should be considered for the evaluation of transport investments, i.e. infrastructure investments for different modes. Most important are time savings for the transport users and additional regional benefits. In order to apply a comprehensive cost benefit analysis, the external costs (accidents and environmental unit costs) have to be included; this study provides the basic figures per country that could be used when evaluating projects.

5.4 Conclusions from the outlook 2010

The outlook for 2010 based on the two scenarios (trend and environmentally sustainable transport) suggests the following:

- External costs will increase, although there are technical improvements. The main reasons are transport and economic growth. The latter does not affect the share of external costs to GDP since it is assumed that economic growth leads to higher willingness to pay for safety and environmental improvements.
- A policy path implementing best available technology and improving modal split towards rail is a promising approach to reduce external costs of transport.
- The EST-scenarios are focussing on environmental nuisances. A significant reduction of the external costs (esp. for road transport) however has to include accidents costs, being the predominant cost category. Thus the EST-scenarios should consider possible safety improvements as well.
- The shift from a trend towards an EST scenario must be based on strong investment priorities towards rail, stringent measures to enforce technical improvement and pricing measures to finance this structural shift.

5.5 Outlook for further research

This study is a first attempt to provide a quantitative basis for the monetary valuation of safety and environmental issues in the transport sector of the CEI countries. Due to lack of data, gaps in available statistics and missing valuation studies for the CEI countries themselves, the study had to use many assumptions and apply a value transfer procedure from basic studies for Western Europe. In order to improve this quantitative basis and to bring it closer to policy relevant topics in Eastern Europe, we would recommend further work on:

- Studies on unit values and external costs in CEI countries (i.e. willingness to pay studies for risk reduction with respect to road safety and air pollution related health risks or noise).
- Improvement of the quantitative transport data and statistics (traffic volumes, load factors, emission data etc.).
- Estimation of marginal costs for accidents, congestion, environment and infrastructure, based on the results of UNITE project of the European Union; application of these figures for **corridor analysis**.
- Estimation of total subsidies and congestion costs in CEI countries.
- Development of internalisation strategies for the CEI countries.
- Improvement of the forecasting procedure and estimates for policy scenarios of future transport development.

ANNEX

1. General Input Data

2. Detailed Description of Methodology

3. Detailed Results for each Cost Category

1. GENERAL INPUT DATA

The following tables show the most important basic data which were used for the calculation of external costs.

1.1 Socio-economic data

BASIC SOCIOECONOMIC DATA								
Country	**GDP**	**Population total**	**GDP per Capita**	**GDP per Capita PPP**	**Country Adjustment Factor**	**Country Adjustment Factor**	**Area**	**Population density**
Unit	billion US$	No.	US$/capita	US$/capita	EUR 17 = 100	CH = 100	km2	Pers./km2
Base year	1995	1995	1995	1995	1995	1995	1995	1995
Albania	2.50	3'248'836	770	2'853	14.5	11.1	28'748	113.0
Belarus	10.34	10'280'805	1'006	4'398	22.4	17.1	207'595	49.5
Bosnia-Herzegovina	1.90	3'400'000	559	1'433	7.3	5.6	51'129	66.5
Bulgaria	13.10	8'406'100	1'558	4'604	23.4	17.9	110'994	75.7
Croatia	19.24	4'776'000	4'029	3'972	20.2	15.5	56'538	84.5
Czech Republic	52.04	10'330'800	5'037	12'366	62.9	48.1	78'864	131.0
FYR Macedonia	3.11	1'966'033	1'583	4'058	20.6	15.8	25'713	76.5
Hungary	44.67	10'229'000	4'367	9'064	46.1	35.3	93'030	110.0
Moldova	1.70	4'338'779	392	1'547	7.9	6.0	33'700	128.7
Poland	127.30	38'587'600	3'299	7'004	35.6	27.3	312'685	123.4
Romania	31.90	22'681'000	1'406	4'431	22.5	17.3	238'391	95.1
Slovak Republic	17.38	5'363'676	3'240	7'400	37.6	28.8	49'036	109.4
Slovenia	18.70	1'983'012	9'431	12'500	63.5	48.7	20'255	97.9
Ukraine	25.33	51'276'556	494	2'361	12.0	9.2	603'700	84.9
Total CEI	**369.21**	**176'868'197**	**2'087**	**5'137**	**26.1**	**20.0**	**1'910'378**	**92.6**

Table 16 Socio-economic data framework for the CEI countries.

Sources: 1) European health for all database, WHO Regional Office for Europe, Copenhagen, Denmark
2) http://www.worldbank.org/data/
3) OECD 1999 (area data)

Remarks: 1) Population data for Bosnia-Herzegovina: http://www.worldbank.org/data/
2) GDP data for Albania, Bosnia-Herzegovina, Bulgaria and Romania taken from worldbank.org homepage
3) GDP PPP per capita for Bosnia-Herzegovina estimated based on GDP/GDP PPP ratio of FYROM

Definitions: GDP (WHO): Gross domestic product (GDP), US$: The total output of goods and services for final use produced by an economy, by both residents and non-residents, regardless of the allocation to domestic and foreign claims. GDP (Worldbank): GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars. Dollar figures for GDP are converted from domestic currencies using single year official exchange rates.

Exchange Rate: 1 US$ = 0.7647 EUR 1995, Source: Schweizerische Nationalbank, Statistisches Monatsheft 1/2000, p. 72 (Devisenkurse, Interbankhandel, Jahresmittel)

1.2 Transport data

The following traffic data are available.

(a) Road

ROAD TRANSPORT PERFORMANCE										
Country	**Passenger cars**	**Buses and coaches**	**Lorries and Vans**	**Motorcycles**	**Passenger cars**	**Buses and coaches**	**Lorries and Vans**	**Motorcycles**	**Passenger transport**	**Freight transport**
Unit	million vkm	million vkm	million vkm	million vkm	million pkm	million pkm	million tkm	million pkm	million pkm	million tkm
Base year	1995	1995	1995	1995	1995	1995	1995	1995	1995	1995
Albania	587	285	903	24	1'291	9'983	2'708	29	11'303	2'708
Belarus	8'600	325	2'004	1'757	18'919	11'379	6'011	2'108	32'407	6'011
Bos. Herzeg	468	150	223	n.a.	1'030	5'256	670	n.a.	6'287	670
Bulgaria	14'828	360	3'619	1'817	32'621	12'600	10'858	2'181	47'402	10'858
Croatia	6'398	206	3'403	70	14'076	7'221	10'209	84	21'380	10'209
Czech Rep.	24'540	1'040	13'865	3'939	49'080	36'400	41'595	4'726	90'207	41'595
FYRO Maced.	2'621	87	702	8	5'766	3'042	2'106	10	8'817	2'106
Hungary	18'122	446	6'950	557	36'244	15'610	20'850	669	52'523	20'850
Moldova	1'245	577	2'360	49	2'738	20'180	7'079	58	22'976	7'079
Poland	75'150	2'340	32'700	6'650	131'513	81'900	98'100	7'980	221'393	98'100
Romania	24'019	752	6'148	1'147	52'842	26'320	18'444	1'376	80'538	18'444
Slovak Rep.	8'251	685	4'337	802	18'152	23'963	13'012	962	43'077	13'012
Slovenia	6'501	101	786	30	13'002	3'535	2'358	35	16'572	2'358
Ukraine	44'687	2'913	12'316	10'859	98'311	101'955	36'948	13'031	213'297	36'948
Total CEI	**236'016**	**10'267**	**90'316**	**27'709**	**475'586**	**359'343**	**270'949**	**33'251**	**868'179**	**270'949**

Table 17 Road mileage and transport data.
Source: IRF 1998, OECD 1999, own assumptions and calculations

Road transport calculations are mainly based on vehicle fleet data and data concerning average annual mileage. Those were taken from OECD (1999) and IRF (1998). OECD hereby is on the one hand based on a questionnaire and on the other hand on IRF (1998) data. Average annual mileage for some countries could also be found in the data sources mentioned above, for other data own assumptions were made.

To derive transport volume data, assumptions for load factors of passenger cars, buses, motorcycles and freight transport were made. These values were taken out of OECD (1999).

(b) Rail

RAIL TRANSPORT – TRAIN MOVEMENTS							
Country	Diesel traction			Electric traction			Total
	Total	Passenger	Freight	Total	Passenger	Freight	
Unit	1'000 train-km	1'000 train-km	1'000 train-km	1'000 train-km	1'000 train-km	1'000 train-km	1'000 train-km
Base year	1995	1995	1995	1995	1995	1995	1995
Albania	1'113	n.a.	n.a.	0	0	0	1'113
Belarus	39'306	26'956	12'350	22'028	17'627	4'402	61'334
Bos. ~~H~~erzeg	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Bulgaria	9'382	6'128	3'254	38'196	24'626	13'570	47'578
Croatia	12'543	9'819	2'724	12'379	9'198	3'181	24'922
Czech Rep.	79'266	64'931	14'335	79'768	43'284	36'485	159'034
FYRO Maced.	1'596	1'339	257	1'303	1'036	267	2'899
Hungary	46'133	39'238	6'895	56'048	41'753	14'296	102'181
Moldova	7'801	5'431	2'370	0	0	0	7'801
Poland	48'027	33'690	14'337	244'399	146'608	97'791	292'426
Romania	49'882	37'812	12'070	72'487	43'285	29'202	122'369
Slovak Rep.	24'694	10'860	13'834	39'807	39'807	0	64'501
Slovenia	7'824	5'554	2'270	10'691	5'877	4'814	18'515
Ukraine	86'781	63'091	23'690	198'156	109'129	89'027	284'937
Total CEI	**414'347**	**304'849**	**108'385**	**775'263**	**482'229**	**293'034**	**1'189'610**

Table 18 Rail transport – train movements 1995.
Source UIC 1996.

Rail transport data were taken from the official International Railway Statistics (UIC 1996). The allocation of passenger and freight traffic (pkm/tkm) per type of traction was calculated based on gross-tonne kilometres.

RAIL TRANSPORT – PASSENGER AND FREIGHT TRAFFIC						
Country	Passenger traffic			Freight traffic		
	All types of traction	Diesel traction	Electric traction	All types of traction	Diesel traction	Electric traction
Unit	million pkm	million pkm	million pkm	million tkm	million tkm	million tkm
Base year	1995	1995	1995	1995	1995	1995
Albania	197	197	0	53	53	0
Belarus	12'505	7'526	4'979	25'510	19'040	6'470
Bos. Herzeg	0	0	0	0	0	0
Bulgaria	4'693	697	3'996	8'560	1'053	7'507
Croatia	943	472	472	1'975	988	988
Czech Rep.	8'023	2'675	5'348	22'634	3'325	19'309
FYRO Maced.	65	24	41	169	67	102
Hungary	6'224	1'815	4'409	8'397	1'826	6'571
Moldova	1'019	1'019	0	3'004	3'004	0
Poland	20'960	2'426	18'534	68'190	5'018	63'172
Romania	18'847	7'267	11'580	24'033	5'483	18'550
Slovak Rep.	4'202	1'016	3'186	13'762	2'416	11'346
Slovenia	595	132	463	2'881	590	2'291
Ukraine	63'752	19'433	44'319	195'762	33'028	162'734
Total CEI	**142'025**	**44'698**	**97'327**	**374'930**	**75'890**	**299'040**

Table 19 Rail transport – passenger and freight traffic 1995.
Source UIC 1996.

(c) Aviation

Aviation data was taken from the Civil Aviation Statistics of the World (ICAO 1996). LTO cycles were derived from aircraft departures for scheduled air traffic (ICAO 1996). LTO cycles for non-scheduled air traffic were estimated based on the data for scheduled air traffic.

AIR TRANSPORT				
Country	**Aircraft kilometres**	**Passenger kilometres**	**Tonne kilometres**	**LTO**
Unit	million km	million pkm	million tkm	No.
Base year	1995	1995	1995	1995
Albania	0.2	4	0	222
Belarus	36	2604	2.4	40'000
Bos. Herzeg	n.a.	n.a.	n.a.	n.a.
Bulgaria	24.5	3104.9	121	20'608
Croatia	8.1	443	5.1	13'911
Czech Rep.	26.7	2640.2	54.7	29'627
FYRO Maced.	5.3	350.1	1.1	6'064
Hungary	26.5	2396.4	93	31'122
Moldova	4.2	228	2.4	5'043
Poland	41.5	4411.8	82.1	33'281
Romania	29.7	2673.8	33.2	23'287
Slovak Rep.	1.5	144.3	8.7	6'712
Slovenia	6.3	613.7	26.7	13'752
Ukraine	28.9	2819.6	167.8	36'761
Total CEI	**239**	**22'434**	**598**	**260'389**

Table 20 Air Transport Data.
Source: ICAO 1996, own estimations.

(d) Inland waterways

For this transport mode, only rough figures are available from the OECD/CEI report (OECD 1999). These can be used for the estimation procedures.

WATERBORNE TRANSPORT	
Country	**Inland waterways**
Unit	million tkm
Base year	1995
Albania	0
Belarus	133
Bos. Herzeg	0
Bulgaria	733
Croatia	230
Czech Rep.	1'348
FYRO Maced.	0
Hungary	1'454
Moldova	251
Poland	876
Romania	3'107
Slovak Rep.	1'468
Slovenia	0
Ukraine	5'680
Total CEI	**15'280**

Table 21 Waterborne transport.
Source: OECD 1999.

1.3 Accident data

The following data are available:

ECMT - ROAD ACCIDENT STATISTICS - 1995			
	Casualties 1)	**Killed** 1) [30 days]	**Injuries** 1), 2)
Unit	No.	No.	No.
Base year	1995	1995	1995
Albania**	3'819	306	3'513
Belarus	9'238	1'781	7'457
Bosnia-Hercegovina*	2'683	215	2'468
Bulgaria	9'981	1'264	8'717
Croatia	18'465	800	17'665
Czech Republic	38'555	1'588	36'967
FYRO Macedonia*	36	157	3'443
Hungary	27'476	1'589	25'887
Moldova	3'613	544	3'069
Poland	77'126	69	70'226
Romania	10'561	2'863	7'698
Slovak Republic*	12'233	660	11'573
Slovenia	8'416	415	8'001
Ukraine*	46'943	753	39'413

Table 22 Road accident data.

1) ECMT: Road Accident Statistics, 1995

2) MOTORSAT - STATISTIQUES AUTOMOBILES EN FRANCE & DANS LE MONDE :International automobile statistics

* estimated, CEMT

** Casualties and Injuries estimated via proportion of causalities to killed people form BIH

UIC RAIL ACCIDENT STATISTIC						
	Fatalities			Injuries		
	Collisions	Other accidents	per 1 billion Pkm	Collisions	Other accidents	per 1 billion Pkm
Unit	no.	no.	no.	no.	no.	no.
Base year	1995	1995	1995	1995	1995	1995
Albania	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Belarus	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Bosnia-Hercegovina	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Bulgaria	0	0	0.0	2	0	0.0
Croatia	0	n.a.	n.a.	0	n.a.	0.0
Czech Republic	17	0	2.1	47	0	5.9
FYRO Macedonia	0	0	0.0	0	0	0.0
Hungary	0	18	2.9	11	248	42.3
Moldova	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Poland	0	0	0.0	9	3	0.6
Romania	2	0	0.1	17	0	0.9
Slovak Republic	0	0	0.0	13	0	3.1
Slovenia	0	0	0.0	0	8	13.4
Ukraine	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

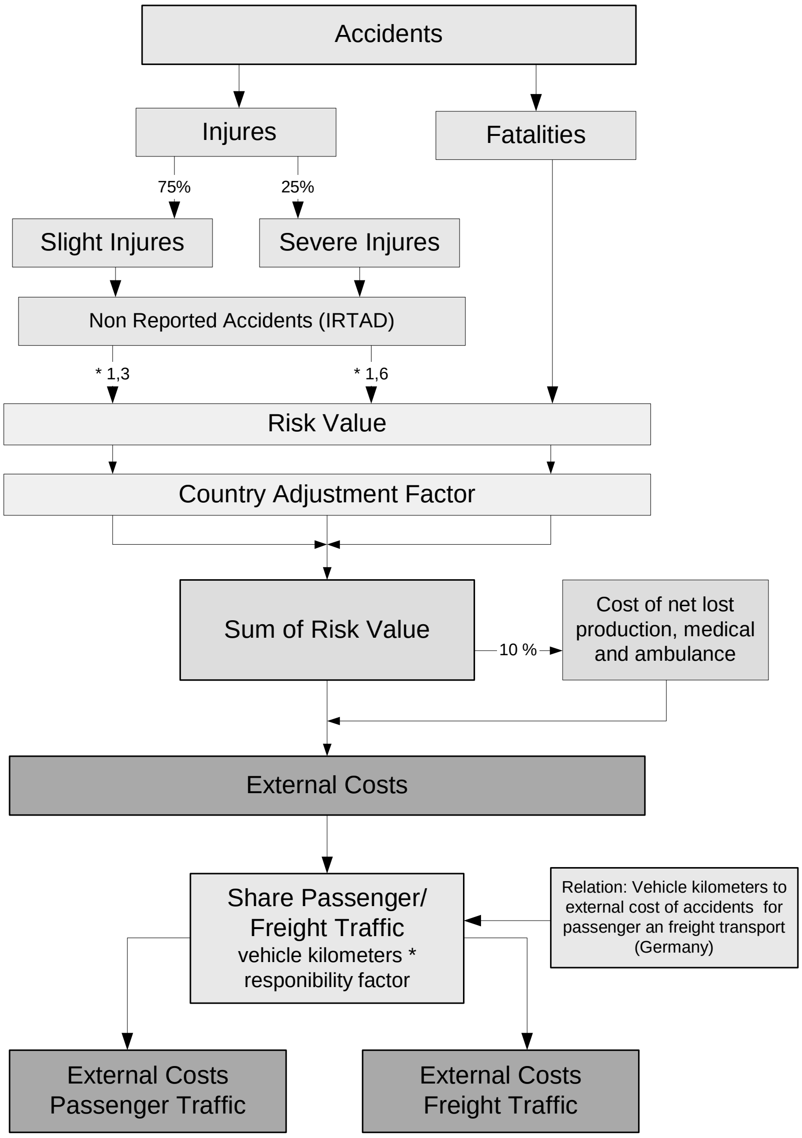
Table 23 Rail accident data.
Source: UIC 1996.

2. DETAILED DESCRIPTION OF METHODOLOGY

2.1 Accidents

a) Road

The following picture presents the methodology of (external) road accidents costs in detail.



flow chart - accident - 02-04-24.vsd

Base-Data are Road-accidents causing Causalities in 1995 (ECMT: Road Accident Statistics, 1995), differentiated in killed (within 30 Days) and injured People. For the countries Bosnia-Herzegovina, FYRO Macedonia, the Slovak Republic and Ukraine only estimated accident data for 1995 is available.

The reported injuries have been divided into slight and severe injuries by an estimated share of 25% for severe Injuries and 75% for slight injuries. Based on this distribution of slight and severe injuries an adjustment for non reported accidents is applied.

ADJUSTMENT FACTORS FOR ACCIDENTS		
Killed [30 days]	**Severe Injuries**	**Slight Injuries**
1,00	1,30	1,60

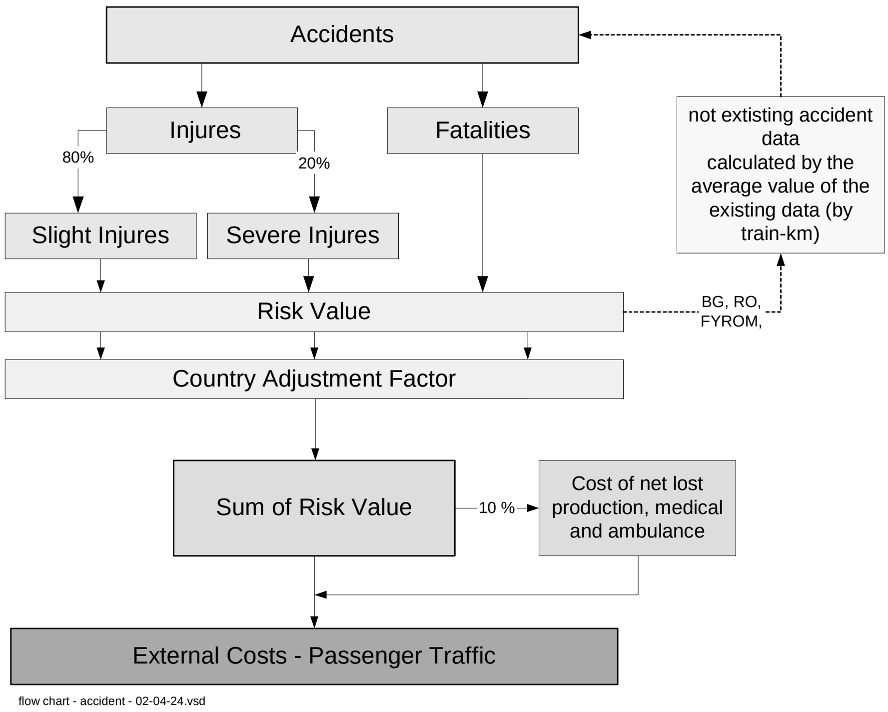
Since no data are available on the responsibility in all observed counties, the German national accident risk (per vehicle km) was extrapolated to the remaining counties.

For the distribution of total accident costs to passenger (passenger cars, Motorcycles and Busses) and freight transport (LDV and HDV), a responsibility for accidents in relation to vehicle kilometres has been used. This factor has been taken from the UNITE study[10] and is calculated as a proportion of vehicle kilometres (for passenger and freight traffic) and total accident costs (for passenger and freight traffic). The value transfer is based on values for Germany. The weighting factor (responsibility-factor) has been applied to the passenger- and freight vehicle kilometres in each country.

[10] UNIfication of accounts and marginal costs for Transport Efficiency

b) Rail

The following figure presents the methodology of (external) rail accidents costs in detail.



Basic data for rail accidents have been taken from the UIC Supplementary Statistics to the International Railway Statistics 1995-1996, differentiated in passenger fatalities (at collisions and derailments and other accidents) and passenger injuries (at collisions and derailments as well as other accidents).

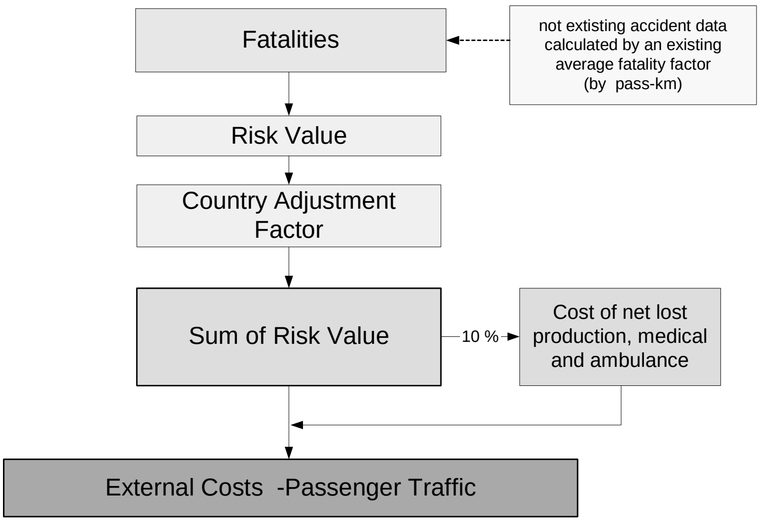
The reported injuries have been divided into slight and severe injuries by an estimated share of 20% for severe injuries and 80% for slight injuries.[11] Because the available data covers fatalities and injuries from rail passengers only, external accident costs for rail freight traffic are not considered. Accident data (fatalities and injuries) for the countries Albania, Belarus, Bosnia-Herzegovina, Croatia, Moldavia and Ukraine are not available. For these countries the total accident costs for rail are estimated on the basis of the average accident costs by train-kilometres from Bulgaria, Romania and FYRO Macedonia.

[11] The proportion for severe and slight injuries has been taken from INFRAS/IWW (2000)–Average Ratio for EU-countries

c) Aviation

The following figure presents the methodology of (external) rail accidents costs in detail.

Air - Accident - External Costs



For the number of casualties of air transport there are no data available. In this case, the numbers of fatalities were estimated using average fatality rates given by the ICAO for 1995. External costs for injuries could not be included.

FATALITY RATES IN COMMERCIAL AIR TRANSPORT							
		1987	1992	1993	1994	1995	1996
Scheduled Services							
Aircraft Accidents	No.	26	29	34	28	26	23
Passenger Fatalities	No.	901	1'076	936	941	710	1'135
Fatality Rates	Fatalities / 100 Mio. Pass km	0.06	0.06	0.05	0.04	0.03	0.05
Non-Scheduled Services							
Aircraft Accidents	No.	2	12	6	6	13	4
Passenger Fatalities	No.	3	224	48	35	271	342
Fatality Rates	Fatalities / 100 Mio. Pass km	0.00	0.01	0.02	0.01	0.11	0.13

Table 24 Fatality Rates in commercial air transport.
Source ICAO.

For Eastern Europe 1995 we assumed that 90% of Air Transport passenger kilometres are covered by Scheduled Services and 10% by Non-Scheduled Services (charter flights).

d) Inland waterways

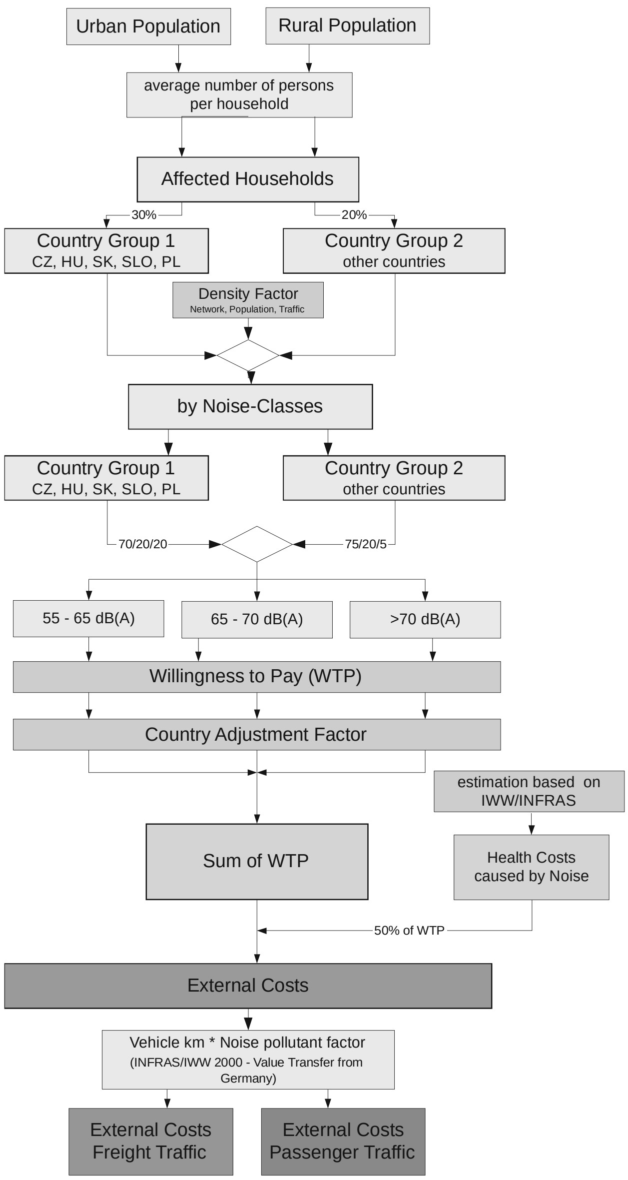
Generally there is no accident data available for inland waterway. For Hungary, an external cost study for the Year 1998 indicates external accident costs for inland waterways (per tonne km). The per tonne-km value for accident costs is extrapolated to other countries.

2.2 Noise

a) Road

The following figure presents the methodology of (external) road noise costs in detail.

Road - Noise - External Costs



For Eastern European Countries, there is no information available on number of households. The number of households has been estimated by average household sizes for urban and rural areas (urban household size: 2,5 persons, rural: 3,5 persons).

There is no data available on the number of households exposed to road transport noise. Therefore, an estimation of exposed households within different noise classes is applied according to INFRAS/IWW (1995)[12].

NOISE EXPOSITION ROAD					
Countries		**Households exposed to road traffic noise**	**Within Noise Classes**		
			55 - 65 dB(A)	**65 - 70 dB(A)**	**>70 dB(A)**
Country Group 1	CZ, SLO, HU, SK, PL	30%	70%	20%	10%
Country Group 2	Other Countries	20%	75%	20%	5%
Germany		40%	69%	19%	12%
Greece		30%	75%	20%	5%

Table 25 Estimation of Households exposed to Road Traffic Noise[13]

Within each Country Group the Number of exposed households is weighted as follows:

$$Weight = \sqrt{\frac{Network\,density + Population\,density}{2} * Average\,Traffic\,Load}$$

The maximum for each country group is set to the value shown in Table 25.

EXPOSITION ROAD TRAFFIC NOISE			
	Households	**Affected households**	
Unit	No.	No.	%
Base year	1995	1995	1995
Albania	1'066'361	115'663	11%
Belarus	3'771'587	263'995	7%
Bosnia-Herzegovina	1'131'131	50'369	4%
Bulgaria	3'057'899	422'530	14%
Croatia	1'669'144	239'337	14%
Czech Republic	3'724'047	1'117'214	30%
FYRO Macedonia	696'223	77'397	11%
Hungary	3'677'764	578'685	16%
Moldova	1'495'515	299'103	20%
Poland	13'834'206	2'707'419	20%
Romania	7'929'278	801'686	10%
Slovak Republic	1'892'795	481'669	25%
Slovenia	682'836	98'906	14%
Ukraine	18'764'289	1'989'325	11%
Total CEI	63'393'075	9'243'297	15%

Table 26 Households exposed to road traffic noise

Noise costs per exposed household and year are calculated via WTP per household. For an exposed household the WTP per reduced db(A) is 30 € , based on UNITE assumptions and existing

[12] INFRAS/IWW 1995;

[13] Values for Germany and Greece taken from INFRAS/IWW 1995

studies. Because there is no data available for health risks caused by traffic noise, the relation of WTP to Health Costs is set to 1 : 0,5.

The distribution to modes is calculated by vehicle kilometres for each vehicle category weighted by a responsibility factor – this means that the vehicle kilometres for lorries, busses and motorcycles have been multiplied with the respective factors shown in Table 27:[14]

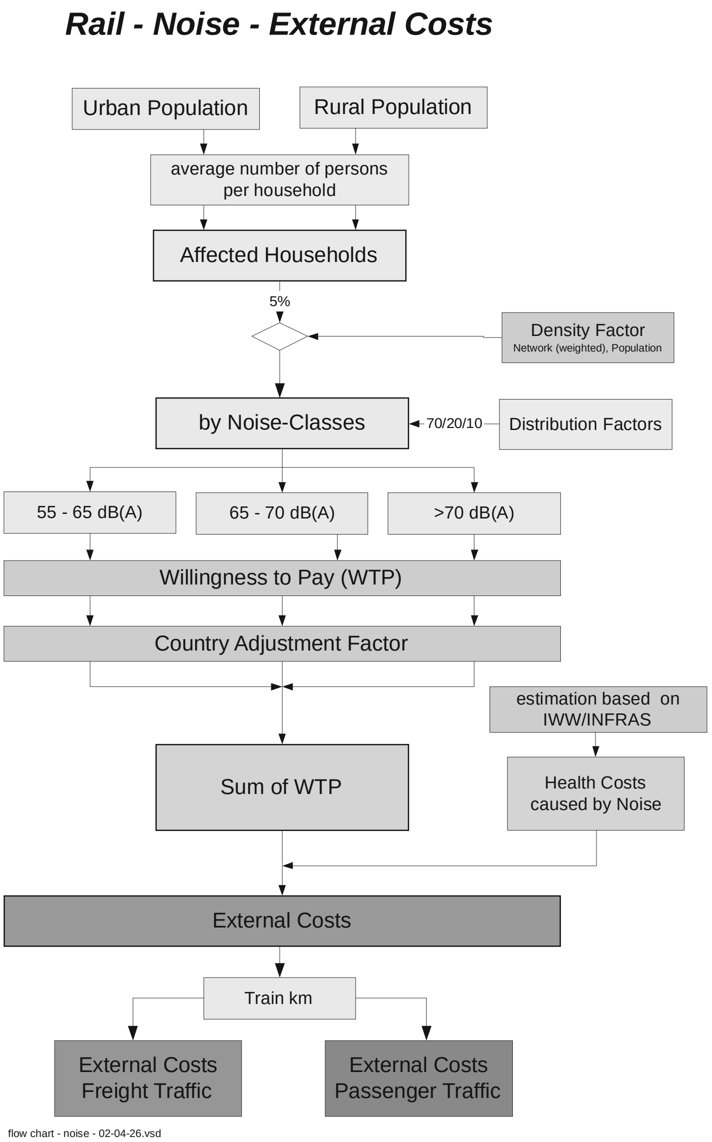
TRAFFIC NOISE RESPONSIBILITY FACTOR - ROAD			
Passenger Cars	**Busses and Coaches**	**Motorcycles**	**Lorries and Vans**
Factor	Factor	Factor	Factor
1	2.5	2	3

Table 27 Responsibility factor – road.

[14] INFRAS/IWW 2000, Country for value transfer is Germany

b) Rail

The following figure presents the methodology of (external) rail noise costs in detail.



There are no data available for the number of households exposed to rail transport noise. Therefore, an estimation of exposed households has been applied within different noise classes by taking into account estimations for Western Europe (INFRAS/IWW 1995).

NOISE EXPOSITION RAIL			
Households exposed to road traffic noise	Within Noise Classes		
	55 - 65 dB(A)	65 - 70 dB(A)	>70 dB(A)
5%	70%	20%	10%

Table 28 Estimation of Households exposed to rail traffic noise.

The number of exposed households is weighted by:

$$Weight = \sqrt{\frac{Network density + Population density}{2}} * Average Traffic Load$$

The maximum weight is 1 – this means, that within the country with the highest density factor 5% of all households are exposed to rail traffic noise.

EXPOSITION RAIL TRAFFIC NOISE			
	Households	Affected households	
Unit	No.	No.	%
Base year	1995	1995	1995
Albania	1'066'361	13'818	1.3%
Belarus	3'771'587	78'309	2.1%
Bosnia-Herzegovina	1'131'131	7'550	0.7%
Bulgaria	3'057'899	80'419	2.6%
Croatia	1'669'144	49'495	3.0%
Czech Republic	3'724'047	186'202	5.0%
FYRO Macedonia	696'223	12'458	1.8%
Hungary	3'677'764	144'900	3.9%
Moldova	1'495'515	35'227	2.4%
Poland	13'834'206	484'333	3.5%
Romania	7'929'278	225'617	2.8%
Slovak Republic	1'892'795	79'354	4.2%
Slovenia	682'836	24'575	3.6%
Ukraine	18'764'289	513'722	2.7%
Total CEI	63'393'075	1'935'980	3.1%

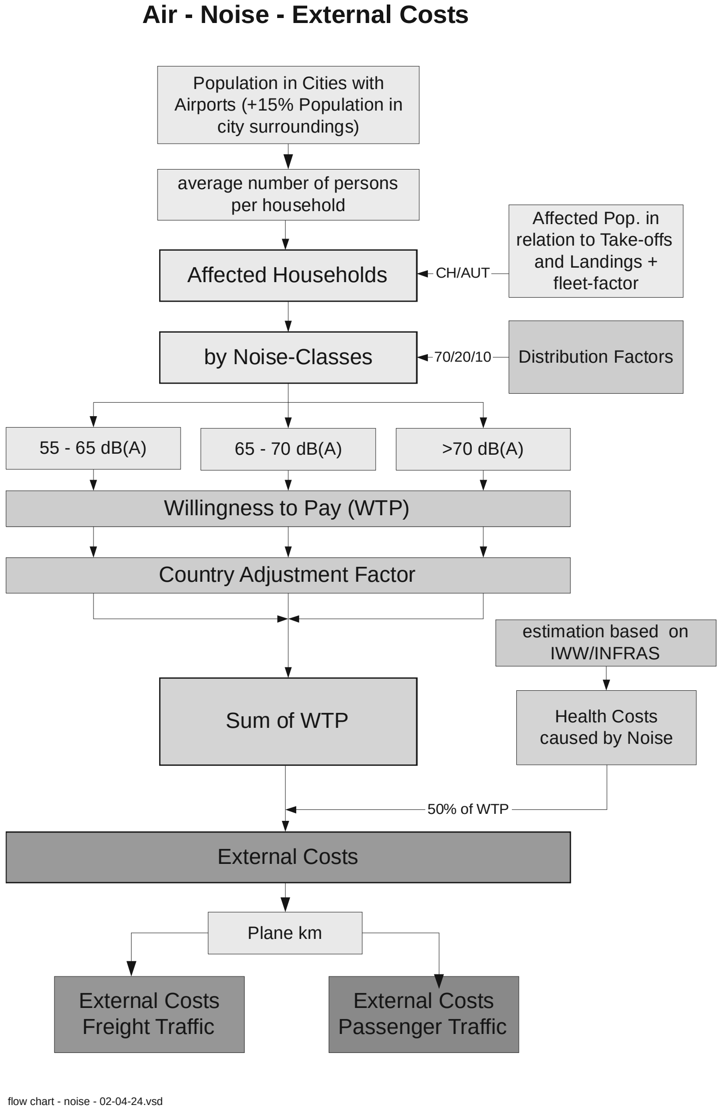
Table 29 Households exposed to rail traffic noise

Noise costs per exposed household and year are calculated via WTP per household. For an exposed household the WTP per reduced db(A) is 30 EURO. Because there are not available any data for health risks caused by traffic noise, the relation of WTP to Health Costs is set to 1 : 0,5.

The distribution to modes is calculated by train kilometres for passenger and freight traffic. Freight and passenger trains are regarded as equal concerning noise emissions.

c) Aviation

The following figure presents the methodology of (external) air noise costs in detail.



There are no data available for the number of households exposed to air transport noise. Therefore, an estimation of exposed households within different noise classes is applied. Base for the estimation of households exposed to aviation noise is the population in cities with international airports. For these airports the number of take-offs and landings (LTO's) are available.

Countries for value transfer are Switzerland and Austria. From these two countries the following estimation is derivate.

$P_{exposed}[\%] = LTO/38000 + 0,2$

In addition to that, there are added further 15% representing the population in city surroundings. Beyond that, a "fleet-factor" (taking into account higher emissions of airplane fleets in Eastern Europe) has been applied.

FLEET FACTOR NOISE EMISSIONS		
Country		**Fleet Factor - Noise Emissions**
Country Group 1	CZ, SLO, HU, SK, PL	1.1
Country Group 2	Other Countries	1.3

Table 30 The fleet factor takes into a account higher emissions of airplane fleets in Eastern Europe.

EXPOSITION AIR TRAFFIC NOISE			
	Households	**Affected households**	
Unit	No.	No.	%
Base year	1995	1995	1995
Albania	1'066'361	292	0.0%
Belarus	3'771'587	27'790	0.7%
Bosnia-Herzegovina	1'131'131	0	0.0%
Bulgaria	3'057'899	21'242	0.7%
Croatia	1'669'144	14'010	0.8%
Czech Republic	3'724'047	38'140	1.0%
FYRO Macedonia	696'223	5'361	0.8%
Hungary	3'677'764	30'789	0.8%
Moldova	1'495'515	3'989	0.3%
Poland	13'834'206	24'112	0.2%
Romania	7'929'278	43'373	0.5%
Slovak Republic	1'892'795	4'110	0.2%
Slovenia	682'836	2'975	0.4%
Ukraine	18'764'289	108'036	0.6%
Total CEI	63'393'075	324'220	0.5%

Table 31 Households exposed to air traffic noise.

Noise costs per exposed household and year are calculated via WTP per household. For an exposed household the WTP per db(A) reduced is 30 EURO. Because there are no data available for health risks caused by traffic noise, the relation of WTP to Health Costs is set to 1 : 0,5.

The distribution to passenger and freight traffic is calculated by the proportion of airplane-kilometres. Freight and passenger planes are regarded as equal concerning noise emissions.

2.3 Air pollution and climate change

a) Health costs

The methodology for the calculation of health costs is mainly based on the UIC study (INFRAS/IWW 2000). This study is based on the trilateral WHO study for Austria, France and Switzerland (WHO 1999). The study mentioned uses population weighted PM_{10} average exposure due to transport to estimate morbidity and mortality cases for every country. As PM_{10} concentration data for the CEI countries are barely available, a correlation between PM_{10} emissions and PM_{10} exposure data was conducted for countries where both datasets were available (Austria, France, and Switzerland). The resulting function was used to estimate PM_{10} exposition for the CEI countries.

PM_{10} EXPOSITION		
Country	**Total PM_{10}**	**Estimated PM_{10} population weighted average**
Unit	kg PM_{10}/capita	µg PM_{10}/m3
Base year	1995	1995
Albania	0.9	6.9
Belarus	1.3	7.1
Bosnia-Hercegovina	0.3	6.4
Bulgaria	1.8	7.4
Croatia	2.2	7.7
Czech Republic	4.8	9.4
FYRO Macedonia	1.2	7.1
Hungary	2.8	8.0
Moldova	1.8	7.4
Poland	2.9	8.2
Romania	1.4	7.1
Slovak Republic	2.9	8.2
Slovenia	1.7	7.4
Ukraine	1.9	7.5
Average CEI	**2.2**	**7.7**

Table 32 Estimated population weighted PM_{10} exposition values.

For the calculation of the additional cases caused by transport PM_{10} emissions, the fixed baseline increase function from the WHO-study was used.

HEALTH EFFECTS OF PM_{10} EXPOSURE Fixed baseline increment per 10 µg/m^3 PM_{10} and 1 million inhabitants additional cases (+/-95% Confidence Interval)				
Health effect	**Austria**	**France**	**Switzerland**	**Mean**
Long-term mortality (adults >= 30 years)	374	340	337	**350**
Respiratory Hospital admission (all ages)	228	148	133	**170**
Cardiovascular Hospital Admission (all ages)	449	212	303	**321**
Chronic Bronchitis Incidence (adults >= 25 years)	413	394	431	**413**
Bronchitis (children< 15 years)	3'196	4'830	4'622	**4'216**
Restricted Activity Days (adults >= 20 years)	208'355	263'696	280'976	**251'009**
Asthmatics: Asthma attacks (children < 15 years)	2'325	2'603	2'404	**2'444**
Asthmatics: Asthma attacks (adults >= 15 years)	6'279	6'192	6'366	**6'279**

Table 33 Number of additional cases per 10 mg/m^3 PM_{10} and 1 million inhabitants. For all countries the same mean values were used.

The exposition values were then used to calculate the cases of morbidity and mortality which were finally multiplied with country adjusted WTP values to receive total external transport health costs.

b) Crop Losses and building damages

The following formula for the adjustment to different emission levels was used.

(i) Crop losses:

The following formula will be used to compute crop losses (CL), while α=0.0037 [km^2/t]:

$$CL = \alpha \cdot \frac{NO_x\ Emissions}{Country\ area} \cdot Agricultural\ production$$

Building damages:

Building damages will be estimated using the following formula, while β=0.322 [Mio. €/t] and rf =0.66 where rf is a reduction factor[15]:

$$BD = \beta \cdot rf \cdot \frac{NO_x Emissions}{Country\ \ area} \cdot Building\ surface \cdot PPP$$

The following data was used to calculate crop losses and building damages. The different calculation steps are described in the methodology chapter.

		Socio economic data				
Country	Shortcut	Gross value added at market prices 1)	Agriculture, value added 1)	Agriculture, value added	Country Area	Adjust. Fact.
Unit		billion US$	% of GDP	Million US$	km2	% Euro17
Base year		1995	1995	1995	1995	
Albania	AL	2.5	54.6%	1365	28'748	14.5
Belarus	BY	20.1	17.7%	3558	207'595	23.4
Bosnia-Herzegovina	BiH	1.9	24.6%	467	51'129	7.3
Bulgaria	BG	13.1	12.7%	1664	110'994	14.5
Croatia	HR	15.8	10.7%	1691	56'538	20.6
Czech Republic	CZ	52.0	5.0%	2600	78'864	23.4
FYRO Macedonia	FYROM	2.5	13.2%	330	25'713	20.6
Hungary	HU	44.7	7.1%	3174	93'030	46.1
Moldova	MD	3.1	33.0%	1023	33'700	7.9
Poland	PL	110.7	6.0%	6642	312'685	35.6
Romania	RO	31.9	20.6%	6571	238'391	22.5
Slovak Republic	SK	18.4	5.3%	975	49'036	37.6
Slovenia	SLO	18.7	4.6%	860	20'255	63.5
Ukraine	UA	49.1	15.4%	7561	603'700	12.0
Total		385	16%	38'481	1'910'378	25

1) Worldbank 1995

Table 34 Social economic input data to calculate crop losses.

15 rf is the building area reduction factor for CEI. It is assumed that in the states of CEI a person has less space for living than in western European countries and therefore there is less building area per person in CEI.

	Socio economic data			
Country	Population	Building Surface	Country Area	Adjust. Fact. CH
Unit	Persons	km2	km2	% CH
Base year	1995	1995	1995	1995
Albania	3'248'836	214	28'748	11.1
Belarus	8'406'100	555	207'595	17.9
Bosnia-Hercegovina	3'400'000	224	51'129	5.6
Bulgaria	3'248'836	214	110'994	11.1
Croatia	1'966'033	130	56'538	15.8
Czech Republic	8'406'100	555	78'864	17.9
FYRO Macedonia	1'966'033	130	25'713	15.8
Hungary	10'229'000	675	93'030	35.3
Moldova	4'338'779	286	33'700	6.0
Poland	38'587'600	2547	312'685	27.3
Romania	22'681'000	1497	238'391	17.3
Slovak Republic	5'363'676	354	49'036	28.8
Slovenia	1'983'012	131	20'255	48.7
Ukraine	51'276'556	3384	603'700	9.2
Total	165'101'561	10'897	1'910'378	19

Table 35 Social economic input data to calculate building damages.

c) Input data

c1) Emission factors

Emission factors for road transport were taken out of OECD (1999). Non-exhaust PM_{10} emission factors are based on INFRAS/IWW (2000). Additional assumptions were made concerning the HDV/LDV-share and the emissions factor for buses. The latter, a reduction factor of 20% compared to HDV was applied, based on experience in Switzerland and Germany.

ROAD EMISSION FACTORS 1995/2010					
	Base year	Passenger cars	Buses and coaches	Lorries and Vans	Motorcycles
Unit		g/vkm	g/vkm	g/vkm	g/vkm
CO_2	1995	221.00	553.60	572.90	138.40
NO_X	1995	2.71	11.69	10.70	0.56
VOC	1995	4.83	5.74	5.28	6.43
PM_{10} total	1995	0.13	2.29	2.14	0.084
CO_2	2010	187.00	553.60	551.90	138.40
NO_X	2010	1.56	9.928	8.90	0.56
VOC	2010	2.41	4.28	3.83	2.6
PM_{10} total	2010	0.13	1.36	1.29	0.084
CO_2	EST3-2010	154.00	553.60	547.00	96.90
NO_X	EST3-2010	0.41	4.968	4.44	0.28
VOC	EST3-2010	0.29	1.288	1.15	2.6
PM_{10} total	EST3-2010	0.049	0.678	0.62	0.084

Table 36 Emission factors road

Sources: **OECD 1999:** Environmentally Sustainable Transport in the CEI Countries in Transition, Final Report, Paris 1999, p. 106
INFRAS/IWW 2000: External Costs of Transport, UIC, commissioned by UIC, Paris, Zurich, Karlsruhe 2000, p. 192
BUWAL 2001: Massnahmen zur Reduktion von PM_{10}-Emissionen, 2001, p. 99

Remarks: Emission factors in OECD 1999 refer to 1994 values, same values for 1995 applied in this study

Assumptions: Buses and coaches: HDV factors applied - 20%
Lorries and vans: a share of 70% HDV and 30% LDV assumed
Motorcycles: only non-exhaust PM_{10} emissions considered (abrasion, etc.)

Factors: Red. Factor HDV for buses: 20%
HDV/LDV Split (Share of HDV): 70%

Diesel and electric traction emission factors for rail transport are mainly based on OECD (1999). Factors for non-exhaust PM_{10} emissions (abrasion, etc.) were taken from INFRAS/IWW (2000).

EMISSION FACTORS RAIL DIESEL TRACTION								
Country	CO_2		NO_X		VOC		PM_{10} total	
	Passenger	Freight	Passenger	Freight	Passenger	Freight	Passenger	Freight
Unit	g/gross-tkm	g/gross-tkm	g/gross-tkm	g/gross-tkm	g/gross-tkm	g/gross-tkm	g/gross-tkm	g/gross-tkm
Base year	1995	1995	1995	1995	1995	1995	1995	1995
Albania	20.83	21.08	0.40	0.40	0.13	0.13	0.16	0.13
Belarus	14.00	14.01	0.27	0.27	0.09	0.09	0.11	0.09
Bosnia-Herzegovina	20.83	21.08	0.40	0.40	0.13	0.13	0.16	0.13
Bulgaria	25.87	26.42	0.49	0.50	0.16	0.17	0.21	0.16
Croatia	22.62	23.18	0.43	0.44	0.14	0.15	0.18	0.14
Czech Republic	20.83	21.08	0.40	0.40	0.13	0.13	0.16	0.13
FYRO Macedonia	38.57	39.00	0.73	0.74	0.24	0.25	0.30	0.23
Hungary	25.23	25.62	0.48	0.49	0.16	0.16	0.20	0.16
Moldova	7.60	7.69	0.14	0.15	0.05	0.05	0.06	0.05
Poland	42.85	41.34	0.82	0.79	0.27	0.26	0.32	0.27
Romania	25.70	25.63	0.49	0.49	0.16	0.16	0.20	0.16
Slovak Republic	20.83	21.08	0.40	0.40	0.13	0.13	0.16	0.13
Slovenia	20.83	21.08	0.40	0.40	0.13	0.13	0.16	0.13
Ukraine	20.83	21.08	0.40	0.40	0.13	0.13	0.16	0.13
Weighted average	**20.83**	**21.08**	**0.40**	**0.40**	**0.13**	**0.13**	**0.16**	**0.13**

Table 37 Emission factors Rail – diesel traction.

Sources: OECD 1999, UIC 1996
Assumptions: Diesel traction: Calculation based on gross-ton kms and basic values OECD 1999
For countries, where in OECD (1999) no emission factors could be found, a weighted average of the available emission factors was used
Allocation of pkm/tkm to diesel and electric traction based on gross-ton kilometres (UIC 1996)
PM_{10} Passenger/Freight: Non-exhaust emissions considered (INFRAS/IWW 2000)

EMISSION FACTORS RAIL ELECTRIC TRACTION								
Country	CO_2		NO_X		VOC		PM_{10} total	
	Passenger	Freight	Passenger	Freight	Passenger	Freight	Passenger	Freight
Unit	g/pkm	g/tkm	g/pkm	g/tkm	g/pkm	g/tkm	g/pkm	g/tkm
Base year	1995	1995	1995	1995	1995	1995	1995	1995
Albania	58.30	60.70	0.24	0.25	0.06	0.06	0.22	0.18
Belarus	58.30	60.70	0.076	0.195	0.06	0.06	0.22	0.18
Bosnia-Herzegovina	58.30	60.70	0.24	0.25	0.06	0.06	0.22	0.18
Bulgaria	58.30	60.70	0.24	0.25	0.06	0.06	0.22	0.18
Croatia	58.30	60.70	0.11	0.22	0.06	0.06	0.04	0.08
Czech Republic	88.00	96.31	0.176	0.193	0.06	0.06	0.32	0.28
FYRO Macedonia	58.30	60.70	0.24	0.25	0.06	0.06	0.22	0.18
Hungary	142.40	90.81	0.207	0.132	0.06	0.06	0.63	0.46
Moldova	58.30	60.70	0.24	0.25	0.06	0.06	0.22	0.18
Poland	48.00	62.46	0.124	0.161	0.06	0.06	0.13	0.14
Romania	58.30	60.70	0.24	0.25	0.06	0.06	0.22	0.18
Slovak Republic	46.50	65.66	0.05	0.07	0.01	0.014	0.07	0.08
Slovenia	26.20	31.75	0.073	0.088	0.06	0.06	0.04	0.04
Ukraine	58.30	60.70	0.24	0.25	0.06	0.06	0.22	0.18
Weighted average	**58.30**	**60.70**	**0.24**	**0.25**	**0.06**	**0.06**	**0.22**	**0.18**

Table 38 Emission factors Rail – electric traction.
Sources: OECD 1999, UIC 1996
Assumptions: Electric traction: Calculation based on pkm/tkm and basic values OECD 1999
For countries, where in OECD (1999) no emission factors could be found, a weighted average of the available emission factors was used
Allocation of pkm/tkm to diesel and electric traction based on gross-ton kilometres (UIC 1996)
PM_{10} Passenger/Freight: Non-exhaust emissions considered (INFRAS/IWW 2000)

EMISSION FACTORS AVIATION						
	Base year	Short distance	Long distance	Passenger transport	Freight transport	Results per LTO cycle
Unit		g/pkm	g/pkm	g/pkm	g/tkm	kg per LTO cycle
CO_2	1995	306	246	276.0	1'452.6	
NO_X	1995	1.012	0.8943	0.95	5.02	10.802
VOC	1995	0.1386	0.0913	0.1150	0.6050	1.87
PM_{10} total	1995	0.0013	0.0008	0.0011	0.0056	
SO_2	1995					0.924
CO_2	2010	269.6	218.7	244.1	1'284.9	
NO_X	2010	0.9	0.8	0.8	4.4	12.1
VOC	2010	0.12474	0.08217	0.1035	0.5445	2.09
PM_{10} total	2010	0.0011	0.0007	0.0009	0.0046	
SO_2	2010					1.1

Table 39 Emission factors aviation 1995 and 2010
Sources: **INFRAS/IWW 2000:** External Costs of Transport, UIC, commissioned by UIC, Paris, Zurich, Karlsruhe 2000
Assumptions: Split short/long-haul: Short-haul 50% - Long-haul 50%

Reduction factors 1995-2010 for CO_2, NO_X and PM_{10} taken from INFRAS/IWW 2000

Main source of emission factors: ICAO Engine Exhaust Emissions Data Bank 1995 - values for older aircrafts applied
Additional emission surcharge for PM_{10}, VOC, NO_X and SO_2 due to an older aircraft fleet (+ 10%)

Conversion factor pkm -> tkm: 1 passenger = 190 kg

EMISSION FACTORS WATERBORNE TRANSPORT		
	Base year	Emission factors
Unit		mg/tkm
CO_2	1995	37200
NO_X	1995	708
PM_{10} total	1995	46.8
CO_2	2010	33'960.0
NO_X	2010	82.8
PM_{10} total	2010	6.0

Table 40 Emission factors waterborne transport (inland waterways) 1995 and 2010

Sources: INFRAS/IWW 2000: External Costs of Transport, UIC, commissioned by UIC, Paris, Zurich, Karlsruhe 2000

Assumptions: Additional emission surcharge for CO_2, NO_X and PM_{10} due to an older vessel fleet (+ 20%)

Reduction factors 1995-2010 for CO_2, NO_X and PM_{10} taken from INFRAS/IWW 2000

c2) Emissions:

	PM_{10} Emission per means of transport									
	Road				Rail		Aviation		Inland Water	Total Emissions
Country	Passenger cars	Buses and coaches	Lorries and Vans	Motorcycles	Passenger	Freight	Passenger transport	Freight transport	Freight Transport	All transport means
Unit	t PM_{10}	t PM_{10}	t PM_{10}	t PM_{10}	t PM_{10}	t PM_{10}	t PM_{10}	t PM_{10}	t PM_{10}	t PM_{10}
Base year	1995	1995	1995	1995	1995	1995	1995	1995	1995	1995
Albania	76	653	1'936	2	69	14	0.0	0.00	0	2'750
Belarus	1'118	744	4'297	148	2'369	4'366	2.8	0.01	6	13'050
Bosnia-Hercegovina	61	344	479	0	0	0	0.0	0.00	0	883
Bulgaria	1'928	824	7'762	153	1'206	1'669	3.3	0.68	34	13'579
Croatia	832	472	7'298	6	208	378	0.5	0.03	11	9'205
Czech Republic	3'190	2'380	29'734	331	2'764	6'415	2.8	0.31	63	44'879
FYRO Macedonia	341	199	1'505	1	65	54	0.4	0.01	0	2'165
Hungary	2'356	1'020	14'904	47	3'679	3'648	2.5	0.52	68	25'725
Moldova	162	1'319	5'060	4	190	273	0.2	0.01	12	7'020
Poland	9'770	5'354	70'125	559	4'323	11'432	4.7	0.46	41	101'609
Romania	3'122	1'721	13'184	96	5'012	5'251	2.8	0.19	145	28'535
Slovak Republic	1'073	1'566	9'301	67	614	1'569	0.2	0.05	69	14'259
Slovenia	845	231	1'686	2	86	239	0.7	0.15	0	3'090
Ukraine	5'809	6'665	26'412	912	15'590	37'019	3.0	0.94	266	92'676
Total CEI	**30'682**	**23'491**	**193'683**	**2'328**	**36'176**	**72'325**	**24**	**3**	**715**	**359'427**

Table 41 PM_{10} emissions for different means of transport

	NO_X Emissions per means of transport										
	Road				Rail		Aviation			Inland Water	Total
Country	Passenger cars	Buses and coaches	Lorries and Vans	Motorcycles	Passenger	Freight	Passenger transport	Freight transport	LTO only	Water	All means of transport
Unit	t NO_X	t NO_X	t NO_X	t NO_X	t NO_X	t NO_X	t NO_X	t NO_X	t NO_X	t NO_X	t NO_X
Base year	1995	1995	1995	1995	1995	1995	1995	1995	1996	1995	1995
Albania	1'590	3'334	14	9'659	170	43	6	0	2	0	14'815
Belarus	23'305	3'800	984	21'443	3'441	11'026	2'912	14	432	94	67'019
Bosnia-Hercegovina	1'269	1'755	0	2'390	0	0	0	0	0	0	5'414
Bulgaria	40'183	4'208	1'018	38'731	1'702	2'857	3'144	645	223	519	93'006
Croatia	17'339	2'411	39	36'416	505	1'145	564	34	150	163	58'617
Czech Republic	66'503	12'156	2'206	148'369	3'543	6'783	2'805	306	320	954	243'625
FYRO Macedonia	7'103	1'016	5	7'512	145	137	398	7	66	0	16'322
Hungary	49'111	5'213	312	74'372	3'038	2'757	2'563	524	336	1'029	138'919
Moldova	3'373	6'739	27	25'250	460	845	269	15	54	178	37'156
Poland	203'657	27'350	3'724	349'923	7'226	18'521	4'533	444	360	620	615'996
Romania	65'091	8'789	642	65'790	8'704	10'437	2'785	182	252	2'200	164'621
Slovak Republic	22'360	8'002	449	46'414	1'105	2'800	193	61	72	1'039	82'424
Slovenia	17'618	1'180	17	8'411	201	667	706	162	149	0	28'961
Ukraine	121'102	34'047	6'081	131'794	24'461	64'089	2'990	936	397	4'021	389'521
Total CEI	**639'604**	**120'000**	**15'517**	**966'473**	**54'702**	**122'105**	**23'867**	**3'329**	**2'813**	**10'818**	**1'956'417**

Table 42 NO_X-emissions for different means of transport

	CO_2 Emissions per means of transport									
	Road				Rail		Aviation		Inland Water	Total
Country	Passenger cars	Buses and coaches	Lorries and Vans	Motorcycles	Passenger	Freight	Passenger transport	Freight transport	Water	All means of transport
Unit	t CO_2	t CO_2	t CO_2	t CO_2	t CO_2	t CO_2	t CO_2	t CO_2	t CO_2	t CO_2
Base year	1995	1995	1995	1995	1995	1995	1995	1995	1995	1995
Albania	129'687	157'895	517'128	3'365	8'917	2'235	1'104	0	0	820'331
Belarus	1'900'541	179'984	1'147'968	243'141	451'024	905'406	718'704	3'486	4'948	5'555'202
Bosnia-Hercegovina	103'511	83'142	127'929	0	0	0	0	0	0	314'582
Bulgaria	3'276'911	199'296	2'073'553	251'532	271'930	507'136	856'952	175'768	27'268	7'640'347
Croatia	1'414'000	114'208	1'949'627	9'681	51'246	108'639	122'268	7'408	8'556	3'785'634
Czech Republic	5'423'340	575'749	7'943'261	545'115	607'228	2'020'121	728'695	79'459	50'146	17'973'114
FYRO Macedonia	579'241	48'109	402'176	1'117	9'537	12'059	96'628	1'598	0	1'150'464
Hungary	4'004'962	246'906	3'981'655	77'116	739'437	695'904	661'406	135'095	54'089	10'596'570
Moldova	275'047	319'187	1'351'808	6'733	24'168	44'396	62'928	3'486	9'337	2'097'091
Poland	16'608'150	1'295'424	18'733'830	920'360	1'148'360	4'384'092	1'217'657	119'261	32'587	44'459'721
Romania	5'308'199	416'307	3'522'189	158'750	986'241	1'430'493	737'969	48'227	115'580	12'723'955
Slovak Republic	1'823'471	379'021	2'484'874	110'985	197'812	850'302	39'827	12'638	54'610	5'953'540
Slovenia	1'436'721	55'914	450'299	4'083	20'903	97'185	169'381	38'785	0	2'273'271
Ukraine	9'875'827	1'612'637	7'055'836	1'502'919	3'309'495	11'106'817	778'210	243'752	211'296	35'696'788
Total CEI	**52'159'609**	**5'683'778**	**51'742'134**	**3'834'897**	**7'826'297**	**22'164'784**	**6'191'729**	**868'964**	**568'416**	**151'040'609**

Table 43 CO_2-emissions for different means of transport

2.4 Nature and landscape

For the calculation of the external costs for nature and landscape, the sealed and impaired areas are needed, as explained in the methodology chapter. These figures for road, rail and aviation are listed in Table 44, Table 45 and Table 46.

Country	Total sealed area				Additional impaired area			
	Motorways	highways main or national roads	Secondary or regional roads	Other roads	Motorways	highways main or national roads	Secon-dary or regional roads	Other roads
Unit	km2	km2	km2	km2	km2	km2	km2	km2
Albania	0.0	6.8	7.4	13.8	0.0	7.7	6.5	15.7
Belarus	7.2	6.5	17.2	30.8	4.7	7.4	15.1	35.0
Bosnia-Herzegovina	0.0	7.8	7.0	18.5	0.0	8.9	6.2	21.0
Bulgaria	0.0	6.8	7.4	13.8	0.0	7.7	6.5	15.7
Croatia	8.7	62.3	90.1	69.9	5.7	71.2	79.0	79.4
Czech Republic	7.2	6.5	17.2	30.8	4.7	7.4	15.1	35.0
FYRO Macedonia	3.1	1.5	4.9	6.4	2.0	1.7	4.3	7.2
Hungary	8.7	62.3	90.1	69.9	5.7	71.2	79.0	79.4
Moldova	0.0	5.9	11.0	4.0	0.0	6.7	9.6	4.6
Poland	5.7	95.4	219.9	261.6	3.7	109.0	192.9	297.3
Romania	2.6	30.8	99.5	105.9	1.7	35.2	87.3	120.3
Slovak Republic	4.6	6.5	6.6	14.1	3.0	7.4	5.8	16.1
Slovenia	5.0	2.8	5.8	12.9	3.3	3.3	5.1	14.7
Ukraine	0.0	65.3	241.4	0.0	0.0	74.6	211.8	0.0

Table 44 Estimated sealed and impaired area for the road network built after 1950.

Country	Shortcut	10% of single tracks 1)	10% of double or more tracks	Width single track	average width double or more track	additional width, side effects	Total sealed area (10%)*	Total additional impaired area (10%)*
Unit		km	km	m	m	m	km2	km2
Albania	AL	67	0	7.0	13.0	5.0	0.5	0.3
Belarus	BY	382	172	7.0	13.0	5.0	4.9	2.8
Bosnia-Herzegovina	BiH	67	0	7.0	13.0	5.0	0.5	0.3
Bulgaria	BG	67	0	7.0	13.0	5.0	0.5	0.3
Croatia	HR	211	18	7.0	13.0	5.0	1.7	1.1
Czech Republic	CZ	333	97	7.0	13.0	5.0	3.6	2.1
FYRO Macedonia	FYROM	333	97	7.0	13.0	5.0	3.6	2.1
Hungary	HU	664	119	7.0	13.0	5.0	6.2	3.9
Moldova	MD	112	21	7.0	13.0	5.0	1.1	0.7
Poland	PL	1'508	891	7.0	13.0	5.0	22.1	12.0
Romania	RO	841	297	7.0	13.0	5.0	9.7	5.7
Slovak Republic	SK	264	103	7.0	13.0	5.0	3.2	1.8
Slovenia	SLO	87	33	7.0	13.0	5.0	1.0	0.6
Ukraine	UA	1'506	755	7.0	13.0	5.0	20.4	11.3

Table 45 Estimated sealed and impaired area for singles and double railroad tracks in CEI built after 1950..

Country	Shortcut	Number of Airports (with paved runways)		Assumed sealed area [km2] 3)		Assumed additional impaired area [km2] 4)		Total sealed area (10%)*	Total additional impaired area (10%)*
Unit		National 1)	Regional 2)	National	Regional	National	Regional	km2	km2
Albania	AL	1	1	1.5	0.4	0.16	0.04	1.9	0.2
Belarus	BY	2	19	1.5	0.4	0.16	0.04	10.6	1.1
Bosnia-Herzegovina	BiH	0	4	1.5	0.4	0.16	0.04	1.6	0.2
Bulgaria	BG	1	19	1.5	0.4	0.16	0.04	9.1	0.9
Croatia	HR	2	6	1.5	0.4	0.16	0.04	5.4	0.6
Czech Republic	CZ	2	10	1.5	0.4	0.16	0.04	7.0	0.7
FYRO Macedonia	FYROM	0	2	1.5	0.4	0.16	0.04	0.8	0.1
Hungary	HU	2	8	1.5	0.4	0.16	0.04	6.2	0.6
Moldova	MD	1	2	1.5	0.4	0.16	0.04	2.3	0.2
Poland	PL	3	29	1.5	0.4	0.16	0.04	16.1	1.6
Romania	RO	3	10	1.5	0.4	0.16	0.04	8.5	0.9
Slovak Republic	SK	1	3	1.5	0.4	0.16	0.04	2.7	0.3
Slovenia	SLO	1	1	1.5	0.4	0.16	0.04	1.9	0.2
Ukraine	UA	14	50	1.5	0.4	0.16	0.04	41.0	4.2

1) the World Factbook - CIA 2001, a national airport has a runway > 3047m

2) the World Factbook - CIA 2001, a regional airport has a runway > 2438m

3) Assumptions: area of national airports corresponds to the sealed area of the airport Zurich-Kloten multiplied by 1/2
area of regional airports corresponds to the sealed area used in External Costs of Transport, INFRAS & IWW, 2000 multiplied by 1/2

4) Assumption: airport area corresponds to a circle.
The additional impaired area is calculated by taking an additional radius of 50 m resp. 20 m
it corresponds to the impaired area used in External Costs of Transport, INFRAS & IWW, 2000 multiplied by 1/2

Table 46 Estimated sealed and impaired area for airports in CEI built after 1950.

3. DETAILED RESULTS FOR EACH COST CATEGORY

a) Accident costs

Main assumptions:

- The average Risk Value for fatalities in Eastern European countries amounts to 1.5 million -Euro.

- The Risk value for severe injuries amounts to 13% and for slight injuries to 1% of the Risk value for fatalities

- No additional Risk value for relatives and friends is included

- Total costs are allocated to the modes according to the responsibility for the accident.

ACCIDENTS: TOTAL COSTS 1995 BY COUNTRY & TRANSPORT MODE												
		Road						**Rail**		**Aviation**		**Water-borne**
[million Euro / year]		Car	MC	Bus	LDV & HDV	Pass. Total	Freight total	Pass.	Freight	Pass.	Freight	Freight
Albania	120	63.3	26.3	11.5	18.7	101.0	18.7	0.0	0.0	0.0	0.0	0.0
Belarus	810	407.7	13.2	364.5	23.9	785.3	23.9	0.3	0.0	0.4	0.0	0.0
Bos.-Herceg.	42	31.0	8.5	n.a.	2.7	39.5	2.7	0.0	0.0	0.0	0.0	0.0
Bulgaria	675	417.9	8.7	224.2	23.7	650.8	23.7	0.0	0.0	0.5	0.0	0.0
Croatia	592	502.7	13.9	24.1	51.6	540.6	51.6	0.1	0.0	0.1	0.0	0.0
Czech Rep.	3'790	2'010.2	72.8	1'412.1	274.0	3'495.1	274.0	19.3	0.0	1.1	0.0	0.0
FYRO Maced.	118	108.3	3.1	1.5	5.5	112.8	5.5	0.0	0.0	0.0	0.0	0.0
Hungary	2'319	1'863.5	39.2	250.8	143.9	2'153.5	143.9	20.6	0.0	0.7	0.0	0.0
Moldova	93	47.9	19.0	8.2	17.5	75.1	17.5	0.0	0.0	0.0	0.0	0.0
Poland	6'338	4'196.0	111.7	1'625.1	404.3	5'932.8	404.3	0.2	0.0	1.0	0.0	0.0
Romania	1'224	948.5	25.4	198.3	50.4	1'172.2	50.4	0.9	0.0	0.4	0.0	0.0
Slovak Rep.	808	500.5	35.5	212.9	58.3	748.9	58.3	0.3	0.0	0.0	0.0	0.0
Slovenia	900	851.5	11.3	16.9	19.6	879.7	19.6	0.3	0.0	0.3	0.0	0.0
Ukraine	1'924	878.0	48.9	933.8	62.5	1'860.7	62.5	0.8	0.0	0.2	0.0	0.0
CEI 1995	19'753	12'827	437	5'284	1'157	18'548	1'157	43	0	5	0	0

Table 47 Total accident costs.

Nearly all of the external accident costs are due to road transport. Rail, air and inland waterway traffic only comprise 0.2% of total accident costs. It has to be mentioned that aviation related accident costs could only be estimated for fatalities, because data for airborne injuries are not available.

In the CEI Countries, about 65% of external accident costs are caused by cars, followed by 27% for Motorcycle, 7% for trucks and 2.5% for busses.

ACCIDENTS: AVERAGE COSTS 1995 BY COUNTRY & TRANSPORT MODE										
	Average Cost Passenger						Average Cost Freight			
	Road				Rail	Aviation	Road	Rail	Aviation	Water-borne
	Car	MC	Bus	Pass. total						
	Euro / 1000 pkm						Euro / 1000 tkm			
Albania	49.0	2.6	393.2	8.9	0.0	0.1	6.9	0.0	n.a.	n.a.
Belarus	21.5	1.2	172.9	24.2	0.0	0.1	4.0	0.0	0.0	0.0
Bos.-Herceg.	30.1	1.6	n.a.	6.3	n.a.	n.a.	4.0	n.a.	n.a.	n.a.
Bulgaria	12.8	0.7	102.8	13.7	0.0	0.2	2.2	0.0	0.0	0.0
Croatia	35.7	1.9	286.6	25.3	0.1	0.1	5.1	0.0	0.0	0.0
Czech Rep.	41.0	2.0	298.8	38.7	2.4	0.4	6.6	0.0	0.0	0.0
FYRO Maced.	18.8	1.0	150.7	12.8	0.0	0.1	2.6	0.0	0.0	n.a.
Hungary	51.4	2.5	375.1	41.0	3.3	0.3	6.9	0.0	0.0	0.0
Moldova	17.5	0.9	140.5	3.3	0.0	0.0	2.5	0.0	0.0	0.0
Poland	31.9	1.4	203.7	26.8	0.0	0.2	4.1	0.0	0.0	0.0
Romania	17.9	1.0	144.0	14.6	0.1	0.1	2.7	0.0	0.0	0.0
Slovak Rep.	27.6	1.5	221.2	17.4	0.1	0.3	4.5	0.0	0.0	0.0
Slovenia	65.5	3.2	477.7	53.1	0.6	0.4	8.3	0.0	0.0	n.a.
Ukraine	8.9	0.5	71.7	8.7	0.0	0.1	1.7	0.0	0.0	0.0
CEI 1995	27.0	1.2	158.9	21.4	0.3	0.2	4.3	0.0	0.0	0.0

Table 48 Average accident costs.

Average costs estimate the relative external costs in Euro per 1000 pkm or tkm. In the CEI passenger transport, motorcycles have the highest average costs (159 Euro), followed by cars (27 Euro) and busses (1.2 Euro). Travelling by rail or air causes less than 0.2 Euro/ 1000 pkm. Regarding freight transport, the average costs in road transport are about 4.3 Euro / 1000 tkm.

Comparing average road accident costs on country level, the differences between the CEI countries are rather big. The average accident costs for road passenger transport varies from 3.3 Euro/ 1000 pkm in Moldavia up to 53 Euro/ 1000 pkm in Slovenia. This is biased mainly by the different income levels in the Eastern European countries.

b) Noise costs

Main assumptions:

- Linear increase of noise costs with increasing noise volume

- 55dB(A) is considered as level of silence (WTP=0) for Road, Rail and Airborne Transport

- Health costs caused by noise emissions are included as an additional share of WTP

NOISE: TOTAL COSTS 1995 BY COUNTRY & TRANSPORT MODE												
		Road						**Rail**		**Aviation**		**Water-borne**
[million Euro / year]		Car	MC	Bus	LDV & HDV	Pass. Total	Freight total	Pass.	Freight	Pass.	Freight	Freight
Albania	6	0.8	1.0	0.1	3.6	1.8	3.6	0.5	0.2	0.0	0.0	0.0
Belarus	27	8.7	0.8	3.5	6.1	13.1	6.1	4.4	1.6	2.2	0.0	0.0
Bos.-Herceg.	1	0.4	0.3	0.0	0.5	0.7	0.5	0.2	0.0	0.0	0.0	0.0
Bulgaria	41	15.7	1.0	3.9	11.5	20.5	11.5	4.3	2.4	1.6	0.2	0.0
Croatia	20	5.8	0.5	0.1	9.3	6.4	9.3	2.2	0.7	1.0	0.0	0.0
Czech Rep.	300	80.0	8.5	25.7	135.6	114.1	135.6	28.3	13.3	8.1	0.4	0.0
FYRO Maced.	6	2.7	0.2	0.0	2.2	3.0	2.2	0.7	0.2	0.4	0.0	0.0
Hungary	124	41.7	2.6	2.6	48.0	46.8	48.0	13.2	10.6	4.6	0.4	0.0
Moldova	9	1.0	1.1	0.1	5.5	2.2	5.5	0.7	0.2	0.1	0.0	0.0
Poland	407	133.9	10.4	23.7	174.7	168.0	174.7	42.7	18.6	2.9	0.1	0.0
Romania	79	30.1	2.4	2.9	23.1	35.4	23.1	10.7	6.7	3.4	0.1	0.0
Slovak Rep.	76	21.6	4.5	4.2	34.1	30.3	34.1	7.0	3.6	0.5	0.1	0.0
Slovenia	29	15.8	0.6	0.1	5.7	16.6	5.7	3.4	2.1	0.6	0.1	0.0
Ukraine	104	31.2	5.1	15.2	25.8	51.5	25.8	14.5	7.5	4.0	0.6	0.0
CEI 1995	1'228	389.5	38.8	82.0	485.8	510.3	485.8	132.8	67.6	29.4	2.0	0.0

Table 49 Total noise costs.

In 1995 the total noise costs in the 14 CEI countries amount to 1.2 billion Euro, which is about 0.35% of GDP. Two thirds of these costs comprise the WTP for the reduction of noise nuisance; the remaining third stems from increased mortality (cardiac infarctions) due to noise exposure. This share is lower for railways due to a lower share of exposed population in noise classes up from 65 and more dB(A). Road passenger transport comprises 41% and road freight transport 39% of total costs.

NOISE: AVERAGE COSTS 1995 BY COUNTRY & TRANSPORT MODE										
	Average Cost Passenger						**Average Cost Freight**			
	Road				Rail	Aviation	Road	Rail	Aviation	Water-borne
	Car	MC	Bus	Pass. total						
	Euro / 1000 pkm						Euro / 1000 tkm			
Albania	0.6	0.1	2.2	0.2	2.4	3.8	1.3	4.6	n.a.	n.a.
Belarus	0.5	0.1	1.7	0.4	0.3	0.8	1.0	0.1	2.1	0.0
Bos.-Herceg.	0.4	0.1	n.a	0.1	n.a.	n.a.	0.8	n.a.	n.a.	n.a.
Bulgaria	0.5	0.1	1.8	0.4	0.9	0.5	1.1	0.3	1.3	0.0
Croatia	0.4	0.1	1.5	0.3	2.4	2.2	0.9	0.4	5.5	0.0
Czech Rep.	1.6	0.2	5.4	1.3	3.5	3.1	3.3	0.6	7.7	0.0
FYRO Maced.	0.5	0.1	1.7	0.3	11.5	1.1	1.0	1.0	2.8	n.a.
Hungary	1.2	0.2	3.8	0.9	2.1	1.9	2.3	1.3	4.8	0.0
Moldova	0.4	0.1	1.3	0.1	0.7	0.5	0.8	0.1	1.2	0.0
Poland	1.0	0.1	3.0	0.8	2.0	0.7	1.8	0.3	1.7	0.0
Romania	0.6	0.1	2.1	0.4	0.6	1.3	1.3	0.3	3.1	0.0
Slovak Rep.	1.2	0.2	4.4	0.7	1.7	3.3	2.6	0.3	8.3	0.0
Slovenia	1.2	0.2	4.1	1.0	5.8	1.0	2.4	0.7	2.5	n.a.
Ukraine	0.3	0.0	1.2	0.2	0.2	1.4	0.7	0.0	3.6	0.0
CEI 1995	0.8	0.1	2.5	0.6	0.9	1.3	1.8	0.2	3.4	0.0

Table 50 average noise costs.

The average noise costs that a car in the CEI countries produces, amounts 0.8 Euro/1000 pkm. Due to low vehicle kilometres, the average cost for rail passenger traffic are higher and amount 0.94 Euro/1000 pkm. The most favourable means of transport are busses, while motorcycles cause the strongest noise damage. Air transport is not really comparable, because long distance transports reduce the strong noise effects caused by take off and landing of short distance flights.

In freight transport average noise costs are set in relation to tonne kilometre (tkm). Railways have the lowest average costs (0.2 Euro/ 1000 tkm). The average noise costs for Road freight transport amount 1.8 Euro/1000 tkm. Comparison with air freight traffic is problematic, but when taking into account the distortions of long distance flights, planes are far more unfavourable for goods transport than trains and even trucks.

Variations of the country values can be explained by the different exposure levels and as well by variations of per capita income, which affect the WTP:

c) Air pollution costs

AIR POLLUTION: TOTAL COSTS 1995 BY COUNTRY & TRANSPORT MODE												
		Road						**Rail**		**Aviation**		**Water-borne**
[million Euro / year]		Car	MC	Bus	LDV & HDV	Pass. Total	Freight total	Pass.	Freight	Pass.	Freight	Freight
Albania	142	4	34	0	100	38	100	4	1	0	0	0
Belarus	716	63	41	8	236	112	236	129	238	0	0	0
Bos.-Herceg.	70	5	27	0	38	32	38	0	0	0	0	0
Bulgaria	630	91	38	7	359	136	359	56	77	0	0	2
Croatia	320	30	16	0	253	47	253	7	13	0	0	0
Czech Rep.	2'630	201	139	20	1'739	360	1'739	159	368	1	0	4
FYRO Maced.	126	21	11	0	87	32	87	4	3	0	0	0
Hungary	1'698	177	67	3	980	247	980	233	231	2	0	5
Moldova	113	3	21	0	81	24	81	3	4	0	0	0
Poland	5'061	558	264	28	3'456	850	3'456	206	544	2	0	2
Romania	1'613	188	97	5	743	291	743	278	292	1	0	9
Slovak Rep.	738	63	81	4	478	147	478	31	78	0	0	4
Slovenia	420	122	31	0	224	153	224	11	31	1	0	0
Ukraine	2'033	138	147	20	582	306	582	337	802	0	0	6
CEI 1995	16'310	1'664	1'014	96	9'355	2'775	9'355	1'457	2'682	8	1	32

Table 51 Total air pollution costs.

AIR POLLUTION: AVERAGE COSTS 1995 BY COUNTRY & TRANSPORT MODE										
	Average Cost Passenger						**Average Cost Freight**			
	Road				Rail	Aviation	Road	Rail	Aviation	Water-borne
	Car	MC	Bus	Pass. total						
	Euro / 1000 pkm						Euro / 1000 tkm			
Albania	3.2	3.4	3.6	3.4	18.0	0.4	37.0	13.5	n.a.	n.a.
Belarus	3.3	3.6	3.9	3.5	10.3	0.2	39.2	9.3	1.0	2.6
Bos.-Herceg.	4.7	5.1	n.a.	5.1	n.a.	n.a.	56.3	n.a.	n.a.	n.a.
Bulgaria	2.8	3.0	3.2	2.9	11.9	0.1	33.1	9.0	0.5	2.2
Croatia	2.1	2.3	2.4	2.2	7.6	0.2	24.8	6.6	0.8	1.7
Czech Rep.	4.1	3.8	4.1	4.0	19.8	0.4	41.8	16.2	1.9	2.9
FYRO Maced.	3.6	3.8	4.1	3.6	57.2	0.3	41.3	18.2	1.4	n.a.
Hungary	4.9	4.3	4.7	4.7	37.4	0.7	47.0	27.5	3.7	3.4
Moldova	1.1	1.0	1.1	1.0	2.9	0.2	11.5	1.4	0.8	0.8
Poland	4.2	3.2	3.5	3.8	9.8	0.6	35.2	8.0	2.9	2.5
Romania	3.6	3.7	4.0	3.6	14.8	0.3	40.3	12.1	1.7	2.8
Slovak Rep.	3.5	3.4	3.7	3.4	7.3	0.7	36.7	5.7	3.5	2.6
Slovenia	9.4	8.7	9.4	9.2	18.9	1.0	94.8	10.9	5.2	n.a.
Ukraine	1.4	1.4	1.6	1.4	5.3	0.1	15.7	4.1	0.8	1.1
CEI 1995	3.5	2.8	2.9	3.2	10.3	0.4	34.5	7.2	1.9	2.1

Table 52 Average air pollution costs

d) Costs of climate change

CLIMATE CHANGE: TOTAL COSTS 1995 BY COUNTRY & TRANSPORT MODE												
		Road						**Rail**		**Aviation**		**Water-borne**
[million Euro / year]		Car	MC	Bus	LDV & HDV	Pass. Total	Freight total	Pass.	Freight	Pass.	Freight	Freight
Albania	7	1.0	1.3	0.0	4.1	2.3	4.1	0.1	0.0	0.0	0.0	0.0
Belarus	44	15.2	1.4	1.9	9.2	18.6	9.2	3.6	7.2	5.7	0.0	0.0
Bos.-Herceg.	3	0.8	0.7	0.0	1.0	1.5	1.0	0.0	0.0	0.0	0.0	0.0
Bulgaria	61	26.2	1.6	2.0	16.6	29.8	16.6	2.2	4.1	6.9	1.4	0.2
Croatia	30	11.3	0.9	0.1	15.6	12.3	15.6	0.4	0.9	1.0	0.1	0.1
Czech Rep.	144	43.4	4.6	4.4	63.5	52.4	63.5	4.9	16.2	5.8	0.6	0.4
FYRO Maced.	9	4.6	0.4	0.0	3.2	5.0	3.2	0.1	0.1	0.8	0.0	0.0
Hungary	85	32.0	2.0	0.6	31.9	34.6	31.9	5.9	5.6	5.3	1.1	0.4
Moldova	17	2.2	2.6	0.1	10.8	4.8	10.8	0.2	0.4	0.5	0.0	0.1
Poland	356	132.9	10.4	7.4	149.9	150.6	149.9	9.2	35.1	9.7	1.0	0.3
Romania	102	42.5	3.3	1.3	28.2	47.1	28.2	7.9	11.4	5.9	0.4	0.9
Slovak Rep.	48	14.6	3.0	0.9	19.9	18.5	19.9	1.6	6.8	0.3	0.1	0.4
Slovenia	18	11.5	0.4	0.0	3.6	12.0	3.6	0.2	0.8	1.4	0.3	0.0
Ukraine	286	79.0	12.9	12.0	56.4	103.9	56.4	26.5	88.9	6.2	2.0	1.7
CEI 1995	1'208	417.3	45.5	30.7	413.9	493.4	413.9	62.6	177.3	49.5	7.0	4.5

Table 53 Total costs of climate change.

CLIMATE CHANGE: AVERAGE COSTS 1995 BY COUNTRY & TRANSPORT MODE										
	Average Cost Passenger						**Average Cost Freight**			
	Road				Rail	Aviation	Road	Rail	Aviation	Water-borne
	Car	MC	Bus	Pass. total						
	Euro / 1000 pkm						Euro / 1000 tkm			
Albania	0.8	0.1	0.9	0.2	0.4	2.2	1.5	0.3	n.a.	n.a.
Belarus	0.8	0.1	0.9	0.6	0.3	2.2	1.5	0.3	11.6	0.3
Bos.-Herceg.	0.8	0.1	n.a	0.2	n.a.	n.a.	1.5	n.a.	n.a.	n.a.
Bulgaria	0.8	0.1	0.9	0.6	0.5	2.2	1.5	0.5	11.6	0.3
Croatia	0.8	0.1	0.9	0.6	0.4	2.2	1.5	0.4	11.6	0.3
Czech Rep.	0.9	0.1	0.9	0.6	0.6	2.2	1.5	0.7	11.6	0.3
FYRO Maced.	0.8	0.1	0.9	0.6	1.2	2.2	1.5	0.6	11.6	n.a.
Hungary	0.9	0.1	0.9	0.7	1.0	2.2	1.5	0.7	11.6	0.3
Moldova	0.8	0.1	0.9	0.2	0.2	2.2	1.5	0.1	11.6	0.3
Poland	1.0	0.1	0.9	0.7	0.4	2.2	1.5	0.5	11.6	0.3
Romania	0.8	0.1	0.9	0.6	0.4	2.2	1.5	0.5	11.6	0.3
Slovak Rep.	0.8	0.1	0.9	0.4	0.4	2.2	1.5	0.5	11.6	0.3
Slovenia	0.9	0.1	0.9	0.7	0.3	2.2	1.5	0.3	11.6	n.a.
Ukraine	0.8	0.1	0.9	0.5	0.4	2.2	1.5	0.5	11.6	0.3
CEI 1995	0.9	0.1	0.9	0.6	0.4	2.2	1.5	0.5	11.6	0.3

Table 54 Average costs of climate change.

e) Costs of nature & landscape

NATURE & LANDSCAPE: TOTAL COSTS 1995 BY COUNTRY & TRANSPORT MODE												
		Road						**Rail**		**Aviation**		**Water-borne**
[million Euro / year]		Car	MC	Bus	LDV & HDV	Pass. Total	Freight total	Pass.	Freight	Pass.	Freight	Freight
Albania	9	1	2	0	5	3	5	0	0	0	0	0
Belarus	33	16	2	2	9	19	9	1	0	3	0	0
Bos.-Herceg.	5	2	2	0	2	3	2	0	0	0	0	0
Bulgaria	17	8	1	0	5	9	5	0	0	2	0	0
Croatia	98	39	4	0	52	43	52	0	0	1	0	0
Czech Rep.	88	30	4	2	43	36	43	2	1	5	1	0
FYRO Maced.	8	4	0	0	2	4	2	1	0	0	0	0
Hungary	226	106	8	2	102	116	102	3	1	3	1	0
Moldova	4	0	1	0	2	1	2	0	0	0	0	0
Poland	447	192	18	9	209	219	209	7	4	7	1	0
Romania	116	63	6	2	40	70	40	2	1	2	0	0
Slovak Rep.	28	9	2	0	12	12	12	1	0	1	0	0
Slovenia	37	25	1	0	8	27	8	1	0	1	0	0
Ukraine	84	36	7	4	25	48	25	3	2	5	2	0
CEI 1995	1'199	533	57	21	517	611	517	22	11	33	5	0

Table 55 Again road passenger and freight transport is responsible for the majority of the external costs of nature and landscape.

NATURE & LANDSCAPE: AVERAGE COSTS 1995 BY COUNTRY & TRANSPORT MODE										
	Average Cost Passenger						**Average Cost Freight**			
	Road				Rail	Aviation	Road	Rail	Aviation	Water-borne
	Car	MC	Bus	Pass. total						
	Euro / 1000 pkm						Euro / 1000 tkm			
Albania	1.0	0.2	1.0	0.3	0.5	94.4	1.9	0.5	n.a.	0.0
Belarus	0.8	0.2	0.8	0.6	0.1	1.2	1.5	0.0	6.4	0.0
Bos.-Herceg.	1.6	0.3	n.a.	0.5	0.0	n.a.	2.9	0.0	n.a.	0.0
Bulgaria	0.2	0.0	0.2	0.2	0.0	0.8	0.4	0.0	4.0	0.0
Croatia	2.8	0.5	2.6	2.0	0.5	3.1	5.1	0.1	16.5	0.0
Czech Rep.	0.6	0.1	0.5	0.4	0.3	2.0	1.0	0.0	10.4	0.0
FYRO Maced.	0.6	0.1	0.6	0.5	15.0	0.6	1.2	1.3	3.3	0.0
Hungary	2.9	0.5	2.4	2.2	0.5	1.3	4.9	0.1	6.9	0.0
Moldova	0.2	0.0	0.2	0.0	0.1	1.1	0.3	0.0	5.7	0.0
Poland	1.5	0.2	1.1	1.0	0.3	1.6	2.1	0.1	8.2	0.0
Romania	1.2	0.2	1.1	0.9	0.1	0.9	2.2	0.0	4.7	0.0
Slovak Rep.	0.5	0.1	0.5	0.3	0.3	7.1	0.9	0.0	37.2	0.0
Slovenia	2.0	0.3	1.6	1.6	1.0	2.1	3.3	0.1	11.0	0.0
Ukraine	0.4	0.1	0.3	0.2	0.0	1.8	0.7	0.0	9.7	0.0
CEI 1995	1.1	0.2	0.6	0.7	0.2	1.5	1.9	0.0	8.2	0.0

Table 56 Average costs of nature and landscape.

4. COUNTRY TABLES

Total Costs 1995 - Albania

[Million Euro / Year]	Road						Rail		Aviation		Water Borne	Total 1995
	Car	Bus	MC	LDV & HDV	Pass. Total	Feight Total	Pass.	Freight	Pass.	Freight	Freight	
Accidents	63.3	26.3	11.5	18.7	101.0	18.7	0.0	0.0	0.0	0.0	0.0	119.7
Noise	0.8	1.0	0.1	3.6	1.8	3.6	0.5	0.2	0.0	0.0	0.0	6.2
Air Pollution	4.2	33.8	0.1	100.1	38.1	100.1	3.6	0.7	0.0	0.0	0.0	142.5
Climate Change	1.0	1.3	0.0	4.1	2.3	4.1	0.1	0.0	0.0	0.0	0.0	6.6
Nature & Landscape	1.3	2.0	0.0	5.1	3.3	5.1	0.1	0.0	0.4	0.0	0.0	9.0
Total 1995	70.6	64.2	11.7	131.8	146.5	131.8	4.2	1.0	0.4	0.0	0.0	283.9

Average Costs 1995 - Albania

	Average Costs Passenger							Average Costs Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water Borne	Overall
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	49.0	2.6	393.2	8.9	0.0	0.1	453.8	6.9	0.0	n.a.	n.a.	6.9
Noise	0.6	0.1	2.2	0.2	2.4	3.8	9.2	1.3	4.6	n.a.	n.a.	5.9
Air Pollution	3.2	3.4	3.6	3.4	18.0	0.4	32.0	37.0	13.5	n.a.	n.a.	n.a.
Climate Change	0.8	0.1	0.9	0.2	0.4	2.2	4.6	1.5	0.3	n.a.	n.a.	1.9
Nature & Landscape	1.0	0.2	1.0	0.3	0.5	94.4	97.4	1.9	0.5	n.a.	0.0	n.a.
Total 1995	54.7	6.4	400.9	13.0	21.3	100.8	597.1	48.7	18.9	n.a.	n.a.	n.a.

Total Costs 1995 - Belarus

[Million Euro / Year]	Road						Rail		Aviation		Water Borne	Total 1995
	Car	Bus	MC	LDV & HDV	Pass. Total	Feight Total	Pass.	Freight	Pass.	Freight	Freight	
Accidents	407.7	13.2	364.5	23.9	785.3	23.9	0.3	0.0	0.4	0.0	0.0	810.0
Noise	8.7	0.8	3.5	6.1	13.1	6.1	4.4	1.6	2.2	0.0	0.0	27.3
Air Pollution	63.3	40.8	8.1	235.6	112.2	235.6	128.9	238.2	0.5	0.0	0.3	715.7
Climate Change	15.2	1.4	1.9	9.2	18.6	9.2	3.6	7.2	5.7	0.0	0.0	44.4
Nature & Landscape	23.6	2.7	2.4	13.7	28.6	13.7	1.2	0.5	3.2	0.0	0.0	47.3
Total 1995	518.4	58.9	380.5	288.5	957.8	288.5	138.5	247.5	12.0	0.1	0.4	1'644.7

Average Costs 1995 - Belarus

	Average Costs Passenger							Average Costs Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water Borne	Overall
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	21.5	1.2	172.9	24.2	0.0	0.1	220.0	4.0	0.0	0.0	0.0	4.0
Noise	0.5	0.1	1.7	0.4	0.3	0.8	3.8	1.0	0.1	2.1	0.0	3.2
Air Pollution	3.3	3.6	3.9	3.5	10.3	0.2	24.7	39.2	9.3	1.0	2.6	52.1
Climate Change	0.8	0.1	0.9	0.6	0.3	2.2	4.9	1.5	0.3	11.6	0.3	13.7
Nature & Landscape	1.2	0.2	1.1	0.9	0.1	1.2	4.8	2.3	0.0	6.4	0.0	8.7
Total 1995	27.4	5.2	180.5	29.6	11.1	4.6	258.3	48.0	9.7	21.1	2.9	81.7

Total Costs 1995 - Bos.-Herceg.												
	Road						**Rail**		**Aviation**		**Water Borne**	**Total 1995**
[Million Euro / Year]	Car	Bus	MC	LDV & HDV	Pass. Total	Feight Total	Pass.	Freight	Pass.	Freight	Freight	
Accidents	31.0	8.5	n.a.	2.7	39.5	2.7	0.0	0.0	0.0	0.0	0.0	42.2
Noise	0.4	0.3	0.0	0.5	0.7	0.5	0.2	0.0	0.0	0.0	0.0	1.4
Air Pollution	4.8	27.0	0.0	37.7	31.9	37.7	0.0	0.0	0.0	0.0	0.0	69.6
Climate Change	0.8	0.7	0.0	1.0	1.5	1.0	0.0	0.0	0.0	0.0	0.0	2.5
Nature & Landscape	1.6	1.6	0.0	1.9	3.2	1.9	0.0	0.0	0.0	0.0	0.0	5.1
Total 1995	38.7	38.1	0.0	43.9	76.8	43.9	0.2	0.0	0.0	0.0	0.0	120.8

Average Costs 1995 - Bos.-Herceg.												
	Average Costs Passenger							**Average Costs Freight**				
	Road				**Rail**	**Aviation**	**Overall**	**Road**	**Rail**	**Aviation**	**Water Borne**	**Overall**
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	30.1	1.6	n.a.	6.3	n.a.	n.a.	38.0	4.0	n.a.	n.a.	n.a.	4.0
Noise	0.4	0.1	n.a	0.1	n.a.	n.a.	0.5	0.8	n.a.	n.a.	n.a.	0.8
Air Pollution	4.7	5.1	n.a.	5.1	n.a.	n.a.	n.a.	56.3	n.a.	n.a.	n.a.	n.a.
Climate Change	0.8	0.1	n.a	0.2	n.a.	n.a.	1.2	1.5	n.a.	n.a.	n.a.	1.5
Nature & Landscape	1.6	0.3	n.a.	0.5	0.0	n.a.	n.a.	2.9	0.0	n.a.	0.0	n.a.
Total 1995	37.5	7.2	n.a.	12.2	n.a.	n.a.	n.a.	65.5	n.a.	n.a.	n.a.	n.a.

Total Costs 1995 - Bulgaria												
	Road						**Rail**		**Aviation**		**Water Borne**	**Total 1995**
[Million Euro / Year]	Car	Bus	MC	LDV & HDV	Pass. Total	Feight Total	Pass.	Freight	Pass.	Freight	Freight	
Accidents	417.9	8.7	224.2	23.7	650.8	23.7	0.0	0.0	0.5	0.0	0.0	674.9
Noise	15.7	1.0	3.9	11.5	20.5	11.5	4.3	2.4	1.6	0.2	0.0	40.5
Air Pollution	90.8	38.1	7.1	359.4	136.0	359.4	55.6	77.0	0.3	0.1	1.6	630.0
Climate Change	26.2	1.6	2.0	16.6	29.8	16.6	2.2	4.1	6.9	1.4	0.2	61.1
Nature & Landscape	16.9	1.2	1.0	10.3	19.2	10.3	0.9	0.5	2.4	0.5	0.0	33.6
Total 1995	567.6	50.6	238.2	421.4	856.3	421.4	63.0	83.9	11.6	2.1	1.8	1'440.2

Average Costs 1995 - Bulgaria												
	Average Costs Passenger							**Average Costs Freight**				
	Road				**Rail**	**Aviation**	**Overall**	**Road**	**Rail**	**Aviation**	**Water Borne**	**Overall**
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	12.8	0.7	102.8	13.7	0.0	0.2	130.2	2.2	0.0	0.0	0.0	2.2
Noise	0.5	0.1	1.8	0.4	0.9	0.5	4.2	1.1	0.3	1.3	0.0	2.6
Air Pollution	2.8	3.0	3.2	2.9	11.9	0.1	23.9	33.1	9.0	0.5	2.2	44.8
Climate Change	0.8	0.1	0.9	0.6	0.5	2.2	5.2	1.5	0.5	11.6	0.3	13.9
Nature & Landscape	0.5	0.1	0.5	0.4	0.2	0.8	2.4	0.9	0.1	4.0	0.0	5.0
Total 1995	17.4	4.0	109.2	18.1	13.4	3.7	165.8	38.8	9.8	17.5	2.5	68.6

Total Costs 1995 - Croatia

	Road						Rail		Aviation		Water Borne	Total 1995
[Million Euro / Year]	Car	Bus	MC	LDV & HDV	Pass. Total	Feight Total	Pass.	Freight	Pass.	Freight	Freight	
Accidents	502.7	13.9	24.1	51.6	540.6	51.6	0.1	0.0	0.1	0.0	0.0	592.4
Noise	5.8	0.5	0.1	9.3	6.4	9.3	2.2	0.7	1.0	0.0	0.0	19.6
Air Pollution	30.1	16.4	0.2	253.1	46.7	253.1	7.2	13.0	0.1	0.0	0.4	320.4
Climate Change	11.3	0.9	0.1	15.6	12.3	15.6	0.4	0.9	1.0	0.1	0.1	30.3
Nature & Landscape	8.3	0.8	0.0	11.1	9.2	11.1	0.4	0.1	1.4	0.1	0.0	22.3
Total 1995	558.2	32.4	24.5	340.6	615.1	340.6	10.4	14.7	3.5	0.2	0.5	984.9

Average Costs 1995 - Croatia

	Average Costs Passenger							Average Costs Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water Borne	Overall
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	35.7	1.9	286.6	25.3	0.1	0.1	349.8	5.1	0.0	0.0	0.0	5.1
Noise	0.4	0.1	1.5	0.3	2.4	2.2	6.9	0.9	0.4	5.5	0.0	6.8
Air Pollution	2.1	2.3	2.4	2.2	7.6	0.2	16.8	24.8	6.6	0.8	1.7	33.9
Climate Change	0.8	0.1	0.9	0.6	0.4	2.2	5.1	1.5	0.4	11.6	0.3	13.9
Nature & Landscape	0.6	0.1	0.5	0.4	0.5	3.1	5.3	1.1	0.1	16.5	0.0	17.6
Total 1995	39.7	4.5	292.0	28.8	11.0	7.8	383.7	33.4	7.5	34.4	2.0	77.2

Total Costs 1995 - Czech Rep.

	Road						Rail		Aviation		Water Borne	Total 1995
[Million Euro / Year]	Car	Bus	MC	LDV & HDV	Pass. Total	Feight Total	Pass.	Freight	Pass.	Freight	Freight	
Accidents	2'010.2	72.8	1'412.1	274.0	3'495.1	274.0	19.3	0.0	1.1	0.0	0.0	3'789.5
Noise	80.0	8.5	25.7	135.6	114.1	135.6	28.3	13.3	8.1	0.4	0.0	299.8
Air Pollution	201.2	139.2	19.5	1'738.6	359.9	1'738.6	158.7	367.8	1.0	0.1	3.9	2'630.0
Climate Change	43.4	4.6	4.4	63.5	52.4	63.5	4.9	16.2	5.8	0.6	0.4	143.8
Nature & Landscape	46.0	5.8	3.7	64.9	55.5	64.9	4.7	2.2	5.2	0.6	0.0	133.0
Total 1995	2'380.7	231.0	1'465.4	2'276.7	4'077.1	2'276.7	215.7	399.4	21.2	1.7	4.3	6'996.1

Average Costs 1995 - Czech Rep.

	Average Costs Passenger							Average Costs Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water Borne	Overall
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	41.0	2.0	298.8	38.7	2.4	0.4	383.3	6.6	0.0	0.0	0.0	6.6
Noise	1.6	0.2	5.4	1.3	3.5	3.1	15.2	3.3	0.6	7.7	0.0	11.5
Air Pollution	4.1	3.8	4.1	4.0	19.8	0.4	36.2	41.8	16.2	1.9	2.9	62.9
Climate Change	0.9	0.1	0.9	0.6	0.6	2.2	5.3	1.5	0.7	11.6	0.3	14.2
Nature & Landscape	0.9	0.2	0.8	0.6	0.6	2.0	5.0	1.6	0.1	10.4	0.0	12.0
Total 1995	48.5	6.3	310.0	45.2	26.9	8.0	445.0	54.7	17.6	31.6	3.2	107.2

Total Costs 1995 - FYRO Maced.

[Million Euro / Year]	Road: Car	Road: Bus	Road: MC	Road: LDV & HDV	Road: Pass. Total	Road: Feight Total	Rail: Pass.	Rail: Freight	Aviation: Pass.	Aviation: Freight	Water Borne Freight	Total 1995
Accidents	108.3	3.1	1.5	5.5	112.8	5.5	0.0	0.0	0.0	0.0	0.0	118.4
Noise	2.7	0.2	0.0	2.2	3.0	2.2	0.7	0.2	0.4	0.0	0.0	6.5
Air Pollution	20.6	11.5	0.0	86.9	32.1	86.9	3.7	3.1	0.1	0.0	0.0	125.9
Climate Change	4.6	0.4	0.0	3.2	5.0	3.2	0.1	0.1	0.8	0.0	0.0	9.2
Nature & Landscape	3.7	0.4	0.0	2.5	4.1	2.5	0.1	0.0	0.2	0.0	0.0	6.9
Total 1995	140.0	15.5	1.5	100.3	157.0	100.3	4.7	3.4	1.5	0.0	0.0	266.9

Average Costs 1995 - FYRO Maced.

	Average Costs Passenger							Average Costs Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water Borne	Overall
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	18.8	1.0	150.7	12.8	0.0	0.1	183.4	2.6	0.0	0.0	n.a.	2.6
Noise	0.5	0.1	1.7	0.3	11.5	1.1	15.3	1.0	1.0	2.8	n.a.	4.8
Air Pollution	3.6	3.8	4.1	3.6	57.2	0.3	72.5	41.3	18.2	1.4	n.a.	n.a.
Climate Change	0.8	0.1	0.9	0.6	1.2	2.2	5.8	1.5	0.6	11.6	n.a.	13.7
Nature & Landscape	0.6	0.1	0.6	0.5	2.1	0.6	4.6	1.2	0.2	3.3	0.0	4.6
Total 1995	24.3	5.1	158.0	17.8	72.0	4.3	281.5	47.6	19.9	19.1	n.a.	n.a.

Total Costs 1995 - Hungary

[Million Euro / Year]	Road: Car	Road: Bus	Road: MC	Road: LDV & HDV	Road: Pass. Total	Road: Feight Total	Rail: Pass.	Rail: Freight	Aviation: Pass.	Aviation: Freight	Water Borne Freight	Total 1995
Accidents	1'863.5	39.2	250.8	143.9	2'153.5	143.9	20.6	0.0	0.7	0.0	0.0	2'318.6
Noise	41.7	2.6	2.6	48.0	46.8	48.0	13.2	10.6	4.6	0.4	0.0	123.6
Air Pollution	176.9	67.2	3.1	980.2	247.2	980.2	232.9	230.8	1.7	0.3	4.9	1'698.1
Climate Change	32.0	2.0	0.6	31.9	34.6	31.9	5.9	5.6	5.3	1.1	0.4	84.8
Nature & Landscape	106.5	7.9	1.6	102.1	116.0	102.1	3.3	0.9	3.1	0.6	0.0	226.0
Total 1995	2'220.6	118.8	258.7	1'306.0	2'598.1	1'306.0	275.8	247.8	15.4	2.5	5.3	4'451.0

Average Costs 1995 - Hungary

	Average Costs Passenger							Average Costs Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water Borne	Overall
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	51.4	2.5	375.1	41.0	3.3	0.3	473.6	6.9	0.0	0.0	0.0	6.9
Noise	1.2	0.2	3.8	0.9	2.1	1.9	10.1	2.3	1.3	4.8	0.0	8.4
Air Pollution	4.9	4.3	4.7	4.7	37.4	0.7	56.7	47.0	27.5	3.7	3.4	81.5
Climate Change	0.9	0.1	0.9	0.7	1.0	2.2	5.8	1.5	0.7	11.6	0.3	14.1
Nature & Landscape	2.9	0.5	2.4	2.2	0.5	1.3	9.9	4.9	0.1	6.9	0.0	11.9
Total 1995	61.3	7.6	386.9	49.5	44.3	6.4	556.0	62.6	29.5	26.9	3.7	122.8

Total Costs 1995 - Moldova

	Road						**Rail**		**Aviation**		**Water Borne**	**Total 1995**
[Million Euro / Year]	Car	Bus	MC	LDV & HDV	Pass. Total	Feight Total	Pass.	Freight	Pass.	Freight	Freight	
Accidents	47.9	19.0	8.2	17.5	75.1	17.5	0.0	0.0	0.0	0.0	0.0	92.7
Noise	1.0	1.1	0.1	5.5	2.2	5.5	0.7	0.2	0.1	0.0	0.0	8.6
Air Pollution	2.9	21.2	0.1	81.1	24.1	81.1	3.0	4.3	0.0	0.0	0.2	112.7
Climate Change	2.2	2.6	0.1	10.8	4.8	10.8	0.2	0.4	0.5	0.0	0.1	16.8
Nature & Landscape	0.5	0.6	0.0	2.2	1.1	2.2	0.1	0.1	0.2	0.0	0.0	3.8
Total 1995	54.5	44.5	8.4	117.1	107.3	117.1	4.0	4.9	0.9	0.0	0.3	234.6

Average Costs 1995 - Moldova

	Average Costs Passenger							**Average Costs Freight**				
	Road				**Rail**	**Aviation**	**Overall**	**Road**	**Rail**	**Aviation**	**Water Borne**	**Overall**
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	17.5	0.9	140.5	3.3	0.0	0.0	162.3	2.5	0.0	0.0	0.0	2.5
Noise	0.4	0.1	1.3	0.1	0.7	0.5	3.0	0.8	0.1	1.2	0.0	2.0
Air Pollution	1.1	1.0	1.1	1.0	2.9	0.2	7.4	11.5	1.4	0.8	0.8	14.5
Climate Change	0.8	0.1	0.9	0.2	0.2	2.2	4.5	1.5	0.1	11.6	0.3	13.6
Nature & Landscape	0.2	0.0	0.2	0.0	0.1	1.1	1.6	0.3	0.0	5.7	0.0	6.0
Total 1995	19.9	2.2	144.0	4.7	4.0	4.0	178.7	16.5	1.6	19.3	1.1	38.6

Total Costs 1995 - Poland

	Road						**Rail**		**Aviation**		**Water Borne**	**Total 1995**
[Million Euro / Year]	Car	Bus	MC	LDV & HDV	Pass. Total	Feight Total	Pass.	Freight	Pass.	Freight	Freight	
Accidents	4'196.0	111.7	1'625.1	404.3	5'932.8	404.3	0.2	0.0	1.0	0.0	0.0	6'338.3
Noise	133.9	10.4	23.7	174.7	168.0	174.7	42.7	18.6	2.9	0.1	0.0	407.1
Air Pollution	557.9	264.1	28.0	3'455.6	850.0	3'455.6	206.0	544.4	2.5	0.2	2.2	5'060.9
Climate Change	132.9	10.4	7.4	149.9	150.6	149.9	9.2	35.1	9.7	1.0	0.3	355.7
Nature & Landscape	192.2	18.0	8.5	209.1	218.6	209.1	7.1	4.4	6.9	0.7	0.0	446.8
Total 1995	5'212.7	414.6	1'692.7	4'393.6	7'320.0	4'393.6	265.1	602.5	23.0	2.0	2.5	12'608.7

Average Costs 1995 - Poland

	Average Costs Passenger							**Average Costs Freight**				
	Road				**Rail**	**Aviation**	**Overall**	**Road**	**Rail**	**Aviation**	**Water Borne**	**Overall**
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	31.9	1.4	203.7	26.8	0.0	0.2	264.0	4.1	0.0	0.0	0.0	4.1
Noise	1.0	0.1	3.0	0.8	2.0	0.7	7.6	1.8	0.3	1.7	0.0	3.7
Air Pollution	4.2	3.2	3.5	3.8	9.8	0.6	25.2	35.2	8.0	2.9	2.5	48.7
Climate Change	1.0	0.1	0.9	0.7	0.4	2.2	5.4	1.5	0.5	11.6	0.3	14.0
Nature & Landscape	1.5	0.2	1.1	1.0	0.3	1.6	5.6	2.1	0.1	8.2	0.0	10.4
Total 1995	39.6	5.1	212.1	33.1	12.6	5.2	307.7	44.8	8.8	24.4	2.9	80.9

Total Costs 1995 - Romania												
	Road						Rail		Aviation		Water Borne	Total 1995
[Million Euro / Year]	Car	Bus	MC	LDV & HDV	Pass. Total	Feight Total	Pass.	Freight	Pass.	Freight	Freight	
Accidents	948.5	25.4	198.3	50.4	1'172.2	50.4	0.9	0.0	0.4	0.0	0.0	1'223.9
Noise	30.1	2.4	2.9	23.1	35.4	23.1	10.7	6.7	3.4	0.1	0.0	79.4
Air Pollution	188.2	97.0	5.5	742.8	290.6	742.8	278.3	291.9	0.8	0.1	8.6	1'613.1
Climate Change	42.5	3.3	1.3	28.2	47.1	28.2	7.9	11.4	5.9	0.4	0.9	101.8
Nature & Landscape	62.8	5.9	1.5	40.2	70.2	40.2	2.3	1.2	2.4	0.2	0.0	116.5
Total 1995	1'272.1	134.0	209.4	884.7	1'615.5	884.7	300.2	311.2	12.9	0.7	9.5	3'134.7

Average Costs 1995 - Romania												
	Average Costs Passenger							Average Costs Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water Borne	Overall
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	17.9	1.0	144.0	14.6	0.1	0.1	177.7	2.7	0.0	0.0	0.0	2.7
Noise	0.6	0.1	2.1	0.4	0.6	1.3	5.0	1.3	0.3	3.1	0.0	4.7
Air Pollution	3.6	3.7	4.0	3.6	14.8	0.3	29.9	40.3	12.1	1.7	2.8	56.8
Climate Change	0.8	0.1	0.9	0.6	0.4	2.2	5.1	1.5	0.5	11.6	0.3	13.9
Nature & Landscape	1.2	0.2	1.1	0.9	0.1	0.9	4.4	2.2	0.0	4.7	0.0	7.0
Total 1995	24.1	5.1	152.1	20.1	15.9	4.8	222.1	48.0	12.9	21.2	3.1	85.2

Total Costs 1995 - Slovak Rep.												
	Road						Rail		Aviation		Water Borne	Total 1995
[Million Euro / Year]	Car	Bus	MC	LDV & HDV	Pass. Total	Feight Total	Pass.	Freight	Pass.	Freight	Freight	
Accidents	500.5	35.5	212.9	58.3	748.9	58.3	0.3	0.0	0.0	0.0	0.0	807.6
Noise	21.6	4.5	4.2	34.1	30.3	34.1	7.0	3.6	0.5	0.1	0.0	75.6
Air Pollution	63.0	80.6	3.5	478.1	147.1	478.1	30.6	78.3	0.1	0.0	3.9	738.2
Climate Change	14.6	3.0	0.9	19.9	18.5	19.9	1.6	6.8	0.3	0.1	0.4	47.6
Nature & Landscape	9.4	2.3	0.5	12.3	12.2	12.3	1.4	0.4	1.0	0.3	0.0	27.6
Total 1995	609.1	126.0	222.0	602.7	957.0	602.7	40.9	89.1	1.9	0.5	4.3	1'696.5

Average Costs 1995 - Slovak Rep.												
	Average Costs Passenger							Average Costs Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water Borne	Overall
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	27.6	1.5	221.2	17.4	0.1	0.3	268.0	4.5	0.0	0.0	0.0	4.5
Noise	1.2	0.2	4.4	0.7	1.7	3.3	11.4	2.6	0.3	8.3	0.0	11.2
Air Pollution	3.5	3.4	3.7	3.4	7.3	0.7	21.9	36.7	5.7	3.5	2.6	48.6
Climate Change	0.8	0.1	0.9	0.4	0.4	2.2	4.9	1.5	0.5	11.6	0.3	13.9
Nature & Landscape	0.5	0.1	0.5	0.3	0.3	7.1	8.8	0.9	0.0	37.2	0.0	38.1
Total 1995	33.6	5.3	230.7	22.2	9.7	13.5	314.9	46.3	6.5	60.6	2.9	116.3

Total Costs 1995 - Slovenia												
	Road						Rail		Aviation		Water Borne	Total 1995
[Million Euro / Year]	Car	Bus	MC	LDV & HDV	Pass. Total	Feight Total	Pass.	Freight	Pass.	Freight	Freight	
Accidents	851.5	11.3	16.9	19.6	879.7	19.6	0.3	0.0	0.3	0.0	0.0	899.9
Noise	15.8	0.6	0.1	5.7	16.6	5.7	3.4	2.1	0.6	0.1	0.0	28.6
Air Pollution	122.1	30.7	0.3	223.6	153.1	223.6	11.3	31.3	0.6	0.1	0.0	420.0
Climate Change	11.5	0.4	0.0	3.6	12.0	3.6	0.2	0.8	1.4	0.3	0.0	18.2
Nature & Landscape	25.4	1.2	0.1	7.7	26.6	7.7	0.6	0.4	1.3	0.3	0.0	36.8
Total 1995	1'026.2	44.2	17.5	260.2	1'087.9	260.2	15.8	34.5	4.1	0.8	0.0	1'403.4

Average Costs 1995 - Slovenia												
	Average Costs Passenger							Average Costs Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water Borne	Overall
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	65.5	3.2	477.7	53.1	0.6	0.4	600.5	8.3	0.0	0.0	n.a.	8.3
Noise	1.2	0.2	4.1	1.0	5.8	1.0	13.2	2.4	0.7	2.5	n.a.	5.6
Air Pollution	9.4	8.7	9.4	9.2	18.9	1.0	56.6	94.8	10.9	5.2	n.a.	n.a.
Climate Change	0.9	0.1	0.9	0.7	0.3	2.2	5.1	1.5	0.3	11.6	n.a.	n.a.
Nature & Landscape	2.0	0.3	1.6	1.6	1.0	2.1	8.6	3.3	0.1	11.0	0.0	14.4
Total 1995	78.9	12.5	493.7	65.6	26.5	6.7	684.0	110.4	12.0	30.4	n.a.	n.a.

Total Costs 1995 - Ukraine												
	Road						Rail		Aviation		Water Borne	Total 1995
[Million Euro / Year]	Car	Bus	MC	LDV & HDV	Pass. Total	Feight Total	Pass.	Freight	Pass.	Freight	Freight	
Accidents	878.0	48.9	933.8	62.5	1'860.7	62.5	0.8	0.0	0.2	0.0	0.0	1'924.4
Noise	31.2	5.1	15.2	25.8	51.5	25.8	14.5	7.5	4.0	0.6	0.0	103.9
Air Pollution	138.4	146.9	20.3	581.7	305.6	581.7	337.3	801.6	0.4	0.1	6.2	2'033.0
Climate Change	79.0	12.9	12.0	56.4	103.9	56.4	26.5	88.9	6.2	2.0	1.7	285.6
Nature & Landscape	36.5	7.1	4.4	25.1	48.0	25.1	2.6	1.7	5.2	1.6	0.0	84.3
Total 1995	1'163.1	220.9	985.7	751.7	2'369.8	751.7	381.7	899.7	16.1	4.3	7.9	4'431.1

Average Costs 1995 - Ukraine												
	Average Costs Passenger							Average Costs Freight				
	Road				Rail	Aviation	Overall	Road	Rail	Aviation	Water Borne	Overall
	Car	Bus	MC	Total	Total	Total		Total	Total	Total	Total	Total
	Euro / 1000 pkm							Euro / 1000 tkm				
Accidents	8.9	0.5	71.7	8.7	0.0	0.1	89.9	1.7	0.0	0.0	0.0	1.7
Noise	0.3	0.0	1.2	0.2	0.2	1.4	3.4	0.7	0.0	3.6	0.0	4.3
Air Pollution	1.4	1.4	1.6	1.4	5.3	0.1	11.3	15.7	4.1	0.8	1.1	21.7
Climate Change	0.8	0.1	0.9	0.5	0.4	2.2	5.0	1.5	0.5	11.6	0.3	13.9
Nature & Landscape	0.4	0.1	0.3	0.2	0.0	1.8	2.9	0.7	0.0	9.7	0.0	10.4
Total 1995	11.8	2.2	75.6	11.1	6.0	5.7	112.4	20.3	4.6	25.6	1.4	51.9

5. OUTLOOK 2010 ASSUMPTIONS

5.1 Trend scenario

Economic growth

From various sources long term growth factors for GDP are available, with a range between 3.0% to 5.0% p.a. The following growth rates from 1995 to 2010 were used (based on: Environmentally Sustainable Transport in the CEI Countries in Transition, OECD, 1999):

- from 1995 to 2000: 1.5% per annum,

- from 2001 to 2010: 3.5% per annum.

This results in a total growth factor of 1.52 between 1995 and 2010.

Road

The outlook is based on OECD sources (1999), in order to be compatible with existing sources. The following table shows the average growth factors.

GROWTH FACTORS OF ROAD TRAFFIC (1995 – 2010)		
	Growth factor	**Comments**
Road network		
Factor for all types of roads	1.28	The road network grows in the same manner as the GDP does.
Road traffic volumes		
Passenger cars	1.83	Carriage of goods measured in tkm will more than double, mainly due to a boom of road freight traffic and national income growth. The growth rate for passenger car traffic is about half that big.
Motorcycles	1.02	
Buses and coaches	1.12	
Lorries and vans	2.56	
Load factors		
Passenger cars	0.92	As it was observed in the Western countries, it is assumed that the occupancy rates for passenger cars will decrease. On the other hand the load factor for lorries and vans should increase in the period reviewed.
Motorcycles	1.0	
Buses and coaches	1.0	
Lorries and vans	1.13	

Table 57 Figures used for calculation of the forecast 2010. Source: Environmentally Sustainable Transport in the CEI Countries in Transition, OECD, 1999

Rail

Because of the change of the modal split in favour of the road, the future volumes of rail traffic will not increase as much as road or aviation traffic will do. The growth factors between 1995 and 2010 for rail BRT kilometres are based on OECD (1999):

- Rail Passenger: 1.084,

- Rail Freight: 1.093.

These values are assumed for both diesel and electric traction, because of lack of more specific data.

Aviation

Forecasts of traffic volumes concerning aviation are very difficult at the moment. Nevertheless - because of the economic progress and factors like joining the European Union - the landings and take offs in the CEI countries will strongly increase.

It is assumed that air traffic will have the same growth rate as earlier forecasts for Western European countries (INFRAS/IWW, 2000). Total growth rate factors between 1995 and 2010 are:

- Aircraft kilometres: 1.8 (+4.1% per annum),

- LTO: 1.4 (+2.3% per annum),

- Passenger km: 2.1 (+5% per annum),

- Freight km: 2.1 (+5% per annum).

Waterborne

For the year 2010 neither transport volumes nor accident forecasts for inland waterways were available. Fortunately, accidents on inland waterways are very few and the fatality rate is close to zero, so that for this sector a zero-growth was forecasted.

Accidents

The fatality rates (accidents per km) will slightly decrease, due to better safety equipment. An exception is air transport, where the rates were kept constant[16]. The most important driving factor is the change of the value of statistical life, which grows according to GDP change.

Noise

The outlook for noise is strongly correlated with GDP growth, which influences the change of WTP, and population density. The following assumptions were used:

10 % growth of the population living in cities relating to the volume of 1995,

16 ECAC, Eurocontrol, Study on Contraints to Growth 2001, Volume 2; Appendix C: Consequences of Unconstrained Demand for ACCs, page C-6

Reduction of the average number of residents per flat from 2.5 (1995) to 2.3 (2010).

For air transport, the improvement of the fleet (less noisy aircrafts in the future) was considered as well, using the following minor corrections (i.e. the so-called fleet-factors)[17], from

1.3 to 1.15 (for AL, BLR, BiH, BG, CRO, FYROM, MD, RO and UKR) and

1.1 to 1.0 (which means Western European Standard for CZ, H, PL, SK and SLO)

This process is also a consequence of their participation in international and multilateral treaties and agreements (for example the membership of all CEI countries in the European Civil Aviation Conference (ECAC-CEAC)).

Air pollution

The development of the emission factors is based on the assumption of OECD (1999) and INFRAS/IWW (2000). The individual factors are shown in the Annex.

5.2 EST-Scenario

Economic growth

From various sources long term (linear) growth factors for GDP are available, with a range between 3.0% to 5.0% p.a. The following linear growth rates from 1995 to 2010 were used (based on: Environmentally Sustainable Transport in the CEI Countries in Transition, OECD, 1999):

- from 1995 to 2000: 1.5% per annum,

- from 2001 to 2010: 3.5% per annum.

This results in a total growth factor of 1.52 between 1995 and 2010.

Road

The outlook is based on OECD sources (1999), in order to be compatible with existing sources. The transport volumes are projected based on the following elasticities to GDP:

- elasticity of passenger traffic: 0.9 until 2010,

- elasticity of freight transport: 0.7 until 2010.

The following table shows the average growth factors.

17 Corresponding to the higher level of noise emission of airplanes Eastern Europe type (Iljushin, Tupulev etc.) which are especially used for domestic flights and regional distances this factor is used as adjustment to Western Standards

GROWTH FACTORS OF ROAD TRAFFIC (1995 – 2010)		
	Growth factor	**Comments**
Road network		
Factor for all types of roads	1.28	The road network grows in the same manner as the GDP does.
Road traffic volumes		
Passenger cars	1.32	Carriage of goods measured in tkm will still almost double, mainly due to a boom of road freight traffic and national income growth. The growth rate for passenger car traffic is about half that big.
Motorcycles	0.73	
Buses and coaches	1.49	
Lorries and vans	1.86	
Load factors		
Passenger cars	0.92	As it was observed in the Western countries, it is assumed that the occupancy rates for passenger cars will decrease. On the other hand the load factor for lorries and vans should increase in the period reviewed.
Motorcycles	1.0	
Buses and coaches	1.0	
Lorries and vans	1.13	

Table 58 Figures used for calculation of the forecast EST3 2010. Source: Environmentally Sustainable Transport in the CEI Countries in Transition, OECD, 1999

Rail

Because of the change of the modal split in favour of public transport the future volumes of rail traffic will increase as much as aviation and more than road transport will do. The growth factors between 1995 and 2010 for rail BRT kilometres are based on OECD (1999):

- Rail Passenger: 1.73,

- Rail Freight: 1.16.

These values are assumed for both diesel and electric traction, because of lack of more specific data.

Aviation

It is assumed that air traffic will have the same growth rate as in the trend 2010 forecast, which means it is the same as in the earlier forecasts for Western European countries (INFRAS/IWW, 2000). Total growth rate factors between 1995 and 2010 are:

- Aircraft kilometres: 1.8 (+4.1% per annum),

- LTO: 1.4 (+2.3% per annum),

- Passenger km: 2.1 (+5% per annum),

- Freight km: 2.1 (+5% per annum).

Waterborne

In the EST 3 2010 scenario waterborne freight transport has a growth factor of about 1.13, due to the assumed changes in the modal split.

Accidents

The fatality rates (accidents per km) will not change. The most important driving factors are the change of the value of statistical life, which grows according to GDP change and the changes in modal split.

Noise

The outlook for noise is strongly correlated with GDP growth, which influences the change of WTP, and population density. The following assumptions were used:

10 % growth of the population living in cities relating to the volume of 1995,

reduction of the average number of residents per flat from 2.5 (1995) to 2.3 (2010).

For air transport, the improvement of the fleet (less noisy aircrafts in the future) was considered as well, using the following minor corrections (i.e. so called fleet-factors)[18], from

1.3 to 1.15 (for AL, BLR, BiH, BG, CRO, FYROM, MD, RO and UKR) and

1.1 to 1.0 (which means Western Standard for CZ, H, PL, SK and SLO)

Additional technical progress compared to the trend outlook 2010 to reduce noise emissions for road and rail transport, will lead to a reduction of noise:

- Road: - 5dB immission because of better tires, pavements, drive casing and noise protection walls.

- Rail: -7.5 dB immission because of various rail technologies as track construction, wheel technology, new materials for brake blocks and the introduction of disc brakes etc.

Air pollution

The development of the emission factors is based on the assumption of OECD (1999) and INFRAS/IWW (2000). The individual factors are shown in Annex 1.

18 Corresponding to the higher level of noise emission of airplanes Eastern Europe type (Iljushin, Tupulev etc.) which are especially used for domestic flights and regional distances this factor is used as adjustment to Western Standards

GLOSSARY

Accident insurance Voluntary or mandated insurance against the risks of accidents (property and health). The premia serve to (partly) internalise external costs.

Accident rate Accident rates describe the probability of an accident per 1'000 vehicle kilometres.

Annex 1 countries According to the UN Framework Convention of Climate Change: Industrial countries with reduction targets for climate change emissions

Average costs Total costs in a period, divided by the quantity (out-put) produced/consumed in that period. Long term average costs include a share of fixed costs (e.g. costs associated with expansion of existing infra-structure).

Barrier effect Separation of adjacent areas due to road or rail infrastructure investments; negative impact on human beings (e.g. recreation), or on flora and fauna (e.g. constriction of habitat).

Contingent valuation method Valuation technique which asks people directly how much they are willing to pay/to accept for improving/deteriorating environmental quality. Method is based on the → stated preference approach; it is the only method that allows the estimation of → existence value. The values obtained are compared with other opportunities, in order to make visible a budget restriction.

Cost-effectiveness Seeks to minimise the costs of achieving a given (e.g. environmental) objective/target. This principle is a → "second-best" efficiency criterion, often used when a full cost-benefit analysis is not feasible.

CO_2 Carbon dioxide is a major greenhouse gas i.e. it contributes to the climate change.

Decibel (dB(A)) Decibel (dB) is a measure for the intensity of sound energy. According to the characteristic of human ears the relationship between sound energy and dB is logarithmic. Several filters have been defined to achieve a better adaptation of dB measurements and the loudness impression of human beings. The most commonly used type of filter is the (A) filter.

Defensive expenditures → Valuation technique wherein a value for environmental quality is inferred from people's (voluntary) expenditures aimed at improving their situation.

Dose-response-functions Functions showing the connection between a specific concentration and its specific effects. They are especially used for the measurements of air pollution impacts. For example health: Impacts on mortality due to specific air pollution concentrations.

Efficiency Refers to the efficient allocation of scarce resources. At the margin, resources should be used by the individual who is willing to pay the most for them (i.e. where marginal social cost equals marginal social benefit).

Elasticity Proportional change in demand in response to a price increase or decrease (price elasticity); or reaction in total demand after an increase/decrease in income (income elasticity).

Environmental effectiveness Effect on the environment that a given policy response generates. This criterion ignores the economic costs that may result from implementing the policy.

Existence value Economic value which people attribute to something purely for its existence (no consumption is fore-seen); can only be estimated via the → contingent valuation method.

Externality (external cost) Economic cost not normally taken into account in markets and in the decisions made by market players.

EUR 17 EU countries, Norway and Switzerland (Western European countries).

Fixed cost Cost which are not depending on the traffic volume (in the short run).

(Full) fuel cycle Complete fuel cycle; comprising discovery, depletion (mining), processing, transport and use of an energy resource.

Free-flow situation Traffic situation without congestion, used as a reference level. Usually an Off-Peak-Situation can be used for urban traffic.

GDP (= Gross Domestic Product). The GDP is the sum of all goods and services produced within a country and a year. GDP per capita can be regarded as the relative economic power of a country per inhabitant.

HC/VOC Hydrocarbons / Volatile Organic Compounds contribute to ozone formation. Some like benzene, butadiene and benzo-a-pyrene have been found to have impacts on public health.

HDV Heavy duty vehicles (Road trucks) above 3,5 tonne gross weight.

Hedonic pricing→ Valuation technique which infers a value for environmental quality from rent or property price differentials.

Human value (loss) Value attributed to human life in excess of the average economic output produced by an individual (e.g. grief, pain, etc.). –> VSL

Internalisation Incorporation of an externality into the market decision making process through pricing or regulatory intervention. In the narrow sense internalisation is implemented by charging the polluters with the damage costs of the pollution generated by them, the corresponding damage costs resp. according to the polluter pays principle.

LDV Light duty vehicles (Vans up to 3,5 tonnes gross weight).

Life-cycle based approach An approach, where up- and downstream processes of transport services are included (i.e. vehicle production and disposal, fuel cycles of the electricity production etc.).

LTO-cycle Landing – Take-off cycle

Marginal costs Costs related to a small increment in demand (e.g. an extra vehicle-kilometre driven). Long-term marginal costs include the capacity expansion needed to service increased traffic demands.

MC Motorcycle

NO_X Nitrogen oxides, which are formed primarily by fuel combustion and contribute to the formation of acid rain. They also combine with hydrocarbons in the presence of sunlight to form ozone.

Opportunity costs Costs which arise when a particular project restricts alternative uses of a scarce resource (e.g. land-use of infrastructure prevents an alternative use, such as recreation). The size of an opportunity cost is the value of a resource in its most productive alternative use.

Option value Value of keeping open the possibility of consuming a good/service at some time in the future.

PCU (= Passenger Car Units) PCU is used in order to standardise vehicles in relation to a passenger car. Speed and lengths differentials are most common. Within this study they are used for the allocation of different costs (e.g. nature and landscape, urban effects, congestion).

pkm Passenger kilometre

PM Particulate matter. Fine particulate (PM_{10} with a diameter of less than 10 μm) can contribute to the chronic and acute respiratory disease and premature mortality, as they are small enough to be inhaled into the lungs. Larger particles decrease visibility and increase fouling.

Polluter-pays-principle Political/economic principle which stipulates that the user should pay the full social cost (including environmental costs) of his/her activity.

Precombustion Production, storage and transportation of energy for its final use.

Prevention approach → Valuation technique for estimating externalities whereby the costs of preventing damage are used as a proxy for the cost of the damage itself for society.

Productivity Output divided by the inputs needed to produce that output in value terms.

Public good Good/service for which property rights are not defined. Without government intervention, environmental goods (e.g. clean air) are usually treated as public.

Progressivity/Regressivity Term to describe the impact of government policy on income distributions. Progressive/regressive effects occur when poor households spend a smaller/larger proportion of their income for a particular measure (e.g. a tax) than do richer households.

Purchasing power parity (= PPP) The purchasing power parity describes the amount of goods or services which can be bought in a particular country compared to a reference country. The PPP necessarily must be expressed relative to a particular currency.

Revealed preference → Valuation technique wherein consumers. choices are revealed in the marketplace (e.g. by the purchase of a good).

Risk approach → Valuation technique for estimating externalities whereby external costs inferred from premia for risk factors (e.g. the cost of insurance, or of risk diversification).

Risk value Monetary value for pain, grief and suffering of an average transport victim, mainly used for the estimation of accident fatalities.

Shadow Prices Shadow price is the marginal opportunity cost of the use of a resource (i.e. the loss of benefits caused if this resource cannot be used the next best purpose).

Social costs The sum total of internal and → external costs.

Social cost benefit analysis Systematic estimation of all costs and benefits of a project that are relevant to society. Includes both → technological externalities and → pecuniary externalities, as long as the latter are not merely redistribution of income.

SO_2 Sulphur dioxide contributes to the formation of sulphate aerosols and is the primary pollutant in the formation of acid rain. It can also cause respiratory system damage in humans.

Stated preference → Valuation technique wherein monetary estimates are derived from hypothetical statements by individuals about their preferences. The typical method used is a questionnaire approach (e.g. → contingent valuation method).

Technological Externality External effect that is not actively or voluntarily processed through markets, which results in economic inefficiencies. This occurs when some firm or individual uses an asset without paying for it. Technically they occur where one productive activity changes the amount of output or welfare which can be produced by some other activity using any given amount of resources. Negative technological externalities reduce the amount of output or welfare which an economy can produce with any given allocation of inputs.

tkm Tonne kilometre

Traffic mode Category of means of transport (road, rail, aviation, shipping, etc.).

Traffic volume Measure for traffic activity which can be expressed in vehicle-kilometres, or in passenger/tonne kilometres.

UCPTE (Union pour la coordination de la production et du transport de l'éléctricité)
International mix of electricity production, varying slightly every year. The mix used for the forecast 2010 is based on:
50% fossil fuels
15% hydro generation
35% nuclear generation.

Unit costs Costs per unit of service or goods provided (e.g. traffic volume).

Upstream effects Effects of the production of transport related energy, rolling stock and infrastructure.

(User) charge Charge imposed on the user of a good (e.g. road infrastructure), often linked to the costs generated by his or her use.

Utility (Private) Private benefit received by an individual due to his/her consumption of a good or service, or by the existence of that good/service.

Utility (Social) The aggregate of private utilities in an economy.

Valuation Process of estimating the economic value of a certain quantity of a transport good/service; generally expressed in monetary terms.

Value of statistical life (=VSL) The value of statistical life is a methodology to find a monetary pendant to a killed or injured human being. VSL is the → opportunity costs of a saved human life.

Variable costs (→ Fixed costs) Full costs can be subdivided into fixed costs and variable costs. Fixed costs remain constant with varying use of a transport system (e.g. supplier- or capital costs for road and rail networks or administrative costs). The expression "fixed" in the way it is used in the Real Cost Scheme means "fixed in the short run" (without consideration of new infrastructure), as in the long run also infrastructure supply costs vary with the traffic demand, that is in the long run all costs can be made variable. Main relations of variable costs are kilometres driven or the amount of vehicles (e.g. crossing a specific section).

Vkm, Vehicle-kilometre One kilometre travelled by a single vehicle.

Willingness to pay (= WTP) The willingness (or ability) of people to pay for the abolishment, reduction or reception of a particular matter can be estimated by two ways: (1) by → stated preference surveys and by hedonic pricing methods.

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