BUILDING DAMAGES

(Fair & Efficient Prices)

Building damages due to road and rail transport in Switzerland: Update of external costs in 2000

(Verkehrsbedingte Gebäudeschäden in der Schweiz: Aktualisierung der externen Kosten 2000)

SUMMARY

Updating external costs on behalf of DETEC

The law of performance-related Heavy Vehicle Fee (HVF) (1997) commits the Federation to periodically update external costs. DETEC has commissioned a comprehensive update of cost estimations, as the latest Swiss estimations are based on the year 1993. The present study deals with building damages caused by exposure to heavy traffic volumes and will update the study made in 1992 (INFRAS). The value structures (connection analysis of air pollution building damages, cost rates) as well as quantity structures (exposed facades) will be newly collected. The study relates to building damages of the year 2000, which are composed of the following:

› effective renovation costs due to increased renovation work on locations exposed to heavy traffic volumes,

› Costs due to deterioration of facade conditions on and off locations exposed to heavy traffic volumes, without direct renovation impact. The resulting reduced lifespan will lead to additional capital costs.

› Increased cleaning expenses on locations exposed to heavy traffic volumes.

The study relates to costs on building facades. It does not include possible damages on art and architectural monuments.

Analysis of empirical evidence

The 1992 study analysed the connection between air pollution and increased renovation and cleaning work with the help of empirical evaluations of a specific Wüest & Partner data set. The connection – shown also by further foreign studies – is statistically difficult to prove because air pollution is just one of the many factors of influence in building management. That is the reason why not only literature evaluation but also expert interviews and own in-depth data evaluations were made in this study. The following table shows the different elements of the methodology:

APPROACHES TO EVALUATE THE DIFFERENT COSTS OF BUILDING DAMAGES		
Type of cost	**Locations exposed to heavy traffic**	**Locations not exposed to heavy traffic**
Reduction of renovation cycles	Analysis of renovation work and calculation of renovation quota on and off principal axes based on a data set by Wüest&Partner.	Per definitionem: No additional cost
Reduction of facade lifespan	Analysis of connection between air pollution and state of facade based on a data set of Wüest&Partner	
Calculation approach cleaning costs	Analysis of cleaning frequency on principal transport axes compared to side roads and determination of cleaning cost approaches by using expert interviews.	Assumption: No additional cost

Table S-1: Multi method approach to determine building damage costs in areas exposed to and in areas not exposed to heavy traffic volumes. The Wüest&Partner data set includes in total approx. 3000 buildings in representative locations in Switzerland.

The results of these analyses can be summarised as follows:

› It is now commonly acknowledged that PM10 (particulate matter with an aerodynamic diameter less than 10 µm) is the new indicator pollutant. Emissions of small particles in particular lead to pollution and indirectly to corrosion of components.

› Renovation work on locations exposed to high traffic volumes is more frequent than on locations not exposed. The updated analysis results in a 0.5% increased renovation quota. But this figure is noticeably lower than the results of the previous study (1.2% INFRAS 1992). This can, among other things, be explained through lower exposure. Within the last 10 years PM10-exposure has receded by 30–40%, NO_x-exposure by 40–50% and SO_2-exposure by 60–70%.

› A statistically significant connection between PM10-emissions[1] and the state of facades can be determined: The higher the exposure, the greater the probability that the state of facade (independent of the building age) has to be characterised as poor. The following table shows the conversion to the different space types.

REDUCTION OF FACADE LIFESPAN
RESULT OF THE EMPIRICAL EVALUATIONS

Agglomeration type	**Yearly average of PM10 exposure**	**Period of time until facade has to be renovated**	**Average lifespan of facades**	**Reduction of lifespan in years**
Unit	*µg/m³*	*years*	*years*	*years*
1. Metropolitan areas	22.0	31.7	45	13.3
2. Agglomerations of metropolitan areas	18.6	37.5	45	7.5
3. Core communities within metropolitan areas	17.6	39.5	45	5.5
4. other agglomerations within metropolitan areas	16.4	42.5	45	2.5
Other areas	10.9 -7.2	63.9 - 49.2	45	-

Table S-2 A reduced lifespan due to deteriorated facades can be identified in densely populated and exposed areas.

› The different expert interviews substantiate these empirical findings on a qualitative level. But it should be mentioned that according to building experts in the last 10 years air pollution has become significantly less important. It was also conducive that today there is almost no sulphur dioxide (SO_2) pollution any more which used to cause very aggressive reactions on precious sandstone facades as well as on sheet metals and plastics.

› Interviewing different cleaning institutes showed very prominently that cleaning work on locations exposed to heavy traffic volumes is more frequent. The reason why is increased pollution. This connection can only be quantified roughly by increased cleaning frequencies.

[1] The PM10-exposure originates from the current official land registry assessments (acre grids SAEFL), of which the shares of transport can be derived.

Extrapolation on Switzerland: procedure

These empirically realisable basics can be used to extrapolate total costs in Switzerland.
The procedure includes several steps:

1. The quantity structure is based on the building database of Wüest&Partner. This database includes all building facade surfaces, differentiated according to important types of material and can be called a solid empirical foundation. The buildings are differentiated according to different spatial types to better account for exposure loads.
2. The cost rates for the different types of work will be updated through interviews with experts. Component-specific cost for construction work, renovation and cleaning work by surface unit are its central aspect.
3. Renovation costs on locations exposed to heavy traffic volume can be calculated based on increased renovation work (reduced renovation cycles), on facade surfaces exposed to heavy traffic volumes and on the cost rates of the renovation work. Cost will completely be allocated to transport.
4. Increased capital costs due to reduced life spans of facade surfaces under the influence of pollutant exposure will be calculated on the basis of land registry data, on facade surfaces not exposed to heavy traffic volumes and on cost rates for the construction of facade components. These costs will be allocated to transport and other sources.
5. Cleaning costs on locations exposed to heavy traffic will be extrapolated based on exposed windows and glass/metal facade surfaces and specific cleaning work costs.
6. Allocation of damages to the different sources and transport means take place, as a first step, based on exposure shares differentiated according to space respectively agglomeration type and as a second step according to their share of PM10 emissions.

Results: Total costs Switzerland

The following table shows the resulting costs for Switzerland according to type of cost and main sources. They amount to a total of 546 mill. CHF in the year 2000.

BUILDING DAMAGES ACCORDING TO TYPE OF COST AND MAIN SOURCES IN SWITZERLAND
MILLION CHF 2000

Type of cost	Transport	Other sources	Total
Additional renovation cost on locations exposed to heavy traffic	141	-	141
Additional cost due to reduced life spans of	77	281	358
Additional cleaning cost	47	-	47
Total	**265**	**281**	**546**

Table S-3 Transport share on total loss amounts to 49%.

Transport-related building damages amount to 265 mill. CHF per year (2000). The biggest part of cost originates in the metropolitan areas and agglomerations. The following table shows a breakdown according to transport means and types of space. Because of rail particle emissions (through track and wheel abrasion, brake abrasion, contact line abrasion and resuspension) rail transport also generates minor costs.

TOTAL COST 2000 DIFFERENTIATED ACCORDING TO TYPE OF AGGLOMERATION AND TRANSPORT MEANS

Type of community	Road passenger transport	Road freight transport	Rail	Air	Total cost per annum
Unit	*mill. CHF*	*mill.CHF*	*mill.CHF*	*mill.CHF*	*mill.CHF*
Urban	62.3	53.2	7.0	2.5	**125**
Agglomeration	52.3	49.5	5.6	2.6	**110**
Rural	14.4	13.9	1.3	0.2	**30**
Total	**129.1**	**116.6**	**14.0**	**5.3**	**265**

Table Z-4 Road transport causes in total 93% of building damages caused by exposure to heavy traffic volumes, of which 47% are allocated to road freight transport.

Cost rates in the transport sector

The following figures show cost rates, expressed in cost by passenger resp. tonne kilometres (road and rail) and in vehicle kilometres (road transport).

AVERAGE COSTS ROAD AND RAIL

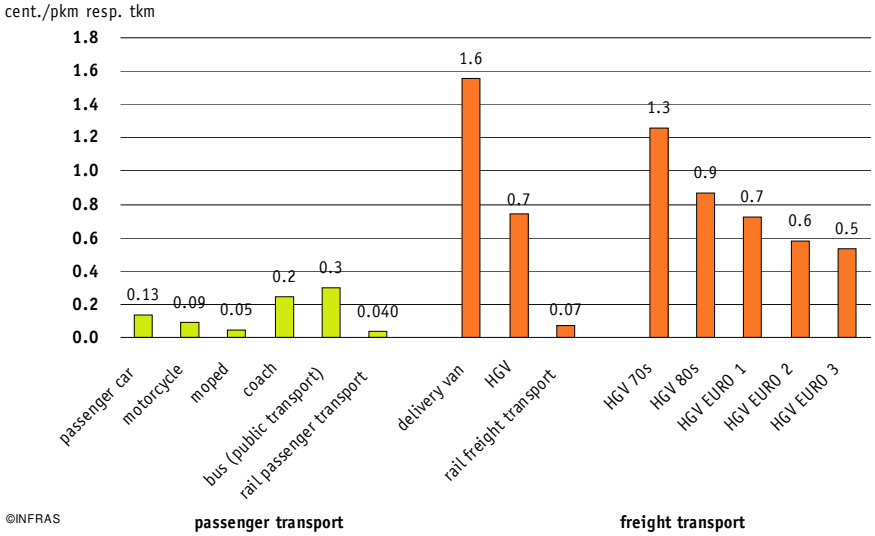

Figure S-1 Rail shows in passenger transport 3.4 times lower cost per passenger kilometre. In freight transport the difference is visibly bigger and has (by tonne-kilometre) a factor 10. Due to their low payloads delivery vans show even more significant specific costs per tonne-kilometre.

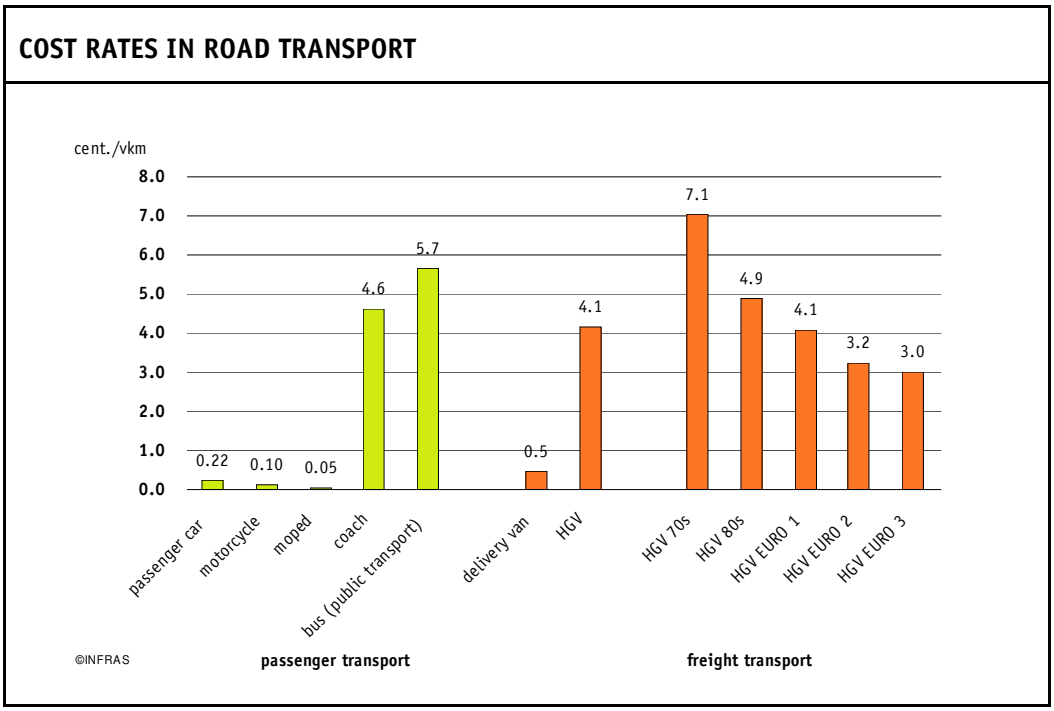

Figure S-2 The costs to determine the rates of the performance-related Heavy Vehicle Fee in road freight transport amount to between 3 and 7 centimes per vehicle kilometre.

Comparison with previous estimations

The following figure shows the differences to the previous estimations made for the year 1993[2].

Costs are about 55% lower. The following are the relevant reasons:

› Heavily reduced emission load of corrosive pollutants caused by exposure to heavy traffic volumes such as NO_x and SO_2,

› Increased use of more robust facade construction materials (glass/steel facades),

› Slightly regressive renovation and construction costs,

› New empirical data base and new methodologies tending to a more prudent estimation of air pollution building damages.

[2] see INFRAS 1995

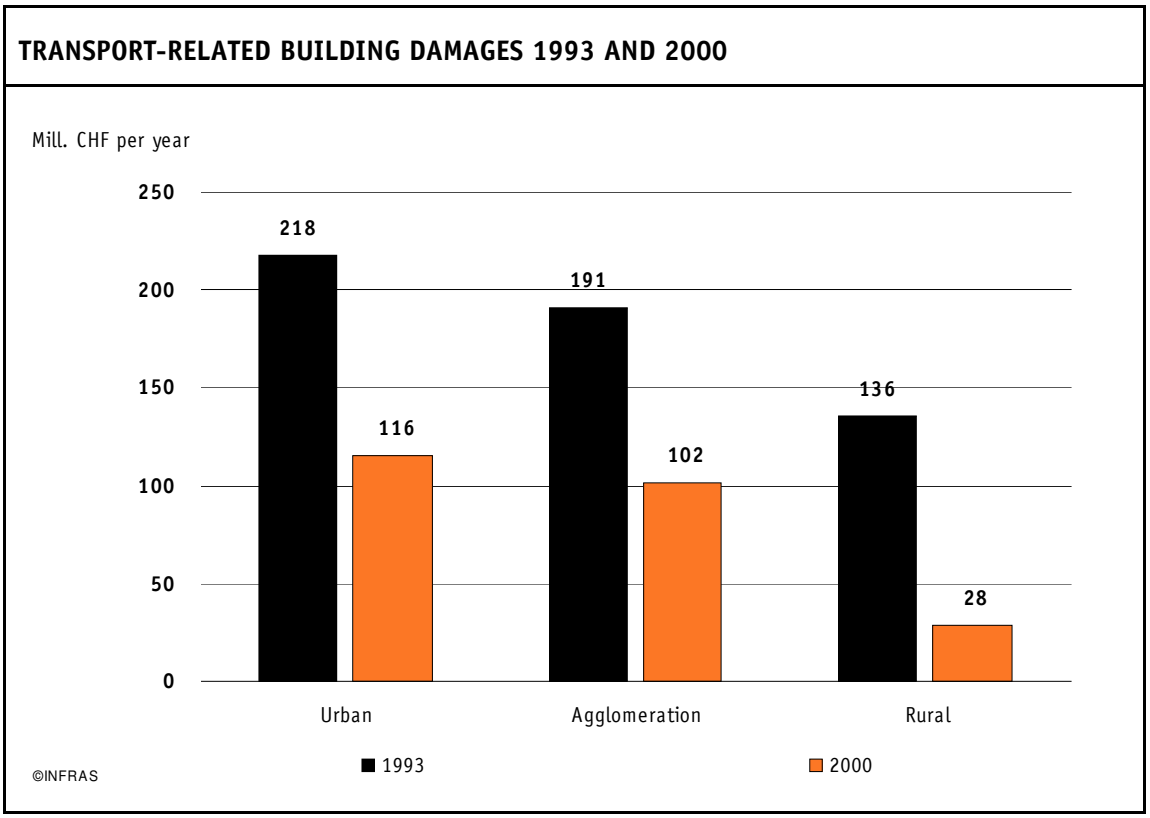

Figure S-3 Previous values originate from INFRAS 1992 and were updated for 1993 (acc. to INFRAS 1995). Note: Building damages 2000 are without rail and air transport because costs for rail and air transport 1993 were not yet calculated.

Synthesis and update concept

The existing analyses support the estimation of building damages because of a new empirical evidence analysis and of new empirical basic data for the exposure load and facade surfaces of Switzerland. The results are therefore more than a reflection of a mere update, but a new evaluation of building damages caused by air pollution. Compared to foreign studies this analysis is significantly more sophisticated.

The analysis also shows that costs due to air pollution can be proven. But at the same time it has to be mentioned that these cost are not very relevant in practice, but they are the calculated result of comparisons between different locations.

This can also be allocated to the building industry because it is always improving materials and makes them more resistant to external impacts and loads. This may also indicate a decrease of the importance of damages in future.

Particle emissions are today's most important cause, and they serve also as basis of the allocation to the different transport means. The biggest part on damages caused by exposure to heavy traffic is allocated to road transport. Here also the future prospective improvements (through cleaner diesel fuel and diesel engines) will lower the resulting costs. But it will be more difficult to reduce the likewise relevant particles which are caused by mechanical processes such as abrasion and re-suspension. Rail transport also is a contributor to these processes.

For a further cost update we propose a multilevel concept:

› Short term (in 5 years) it is expedient to make a simple update by using emission shares and cost rates in the building industry. Cost will change along the forecast emission development and building cost index. This can be determined on the basis of the existing emission trends and the development of price indices. When updating the rates of the performance-related Heavy Vehicle Fee according to emission categories, the emission forecast is only relevant when renewed.
› Long term (after 10 years) it is expedient to obtain plausible results with the help of expert interviews. The main question is if new materials and management practices resp. new pollutant factors will lead to new mechanisms of action.