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RAPPORT

Environmental consequences of better roads

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Environmental consequences of better roads
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ABSTRACT

The project "*Environmental consequences of better roads*" is based on two hypotheses:

H1: *Better roads lead to less emission from car traffic and are regarded as positive contribution to a sustainable environment*

H2: *Restraining the capacity in the road network is an environmentally unsound measure to promote lower emission from road traffic*

In order to prove or disprove these hypotheses we performed microsimulation on three prototypical road sections. The microsimulations where used to calculate fuel consumptions and environmental effects (emissions of CO, NO_x, NMVOC and CO_2) of better roads with a fixed traffic flow.

The results from the study show that there is a close relationship between road design, traffic flow, and the emissions of the various pollutants, and the study proves clearly the hypothesis H1 above.

Our study of a heavy congested urban motorway shows considerabely reductions in emissions from the existing traffic when the motorway is expanded with one extra lane and thus improving the traffic flow conditions. However, these improvements also generate new car traffic, mainly because of change from public transport to cars. This increase in traffic will produce new emissions thus reducing the earlier improvements.

From this study we learned two lessons;

i) A good road standard is also good for the environment; a bad road standard results in high emissions from the car traffic. These results support the hypothesis H1 above.

ii) Lack of sufficient capacity results in very low traffic speed (stop-and-go conditions) with high level of emissions and do not contribute to a sustainable environment. If there is a need to limit the traffic, some kind of demand management (parking control, road pricing, etc) should be applied. Thus the study also gave support to the hypothesis H2.

KEYWORDS	ENGLISH	NORWEGIAN
GROUP 1	Transport, Simulation	Samferdsel, Simulering
GROUP 2	Infrastructure, Transport, Emission, Road	Infrastruktur, Transport, Utslipp, Vei
SELECTED BY AUTHOR	Transport Models, Car traffic, Mode choice	Transportmodeller, Biltrafikk, Reisemiddelvalg
	Environment	Miljø

SUMMARY IN ENGLISH

The hypotheses
The project "*Environmental consequences of better roads*" was based on two hypotheses:

H1: *Better roads lead to less emission from car traffic and are regarded as positive contribution to a sustainable environment*
H2: *Restraining the capacity in the road network is an environmentally unsound measure to promote lower emission from road traffic*

In order to prove or disprove these hypotheses we performed traffic micro simulation on three prototypical road sections (alternatives 1a, 2a and 3a) with road improvements on each section (alternatives 1b, 2b and 3b). Sketches of these different road sections are shown in figure ES-1… ES-5 below.

The prototypical road sections
The first case (alternative 1a) is a narrow winding road with sharp curves which require slow speed and with narrow sections of the road which are only one lane with no passing possibilities. This road also passes through two small villages. The traffic on the road is 200 vehicles/hour.

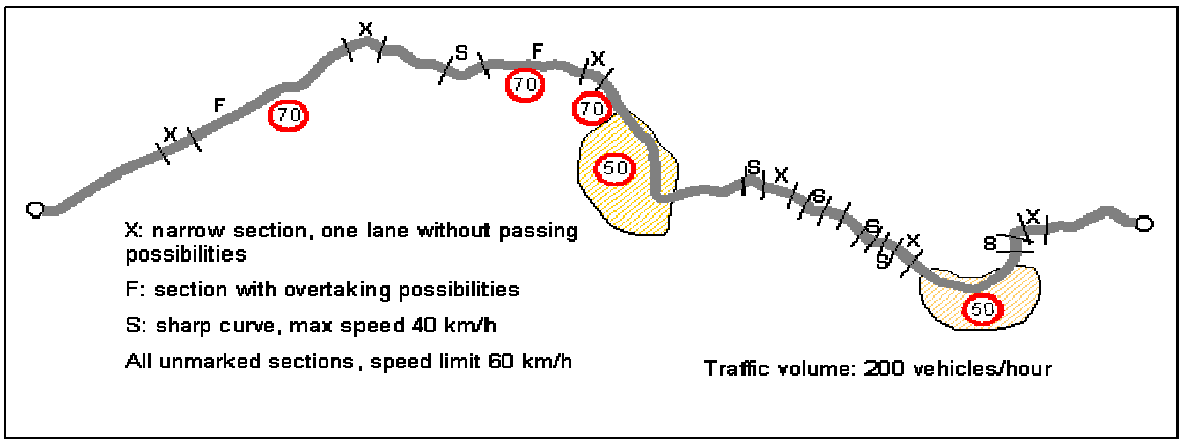

Figure ES-1: Alternative 1a, Narrow, winding two-lane road through two villages

This road is replaced by a more modern two-lane road which passes outside the two villages (alternative 1b). Traffic volume is still 200 vehicles/hour

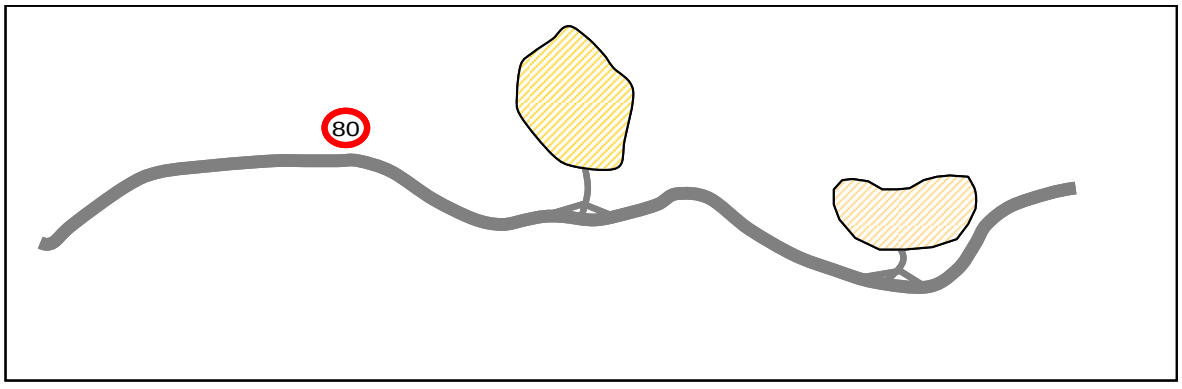

Figure ES-2: Alternative 1b, New two-lane road with satisfying alignment and lane width

The second case (alternative 2a) is a two-lane road of fair standard which goes through two villages, but traffic is approaching the capacity of such a road. Hourly volume is 1200 vehicles pr hour.

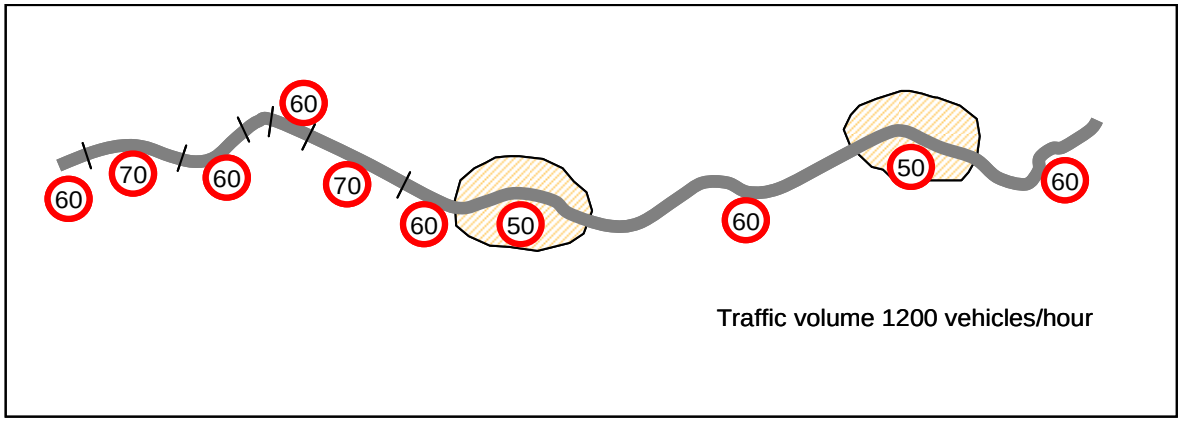

Figure ES-3: Alternative 2a, Two lane road with fair standard and ca 1200 vehivles/hour

This road is replaced by a four-lane motorway passing outside the two villages.

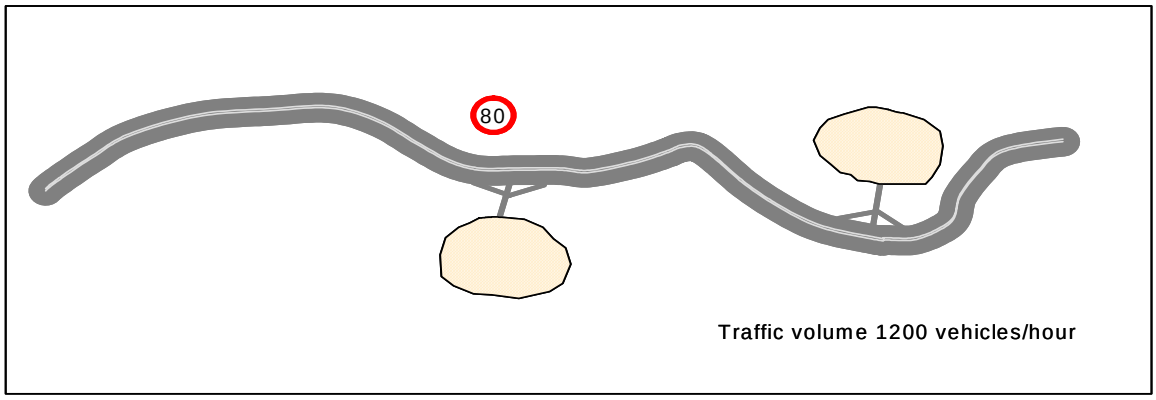

Figure ES-4: Alternative 2b, The four-lane motorway passing outside the two villages

The third case (alternative 3a) is a congested urban motorway which is an arterial in a large city. The traffic volume is 5000 vehicles/hour.

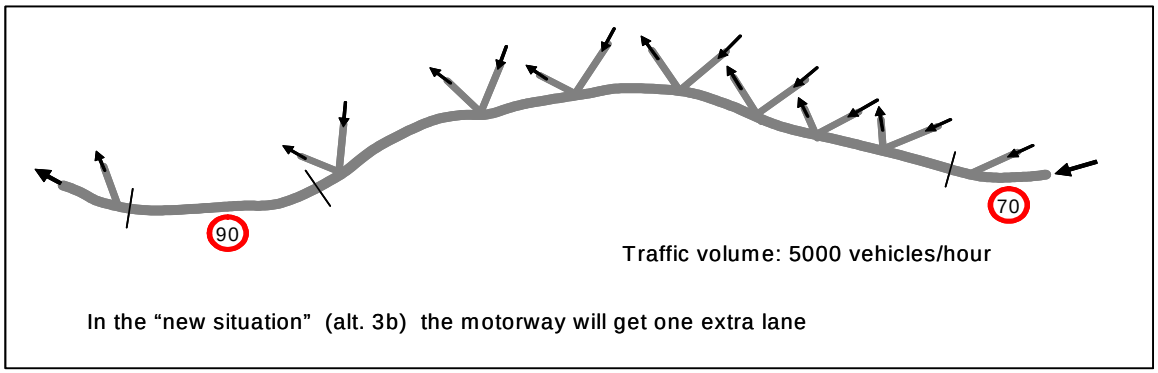

Figure ES-5: Congested urban motorway with several access and egress points

This motorway is expanded by one extra lane (alternative 3b)

The microsimulation

The simulations were performed with the same magnitude of traffic on the base alternative and the improved alternative for each case. The simulation tool was the AIMSUN simulation model and the model contained fuel consumption data and emission data for twenty different vehicle types. In this way we got calculated the environmental effects (emissions of CO, NO_x, NMVOC and CO_2) of better roads for the existing traffic. The results are shown in figures ES-6…. ES-8 below.

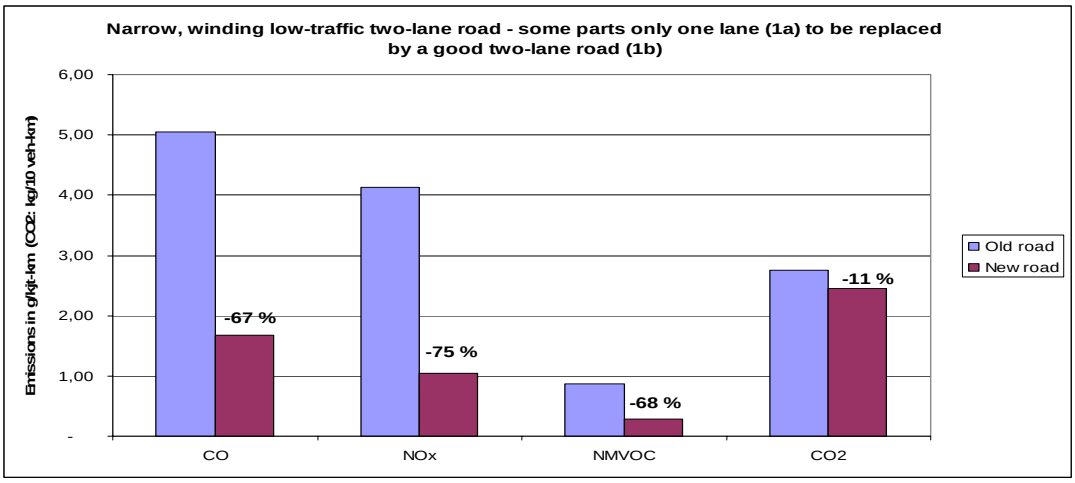

Figure ES-6: Emission results for alternative 1 "The narrow, winding two lane road, partly one-lane"(1a) being replaced by a modern two-lane road (1b) Traffic volume: 200 veh/hour

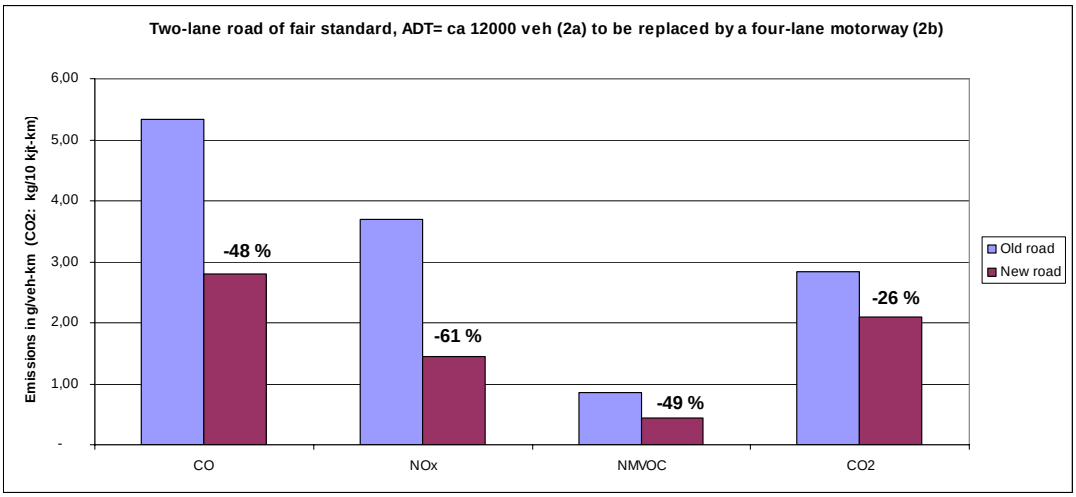

Figure ES-7: Emission results for alternative 2 "the two-lane road of fair standard" (2a) being replaced by a four-lane motorway (2b). Traffic volume: 1200 veh/hour

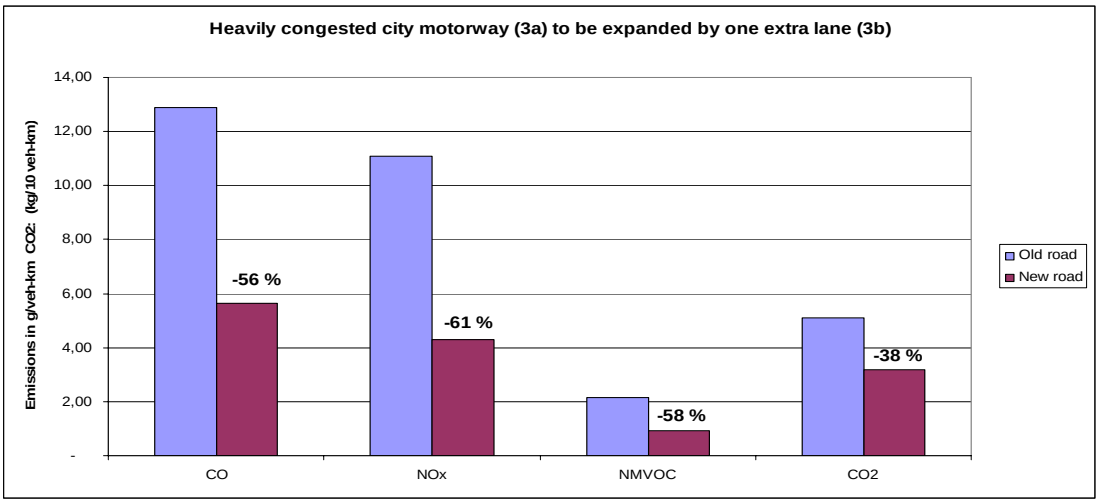

Figure ES-8: Emission results for alternative 3 "the congested urban motorway" (3a) being expanded by one extra lane (3b) Traffic volume: 5000 veh/hour

For all these three cases the simulation results show considerable reductions in the emissions from the existing road traffic. These results are also according to the hypothesis H1:

Better roads lead to less emission from car traffic and are regarded as positive contribution to a sustainable environment.

The question which remains is whether the new roads will generate some new traffic with additional emissions which again will reduce the environmental benefits we have achieved through the improved roads.

New traffic

According to the basic economic theory will the demand for travel increase if the travel cost (resistance) decreases. In the case of transport we usually express cost as generalized cost (sum of driving cost and time cost). In this case we do decrease the time cost and thus we may expect some increase in traffic.

If we observe traffic growth on a new road and ask what kind of "new traffic" are we watching, we can classify the growth according to the following types of traffic:

i) change of driving route
ii) change of time of travel
iii) change of travel destination

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iv) change of travel mode
v) new trips previously suppressed by the traffic conditions

The first three types are regarded as "environmentally friendly". The changes do not usually result in worse conditions from an environmental point of view. On the other hand the last two types of market reactions will result in increased traffic if the change in road quality results in better driving conditions (decrease in generalized travel costs) and no other measures are imposed on the traffic. Except for "time of travel", all the other market reactions are part of the standard "four-step transport model procedure".

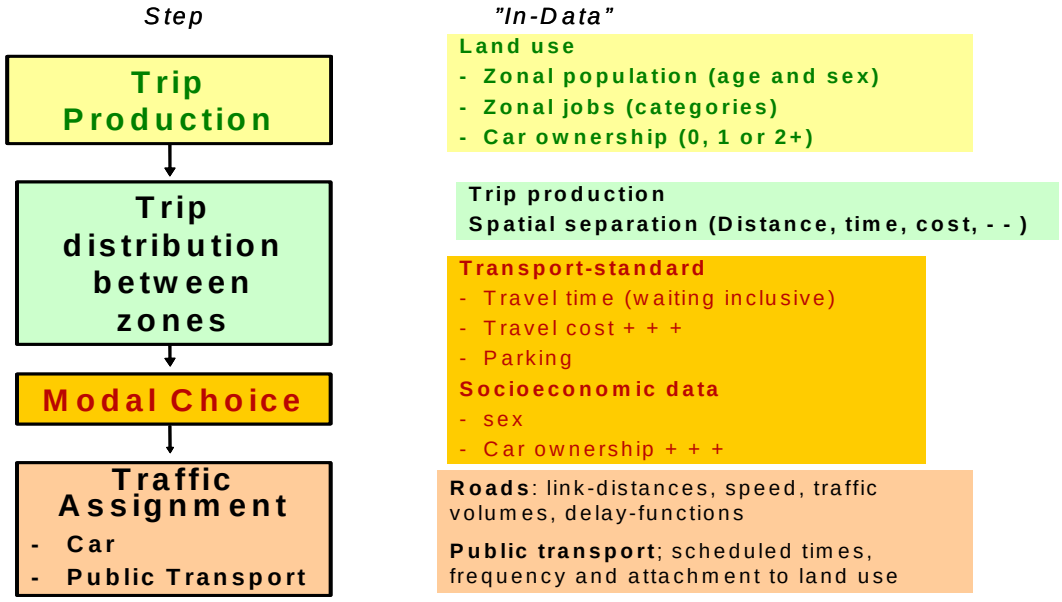


Figure ES-9: The four steps of the four-step transport model procedure

Basic trip production

According to numerous Norwegian travel surveys covering the whole or different parts of the country and years apart, the trip production has remained very stable with no significant variations. Thus there is no evidence that the average trip production will vary according to some measure of average traffic speed or average travel times.

Average trip production in different Norwegian travel surveys		
Area	**Year**	**Trips/person&weekday**
Trondheim	2001	3,28
Trondheim	1992	3,32
Trondheim	1990	4,12
Bergen	2000	3,62
Bergen	1992	3,62
Jæren	1998	3,64
Oslo	1990	3,57
Oslo	1984/85	3,79
Drammen	1990	3,62
Grenland	1990	3,20
Tromsø	1990	3,50
Norway	2005	3,60
Norway	2001	3,33
Norway	1998	3,41
Norway	1992	3,35

Table ES-1: Average trip production in Norwegian travel surveys

Even the Norwegian transport models have for a long time had a static trip production sub-model based on constant average trip production. Only a few models have had dynamic trip production sub-models where number of trips depend partly on the quality of the transport system. However, when these models are analysed we find that the dependency is very weak and variations in the

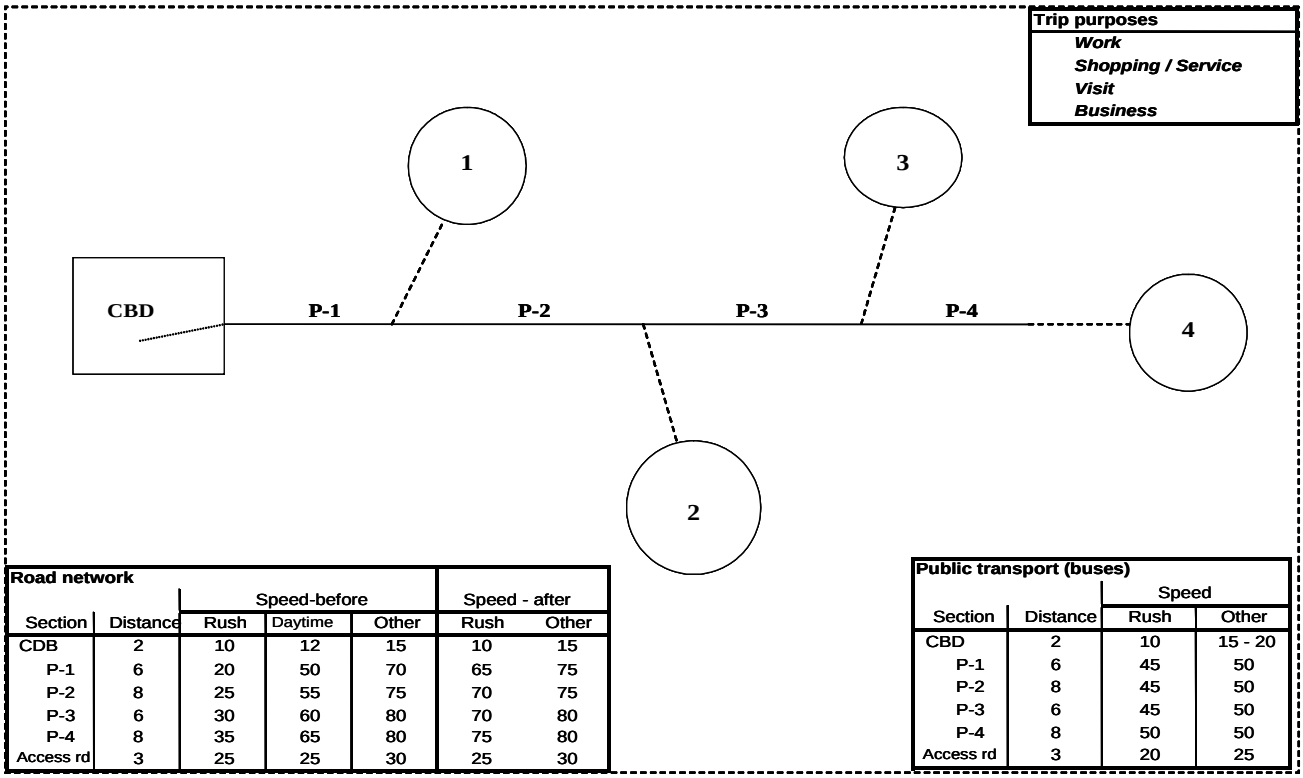
transport system hardly affect the resulting trip production. Thus we can consider that particular effect as negligible in this context.

Then one market reaction remains to be analysed and that is the mode choice.

The mode choice

The first two road section examples in the micro simulation study were two-lane roads which were substituted by better roads. In these cases public transport most often will be run by buses. Thus, an improvement of the roads will affect both the cars and the buses with very little influence on the mode choice of the users.

However, in the third case, the congested urban motorway with separate bus lanes, there will be a completely different situation if an extra lane is added to the motorway. This situation is analysed with respect to mode choice by applying the new regional transport models recently developed for Norwegian regions on an example similar to example three in the micro simulation study.



Road network

Section	Distance	Speed-before			Speed - after	
		Rush	Daytime	Other	Rush	Other
CDB	2	10	12	15	10	15
P-1	6	20	50	70	65	75
P-2	8	25	55	75	70	75
P-3	6	30	60	80	70	80
P-4	8	35	65	80	75	80
Access rd	3	25	25	30	25	30

Public transport (buses)

Section	Distance	Speed	
		Rush	Other
CBD	2	10	15 - 20
P-1	6	45	50
P-2	8	45	50
P-3	6	45	50
P-4	8	50	50
Access rd	3	20	25

Figure ES-10: Example of an urban motorway for analysing mode choice

The results of the mode choice calculations for the before-/after-situations are shown in figure ES-11.

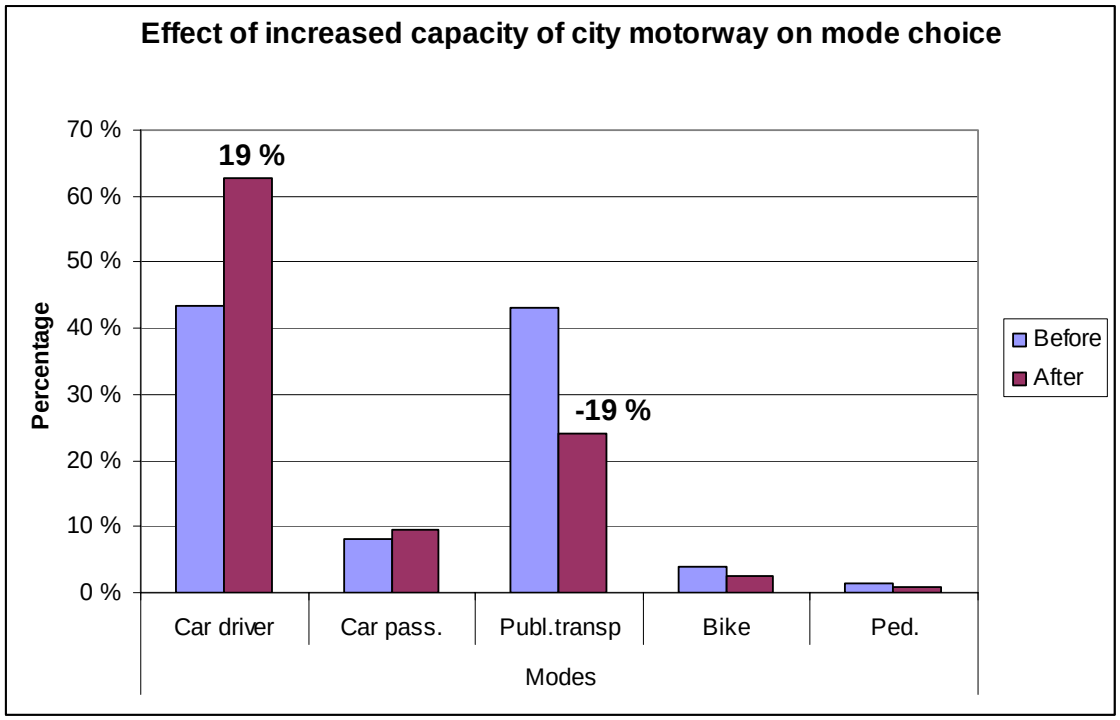


Figure ES-11: Effect of increased capacity of congested urban motorway on mode choice

The results of the study show that we get a substantial growth in car traffic when the capacity of the congested urban motorway is increased by one extra lane. An increase from 43% to 62% in use of car is actually ca 45% increase in car traffic and decrease from 43% to 24% in trips by public transport is ca 45% reduction in trips by public transport. In reality it will not be sufficient to increase the capacity with only one extra lane. Two or three extra lanes will be needed to get free flow on the motorway. In most large cities in Europe there will be a lack of both the economic resources, land space and political will to go for such a solution and the results more or less emphasizes the "old truth" that when cities are larger than a certain size, it is more or less impossible to solve the traffic problems by increasing the road capacities.

On the other hand the micro simulation results show clearly that lack of road capacity is not a feasible measure to restrict the use of cars. Congested roads generate much larger quantities of pollution than if the same number of cars could have travelled the same distance with a fairly steady speed of 50 – 80 km/h.

Conclusions

The conclusions based on the micro simulation study and the analyses based on use of transport models are very much according to the basic hypotheses for the study::

i) Better roads in terms of better alignment, sufficient width and capacity which give the traffic the possibility to flow steadily lead to less emission from car traffic and are regarded as positive contribution to a sustainable environment

ii) Restraining the capacity in the road network is an environmentally unsound measure to promote lower emission from road traffic.

iii) Even on congested roads the measures should be directed towards improving the flow of traffic either by increasing the capacity or by use of some sort of demand management, for example parking regulations in the most relevant destination areas, access control to major roads and/or road pricing.