The combined traffic-related impacts of reducing maximum speeds and compact driving on Dutch urban ring roads

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1. INTRODUCTION

In the Netherlands, it has become increasingly clear that traffic flows cause air quality and environmentally related problems in densely populated urban areas. During the last few years the Dutch government has introduced several measures to address these problems. However, in order to achieve the agreed European standards for air quality (standards for particulate matter and nitrogen dioxide), additional measures to decrease air pollution are still required.

One of those measures is the reduction of the maximum driving speed to 80 km/h on a limited number of sections of motorways around the four main Dutch cities. These sections have been pre-selected owing to the fact that these sections are those with the urgent air quality problems. The total length of the selected sections is approximately twenty kilometers. Owing to the fact that the initial results of the evaluation have proved to positive, the initiative has been extended to examine the possible introduction of a maximum speed reduction on all of the main ring roads of the four main cities of The Netherlands: Amsterdam, Rotterdam, The Hague and Utrecht.

Figure 1 Study area: The Four main cities of The Netherlands

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A reduction of the maximum speed in theory would make it possible to create an additional driving lane on the existing road surface, partially utilizing sections of the hard shoulder. The possible reduction of congestion as a result of the extra capacity could contribute extra to a reduction of the air quality and environmentally related problems. For the purposes of this study a decreased maximum speed combined with an additional driving lane is called *Compact Driving* (C80). Realizing C80 could create a win-win situation: an improvement of air quality and improved traffic flow.

The goal of this research project is to ex ante evaluate the effects of C80 on the ring roads of the four main cities in The Netherlands. The effects that have been examined relate to accessibility (traffic related), Air quality, Traffic safety and Cost benefits. This paper deals with the traffic related impacts. In an overview the results of the other aspects are provided, so that the trade-off between the accessibility and the environmentally related aspects becomes clear.

### 2. METHODOLOGY

#### 2.1 Scenarios

The ex ante scenario-evaluation has been undertaken for the forecast year of 2010. The four different scenarios vary in the extent of introducing a reduced maximum speed on segments (during the day or on parts of the ring roads) and the extent of additional lanes on the ring roads.

The physical possibilities to create an extra lane have been examined. The cost of construction is an important aspect especially in relation to tunnels and bridges. It appears to be impossible to create an additional lane n several parts of the ring roads, without making extreme additional costs. Also the desirability of an extra lane regarding accessibility has been taken into account.

The scenarios, including the reference scenario, are as following:

1. *Reference-scenario* in the year 2010. In this situation the Dutch population has grown to almost 17 million people. All planned infrastructure schemes are supposed to be realized;
2. Only reducing maximum speed on all ring roads of the four main cities during the whole day (*80-scenario*). No extra capacity is introduced within the *80-scenario*;
3. Reducing maximum speed (like 2.) combined with an extra lane on all segments regardless of the costs of the construction (*C80-scenario*);
4. *Air quality-scenario*: an extra lane on as many parts of the ring roads as possible without making additional significant costs. On all segments of the ring roads, the maximum speed is reduced to 80 km/h, during
whole day (like 2.). Note that some segments in the Reference-scenario already have the maximum speed of 80 km/h; and

5. *Traffic Flow-scenario:* an extra lane on those segments of the ring roads where it is desirable and suitable (low costs). Only on these segments the maximum speed will be reduced to 80 km/h only in peak periods. During the rest of the day the extra lane is closed and the maximum speed is 100 km/h.

![Figure 2 Air quality scenario: Decreasing maximum speed on all ring roads of the modeled road network.](image)
2.2 New Regional Model

The strategic transport model NRM Randstad has been used to examine the effects on Accessibility. This New Regional Model (NRM) is a clone of the Dutch National Model System (NMS), developed and owned by the Dutch Ministry of Transport. The NRM Randstad specifically models the most urbanized region in the western part of The Netherlands (Randstad). The four main cities of The Netherlands are part of the Randstad.

The NRM Randstad is a discrete choice model (nested logit) with over 2000 zones. The study area covers four regional areas the provinces of Noord-Holland, Zuid-Holland, Utrecht and Flevoland, and covers approximately one-third of the total Dutch land area and two third of the population. The NRM Randstad enables planners and modellers to make transport and traffic forecasts for future years 2010 and 2020. The base year of the model is 2000. It distinguishes three time periods for an average working day: morning peak (7:00-9:00), evening peak (16:00-18:00) and the rest of the day. The assignment is based on the static assignment named QBLOK. This equilibrium assignment method models blocking back as a result of congestion. The technique is suited for visualizing differences in traffic flows. QBLOK is not able to make in depth analysis of traffic flows on specific locations. Results are given for the ring roads.
all together, other roads (e.g. city networks) and all the roads together in the Randstad.

Forecasts are made for the future year 2010. The whole transport system is modeled and as such not only route choice effects but also distributional effects and modal shift are taken into account.

2.3 Variables

The study provides an insight into a number of different traffic variables. These variables are also used for the evaluation of traffic related aspects like Air quality and Traffic safety.

- Total amount of car mobility measured in distance traveled. Three different sections of the network are distinguished:
  - The four ring roads together (RR). The information for each single ring road has been examined but is not presented here;
  - Other roads (OR) in the Randstad; and
  - All roads in the Randstad (Total).

- Average speed in kilometers per hour for the three different parts of the network RR, OR and Total. Insight is given into the quality of the traffic flows depending on the levels of congestion experienced and the maximum speed compared to the Reference-scenario.

All variables are presented for the three modeled time periods of an average working day: morning peak, evening peak and the rest of the day. Public transport and the use of slow modes are incorporated in the model but are not presented here.

3. TRAFFIC RELATED IMPACTS

3.1 Total amount of car mobility

Figure 4 shows the estimated effects of the different scenarios on the total distance traveled.
Only by reducing the maximum speed on all ring roads during the whole day without introducing extra capacity (80-scenario) leads to an increase in the use of other roads (+3%). Particularly outside the peak periods motorways lose their attractiveness (-14% during the day).

The total distance traveled on the whole road network decreases by almost -4%, without a corresponding reduction in car trips. This means that the average distance traveled reduces directly as a result of drivers choosing other roads (routes). In other words due to the high maximum speed on ring roads in the Reference-scenario drivers travel more kilometers than strictly needed for their trips. In the peak periods this mechanism is less obvious due to the levels of congestion encountered on motorways.

In the C80-scenario the reduced attractiveness of the ring roads is less than in the 80-scenario (-8% during the day compared with –14% in the 80-scenario). In the peak periods the additional lane results in increased traffic levels on the ring roads despite the introduction of a lower maximum speed (+2% compared with –7% in the 80-scenario). This results in the fact that congestions levels in the peak periods reduce due to the extra lane. The total distance traveled during the day falls only by -2%. Outside the peak periods the motorways still lose their attractiveness due to the introduction of a reduced maximum speed.

Within the Air quality-scenario the level of additional capacity is somewhat less than in the C80-scenario due to the high costs relating to tunnels and bridges. In fact this is the only difference between these two scenarios. This leads to results that lie between the effects of the 80-scenario and the C80-scenario. Also in the peak periods the use of the rings roads drops by –2% compared with +2% in the C80-scenario and –7% in the 80-scenario. The total distance traveled during the day drops –3%.
The **Traffic Flow-scenario** introduces only an additional lane on those segments of the ring roads where it is desirable and suitable and only on these segments the maximum speed will be reduced to 80 km/h during the peak-periods only.

Outside the peak periods there is no difference with the **Reference-scenario**. For the Traffic Flow scenario the model predicts no increase in the use of other roads compared to the other scenarios during the day. In the peak periods there is a reduction of the use of other roads. The physical combination of a lower maximum speed and an extra lane is positive for the average speed on motorways leading to an increase of attractiveness of ring roads. The total amount of distance traveled is constant.

### 3.2 Average speed

Figure 5 shows the estimated effects of the average speed in kilometers per hour for the different scenarios.

Only by reducing the maximum speed on all of the ring roads during the whole day (**80-scenario**) leads to a substantial drop in average speeds. On the Ring Roads this reduction is in the order of –17%. The average reduction for the network as a whole is –5%. In the peak periods the reduction is less due to the fact that the average speed is already lower as a result of congestion.

In a subsequent section of this paper it is shown that this drop in average speed directly results in a big loss of social benefits when the Value of Time method is used to estimate Cost benefits. The increased use of other roads (+3%) doesn’t lead to significant loss in average speed on these roads.

Also within the **C80-scenario** there is a drop in average speed (–12% on motorways compared to –17% in the **80-scenario**). However, as a direct result of the extra lane there is also an increase in the average speed during the peak
periods of +2%. In addition due to the increased attractiveness, during peak periods, the average speed on the other roads also rises. In the peak periods there is a surplus in speed gained by the extra lane and speed lost by introducing a lower maximum speed. During the rest of the day this surplus is negative for the C80-scenario due to the lower congestion levels outside the peak periods.

In the Air quality-scenario the extent of additional capacity is somewhat less than in the C80-scenario. The reduction of average speed during the day is also quite drastic, for Motorways is the reduction –15% on average and for the whole network –5%.

The Traffic Flow-scenario introduces a reduced maximum speed when an extra lane has been added but only in the peak periods. The physical combination of a lower maximum speed and an extra lane is positive for the average speed on motorways and other roads also outside peak periods. The peak periods are more attractive as a result and this leads to a small shift in departure time.

4. OTHER IMPACTS

As mentioned in the introduction this paper also deals with the impacts of the scenario on Air quality Traffic safety and Cost benefits. In short we mention the impacts and give some highlighted conclusions.

Table 1 Other impacts than Accessibility for the scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Air quality</th>
<th>Traffic safety</th>
<th>Cost benefits</th>
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<tbody>
<tr>
<td>80-scenario</td>
<td>+</td>
<td>-</td>
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<tr>
<td>C80-scenario</td>
<td>+++</td>
<td>+</td>
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</tr>
<tr>
<td>Air quality-scenario</td>
<td>++</td>
<td>0</td>
<td>-</td>
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<tr>
<td>Traffic Flow-scenario</td>
<td>0</td>
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The introduction of a reduced maximum speed in the 80-scenario is better for the urban Air quality than doing nothing but is not enough to meet the agreed European standards. The main bottleneck is the standard for particulate matter. The combination of 80 km/h and extra capacity on the ring roads in the C80-scenario has a much more positive impact on Air quality but still is not enough. Decreasing congestion levels is positive for the Air quality: the C80-scenario is better for Air quality than the Air quality-scenario. However, when the maximum speed is not reduced in a significant manner, as within the Traffic Flow-scenario, then it is not possible to improve the Air quality to a satisfactory level.

80 km/h has a positive effect on Traffic safety on motorways but is negative for other roads because of the increased use of other roads. Despite higher accident rates on other roads there is a balance in Traffic safety due to the reduction of
car mobility. The more the use of other roads is prevented the more Traffic safety gains.

None of the scenarios has a positive Cost benefit analysis due to the severe time losses outside the peak hours. The weighted gain in Air quality and losses in Accessibility is negative for all scenarios. The Traffic Flow-scenario has the best Cost benefit score but is still negative due to the limited impacts on average speed and Air quality and also because of the associated building costs.

5. CONCLUSIONS

The introduction of a reduced maximum speed of 80 km/h on ring roads has a large negative effect on Accessibility, particularly outside peak hours a shift towards the use of other roads can be expected.

The introduction of 80 km/h contributes to a reduction in congestion levels due to a loss of attractiveness for the use of motorways. The reduction in congestion is greater when the 80 km/h is combined with an extra lane. The trade-off between congestion levels and maximum speed of the average speed assumed for compact driving is negative.

Decreasing congestion levels is positive for the Air quality: the more congestion can be decreased the better the Air quality. However, when the maximum speed is not reduced in a significant manner then it is not possible to improve the Air quality to a satisfactory level.

The introduction of an extra lane in combination with a reduced maximum speed can have positive effects on Accessibility when it is applied only when needed in time (peak hours) and space (low cost). The gain in Air quality however is low.

6. REFERENCES

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