Evolution of road accidents

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"We can not predict the future
We can invent it"

1. Figures rule the world

Let's take sport. Coaches and players, but also the general public are lost without figures. Consider baseball scores, or Formula 1 racing times, for example.
There is always great interest in economic figures: the growth in the GNP, the size of the financial deficit, the growth in employment, the inflation percentage and index numbers enabling entry into the EMU represent some examples of figures which are not only published and discussed in the trade press; the national newspapers also print them. When economic figures are presented, the trade on the stock market responds. More markedly, business even responds to the announcement that economic figures will be published. This not only relates to the reproduction of series of figures from the past, it also concerns explanations for the noted developments. Favourable developments seem to have many claimants. In addition, the more one understands about the developments in the past, of causal relationships, the more one feels in a position to make predictions about the future.

Road safety is no exception to this rule. Several weeks ago, bold headlines in the Dutch daily newspapers declared: fewer traffic fatalities due to poor weather in the first half of the year. In the first six months of 1994, 575 fatalities were noted on Dutch roads, 52 less than in the same period a year previously - a drop of 8%, no less. The conclusion cannot be difficult: the signs for road safety in the Netherlands are healthy. There were even a few renowned experts who already had an explanation for this favourable development: the poor weather. The wintry weather in early 1994 meant that fewer old people left their homes; although the snow led to more collisions, their outcome was less severe, according to the newspaper reports.

It is extremely annoying for a Minister responsible for the improvement of road safety that this expert 'blamed' the poor weather for the favourable development in the number of road accident casualties. It would be very attractive for a politician, after all, to make an announcement in Parliament which would also be widely distributed to the press, stating that the number of road traffic fatalities is 8% less than last year as a result of the policy conducted, only to be thwarted by an expert who credits the poor weather for this drop. Would anyone dare doubt the conclusions of the expert, or is there still hope for the Minister?

Two questions will now need to be answered:
1. Is there indeed question of a drop in road hazard if the number of fatalities drops from 627 to 575? And, if there is a drop, is this drop incidental or structural?
2. What explanation can be given for this drop, if it is recognised as such?

2. Three pitfalls

If the monthly or quarterly figure for the number of road traffic fatalities is known, does this figure say something about the number of fatalities to be anticipated one month or one quarter later? This is certainly the case, but those who wish to make statements here should avoid the pitfalls. Firstly, there is a seasonal effect. The same number of road traffic fatalities is not seen every month: in the Netherlands, the figure in winter is less than in summer. This is because fewer trips are made in winter, people cycle and walk more in summer, etc. The seasonal difference is shown in Figure 1. Correction for monthly and quarterly figures is therefore required.

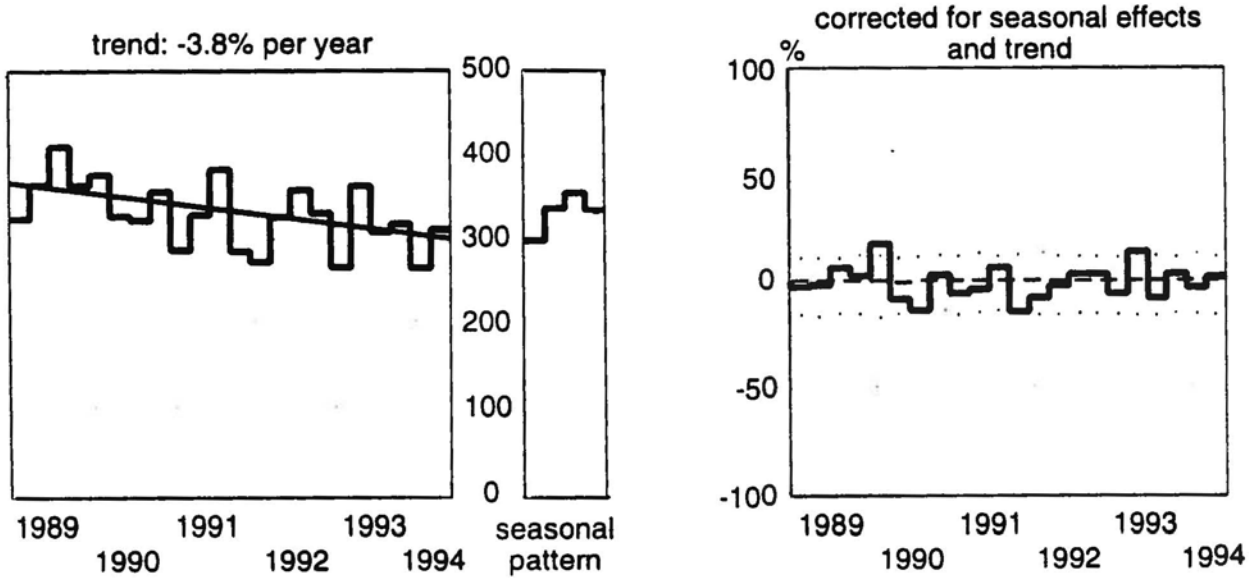

Figure 1. *Fatalities in the Netherlands 1989-1994.*

When one considers the development in the road accident figures over a number of years and makes a correction for quarterly influences, this leads to the situation shown. One can here draw a trend line, in this case strongly linear, tracing the actual development. This shows that the number of traffic fatalities in the Netherlands has dropped by an average of 3.8% in recent years, indicating that the conclusion that something quite unusual had occurred in 1994 was incorrect. Unfortunately for our expert, 1993 had an unusual second quarter, namely relatively high. Therefore, it is more pertinent to ask why this quarter was so unfavourable, rather than to ask why the first six months of 1994 were so favourable.
Our conclusion was therefore different from that of the quoted expert: the annual number of fatalities is dropping, and the drop in the first half of 1994 fits the trend very well.

As a consequence, politicians and policy makers for example would be advised to give themselves time to enable an overall analysis following the publication of new figures, so as not to make demonstrably erroneous statements. However, do not worry: our policy makers ensure that ministers do not step into the 'seasonal effect pitfall' or the 'pitfall of bi-annual comparisons'.

The third pitfall is the 'coincidence pitfall'. If the number of traffic fatalities drops from 100 a year to 95, not many people will dare to claim that there is question of a 5% drop; intuitively, many will say that the annual figure has remained constant. This intuition is correct. Road hazard should be seen as characteristic of the traffic system, a phenomenon expressed through the number of accidents and victims. These actual realisations lead to estimates for road hazard. As a result of the distribution of probabilities for the actual figures, these estimates are stochastic in nature. An essential question here of course is how great the fluctuations in probability are. It is general practice to adhere to the Poisson distribution as stochastic model for the distribution in the number of accidents. This means that if the anticipated value is 100, the distribution surrounding this value is the square root of 100, or 10. In other words, if the number of fatalities drops from 100 to 95, the conclusion should be: no change, the number has remained constant. The shadowed area in Figure 1 indicates the boundary within which there is in fact 'no change' in road hazard.

3. A trend?

When one considers the actual development over a longer period, e.g. fifteen years, then the Netherlands is represented by the figure shown in Figure 2. This indicates that a drop in the annual number of traffic fatalities from over 2000 in 1980 to approximately 1250 in 1993 represents a drop of almost 40%. The Netherlands scores quite well with this figure when compared to the international community. Nevertheless, a smooth, constant development is not unfolding before our eyes here. Sometimes, it seems that this favourable trend comes to an abrupt halt. However, two conclusions are impressed on us here:
1. It is very dangerous to announce an unfavourable trend if more road casualties are registered in one year than in the preceding year; the converse holds true also.
2. A higher than average drop seems always to be followed by a rise in the subsequent year.

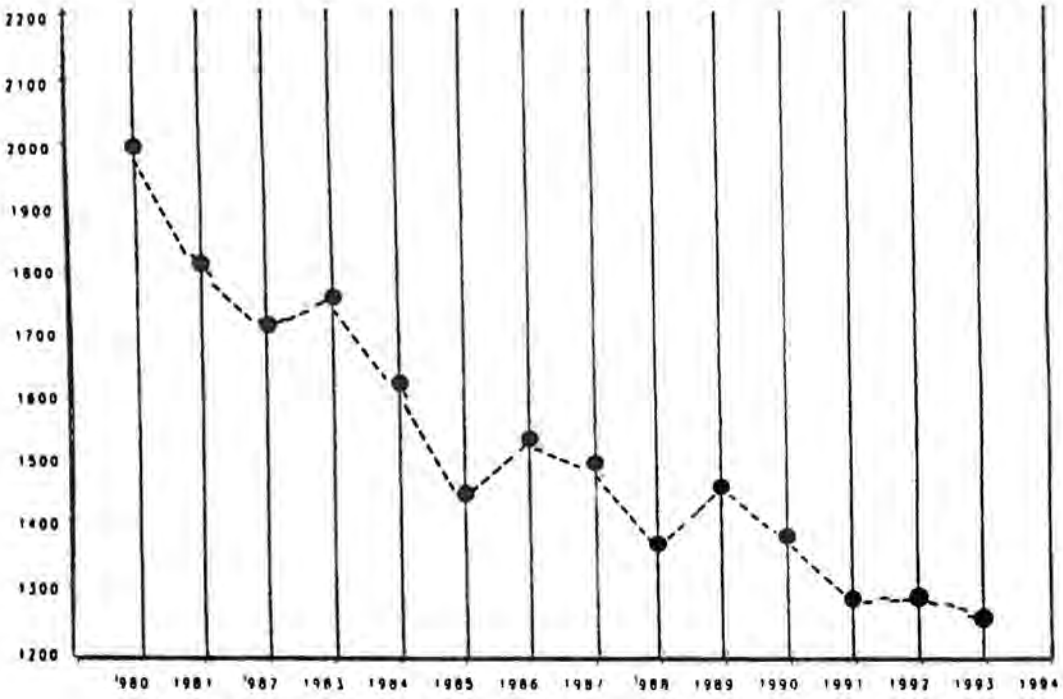

Figure 2. *Fatalities in the Netherlands since 1980, annual numbers.*

The picture becomes clearer if we do not try to pinpoint a trend in the actual annual number of traffic fatalities, but rather consider the moving average over the last twelve months. For the Netherlands, these values are shown in Figure 3. This graph again shows a downward trend.

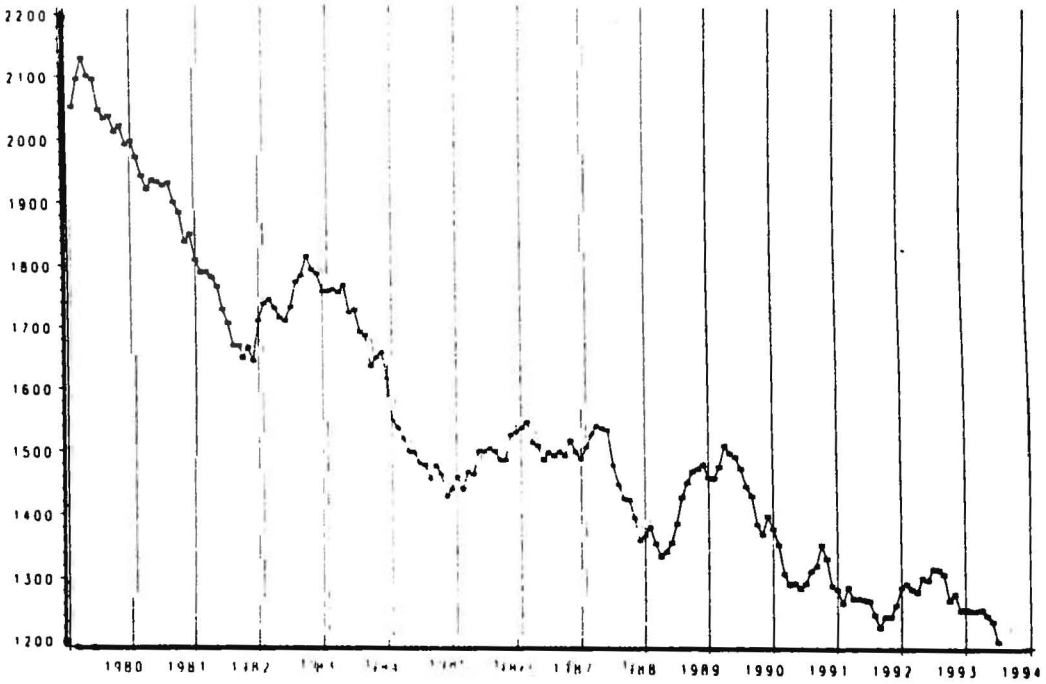

Figure 3. *Fatalities in the Netherlands since 1980, 12 month moving average.*

Furthermore, it is very interesting to find explanations for favourable and unfavourable deviations from the average downward trend. Methods have been developed to do so systematically. It is not sufficient to only make use of data about road accidents, but it is also necessary to understand the developments in the relevant factors of influence to understand the development in road safety. For example, the changes in driving under the influence of alcohol, the use of seat belts, speeding behaviour etc. Prior to this, however, one must answer the question of whether changes in a trend are due to changes in the road transport system: the mobility, the infrastructure, road safety legislation etc.

However, the trends shown in Figure 2 and 3 still leaves an important question unanswered: if there is a true drop in road hazard, why is this drop reasonably steady?

4. Developments in Eastern Europe

The developments in the field of road hazard do not show a steady, continuous pattern. Figure 4 shows the developments for several countries, with no recognisable trend. The political and economic changes at the end of the 1980s seem to be expressed also in terms of a growth in the annual number of road accident fatalities. Of course, indications can be given to explain this phenomenon, which can also be found in the literature: a rapid growth in the number of vehicles, many new and inexperienced drivers on the road, many western new and second hand cars driving at relatively highs speeds on inadequate and insufficiently maintained roads, much driving under the influence of alcohol in situations where there is

little police enforcement and a poorly equipped police force, etc. These are possible explanations, but scientifically supported evidence is not available.

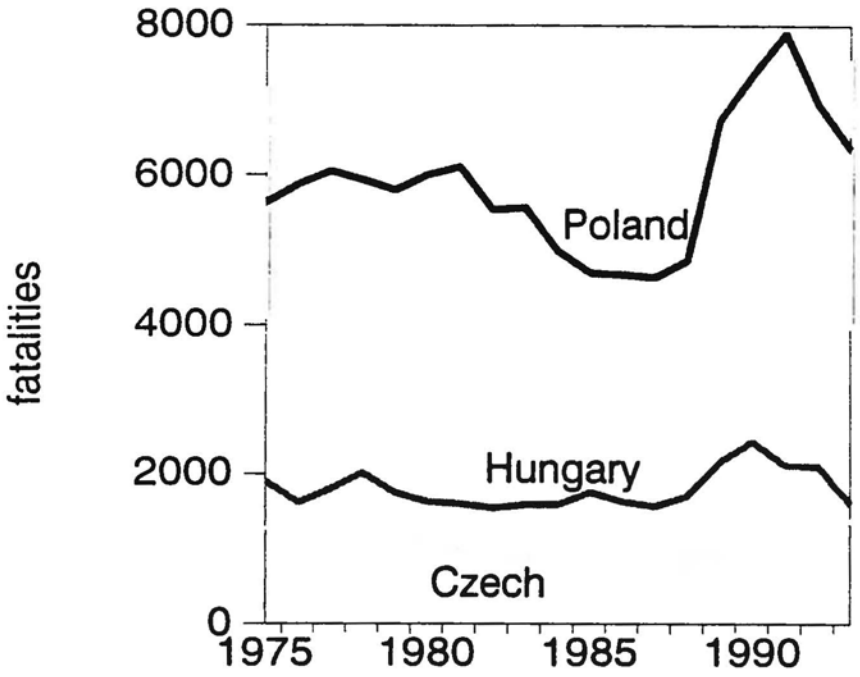

Figure 4. *Fatalities in Hungary, Poland and the Czech Republic, 1975-1992.*

It is furthermore striking that, in a number of countries, the growth in road hazard has come to a halt. There are even countries where the 'war seems to be won'. Is the drop in road hazard in countries such as Hungary and Poland the herald of a favourable development, or is there question of a temporary favourable development which will soon revert? In order to be able to answer this question, it is useful to consider what developments have occurred in this field in highly motorised countries. If these developments can also be applied to Eastern Europe, then predictions can be made for these countries on the same basis. However, it is risky to make statements about anticipated changes, particularly for the future. Reason enough to say something about the past in highly motorised countries, but not to be too eager to make statements about future road hazard developments for countries in Central and Eastern Europe. Nevertheless, lessons can be learnt!

5. More mobility, yet fewer traffic fatalities

In Figure 2, the development in the annual number of traffic fatalities after 1980 is shown. However, the development since 1950 gives a different impression (Figure 5). The annual number of traffic fatalities rose each decade, from 1000 in 1950 to 2000 in 1960, progressing to over 3000 in 1970. After that time, the annual figure dropped by more than 60%, to 1250 in 1993. How can this apparently strange development be understood, when we consider that mobility in the Netherlands multiplied by a factor of seven between 1950 and 1970, while after 1970 to the present day, mobility has further doubled. More mobility and yet, fewer traffic fatalities?

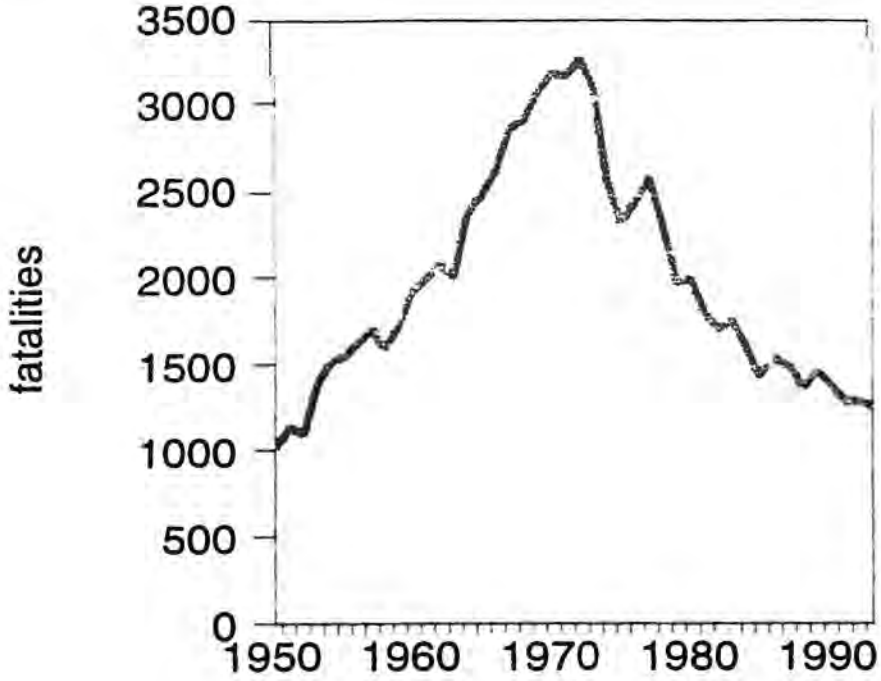

Figure 5. *After a decrease road safety in the Netherlands more than doubled since 1972.*

In various papers my colleagues Koornstra and Oppe have successfully modelled the developments of road fatalities based on long term developments in traffic growth (motorised kilometres) and in fatality rates (road deaths per distance of travel). The so-called logistic function, which is a S-shaped curve, fits the long term trend of traffic growth for many highly motorized countries. This could be illustrated for example by data from the USA, covering a period of almost 70 years (Figure 6).

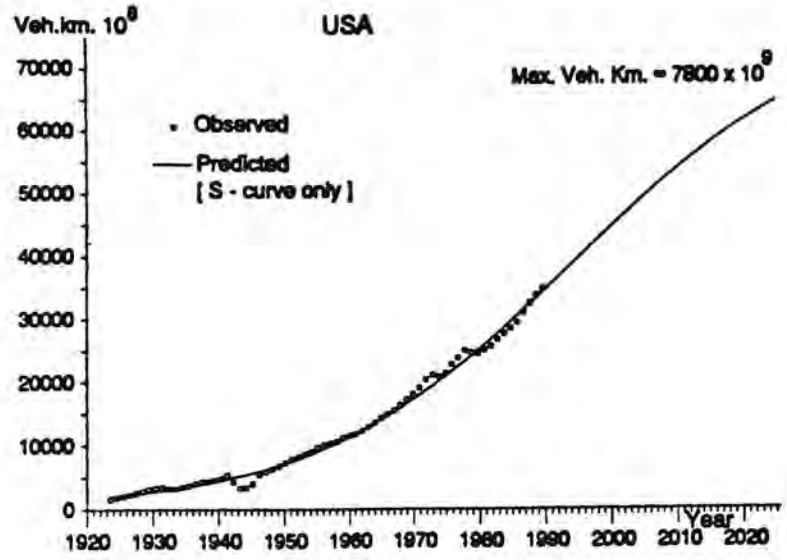

Figure 6. *The S-shaped development of kilometrage in the USA.*

The growth of motorisation is accompanied by exponentially decreasing curve for fatality rates. This means a reduction in annual road fatalities per kilometre driven with a constant percentage (log-lineair trend), although this percentage differs from one year to the next. The exponential curve is given for the USA, as an example (Figure 7).

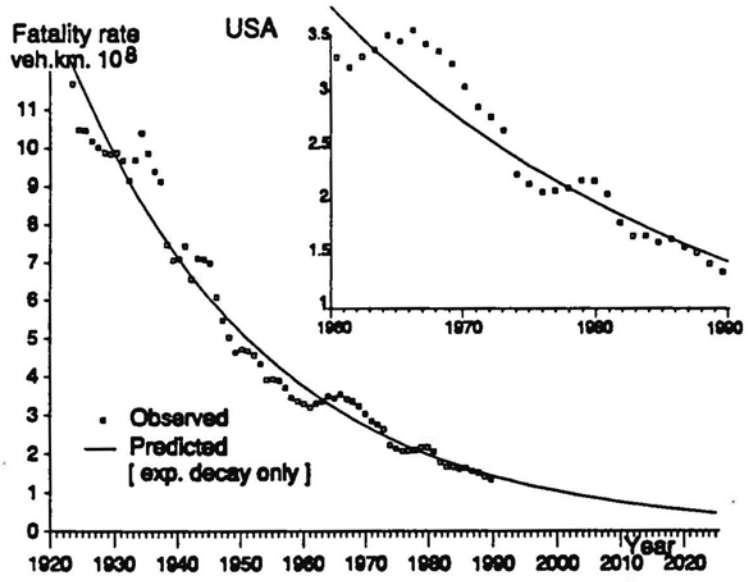

Figure 7. *The exponential decay of the fatality rates in the USA.*

The percent decline per year differs for different countries. Higher rates do not correspond with higher decline rates, although some indication could be found in different highly-motorized countries that nowadays the fatality rate decline is lower than in the past.
Koornstra and Oppe concluded on empirical data that cyclic modifications should be added to the longterm macroscopic trend of mobility growth and of fatality rate decrease as well, although some space for discussion remains. **Just by combining both developments as a product [fatalities = fatalities/kilometrage * kilometrage] the development of fatalities could be described (Figure 8).** This leads to the conclusion that a reduction in number of fatalities ought to be the result of a higher decrease in fatality rate than increase in mobility

Figure 8. *Relation between mobility, fatality rates and fatalities.*

growth. Should the growth in mobility accelerate, for example due to high economic growth, then extra attention should be devoted to (road safety) measures with the aim of further decreasing risk in road traffic, otherwise an immediate increase of fatalities will be the result.

The following interesting results of these modelling activities are of great importance for policy making in Central and Eastern European Countries.

First of all, remarkable differences are to be notified between different countries: high reduction rates in Japan and Finland (ca. 10% per year) and lower rates in the UK and USA with ca. 4%. It seems to be that the more recent the motorization and the more explosive, the larger the annual decrease in fatality rate. **This indicates that reduction rates of 8-10% in fatality rates must be considered as realistic targets for Central and Eastern European countries.**
Secondly, a correlation has been established in highly-motorized countries between traffic growth and fatality rate reduction: the slower the growth of mobility the less the reduction in fatality rate. High traffic growth percentages correspond with high fatality rate reductions in highly-motorized countries. However, in no sense this correlation is a result of a natural law or a spontaneous development. We might consider this correlation as a collective influence to adapt a society to growing traffic. Growing traffic requires an enlarged, renewed, improved and well-maintained road traffic system. This traffic growth and its corresponding adaptation results in better and newer roads, increasing mean driver experience, newer and safer vehicles and appropriate traffic regulations and enforcement. All highly-motorized countries went through this adaptation to mass-motorization. And a lot of information is available nowadays about effective measures to improve road safety. **So, if (accelerated) traffic growth is not accompanied by appropriate risk reducing countermeasures and activities, a (disastrous) increase of road fatalities might be an outcome.**
But, thirdly, a lagged correlation between traffic growth and fatality rate reduction were observed. So, after some years high traffic growth leads to higher fatality rate reductions. This could be understood as time-lag which is needed to implement effective counter-measures for risk reduction. But this means more fatalities due to traffic growth and some years later, hopefully, reduction. **The lesson to be learnt here is, when accelerated traffic growth is anticipated, no time has to be lost to invest in safety!** A long time-lag could be considered as a poor quality of the answer to traffic growth.

6. An example: developments in Poland

The developments of road traffic and casualties in Poland might serve as an example to illustrate the developments in Central and Eastern European Countries. In the framework of a co-operation between Poland and the Netherlands, SWOV works together with Polish road safety experts in the GAMBIT-project. Figure 9 shows the long term development of road accident casualties since 1955 in Poland. This development can be understood by a regular increase of traffic and decrease in fatality rate.

We learn from this an average decrease in fatality rate over the period 1955 - 1992 of 8.9%. However the decrease from 1982-1992 is only 6.2%. But Figure 10 clearly shows this average value hides the increase during the last few years, starting in 1988. The fatality rate is during the last few years rather low. When we assume that the fatality rate should be at least at the same level as during the years before (minus 5% and minus 10%) the conclusion could be drawn that the steep increase in fatalities in 1989/91 have been of a temporary nature.

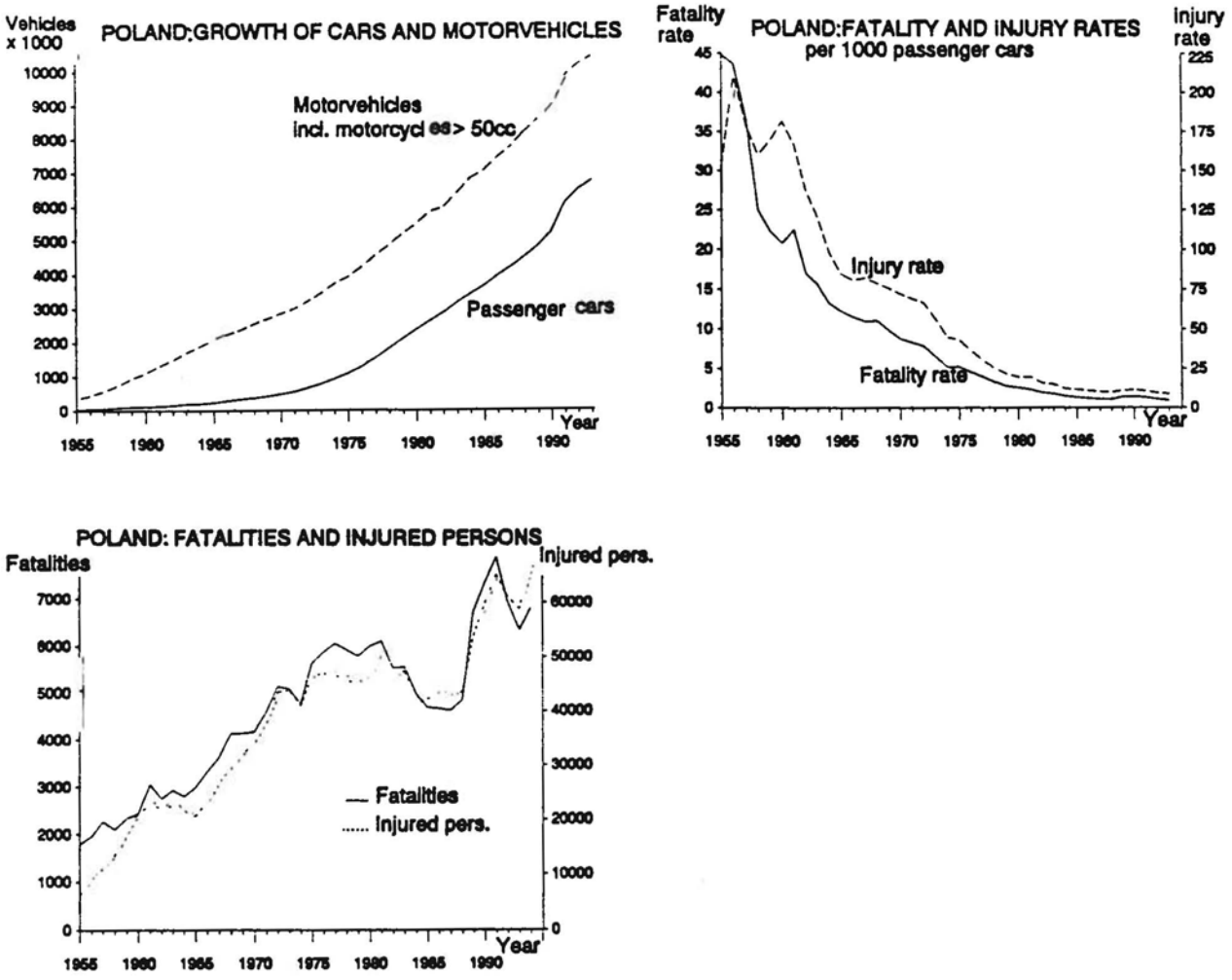

Figure 9. *Relation between growth of vehicles, risk development and casualties in Poland.*

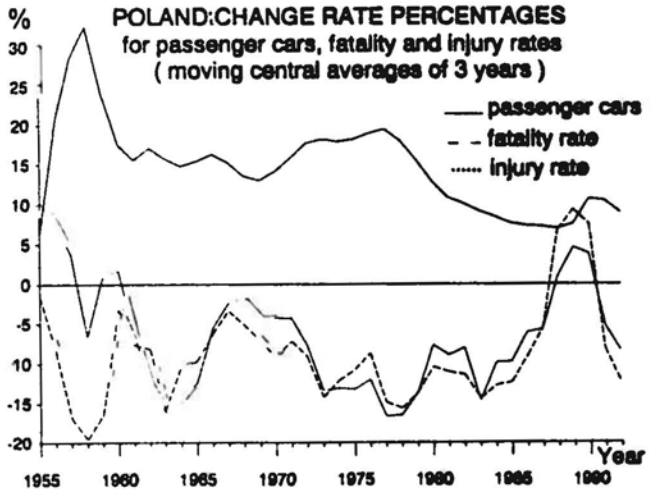

Figure 10. *Rate change percentages in Poland.*

The question then remains what to expect from the future? First we assume two possible saturation levels (Figure 11A): one car per two inhabitants (20 million cars) and one per three inhabitants (13 million cars). Two possible prediction curves for fatality rates are given. There is no evidence to decide which of both curves is most valid (Figure 11B). Based on these developments different scenarios could be made. A moderate traffic growth combined with a steep risk reduction, may be much optimistic, but nevertheless the most needed scenario (Figure 11C and D). The scenario with a fast traffic growth and a moderate risk reduction somewhat too pessimistic. We can suggest to learn lessons from examples in highly-motorized countries to reduce fatalities.

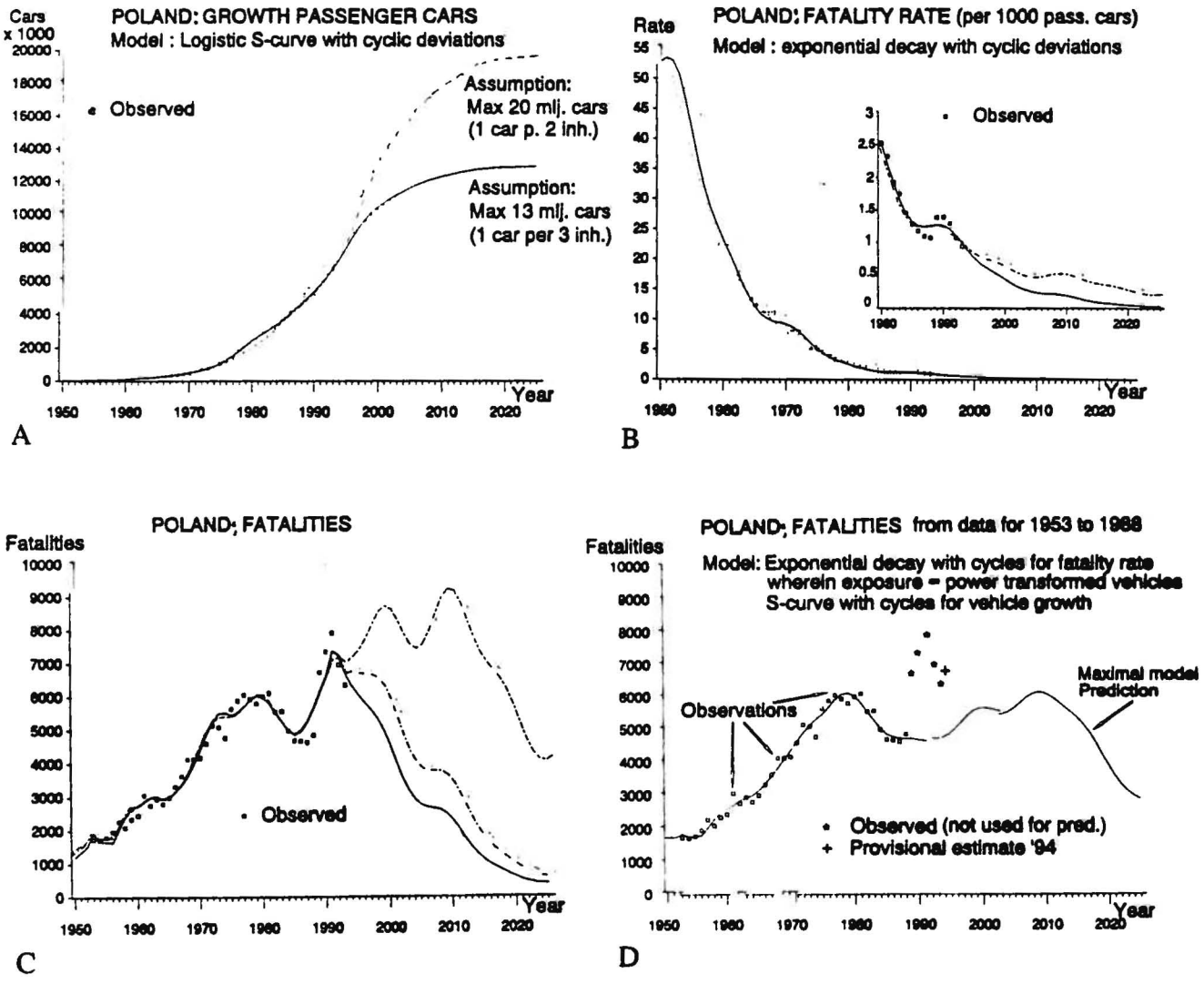

Figure 11A,B,C,D. *Analysis of growth of vehicles, risk development and predicted fatalities in Poland.*

In Figure 12 a scheme is presented of different accents in road safety policy in the Netherlands. Using different strategies and approaches have resulted in a rather positive result. The challenge for Central and Eastern European Countries is to reach the same road safety levels as high-motorized countries. From our experiences it is quite clear that growing mobility in a society could result in decreasing number of fatalities. The speed of

improvement could be influenced which mean that effective efforts pay. However, an evolution like this is not a spontaneous one in any sense. It is a result of investing in the quality of your road traffic system: the future can not be predicted. To invent a future, also in the field of road safety is a challenging task ahead. We wish you all success.

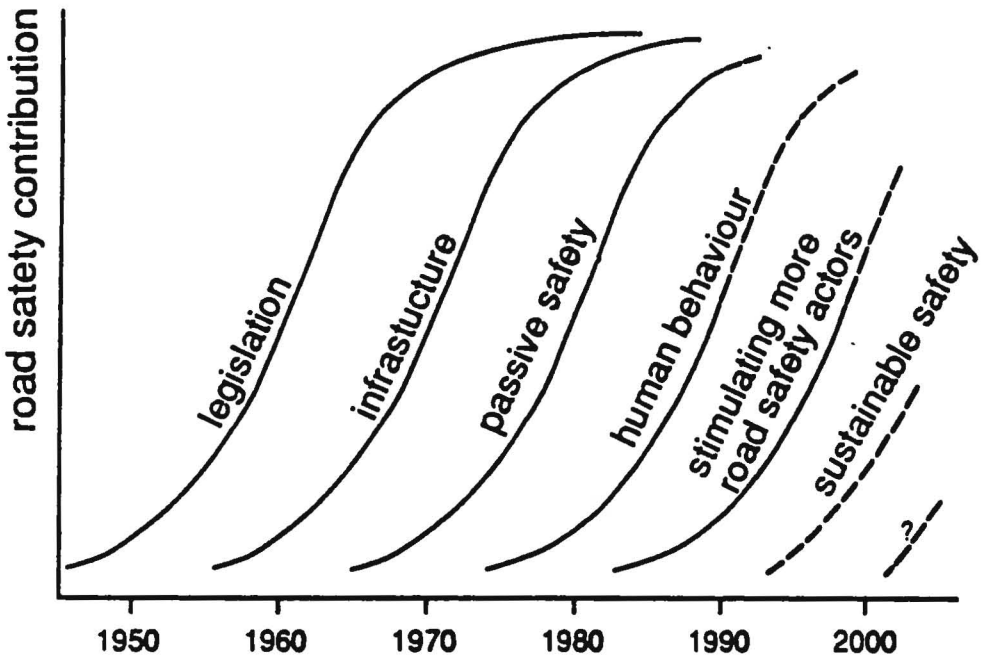

Figure 12. *Scheme of different accents in road safety policy in the Netherlands.*

7. Conclusions and recommendations

1. Road safety development is strongly related to traffic growth and to the quality (of improvements) of the road transport system. This relationship requires a road safety policy which is integrated in traffic policy and in infrastructure policy. Other integrations (police, public health, education etc.) are relevant as well. A National Road Safety Committee is to be considered as an adequate step to deal with this integration. Road safety policy which denies the relationship between traffic growth and road safety is undeniable too limited.
2. WorldBank projects and projects of other banking institutions have to acknowledge the relationships between traffic growths, investments in road transport and road safety. Sub-standard solutions in investments could result in accident risks which are avoidable too high.
3. Knowledge about the quantitative relationships between traffic growth and road safety in a certain jurisdiction, combined with knowledge on the effectiveness of road safety measures and interventions opens the possibility of formulating realistic road targets and targeted road safety programmes.
4. A Road Safety Information System (RIS) is needed to monitor road safety trends, to establish long term trends, to assess short term deviations of this trend and to explain trends and deviations. It is recommended to commission independent institutes for these analyses. Data which are needed for this Road Safety Information System have to be collected on a regular basis. Methodology to carry out this monitoring and assessment should be developed in all Central and Eastern European Countries.

5. The relationship between traffic growth and road safety seems to be a rather complicated one, but the results of the analyses of many high-motorized countries gives us the trust of the validity of these models, also for Central and Eastern European Countries.
6. (Accelerated) Traffic growth has to be acompanied by appropriate risk reducing measures. Fatality rates tend to decrease but only as a result of collective efforts and in no sense sponteneous. Fatality rate reductions of 8-10% per year can be considered as realistic targets for Central and Eastern European Countries. When traffic growths is anticipated no time has to be lost to invest in safety.