SWOV Fact sheet

The high risk location approach

Summary
The high risk location approach is one of the most traditional ways of improving road safety. This reactive approach tackles unsafe situations at locations with the most crashes. On average, this approach results in an 18% reduction in casualties at such locations. However, in the Netherlands this approach can no longer make a substantial contribution to a further road safety improvement. This is because there are ever fewer high risk locations and ever fewer casualties at these locations. Nowadays a growing proportion of severe crashes occur at unique locations. Therefore, it is better to reduce crashes with a systematic, proactive approach such as Sustainable Safety.

Background
Traditionally, dealing with high risk locations, also called black spots, has often been the method to reduce crashes and casualties. This is an appealing approach because dangerous situations are tackled there where they occur, viz. at locations with the most crashes. This fact sheet discusses the ins and outs of the approach and shows that in the Netherlands the number of high risk locations and the casualties at high risk locations have decreased considerably during the last decades.

How has the high risk location approach developed?
The method of tackling what were initially called Road Crash Concentrations began in the late 1970s. The Dutch government published a manual, organized training programmes for the personnel of road authorities and consultancies, and - last but not least – provided money for both the analysis of high risk locations (usually intersections) and for the resulting measures. The Ministry of Transport's *Road crash concentrations manual* (1979) supported this approach. From 1992 onwards these crash concentrations were renamed 'dangerous situations' which made it possible to include routes, areas, and specific crash types in the definition (CROW, 1992/1993). In other words, it no longer focused on locations.

For many years the emphasis on dangerous situations was a policy spearhead that had to make an important contribution to a further reduction of crashes and casualties. Many provincial and municipal governments used, and still use, one type or another of high risk location approach (Vis, 2000). The central government no longer contributes to the dangerous situation approach, but some provinces and regions still have subsidy regulations.

What does the approach involve?
The high risk location approach consists of three steps. The first step is identifying the high risk locations: looking for locations with many crashes within a particular area. The simplest method is to literally map crashes. By comparing their basic features with similar situations elsewhere, it can be determined whether a particular high risk location is relatively unsafe in terms of crashes and casualties, or whether there has been a relatively large increase. The next step is the analysis which looks for patterns and common characteristics of the identified locations in order to determine why the crashes happened. Finally, the results of the analysis are the basis for the third step in which the most effective measures are determined; these are often local infrastructural measures. Strictly speaking, the implementation of measures and their evaluation are not part of the high risk location approach, but are of course the normal steps within the execution of any measure.

Why is there a high risk location approach?
Crashes happen everywhere in the network of roads and streets. Some locations have more crashes than others. The question is whether this is purely random or whether there are specific factors that contribute to there being locations where more crashes occur. For a long time now, road safety research and policy have assumed that there are indeed factors that lead to many crashes, or high risk locations, and that it is possible to influence these factors and thus make the high risk locations disappear.

A practical reason for the high risk location approach is that it makes it possible to set priorities. In principle, a road authority can adapt all its roads and streets to improve road safety, but there are limitations in time and money. The high risk location approach makes it possible to use all available means for the locations with the most crashes. If many crashes occur at a particular location and effective measures are taken, these measures are probably also cost- effective i.e. the reduction in the number of casualties is in a positive ratio to the costs of the measures.

What is the definition of a high risk location?
The general definition of a high risk location in the Dutch Ministry of Transport's *Road crash concentrations manual* (1979) is as follows: "A road crash concentration is a location at which more crashes occur than at comparable locations elsewhere". The elaborations of this general definition indicate how many crashes must have occurred at a location for it to be referred to as a high risk location. It is important here that the criterion of 'at least X crashes (if necessary with the addition 'of a particular type') in a period of Y years' is chosen in such a way that the number of incorrectly selected, or, on the other hand, incorrectly not-selected locations is as small as possible (a not-selected high risk location or a selected non-high risk location).

At present, there is no hard definition of a 'dangerous situation': if during a period of three to five years ten crashes or five crashes with 'a comparable characteristic' (e.g. bicycle crashes or injury crashes in general) have been registered at a location, there is a dangerous situation. In practice one also still uses a variation of the older 1979 definition: six injury crashes[1] in a period of three years. In addition, it is possible that the number of high risk locations found is larger than can be tackled with the available budget. In that case it could be decided to raise the threshold somewhat, or, based on cost-benefit analyses, to increase the budget.

It is of course important that the body that selects the high risk locations has the necessary crash data, the instruments to process them, and the necessary skills. In the Netherlands, various data processing and data analysis tools have become available since the early nineties. Crash data availability is an increasing problem, particularly if a high risk location is partly determined by the number of Material Damage Only (MDO) crashes. The registration rate of MDO crashes is extremely low, is getting even lower, and there even are suggestions to remove MDO crash registration completely from the Dutch police tasks. In that case injury crashes will need to be used to identify high risk locations, and this crash type is increasingly less concentrated at specific locations (see further on). An additional problem in using MDO crashes for identifying high risk locations is that no relation between the number of MDO crashes and the number of casualties has ever been shown. Therefore it is not correct to assume that a reduction in MDO crashes at a particular location automatically means fewer casualties.

How effective is the high risk location approach?
The most recent evaluation of the high risk location approach in the Netherlands was carried out more than 15 years ago by Erné (1991) and involved 143 Road Crash Concentrations. This study showed a reduction in the total number of crashes, including MDO crashes, of 32% and a reduction in injury crashes of about 45%. However, the effects were not corrected for possible 'biasing factors'. More about this subject can be found in an evaluation study by Elvik (1997), in which he raised the matter of four potential 'biases'. For a correct determination of an effect the influence of these biases must be eliminated as much as possible:

1. Changes in the traffic volume
Changes in traffic volume affect the number of crashes. These can be corrected for by assuming that the number of crashes increases with the number of passing vehicles. Calculation models are available to make corrections for road sections (Reurings & Janssen, 2007) and are being developed for intersections.

2. General crash trends
A correction for the general trend can be made by comparing road safety developments in a control area or at comparable locations, assuming that these developments would also have happened in the high risk locations without the measure having been taken. This development must then be compared with the effect found at the location. In practice it is very difficult to obtain reliable data from a correct

[1] Injury crashes are crashes with at least one (slightly) injured victim

control area for the assessment. Often a comparison with all the crashes in a particular area, i.e. the municipality involved or the road network of a province, is considered to be sufficient.

3. Regression to the mean
The expression 'regression to the mean' refers to the phenomenon that locations with an extra high number of crashes during a particular period, will often have a lower number in the following period, even if no measure has been taken. This is a consequence of ever present fluctuations in the number of crashes per location. Several statistical calculation models have been developed to correct for regression to the mean. An acceptable correction method is to examine developments that occur for a group of similar 'dangerous' locations where no measure has been taken. This method is certainly not airtight because it can never be completely excluded that measures of a different kind at those locations may have had an effect.

4. Migration of crashes
Migration is the phenomenon in which the number of crashes in the immediate vicinity (also called the influence area) increases as a result of the measure at the dangerous location or in the area dealt with; in other words, crashes move to somewhere else. This can wholly or partially counteract the benefit from the measure taken. The effects within any influence area should therefore also be taken into account in the evaluation.

Elvik (1997) examined the relationship between the effects of the high risk location approaches and the way in which the evalaution study takes the misleading factors into account. He showed that the largest positive effects were found in those studies which made no allowances for any of the four misleading factors. On the other hand, only slight positive effects remained in studies in which the assessment had indeed taken influences of the general trend, regression to the mean, and migration of crashes into account; changes in traffic flow were seldom measured reliably. His conclusion was that the more refined the design of the evaluation study was - and therefore, generally, also more accurate and reliable - the smaller the positive effect of the high risk location approach involved.

In the approximately 40 studies that Elvik examined, the average effect was *a decrease in crashes of 18%*. This is a lot less than the effect of the previously mentioned Dutch evaluation study of Erné (1991). Up till now the positive effect of the classical high risk location approach may have been overestimated because many (international) evaluation studies have shortcomings.

Is a high risk location approach cost-effective?
The cost-effectiveness of the high risk location approach was also studied by Erné (1991). The average costs of tackling the high risk location amounted to about € 120,000 (Dutch price level 2007) per location. The locations studied had an average of 1.45 of injury crashes per year. If we assume the effect to be 18% fewer injury crashes rather than 45% (see Elvik, 1997), the reduction would be (1.45 x 0.18) = 0.26 injury crashes during the first year. The cost-effectiveness is calculated by using the number of crashes saved during a period of 10 years. If 0.26 injury crashes are saved in the first year, then 2.19 injury crashes are saved in 10 years[2]. The costs then are €120,000 ÷ 2.19 = € 54,871 for each injury crash saved. In the 1999-2008 period, an injury crash at a black spot had an average of 0.221 deaths and in-patients; consequently the cost-effectiveness is € 54,871/ 0.221 = € 248,283 per casualty saved. The social costs of a such a casualty (mainly in-patients and for a small part road deaths) amount to an average of € 315.320 (calculation based on Wesemann 2000a; 2000b). By preventing one casualty this amount can be regarded as a social benefit. The cost-benefit of the high risk location approach is therefore (248,283 / 315,320 =) 0.79. This means that at the locations studied the social benefits were higher than the social costs. Therefore, the measures were cost-effective. It must however be noted that the number of casualties (fatalities and in-patients) per injury crash in the period 1999-2008 initially went down from 0.267 to 0.115, but afterwards went up again to the 1999 level.

Does the high risk location approach contribute to reducing the number of casualties?
During the last 20 years there has been a clear reduction in the number of high risk locations in the Netherlands: in the 1987-1989 period there still were 1,909 high risk locations (with at least six injury crashes in three years), and in the 2006-2008 period their number had gone down to 275, an 86% decrease. The numbers of deaths and in-patients at the high risk locations during the 1987-1989

[2] This figure is reached by determining the so-called 'contant' number of injury crashes. The costs and effects are made contant to the first year using a discount rate.

period were 397 and 4,367 respectively, whereas in the most recent period these numbers were 32 and 542, decreases of 92% and 88% respectively.
The percentage of all fatalities and in-patients at high risk locations in the Netherlands is also decreasing. During the 1987-1989 period 10.5% of all fatalities and inpatients occurred at high risk location locations, in the 1997-1999 period this percentage had declined to 6%, and to 1.8% in the latest available period of 2006-2008. In other words, in a relative sense, an increasing number of serious crashes occur at locations that are not high risk locations; often at unique locations. Therefore, the high risk location approach is having ever less effect on the reduction of deaths and in-patients.

Figure 1 shows that the number of high risk locations and their registered deaths have shown a large decline since 1987. If we were to tackle all high risk locations we would save a maximum of 32 deaths in three years. An approach with an 18% effect would result in a reduction of (32 / 3 x 0.18) = approximately 2 deaths a year.

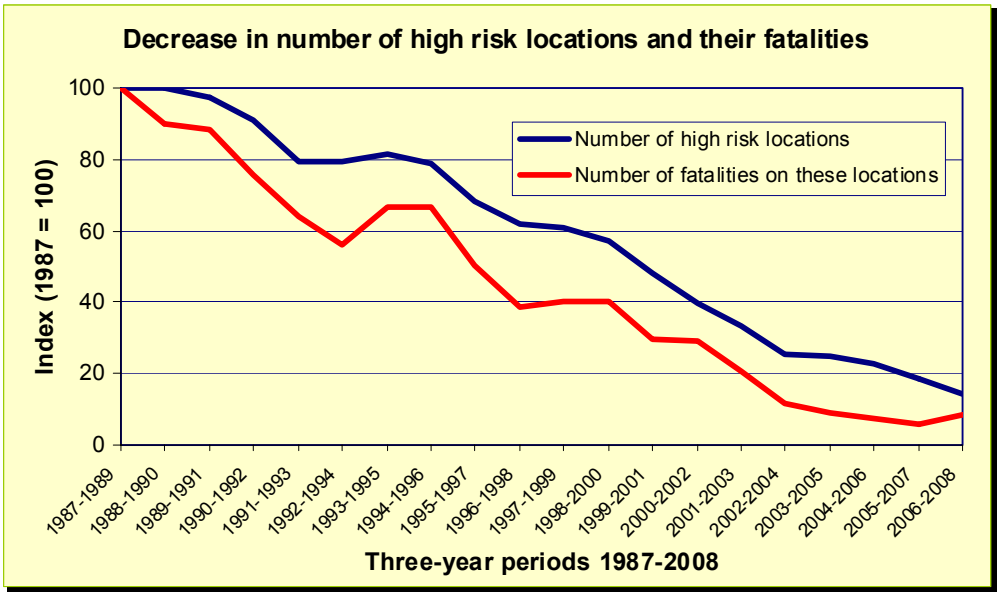

Figure 1.

In addition to the decreasing number of high risk locations and their casualties, the question remains whether it is still correct to use the 18% effectiveness of the high risk location approach. The effectiveness may have become less in the course of time. It is correct to assume that the general road safety improvement as a result of the many measures taken also applies to high risk locations; and that therefore there is less to be gained at those locations by taking new measures. Although the general improvement mainly refers to the number of deaths and less to the number of injury crashes, even the two deaths saved per year, as calculated above, could be an overestimation. Everything considered, the conclusion is that in the Netherlands the high risk location approach can no longer make a substantial contribution to a further reduction of the number of deaths and in-patients.

Conclusion
The high risk location approach is one of the most traditional ways of tackling unsafe traffic situations. It is an appealing approach because road crashes are tackled where they occur, viz. at locations with the most crashes. On average, a high risk location approach results in an 18% reduction in casualties, and in most cases is cost-effective. However, this fact sheet has made plausible that in the coming years the high risk location approach will no longer make a substantial contribution to the reduction of casualties in the Netherlands. This is due to the fact that since the 1987-1989 period the number of high risk locations has declined by 86% and the number of deaths at these locations by 92%. Comparatively more serious crashes occur at unique locations. At those locations crashes can still be tackled, but a systematic, proactive approach offers better possibilities than a reactive approach such as the high risk location approach. There are many examples of an effective proactive approach, as, for example, set out in the Dutch Sustainable Safety vision (Wegman & Aarts 2006).
From the viewpoint of effectiveness and cost-effectiveness considerations, the high risk location approach can certainly still play a role in road safety policy. The measures for tackling these high risk locations should be specifically focussed on the problems brought to light by analysis of the crashes

that occur there. In the Netherlands these measures must, of course, also conform with the general Sustainable Safety principles.

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(SWOV reports in Dutch have an English summary)

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