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QUANTITATIVE ANALYSIS OF BIRD DISTURBANCE IN ENVIRONMENTAL IMPACT ASSESSMENT

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Summary

For large infrastructural projects in the Netherlands an Environmental Impact Assessment (EIA) is compulsory. An important ecological consequence of the construction of motorways is the disturbance of breeding bird populations. To quantify this impact a GIS application has been developed.
Using variables as maximum speed and expected number of vehicles per day the impact of several motorway alternatives is predicted. The road alternatives are compared in a quantitative and objective way. The paper focuses on the implementation of the impact relationships from ecological fieldwork in a GIS application and the practical use of the application in EIA. The described, GIS-assisted method proves to be a flexible and efficient way of quantifying environmental impact.

Introduction

Because of the growing population and mobility new infrastructure is necessary to keep the economic centres of the Netherlands accessible. The Ministry of Transport, Public Works and Water Management is responsible for the planning and construction of new infrastructure. The shortage of space in the Netherlands demands well-considered planning. To take into consideration the environmental consequences of such projects an Environmental Impact Assessment (EIA) is a compulsory part of the planning. This paper describes a GIS-assisted method to quantify an important ecological consequence of motorway construction: the disturbance of breeding bird populations. The method is based on extensive ecological fieldwork. After a concise description of the field research, the paper describes the method and its conversion in a GIS-application. Finally some examples of the practical use of the application are presented. From these examples the benefits are shown of the use of GIS in Environmental Impact Assessment.

Field research

The prediction of breeding bird disturbance by motorways is based on a study carried out over a seven year period by the Road and Hydraulic Engineering Division in cooperation with the DLO Institute for Forestry and Nature Research. At 69 locations throughout the Netherlands the density of breeding bird populations was examined at various distances from motorways and other roads with predominantly fast traffic. These locations consisted of woods and

agricultural grasslands. From this research so-called effect distances were derived. The effect distance is the distance from the road edge until where the disturbance can be detected. Further from the road the traffic seems to have no disturbing effect. The research showed an average 35 percent decrease in breeding bird density within the effect distance. Effect distances proved to be different for woodland birds and grassland birds. Disturbance and therefore effect distance increased with growing traffic intensity or increasing speed limit. An increase in woodland cover along the road showed less disturbance and thus a smaller effect distance. This result was attributed to the sound absorbing and reflecting capacity of tall vegetation.

Prediction of effect distances

Analysis of the research results showed a strong relationship between noise load and effect distance. Visibility of cars turned out to be unimportant compared to noise load [1]. Based on dose-effectrelationships tables are made to predict effect distances. The relationships of individual bird species are combined into two groups; woodland birds and grassland birds. Table 1 shows a part of a table for woodland birds. Each table lists, at a given speed limit and traffic intensity, four effect distances corresponding with different wood cover classes.

Table 1. Some effect distances [meters] for woodland birds at a speed limit of 120 km/hour.

traffic intensity [vehicles/24 hours]	woodland fraction			
	> 0.9	0.9-0.5	0.5-0.3	< 0.3
40.000-50.000	210	360	605	880
50.000-70.000	253	435	715	1010
70.000-90.000	305	520	830	1160
90.000-110.000	355	595	930	1280
110.000-130.000	402	660	1010	1380

From method to a GIS-application

Because of its clearly described quantitative relationships the method to predict effect distances could be translated in a GIS-application. In 1993 a menu controlled application was built for a large Environmental Impact Assessment in the southwest of the Netherlands. The working of the GIS-application is illustrated with the following set of eight figures. In the described example just one effect zone is created. When disturbance is studied for woodland birds as well as grassland birds, two zones have to be constructed.

Figure 1 shows a typical situation: a planned motorway (thin line) in a varied landscape of woodlands (dark areas) and grasslands (light coloured areas). For the calculation the motorway is sectioned in 250 meter stretches (figure 2). For every stretch four triangles are created at the effect distances that apply to a motorway with a certain speed limit and traffic intensity. Each triangle corresponds with a woodland fraction class. Figure 3 shows these triangles for a selected stretch on both sides of the road. The triangles are created with an angle of 113°. The woodland cover within this angle is supposed to determine the noise reduction [2]. With each of the four triangles a cutout of the woodland file is constructed (figure 4). In this way the woodland cover of each triangle can be calculated as a percentage of the total surface area of the triangle. For the larger triangles the surface area of the smaller triangles is also used, so the largest triangle of figure 4 comprises the complete coloured area. To select an effect distance the woodland percentage in each triangle is compared to the limiting values of table 1, starting with the smallest effect distance. In figure 4 the wood cover in the first triangle is more than 90%, the first limiting value, so the smallest effect distance is chosen.
Subsequently the other side of the road is examined (figure 5). Again the woodland cover in the first triangle is more than 90%, so again the smallest triangle is selected. For the next road stretch (figure 6) the wood cover is less than 90% in the first triangle, less than 50% in the second triangle and also less than 30% in the third triangle. In this case the largest effect distance is selected. When all effect distances are chosen (figure 7) the individual lines are combined into one effect zone (figure 8).

For further analysis the effect zone is easily combined with for example a file containing important breeding bird locations. In this way the impact of a proposed motorway on the local bird communities can be estimated.

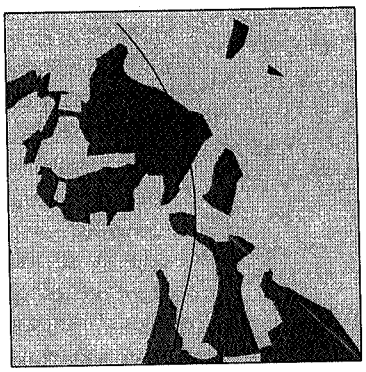

Figure 1. Proposed motorway in partly wooded landscape (dark areas)

Figure 2. Motorway sectioned in stretches of 250 metres

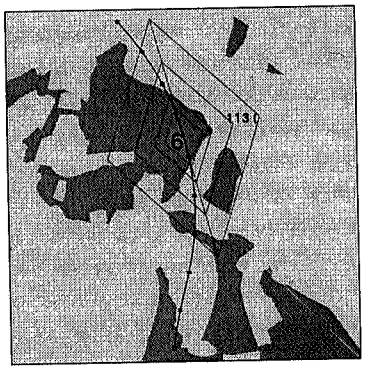

Figure 3. Triangles created for selected stretch

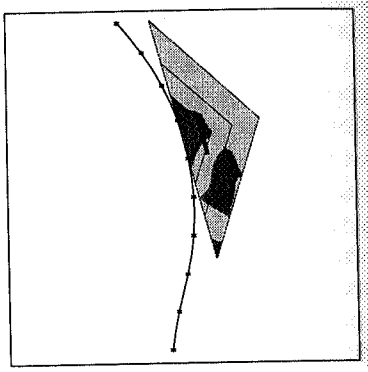

Figure 4. Cutout of woodland file, effect distance selected at one side

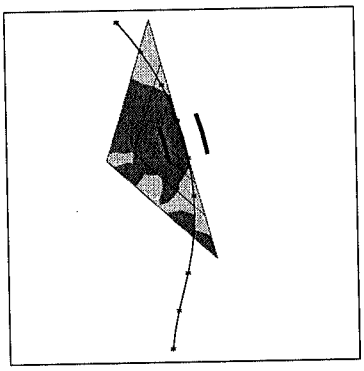

Figure 5. Effect distance selected at other side

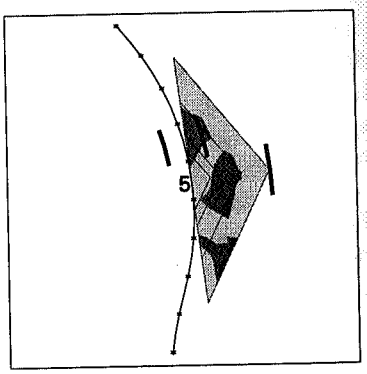

Figure 6. Effect distance selected for next stretch

Figure 7. All effect distances are selected

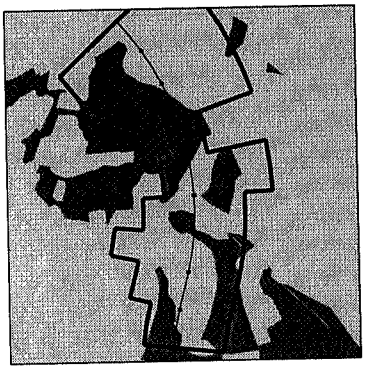

Figure 8. Distances combined into one effect zone

The use of the GIS-application

In several Environmental Impact Assessments the GIS-application has been used. It was originally developed for a large EIA in the southwest of the Netherlands. For several alternatives of two new, related motorway stretches the disturbance of birds was predicted. The effect zone for each alternative was combined with a breeding bird location file. From this analysis the number of disturbed breeding bird couples was obtained. Every species of bird was rated according to its rarity, based on a regional classification system. A rare kingfisher for example had a higher value than a more common duck. By multiplying the number of disturbed couples with the species specific rating a score was obtained for every alternative. In this way a comparison between the alternatives was possible and a distinction was made between the harmful and less harmful alternatives. A disadvantage of the aforementioned use of the GIS-application is the coincidental character of breeding bird location files. The number and location of breeding bird couples varies considerably throughout the years. In subsequent analyses valuable breeding bird areas were used, based on long-term inventories.

In 1996 one alternative was chosen and a detailed technical road design was prepared. The Dutch Ministry of Transport, Public Works and Water Management has committed itself to compensate for the expected loss in natural values if avoidance or reduction is not possible. Therefore a nature compensation study was started to determine the destroyed and disturbed nature area. The destroyed area is defined as the area that will disappear because of the constructed motorway. To calculate this, a nature area file was combined with the surface area of the future motorway. The disturbance of natural values was supposed to be represented by the disturbance of birds. An

effect zone was created around the elaborated motorway route. This zone was also combined with the nature area file to calculate the expected disturbed surface area in hectares.

Along some parts of the motorway route noise reduction measures are proposed, for example the construction of 3 meter high screens along the road. To calculate the noise reducing effect of these measures an extra option was added to the GIS-application. At the site of the barrier a reduction factor is applied to the effect distance according to the height of the barrier. Figure 9 shows an example of this analysis. The destroyed and disturbed nature areas are presented in this figure. The destroyed nature area will be fully compensated for, the disturbed area only partly. The noise reducing effect of the sound barriers will be taken into account when their construction is approved.

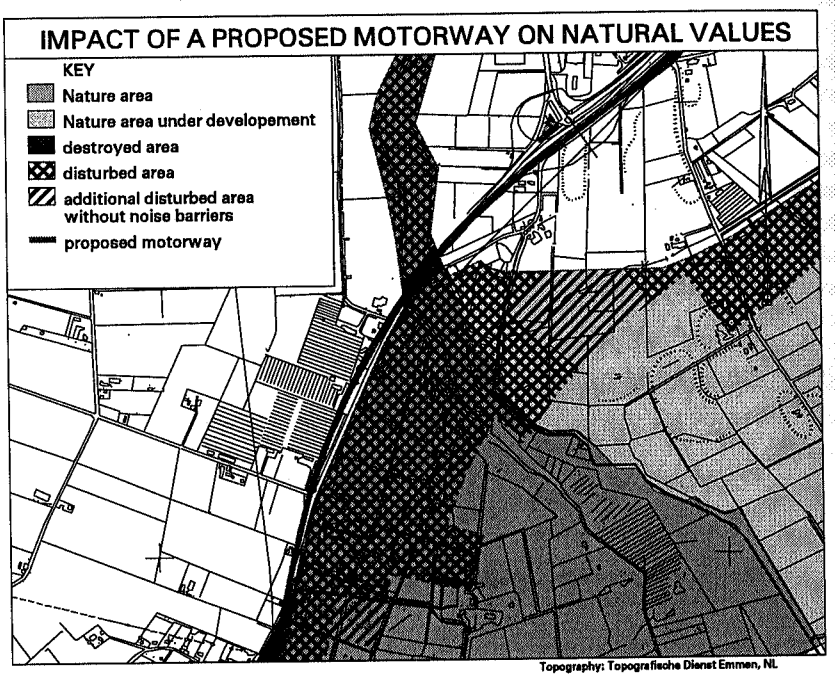

Figure 9. Disturbance and destruction of nature areas

Concluding remarks

The use of a GIS-application in the analysis of bird disturbance allows a clear, quantitative and therefore objective comparison between various motorway alternatives. The application facilitates the reproduction of analyses. For example, when a new motorway alternative is developed its effect on the breeding bird populations can quickly be determined. Adjustment to new circumstances, for example noise reducing measures, is reasonably easy. The flexible and time-effective qualities of GIS-analysis were highly appreciated in the presented examples.

References

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