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COMBINED ASSESSMENT OF NOISE FROM SHOOTING AND TRAINING AREAS

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1. INTRODUCTION

Military shooting and training areas host many different activities the noise of which can affect people living in the vicinity. Training schemes may include use of heavy weapons, blasting, or use of hand weapons. Hand weapons may be fired on regular shooting ranges, or they may be fired with blanks as a part of field exercise from almost anywhere on training areas. The noise impact consists of impulsive noises with a wide range of maximum levels and different spectra.

This paper outlines a method for assessing the combined influence from heavy weapons and hand weapons used on shooting and training areas. It is based on literature studies and has been used for planning purposes in Denmark. Shooting ranges have to obtain environmental approval, and noise limits exist that influence the allowed number of firing days. Noise from heavy weapons and shooting and training areas is not yet being regulated.

2. COMBINED ASSESSMENT

In Denmark different kinds of noise are treated individually. Separate guidelines deal with road traffic noise, rail noise, industrial noise, and shooting noise. The noise metrics as well as the noise limits differ, so it is erroneous to simply add the contributions from different kinds of sources. A literature study [1] should illustrate if it is possible to assess the total annoyance from more noise sources.

The basic conclusions, which are based mainly on laboratory experiments, are:

- when one type of noise is much more annoying than other types, the total annoyance equals the annoyance from this noise type, and
- when more types of noise are almost equally annoying, the total annoyance is higher than the annoyance due to each of the sources.

Prior to adding noise levels from different kinds of sources, they must be corrected for differences in dose-effect relationship. This may take place by addition of (level dependent) penalties. A method published by J. Vos [2] for assessing the combined influence from impulsive, aircraft, and road traffic noise

includes addition of corrected noise levels along these rules.

3. COMMUNITY RESPONSE TO NOISE FROM HEAVY WEAPONS

The dose-effect relationship for noise from heavy weapons was established in another literature study [3]. The results from several social surveys [4-9] were compared, and causes for differences investigated. One cause was the propagation model applied; a model for the average year weather conditions gives 3 dB lower noise level for the same community response than a downwind model. Fig. 1 shows the dose-effect relationship from the surveys, offset by a number of dB to agree in the range 0 - 20% highly annoyed.

The C-weighted long-term equivalent noise level had the closest relation to the annoyance, and a penalty for events during the evening, the night, and the weekend period was recommended. The one-year equivalent noise level, with a 5 dB penalty for the evening and the weekend period and a 10 dB penalty for the night, is called $L_{C,DEN}$. The estimated dose-effect relationship is given in Table 1.

% highly annoyed	5%	10%	15%	20%
$L_{C,DEN}$, dB (downwind)	48 dB	53 dB	57 dB	60 dB

Table1. *Estimated dose-effect relationship for noise from heavy weapons.*

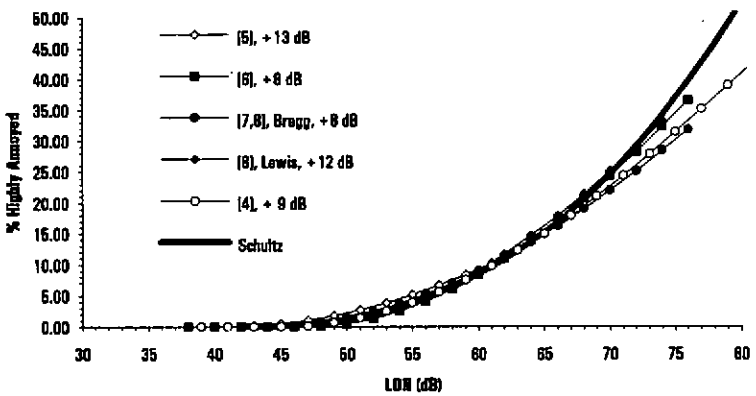

Fig. 1. *Dose-effect relationship for noise from heavy weapons from different investigations. The curves are offset a number of dB as indicated to coincide with the curve from Schultz (1985) for traffic noise.*

4. COMMUNITY RESPONSE TO NOISE FROM HAND WEAPONS

The metrics used for description of noise from hand weapons at shooting ranges in Denmark is the maximum level $L_{pA,I}$ of a single shot from the most noisy weapon. This is not suited for describing the noise from a training area, where different weapons are fired from different places and in different directions. A third

literature study [10] dealt with noise from hand weapons using the long term equivalent noise level as a descriptor. The results from four social surveys [11-15, based partly on 16] were compared. The connection between the different surveys was not obvious, but some degree of agreement was found. The estimated dose-effect relationship for hand weapons gave 10 dB lower values for $L_{A,DEN}$ than the corresponding $L_{C,DEN}$ levels for heavy weapons in Table 1.

5. CALCULATION OF NOISE FROM HEAVY WEAPONS

The program LarmLast [17] was used to determine the noise from heavy weapons in the vicinity of shooting and training areas. The program includes a data base of weapon noise, and uses a simple sound propagation model for the C-weighted noise level. This is sufficiently accurate as the noise from heavy weapons is low frequent noise that is little influenced by ground effect, vegetation and small hills. From calculation of C-weighted SEL of single shots, $L_{C,DEN}$ is calculated based on the number of firings from each stand.

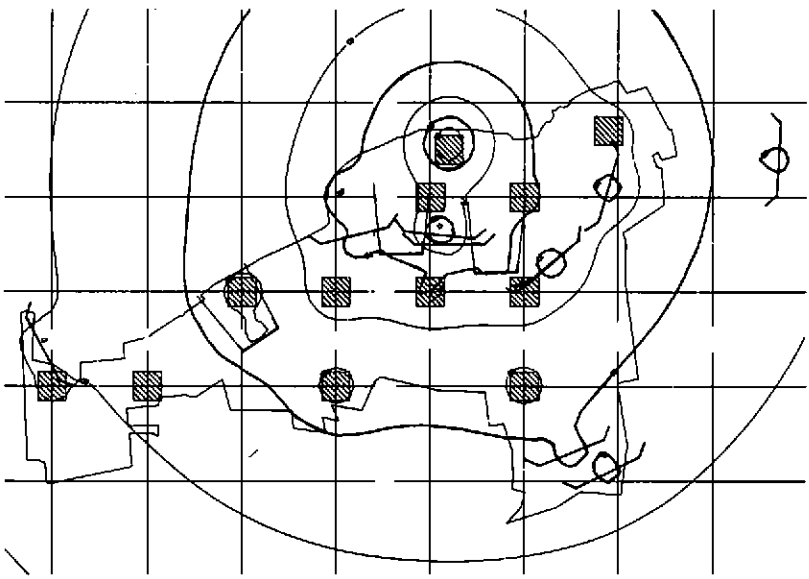

Fig. 2. *Example of noise contours for heavy weapons.*

A noise map is shown in Fig. 2. The main part of the noise is from explosions and detonating shells, and at large distance the noise contours are circles around the target and blasting area.

6. CALCULATION OF NOISE FROM HAND WEAPONS

The calculation of noise from hand weapon was done with the program SoundPLAN [18] applying the Nordic model for sound propagation of industrial noise, where the calculations are made in 1/1-octave bands. The program can define a large number of source locations thus simulating the firing of weapons over an area. The noise emission from hand weapons is directional. As any firing direction is equally probable, the energy average of the noise emission in the different directions was used for source strength. The total number of firings and the distribution over the area was used for calculation of $L_{A,DEN}$.

The calculations showed that the noise zones due to the hand weapons, corrected for the difference between the dose-effect relationship, were at least 10 dB less than the noise zones from the heavy weapons. Following the total noise impact equals that due to the heavy weapons alone.

7. CONCLUDING REMARKS

In three cases the combined noise from heavy weapons and hand weapons was assessed. In most cases when heavy weapons are used, the influence from hand weapons can be disregarded. On training areas where the main activity is use of hand weapons and training ammunition, the noise from the hand weapons may have a significant influence. The method may be extended to also account for noise from aircraft, vehicles and other equipment.

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ENVIRONMENTAL ASSESSMENT FOR THE RELOCATION OF THE MAIN ROAD NO. 43

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The Hungarian government decree on environmental impact assessment of 86/1993. (VI. 4.) and its modification of 67/1994. (V. 4.) and 152/1995. (XII. 12.) made it compulsory to conduct environmental impact assessments for investments and activities.

The Technical Directive (MI-13-45-1990) contains the "General contents and methodology for environmental impact assessments of investments".

Environmental Impact Assessment (EIA) is an instrument which is used to aid and imporve the decision-making process.

The purpose of the environmental assessment is to investigate the processes and conflicts of the area involved in the planning stage, and to explore the possible negative effects on the environment, and also to propose a track on the area where the least conflicts occur.

The present main road 43., having a big transit traffic, crosses tow towns, Szeged and Makó, and 6 villages. It seems necessary to destress this region by construction of the Motorway M43.

The planned track ot the Motorway runs on the Great Plain, crossing mainly agricultural lands, relatively far from residential areas.

The detailed survey deals with the factors, and effective processes, and with the limits of their effects, of the main road M43, and also with the protection of the surrounding environment, namely, the animals, waters, air, soil, and the countryside, added to the other social and economical effects.

On the basis of our measurements, investigations, discussing with local people and local agencies, the following environmental impact network can be presented (Fig. 1).

The preliminary survey examined two main and more individual versions, whereas the detailed assessment deals with two track versions.

The directly affected area is the surrounding 75 to 170 meters of the planned track. This has been calculated from the expected nightly noise effect coming from the planned completion stage.

The indirectly affected area means the surrounding 80 meters of the roads built next to the main road M43 (junctures, etc.) where an increasing noise effect is expected.

We have examined the noise level of both areas in the following cases:

- present state
- reference state (2005) [by reference state we mean the forecast state that would be realised without the main road)
- forecast state as planned (2005)

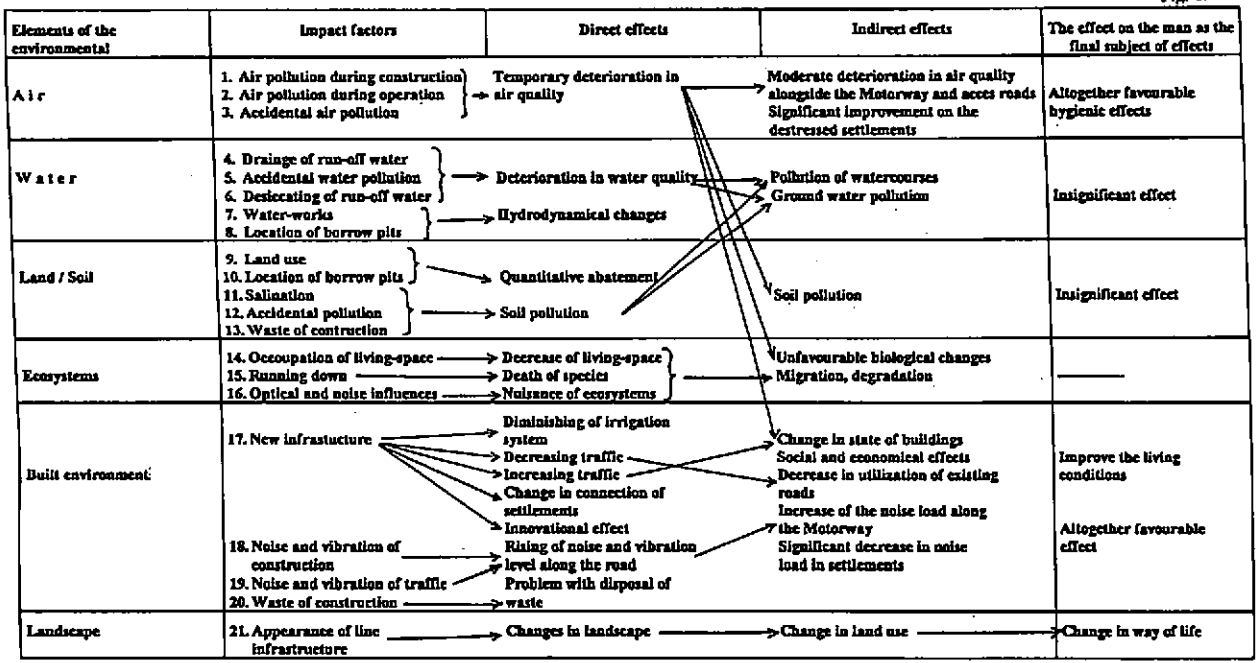
We can conclude from the survey that the planned track of the road avoids the inhabited dwelling places, so the number of establishments involved is small. We cannot speak about a remarkable noise effect on the directly affected areas neither in the case of the present state, nor in the reference one, so building the road necessarily means more noise in these areas. The rate of this change is remarkable in the case of one area where we proposed a new track version, and in the case of 11 other farm-houses the problem of the increased noise can be solved by noise-isolating fences.

We developed a method to compare the two track versions in terms of overriding the allowed noise level. This method works with respect to the different types of building.
On the indirectly affected area a decreased noise exposure was detected in the case of 1610 buildings. We expect a 3-6 dB decrease in noise in the dwelling places next to the present day road No.43.

From the point of view of noise isolation, there was not much difference, so the hoice between the possible tracks was made according to the other effects of the track where the least conflicts occur.

Environmental impact network of Motorway M43

Fig. 1.



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