ELEMENTS FOR NIGHT TIME NOISE REGULATION

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Introduction What is the best way from the regulatory point of view to protect populations against noise? The answer is not easy to formulate as it depends on cultural and political preferences. It is however possible to describe the process by which such a regulation comes to be. In this paper the elements which are necessary in such process are described. Although this process cannot guarantee a fair and just outcome, at least it may show which stakeholder get the best part of the deal.

General approach In a blank situation the general approach for a night noise regulation – indeed for many environmental or other types of regulation- would be:

1) assessing the impact on the population
2) evaluation of impact
3) assessing options to avoid or reduce impact considered un desirable.
4) cost-benefit analysis of the options or of mix of options
5) assessment of the preferred option
6) implementation

As a general principle which applies to all the steps, is the discussion with stakeholders, the affected as well as the producers.

Assessing population impact According to various sources [3,5,7,12], the following table summarizes the impact of noise during sleep.

Table 1. Effects of noise exposure at night.

	Relevant indicator	Threshold [1)], dB(A) (inside levels [2)])	Dose-effect relationship
Instantaneous effects			
- awakening	SEL/Lmax	30	Yes
- sleep onset		?	No
- sleep stage shift		-	No
- heart rate		-	No
- motility		-	Yes
Night effects			
- sleep length	LAeq	20	No
- time in REM-sleep		?	No
- mean motility		-	Yes
- annoyance		20	Yes

Table 1. Effects of noise exposure at night.			
	Relevant indicator	Threshold [1], dB(A) (inside levels [2])	Dose-effect relationship
After effects			
- mood	LAeq	30	No
- sleepiness		?	No
- accidents		?	No
- annoyance	LAeq	40	Yes
- health complaints	LAeq	-	Yes
- medicine use	LAeq	-	Yes
- blood pressure	LAeq	35	Yes
		[1] ? = not known - = very low [2] outside levels converted by subtracting 20	

For the effects for which a dose-effect relationship is known an estimate for the impact in the population can be made.
The most straightforward way would be to assess the night time exposure of the population and then multiply the resulting numbers by the relevant dose-effect relation. In practice this is not simple, as the following factors need to be taken into account:

- start and end of night time. Although people sleep on the average between 7 and 7.5 hrs, they don't all go to bed at the same time. The EU-standard is 8 hrs, and that can be chosen such that 50% of the population may be protected. In some countries night time is 9 hrs, protecting ca 70% of the population. In weekends night time is shifted with ca 1 hr. As the behaviour of the population may very from country to country, depending on cultural habits and to some extent position in the time zone, a time use study should be carried out.
- insulation: if the amount of bedroom insulation is not uniformly random distributed over noise levels this should be corrected for. As the window behaviour (closing and opening windows) influences dramatically the amount of insulation and therefore the exposure levels, this should be taken care off.
- Most exposed façade: bedrooms could be situated on the least exposed façade, thereby reducing the exposure.
- Input data: especially traffic data at night is difficult to get because roads are dimensioned on the busiest (rush) hour, so traffic data is not often collected at night times. Recent studies show that at night the proportion of heavy traffic is higher, speeds are higher and the night volume is increasing more rapidly then total volume. This means that in order to calculate night time noise levels new data collection has to be performed.

When an accurate image of the night time exposure in (a representative sample of) the population is available, the impact can be calculated.

Evaluation of impact In this step it is evaluated how the estimated impact is to be considered in terms of health. According to [6] "health" is a concept with many dimensions and the exact description therefore may differ between times and locations.
Pathological effects such as death or recognized illness, are obviously relevant to general health, as are carcinogenic or congenital effects. By contrast, reflex reactions to the –over-stimulation of senses and other temporary physiological reactions of the organism cannot automatically be classed as adverse effects on health. Sound in particular is a natural stimulus

and it is difficult to tell when the natural reactions to everyday sound exposure become a health problem.
The decision if a certain observed effect is relevant to health in a given – national, cultural, etc- setting is in the end a political one. On reaching the decision however scientific information on the effects of the exposure should be ordered and evaluated by qualified experts. A usable checklist might consist of the following 3 main topics:
Type and seriousness of effect;
Number of people affected;
Evaluation of risk;
A well known system to assess seriousness of effects is the DALY=Disability Adjusted Life Years and variations thereof. Although it is still under discussion and has evident limitations and drawbacks, it offers an opportunity to scale and even "sum" adverse effects. Some studies [Lit. 2] show a remarkable consistency in rating illnesses even between cultures. The method used to generate weights and the weights already established can be used to rank the effects listed in table 1.
If then the weights are multiplied by the number of people affected, corrected for the time the effect occurs (to calculate the number of adjusted life years), the resulting number may be compared with the DALY's for other health impacts. Although the results should still be treated with caution, and certainly not as an absolute indication of the loss of healthy life years, it helps to estimate if we are dealing with an major impact on the population or a second order impact. To illustrate this point figure 1 is presented, which ranks DALY's for a number of environmental factors and a few non-environmental factors for comparison.

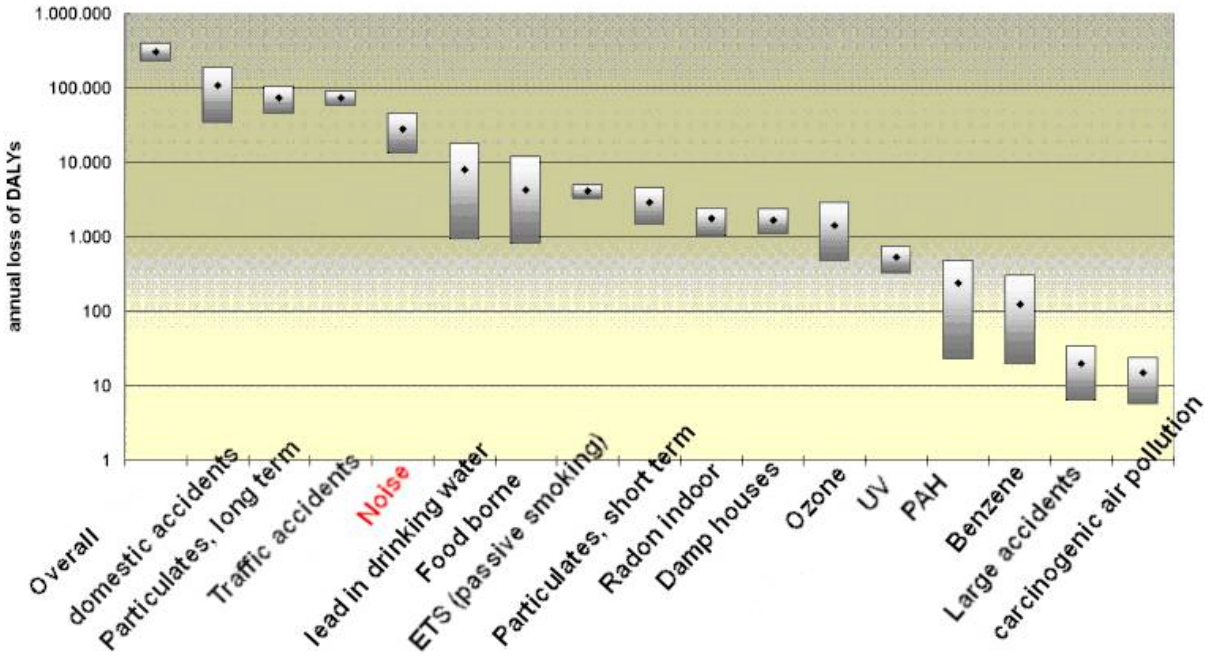

Figure 1 Loss of healthy life years. Source: National Institute of Health and Environment, Netherlands, 2002

As for the application of this method to sleep disturbance, there is a need for additional refinement, like separate weighting factors for the effects listed in table1.
Finally, there is the precautionary principle. The more an effect is uncertain and the larger the possible impact, the more it pays to err on the prudent side. On the other hand it means that it is worthwhile to reduce uncertainties by appropiate studies.

Assessing options to reduce impacts Depending on the source and the place of impact there may be a large number of possible measures to tackle the problem. Reducing noise at the source is the preffered option, and in the long run probably the most cost effective. However, the time span could be unacceptably long, the initial investment may be high and sometimes international law must be changed before reductions can be enforced. Second best options include keeping distance, screens and barriers and placing noise insensitive buildings in strategic places. If all fails, insulation of the (bedroom) windows is a possibility. This last one, which is a preferred policy option in many countries, is much overrated in its efficacy. Because of behavioural aspects –window opening- there is little difference in effective noise insulation between insulated houses and non-insulated houses.
Unfortunately the balance of the option selection is much disturbed by the time scale. Although the reduction at the source is the preferred option, it is also the option which takes the longest time to become effective. The time to renew a car fleet is about 12 years (and a tendency to become longer) and for trains and airplanes it may be twice as long. And that is calculated from the time the regulations become effective. Negotiations to achieve substantial reduction of levels may cost as least as much time.
Therefore some measures which achieve an immediate reduction may be necessary. One approach is to start at the highest levels and take fast acting local measures that reduce noise to a level that just acceptable, and leave it to time to arrive at the preferred level after a number of years.
This results in a matrix like this:

	Cost and effectiveness of measures (arbitrary figures)							
measures	2005		2010		2015		2020	
	cost	effect	cost	effect	Cost	Effect	cost	effect
1	100	50	100	50	100	50	100	50
2	200	60	300	70	400	80	400	80
3	100	10	200	20	300	50	400	80

Notice that up to this point the notion of “standard” or “limit value” doesn’t play an important role. In principle the effects are calculated for all exposures above the thresholds. The measures however should be calculated from a cut-off point, like insulation of bedrooms. The efficiency of the different cut-off points is shown in the cost-benefit analysis matrix. Measure 1 might read: insulate all dwellings with Lnight, outside of 55 dB, measure 2: dwellings above 50 dB, etc. Lower cut-off points give higher protection, but the costs increase rapidly.

Preferred option When all the data is available, a choice may be made. In the political process that follows, the opinion of the citizens is important, but the politicians should be aware that people actually affected may have strong opinions, while not –yet- affected are apparently not interested. Also this element will have to be put on the balance.
Other important questions that arise are the durability of the solutions, and the financial side. The polluter pays principle is widely accepted, but strong lobby clubs may try to shift the costs to society.
This is all part of the political play, and the civil servants and scientists should expect this kind of issues and be prepared to answer them.

Implementation Each measure then has to be implemented, and depending on the choices this may be more or less an undertaking. Implementing sound insulation is usually relatively easy (a subsidy scheme and/or change of a Building Code), but enforcing demands for quieter

equipment involves influencing international legislation. Especially for small countries this may be very difficult. Already in the preparation phase too much optimism should be avoided.

Conclusion The regulation of night time exposure to excessive noise is too important to be treated casually. There is now enough knowledge to allow us to follow a stepwise approach, leading to a well balanced mix of measures. A night time noise standard could well be an element in the package, but only accompanied by a strategy and the financial means to achieve it.

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