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The STAIRRS Project: A cost-benefit analysis of different measures to reduce railway noise on a European scale

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Abstract

Several countries have enacted severe noise control standards and European noise legislation is being considered as well. Detailed studies in Switzerland, the Netherlands as well as a UIC sponsored study on two freight lines have demonstrated very high costs for noise control, however considerable savings can be achieved by choosing those noise control strategies with the best cost-benefit ratio. In an effort to determine optimal strategies on a European as well as on national levels, the E.U. 5th framework program is co-financing the STAIRRS project (Strategies and Tools to Assess and Implement noise Reducing measures for Railway Systems). Work Package 1 is designed to develop the software necessary to undertake large scale cost-benefit analyses. The acoustically relevant geographic, traffic and track data have been collected for 11'000 km of line length in seven European countries. Noise calculations are undertaken with the Eurano 2001 software program. Standard cost-benefit analysis methodologies were adapted to fit the requirements of noise control projects. A specifically developed extrapolation methodology enables studies on any geographic area of interest, be it individual countries, the EU or Europe as a whole. In parallel an optimization algorithm allows determining optimal strategies for a specific line under given constraints. The STAIRRS project coordinator is the European Rail Research Institute, the work package leader are the Swiss Federal Railways with the participation of AEAT Technology (NL), German Railways, French Railways, PSI -Akustik (A), the Swiss Federal Institute of Technology and the Free University of Brussels.

1. Introduction

Noise control is a major economic factor for the railways as national and E.U. wide environmental legislation is being enacted. It is therefore important for the railways to determine an optimal noise control strategy, allowing for maximum benefits in terms of noise reduction per lineside inhabitant for given cost levels.

Studies in Switzerland and on two major European freight freeways show large cost savings if cost-benefit criteria are included in planning. Swiss studies demonstrated that an optimal cost distribution consists of spending 65 % of the available finances on rolling stock improvement, 30 % on noise control barriers and 5 % on insulated windows. This mix protects 70 % of the lineside population for 30 % of the cost necessary to attain threshold levels for all inhabitants (1,2). A similar study financed by the UIC (International Union of Railways) on the lines from Rotterdam - Milano and Bettembourg - Lyon tested different combinations of measures. This study found that optimal solutions contain rolling stock improvement, that maximum benefits are achieved at about EURO 60'000/km/year and that above this value there is no additional benefit in scenarios with higher costs (3). Studies in The Netherlands showed that large number of noise barriers can be saved when source measures are applied (4, 5). The total cost for saved barriers is much higher than the cost for source reducing measures. Noise impact is less with noise reduction at the source in combination with barriers.

2. The STAIRRS Project

The STAIRRS (Strategies and Tools to Assess and Implement noise Reducing measures for Railway Systems) consists of three work packages:

- WP1: Railway Noise Strategy Support System
- WP2: Characterization and Classification Methodologies
- WP3: Consensus Building Workshops

This paper consider only the first WP. WP2 is described in another Internoise2001 paper by Pieter Dings (AEAT).

The objective of WP1 is to provide a Europe wide software tool to determine the large scale environmental impact of railway noise. To achieve this goal the project consists of several elements, which are described in the subsequent paragraphs.

3. Computer software: Eurano 2001

Based on the Dutch Gerano program and the UIC financed upgrade Eurano 99, a user friendly software system has been developed that allows rapid data entry and calculation of costs and benefits by simply changing parameters such as noise creation per train type, costs per unit, different weighting of benefits. Figure 1 shows the background maps used for data entry and calculation (compare also below).

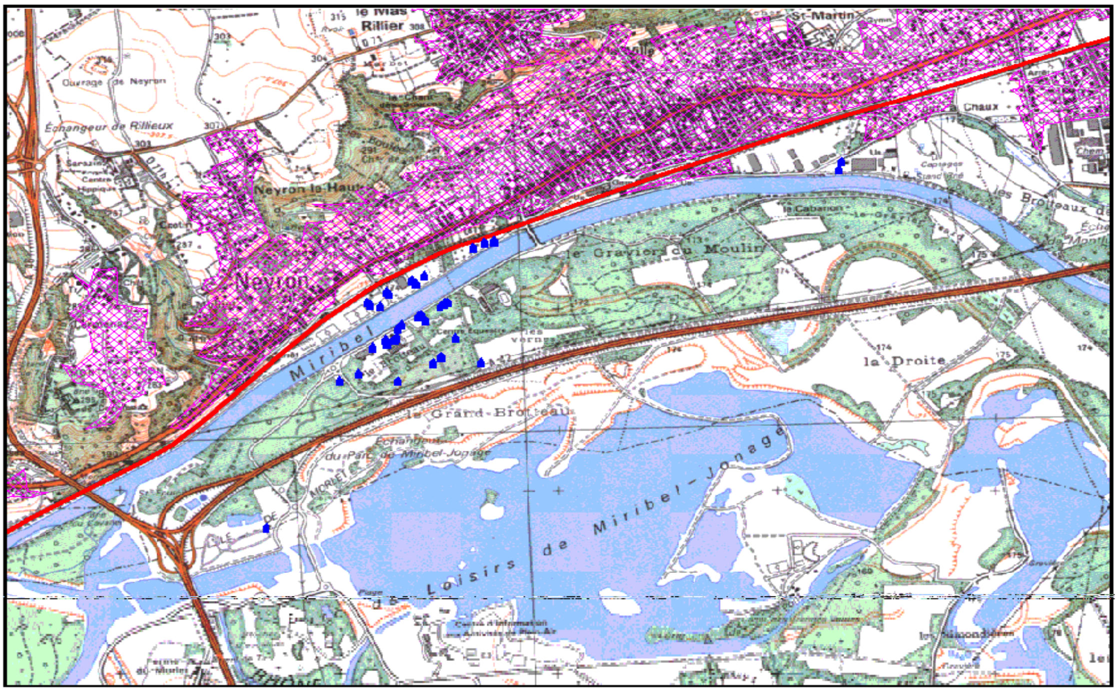

Figure 1: Example of map to the scale of 1:25'000 used for the entry of geographic data, i.e. urban areas and individual houses.

4. Data base

Acoustic data will be collected for total length of 10'974 km, representing about 10 % of the total line length in the seven countries considered.

Railway, Country	**Length to be studied**	**Total network length**
DB, Germany	4121 km	38'450 km
FS, Italy	1557 km	16'031 km
NS, The Netherlands	600 km	3000 km
OeBB, Austria	480 km	5627 km
SBB CFF FFS, Switzerland	576 km	2939 km
SNCB, Belgium	330 km	3422 km
SNCF, France	3310 km	31'821 km
Total	*10'974 km*	*101'290 km*

Table 1: Line length studied in each country

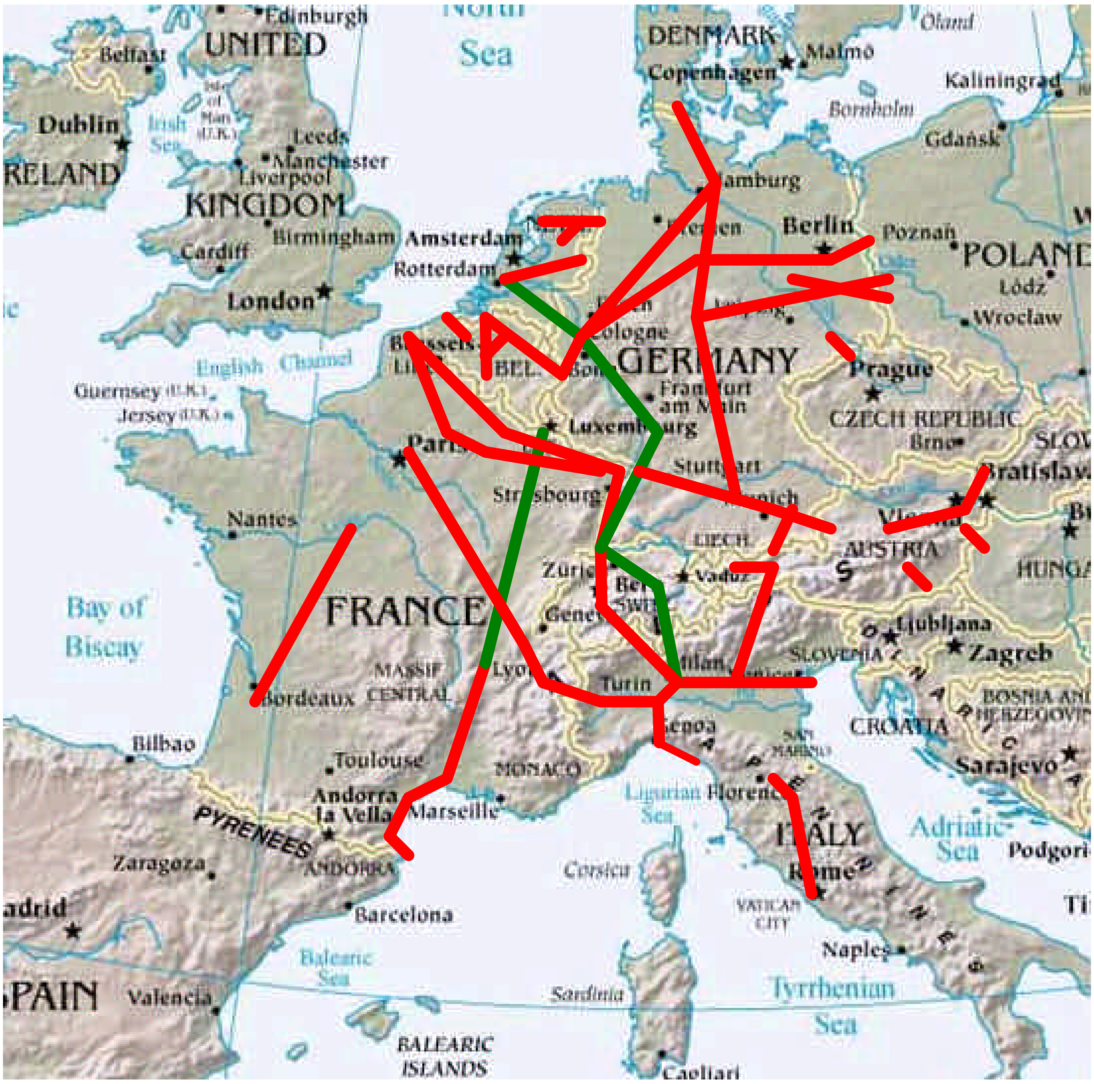

Figure 2: Map showing lines chosen for acoustical data collection. Red shows new lines while green indicates data from a previous UIC sponsored study.

For the above choice of lines the following data were collected and entered into Eurano:

- *Geographic data:* Geographic data consists of the extent of urban areas and individual houses adjacent to the lines. This is determined based on maps to the scale of 1:25'000. Exceptions are Belgium, where maps 1:50'000 and Italy where maps 1:200'000 were used. In Italy, however, a quality control with maps 1:50'000 was undertaken, where such maps were available. In France the extent of the urban areas was purchased digitally from a separate organization so that entry was not necessary.

- *Traffic data:* Traffic data consists of the number and composition of trains. This data is based on prognosis values for the year 2005. If this data is not available, the project undertook a prognosis by itself if factors are available, otherwise current data was used.

- *Track data:* Acoustically relevant elements of the track include type of sleeper (e.g. concrete vs. wood), track condition (e.g. welded vs. non welded track) and noisy bridges.

5. Extrapolation procedure

An extrapolation methodology was developed to allow determination of the optimal noise control strategy for any geographic area of interest, be it Europe as a whole, the E.U. or an individual country. Within the choice of lines - the 11'000 km of line length for which detailed acoustical data is available - acoustical line segments were defined. These consist of segments similar in terms of traffic and population characteristics. As a next step, the ratio of these line segments was determined in the geographic area of interest. Following that, a representative database can be chosen out of the line choice with the same ratio of acoustical line segments as in the area of interest. All calculations are then undertaken on this representative database. Eurano includes an automatic generator of acoustical line segments.

6. Cost-Benefit Analyses

To determine costs and benefits two approaches are used simultaneously:

- *Investment approach:* Different noise control strategies (for example consisting of varying combinations of noise control measures) are compared based on investment costs. These measures have a benefit during their life-time only. This approach implies that technological advances will progress during the life-time of the products thus requiring at the end of their life-times. This approach therefore does not include costs to replace measures.

- *Long term target value approach*: This approach assumes that noise target values must be attained over long periods of time. This requires replacement of noise measures at the end of their life spans so that these costs are included.

Both approaches compare costs using net present values, the benefits however are defined in physical terms (i.e. noise reduction per lineside inhabitant). This subject is considered in greater detail in another paper in Internoise2001 (Da Silva and Baumgartner).

7. Optimization Algorithms

In addition to calculating different measure combinations on large data sets (representative data bases; see above) a methodology was developed to allow determination of optimal solutions for a specific line for a given set of constraints. The optimization algorithms are implemented in the Eurano analysis software. They are described in greater detail in another Internoise2001 paper (Guerrand and De Almeida)

8. Measure combinations to be tested

Noise control measures included in the project are: Operational measures such as re-routing or a limitation on night traffic, rolling stock improvement with composite brake blocks or optimized wheels, rail grinding, tuned absorbers on tracks, noise barriers and insulated windows. First results are expected mid 2002.

9. Work Partners

The STAIRRS project coordinator is the European Rail Research Institute, the work package leader are the Swiss Federal Railways with the participation of AEAT Technology (NL), German Railways, French Railways, PSI -Akustik (A), the Swiss Federal Institute of Technology and the Free University of Brussels.

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