# INPUT DATA PREPARATION FOR NOISE MAPPING ACCORDING TO THE EUROPEAN DIRECTIVE ON ENVIRONMENTAL NOISE

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**Abstract**

One of the strategic objectives of the European IMAGINE project is improving the current assessment of environmental noise from railways, roads, aircraft, and industry. In particular, the target of the Working Package 1 "Mapping specifications and GIS" is to provide practical guidelines, good practice and harmonised data management for the production and exploitation of strategic noise maps according to the requirements and recommendations of the Environmental Noise Directive.

Specifically, these guidelines aim at input data requirements for GIS applications. The work was focused on the requirements of the 2012 noise mapping round and on the needs of future noise models (i.e. HARMONOISE).

It has been shown that high quality input data is already needed for running nowadays models; meeting these new requirements should be possible with little effort. Furthermore, it has also been shown that the use of a common approach is easier and more efficient than many different interim/national methods.

Information collected during this work will complement the EC Working Group-Assessment of Environmental Noise document "Good practice guide for

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strategic noise mapping and the production of associated data on noise exposure", to produce a comprehensive tool. This paper describes in detail the work done so far, showing some of the principal results and the challenges encountered.

## INTRODUCTION

The EU Directive 2002/49/EC of the European Parliament and of the Council, issued on 25 June 2002, relating to the assessment and management of environmental noise (commonly known as the Environmental Noise Directive and hereafter referred to as the END) [1] requires the production of strategic noise maps. To this aim, improved assessment methods for environmental noise should preferably be used in mapping any major noise source: roads, railways, airports and industrial plans in agglomerations.

The first part of the problem has been approached by the 5th framework program HARMONOISE project, that developed improved methods for road and railway noise. The second step, nowadays, is approached by the IMAGINE project (Improved Methods for the Assessment of the Generic Impact of Noise in the Environment), funded by the European Commission under the 6th Framework Program [2], that is extending the HARMONOISE methods to aircraft and industrial noise.

The objectives of the IMAGINE project are also to develop guidelines for noise mapping that, starting from the state of the art [3], will make it easy and straightforward to assess the efficiency of future action plans. Noise mapping, in fact, should be a dynamic process rather than a static presentation of the situation: as an example, maps need to be updated to consider traffic flow management measures.

In this aspect, IMAGINE will provide the link between HARMONOISE and the practical process of producing noise maps and action plans to reduce population exposure. It will establish a platform where experts and end users can exchange their experience and views. It will furthermore deliver methods to perform a good noise mapping, selecting the best methods to associate data coming from measurement campaigns or calculations to the right rate of exposed population.

The IMAGINE project is organised in several work-packages: the first one, dealing with "Mapping specification and GIS", is focused on approaching the problems and finding operative solutions related to the input data collection and the data layout to present maps to the public. The WG-AEN Position Paper [4], which will produce results by the end of 2006, is highly considered in this task. Data collection in order to assess the exposed population and the presentation of results seem to be two of the major problems to meet the END requirements.

The objectives of the Work Package 1 are:
- o to review existing and emerging noise mapping projects with respect to input data collection;
- o to build up high quality input models following the requirements of the new harmonised prediction methods and to promote innovative technologies for constructing high quality input models using new

sources of data;
o  to develop a common reporting scheme on noise mapping methodologies;
o  to demonstrate how such specifications can be used to assess quality of produced noise data and evaluate cost / benefits of new noise mapping projects;
o  to propose a common database approach for storing noise data;
o  to demonstrate how a common approach can be used for efficient reporting of noise data from local up to the European level, identification of conflict situations, prediction and evaluation of the impact of action plans;
o  to study methodologies for transforming noise levels into the assessment of exposed population and to identify "best practice" with respect to available input data, urban topologies, population densities, type of noise source;
o  to demonstrate and promote advanced exploitation of noise databases and mapping systems.

In order to meet some of these objectives, ARPAT has developed in Working Package 1 (WP1) a frame protocol on how to collect available input data for noise mapping, within the task on "Noise mapping methodology specifications and guidelines". Mainly, the output of this frame protocol should be a collection of information from all sub-task leader partners, to be later on merged in a single document (Deliverable 8).

The first result of this process is a list of already available or suggested set of input data for general noise mapping, and it is now available on the IMAGINE web site [5]. At the same time, the questionnaire frame was put on the IMAGINE web site [6], to allow experts to download it and contribute with their experience to the collection of more answers to further enhance its European wide validity.

## INFORMATION COLLECTED AND THE WG-AEN DOCUMENT "GUIDELINES AND GOOD PRACTISE ON STRATEGIC NOISE MAPPING"

The Working Group Assessment of the Exposure to Noise (WG-AEN) has issued the Position Paper "Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure", published in its second version in January 2006 ("GPG2" in the following). Its purpose is to assist Member States and their competent authorities to undertake noise mapping and produce the associated data required by the END.

The GPG2 addresses in particular those requirements associated with the first round of strategic noise mapping, which must be completed by 30 June 2007 and covers major infrastructures and agglomerates. It has been organised in 21 toolkits, each dealing with the most important aspects which anyone who wants to produce a noise mapping must consider.

The IMAGINE project (and in particular the work in WP1) has been finalised to the requirements for the 2012 noise mapping deadline of END, when the use of the HARMONOISE model will be expected. This means that one of the main objectives is to produce indications to support a unique prediction model (such as HARMONOISE) that, as stated in the END itself, could substitute the ad-interim models commonly in use nowadays.

Even if the two documents, one drawn up by WG-AEN and the other prepared within the IMAGINE project seem similar, they have then a different target.

The first is a state of the art collection of good practices, organised in toolkits, that leads users who has to develop a strategic noise map for June 2007; the second gives indications on how to improve the existing methods, in order to develop an unified approach to noise mapping on EU scale, as well as to support for the application of the procedures of the HARMONOISE model and the techniques still to be developed in the model by some WP in IMAGINE.

## THE QUESTIONAIRE AND ITS STRUCTURE

Every partner of the project was invited to contribute to a specific part of the work, in order to maximise the exchange of knowledge and good practice. Each partner had direct responsibility on the sector where he had the best experience, but could give contributions to other subjects, when needed.

Afterwards, ARPAT collected the answers and gave them a uniform aspect, before drawing up the final document.

The questions addressed in the frame are:
- o What kind of external data can be acquired?
- o How useful is it?
- o How difficult is it to transform the input into data to be used internally by the model?
- o What is the effect of using simplified/deteriorated input data?

The frame presents the common format used by each partner to prepare and deliver a document about its specific set of data, based on its experience.

The questionnaire frame has been structured into three parts:
- o Topic field and participants;
- o Requirements: what is it needed for a specific noise mapping project? This part includes required format of data, accuracy, expected error, default values to be used for a specific noise model and its implementation (i.e. software);
- o Sources: what is it available at the moment? This part reports the real/available/usable sources of data, their format and the required needed transformation to adapt them to the PART 2 format.

Filling in this document, each partner used his personal knowledge to present available data formats, but also used his own experience to suggest possible other useful data formats.

# RESULTS

The data collected using the final format could be used for the production of noise maps and the preparation of basic data (e.g.: population distribution, terrain shape, buildings shape, traffic type, ...). This information might be essential in the development of a valuable acoustic model for noise mapping.

The final format could be downloaded on the IMAGINE web site (http://www.imagine-project.org).

*Table 1 –Topics dealt with in the questionnaire.*

| General topic | Specific problem highlighted by this study |
|---|---|
| **Terrain model** | DTM availability, 3D_cartography, isolevel–step, ground point |
| **Ground characteristics** | Impedance |
| **Buildings** | Type of occupancy (residential, office, school), heights, n. of floors, inhabitants, number of apartments per floor, measured absorption coefficients, national absorption coefficients in use |
| **Road and railway infrastructure** | Geometry, 3D information, number of lanes/tracks, asphalt type/track type, embankments |
| **Noise protection / reduction devices** | Digital indications on obstacles, on paper indications, materials used, height, absorption coefficient |
| **Road traffic** | Speed, vehicle types (day/eve/night),vehicles type (specific period/hour/week) |
| **Railway traffic** | Train speed (given by infrastructure owner/measured), train type (given by infrastructure owner/measured) |
| **Aircraft traffic** | Flight profile, ground track data, general airport data, runway data, air traffic data, aircraft data |
| **Industrial sources** | Levels (specific period/hour/day), displacement, source type |
| **Meteorological data** | Measured, obtained from other  measurement stations, distance from source, distribution over the territory, data type (humidity / temperature / temperature gradient / wind / rain) |
| **Population data** | Measured, derived, each apartment / building / area / sub-area |
| **Measured and monitored data** | |
| **Grid points & domain tiling** | |

In particular, a few topics were found to be of fundamental importance to complete a noise mapping project: these have been approached by all the involved partners during their experiences, in their specific area of competence.

By means of the answers, it was possible to identify the methods and the softwares used. For the latter, in most cases the comments regarded commercial software used by many partners (PREDICTOR, IMMI, MITHRA, CADNA, SOUNDPLAN, LIMA), in other cases a specific software solution designed by the answering partner was suggested. All the answers, however, cover the interim methods suggested by the 2002/49/EC Directive (ISO9613, NMPB, ECAC DOC 29).

The availability of input data, their costs and their precision are fundamental information to be processed by the propagation model and, moreover, to evaluate the possibility to improve them in order to meet the HARMONOISE model needs within the 2012 deadline of the END. As it can be expected, the specific results for every topic cannot be reported here because of their complexity, but a simple schematic representation of them can be found in table 2.

A graphical representation using icons has been used in table 2 to represent the availability, the cost and the accuracy for every major topic. When two or more icons are present, they represent different answers or different kind of data sources. The complete output of the work can be once again found on the IMAGINE web site [5].

*Table 2 – Graphical representation for the available data sources for each single topic*
*( ★ High, ■ medium, ● low)*

| | Availability | Cost | Accuracy |
|---|---|---|---|
| **Aircraft Traffic Noise** | ● ■ ★ | ● ■ ★ | ● ■ ★ |
| **Building** | ● | ● ■ | ● |
| **Ground characteristics** | ● | ● | ■ |
| **Industrial source** | ● | ● ★ | ● ■ |
| **Noise protection/reduction devices** | ★ | ● | ★ |
| **Population data** | ● | ● | ● |
| **Railway Traffic** | ■ ★ | ■ ★ | ■ ★ |
| **Road Traffic** | ■ | ● ■ | ■ ★ |
| **Road and Railway Infrastructures** | ● ■ ★ | ● ■ ★ | ● ■ |
| **Terrain Model** | ● | ● ■ | ● |

The analysis of results and answers highlighted the most developed areas of activity (i.e.: the topics) where the input data are more easily available or well tested techniques are used. The same study also outlined the areas where effective instruments and methods are still subject of research, because of the lack of useful input data. The presence of different answers for the same topic highlighted some

areas where new and innovative techniques have been recently introduced in some countries, ready to be shared among the others. An example of innovative technique, also reported in the mentioned survey, is represented by the image processing of satellite photos, in order to extrapolate information about land use and therefore propose a classification of ground impedance of large area or territory.

It should be stressed that, giving a common format for the GIS input data means that in the future, at the end of the IMAGINE project, the people who will draw noise maps as well as the people who will prepare basic data for noise maps (e.g.: population distribution, terrain shape, buildings shape, traffic type, ...) will be able to use the same format (or will have to use this format, if it will be adopted by the EU) in order to save problems and speeding up the process.

Starting from this analysis, it will be also possible to compare the quality of the data available at present with the possibility of using the HARMONOISE model in the future. As an example, in the case of railway noise, several data already available from past projects and from past noise maps are easily converted to input data required by the new HARMONOISE model, since the input values and data format are the same. This is the case of train traffic type, railway line shape, track type, track decay rate and train type.

This activity will be treated in the final WP1 document and it is, for this reason, still in progress. It will consist of a comparison between the input requirements of the HARMONOISE model with the ones used nowadays in different countries and contexts, as derived from the questionnaire's answers. In this way, it will be possible to judge the applicability of the HARMONOISE model, since the scarcity of input data on some topics may prejudice it. This work will underline some of the efforts still to be made to apply the model in real contexts.

It will be also drawn a tabular comparison between the different countries involved in the data collection, in order to help the sharing of innovative solutions and the verification of the effectiveness of existing ones on an European scale.

## CONCLUSIONS

The activities of the Working Package 1 in IMAGINE, described in this document, are still in progress. For this reason, the evaluation of data availability and quality might produce its results only in the future.

Nevertheless, it already gives a clear picture of the "state of the art" of the methods and of the data quality in the main European States. But it will be crucial to formalise the guidelines for the application of the HARMONOISE model, once all its requirements will be pointed out. In addition to that, this study will help to evaluate how much the accuracy of that model is really applicable. Preliminary results show that the HARMONOISE model is generally compatible with the currently available data.

It is worth noticing that it is still possible to contribute to the enrichment of the input data format during the second half of 2006, downloading and compiling the questionnaire form the IMAGINE web site [6]. This will promote the dissemination

of the results and increase the comparison between different models and software users and contribute to make the work of final users easier.

In particular, a precise evaluation of the input needs will help local administrations to quantify the informative requirements they will have to meet because of noise mapping issues or because of the application of the HARMONOISE model, promoting a cost / effective result.

## REFERENCES

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