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SEVENTH FRAMEWORK
PROGRAMME

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Executive Summary

The ENNAH project (*The European Network on Noise and Health*) was funded by the European Union's 7th Framework Program (FP7-ENV-2008-1, project no.226442) to establish a research network of experts on noise and health in Europe. The network brought together 33 European research centres from 16 countries to establish future research directions and policy needs for noise and health in Europe. ENNAH focused on the study of environmental noise sources, in particular transport noise. This network facilitated high level science communication and encouraged productive interdisciplinary discussion and exchange through a series of workshops and reports.

An important aspect of the ENNAH Network has been identifying gaps in noise and health research while at the same time assessing, prioritizing and integrating future research orientations into policy development which would lead to an efficient investment of resources allocated to noise and health research. Noise maps produced under the direction of the Environmental Noise Directive (2002/49/EC) are potentially a very useful resource for noise and health research. We have reviewed the advantages and disadvantages of current noise maps and recommended future changes that would make these maps more appropriate for noise and health research. We have also considered possible new methods for acoustic measurement and modelling which will help to develop innovative exposure measurement techniques in future noise and health studies.

One important development has been the involvement in ENNAH of researchers who are primarily working on air pollution. The aim was to consider the joint impact of both transport noise and air pollution on health. The ENNAH meetings have provided a fruitful exchange of views on how air pollution and noise can be further studied together and the underlying mechanisms elucidated. The EU has made a substantial investment in funding cohort studies on air pollution and health. ENNAH provided an important opportunity here to start to exploit the existing cohort data in Europe that has good information on air pollution and adding in data on noise exposure. This has direct relevance for transport and environmental policy in terms of deciding the priorities for reduction in air pollution or noise or both when planning new environmental mitigation actions.

An exciting part of ENNAH has been the opportunity for young researchers to be involved in an exchange program between EU countries and academic disciplines on noise and health with the aim of establishing research partnerships among a new generation of noise and health researchers. We have fed into the important publications from WHO-JRC on Burden of Disease from environmental noise. Additionally, ENNAH included sessions on skilling up in health impact assessment (HIA).

Most importantly, ENNAH focused on outlining new priorities for research on environmental noise and health which hopefully could feed into future calls for funding on environment and health matters from the EU. In some areas this means strengthening the evidence on existing exposure effect relationships and using more robust methods such as longitudinal rather than cross sectional studies. This is relevant to research on environmental noise and hypertension and coronary heart disease and on studies of noise and children's learning. Increasingly relevant for policy is new research that tests whether interventions to reduce noise do actually do this and also whether they have an impact on health. This is of great practical importance because it can suggest what interventions are efficient and cost optimized.

Last but not least, a further important area identified is to assess where new investment in noise research should be placed, whether this relates to not previously or poorly studied health outcomes or improvements in the noise and health methodological framework.

1. Project Context and Objectives

1.1. The policy background

Environmental noise, caused by traffic, industrial and recreational activities is considered to be a significant local environmental problem in Europe. Noise complaints have increased in Europe since 1992 and it is estimated that roughly 20 % of the Union's population or close to 80 million people suffer from noise levels which scientists and health experts consider being unacceptable (European Commission Green paper, Future noise policy, Brussels, 1996). The Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise (often known as the "Environmental Noise Directive" [END]) aims to define a common approach across the European Union with the intention of avoiding, preventing or reducing, on a prioritised basis, the harmful effects, including annoyance, due to exposure to environmental noise. To this end, the Directive sets two instruments, noise maps and action plans, respectively, to describe the exposure of population to noise from relevant sources (aircraft, road, railway and industry) and to preserve quality areas or reduce noise pollution when necessary. With the development of the END, the European Commission has recognised both the importance of monitoring noise exposure, and also the lack of substantive investigations of the public response to noise and the need for appropriate policies to control noise through legislation, while at the same time not obstructing the economic benefits of activities that generate noise. One important aspect of this debate that requires urgent clarification is the relationship between noise exposure and health outcomes. The ENNAH network aimed to produce information that would be useful for the further development of the END by developing knowledge on the effects of noise on health.

The ENNAH network built upon the existing knowledge on noise and health to prepare the European noise research community for future research in this area. In order to initiate the network, an already existing cross-national core partnership, created within the HYENA[1] and RANCH[2] projects during the 5th Framework, was enlarged to include representatives of other research studies, more recently funded either within the 6th Framework or other national and international research schemes from across Europe including Central and Eastern Europe.

1.2. The evidence background

At the start of the network, the available evidence on noise exposure and health varied across health outcomes and, although there had been considerable research achievements in the field, there were still significant gaps and issues that needed to be further examined. The network focused on the study of environmental noise sources, and in particular transport noise.

There are several accepted health effects of noise exposure. While there is sufficient scientific evidence that elevated workplace noise can cause hearing impairment, several other outcomes have also been the focus of research: disturbance of activities, sleep, and communication as well as cognitive and emotional responses, and annoyance. Several stress indicators may be altered by noise exposure such as the physiological stress reaction, the balance of the sympathetic and parasympathetic system, and hormones secreted from the pituitary and adrenal glands. Biological indicators of the early effects

[1] http://ec.europa.eu/research/environment/pdf/env_health_projects/noise/n-hyena.pdf
[2] http://ec.europa.eu/research/environment/pdf/env_health_projects/noise/n-ranch.pdf

could be apparent through alterations in blood pressure, cardiac output, blood lipids and glucose, blood viscosity and coagulation factors. Immune function can be also affected leading to increased frequency of infections of the respiratory system and bronchial asthma. Finally, signs of cardiovascular disease could occur such as hypertension, atherosclerosis, and ischemic heart disease leading to acute myocardial infarction. Unintentional injuries including road accidents may also result due to decreased attention, sleep disturbance and stress.

An initial goal of the network was to exchange information on recent developments in noise research, including a summary of recent findings and an identification of gaps in research knowledge that need to be addressed, where they are likely to lead to influence on policy. Health outcomes to be considered included those already conventionally linked with noise exposure such as hypertension and coronary heart disease, sleep, annoyance, mental ill-health, cognitive performance in children, as well as those where the evidence is untested, including measurement of long term hormonal responses, reproductive health, respiratory health, diabetes mellitus and immune functions.

Research on noise and health had been significantly advanced by two 5th Framework EU projects: RANCH[3], examining exposure effect relationships for aircraft and road traffic noise and children's cognition and health, and HYENA[4], primarily examining the impact of aircraft and road traffic noise on blood pressure. In addition, there have been several relevant large national studies with high quality data on environmental noise, air pollution and health effects. Further analyses of data collected in these studies could provide additional answers to research questions with relevance for future noise policy. One function of the network was to undertake such secondary analysis of the HYENA and RANCH data and other relevant data sources.

As well as the need to strengthen evidence for associations between noise exposure and health outcomes, there were several other issues that were a focus for the network activities. Most available evidence in the field of community noise and health outcomes comes from epidemiological studies, mainly with cross-sectional designs. Epidemiological research can provide the basis for a quantitative risk assessment, taking into account any factors which may amplify or attenuate the noise effects, including other noise sources acting as confounders and/or effect modifiers of the association of interest. Cohort and case-control studies which usually have greater validity and credibility than cross-sectional and ecological studies, have been more commonly used in health-related noise research but there remains a lack of longitudinal evidence of this nature in noise and health research.

It is clear that transport systems (road traffic in particular) generate both noise and air pollution (e.g., particular matter [PM], nitrogen oxide [NOx] etc). In spite of the likely strong relationship between noise and air pollution, few studies addressing this issue had been published by the start of the network but there was some suggestion that noise and air pollution may affect the cardiovascular system by different mechanisms. Thus, it is possible that combined exposure to these transport related stressors may interact and increase their single effects on cardiovascular risk synergistically. In the network we planned to further analyse existing data collected by network members to further illuminate potential effects on cardiovascular health of combined exposure to air pollution and noise. Allied with this aim, was an aim to establish communication between researchers on noise and researchers on air pollution who have tended to carry out their research in parallel, with little collaboration. Little work had been done at the start of the network to try and apportion health effects between these environmental exposures.

[3] http://ec.europa.eu/research/environment/pdf/env_health_projects/noise/n-ranch.pdf
[4] http://ec.europa.eu/research/environment/pdf/env_health_projects/noise/n-hyena.pdf

In many studies, it has been found that areas exposed to high levels of noise are also those areas with high levels of social disadvantage. In other situations where the more affluent tend to live in city centres, with excessive exposure to noise from road traffic and other sources, the relation between noise exposure and socioeconomic status can be quite different. Social inequalities in health and the effects of social disadvantage on health are of enormous concern both within the European Community and worldwide. A greater understanding of how social disadvantage and noise exposure co-occur and lead to health effects was needed and the network built upon previous efforts begun in the EU-funded PINCHE[5] network in children to explore whether the evidence suggests that the effects of social disadvantage are partially mediated through noise exposure on health or whether there are independent or interactive effects of noise exposure and social disadvantage on health outcomes. This has implications for the relationship between social disadvantage and other environmental stressors.

The network also addressed the issue of vulnerable groups to the effects of noise on health. There is fragmentary evidence that some groups such as children, those with existing illness and those with high self-reported noise sensitivity may be more vulnerable to the health effects of noise than the general population. The evidence is strongest for annoyance and mental ill-health. If this is the case, it has implications for planning, for the development of noise action plans and for the protection of health. The network aimed to review the evidence on vulnerable groups with the aim of identifying further research needs and concluding on new definitions of vulnerability. Clarification of the issue of vulnerable groups could provide greater certainty for policy makers in deciding how the economic benefits associated with noise exposure and the health consequences of noise exposure should be balanced. For example, for more serious events like myocardial infarction, specific sensitive subgroups like people with diabetes or chronic respiratory disorders should be investigated. Could noise exposure have particularly powerful effects on health in those already vulnerable through existing disease? In general, all subjects with chronic systemic inflammatory disease should be considered as potentially sensitive.

Several issues to do with noise exposure indicators and exposure classification were also the focus of the network activities. With the introduction of END, L_{den} and L_{night} were set as the primary noise indicators in the EU. As a result the (strategic) noise maps are given in L_{den} and L_{night}. For several reasons these indicators and maps may not be suitable for the purpose of research on health effects of noise. Although the maps and their indicators may be suitable to estimate the annoyance and self-reported sleep disturbance in residential areas, it is not clear if the noise indicators for annoyance and self-reported sleep disturbance are also the relevant exposure indicators for all of the various potential health effects. For health effects related to the possible (cumulative) effects of noise events, like awakening, impaired cognitive performance and insomnia, the indicators L_{den} and L_{night} might not adequately reflect the effect of exposure to individual events (as L_{max} and SEL might do) and/or the number of noise events. Also the degree of window and façade insulation and the location of rooms in relation to the noisy and quiet side of a building are potential sources of misclassification of the indoor and personal noise exposure, since noise mapping is mostly focused on the noise level at the most exposed façade. The validity of exposure assessments at shielded sides of buildings has also been questioned. Thus further discussion of the use of noise exposure indicators with a specific focus on health outcomes will be beneficial for guiding policy and identifying future research priorities.

The network also planned to consider new approaches to cost-benefit analysis in noise research to evaluate the potential for transferring health outcomes into parameters (e.g., monetary values), that can

[5] http://ec.europa.eu/research/environment/pdf/env_health_projects/multiple_stressors_and_factors/m-pinche.pdf

be directly used for cost-benefit analyses for noise abatement policies and for transport project appraisal.

1.3. Network objectives

The network had the following objectives:

1. To establish a research network of European scientists on noise and health.
2. To review the existing literature on environmental noise exposure and health focussing on the consolidation of existing state of the art knowledge and the identification of gaps in the evidence and future research needs and hypotheses to be tested.
3. To improve the noise exposure assessment in health studies and build more complex analytical models of noise and health effects that take into account moderating factors including the joint effects of air quality and noise.
4. To establish communication between researchers on noise and researchers on air quality.
5. To improve the measurement of health outcomes relevant to noise research and strengthen the available methodologies for future research, by extending analyses on existing research taking advantage of the research benefits for policy from RANCH and HYENA and relevant national studies.
6. To disseminate the results to the EU, to national governments, to fellow researchers, to users including research councils and the general public across Europe.
7. To develop new designs for research on noise and health and to provide to the EU a new strategy for the development of noise and health research in the future.
8. To train junior researchers in noise and health through setting up an exchange network across Europe.

2. Main Science and Technology Results

2.1. Overview of Activities

A series of workshops led by experts considered: a review of the literature and assessment of research gaps (workpackage 2), noise exposure assessment for noise and health studies (workpackage 3), the role of confounding and moderating factors in associations of noise and health (workpackage 4), the measurement of health outcomes in noise studies (workpackage 5), and new strategies for noise and health research in Europe (workpackage 6) (see table 1).

Table 1: List of workshops.

Table 1					
Workshop	**Work package**	**Month**	**Date**	**Length**	**Location**
Launch meeting and workshop 2a - review of evidence	1 & 2	1	26-28 Sep 2009	3 days	London, UK
Workshop 2b – update on review of evidence	2	10	24-26 Jun-2010	2 days	London, UK
Workshop 3 – noise assessment	3	8	26-28 Apr 2010	2 days	Ghent, Belgium
Workshop 4 – moderating factors	4	13	6-7 Sep 2010	2 days	Stockholm, Sweden
Workshop 5a – health outcomes	5	15	22-23 Nov 2010	2 days	Athens, Greece
Workshop 5b – health impact assessment	5	15	22-23 Nov 2010	2 days	Athens, Greece
Workshop 6 – new research strategies	6	18	Feb 16-18 2011	3 days	London, UK
Workshop 7 – final meeting	7	23	Jul 2011	1 day	Brussels, Belgium

2.2. Review of the literature and gaps in knowledge

2.2.1. Background

Two workshops were held for workpackage 2 bringing together experts on non-auditory effects of noise on health. The first workshop was held in London following the launch of the Network in September 2009. The second workshop was held in June 2010, also in London, led by Dr Anna Hansell from Imperial College. A review of reviews on environmental noise and health has been carried out identifying and highlighting gaps in current knowledge.

Specific topics were identified for further follow-up and discussion at the second workshop organised in June 2010 in London:

1. *The interaction between noise and air pollution effects and the issue of possible mutual confounding*.
2. *Identification of vulnerable groups in relation to the effects of noise and health.*

   Groups such as children, elderly, people with existing illness or with high self-reported noise sensitivity may be more vulnerable to health effects of noise than the general population.
3. *Sources of noise.*

   The research literature considering health effects relating to the following noise sources and their combination were actively sought (except for road and aircraft noise for which much research has been already conducted):
   - Industrial
   - Neighborhood noise
   - Entertainment
   - Railways – freight trains and high speed trains
   - Shipping and ports
   - Wind turbines
4. *Acute vs. long-term effects of noise*
5. *Noise as a cause of accidents*
6. *Exposure issues*

   Prediction models, dosimeters, indoor sound levels, effects of opening windows and window sound insulation, time-activity data - moving beyond residential address as an estimate of exposure (and impact of personal exposures, occupational exposures and protective factors e.g. deafness), distance from source, microenvironment models, similarities between inputs in models for noise and air pollution exposure estimates making comparisons of effects difficult, average noise levels vs. noise events above a certain noise threshold, habituation effects.
7. *Low frequency noise and associated health effects*
8. *Positive effects of noise and soundscapes*

9. *Health benefits of noise mitigation and interventional studies*

   For example, sound insulation of buildings.

10. *Health outcomes not or poorly studied to date*

    For example, respiratory health, developmental effects including birth outcomes (birth weight, miscarriages), stress mediators (cortisol, insulin resistance, abdominal obesity, blood lipids), sleep disturbance in infants, immune system dysfunction, and health status.

Figure 1: ENNAH workshop 2a participants meeting in London, UK, 28-30th September 2009.

Following the workshop in September 2009, literature searches were performed on the specific topic areas identified and agreed for a number of electronic databases (PubMed and Web of Science) and other internet search engines. The searches included peer-reviewed journal studies published in English and German between 1980 and May 2010. The following subjects were covered:

- Environmental noise and physiological effects (for example cardiovascular disease or effects on the endocrine system)
- Environmental noise and psychological effects (for example sleep disturbance, effects on cognitive function, annoyance, noise sensitivity)
- Environmental noise and psychosocial effects (for example social adaptability, depression, general well-being)

Studies on hearing impairment were not considered in the literature search. While occupational noise was not included in the noise sources that ENNAH focused on, health studies related to noise at work were reviewed as a potential information source relevant to environmental noise effects.

The selection of relevant studies was made on the basis of comprehensive previous reviews, the number of citations and the ranking provided by the ENNAH partners. Recommendations made by the

ENNAH partners were used to identify national reports, grey literature, especially non-English studies in press or in progress and relevant conference proceedings (e.g., INTERNOISE and ICBEN).

The aim of the second workshop was to identify literature relevant to the research gap areas which were identified in the first stage of the literature review and to provide recommendations for future noise and health studies. Topic areas identified were: sources of noise, occupational noise, noise and co-exposures, vulnerable groups, noise characteristics, acute vs. long term effects of noise, stress and social impacts, positive effects of noise and noise reduction interventions. At the conclusion of this workshop several gaps were identified in the current knowledge about noise and health effects.

It was agreed that the two most important topics to focus most of the new literature review activity on were:

1. Noise and co-exposures (including air pollution)
2. The relationship between noise annoyance, noise sensitivity and health outcomes.

The major gaps identified in the literature at the second workshop were the effects of combined sources of noise, longitudinal studies on the effects of noise on mental health and cognitive performance, and the choice of appropriate noise exposure measures.

A review of the literature on air pollution and health effects including the relative contribution of noise and air pollution to health effects was carried out by Sarah Floud from Imperial College, London. A comprehensive workshop report on the evidence of noise related health effects was drawn up and the main conclusions of the workpackage were added to the Network website. Preparation of two peer review journal papers is underway including a review paper on environmental noise and health studies in East and Central Europe.

2.2.2. Conclusions and recommendations

The major gaps identified in the literature discussed were:

- *Effects of combined sources of noise*. The effect of separate noise sources are studied but there is no information how noise exposure from combined sources changes the response.
- *Mental health, physical health other than cardiovascular disease, reproductive outcomes.* Most studies to date investigating health effects of environmental noise have been conducted on cardiovascular system outcomes.
- *Annoyance and noise sensitivity*. Relatively few studies had looked annoyance and noise sensitivity in relation to health outcomes including cardiovascular disease.
- *Appropriate exposure measures*. Modelled average A-weighted dB-based noise exposures may not be the best measure and other metrics e.g. L_{max}, C-weighting, or other noise characteristics should be investigated.

The most important topics to perform future investigations are:

- Noise and co-exposures (including air pollution).
- The relationship between noise annoyance and health outcomes, also including noise sensitivity and a discussion of causes and mechanisms.

2.3. Noise exposure assessment in Noise and Health Studies

2.3.1. Background

The Commission's Green Paper on Future Noise Policy indicated in 1996 that the available data on noise exposure in Europe are generally poor in comparison with data collected for other environmental factors and often difficult to compare due to different assessment methods. Since the European Noise Directive (END) asked for strategic noise maps and noise action plans for major roads, railways and airports in agglomerations in 2007, substantial efforts have been made in recent years to improve the assessment of noise through developing and harmonising methods for the modelling of transport noise. Due to the requirement of strategic noise maps, an enormous amount of potentially useful information has become obtainable for use in exposure assessment within health studies. Before the data generated by the framework of END can be applied in health studies, it is essential to consider the necessary requirements for exposure indicators since a reliable and valid assessment of noise exposure is essential for the interpretation of any study findings in relation to health outcomes. This was one of the reasons the ENNAH workshop 3 on "Noise Exposure Assessment for Health Studies" was organised.

A workshop was held in Ghent, Belgium in April 2010 hosted by Dick Botteldooren (UGhent) and led by Danny Houthuijs from RIVM in the Netherlands. This workshop assessed the applicability of available modelled noise maps to generate relevant indicators of noise exposure of health studies and their limitations. It identified current methodological problems with noise maps and how they might be remedied. It also identified relevant exposure modifiers that can be used in combination with noise maps to improve the precision of exposure assessment. It pointed out the difficulty of comparing noise maps across Europe that had been constructed in different ways in different countries with different assumption and measurement methods. The usefulness of noise maps in health research and recommendations for their future use were illustrated at a side event at the Fifth Ministerial Conference on the Environment and Health in Parma, Italy in March 2010.

2.3.2. Lessons from EU noise mapping

According to the European Topic Centre Land Use and Spatial Information (2008), 67 million people in Europe are exposed to level of road traffic noise higher than 55 dB L_{den}[6]. This corresponds with about 55% of the population in agglomerations with more than 250 000 inhabitants.

Limitations of the current practices start with general issues, such as the definitions of agglomerations, relevant year and the quality of data. Various methods are used in the generation of noise maps. Examples are the assessment of cut off values and the grid step, the treatment of low levels and of quiet areas, the quality and extent of noise source data (flow and speed), the calculation methods and the methods to assign noise levels to the population.

Levels under 55 dB L_{den} and 50 dB L_{night} are not reported and often not even estimated. Therefore, cut off values may lead to a neglect of the impact of smaller roads. Health studies need detailed assessment at high and low noise levels, but often the extent of the agglomeration and the calculation grid step do not allow it. Even at relative low levels substantial annoyance can occur due to source specific spectral

[6] European Environment Agency (2009) Transport at a crossroads. TERM 2008: indicators tracking transport and environment in the European Union. Report 3/2009. EEA, Copenhagen.

characteristics. Valid and reliable noise maps are required not only for their original aim to serve as a basis for action plans, and to verify targets and limits, but also for comparison of EU countries and for the development of a better insight into the impact of noise on health. The large data sets in GIS could be a unique resource for linking noise to health outcomes. From a noise modeller's perspective, noise exposure assessment in health studies requires high quality mapping beyond END requirements and further standardisation across cities and consultants.

Noise maps are appealing for health researchers, since they document noise levels in large study areas which make it possible to link them to health data. But before using this kind of data, the maps must be critically reviewed. For example, it has to be checked to which source the noise levels refer. Since local authorities do not always consider the whole road network but often only the major roads, the levels do not necessarily refer to the most important noise source for a particular building. Therefore, the quality of the noise data has to be evaluated in each specific case. The quality is an important criterion in the selection of study areas and study populations.

Due to missing exposure information additional assessment methods are sometimes required to fill the gaps. The relationship between noise level and noise annoyance usually shows a steady increase in annoyance with increasing noise level in most social surveys so group mean annoyance levels might serve as an indicator of the noise level. The EC "Good practice guide for strategic noise mapping and the production of associated data on noise exposure" provides a useful tool which can also be used if documented noise exposure data are missing. It would probably be more realistic to set a cut level at the lower end that refers to the background noise environment. Cut levels of 35 dB during the night and 45 dB during the day seem to be reasonable for road traffic. In urban surroundings it is often difficult to measure such low averaged noise levels. On the other hand, subjects may respond to the occurrence of a single noise event, rather than to the L_{Aeq}. In such cases, it would make sense to keep the low exposure levels in the analysis (e.g. for aircraft noise).

Figure 2: ENNAH workshop 3 participants meeting in Ghent, Belgium 26-28th April 2010.

2.3.3. Modelling versus measurements

Noise exposure, in general, can be assessed by measurements and by calculation. For exposure assessment in population studies, use of calculated noise data based on established models is preferred. Long-term assessment of noise exposure by measurements only is generally not feasible, particularly not on a large (spatial) scale. Furthermore, the technical possibilities of source-specific acoustical measurement are still limited for large studies. On the other hand, carrying out noise measurements may be useful to obtain additional or missing information about individual exposure conditions and can be used to validate calculated noise levels. The disadvantage of short-term measurements is that they do not account for seasonal variations or weather conditions. However, in many cases it is reasonable to assume that the long-term exposure does not vary too much from the short-term measurement.

If subjects are falsely grouped into the low noise category or the opposite, this tends to dilute the true association between the exposure and the health outcome. On the other hand, if an association is still found the qualitative reasoning would not be discarded. Carrying out short-term measurements (or traffic counts) can therefore be an option when no other noise information is available.

2.3.4. Issues for noise exposure assessment in health studies

2.3.4.1. Noise indicators

It is not always easy to choose which noise indicator is the most relevant to use. In practice, often there is not much choice, so the indicator used is that which is available. For comparability between studies and for policy purposes, established noise indicators (e. g. L_{den}, L_{night}) should be included. Since indicators such as L_{den} and L_{dn} are weighted noise indicators (+5 dB for the evening hours, +10 dB for the night time) the addition of non-weighted noise indicators like $L_{Aeq,24h}$ in health studies is recommended. In addition to energy-equivalent noise indicators, event-related indicators like L_{max}, Number of events, SEL or combinations (NAT = number of exceedances above a threshold) may be considered as well.

2.3.4.2. Outdoor-indoor exposure

Standardised and regularly assessed noise indicators in noise maps refer to outdoor exposures. Often only the most exposed façade of a building is considered. The attenuation due to the noise reduction of windows and walls as well as the individual window opening habits determines the indoor exposure. Individual information about sound insulation measures and individual behaviour can be assessed by questionnaire. Measuring indoor noise to assess the long-term exposure is not recommended because of easy interference of the relatively low indoor noise levels from external sources by noise from indoor sources.

2.3.4.3. Individual exposure

The link from environmental exposure to the individual exposure is important in health studies. The relevant time-window plays an important role in this. Night time exposure may be a particularly valid indicator because it refers to sleep and the time of the day when most people stay at home. Distinguishing between the exposure of the bedroom and the living room is essential in this respect.

Simple accumulated noise energy throughout the whole day in terms of personal dose is not necessarily a useful indicator, if the levels cannot be related to specific activities and/or noise sources. The time of the day could serve as a proxy to differentiate between activities if no specific information is available. Making use of time activity patterns that are linked to noise exposures could be a sufficient way of improving the assessment of individual noise exposure throughout the whole day, since it offers the opportunity to analyse the contribution of different sources in specific time windows.

2.3.4.4. Historical exposure

Sensitivity analyses could be done, excluding people who were not living for a long period at their present address. In some countries people move a lot, so in such cases the historical exposure from different places of residence has to be assessed. An approach could be the calculation of person-months, where the subjects move from one noise category to another with respect to the retrospective observation period.

2.3.4.5. Continuous or categorical data analysis

If continuous noise exposure data are available, they should be used for statistical analyses. The continuous data analysis results in figures like "increase in risk per decibel" and assumes a steady increase in risk with increasing noise level over the range of exposure. Categorical analyses are useful when grouped noise data are available from the very beginning (e.g. in noise policies often 5 dB categories are considered). Analysis with categorical exposure categories might give insight in non-linear relationships (e.g. u- or j-shaped associations). The best option would be to provide both, linear trend and categorical data in the presentation of results. Dichotomous data analysis that compares only two groups (e.g. extreme groups or separated according to the median) should be avoided. Such analyses may help to test associations as such, but they do not enable consideration of exposure-response analyses, which are needed for practical noise mitigation policies and possible interventions.

2.3.4.6. Exposure/effect modifiers

From a statistical point of view all exposure modifying factors and other potential effect modifiers can be treated as interaction terms in the statistical analyses or in stratified analyses. Room orientation and window opening habits are some of the relevant factors: smaller effect estimates can be expected in sub-samples that do not have rooms/windows facing the street. Also the subgroup that always keeps bedroom windows closed may be an interesting group to be considered in sensitivity analyses. Length of exposure (years of residence) was also found in studies to be an important effect modifier, showing larger effects in subjects that had been living in their homes for at least 10 or 15 years. Type of window (single glazing, double or triple glazing, participation in a sound insulation programme) might be another interesting exposure/effect modifier to examine. The use of other noise reducing remedies such as the use of ear plugs during sleep should also be assessed in the noise questionnaire and be considered in the analyses as an effect modifier (exclusion, interaction, or stratification). The height of buildings and the floor level of an apartment may have an impact (distance) on the perceived exposure. Type of housing, ownership of housing may also be worthwhile effect modifiers considering, that may to some extent, be understood as indicators related to the exposure.

When effect modification is studied at least two important issues should be considered. First, most studies were not designed to study effect modification. Therefore they might not have enough power to assess with enough precision the possible effect modification. Second, random error in the variable that modifies the effect (noise sensitivity, annoyance) tends to diminish the observed modification.

2.3.4.7. Multiple exposures

Multiple exposures do not only refer to different noise sources that may be present at the same time (e.g. combined exposures from road, rail, aircraft, industrial noise) but also to noise exposures that may be temporarily present at different times of the day (e.g. traffic noise at home, occupational noise at work, leisure noise during leisure, neighbourhood noise during relaxation periods). If not advised otherwise, the separate treatment of different noise sources/factors in the statistical model would probably be the most appropriate way of handling multiple exposures. The same applies to time-activity related noise levels that may be assessed with personal noise dosimeters. It is preferable to distinguish the contribution of different sources.

2.3.5. Combined exposure to noise and air pollution

Disentangling the effects of noise and air pollution is a challenging task. Work on the establishment of dose response curves is needed and is continuing. Accurate assessment of exposure to road traffic noise and to air pollution is a prerequisite for disentangling their effects, and is perhaps the most critical element in epidemiological exposure-effect studies. Clever and innovative use of existing knowledge, as well as emerging new technologies creates new opportunities to enhance epidemiological research into the effects of combined exposure.

For the design of epidemiological studies on the combined effect of traffic related air pollution and noise it is important to have an insight into the correlation of both exposures. Accurate exposure assessment with an adequate spatial resolution is a prerequisite for disentangling the effects of both exposures. Results from several studies were discussed. It was not yet possible to conclude whether the correlation of measurements was better than the correlation between modelled data for air pollution and noise, due to the use of data with different quality, different models and different time-windows. The correlation in rural areas seems to be lower than in cities. The correlation within cities fluctuates. In discussions it was proposed that situations like street canyons and the shielding effects of buildings seem promising places, where a lower correlation may support disentangling of the effects of air pollution and traffic-related noise.

The effect of road traffic noise and traffic related air pollution exposure develop (partly) through different physiological mechanisms. Furthermore, knowledge on the separate mechanisms may enhance studies through choices of focus on the exposure and respondent data to be gathered. For instance, certain behavioural aspects will affect exposure to noise and air pollution (and their effects) differentially. Exposure in different microenvironments (schools, bedroom) is a topic of interest.

Noise varies much less from day to day compared to air pollution – because the noise level variation mainly depends on the variability in road traffic flow and is to a much lesser extent related to the meteorology than is the case for air pollution. Noise might vary by 2 dB from winter to summer due to temperature but this is a small range compared to air pollution which can vary to a much greater extent. Noise can vary from weekday to weekend but this would be the same for air pollution as it would depend on road traffic levels.

In order to try and separate out effects, study designs will need to include a spatial element. For example, set studies in places which are exposed to mostly noise and not air pollution (e.g. rail noise) or study the effect of noise barriers which will reduce noise but not air pollution. Physical characteristics of the built environment may affect transmission of noise and dispersion of air pollution differently (e.g. effect of building and noise barriers, vehicle speed and vehicle distribution patterns).

The results of two Madrid studies suggest that city-averaged daily fluctuations in ‘acoustical pollution’ may have a short term effect on the rate of hospital admissions. Short term variation in noise levels is

thought to be related to variation in physiological parameters such as blood pressure (BP) and heart rate variability (HRV). Apart from the Madrid studies, no population studies address the acute clinical effects of noise. Novel simulation techniques can be used to model the temporal variation of noise in more detail. Personal noise and air pollution exposure measurement could be used to get an insight into which microenvironments the correlation between noise and air pollution is weak and where they are strong.

In the Ghent workshop, innovative technical methods to measure noise including dosimetry and multiple microphone arrays backed by sophisticated computer technology were described as well as ways of validating the noise modelling that can be applied to large scale epidemiological studies. Additionally, there were presentations on the further developments in noise modelling for capturing exposure to road traffic noise in different urban situations.

Policy related relevant analysis of HYENA and RANCH data and the BBT/ALPNAP database have been carried out to model combined exposures from several sources in relation to health data such as sleep disturbance and annoyance and some initial analyses have been carried out to examine the variation related to the nature of the structural environment, including the effects of sound insulation, building acoustics and the position of the measurement instrument. The technical aspects of noise mapping were also the subject of a WHO sponsored workshop in Bonn in October 2010 dealing with developing the burden of disease methodology in relation to noise exposure into Central and Eastern European countries where noise mapping has not previously been used and reduced resources may mean that there may be a need for simpler methods to assess noise exposure.

2.3.6. Conclusions and recommendations

Lessons learned from noise mapping for health studies

- Noise maps were required to draw up action plans and compare country results in the EU, so they were not primarily developed for noise assessment in health studies. The maps are a potential vital source for health studies, but their applicability has to be evaluated critically on a case-by-case basis. The major limitation in noise mapping is the road network considered, given the specified cut-off values (55 dB L_{den}; 50 dB L_{night}). In addition, different approaches for the collection and use of input data (traffic flow, speed, composition) lead to differences in quality and accuracy between countries, agglomerations and consultants.
- There is concern about the application of the standard noise maps in health studies. This concern is related to the detail of the assessment (grid size, which façade), the assessment of noise at low levels and the neglect of source spectral characteristics. In spite of this, compelling results from studies that made use of END maps were shown during the workshop.
- The END has been evaluated and this will lead to major improvements and further standardisation in noise mapping. The next round of noise mapping will include more major roads and agglomerations.

In addition to the recommendations already formulated for noise mapping in the framework of END, specific recommendations can be given for the application in for health studies:

- ➔ To increase contrast in exposure for health studies, cut-off points for noise mapping should be lowered (down to 45 dB L_{den})
- ➔ Individual levels and not 5 dB contours bands should be made available.

➔ Extend the noise assessment, now limited to the most exposed façade, to other facades as well

➔ The accuracy of maps should be quantified and supplied - a standardised format for the description of accuracy is needed.

2.4. Moderating and confounding factors of associations between environmental noise and health

2.4.1. Background

A workshop was held in Stockholm in September 2010 led by Goran Pershagen from the Karolinska Institutet to identify potentially important confounding factors and effect modifiers in studies of noise and health, including air pollution, socioeconomic status and other lifestyle and environmental factors.

The aim of ENNAH WP 4 was to:

1. Identify potentially important confounders/effect modifiers in studies on noise effects on health including air pollution and individual susceptibility factors such as lifestyle/environment and genetic factors.
2. Propose strategies for assessment, analysis and interpretation of the role of such factors in health-related noise research.
3. Facilitate and develop interactions between researchers in different fields relevant for studies of effect modification in relation to noise and health.
4. To perform further policy relevant analyses of the HYENA and RANCH and other relevant datasets.

The workshop included extensive discussion of the evaluation of both air quality and noise effects, particularly in relation to road traffic and how the effects of noise and air pollution could be distinguished. Road traffic is a source of both noise and air pollution and it is vital for developing policy interventions to understand which pollutant causes which health effects. One important idea was that it might be possible to identify specific health endpoints that were more related to one pollutant than another. The workshop also included individuals' susceptibility to noise and gender differences in response to noise. A paper related to workpackage 2 will review existing studies on noise and air pollution and cardiovascular and respiratory outcomes. The workshop report from this workpackage was placed on the website.

Figure 3: ENNAH workshop 4 participants meeting in Stockholm, Sweden, 6-7 September, 2010.

2.4.2. Confounding and effect modifiers in RANCH, HYENA and German noise studies

The cross-national (Netherlands, Spain, United Kingdom) cross-sectional *RANCH study* aimed to investigate the relationship between aircraft as well as road traffic noise exposure at school and children's health and cognition. Aircraft noise at school was associated with impairment of reading comprehension, recognition memory, and increased annoyance after adjusting for socioeconomic factors and classroom insulation against noise[7].

In the RANCH study no interaction was found between early biological risk and aircraft or road traffic noise. However, children with early biological risk were more likely to have poor mental health than children without biological risk. The aim of the HYENA study was to investigate the relationship between noise exposure near airports and cardiovascular disease outcomes in six study areas in Europe, and for three study sites examine if this association was affected by air pollution levels. The aircraft noise L_{Aeq16h} distribution by country showed higher exposures for the UK and the Netherlands than for Sweden, whereas the road traffic noise L_{Aeq24h} distribution was similar for the three countries. For NO_2, there were considerable differences between the countries with no overlap between the UK and Swedish data despite the similarities in road traffic noise distribution

In German studies on noise and cardiovascular outcomes, besides 'typical' established confounders (age, gender, socio-economic status, lifestyle factors etc.), additional potential confounders include family history of disease, food intake, hormone intake, shift work, noise from other sources (e.g. work noise) and noise sensitivity. In these studies, effect modification was indicated for gender (increased

[7] http://ec.europa.eu/research/environment/pdf/env_health_projects/noise/n-ranch.pdf

risk primarily for males) employment status (increased risk for the unemployed), attitude towards the noise source (positive attitude possibly protective), exposure to other noise sources (increased risks in presence of more than one source) and annoyance (annoyed subjects seem to have a higher risk).

It is important to recognize that the confounding and effect modifying properties of the factors mentioned above may be related to type of study design, method for assessing outcome (self-reporting or objective measurements) and in which order the assessment of exposure and outcome are performed. To reduce the risk, intermediate factors in the causal pathway between exposure and outcome should be identified.

In analysis of further Swedish studies the correlation between air pollution and noise exposure was found to be study specific and related to differences in exposure assessment methods and study area characteristics. Also the confounder and effect modifiers were found to be study specific and should be evaluated according to the hypothesis under study and biologically plausible mechanisms.

2.4.3. Conclusions and recommendations

- Confounding and effect modification are important to consider in health related noise research.
- For cognitive outcomes socioeconomic factors are crucial to take into account. Effect modification by coping and psychological restoration may also be important.
- For cardiovascular outcomes socioeconomic factors are generally important as well. When road traffic noise is focused on, air pollution exposure needs to be taken into consideration.
- Socioeconomic classification should consider both individual and contextual (area-level) confounding.
- Well validated methods are available for estimating individual air pollution exposure, primarily based on dispersion modeling or land use regression.
- There is a great need for further studies on interactions in relation to noise induced health effects, this may be important both for identification of susceptible subgroups and for setting priorities in prevention. As a minimum effect modification by age and sex should be investigated.

2.5. Health outcomes and health impact assessment

2.5.1. Background

A workshop was held on 22-23rd November 2010 in Athens, Greece led by Francesco Forastiere (ASL, Italy). This workshop examined the measurement of a range of health outcomes relevant to environmental noise exposure and also, separately, examined the methodology for health impact assessment in relation to noise. The first day of the workshop was devoted to measurements of health outcomes in epidemiological studies on noise organised by the Department of Epidemiology, Lazio Regional Health Service in collaboration with the National Kapodistrian University of Athens Medical School. In the workshop 30 people from 10 European Countries discussed the measurement of health outcomes including cardiovascular diseases, children's health, biological indicators, respiratory disease, general health status, sleep and mental health. For each specific health effect speakers considered outcome definitions and the available assessment tools and the existing available diagnostic

guidelines. The usual ranges of prevalence and incidence rates, validity and reliability issues and the main approach already used in epidemiological research to assess the health effects of noise was discussed. The workshop usefully identified gaps in knowledge and provided recommendations for noise effects' assessments in future health studies. In discussion, the importance was recognised of having standardised definitions of health outcomes for scientific research – especially relevant for carrying out cross-national comparisons. It was pointed out that we need to make clear conceptual distinctions between short and long term effects of noise on health and get better conceptual overviews of the exposure-disease pathways and further proposals for plausible biological mechanisms of effect.

We recommended that instruments used to measure outcomes should be tailored for specific age groups under study, e.g., infants, children, adolescents, adults and the elderly. Biological indicators should be used according to their intrinsic reliability and considering the possibility of well-defined clinical interpretation of the results. Emerging areas of research were identified for specific age ranges: for children: perinatal disorders, growth effects on growth hormone, puberty and sleep disorders; for adults: fertility, reproductive disorders, diabetes mellitus, secondary hypertension; for the elderly: diabetes mellitus, transient ischaemic attacks and strokes.

On the second day, the workshop considered noise Health Impact Assessment (HIA) organised by the Swiss Tropical and Public Health Institute. HIA is a methodology to evaluate the health impacts of policy scenarios or actions and has proved useful to bridge science and policy to monitor and reduce the impact of environmental exposures. The workshop brought together individuals active in the noise HIA field in Europe and compared approaches and methods currently used to recommend common criteria for conducting Europe wide evaluations. Examples of HIA presented indicated that there is already an existing standardised framework for performing calculations of cases of ill-health attributable to noise exposure and disability-adjusted life years for some specific outcomes for which sufficient evidence exists to suggest causal adverse effects such as annoyance, sleep disturbance and cardiovascular disease. Because annoyance has been shown to constitute the largest burden for noise there is a need for developing more meaningful aggregated indicators for health and wellbeing into the noise HIA process. Workshop discussions helped to identify some priority areas for considering vulnerable population sub-groups, such as evaluating impacts for different socioeconomic groups or integrating reading disability in children as a new HIA indicator. The workshop report was completed and placed on the website.

Figure 4: ENNAH workshop 5a & 5b participants meeting in Athens, Greece, 22-23 November, 2010.

2.5.2. Conclusions and recommendations:

For measurement of health outcomes:

- It is important to provide standardised health outcome definitions and use appropriate terms in scientific reports and papers.
- There is a need for a clearer conceptual distinction between short-term and long-term effects (as in air pollution studies). Research on incidence of diseases should be separated from research on aggravation of pre-existing conditions.
- There is a need for a conceptual overview of the exposure-disease pathways for some disorders/diseases.
- Plausible biological mechanisms should be postulated before including a noise related health outcome in new research studies.
- The instruments should be tailored for the specific age groups under study (infants, children, adolescents and the elderly).
- Consider risk of recall bias for self-reported disorders versus complexity of measurements with a potential low response rate.
- For acute effects laboratory studies are worthwhile but application in the field is essential to establish an association under realistic conditions. Need more research on long term effects.

- ❖ Although some outcomes have been already relatively well-studied in experimental settings, application in field studies (in every day life) would be desirable, especially for acute health effects, in particular for people with chronic diseases.
- ❖ Important need to evaluate the effects of interventions and remedial actions to reduce noise exposure. It can be useful also for aetiological studies.
- ❖ New biological indicators are proposed: prolactin, blood lipids, inflammatory markers, and serotonin.
- ❖ Biological indicators should be used according to intrinsic reliability and consider the possibility of a well-defined clinical interpretation of the results.
- ❖ Stress and coping model is a well established framework for noise effects.
- ❖ Use already on-going cohort studies (add noise component/assessment).

For Health Impact Assessment:

- The criteria for an European wide HIA should be built on the existing experiences from other major European projects, and include integrating a systematic identification and description of key uncertainties and limitations to move the noise HIA methodology forward and help minimise noise impact in Europe.
- For comparison and consistency purposes a European-wide HIA could be applied, although further research and methodological development, overlapping with those identified in other ENNAH workshops, are needed. For example, methods for expanding the coverage of the noise data available for the European population are needed.
- The strategic noise mapping in the context of the END provides an opportunity to perform a European-wide burden calculation of the long-term health effects of noise.
- Based on several expert working groups, a methodology to evaluate DALYs has already been developed for several health end-points.
- Because annoyance and sleep disturbance, two subjectively reported health outcomes, have been shown to constitute the largest noise burden in past evaluations, the development of aggregated indicators of health and well-being (e.g. quality of life and cardiovascular scores) would prove meaningful in evaluating and implementing specific policy options.
- The role of vulnerabilities or what sub-groups of the population are most susceptible to noise will also need a special consideration, an issue only marginally integrated in current evaluations. Of special priority is the evaluation of impacts for different socio-economic groups to take into account setting-specific co-exposures and environmental justice.

2.6. New strategies for noise and health research in Europe

2.6.1. Background

A preliminary workshop to develop new research strategies for environmental noise and health was held in Stockholm, Sweden, September 7-8th 2010 led by Stephen Stansfeld including the workpackage leaders. This workshop was able to focus on the immediate priority needs for future research on noise and health to be fed into the next call for research which would occur before the end of the ENNAH project. The set of research recommendations was prepared with background justification based on the existing literature and backed up by the scientific references in peer-reviewed journals. These research recommendations included:

(a) Further large cohort studies on road traffic noise and cardiovascular disease to confirm exposure response relationships and explore the effects by gender and selected covariates.

(b) To carry out longitudinal studies of environmental noise in school children and effects on reading and memory.

(c) To carry out cohort studies on environmental noise and mental health including standardised measures of mental health and accompanying physiological measurements.

(d) To further refine community studies of annoyance, taking into account the quiet side of buildings and other exposure modifying factors and develop studies of newly emergent noise sources such as windfarms.

Following the workshop of September 7-8th 2010 in Stockholm, a further workshop was held at Queen Mary University of London on February 16-18th 2011. The aim of this workshop was to develop new future strategies for noise and health research in Europe. Network members met to discuss and agree future research directions for noise and health research. The workshop was informed by outputs from the earlier workpackages which focused on gaps in knowledge (workpackage 2), noise exposure assessment (workpackage 3), on moderating and confounding factors (workpackage 4), and on measurement of health outcomes and health impact assessment (workpackage 5). In the workshop discussions were specifically focused on different health outcomes. These were led by an expert or champion in the field for that health outcome. These included: Wolfgang Babisch for coronary heart disease and hypertension, Staffan Hygge for cognition, Birgitta Berglund for annoyance, Barbara Griefahn for sleep, Irene van Kamp for children's health, Mariola Sliwinska-Kowalska for hearing loss and Stephen Stansfeld for mental health.

The workshop included 'think-tanks' to discuss scientific areas that impinge on the study of noise and health but are not currently strongly involved in environmental noise studies. Professor Paolo Vineis from Imperial College talked about genetic factors in relation to the effects of environmental stressors on health and Professor Andrew Steptoe from University College London gave a most informative talk on methods of investigating biological pathways linked to stress and health. Anna Hansell from Imperial College led a think tank on cross-cutting themes and research gaps and Barbara Griefahn led a session on new directions for noise and sleep research. Rosanna Crombie gave a presentation on secondary data analysis in the RANCH project examining biological risk as a moderator of noise

effects on children's health and cognition. The resulting research recommendations were presented by type of health outcome and were relevant across Central, Eastern and Western Europe.

Figure 5: ENNAH workshop 6 participants meeting in London, UK, 16-18th February, 2011.

2.6.2. Key findings

Cross-cutting themes included the need for further assessment of exposure-effect associations in different contexts for different samples and vulnerable groups and for different noise metrics across a variety of health outcomes. There is a need for longitudinal cohort studies, studies assessing change in noise levels and health and for studies to assess the health benefits of interventions to reduce noise exposure.

Future studies should pay more attention to number of noise events, peak sound events and duration of noise exposure as well as using energy-averaged methods of assessment. EU END noise maps should be assessed for their validity for use in health impact studies. Future research should examine the health impact of combined noise sources and the effects of noise in combination with air pollution. Moderators of the associations between noise and health, such as noise sensitivity and noise annoyance, as well as exposure modifiers, should be addressed in future studies. A better specification of underlying biological models of noise and health associations can help to formulate critical hypotheses that could be used to test health effects. Furthermore, a number of specific recommendations for a range of health outcomes were set out in the workshop report and in the second leaflet issued from this workshop.

2.6.3. ENNAH Research recommendations

The workshops for workpackage 6 brought together the expertise and the workshop deliberations from across the network to develop future research recommendations on environmental noise and health. We present the research recommendations by type of health outcome. An important imperative is to strengthen the evidence base for the effects of environmental noise on chronic disease in addition to the knowledge needed to effectively tackle and reduce the widespread impact on annoyance and secure quality of life. Should these noise and health associations be further strengthened there will be definite public health implications. The research recommendations listed below start with the more severe (cardiovascular morbidity) but less prevalent health effects, and lead on to the omnipresent effects (annoyance, children's cognition, mental health, and sleep disturbance) which affect a large number of EU citizens.

2.6.3.1. Research on environmental noise and cardiovascular disease

Research should focus on providing robust exposure-effect relationships between road traffic noise exposure and cardiovascular health effects including cardiovascular risk markers, hypertension and myocardial infarction. Further studies of aircraft noise are also needed and studies of newly emerging sources such as high speed trains. New large prospective cohort studies with detailed noise exposure assessment possibly using additional indicators, and objective assessment of cardiovascular outcomes would be the best solution to address these issues. Consideration should be given to the use of existing cohort studies. Stable exposure-response relationships are needed for the dominant environmental noise sources that affect most EU citizens, of which road traffic noise is the most prevalent. The effects of understudied exposures such as rail and industrial noise should also be investigated. Cohort studies should take account of co-exposures and effect modifiers such as air pollution that may affect associations between noise from road traffic and cardiovascular outcomes such as hypertension or myocardial infarction. A greater understanding is also needed of the mechanisms leading to cardiovascular effects. This might involve studying effects on cardiovascular risk markers. New outcomes that should be considered in addition to IHD, MI, and hypertension, include stroke and the degree of atherosclerosis assessed by carotid artery intima-media thickness. Noise exposure assessment should take advantage of existing noise maps, preferably in combination with information on exposure modifying factors such as open or closed windows and room orientation. Based on previous studies night time as well as day time noise exposure should be included. Improved alternative exposure indicators based on perception should be validated in sub-studies.

2.6.3.2. Research on environmental noise and children's cognitive performance

Longitudinal studies of children's cognition and school performance should be carried out to examine whether cross sectional findings such as impairment of reading comprehension and memory with aircraft and road traffic noise persist over time. The duration and severity weights of cognitive impairment in childhood should be investigated, so this information can be used in future burden of disease studies. Studies involving noise exposure ascertained from GIS noise maps of aircraft and road traffic noise at school and at home complemented with sound insulation information or direct indoor exposure measurement and standardised cognition and educational outcomes would be appropriate. Studies may include pre-school cognitive development, or primary and secondary schools. These studies should include the measurement of classroom acoustics and sound insulation of the classroom.

Another research priority relates to the evaluation of interventions that may reduce noise induced learning impairments. To date there has been little research testing sound insulation in relation to health effects. Such studies will inform policy for noise exposed populations. Future studies should focus on whether learning impairments related to noise exposure can be reduced by sound insulation of the

classroom in large scale studies. In some cases, such studies may take advantage of naturalistic reductions in noise exposure associated with the END action plans or changes in airport operations. A greater understanding is also needed of the mechanisms of working memory and episodic long-term memory. This might involve studying sub-processes in working memory as precursors of what will happen in episodic long-term memory. There needs to be further study of speech intelligibility, attention focussing, and memory in less than perfect acoustical classroom conditions. The hitherto less studied effects of a restorative environment for children doing homework should be more carefully followed up.

2.6.3.3. Research on environmental noise and mental health

Existing studies of noise and mental health in adults are largely outdated. Longitudinal studies using standardised clinical interviews to assess mental health diagnoses (common mental disorders such as affective and anxiety disorders) taking into account exposure to other environmental and social stressors would be an advance in this area of research. Additional measurement of stress hormones (cortisol and catecholamines) preferably combined with noise monitoring would further strengthen these studies. Studies should also include measurement of moderating factors such as noise sensitivity and should involve genetic analyses of vulnerability to environmental stressors. Developments in neuroscience also suggest the scope for future f-MRI studies of responses to noise in the laboratory. Also, sources of psychological restoration from noise should be studied and the impact of quiet and restorative environments with suitable positive soundscapes on wellbeing.

2.6.3.4. Research on environmental noise and annoyance

Following the END, EU countries have developed action plans which aim to reduce environmental noise exposure and its adverse effects, of which annoyance and sleep disturbance are the most widespread. This implies the need for quantification of the effectiveness of practical intervention measures that may be applied. Further studies of annoyance by transportation noise should quantify the effects of situational aspects, such as noise insulation, noise reducing architecture, the presence of a quiet side to noise exposed buildings, quiet areas, as well as source characteristics such as the rate of occurrence and level of individual noise events and its noticeability in different residential building layouts and areas. The effects of noise exposure combined with other environmental exposures on annoyance should also be explored in future research. Updated studies of aircraft noise annoyance to help understand the recent increase in the percentage of highly annoyed subjects including more detailed noise exposure indicators may be informative. Further exploring the mechanisms and models that can explain observations including psychophysical knowledge that may have been gathered in the laboratory should lead to a better understanding of existing and new findings and could ultimately lead to more precise action planning. Furthermore, studies are needed to quantify the impact of emerging noise sources such as high speed and high volume freight rail and wind turbine noise and the impact of interventions to reduce noise. In order to protect circumscribed quiet areas the impact of special noise sources such as motorcycles and mopeds and other recreational noise needs to be evaluated.

2.6.3.5. Research on environmental noise and sleep

New research on sleep should address the mechanisms by which noise disturbs sleep, and how noise-disturbed sleep may lead to health effects. This insight is needed to predict the impact of noise events and to evaluate the effectiveness of possible measures to reduce the impact of night-time noise exposure. There needs to be an appreciation of groups vulnerable to sleep disturbance and studies of sleep in those with chronic diseases. Future research may include assessing the effects of combined noises and combined environmental stressors on sleep. This concerns especially the changing pattern of freight trains, where noise, vibration and low frequencies act together and question the hitherto established ‘rail bonus’ in some countries. This may be carried out in extended field studies with new

cost-effective methods of recording disturbance including cardiac arousals, as well as established measurement tools such as actimetry and subjective assessment.

2.6.3.6. Research on environmental noise and hearing loss

Occupational noise exposure is generally more important for hearing loss than environmental exposure. Recently there has been widespread use of personal listening devices. Although most studies, so far, have found little impact on permanent threshold shift in young people there is a need for longitudinal cohort studies of personal listening device usage in young people to answer this question substantively. The combination of exposure to organic solvents and noise increases the risk of hearing loss; further studies of organic solvents and noise exposure are necessary to establish dose-response relationships.

2.6.3.7 Research on noise and health in children

It was identified that there was a need for the harmonisation of child health outcome measures; the assessment of exposure-response curves specifically for child populations; defining vulnerable settings and vulnerable groups of children; investigating the long-term health effects of noise exposure especially for children young than 8 years old; and further exploring the role of behavioural changes, coping behaviour, and psychological restoration in noise effects on children's health.

2.6.3.8. Emerging topics for environmental noise research

From the review of the previous literature the following health outcomes have been little studied in relation to environmental noise: reproductive outcomes, and the potential further health effects of noise–disturbed sleep. The effects of exposure to a combination of noise sources and noise, in combination with other environmental stressors and sensory inputs merit further investigation. Sources of noise including low frequency noise, vibration in combination with noise, high speed trains, wind turbines and personal listening devices deserve further study.

2.6.3.9. Future directions for exposure assessment in noise and health research

Noise mapping and the use of Geographic Information Systems techniques has been a technical advance in assessing environmental noise exposure across large areas. However, these assessment tools have not been applied to their full potential, particularly in terms of the coverage of the road network, the cut-off values at the lower end, the quality and comparability of the input data across countries. Noise maps need validation against fixed site noise monitoring in areas with contrasting noise sources and should also include measurements at the quiet side of buildings. The emphasis on energy averaged noise measures has led to a neglect of the measurement of numbers of events and its perception in practice. In transport noise studies this has become increasingly relevant as the magnitude of noise related to individual transport sources has reduced but the number of events has increased. Studies using C-weighting of sound and low frequency noise might also be relevant in relation to health and wellbeing. Diurnal exposure patterns based on personal activities and more accurate inclusion of building insulation for assessing exposure indoors have to be included since these parameters may change over time due to action plans.

2.7. ENNAH Young Researcher Exchange Programme

2.7.1. Background to the ENNAH young researcher exchange programme

The ENNAH young researcher exchange programme funded exchanges between countries and academic disciplines with the aim of establishing research partnerships among a new generation of noise and health researchers. During the network, ten exchanges have been funded by ENNAH from applicants working in epidemiology and public health, psychology, acoustics, engineering, audiology and medicine. The successful applicants included Anneliese Bockstael from Ghent University, Belgium who undertook an exchange at the Medical University of Innsbruck, Austria, investigating exposure effect relationships for traffic noise; Sarah Floud from Imperial College, London who has undertaken exchanges at the University of Athens, Greece, RIVM, the Netherlands, and the Karolinska Institute in Sweden, exploring the influence of air pollution on the association between transport noise and health outcomes; Maria Foraster Pulido from the Centre for Research and Environmental Epidemiology, Spain who undertook an exchange at the Swiss Tropical Institute examining traffic related noise and air pollution effects on blood pressure; Helena Jahncke from the University of Gavle in Sweden who undertook an exchange at the Raunhofer-Institut for Bauphysik, Germany examining relationships between speech intelligibility, cognitive performance and health in open plan offices; Mara Nolli from the Environmental Protection Agency of Tuscany Region in Italy who exchanged with the University of Stockholm, exploring long term exposure to road traffic noise and health effects focusing on the use of noise maps and annoyance on cardiovascular disease; Katrin Ohlau from University of Stuttgart in Germany who undertook an exchange at INRETS, Lyon, France exploring how a monetary estimate of health damages and annoyance caused by traffic noise can be carried out in Europe; Katarina Paunovic from the University of Belgrade in Serbia who exchanged with Queen Mary University of London examining novel methods of blood pressure measurement in children in relation to noise exposure; Patrik Sorqvist from the University of Gävle who exchanged with Cardiff University examining the role of working memory capacity and noise exposure; Elise Van Kempen from RIVM in the Netherlands who exchanged with the Federal Environment Agency in Germany updating a meta-analysis on the effects of environmental noise on the blood pressure of children and adults; Gordana Ristovska from Republic Institute for Health Protection, Macedonia who undertook an exchange with Imperial College London, examining reproductive outcomes in relation to road and aircraft noise exposure. We were able to establish ten exchanges rather than the original five planned within the same financial envelope, because most participants have exchanged for shorter periods than originally envisaged.

ENNAH was subsequently able to organise a bursary to cover registration and accommodation costs which enabled all ten ENNAH Young Researchers to attend the ICBEN conference in London July 2011 to present their work either as an oral or poster presentation. This was a valuable networking experience for the young researchers. Several journal papers are in progress or have been accepted based upon the research conducted as part of this young researcher exchange programme.

3. Impact

3.1. Overview

3.1.1. Strategic Impact

The Network has successfully brought together scientists from a range of disciplines working on the common problem of environmental noise and health. The workshops have generated new contacts between scientists and allowed productive scientific discussion. ENNAH has also brought together scientists working on air pollution and noise to work together. It has been the foundation for several new research proposals submitted to the EU, including ENACT, NEFELI, NECHTAR (Initial Training Network) as well as an Erasmus Mundus doctoral proposal. Shared expertise has been helpful in suggesting common recommendations for new noise maps. The involvement of our Central and Eastern European Partners has raised the profile of noise research in these countries and led to greater cooperation across Europe recognised in joint papers and the WHO meeting on the Burden of Disease.

3.1.2. Lead users of the research

Researchers within the Network have benefited from the Network's activities. Dissemination to international conferences such as ICBEN and INTERNOISE has also led to this expertise being disseminated further afield including to the FAA in USA contributing to their deliberations on new noise and health research. Secondly, the Network results have been fed back to policy makers at two meetings in Brussels and at a workshop co-organised with DEFRA in the UK. Policy makers have also attended our workshops and our newsletters and leaflets have been disseminated to policy makers through our directory of end users. We anticipate our findings will be relevant to policy makers involved with the European Noise Directive. These include both our recommendations about noise maps, our findings on assessment of noise exposure and measurement of health outcomes in noise studies and our final recommendations for research. These recommendations are directly relevant to EU policy makers who are responsible for developing new calls for research proposals.

Our findings have been disseminated through the workshops, newsletters, scientific leaflets, peer-reviewed papers, conference papers, conference presentations and a website. Apart from this final publishable summary we are preparing a much longer, more detailed final report under the guidance of workpackage 7.

A further important outcome of ENNAH has been building up research capacities through the training of junior researchers and doctoral students as part of the next generation of environmental researchers working on noise and health.

3.1.3. Exploitation of the results

The Network is establishing a framework for future noise research. This is the start of a process. The future research will help to clarify the associations of environmental noise and health to improve the guidance for policy makers. More precision in defining health effects, for which this Network is a first step, will contribute to more informed environmental policy making which can combine economic growth with higher standards of living and better health. As noise exposure affects large numbers of the EU population better management of noise could lead to higher levels of wellbeing for very large

numbers of people. Exploitation of the Network findings has been almost exclusively in the scientific and policy implications arena. Interaction has been established with policy makers and EC services to communicate the recommendations of the project concerning needs for new research strategies on noise, air pollution and related health effects in the EU. Policy makers have acknowledged the helpfulness of ENNAH in providing ideas where future thinking on noise and health issues should focus. A greater understanding of the adverse effects of noise can be used for better informed policy making and for prioritising key gaps for future research.

3.2. ENNAH Information Strategy Plan & Dissemination

ENNAH's work package 7 was led by European Commission's Joint Research Centre - Institute for Health and Consumer Protection and co-ordinated by Dr. Stylianos Kephalopoulos in liaison with his collaborator Dr. Jurgita Lekaviciute.

The main objective of ENNAH WP 7 was:

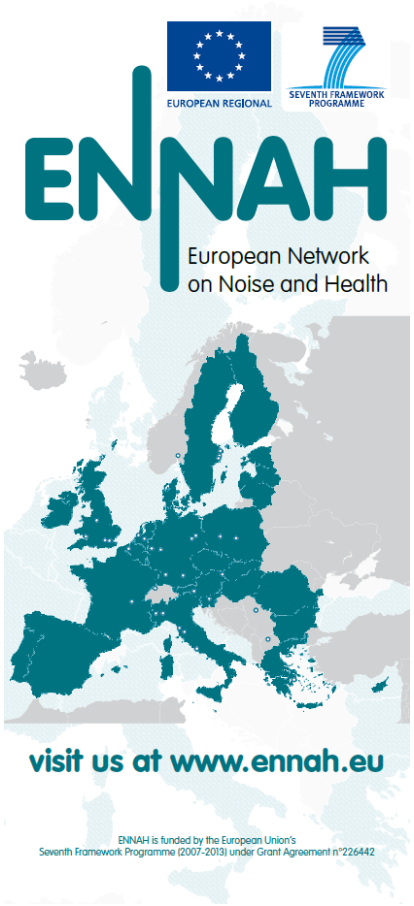
To develop an information strategy plan and dissemination of the scientific findings of ENNAH through dedicated actions focused on the various target groups of end-users (scientific community, policy makers in EC and member states, NGOs, industries and the general public).

We believe that we have created structures that have encouraged dialogue and creative work between network members and we have made sure that individual workpackages communicate and interact together with considerable amount of shared membership between workpackages and liaison between partners.

3.3. Results of dissemination

3.3.1. Project website

In the autumn of 2009 ENNAH project website (www.ennah.eu) (Figure 6) was setup and launched by the ENNAH co-ordinator (QMUL, UK). The website continues to remain active and it is planned that it will remain active for a further five years. It contains details of the network, the organizations and people involved in the ENNAH project. It is possible to download all the workshop reports, the newsletters and leaflets from the website.



3.3.2. Newsletters

Four electronic newsletters, outlining the work performed in the context of the ENNAH network, were released. They were made available in both, electronic format and hard copies.

The first ENNAH newsletter (Figure 7) was released in early 2010 and it presented the ENNAH project's objectives, planned activities and partnership. The second newsletter produced in August 2010 presented the news from project activities: from two workshops related to WP 2 (held in London, in June 2010) and to WP3 (held in

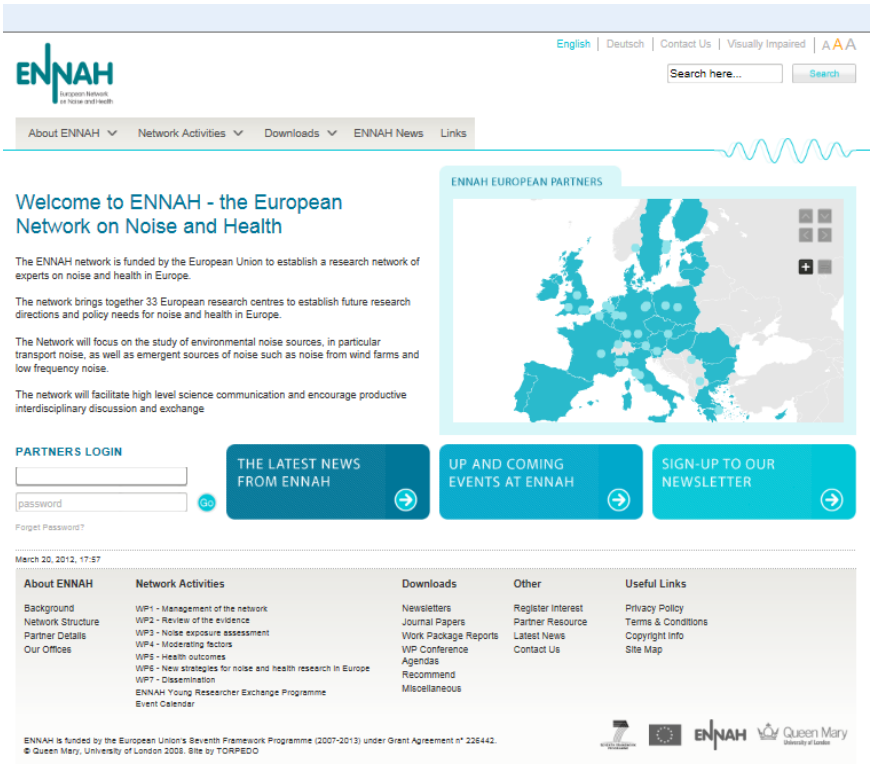


Figure 6. The ENNAH website

Figure 7. ENNAH Newsletters.

Ghent, in April 2010), as well as news from INTERNOISE 2010, where some ENNAH partners were participating.

The third ENNAH newsletter also presented the news from two workshops related to WP4 (held in Stockholm, in September 2010) and to WP 5 (held in Athens, in November 2010), respectively. This also included the participation of several ENNAH partners in the WHO meeting on "Burden of disease from environmental noise" organized by the WHO in October 2010 in Bonn, as well as the Slovakian experience concerning capacity building in Central Europe and finally experiences from ENNAH young researcher exchange programme. The final – fourth ENNAH Newsletter presented the last workshop organized related to WP 6 (held in London, 2011) and the final ENNAH conference (held in Brussels, in July 2011). This newsletter also presented the common work of ENNAH partners from Central and Eastern Europe, South-East Europe and Newly Independent States on a review of environmental noise and health research. It also reported on other dissemination activities: the ENNAH film, as well as in several international conferences, and one more experience from the young researcher exchange programme (Figure 7). All ENNAH newsletters can be found in and downloaded from the ENNAH website.

3.2.3. ENNAH leaflets

Three ENNAH leaflets were prepared in collaboration with the ENNAH Co-ordinator and the WP leaders to give information about the objectives and major outcomes of WP2 on evidence (Leaflet 1) and WP6 on new research strategies (Leaflet 2). The final leaflet, presenting ENNAH outcomes from the policy maker's perspective (Leaflet 3), was prepared at the end of the project and distributed to the ENNAH platform of end users (see 3.3.4.) (Figure 8). All ENNAH leaflets can be found and downloaded from the ENNAH website.

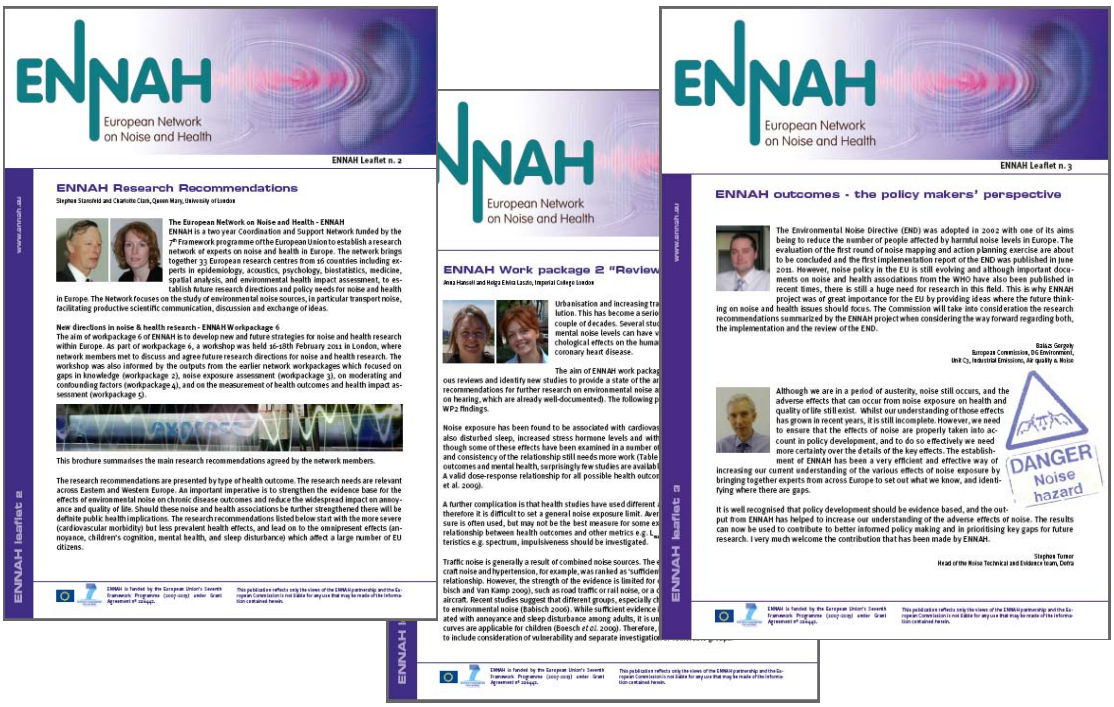


Figure 8. ENNAH Leaflets.

3.3.4. Platform for end-users

A platform for end-users was set up including 156 organizations/people from:

- **European Commission**: Directorate-General (DG) Research, DG Environment, DG Enterprise, DG MOVE, DG SANCO and Agencies: European Environmental Agency (EEA) and European Railway Agency (ERA) – 9 representatives;
- **Commission Working Groups on Noise Policy**: Assessment of Exposure to Noise (*WG AEN*), Airport noise (*WG AN*), Health and Socio-economics (*WG HSEA*), Outdoor Equipment, Railway Noise and Road Traffic Noise – 6 representing experts;
- **WHO-Regional Office for Europe** – 1 representative;
- **WHO Temporary Advisors** (*Risk assessment of environmental noise*) – 43 experts from national authorities, scientists working in research institutes and universities in noise field;
- **DG ENV Noise Regulatory Committee** - 41 experts from national EU authorities;
- **Observers States** – 4 representatives from Norway, Switzerland and Turkey.
- **EEA Expert Panel on Noise** – 11 experts
- **Non-governmental organizations** – 4 organizations
- **Local authorities**: EUROCITIES, Council of European Municipalities and Regions (CEMR/CRRE) and National Roads Authority – 5 representatives
- **Industry** – 11 industry related unions and associations
- **Non-EU organizations** (US Federal Aviation Agency (FAA) and US National Institute for Occupational Safety and Health (NIOSH) – 2 institutions
- **Noise related European projects**: **CALM II Network, COST TD0804** (*Soundscapes of European Cities and Landscapes*), **ECTRI** (*European Conference of Transport Research Institutes*), **EFFNOISE (***Effectiveness of Noise Mitigation Measures***), ESCAPE** (*European Study of Cohorts for Air Pollution Effects*), **HEAVEN** (*Healthier Environment through Abatement of Vehicle Emission and Noise*), **HEIMTSA** (*Health and Environment Integrated Methodology and Toolbox for Scenario Assessment*), **HOSANNA** (*Holistic and sustainable abatement of noise by optimized combinations of natural and artificial means*), **HYENA** (*Hypertension and Exposure to Noise near Airports*), **IDEA** (*Intelligent Distributed Environmental Assessment*), **IMAGINE** (*Improved Methods for the Assessment of the Generic Impact of Noise in the Environment*), **INTARESE** (*Integrated Assessment of Health Risks of Environmental Stressors in Europe*), **QCITY** (Quiet City Transport), **RANCH (*Road traffic and Aircraft Noise exposure and children's Cognition & Health)*, ROTRANOMO** (*Development of a Microscopic Road Traffic Noise Model for the Assessment of Noise Reduction Measures*), **SILENCE** (*Quieter Surface Transport in Urban Areas*), **SOUNDSCAPE** (*Soundscape Support to Health*), **STAIRRS** (*Strategies and Tools to Assess and Implement Noise Reducing Measures for Railway Systems*), **X2-NOISE** (*Aircraft External Noise Network Phase II*) – 19 contact points.

This platform of end users was used for the invitations to the organized ENNAH workshops and to the final conference.

3.3.5. Publications in scientific journals and conferences

The main achievements of the ENNAH network were also disseminated through articles published in scientific journals and presentations made at international conferences (e.g. EURONOISE 2009, INTERNOISE 2010, 2011, ISEE 2011 and ICBEN 2011) and also in expert meetings. Of particular importance was participation of several ENNAH partners at the Fifth Ministerial Conference on the Environment and Health in Parma, Italy (10-12 March 2010) and at the WHO meeting on "Burden of Disease from Environmental Noise" (14-15 October 2010, Bonn, Germany). At the Fifth Ministerial Conference on the Environment and Health in Parma, Italy, ENNAH organized a side event which was well attended by policy makers and researchers.

Numerous oral or poster presentations and scientific publications (manuscripts or posters) have been made during and after the project period. More detailed information on the scientific articles and presentations given by ENNAH members and information on other dissemination activities, can be found in the Table A1 (List of scientific (peer reviewed) publications) and Table A2 (list of dissemination activities) below.

The ENNAH partners also collaborated on applications for the Marie Curie Initial Training Network (NECHTAR).

3.3.6. Final meeting

The Final ENNAH conference was held at the Committee of the Regions in Brussels on the 6th July 2011. This conference was the concluding event of the ENNAH project. It was co-organized by the ENNAH's project coordinator Queen Mary, University of London jointly with the European Commission's Joint Research Centre – Institute of Health and Consumer Protection.

The main objective of this final event was to inform EU policy makers and other interested stakeholders about the major findings of the ENNAH network concerning strategies for research that will enable mechanisms for noise effects on health to be further examined and implemented in EC policies on noise, air pollution and related health effects.

This event gathered more than 80 participants including policy makers, representatives from Environment and Health Ministries in the EU MS, noise scientists, representatives from industry, WHO, NGOs and other stakeholders interested in noise and health issues.

The conference was opened on behalf of the European Commission by Andrea Tilche (DG Research & Innovation). Afterwards four key note lectures were then given by ENNAH co-ordinators (Stephen Stansfeld and Charlotte Clark) and WP leaders (Anna Hansell and Goran Pershagen), on the ENNAH achievements and recommendations for future research related to noise and health in Europe.

Two more representatives from the European Commission: from DG ENV (Mr. Joachim D'Eugenio) and DG ENTR (Mr. Bernd Merz) in their speeches stressed the increasing efforts undertaken by the European Commission to integrate noise related health aspects in noise related policy instruments (i.e. the Environmental Noise Directive 2002/49/EC and the Outdoor Noise Machinery Directive 2000/14/EC).

The conference was closed by discussions about future research strategies and policy orientations in noise and health. The discussions were stimulated by a Panel of experts composed of representatives from: DG R&I (Tuomo Karjalainen), DG ENTR (Bernd Merz), DG ENV (Joachim D'Eugenio), DG

JRC (Stylianos Kephalopoulos), WHO (Rokho Kim) and leading scientists in noise and health (Wolfgang Babisch, Birgitta Berglund, Staffan Hygge Sonja Jeram and Stephen Stansfeld).

3.3.7. Final report

An extended version of the final report was prepared by JRC-IHCP, as WP 7 leader in liaison with the ENNAH co-ordinator on the basis of the individual ENNAH workshop reports provided by the ENNAH WP leaders.

3.3.8. ENNAH film

ENNAH was also disseminated using an innovative approach – by creation of a film focused on the ENNAH network. This film was undertaken by ENNAH partners from Cardiff University, Andrew Smith and Paul Allen – who has recently trained as a film director.

The aim of the film about the ENNAH project was to describe the activities of the different work packages and to offer some suggestions for future directions. It was intended to to give an indication of the breadth of the work packages and to stimulate interest in the subject matter. The film can currently be viewed from www.ennahfilm.com.

3.3.9. DEFRA ENNAH UK Workshop February 2012

The ENNAH network were asked by the UK Department of Environment, Food, and Rural Affairs to organise and host a workshop for local authorities and policy makers in the UK that would disseminate the findings of the network, as well as providing an update on the strength of the evidence for noise effects on health. The workshop was held on 22nd February 2012 in London and was attended by over 70 participants. Network members gave talks on cardiovascular effects, noise annoyance, cognition effects, air pollution and mental health and lively discussions were held with policy makers around these issues.

Section A

Table A1: List of Scientific Publications

TABLE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES										
NO.	Title	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers (if available)	Is/Will open access provided to this publication?
1.	An updated meta-analysis on hypertension due to road noise	van Kempen/Babisch	*Journal of Hypertension*	In press	*Lippincott, Williams, & Wilkins*	*Philadelphia, USA*	*2012*	*tbc*		Yes
2.	Does traffic-related air pollution explain associations of aircraft and road traffic noise exposure on children's health and cognition? A secondary analysis of the UK sample from the RANCH project.	*Clark C (QMUL)*	*American Journal of Epidemiology*	*In press, 2012*	*Oxford Journals*	*Cary, NC, USA*	*2012*	*tbc*		Yes
3.	Epidemiological studies on noise and blood pressure in children: Observations and suggestions.	Paunovic (UBelgrade)	*Environment International*	37; 5:, 2011	*Elsevier*		*2011*	*1030-41*	doi:0.1016/j.envint.2011.03.017, PMID:21496926	No
4.	Environmental noise exposure, early biological risk and mental health in nine to ten year old children: a cross-sectional field study	Crombie, R (QMUL)	*Environmental Health*	14;10, 2011	*BioMed Central*		*2011*	*39*	doi:10.1186/1476-069X-10-39 PMID: 21569605	Yes
5.	Cardiovascular effects of environmental noise: research in the United Kingdom.	Stansfeld SA (QMUL)	*Noise & Health*	13; 52, 2011	*Medknow*		*2011*	*229-233*	PMID: 21537107	No
6.	Cardiovascular effects of	Babisch W	*Noise and*	13; 52: 201-4	*Medknow*	*Mumbai,*	*2011*	*201-4*	PMID 21537102	No

	noise		*Health*			*India*				
7.	Cardiovascular effects of environmental noise: Research in Sweden	Bluhm G, Eriksson C	*Noise and Health*	13; 52:212-6	*Medknow*	*Mumbai, India*	*2011*	*212-6*	PMID 21537104	No
8.	Cardiovascular effects of environmental noise research in Serbia	Belojevic G, Paunovic K, Jaklovljevic B, Stojanov V, Ilic J, Slepcevic V, Saric-Tanaskovic M.	*Noise and Health*	13; 52: 217-20	*Medknow*	*Mumbai, India*	*2011*	*217-20*	PMID 21537105	No
9.	Cardiovascular effects of environmental noise: Research in the Netherlands	Van Kempen E	*Noise and Health*	13; 52: 221-8	*Medknow*	*Mumbai, India*	*2011*	*221-8*	PMID 21537106	No
10.	Cardiovascular effects of environmental noise: Research in Austria	Lercher P, Botteldooren D, Widmann U, Uhrner U, Kammeringer E	*Noise and Health*	13; 52: 234-50	*Medknow*	*Mumbai, India*	*2011*	*234-50*	PMID 21537108	No
11.	Relationship between noise annoyance from road traffic noise and cardiovascular diseases: A meta-analysis	Ndrepepa A, Twardella D	*Noise and Health*	13; 52: 251-9	*Medknow*	*Mumbai, India*	*2011*	*251-9*	PMID 21537109	No
12.	Noise & Health in vulnerable groups: a review	van Kamp, I. & Davies, H.	*Noise and Health*	Submitted	*Medknow*	*Mumbai, India*				No
13.	ICBEN review 2011 on Noise-induced Hearing Loss	Sliwinska-Kowalska, M. & Davis, A.	*Noise and Health*	Submitted	*Medknow*	*Mumbai, India*				No
14.	Overview of research into sleep disturbance due to noise in the last three years	Hume, K.	*Noise and Health*	Submitted	*Medknow*	*Mumbai, India*				No
15.	ICBEN review 2011: A 3 Year Update on the Influence of Noise on Performance and Behavior	Clark C. & Sörqvist, P.	*Noise and Health*	Submitted	*Medknow*	*Mumbai, India*				No
16.	Medication use in relation to noise from aircraft and road traffic in six European countries: results of the HYENA study	Floud, S., Vigna-Taglianti, F., Hansell, A. L., Blangiardo, M., Houthuijs, D., Breugelmans,	*Occupational & Environmental Medicine*	68(7):	*BMJ Journals*	*UK*	*2011*	*518-24*	doi: 10.1136/oem.2010.058586	Yes

		O., Cadum, E., Babisch, W., Selander, J., Pershagen, G., Antoniotti, M. C., Pisani, S., Dimakopoulou, K., Haralabidis, A. & Velonakis, V.								
17.	The European Network on Noise & Health – research recommendations on environmental noise and health	Stansfeld, S., Pershagen, G., Clark, C., Botteldooren, D., Hansell, A., Houthuijs, D., Forastiere, F., Hygge, S., Kephalopoulos, S.	*Environmental Health Perspectives*	In preparation	*NIH*	*USA*				Yes
18.	Environmental noise and cardiovascular disease: research in Central and Eastern Europe, South-East Europe and Newly Independent States	Argalasova-Sobotova, L,, Paunovic, K., Belojevic,G., Jeram, S., Ristovska, G., Lekaviciute, J., Preis, A., Jurkovicova, J., Sevcikova, L., Sliwinska-Kowalska, M., Stansfeld, S.	*Noise & Health*	In preparation	*Medknow*	*Mumbai, India*				No
19.	Children's exposure to elevated road traffic noise in Ljubljana	Jeram, S.		In preparation						
20.	Measurements of health outcomes in epidemiological studies on noise	Ancona, C., Costa, G., Griefanh, B., Haralabilis, A., Lercher, P.,		In preparation						

		Stansfeld, S., Katsouyanni, K., van Kamp, I., Forastiere, F.								
21.	Heart disease and stroke in relation to aircraft and road traffic noise in six European countries – the HYENA study	Floud, S., Blangiardo, M., Clark, C., Babisch, W., Houthuijs, D.,Pershagen, G., Katsouyanni, K., Velonakis, M., Vigna-Taglianti, F., Cadum, E., Hansell, A.		In preparation						
22.	Methodological issues when assessing the effect of noise and air pollution on cardiovascular disease - the HYENA study example	Floud, S., Blangiardo, M., Clark, C., de Hoog, K., Babisch, W., Houthuijs, D.,Pershagen, G., Katsouyanni, K., Velonakis, M., Vigna-Taglianti, F., Cadum, E., Hansell, A.		In preparation						
23.	Annoyance and other reaction measures to changes in noise exposure – a review.	Laszlo, H., McRobie, E., Hansell, A.	*Science of the Total Environment*	In preparation						
24.	Reviewing Evidence on Environmental Noise Related Health Effects in the European Network for Noise and Health (ENNAH)	Hansell, A. & Laszlo, H.	*Noise & Health*	In preparation						
25.	Health effects of environmental noise exposure when combined with other environmental	Lekaviciute J., De Kluizenaar Y., Laszlo H., Hansell A.,	*Environmental Health*	In preparation						

	exposures: state of the art review.	Floud S., Lercher P., Babisch W., Kephalopoulos S :								
26.	Noise and perinatal health.	Ristovska, G., Laszlo, H., & Hansell, A.		In preparation						

Table A2: List of Dissemination Activities

TABLE A2: LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities	Main leader	Title	Date	Place	Type of audience	Size of audience	Countries addressed
1.	*Film*	*Smith (CARDIFF)*	*European Network on noise and health*	*July 2011*	*www.ennahfilm.com YouTube*	*Civil society Industry Scientific Policy makers*	*Unlimited*	International
2.	*Newsletter*	*JRC/QMUL*	*ENNAH – 1st newsletter*	*January 2010*	*www.ennah.eu*	*Civil society Industry Scientific Policy makers*	*Unlimited*	International
3.	*Newsletter*	*JRC/QMUL*	*ENNAH – 2nd newsletter*	*August 2010*	*www.ennah.eu*	*Civil society Industry Scientific Policy makers*	*Unlimited*	International
4.	*Newsletter*	*JRC/QMUL*	*ENNAH – 3rd newsletter*	*February 2011*	*www.ennah.eu*	*Civil society Industry Scientific Policy makers*	*Unlimited*	International
5.	*Newsletter*	*JRC/QMUL*	*ENNAH – 4th newsletter*	*January 2012*	*www.ennah.eu*	*Civil society Industry Scientific Policy makers*	*Unlimited*	International
6.	*Scientific leaflet*	*JRC/QMUL*	*ENNAH – 1st scientific leaflet Literature Review*	*July 2010*	*www.ennah.eu*	*Scientific Policy makers*	*Unlimited*	International

7.	*Scientific leaflet*	*JRC/QMUL*	*ENNAH – 2ND scientific leaflet Research recommendations*	*September 2011*	*www.ennah.eu*	*Scientific Policy makers*	*Unlimited*	International
8.	*Scientific leaflet*	*JRC/QMUL*	*ENNAH – 3rd scientific leaflet Policy Implications*	*January 2012*	*www.ennah.eu*	*Policy makers*	*Unlimited*	International
9.	*ENNAH extended final report*	*Lekaviciute and Kephalopoulos (JRC), Stansfeld and Clark (QMUL)*	*Final report*	*March 2012*	*www.ennah.eu*	*Scientific Policy makers*	*500 copies*	International
10.	*Workpackage report – WP2*	*Hansell (Imperial)*	*Review of the evidence*	*December 2010*	*www.ennah.eu*	*Scientific Policy makers*	*Unlimited*	International
11.	*Workpackage report – WP3*	*Houthuijs (RIVM)*	*Noise Exposure Assessment*	*December 2010*	*www.ennah.eu*	*Scientific Policy makers*	*Unlimited*	International
12.	*Workpackage report – WP4*	*Pershagen (Karolinska)*	*Moderating factors*	*February 2011*	*www.ennah.eu*	*Scientific Policy makers*	*Unlimited*	International
13.	*Workpackage report – WP5*	*Forestiere (ASL Rome)*	*Measurements of health outcomes in epidemiological studies on noise (WP5a) and European Health Impact Assessment (WP5b)*	*April 2011*	*www.ennah.eu*	*Scientific Policy makers*	*Unlimited*	International
14.	*Workpackage report – WP6*	*Stansfeld (QMUL)*	*New Strategies for Noise and Health Research in Europe*	*May 2011*	*www.ennah.eu*	*Scientific Policy makers*	*Unlimited*	International
15.	*Conference Internoise 2011*	*Stansfeld (QMUL)*	*Plenary Session 'Outcomes of the European Network on Noise and Health (ENNAH)'*	*4-7th September 2011*	*Osaka Japan*	*Scientific*	*1000-1500*	International

16.	Conference Euronoise 2009	Stansfeld (QMUL)	Plenary Session New Directions in Noise and Health Research	*26-28th October 2009*	*Edinburgh, UK*	*Policy makers Scientific*	*1000*	International
17.	Conference World Health Organisation Fifth Ministerial Conference on Environment and Health 2010	Stansfeld/KIM (QMUL/WHO)	Symposia of papers from network members Environmental noise and health: the ENNAH network	10-12th March, 2010	Parma, Italy	Policy makers Scientific Industry Civil Society	30	Europe
18.	Conference World Health Organisation Fifth Ministerial Conference on Environment and Health 2010	Stansfeld (QMUL)	The ENNAH network: designing new noise and health research in adults and children.	10-12th March, 2010	Parma, Italy	Policy makers Scientific Industry Civil Society	30	Europe
19.	Conference World Health Organisation Fifth Ministerial Conference on Environment and Health 2010	Babisch (UBA)	Noise, annoyance, blood pressure and hearing in German 8-14 year old children	10-12th March, 2010	Parma, Italy	Policy makers Scientific Industry Civil Society	30	Europe
20.	Conference World Health Organisation Fifth Ministerial Conference on Environment and Health 2010	Nilsson (SU)	Using noise maps and geographic information systems to assess individual traffic noise exposure.	10-12th March, 2010	Parma, Italy	Policy makers Scientific Industry Civil Society	30	Europe
21.	Conference World Health Organisation Fifth Ministerial Conference on Environment and Health 2010	Pierik (TNO)	Health effects of road traffic-related noise and air pollution.	10-12th March, 2010	Parma, Italy	Policy makers Scientific Industry Civil Society	30	Europe
22.	Conference Internoise 2011	Belojevic/Argalasova-Sobotova (UBelgrade/CUB)	Oral Presentation Highlights on environmental noise and health research in Central and	*4-7th September 2011*	*Osaka Japan*	*Scientific*	*1000-1500*	International

			Eastern Europe, South-East Europe and Newly Independent States					
23.	Meeting Aviation Noise Impacts Roadmap Annual Meeting 2011	Clark (QMUL)	Oral Presentation The European Network on Noise & Health (ENNAH): new directions in noise and health research	*19-20th April 2011*	*Washington D.C., USA*	*Policy makers Scientific*	*60*	USA Europe
24.	Conference Internoise 2011	Stansfeld (QMUL)	Symposia of papers from network members 'New Directions in Noise and Health Research'.	*13-16th June, 2010*	*Lisbon, Portugal*	*Policy makers Scientific*	*1000*	International
25.	Workshop DEFRA sponsored workshop on noise and health	Stansfeld/Clark (QMUL)	Workshop on noise and health - Presentations on ENNAH research recommendations by network members	22nd February 2012	London, UK	Policy makers	75	UK
26.	Conference International Congress on the Biological Effects of Noise 2011 (ICBEN)	Clark/Stansfeld (QMUL)	Young researcher papers and posters	24-28th July 2011	London, UK	Scientific Policy makers	300	International
27.	Conference International Congress on the Biological Effects of Noise 2011 (ICBEN)	Ohlau (UStuttgart)	YR PRESENTATION Health costs of noise: what have we learnt from the literature and their use in noise policy?	24-28th July 2011	London, UK	Scientific Policy makers	300	International
28.	Conference International Congress on the	Laszlo (Imperial)	YR PRESENTATION	24-28th July 2011	London, UK	Scientific Policy	300	International

	Biological Effects of Noise 2011 (ICBEN)		The types of human response to changes in noise exposure – a review.			makers		
29.	Conference	Bockstael (Ghent)	YR PRESENTATION Influence of temporal structure of the sonic environment on annoyance.	24-28th July 2011	London, UK	Scientific Policy makers	300	International
30.	International Congress on the Biological Effects of Noise 2011 (ICBEN)	Foraster (CREAL)	YR PRESENTATION Cross-sectional association between road traffic noise and hypertension in a population-based sample in Girona, Spain (REGICOR-AIR project).	24-28th July 2011	London, UK	Scientific Policy makers	300	International
31.	Conference	Nolli (ARPAT)	YR POSTER Example of correction of soundscape: an intelligent and interactive audio system for masking the noise and increase the pleasantness inside a sonic garden in Florence.	24-28th July 2011	London, UK	Scientific Policy makers	300	International
32.	International Congress on the	van Kempen	YR	24-28th July 2011	London,	Scientific	300	International

	Biological Effects of Noise 2011 (ICBEN)	(RIVM)	PRESENTATION The quantitative relationship between road traffic noise and hypertension: a meta-analysis		UK	Policy makers		
33.	Conference	Paunovic (UBelgrade)	YR POSTER The effects of recorded traffic noise on hemodynamic parameters in healthy women - a pilot study.	24-28th July 2011	London, UK	Scientific Policy makers	300	International
34.	International Congress on the Biological Effects of Noise 2011 (ICBEN)	Laszlo/Hansell (Imperial)	YR PRESENTATION Reviewing evidence on noise exposure and non-auditory health effects in the European Network for Noise and Health (ENNAH).	24-28th July 2011	London, UK	Scientific Policy makers	300	International
35.	Conference International Congress on the Biological Effects of Noise 2011 (ICBEN)	Clark/Sorqvist (QMUL/GAVLE)	Presentation 3 year update on research on effects of noise on performance and behaviour	24-28th July 2011	London, UK	Scientific Policy makers	300	International
36.	Conference International Congress on the Biological Effects of Noise 2011 (ICBEN)	Sliwinska-Kowalska (NOFER)	Presentation Contribution of genetic factors to noise-induced hearing loss	24-28th July 2011	London, UK	Scientific Policy makers	300	International
37.	Conference International Congress on the Biological Effects of Noise 2011	Hume (MMU)	Presentation Overview of research into	24-28th July 2011	London, UK	Scientific Policy makers	300	International

	(ICBEN)		sleep disturbance due to noise in the last three years.					
38.	Conference International Congress on the Biological Effects of Noise 2011 (ICBEN)	van Kamp (RIVM) Davies, H (UBC)	Noise & health in vulnerable groups: a review	24-28th July 2011	London, UK	Scientific Policy makers	300	International
39.	Conference Euronoise 2009	Paunovic (UBelgrade)	Presentation The effects of road-traffic noise on blood pressure of children aged 7-11 years in Belgrade	26-28th October 2009	Edinburgh, UK	Scientific Policy Makers	1000	International
40.	Conference Euronoise 2009	Bockstael (Ghent)	Presentation Speech recognition in noise with active and passive hearing protectors: a comparative study	26-28th October 2009	Edinburgh, UK	Scientific Policy Makers	1000	International
41.	Conference Euronoise 2009	Clark (QMUL)	Presentation The long-term effects of aircraft noise exposure on children's cognition: findings from the UK RANCH follow-up study	26-28th October 2009	Edinburgh, UK	Scientific Policy Makers	1000	International
42.	Meeting WHO expert meeting on Burden of Disease from Environmental Noise.	Kim (WHO)	Presentations from network members [see below]	14-15th October, 2010.	Bonn, Germany,	Scientific Policy Makers	50	International
43.	Meeting WHO expert meeting on Burden of Disease from Environmental Noise.	Ristovska / Sobotova. (RIHP/CUB)	Need for knowledge transfer and capacity building	14-15th October, 2010.	Bonn, Germany,	Scientific Policy Makers	50	International

			in the New EU members, SEE and CIS countries.					
44.	Meeting WHO expert meeting on Burden of Disease from Environmental Noise.	Houthuijs (RIVM)	Uncertainties in the EBD estimation.	14-15th October, 2010.	Bonn, Germany,	Scientific Policy Makers	50	International
45.	Meeting WHO expert meeting on Burden of Disease from Environmental Noise.	Babisch (UBA)	Updating exposure-response relationship for cardiovascular diseases.	14-15th October, 2010.	Bonn, Germany,	Scientific Policy Makers	50	International
46.	Meeting WHO expert meeting on Burden of Disease from Environmental Noise.	Janssen (TNO)	Updating exposure-response relationship for sleep disturbances.	14-15th October, 2010.	Bonn, Germany,	Scientific Policy Makers	50	International
47.	Meeting WHO expert meeting on Burden of Disease from Environmental Noise.	Lekaviciute/ Kephalopoulos (JRC)	How useful are the strategic noise maps as exposure data for estimating burden of diseases?	14-15th October, 2010.	Bonn, Germany,	Scientific Policy Makers	50	International
48.	Meeting WHO expert meeting on Burden of Disease from Environmental Noise.	Belojevic/Ristovska (UBelgrade/RIHP)	How can EBoDE methods be applied to the countries not having the strategic noise maps?	14-15th October, 2010.	Bonn, Germany,	Scientific Policy Makers	50	International
49.	Meeting WHO expert meeting on Burden of Disease from Environmental Noise.	Stansfeld/Belojevic, Jeram/Ristovska (QMUL/UBelgrade/ IVZRS/RIHP)	Role of experts networks (e.g., ENNAH, ICBEN) in the capacity	14-15th October, 2010.	Bonn, Germany,	Scientific Policy Makers	50	International

			building and risk communication in the member states.					
50.	Meeting WHO expert meeting on Burden of Disease from Environmental Noise.	Kephalopoulos (JRC)	Communication and dissemination informing the policy-makers and the public: CNOSSOS-EU in relation to WHO BoD from environmental noise project.	14-15th October, 2010.	Bonn, Germany,	Scientific Policy Makers	50	International
51.	Conference EPH (Environment and Public Health in Society) Consultative Conference Berlin-Potsdam	Clark (QMUL)	Future research priorities from the European Network on noise and health (ENNAH)	7-9th November 2011	Berlin-Potsdam, Germany	Scientific Policy Makers	50	European
52.	Conference 19th International Congress on Sound and Vibration	Ristovska (RIHP)	Summary of evidence for reproductive outcomes associated with occupational and environmental noise exposure	8 -12th July 2012	Vilnius, Lithuania	Scientific	400	International
53.	Conference ISEE 2012	Floud (Imperial)	Heart disease and stroke in relation to aircraft and road traffic noise in six European countries – the HYENA study	26-30th August 2012	Columbia, South Carolina, USA	Scientific	700	International
54.	Conference Internoise 2012	Laszlo (Imperial)	Noise sensitivity and sleep disturbance	19-22nd August 2012	New York, USA	Scientific Policy Makers	1000	International

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Karolinska Institutet, Sweden

Medizinische Universität Innsbruck
Medical University of Innsbruck, Austria

ARPA Piemonte
ARPA Piemonte, Italy

Manchester Metropolitan University
Manchester Metropolitan University, United Kingdom

Swiss TPH
Swiss Tropical and Public Health Institute
Schweizerisches Tropen- und Public Health-Institut
Institut Tropical et de Santé Publique Suisse
Swiss Tropical Institute, Switzerland

IfADo
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Leibniz Research Centre for Working Environment and Human Factors
Leibniz Research Centre, Germany

IER
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Universiteit Gent
University of Gent, Belgium

Nofer Institute of Occupational Medicine
Nofer Institute of Occupational Medicine, Poland

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Federal Environmental Agency, Germany

University of Gävle
University of Gävle, Sweden

TNO
Organization for Applied Scientific Research, Netherlands

HelmholtzZentrum münchen
German Research Center for Environmental Health
Helmholtz Zentrum, Munich, Germany

Inštitut za varovanje zdravja Republike Slovenije
Institute of Public Health, Slovenia

Comenius University of Bratislava, Slovakia

rivm
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National Institute for Public Health and the Environment, Netherlands

JRC IHCP
European Commission
European Commission, Joint Research Centre

UAM
Adam Mickiewicz University, Poland

University of Belgrade, Serbia

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IFSTTAR
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Memolix Environmental Consultants, Italy

Институт за јавно здравје
Institute of public health
Instituti i shëndetit publik
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4. Report on societal implications

A General Information

Grant Agreement Number:	226442
Title of Project:	European Network on Noise and Health: ENNAH
Name and Title of Coordinator:	Stephen Stansfeld Professor of Psychiatry

B Ethics

1. Did your project undergo an Ethics Review (and/or Screening)? • If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final project reports?	***●Yes 0No***
2. Please indicate whether your project involved any of the following issues (tick box) :	***YES***
RESEARCH ON HUMANS	
• Did the project involve children?	Yes
• Did the project involve patients?	No
• Did the project involve persons not able to give consent?	No
• Did the project involve adult healthy volunteers?	Yes
• Did the project involve Human genetic material?	No
• Did the project involve Human biological samples?	Yes
• Did the project involve Human data collection?	Yes
RESEARCH ON HUMAN EMBRYO/FOETUS	
• Did the project involve Human Embryos?	No
• Did the project involve Human Foetal Tissue / Cells?	No
• Did the project involve Human Embryonic Stem Cells (hESCs)?	No
• Did the project on human Embryonic Stem Cells involve cells in culture?	No
• Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	No
PRIVACY	
• Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	Yes
• Did the project involve tracking the location or observation of people?	Yes
RESEARCH ON ANIMALS	
• Did the project involve research on animals?	No
• Were those animals transgenic small laboratory animals?	No
• Were those animals transgenic farm animals?	No
• Were those animals cloned farm animals?	No
• Were those animals non-human primates?	No
RESEARCH INVOLVING DEVELOPING COUNTRIES	
• Did the project involve the use of local resources (genetic, animal, plant etc)?	No
• Was the project of benefit to local community (capacity building, access to healthcare, education etc)?	NA
DUAL USE	
• Research having direct military use	No
• Research having the potential for terrorist abuse	No

C Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator	1	1
Work package leaders	1	4
Experienced researchers (i.e. PhD holders)	30	32
PhD Students	4	1
Other	1	

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	
Of which, indicate the number of men:	2, no men

Gender Aspects

5. Did you carry out specific Gender Equality Actions under the project?	○ ●	Yes No

6. Which of the following actions did you carry out and how effective were they?

		Not at all effective				Very effective
☒	Design and implement an equal opportunity policy	○	○	○	○	○
☒	Set targets to achieve a gender balance in the workforce	○	○	○	○	○
☒	Organise conferences and workshops on gender	○	○	○	○	○
☒	Actions to improve work-life balance	○	○	○	○	○
●	Other:	All actions were carried out within the existing equal opportunity legislation at the organisations involved.				

7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?

● Yes- please specify: Gender specific analyses/hypotheses were examined

○ No

E Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?

○ Yes- please specify:

● No

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?

● Yes- please specify: Website and film

○ No

F Interdisciplinarity

10. Which disciplines (see list below) are involved in your project?

3.3 Main discipline[8]:

1.4 Associated discipline[8]: ○ Associated discipline[8]:

G Engaging with Civil society and policy makers

11a Did your project engage with societal actors beyond the research community? *(if 'No', go to Question 14)*	● ○	Yes No

11b If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?

○ No

● Yes- in determining what research should be performed

○ Yes - in implementing the research

[8] Insert number from list below (Frascati Manual).

● Yes, in communicating /disseminating / using the results of the project		
11c In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?	○ ●	Yes No

12. Did you engage with government / public bodies or policy makers (including international organisations)

- ○ No
- ● Yes- in framing the research agenda
- ● Yes - in implementing the research agenda
- ● Yes, in communicating /disseminating / using the results of the project

13a Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?

- ● Yes – as a **primary** objective (please indicate areas below- multiple answers possible)
- ○ Yes – as a **secondary** objective (please indicate areas below - multiple answer possible)
- ○ No

13b If Yes, in which fields?

Agriculture		Energy		Human rights	
Audiovisual and Media		Enlargement		Information Society	
Budget		Enterprise		Institutional affairs	
Competition		***Environment***	☒	Internal Market	
Consumers		External Relations		Justice, freedom and security	
Culture		External Trade		***Public Health***	☒
Customs		Fisheries and Maritime Affairs		Regional Policy	
Development Economic and		Food Safety		Research and Innovation	
Monetary Affairs		Foreign and Security Policy		Space	
Education, Training, Youth		Fraud		Taxation	
Employment and Social Affairs		Humanitarian aid		***Transport***	☒

13c If Yes, at which level?

- Local / regional levels
- National level
- European level
- International level

H Use and dissemination

14. How many Articles were published/accepted for publication in peer-reviewed journals?	**16**
To how many of these is open access[9] provided?	**4**
How many of these are published in open access journals?	**4**
How many of these are published in open repositories?	**0**
To how many of these is open access not provided?	**12**
Please check all applicable reasons for not providing open access:	
☒ publisher's licensing agreement would not permit publishing in a repository ☒ no suitable repository available ☒ no suitable open access journal available ☒ no funds available to publish in an open access journal ❑ lack of time and resources ❑ lack of information on open access ❑ other[10]: ……	

15. How many new patent applications ('priority filings') have been made? *("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).*		**0**
16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	Trademark	**0**
	Registered design	**0**
	Other	**0**
17. How many spin-off companies were created / are planned as a direct result of the project?		**0**
Indicate the approximate number of additional jobs in these companies:		

18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:

❑	Increase in employment, or	❑	In small & medium-sized enterprises
❑	Safeguard employment, or	❑	In large companies
❑	Decrease in employment,	☒	None of the above / not relevant to the project
☒	Difficult to estimate / not possible to quantify		

[9] Open Access is defined as free of charge access for anyone via Internet.
[10] For instance: classification for security project.

19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (*FTE = one person working fulltime for a year*) jobs:	*Indicate figure:* *7*
Difficult to estimate / not possible to quantify	❑

I Media and Communication to the general public

20. As part of the project, were any of the beneficiaries professionals in communication or media relations?

○ Yes ● No

21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?

● Yes ○ No

22 Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?

☒	Press Release	☒	Coverage in specialist press
❑	Media briefing	❑	Coverage in general (non-specialist) press
☒	TV coverage / report	❑	Coverage in national press
☒	Radio coverage / report	❑	Coverage in international press
☒	Brochures /posters / flyers	☒	Website for the general public / internet
☒	DVD /Film /Multimedia	☒	Event targeting general public (festival, conference, exhibition, science café)

23 In which languages are the information products for the general public produced?

❑	Language of the coordinator	☒	English
☒	Other language(s) - GERMAN		