Environmental Noise Directive implementation: state of art, public participation and noise awareness

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Abstract

In this paper some aspects of the Environmental Noise Directive 2002/49/EC (END) state of implementation in EU countries are presented with special regard to public information and participation in action plans and to the experiences of participatory approaches to planning and design of solutions for noise mitigation. The results of public and stakeholders involvement are shown in case studies implemented in Italy and in other EU countries, in pilot areas of EU funded projects, regarding END implementation issues. The review includes examples of participatory design derived by strategic noise mapping and action plans implementation for agglomerations and infrastructures of transport. The International Noise Awareness campaigns are considered as a very important event for public information and participation.

Key words: environmental noise, directive, action plans, participation, awareness.

Реализация директивы внешнего шума: уровень технического развития, участие общественности и информированность о шуме

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Аннотация

В этой статье раскрываются некоторые аспекты Директивы шума окружающей среды (внешнего шума) 2002/49/ЕС (The European Directive 2002/49/ЕU on Environmental Noise) по состоянию ее реализации в странах ЕС с уделением особого внимания информированию и участию общественности в отношении планов действий и опыта совместных подходов к планированию и проектированию решений для снижения уровня шума. Результаты участия общественности и других заинтересованных сторон представлены в исследованиях, выполненных в Италии и в других странах ЕС, в проектах финансируемых ЕС и реализованных в пилотных регионах. Освещена проблема внедрения. Обзор включает в себя примеры совместно разработанных стратегических карт шума и планы действий по реализации для крупных населённых пунктов и транспортной инфраструктуры. Международная компания по информированию о шуме (The International Noise Awareness) рассматривается, как очень важное событие для информирования и участия общественности

Ключевые слова: шум окружающей среды, директива, планы действий, участие, информирование.

Introduction

Among the aims of Environmental Noise Directive 2002/49/EC (END) there is the definition of a common approach intended to map, prevent or reduce, on a prioritized basis, the harmful effects, including annoyance, due to exposure to environmental noise. The END also aims at providing a basis for developing Community measures to reduce noise emitted by the major sources, in particular road and rail vehicles and infrastructure, aircraft, outdoor and industrial equipment and mobile machinery.

The END (1) provides indications and recommendations about items such as noise mapping, action planning, quiet areas and the importance of communication and dissemination towards citizens.

In many cases only definitions and general indications are made available by the END, while specific suggestions about how to deal in practice with the above cited items are still absent. To help solving this problem the EU funded projects LIFE+2008 HUSH (2-4), LIFE+2009 NADIA (5-7) and LIFE+2010 QUADMAP (8-13) have given important contributions to END interpretation and implementation.

In this paper, after a brief analysis of the state of the art about the END implementation, aspects related to public participation and information are further discussed. The results of public and stakeholders involvement are shown in case studies implemented in Italy and in other EU countries, in pilot areas of HUSH and QUADMAP EU funded projects.

1. State of art of END implementation

Noise mapping and action planning have been performed for almost all EU agglomerations and main infrastructures. At this time, agglomerations and main infrastructures are currently working for the updating their noise maps and action plans. In particular, END has been transposed in all 28 Member States and any transposition and legislative issues have been resolved. In 15 member States the END was the first national legislative milestone in the frame of environmental noise. Concerning the administrative approach to the END implementation, some Member States have preferred a centralised approach, while others a decentralised one; moreover, also combined approaches have been adopted. In terms of noise mapping and action planning implementation, significant delays have been encountered both in the first (2007/2008) and in the second (2012/2013) rounds. As a relevant example, in the last round (to be completed in 2012) more than 30% of the maps were missing at the time of analysis at the end of 2014 (5).

On the technical point of view, the END made available only definitions and general indications, while specific suggestions about how to deal in practice with the above cited items are absent. Concerning the preparation of noise maps, a significant methodological reference used by the operators is the Good Practice Guide (GPG) published by European Commission (14). Anyway, referring to the GPG practical application, numerous publications in recent national and international congresses pointed out the difficulties in noise mapping procedures (15/18).

Referring to the main aspects defined by END like action planning, quiet areas and information and participation of public, since a few years ago practical guideline were not available. Some relevant contributions came from some EU funded projects like LIFE+2008 HUSH, LIFE+2009 NADIA and LIFE+2010 QUADMAP that have given important contributions to END interpretation and implementation.

Concerning the evaluation of the END through the Regulatory Fitness and Performance Programme (REFIT), according to criteria of Relevance, Coherence, Effectiveness, Efficiency and EU added value, good outcomes have been achieved. Moreover, considerable progresses have been made towards the development of a common approach to noise assessment methods in Europe thanks to CNOSSOS-EU process, which was completed in 2015. Some important news have recently come with the introduction of European Directive 2015/996 (19) that defines new calculation procedures to be used for noise mapping. The new procedures will be mandatory effective in 2018 and it will be important to understand possibilities and limits of new calculation procedures. In fact, the effectiveness of new calculation methods and their adaptability to different territories need to be verified in practice. Finally, European Directive 2015/996 clarifies some issues on noise mapping which have been left open by European Directive 2002/49: required accuracy levels, use of default data, verification of how methods are implemented by different software (20).

Moreover, concerning the second objective, its achievement is considered reasonably effective (21-22).

2. Public Participation and Noise Reduction Actions

The article 9 of END (1) established that information to the public must be ensured by Member States as the strategic noise maps are adopted and the action plans are drawn up. Data should be made fully available and disseminated to the public, information must be clear, comprehensible and accessible. It sounds evident that information, communication and participation are important keywords for a correct and effective implementation of the Directive. Sometimes the participation of public is needed to make the best choice among different solutions for actions of noise reduction plan and acoustic quality improvement in strategic action plans, sometimes the public can be involved, as main stakeholder, in the definition of policies for noise control at local level including regulations for the correct use of entertainment areas and quiet areas as well.

2.1. Public participation: general definition

As a general definition, it can be said that public participation is a process that directly engages the public in decision-making and gives full consideration to public input in making that decision. If we consider public participation as a process, its basic steps consist of a series of activities and actions aiming to both inform the public and obtain input from the public. In figure 1 the general scheme of public participation process, proposed by US Environmental Protection Agency (23) and agreed by all the most important experts in environmental issues governance and policy makers, is shown.





2.2. Public participation: a definition for noise control and reduction

In figure 2 a more detailed table of actions and expectations (24), in terms of goals and promises, is proposed. It can be easily applied to noise control issues and in particular to the strategic actions that END requires in the Action Plans for agglomerations and transport infrastructures authorities. The general plan and the punctual solution can be designed and implemented following the five-step path, listening to public and stakeholder suggestions, defining consequently the goals and the promises.

	INCREASING IMPACT ON THE DECISION				
	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision. We will seek your feedback on drafts and proposals.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will work together with you to formulate solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

Fig. 2. Public participation: actions and expectations (Source IAPP, 2016)

According to the END disposals, urban areas and areas located in proximity of infrastructures are identified by means of their acoustic climate and of the number of citizens exposed to relevant levels of noise in the areas: consequently hotspots (noisy critical areas) are individuated and action plans are defined and implemented for reducing noise in hotspots and, at the same time, for preserving quiet and for improving soundscapes in quiet areas. In the EU countries, following the disposals of END (1), methods like questionnaires, surveys, soundscapes analysis are frequently used in combination with traditional methods for mapping territory and planning noise management and control, adding information and preferences of residents to measured data.

In the case studies and pilot areas experiences reported in this paper, public orientation has been considered in the various phases of decisional processes regarding noise management and control planning. The public participation in decision on general strategic choices and on specific issues as well, has been considered submitting checklists of problem and solutions, collecting lists of possible expectations, and being careful in checking that expected solutions are actually feasible. Annoyance and heavy annoyance, as defined by the WHO guidelines for Europe (25) and general comfort indicators have been taken in account.

The five-steps procedure for public participation defined in figure 1, as detailed in figure 2, has been adapted to noise policies and noise actions required by END as shown in figure 3. In this general scheme, after the preliminary analysis and data collection, operated by the agglomeration or infrastructure authorities, stakeholders and end-users of areas are involved in dynamic and participative processes that carry to shared strategies and shared actions (compatible with strategies), respectively.



Fig. 3 – Flowchart of public participation in the frame of END implementation

2.3. Examples of participatory design of barriers for school and school yards

According to the END Directive and to the National Legislation of European Countries, schools are considered sensitive receivers. Local administrators and policy makers must consider with particular care the noise mitigation in schools and their external areas. In the following examples the Participatory Design Scheme has been implemented in action plans and noise reduction plans relative to a group of primary schools of Florence involved in some project co-funded by the European Union. Stakeholders opinions have been collected on strategic issues, end user questionnaires have been defined to collect the perceived level of acoustic comfort and acoustic quality of investigated areas, aiming to carry out, via simple analysis, useful results for designing phase.

The noise reduction interventions are generally designed with the only aim of noise reduction without considering other environmental aspects and the effective perception from the end-users. However, the participatory design and awareness-raising activities are considered as valuable tools for informing, consulting and involving the students and scholastic staff in general in the intervention designing process (26).

2.3.1. Participatory design for smart acoustic barriers

In the frame of HUSH (27) and QUADMAP projects (28), three interventions of noise reduction for the school courtyards have been developed according to the participatory design approach. The first intervention, as pilot-case of HUSH Project (27), regards the acoustic requalification of the courtyard of "Don Minzoni" School in Florence. In this case study the students have been involved into the design process with ideas and drawings about their courtyard. The school has followed the INAD experience during the three years for designing and construction of the intervention.



Fig. 4 – Drawings for the design of the new garden made by pupils of "Don Minzoni" School

The intervention has been defined and implemented according to the indications emerged by end-users questionnaire and suggestions derived by involvement of pupils, parents and teachers in a noise awareness campaign. It consists of:

- integrated barriers with elements that make the barrier enjoyable to pupils during lessons and playtime;

- integrated playground and outdoor spaces for educational purposes, including a mobile amphitheater where to give lesson in the garden.

The location of different functions is closely related to the noise climate of the garden sub-areas. A noise barrier has been built with a continuous bench very useful as a part of playground for children, and as a seat for teachers and parents as well.



Fig. 5 - Barriers and playground at "Don Minzoni" School

The second intervention, as pilot-case of QUADMAP Project (28), regards the noise reduction in the garden of "Dionisi" Primary School in Florence.

The intervention defined and built according to the indications given by end-users questionnaire consisted of a noise barrier with some blackboards applied in the internal side, allowing to be used from students and teachers when they are in the garden.



Fig. 6 – Intervention at "Dionisi" School

Another pilot case of QUADMAP Project (28) is relative to noise reduction in the garden of "Vamba-Montessori" School in Florence where the results of the acoustic measurements in ante-operam scenario had shown the need to protect the school garden from the noise emitted by the nearby road infrastructure. This need has been confirmed by the non-

acoustic investigation. For this reason, the intervention implemented for the noise reduction in the scholastic courtyard has been a noise barrier. A part of this barrier is made of plants for botanical education.

In this case the non-acoustic investigation showed the need to design a space for teaching in external. To do this a wooden gazebo in the garden area protected by the barrier has been designed. This element has been used for the external teaching and is shaded, as required by end-users.



Fig 7 – Intervention at "Vamba-Montessori" School

In the following paragraphs the results of the participatory design approach are analysed comparing with a traditional design approach and by using data collected in ante and post operam scenarios.

2.3.2. Comparative analysis between traditional and participatory design approaches in the schools

The participatory design method has been evaluated also through the comparison with the traditional design procedures. The case-studies used for the comparison is the intervention carried out in the HUSH project in "Don Minzoni" school performing a participatory design approach and the intervention implemented some years before (2007) in "M. L. King" school in Florence, consisting in a noise barrier, realized with a traditional and non-participatory design approach.

The comparison has been carried out through the definition of objective and subjective criteria. The objective evaluation is based on the analysis of all documents (reports and technical drawings) foreseen in the several design phases and the effectiveness of the design process. Referring to the subjective criteria, specific end-users questionnaires have been defined and collected in post-operam scenario (29).

According to results obtained from objective and subjective evaluation previously described, the participatory design developed in the school pilot cases have produced the following results:

- the participatory design was effective: the end-users can give a "direction" to the designing phase (based on the ante-operam questionnaire results);

- the intervention is able to match the expectations of end-users (based on the postoperam questionnaire results);

- the intervention is able to take into account noise reduction together with other nonacoustic aspects (based on objective comparison of the design of a similar intervention developed for another school of Florence).

In the pilot-case of "Dionisi" School the satisfaction of the intervention according to participatory design has been evaluated through the comparison between the results in ante and post-operam scenario.

In figures 8 and 9 some results of the survey on levels of perceived pleasantness are reported. They show that the percentage of people who consider the current soundscape as a good acoustic environment is higher in the post-operam scenario as well as people who consider the current sounds very congruent with the scholastic garden. The considered rating of pleasantness consists in five categories of agreement, from 5 (strongly agree) to 1 (strongly disagree).



Fig. 8 – Agreement with pleasantness statement in the ANTE-OPERAM SCENARIO





2.4. Participatory design for noise masking and active soundscape correction

In the frame of HUSH project, a strategical intervention of noise masking for the school yard of "Paolo Uccello" School has been developed according to the participatory design.

The school staff had expressed both the disagreement with barrier and the desire of a more interesting and pleasant soundscape in the garden, that was not used by students because of road traffic noise.

The intervention consists of the introduction of sound sculptures in the school garden (shown in figure 10) that diffuse composed soundscapes as a mix of natural sound and artificial sounds typical of the area with the aim of masking the traffic noise in active control mode.



Fig. 10 - Noise masking in the "Paolo Uccello" school yard

Also in this case the participatory design procedures have been tested in the pilot cases, based on ante and post operam end-users questionnaires. In figure 11 the chart shows the users' opinion on the improvement of sound quality, the increased use of the area and the cost/benefit ratio of the project.



Fig. 11 - Users' opinion about the intervention at "Paolo Uccello" School

2.5. Participatory design for acoustic comfort in classrooms

In the "Papini" School a participatory approach in designing the acoustic correction of classrooms, canteen, gym, auditorium and art-laboratory. The children took part in a project called "Planning together the acoustics of your school". During this project, students after some lesson on basic concepts of acoustics, materials, etc., have joined the acousticians involved in the measurements of reverberation time and other parameters. In the second phase of the project the students have provided together with their teachers a relevant contribution in the design of the intervention (choice of materials, shapes and colors).



Fig.12 – Participatory room acoustic design at "Papini" School



Fig.13 – Intervention at "Papini" School

3. Noise awareness and Public Participation

Information, communication and participation are important keywords for a correct and effective implementation of END. Following the article 9 of END, information to the public must be ensured by Member States as the strategic noise maps are adopted and the action plans are drawn up. Data should be made fully available and disseminated to the public, information must be clear, comprehensible and accessible.

Sometimes the participation of public is needed to make the best choice among different solutions for actions of noise reduction plan and acoustic quality improvement in strategic action plans. In other situations the public can be involved, as main stakeholder, in the definition of policies for noise control at local level including regulations for the correct use of entertainment areas and quiet areas as well.

One of the most important event to increase the information of public and the public noise awareness consists of the International Noise Awareness Day (INAD), launched by the American Center for Hearing and Communication in 1996 and celebrated every year in the last week of April. In general, during this event, students and teachers of primary and secondary schools are invited, with the help of acousticians, to give direct contribution in terms of participatory design of quieter schoolyards and green areas open to neighborhood as well as more comfortable classrooms. Since 1996, every year, some private and public institutions, together with schools, in a growing number of nations, organize initiatives involving students and citizens.

The event involves also Communities responsible of regulating the noise problems in public spaces and neighborhood. In the INAD frame of activities, communities can hold a town meeting to "sound off on noise" inviting local officials from the Police Department, City Council and the Department of Environmental Protection; attend public meetings, meet with town or city officials and educate them about the hazard of noise; analyze local noise ordinances and share the results of Noise Maps and Action Plans, according to END.

3.1 Noise awareness in the Italian experience

In the past seven years AIA (the Acoustic Society of Italy) working group has involved schools of different level in educational events on the theme of Noise Awareness (1). Original materials have been produced and distributed in schools, the Quiet Diet has been presented and a web connection among "schools of the world" participating at the event has been established on the last week of April. A very active Facebook group has been created, developed and updated in the following months with news and information regarding sound and noise, stimulating interest of the numerous young and adult members of the group itself.

AIA has also defined the general objectives of "Noise Awareness Day – Italia", the awareness program to be implemented in Italy, drafting the initiatives yearly organized in Italian schools, aiming to: inform and increase awareness of students and citizens on noise reduction by social media (posters, publications, social networks, etc..); measure and assess noise in schools (indoor and outdoor); design solutions for noise mitigation and improve acoustic climate; describe soundscapes of schools and scholastic gardens; write and / or draw an advertising campaign on noise; understand, define and observe a "quiet diet"; distribute and collect questionnaires and interviews about sound quality in schools and in living environments; invent games and playing activities related to acoustic and noise; take a minute for listening to silence; create links between schools in different cities and countries to share the actions taken.



Fig. 14 – INAD Italia – posters of past 7 editions (2010-2016)

3.2 INAD 2017 in Europe – the EAA proposal

The European Acoustics Association (EAA), that includes in its membership the national societies of 32 European countries, interested to promote development and progress of acoustics in its different aspects, plans to organize in 2017 a wide campaign in order to raise the interest of the European citizens towards noise and its bad effects on the quality of life and their health. It is the purpose of the EAA to collaborate with the European Commission (in particular the DG-Environment) and the European Environment Agency for promoting and coordinating specialized activities during this year, among EAA Member Societies, European and National authorities, associations, schools, museums, etc. in order

that a wide audience gets the most accurate and scientifically correct information on noise effects.

Conclusions

The END provides indications and recommendations about items such as noise mapping, action planning, quiet areas and the importance of communication and dissemination towards citizens.

In this paper some examples of solutions based on participatory design process, using also the awareness campaigns, are shown. The participatory design represents an opportunity for a better education in acoustics and for designing more appropriated solutions according to end-users expectations.

The participation of public seems to be needed to make the best choice among different solutions for actions of noise reduction plan and acoustic quality improvement in strategic action plans, sometimes the public can be involved, as main stakeholder, in the definition of policies for noise control at local level including regulations for the correct use of entertainment areas and quiet areas as well. Information, communication and participation are important keywords for a correct and effective implementation of END.

References

1. 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.

2. Borchi, F., Carfagni, M., Governi, L., The H.U.S.H. project - A harmonized methodology for action planning, Euronoise 2012 Proceedings, Prague, 2012.

3. Borchi, F., Carfagni, M., Curcuruto, S., Governi, L., Silvaggio, R., HUSH project results: definition of a platform for an integrated and harmonized noise Action Plan and proposals for revision of Italian legislation and END Directive, AIA-DAGA 2013 Proceedings, Merano, Italy, 2013.

4. Borchi, F., Carfagni, M., Governi, L., Curcuruto, S., Silvaggio, R., Bellomini, R., Luzzi, S., Licitra, G., Palazzuoli, D., Melloni, A., LIFE+2008 HUSH project results: a new methodology and a new platform for implementing an integrated and harmonized noise Action Plan and proposals for updating Italian legislation and Environmental Noise Directive, Noise Mapping, 3, 71-85, 2016.

5. Schiavoni, S., D'Alessandro, F., Conte, A., The contribution of LIFE+ NADIA project on the implementation of the European Directive on Environmental Noise, Noise Mapping, 2, 13-20, 2015.

6. D'Alessandro, F., Schiavoni, S., A review and comparative analysis of European priority indices for noise action plans, Science of the Total Environment, 518-519, 290-301, 2015.

7. Asdrubali, F., Schiavoni, S. and D'Alessandro, F., An innovative approach for the realization of a Noise Action Plan: the experience of Vicenza agglomeration, Proceedings of the 23rd International Congress on Sound and Vibration, Athens, Greece, 10–14 July, 2016.

8. Bartalucci, C., Borchi, F., Carfagni, M., Governi, L., Weber, M., Wolfert, H., Quiet areas definition and management in action plans: general overview, Proceedings of the Internoise 2012, New York City, USA, 2012.

9. Bartalucci, C., Bellomini, R., Borchi, F., Carfagni, M., Governi, L., Luzzi, S., Natale, R., LIFE+2010 QUADMAP project (Quiet Areas Definition and Management in

Action Plans): the proposed methodology and its application in the pilot cases of Firenze, Proceedings of the InterNoise 2013, Innsbruck, Austria, 2013.

10. Carfagni, M., Bartalucci, C., F. Borchi, L. Governi, Petrucci, A., Weber, M., Aspuru, I., Bellomini, R., Gaudibert, P., LIFE+2010 QUADMAP Project (QUiet Areas Definition and Management in Action Plans): the new methodology obtained after applying the optimization procedures, Proceedings of the 21st International Congress on Sound and Vibration, Beijing, China, 13-17 July, 2014.

11. QUADMAP project 2015, Guidelines for the identification, selection, analysis and management of Quiet Urban Areas, ver. 2.0, March 2015, [Online.] available: www.quadmap.eu

12. Bartalucci, C., Borchi, F., Carfagni, M., Governi, L., Zonfrillo, G., Bellomini, R., Wolfert, H., Aspuru, I., Gaudibert, P., LIFE+2010 QUADMAP Project (QUiet Areas Definition and Management in Action Plans): results of post operam data analysis and the optimized methodology, Proceedings of the 22nd International Congress on Sound and Vibration, Firenze, Italy, 12-16 July, 2015.

13. Aspuru, I., Garcia, I., Bartalucci, C., Borchi, F., Carfagni, M., Governi, L., Bellomini, R., Luzzi, S., Wolfert, H., Gaudibert, P., LIFE+2010 QUADMAP Project: a new methodology to select, analyze and manage Quiet Urban Areas defined by the European Directive 2002/49/EC, Noise Mapping, 3, 120-129, 2016.

14. European Commission Working Group Assessment of Exposure to Noise (WG-AEN), Good Practice Guide for strategic noise mapping and the production of associated data on noise exposure – Version 2, 13 August 2007.

15. Borchi, F., Carfagni, M., An Urban Noise Management System integrated into a GIS, Proceedings of Euronoise 2003, Naples, Italy, 2003.

16. Nijland, HA, Van Wee, GP., Traffic noise in Europe: A comparison of calculation methods, noise indices and noise standards for road and railroad traffic in Europell, Transport Reviews, 25, 591-612, 2005.

17. O'Malley, V., King, E., Kenny, L., Dilworth, C., Assessing methodologies for calculating road traffic noise levels in Ireland – Converting CRTN indicators to the EU indicators (Lden, Lnight), Applied Acoustics; 70, 284-296, 2009.

18. Baldinelli, G., Bellomini, R., Borchi, F., Carfagni, M., Curcuruto, S., Luzzi, S., Silvaggio, R., Stortini, M., Correlation between traffic flows and noise reduction in HUSH project strategic actions, Proceedings of Forum Acusticum 2011, Aalborg, Denmark, 2011.

19. Directive 2015/996/EC of 19 May 2015 establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council.

20. Paviotti M.; Kephalopoulos S., The main requirements of the Commission Directive 996/2015, Proceedings of the 23rd International Congress on Sound and Vibration, Athens, Greece, 10-14 July, 2016.

21. Juraga I., Berger B., Paviotti M., Introduction: Policy context and evaluation of the Environmental Noise Directive, Proceedings of the InterNoise 2016, Hambourg, Germany, 21-24 August, 2016.

22. Kephalopoulos S., Paviotti M., Common noise assessment methods for Europe (CNOSSOS-EU): implementation challenges in the context of EU noise policy developments and future perspectives, Proceedings of the 23rd International Congress on Sound and Vibration, Athens, Greece, 10-14 July, 2016.

23. EPA (US Environmental Protection Agency, Public Participation Guide: Introduction to Public Participation, 2014.

24. International Association for Public Participation, The public-participation-SPECTRUM, 2016.

25. World Health Organization, Night noise guidelines, 2009.

26. Luzzi S, Natale R, Mariconte R, Noise Awareness for smart cities, in Proc. ICSV20, Bangok, 2013.

27. HUSH project, website: www.hush.eu.

28. QUADMAP project, website: www.quadmap.eu.

29. Borchi F., Carfagni M., Governi L., Curcurutu S., Silvaggio R., Bellomini R., Luzzi S., Licitra G., Palazzuoli D. and Melloni A., LIFE+2008 HUSH project results: a new methodology and a new platform for implementing an integrated and harmonized noise Action Plan and proposals for updating Italian legislation and Environmental Noise Directive, Noise Mapping magazine, 2016; 3:71–85.