Research Outcomes for Urban Sound Planning from EU projects

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Summary
In the last decade, the European Union (EU) supported many important research projects whose common objectives were to increase the citizen's quality of life in urban environments by improving the noise situation. One of the SONORUS project milestones was to deliver a review report on the "state of art of noise control elements and tools and planning processes". The main concern of this report was to provide consistent material for the development of a "tool-box" that could support the urban sound planning process. The outcomes of EU projects for noise reduction in urban areas are extensive and were the main sources of information.
This paper summarises the research outcomes for urban sound planning of 20 EU research projects. Therefore, the most relevant examples will be described, which include several prediction tools, different designing solutions and innovative urban sound planning processes. Altogether, these examples provide a state of the art "toolbox" as well as an extensive literature review that can support the planning processes implemented by European cities under the Environmental Noise Directive or any other noise policy.

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1. Introduction

The SONORUS project proposes a new methodology to urban sound planning, a holistic approach. In summary, the "Holistic Approach" means: involve urban sound planners at the earliest planning stage; extend the scope from pure noise control to sound quality and sound design; consider acoustic aspects altogether, as an integral part of all planning disciplines [1]. The new methodology therefore, demands state of the art knowledge on different acoustical fields and improved planning skills thus generating a new occupational profile: the urban sound planner.
The EU supported important research projects whose common objective was to improve the acoustic urban environment. Some of the relevant outcomes of these projects include: new and sustainable noise control and design techniques, reliable prediction methods, innovative auralisation tools, soundscape considerations to improve the urban sonic environment and state of the art urban planning approaches. Nonetheless, this information is usually spread and sometimes difficult to access.
One of the milestones within SONORUS project was to deliver a review report that provided consistent information about solutions integrating cutting edge knowledge from different acoustic disciplines [2]. The reference list of this review report is extensive and includes: European research projects, most recent Noise Action Plans (European cities), journal and conference papers and other documents or tools that can be relevant for urban sound planning. The outcomes from EU research projects were a significant part of this report. Therefore, this paper describes the most relevant outcomes of twenty selected EU research projects, for urban sound planning. Furthermore, selected projects are also presented and shortly described.
In summary, this paper presents a state of the art "toolbox" to be used within the project, but also by planners or other stakeholders involved in the urban sound planning process.

2. Selection process

The EU funds scientific research through several different programs. Identifying databases where relevant projects could be selected was the first step of this review. The projects´ selection process and criteria to select relevant tools are going to be described in the following sections.

2.1 Projects selection process

In order to obtain a comprehensive list of EU research projects, three main research support frameworks were consulted:

- CORDIS (Community Research and Development Information Service)
- LIFE (EU funding instrument for the environment and climate action).
- COST (European Cooperation in Science and Technology)

CORDIS [3] is the "European Commission's primary public repository and portal to disseminate information on all EU-funded research projects and their results in the broadest sense". CORDIS project data includes information about framework programmes FP7, FP6, FP5 and earlier projects back to 1990. Section "Projects and Results" allows searching all projects using "free-text", "project acronym", "reference" or "record number" options. "Free-text" option was selected and the following keywords used: acoustics, noise, noise reduction, road, road traffic, soundscape. These words will return all acoustic/noise/soundscape related projects. The application of the criteria defined below will then filter the relevant projects. As road traffic noise is the main noise source in all test sites of SONORUS project [1], projects related with road/transportation noise were also considered.

LIFE programme [4], which is an EU funding instrument for environmental related actions, was also one of the main supporters of projects involving urban noise. LIFE's database has a project search tool under the section "project database". The search was restricted to the theme "Air and Noise" and refined by using sub-theme "Noise".

COST [5] is an "intergovernmental framework for European Cooperation in Science and Technology, allowing the coordination of nationally-funded research on a European level". A database search tool is provided under Cost Actions- All actions. Once again "full text search" and "all domains" options were selected and the keywords were the same aforementioned.

The first search returned 30 research projects to which the following selection criteria were applied:

- Project's start date after 01/01/2005. Most projects run for 3-4 years, this means that the oldest considered projects ended around 2008/2009. Thus, the projects' outcomes represent the state of the art knowledge of their field;
- Research relevant results should be available to the public either on a project webpage or at the European database;
- Project's research topics should be related with SONORUS theme "Urban Sound Planning", and research topics (prediction methods, soundscaping, noise control and design). Road traffic noise related projects were also considered;
- The project's outcomes should be available in English.

Twenty projects met the requirements and were included in this study. Section 3 summarises the selected projects, including the following information: name, start date, website and the funding programme.

2.2 Outcomes selection process

After the selection of the research projects, the next step was to identify outcomes according to defined criteria. To build a state of the art toolbox that supports the holistic approach, it is important that each outcome can be applied to real-life projects. This was the main selection requirement. Therefore, the outcomes include new methods, software, planning policies, databases and good practice guides.

Outcomes were classified according to their general application as: prediction, design or planning solutions. "Prediction solutions" included: auralisation software, noise scoring methods, new indexes to describe/predict/prioritise urban noise, rating methods, perception tools. "Design solutions" included noise engineering solutions applied at the receiver, at the propagation path or at the source (solutions´ databases were also included). Finally, "planning solutions" included outcomes to support the planning process as cost-benefit analysis or urban planning policies.

A total of 24 outcomes were identified and are described in section 3. The collection of outcomes provides a state of the art "toolbox", that can be useful to support the urban sound planning process.

3. Selected research projects and relevant outcomes for urban sound planning

3.1. Research projects

According to the selection method described in previous section, Table 1 presents the list of the 20 selected projects.

3.1. Outcomes

As described in the former section, the outcomes for urban sound planning were categorized according to prediction, design or planning solutions. This section presents a short description of all the selected outcomes.

3.1.1 Prediction solutions

Outcome 1	Algorithm of a critical area rating system based in Lden values obtained from noise maps (Noise Environmental Rating System- NERS)
Source(s)	Q City Project (Deliverable D 1.5)
Short-description	Rating system complies with the END and can be helpful to rate critical areas on a noise action plan.

Outcome 2	Noise Scoring tool (Noise Environmental rating System- NERS)
Source(s)	Q City Project (Deliverable D 1.2)
Short-description	Rating system complying with the END and can be helpful to rate critical areas on a noise action plan.

Outcome 3	Refined Noise Scoring Tool (Refined Noise Environmental Rating System – RNERS)
Source(s)	City Hush (Deliverables D2.2.1 and 2.2.2)
Short-description	Rating system reflecting outdoor noise, improvements at the façade level and indoor levels.

Outcome 4	Rating method based in Lden values obtained from noise maps
Source(s)	HUSH (Report action 7- Section B.3)
Short-description	Rating system based in an Italian Standard.

Outcome 5	Decision support tool – for noise mitigation measures
Source(s)	QCity Project (Deliverable D 6.3)
Short-description	Interactive software system that helps locating most relevant noise sources and decides about most efficient measures.

Outcome 6	Quiet Urban Areas definition methodology (QUA- methodology)
Source(s)	QUADMAP (D 7-1 – Action B.6)
Short-description	A methodology for QUAs selection, analysis and definition, is proposed.

Outcome 7	Performance evaluation tool for noise mitigation measures
Source(s)	QCity Project (Deliverable D 4-5_ACC_12M)
Short-description	Classify the efficiency of measures and highlight cost-effect relations.

Outcome 8	Perception tool for traffic noise
Source(s)	QCity Project (Deliverable D 5.12-12_HAC_48M)
Short-description	Tool that predicts the subjective response to traffic noise concerning “outdoor noise perception”.

Outcome 9	Holistic optimisation tool of Noise Reduction Devices (NRD)
Source(s)	Quiesst (Guidebook to Noise Reducing Devices Optimisation WP5)
Short-description	Database of optimized solutions that could be queried, to help decide for the best action. (It considers acoustic and non-acoustic parameters).

Outcome 10	Prioritization Index (Noise Hot-Spots)
Source(s)	NADIA (Deliverable D4)
Short-description	Definition of the Index of Priority (IP) that should be calculated for each of the critical areas.

Outcome 11	Harmonica index
Source(s)	Harmonica (http://www.noiseineu.eu/)
Short-description	New index to describe environmental noise.

Outcome 12	Open PSTD software
Source(s)	Open PSTD web-site (see table 1)
Short-description	Software tool which enables to compute sound propagation in the urban environment. Applies to noise reduction measures and to support positive sound environments.

3.1.2 Design solutions

Outcome 13	Database on noise abatement actions
Source(s)	Harmonica Project (http://www.noiseineu.eu/en/33-initiatives/subpage)

Short-description	The site includes a list of "initiatives". Each "initiative" is described very comprehensively, includes information about financial costs, location, authorities involved, evaluation documents, among other topics. It is important to add that this database will grow in the future, as other planning authorities can send their examples, which will be added to this database.

Outcome 14	New poroelastic low noise road surface (application in urban environment)
Source(s)	Persuade web-site (see table 1)
Short-description	Poroelastic surfaces reduce tyre vibrations and thus tyre-noise.

Outcome 15	New ground treatments
Source(s)	HOSANNA (Deliverable 4) and brochure, available in the web-site (see table 1)
Short-description	Different types of soil applied with different configurations, can reduce noise up to 9 dB (A).

Outcome 16	Innovative barriers
Source(s)	QUIESST (Deliverable 4.3 and MS 4.2 - Public database of European NRD, data analysis and definition of NRD families)
	Hush (database of barriers - Action report 5)
	HOSANNA (Deliverable 2.4)
	CALM-Tracks & Routes (Final report)
Short-description	Several projects developed innovative solutions for noise barriers or berms. Either by research more efficient designs, new/recycled materials, green coverings, etc. Some are specific to apply in an urban environment.

Outcome 17	Tunnels
Source(s)	QUIESST (Guidebook to Noise reducing Devices optimisation)
	Hush (database of tunnels - Action report 5)
Short-description	Several tunnels were tested and the noise reduction results are presented in databases.

Outcome 18	Planting
Source(s)	HOSANNA (Deliverable 3)
Short-description	The interaction of the sound waves with vegetation can contribute (in a smaller extension) for noise reduction. This project presents the latest results.

Outcome 19	Greening buildings
Source(s)	HOSANNA (Deliverable 5)
Short-description	The noise reduction effects of applying vegetation in building facades, roofs or at courtyard openings was studied in this project and results indicate that a reduction of up to 3 dB(A) can be achieved.

Outcome 20	Building insulation (descriptors and solutions)
Source(s)	Cost Action 0901 (see table 1)
Short-description	The two e-books available at the project´s webpage try to harmonize sound insulation descriptors, but also present several building solutions.

3.1.3 Planning solutions

Outcome 21	Practitioner Handbook for Local Noise Action Plans
Source(s)	Silence project Webpage (see table 1)
Short-description	This handbook supports local authorities in the process of setting up action plans, presenting several planning strategies.

Outcome 22	Good Practice Guide on Port Area Noise Mapping and Management
Source(s)	NoMEPorts
Short-description	This handbook was specifically designed to deal with noise on Port Areas, nevertheless it can be applied to general management of noise.

Outcome 23	Cost-Benefit Analysis (CBA)
Source(s)	CityHush (Deliverable D2.3.1), follows HEATCO methodology
	NADIA (Deliverable D4 – Noise Reduction Plans)
	HOSANNA (Deliverable 7.2 (Updated Open-CBA and http://greener-cities.info/)
Short-description	These tools are intended to support the planning decisions for the best mitigation measure. The level of implementation varies from the application of an equation, an algorithm or an Open-CBA framework.

Outcome 24	Quiet Zones and Quiet side Planning
Source(s)	City HUSH web-site (see table 1)
	QSide web-site (see table 1)
Short-description	Other planning actions were also tested and presented in these two projects, but these were the main concepts developed.

Table I. List of selected research projects

Project acronym/name	Start date	Project's webpage	Funding Programme
CALM Tracks & Routes - Innovation of Noise Barriers: Improved Noise Abatement for Motorways and Railways Tracks	20.04.2005	http://cordis.europa.eu/project/rcn/107542_en.html	FP6-SME
City Hush - Acoustically green road vehicles and city areas	01.01.2010	http://www.cityhush.eu/	FP7-TRANSPORT
CO2NTROL/Green City Car - Integrated solutions for noise and vibration control in vehicles	01.09.2009	www.fp7-co2ntrol.eu	FP7-TRANSPORT
Cost Action - Soundscape of European Cities and Landscapes	25.06.2009	http://soundscape-cost.org/	COST TD0804
COST Action- Integrating and Harmonising Sound Insulation Aspects in Sustainable Urban Housing Constructions	03.11.2009	http://www.costtu0901.eu/	TUD TU0901
ECOQUEST - Efficient Cooling Systems for QUieter Surface Transport	01.12.2009	http://www.uni-siegen.de/ecoquest/	FP7-TRANSPORT
ENNAH - The European Network on Noise and Health	01.09.2009	http://www.ennah.eu/	FP7-ENVIRONMENT
HARMONICA -HARMOnised Noise Information for Citizens and Authorities	01.10.2011	http://www.harmonica-project.eu/	LIFE10 ENV/FR/
HOSANNA - Holistic and sustainable abatement of noise by optimized combinations of natural and artificial means	01.11.2009	http://www.greener-cities.eu/	FP7-TRANSPORT
HUSH- Harmonisation of Urban Noise reduction strategies for homogeneous action plans	01.01.2010	http://www.hush-project.eu/	LIFE08 ENV/IT
NADIA - Noise Abatement Demonstrative and Innovative Actions and information to the public	01.10.2010	http://www.nadia-noise.eu/en	LIFE09 ENV/IT
NoMePorts- Noise Management in European Ports	01.03.2005	Not available	LIFE05 ENV/NL
OpenPSTD - An open-source software tool for the detailed reproduction of the urban sound environment	01.09.2012	http://www.openpstd.org/	FP7-PEOPLE
Persuade- PoroElastic Road Surface: an innovation to avoid damages to the environment	01.09.2009	http://persuade.fehrl.org/	FP7-ENVIRONMENT
Qcity - Quiet City transport	01.02.2005	http://www.qcity.org/	FP6-SUSTDEV
QSIDE - The positive effects of quiet facades and quiet urban areas on traffic noise annoyance and sleep disturbance	01.09.2010	http://www.qside.eu/	LIFE09 ENV/NL
QUADMAP- Quiet areas definition and management in action plans	01.09.2011	http://www.quadmap.eu/	LIFE10 ENV/IT
QUIESST - Quietening the environment for a sustainable surface transport	01.11.2009	http://www.quiesst.eu/	FP7-TRANSPORT
SILENCE - Quieter Surface Transport	01.02.2005	http://www.silence-ip.org/	FP6-SUSTDEV
SMILE - Towards Sustainable Mobility for people in urban areas	01.02.2005	http://www.transport-research.info	FP6-SUSTDEV

4. Discussion

This review has shown that EU supported research on several topics of urban sound planning. Twenty projects met the selection criteria and the research fields included: new and quieter vehicles and road surfaces, new noise management policies, improved noise control actions, among others. Obtain a comprehensive list of EU-funding research projects was one of the major challenges of this work as the information is spread over several funding frameworks. Additionally, most of the web platforms do not always include optimized search tools, forcing the user to consider several "keywords" which can be ineffective and slow.

Although only the most recent projects were selected, in some cases, the project´s webpage was no longer available (NoMePorts and CALM Tracks & Routes) and some of the projects also did not have the results available on their web-page (e.g. CO2NTROL/Green City Car: the "documents" area is under construction). In such situations the information was retrieved from the respective European funding framework, usually in the form of a "Project final report".

The 24 identified outcomes provide a state of the art toolbox for planners that can be completed with other references than the EU research projects. The final review report [2] includes more tools, retrieved from non-EU resources, which complete this toolbox. This knowledge can help to improve urban sound conditions.

As explained in section 2. this paper intended to present a practical toolbox, rather than focus on more "theoretical" results. Therefore, one should note that the projects´ results are not restricted to the described outcomes and can include other relevant and equally important results.

Future work can extend the research to include general planning topics such as: mobility in urban environment, land-use and planning, improved traffic models and transportation. Some of these topics were already included in [2].

5. Conclusions

EU supported research was, and still is, extremely important for the development of new tools and policies for urban sound planning. However, it is important that this information is accessible in order to be used by planners and other stakeholders involved in the urban sound planning process. Many relevant tools were developed within these projects and they should remain available even after the projects´ lifespan. This review paper presents a selection of the most relevant EU research projects under the topic of the urban sound planning and a state of the art toolbox of solutions to be used by all involved in the urban sound planning process.

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References

[1] S. Alves, B. Altreuther, J. Scheuren: Holistic concept for urban sound planning applied to real sites. Proc. Forum Acusticum 2014.

[2] S. Alves, B. Altreuther, J. Scheuren: Noise reduction Elements and Tools and urban Sound Planning Processes, 2014. (SONORUS-Milestone report).

[3] CORDIS, http://cordis.europa.eu/home_en.html, accessed in 20/01/201

[4] LIFE Programme, http://ec.europa.eu/environment/life/index.htm, accessed in 20/01/2015

[5] COST, http://www.cost.eu/, accessed in 20/01/2015.