

## **Cover letter**

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**Document status:** new

**Title:** The LIFE MONZA: Project description and actions' updating

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Dear Noise Mapping Editor,

please find enclosed the manuscript titled "The LIFE MONZA: Project description and actions' updating".

The manuscript deals with the LIFE MONZA (Methodologies fOr Noise low emission Zones introduction And management) Project started in September 2016 and lasting 46 months.

Currently, Low Emission Zones (LEZ) have been implemented in more than 100 European cities and, in the frame of traffic planning, they are the most common measures adopted in EU. Moreover, the EU Directive 2008/50/EC on ambient air quality and cleaner air for Europe recommends establishing LEZs as a measure to be adopted in air quality action plans. However, there is still a lack of a comprehensive and integrated administration processes about LEZs, the effects and benefits of LEZ concerning the noise have not been examined in depth yet and the definition and applicative criteria for the analysis and managing of Noise Low Emission Zones are not clearly expressed and shared yet.

The main objective of the LIFE MONZA Project is to develop an easy-replicable method and related guidelines for the definition and management of Noise Low Emission Zones.

The current manuscript presents the structure, the objectives and the most recent findings of the Project.

Sincerely,

Chiara Bartalucci

## **The LIFE MONZA: Project description and actions' updating**

### **Abstract**

The introduction of Low Emission Zones, urban areas subject to road traffic restrictions in order to ensure compliance with the air pollutants limit values set by the European Directive on ambient air quality (2008/50/EC), is a common and well-established action in the administrative government of cities. The impacts on air quality improvement are widely analyzed, whereas the effects and benefits concerning the noise have not been addressed in a comprehensive manner. The definition, the criteria for analysis and the management methods of a Noise Low Emission Zone are not yet clearly expressed and shared. LIFE MONZA project (Methodologies fOr Noise low emission Zones introduction And management - LIFE15 ENV/ IT/000586) addresses these issues. The first objective of the project, co-funded by the European Commission, is to introduce an easy-replicable method for the identification and the management of the Noise Low Emission Zone, an urban area subject to traffic restrictions, whose impacts and benefits regarding noise issues will be analyzed and tested in the pilot area of the city of Monza, located in Northern Italy. Further objectives include the monitoring and the analysis of the effects, due to the introduction of the Noise Low Emission Zone, on air quality improvement and on the wellbeing conditions of the inhabitants of a selected pilot area, the identification of the type of interventions that can induce beneficial and synergistic effects, such as those relating to the planning of traffic flows and the adoption of low-noise pavings, and the active involvement of the population in the definition of a more sustainable lifestyle. Background conditions, structure, objectives of the project and actions progress will be discussed in this article.

**Keywords:** Environmental noise, Low Emission Zones, urban planning, top-down approach, bottom-up approach, low noise paving, smart noise monitoring system, App for citizens

### **1. Introduction**

Low Emission Zones (LEZs), as urban areas subject to road traffic restrictions, have been implemented in order to comply with the air quality objectives introduced by the European Directive on ambient air quality (2008/50/EC), as a measure able to improve environmental quality and to reduce health risks due to traffic conditions. Currently, LEZs have been introduced in more than 100 cities in Europe, becoming the most common measure adopted in EU, considering road traffic planning, and they are being considered for other cities worldwide [1].

LEZs implementation in Europe is promoted also according to the objectives of the Europe 2020 strategy, particularly regarding the identification of eco-innovation solutions, able to find a balanced environmental improvement, taking into account also the technical and economic feasibility and the social acceptability.

There are many different typologies of LEZs, based on various classes of most pollutant vehicles which are restricted from entering, diverse speed limits, different time periods, etc. Municipalities may choose the types of vehicles restricted in a LEZ according to the degree of emission reduction that is needed – only heavy duty vehicles, or also light duty vehicles, passenger cars, motorcycles and scooters – based on local assessment [2]. The LEZs introduction can reduce road traffic, optimize traffic flows and induce people to a lower use of cars, enhancing public transport and defining positive effects on mobility management, social wellbeing and environmental impacts.

In Germany, Denmark, Holland, Sweden and Czech Republic a national legislation on LEZ already exists, but, currently, LEZs implementation procedures vary widely among cities, many approaches are used and

there is not a commonly shared legal framework, at EU level, so that a harmonized management method is needed.

The effects of LEZs implementation on air quality improvement are widely analyzed. Many studies have been carried out, having different and contrasting results and in most cases LEZs represent an effective measure to reduce traffic-related air pollutants levels, whereas the effects and the potential benefits concerning the noise reduction have not been addressed in a comprehensive manner.

Noise issue is not taken into account and consequently no specific interventions against noise have not been foreseen and implemented.

Air pollution and noise are the two main environmental problems in Europe and, currently, road traffic is the most dominant source of environmental noise with an estimated 125 million people [3] affected by noise levels greater than 55 dB Lden.

Concerning the EU policy, the EU Directive 2008/50/EC on ambient air quality and cleaner air for Europe considers the establishment of LEZs a measure to be adopted in air quality action plans, whereas the EU 2002/49/EC Environmental Noise Directive (END) does not provide a definition of LEZ in relation to noise and it is not considered as an action to consider in noise action plan drafting.

The END focuses on the assessment of people exposed to environmental noise, drafting strategic noise maps; on preventing and reducing environmental noise where necessary and preserving acoustic quality where it is good, drawing up action plans; it also focuses on ensuring public information on environmental noise and its effects. Annex V of END, Minimum requirements for action plans, suggests some examples of actions that competent authorities should consider, as traffic planning and land-use planning and those issues can be considered in Noise LEZs introduction and management. Furthermore, important contributions to the environmental noise management according to END requirements has been given by some concluded European projects such as LIFE+2010 QUADMAP, LIFE+2008 HUSH and LIFE+2009 NADIA [4-8].

However, at this time, there is a lack of a comprehensive and integrated administrative process about LEZs and noise issue is, in fact, not considered. The definition, the criteria for the identification and the management methods of a Noise Low Emission Zone, the effectiveness and the potential benefits on noise reduction are not clearly analyzed, expressed and shared yet.

LIFE MONZA project (Methodologies fOr Noise low emission Zones introduction And management - LIFE15 ENV/ IT/000586) addresses these issues. The Project begun in September 2016 and it is supposed to end on June 2020. The Project coordinator is ISPRA, The Italian National Institute for Environmental Protection and Research, and the associate members of the projects are the Department of Industrial Engineering of the University of Florence, the Engineering Company Vie en.ro.se. and the Municipality of Monza.

In the current paper the Project objectives and the pilot area will be described, together with the main activities to be implemented. Moreover, updates about the progress of each main activity will be given.

## **2. LIFE MONZA objectives**

LIFE MONZA project aims at introducing an easy-replicable method, and related guidelines, for the identification and the management of the Noise Low Emission Zone (NLEZ), to be intended as an urban area in which road traffic restrictions have been implemented and where low noise levels are present. Impacts and potential benefits of the new method regarding noise issues will be analyzed and tested in a selected pilot area of the city of Monza, located in Northern Italy.

The second objective regards specific top-down measures, adopted by the municipality and able to turn up the pilot area in a permanent Noise LEZ, consisting in infrastructural interventions and traffic management.

The third objective is to involve people in an active management system of more sustainable lifestyle choices (bottom-up measures) related to the reduction of noise and the improvement of air quality and wellbeing conditions in their living and working environment.

The fourth objective is to reduce the average noise levels in the pilot area of Libertà district, with positive complementary effects also on the air quality and benefits on wellbeing conditions of inhabitants. In the district there are significant average levels of noise pollution, affecting many citizens and it is identified as a hotspot in the Noise Action Plan implemented by the city of Monza according to END requirements. In particular, a main average noise reduction and an air quality improvement are expected in correspondence of the Viale Libertà axis, due to the foreseen top-down measures to be put into practice. Moreover, less significant but still relevant noise reduction are expected in the entire Libertà district, thanks to both the top-down measures implemented in the Viale Libertà and the bottom-up actions to be encouraged inside the district itself.

### **3. The case study**

The methodologies for NLEZs introduction and management will be tested in the pilot area of Libertà district, in Monza. The city of Monza has started to develop an Urban Traffic Plan aimed to achieve three important goals: a new parking pricing policy in the city centre and in the immediate surroundings; a park&ride scheme to connect peripheral areas with the city centre by shuttle buses; the implementation of Limited Traffic Zones, one of which, the Libertà district, will also be tested through the current project as a Noise LEZ, in order to have a pilot case to be replicable in other areas in the city and in other contexts. The Libertà district (Figure 1) is a densely populated area with about 15,000 inhabitants, located in the North-Eastern side of the city of Monza, crossed by a major road (Viale Libertà), daily crossed by about 30,000 vehicles. In fact, it is one of the most important access roads to Monza from the Eastern surrounding area and towns and it is currently also the primary East-West corridor of the city center.



Figure 1: Noise LEZ pilot area boundaries (Libertà district).

The area has been identified as a hotspot in Noise Action Plan and, in particular, based on Noise Mapping dated 2012, it can be observed that in a range of 30 m from the Viale Libertà almost the 100% of the receivers is exposed to levels higher than 65 dB during the day and higher than 55 dB during the night.

In the Life MONZA project, in a section of Viale Libertà, infrastructural interventions (top-down measures) to reduce the average noise levels due to the road traffic will be designed and implemented, detecting also the potential positive effects on air quality, with respect of the surrounding area. The effects of these top-down measures, together with the promotion of bottom-up measures carried out by citizens, will allow the Libertà district to become a permanent noise LEZ.

#### 4. LIFE MONZA organizational structure

The Life MONZA project is structured in five Packages, each of which consists of different actions as displayed in Figure 2.

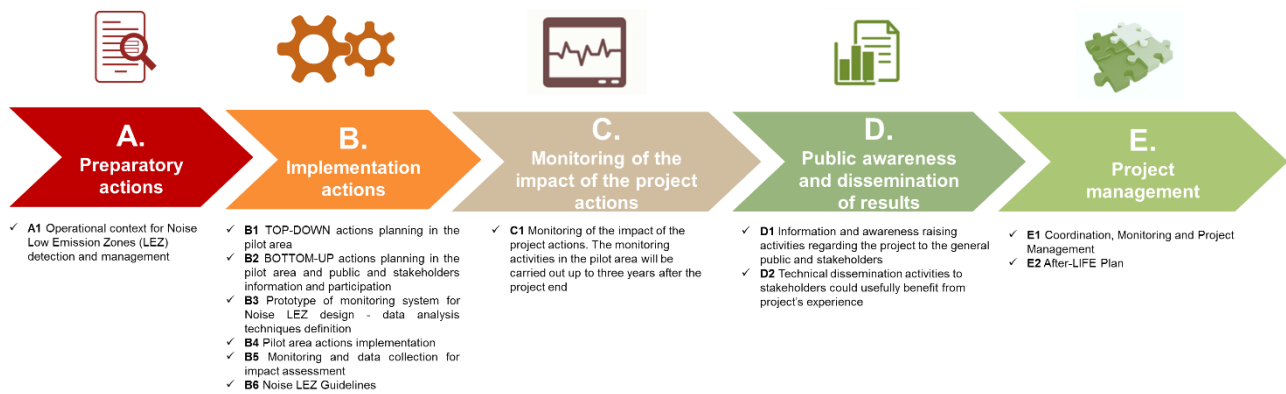


Figure 2: LIFE MONZA Project structure.

Preparatory actions (Package A) concern the updating of the currently available environmental and legislative framework on monitoring systems for noise and air quality, health indicators, etc. with regards to the noise LEZ context.

Implementation actions (Package B) regard the pilot area implementation actions, enclosing the detailed designing of top down and bottom up actions. In particular, tasks are dedicated to the infrastructures actions (silent asphalt designing, LEZ formal introduction, actions to limit high vehicles transit), to the detailed designing of bottom-up actions and methods to be applied in order to actively involve citizens in the Project. Moreover, these actions will be dedicated to the designing of monitoring systems (e.g. a prototype system for smart monitoring activity of noise), techniques for the data analysis and restitution and to all the ante and post-operam monitoring activities with specific attention to road traffic, noise, air quality and health. Finally, Package B includes the drafting of guidelines for the introduction and management of Noise LEZ.

Monitoring actions (Package C) regard the monitoring of the impact of the projects action to be carried out both during the project and for three years after its conclusion.

Finally, in order to ensure the compliance with the demonstrative character of the Project as well as its management, Actions D and E are respectively planned to guarantee adequate communication and dissemination activities as well as a good project management.

In Figure 3 the timetable of the Project actions is shown.



Action		2016				2017				2018				2019				2020				2021			
Action number	Name of the action	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
<b>A. Preparatory actions (if needed)</b>																									
A.1	Operational context for Noise Low Emission Zones (LEZ) detection and management				■	■																			
<b>B. Implementation actions (obligatory)</b>																									
B.1	TOP-DOWN actions planning in the pilot area				■	■	■	■	■	■															
B.2	BOTTOM - UP actions planning in the pilot area and public and stakeholders information and participation				■	■	■	■	■	■															
B.3	Prototype of monitoring system for Noise LEZ design - data analysis techniques definition				■	■	■																		
B.4	Pilot area actions implementation												■	■	■	■	■								
B.5	Monitoring and data collection for impact assessment							■	■	■	■	■	■	■	■	■	■	■							
B.6	Noise LEZ Guidelines							■	■	■	■	■	■	■	■	■	■	■							
<b>C. Monitoring of the impact of the project actions (obligatory)</b>																									
C.1	Monitoring of the impact of the project actions							■	■	■	■	■	■	■	■	■	■	■							
<b>D. Public awareness and dissemination of results (obligatory)</b>																									
D.1	Information and awareness raising activities regarding the project to the general public and stakeholders							■	■	■	■	■	■	■	■	■	■	■							
D.2	Technical dissemination activities to stakeholders could usefully benefit from project's experience							■	■	■	■	■	■	■	■	■	■	■							
<b>E. Project management (obligatory)</b>																									
E.1	Coordination, Monitoring and Project Management				■	■	■	■	■	■	■	■	■	■	■	■	■	■							
E.2	After-LIFE Plan																	■	■						

Figure 3: LIFE MONZA timetable.

## 5. First results achieved in each Project Package

At December 2017, after about 14 months from the beginning of the Project, some Actions turn out to be already concluded (A.1 and B.3), the majority of Actions are in progress (B.1, B.2, B.5, B.6, C.1, D.1, D.2, E.1) while other Actions (B.4 and E.2) have not started yet.

In the following Paragraphs the main objectives of each Actions and results already achieved are described.

### 5.1 Preparatory actions (Package A)

The main objective of Package A, make up on the Action A1, is to achieve a state of the art review about the legislative and technical requirements on noise LEZ as well as the most up to date noise and air quality monitoring systems and the most existing suitable health indicators of the effects due to noise and air pollution.

Action A1 was concluded on December 2016 and the main output was an Abacus on operational context on Noise Low Emission Zone (including sections devoted to noise, air, traffic and health topics) including several technical sheets about different analysed issues.

Inside the Abacus, the legislation regulating the activities of the Municipalities when measures have to be taken to reduce noise and environmental pollution was described. Moreover, the analysis of the experiences and procedures developed in Europe on the smart and low-cost noise monitoring systems was conducted, in order to update the information for the definition of the operating context related to the problems of noise monitoring and also to provide support for prototype development. In this frame, networking activities were started with the LIFE DYNAMAP project and with the Eurocities and FONOMOC networks dedicated to acoustic monitoring. In addition, a "conceptual framework" about the study design regarding the definition of the macro and microscale location criteria of the measurement points for the assessment of air quality in the area where the Noise Low Emission Zone will be implemented has been made, together with a brief review of systems for diffusive gas sampling and Land use regression models. The literature review was deepened also to identify the health indicators useful for the evaluation of the interventions covered by the project. Given the structure and timing of the project, it was decided to select proxy indicators of health status, modifiable in the time of evaluation of the study, related to quality of life (QOL). Finally, a review about





- Development of Noise LEZ guidelines (Action B.6)

In the frame of Package B, main results in terms of delivered actions and research activities are the following ones:

- The delivering of the executive project for the realization of all the interventions in the pilot area (including economic framework and specifications and safety coordination during the design phase) (Action B.1)
- The presentation of the Project in several meetings both with citizens and University students has been made, the questionnaire focusing on health, mobility habits and noise perception has been defined together with the first version of the App and the “games” to be included (Action B.2)
- The prototype of the noise smart monitoring system has been defined and preliminary checked.

In particular, the prototype technical specifications were defined [9] keeping in mind the aim of a long-term monitoring of acoustic parameters. These are expected to be useful both to understand acoustic climate in the pilot area and also to validate the noise maps calculated for ante and post operam scenarios by means of road traffic data as input.

According to the previous general requirements and to the outcome of the carried out state of the art analysis, the following main specifications of monitoring units are defined:

- acoustic parameters: overall A-weighted continuous equivalent sound pressure level, “LAeq” and continuous equivalent sound pressure level, Leq, as 1/3 octave band spectrum data;
- timing for data recording: data will be acquired with a time basis of 1 second in order to permit the recognition of unusual events in the eventual analysis phase;
- timing for data transmission: data will be sent to the remote server every one hour;
- data transmission network: the data will be transmitted through the 3G cellular telephonic network;
- power supply: solar panel (max expected size 60cm x 60cm) and battery for energy storage or direct connection to electricity network;
- sensors location: on streetlight or on façade, height 4 m above the ground level;
- sensor type: ¼ or ½ - inch low-cost microphone with removable rain protection.
- floor noise < 35 dB(A);
- frequency response at nominal frequencies of 1/3 octave within the class I specs  $\pm 1$ dB

Starting from the specs listed above, the monitoring system architecture has been mainly based on monitoring units designed in the Life DYNAMAP project (these units comply with all the specs), tailoring the data transmission, storage and post-analysis to the needs of the Life MONZA project (this latest aspect is not dealt with in the present paper).

A first smart monitoring unit has been installed on a building of the the University of Florence in Sesto Fiorentino and has been tested for a period of two months. Once tests have been successfully completed, 10 control units have been acquired and the respective measurements positions have been chosen (Figure 5).

Moreover, two on-site operation checks have been positively carried at all the installed control units out with traditional instruments in Class I (Action B.3 and B.5)



Figure 5: Selected noise monitoring positions.

### 5.3 Monitoring of the impact of the Project actions (Package C)

The main aim of Package C is to progressively verify that implementation actions belonging to package B are realized according to the originally defined objectives and that the quantitative expected results are achieved. Specifically, a Global Index (GI) combining air quality, noise pollution, road traffic, health and socio-economic parameters and a Smart Global Index, a simpler version of the GI including at least noise indicators, will be developed.

Concerning Package C, a first achieved result is the completion of the state art analysis concerning existing complex environmental indicators. During this phase several articles, books and guidelines have been analysed and it turned out that a complex indicator perfectly fitting the project objectives has not been developed yet. As a consequence, a specific work will be carried out in the next periods in order to adapt the existing and already validated indicators to the environmental, health and socio-economic parameters to be monitored in the frame of the LIFE MONZA Project.

The parameters illustrated in Table 1 have been selected and agreed among Project partners to be introduced in the GI.

Table 1: Noise, air quality, socio-economic, climate parameters selected for the GI.

TYPOLOGY	DESCRIPTION	PARAMETER	UNIT
NOISE	Average value on the noise LEZ area	$L_{den}$	dB
	Average value on the Viale Libertà buffer (30 m)	$L_{den}$	dB
	Average value on the Viale Libertà buffer (30 m)	$L_d$	dB
	Average value on the Viale Libertà 30 m buffer	$L_n$	dB
	% of people exposed to $L_{den}$ values > 65 dB(A) in the noise LEZ area	%	/
	% of people exposed to $L_{night}$ values > 55 dB(A) in the noise LEZ area	%	/
	% of people exposed to $L_{den}$ values > 65 dB(A) in the Viale Libertà 30 m buffer	%	/
	% of people exposed to $L_{night}$ values > 55 dB(A) in the Viale Libertà 30 m buffer	%	/

TYPOLOGY	DESCRIPTION	PARAMETER	UNIT
AIR QUALITY	Particular matter	PM10	$\mu\text{g}/\text{m}^3$
	Particular matter	PM2.5	$\mu\text{g}/\text{m}^3$
	Other air pollutants	$\text{NO}_2$	$\mu\text{g}/\text{m}^3$
	Greenhouse gas emissions	$\text{CO}_2$	metric tons/year

TYPOLOGY	DESCRIPTION	PARAMETER	UNIT
SOCIO-ECONOMIC	Commercial Activities	N° of commercial activities in the noise LEZ	/
	People employed in commercial activities	N° of people employed in the noise LEZ	/
	Services activities	N° of services activities in the noise LEZ	/
	People employed in services activities	N° of people employed in the noise LEZ	/

TYPOLOGY	DESCRIPTION	PARAMETER	UNIT
CLIMATE	Areas potentially affected by climate change covered by adaptation measures	/	$\text{km}^2$

## 5.4 Public awareness and dissemination of results (Package D)

The main objective of Package D is to structure a dynamic, multidisciplinary and spread system to inform, communicate, intrigue and make the method tested in the pilot area transferable and replicable, by involving stakeholders, general public and end users. Another goal is to make people aware of the health risks caused by the noise impact and the poor air quality, encouraging and stimulating people to act in first person to contribute to the improvement of the environmental quality.

In the perspective of disseminating the Project activities, but also of finding and testing new forms of citizens' involvement, until this moment Project partners have participated to two International Congresses and to one Italian Congress presenting some papers and to several meetings about noise. Moreover, a specific event to celebrate the 25<sup>th</sup> anniversary of LIFE projects has been organized in Florence and on the occasion of the Noise Awareness Day dissemination activities with several hundred students have been organized at some schools located in the Liberty District.



Figure 6: Documents presented during some dissemination events.

## Conclusions

In the recent past several studies about Low Emission Zones (LEZs) have been carried out in Europe showing that, in most cases, they represent an effective measure to reduce traffic-related air pollutants. However, the effects and the potential benefits concerning the noise reduction have not been addressed in a deep manner yet. The main objective of the LIFE MONZA Project, started in September 2016, is to develop and test an easy-replicable method, and related guidelines, for the identification and the management of the Noise Low Emission Zone (NLEZ) able to reduce the average noise levels but with positive complementary effects also on the air quality and benefits on wellbeing conditions of inhabitants. The procedure will be firstly applied in the pilot case of the Libertà District, by adopting top-down strategic measures and involving citizens in an active management of more sustainable lifestyle choices related to the reduction of noise and the improvement of air quality and wellbeing conditions in their living and working environment.

In the current article the Project structure is illustrated in terms of Packages and specific Actions. Moreover, the main results achieved until December 2017 are presented, in terms of: the development of an Abacus on operational context on Noise Low Emission Zone, the definition and first tests of the prototype for the noise smart monitoring system, the selection of noise, air quality, socio-economic and climate parameters to be used to build the environmental Global Index.

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