With the contribution of
the LIFE programme of the European Union
LIFE15 ENV/IT/000586 – MONZA

Life MONZA
Methodologies for Noise low emission Zones introduction And management

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Methodologies for Noise Low Emission Zones introduction and management

OBJECTIVES AND CARRIED OUT ACTIVITIES

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COMUNE DI MONZA

UNIVERSITÀ DEGLI STUDI FIRENZE

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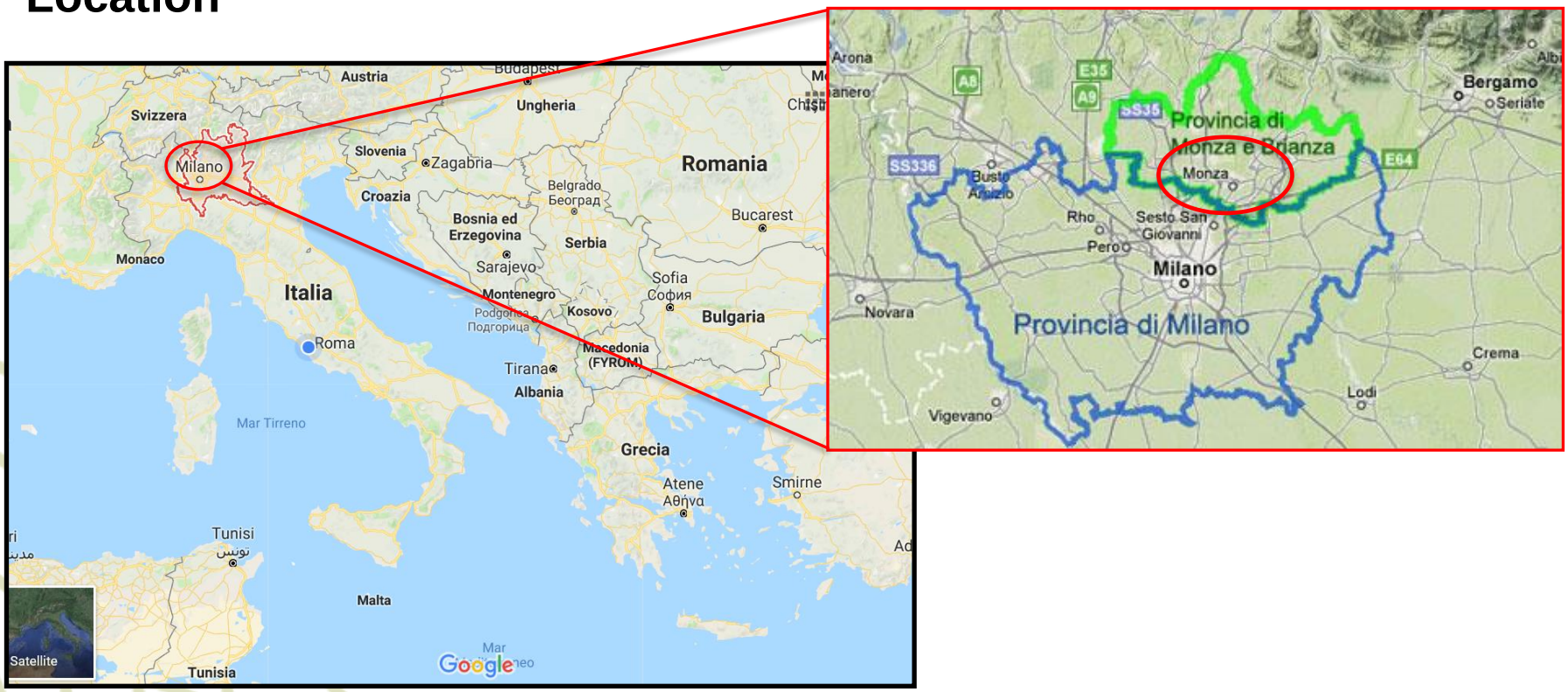
Project location and beneficiaries

Location



Timing

Start: 1st September 2016

Expected end: 30th June 2020

Project location and beneficiaries

Beneficiaries

Municipality of Monza (Coordinator)

COMUNE DI MONZA

ISPRA - Italian Institute for Environmental Protection and Research

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Project background - LEZ

Low Emission Zones (LEZs): urban areas subject to road traffic restrictions to comply with the air pollutants limit values set by the European Directive 2008/50/EC.

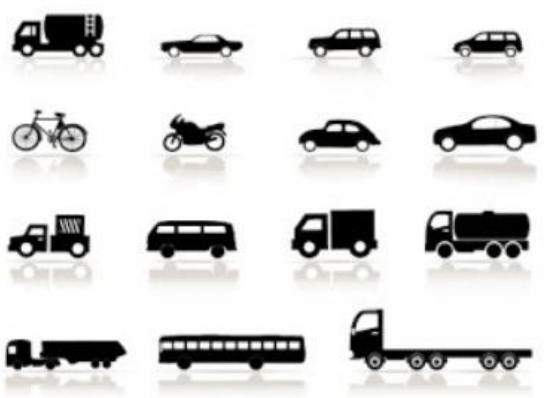
Goal: to improve the environmental quality and to reduce health risks

Benefits: road traffic reduction, traffic flows optimization, lower use of cars, enhancing of public transport, social wellbeing.

Project background - LEZ

Differences between LEZs:

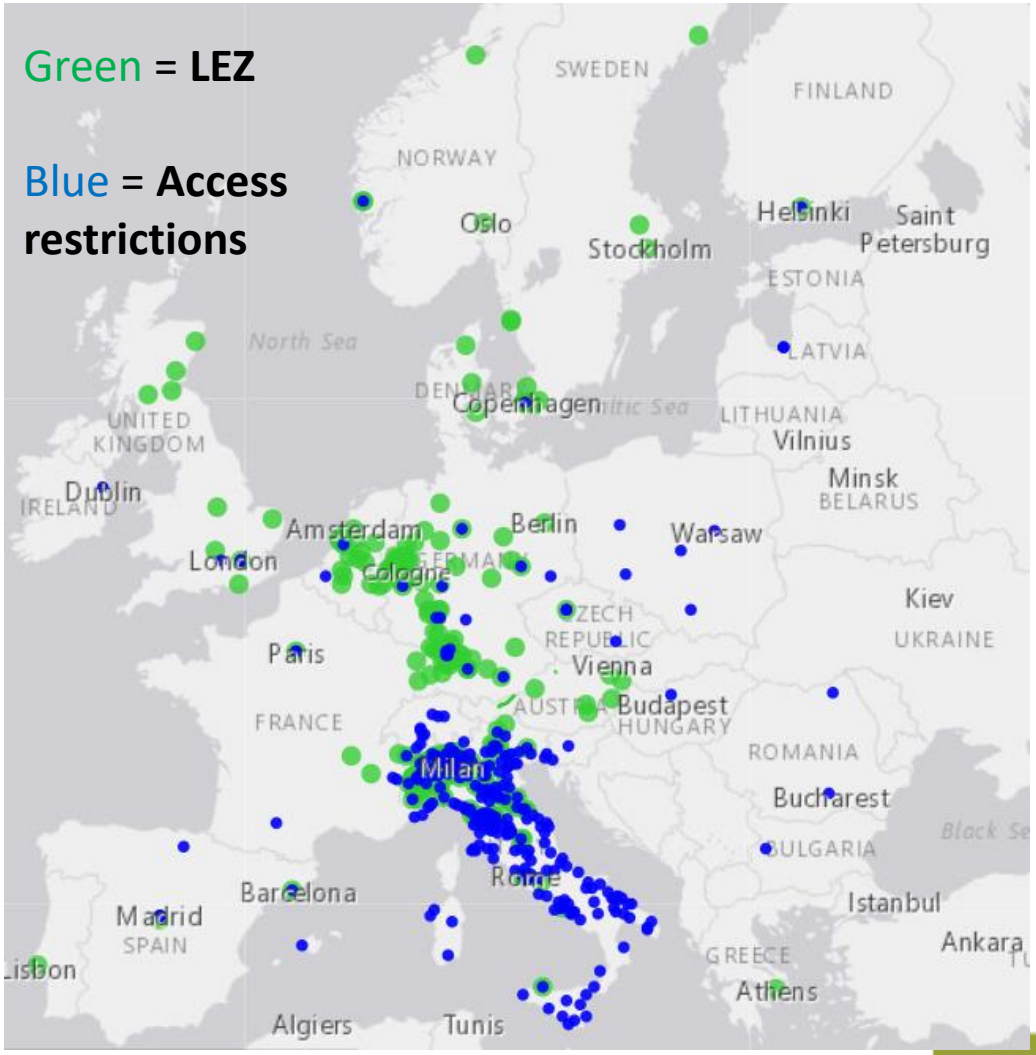
- Typologies of vehicles to which access could be denied (heavy-duty vehicles, and/or light duty vehicles, passenger cars, motorcycles and scooters, …)
- Diverse speed limits
- Different restriction time periods
- …



Project background - LEZ

LEZs implemented in > 200 cities in Europe.

Many approaches used and absence of a commonly shared legal framework, at EU level.



http://urbanaccessregulations.eu/userhome/map

Project background - LEZ

- Effects of LEZs implementation widely analyzed

- LEZs recognized as effective measure to reduce traffic-related air pollutants levels

- Effects and **potential benefits** concerning the **noise reduction** in a LEZ **not addressed in a comprehensive manner** yet

- **Noise aspect** not **taken into account** and no specific interventions against noise foreseen and implemented in the LEZs

Project objectives

Final goal: a common and easy-replicable method, and related guidelines, for the identification and the management of Noise Low Emission Zones.

Case study: Libertà district (Monza)

In a range of 30 m from the Viale Libertà almost the 100% of the receivers are exposed to levels > 65 dB(A) during the day and > 55 dB(A) during the night.

Project objectives

Other specific objectives:

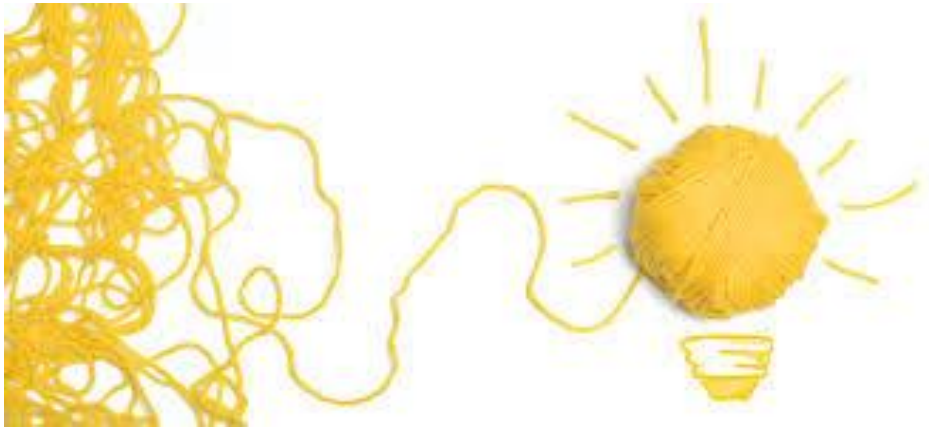
- ✓ adoption of ***top-down measures*** concerning infrastructural interventions (traffic management - limitation of the vehicles speed and access denied to trucks, road paving substitution, two pedestrian crossings)

- ✓ reducing the **average noise levels** in the pilot area of Libertà district, with positive complementary effects also on the **air quality** and on the **quality of life**

- ✓ involving the population in an active management system of lifestyle choices ***(bottom-up measures*** *i.e* lessons at schools about noise effects, ideas contests for Noise LEZ picture and logo, questionnaires on perceptions of specific noise impacts, on quality of life, air quality as well social aspects, mobile App to manage voluntary and sustainable actions)

Innovative aspects of the Project

- ✓ Combined noise and air monitoring
- ✓ Using of smart noise monitoring systems
- ✓ Attention not only on noise effects (air quality, health, social well-being, economic aspects,…)
- ✓ Global index
- ✓ Public involvement



TOP-DOWN actions planning in the pilot area - Update

- ✓ Public tender for replacement Viale Libertà's pavement
- ✓ Road traffic restrictions:
  - Heavy tracks> 3.5 tons (6 months).
  - Heavy tracks > 7.5 tons (after)
- ✓ Final project for Viale Libertà's asphalt replacement

Works for asphalt laying started on 17 September 2018

Bottom Up Actions

Public involvement,meetings organization,ideas contest (MONZA)

Administration of questionnaire about health and mobility habits/noise perception - Ongoing

About 200 questionnaires collected so far (February 2018)

Public involvement: environmental aspect (VIENROSE)

Pedibus

Bottom Up Actions

If you interrupt the noise, you'll feel the life

interrotto il frastuono, sentirai la vita.

LIFE

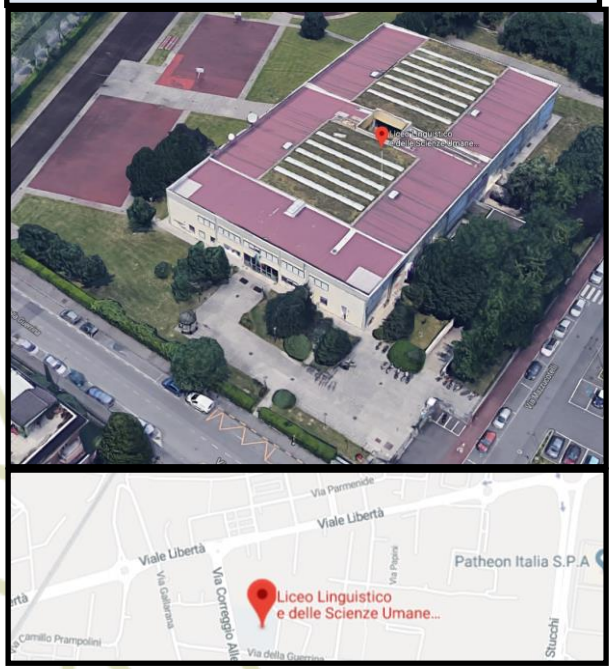
MONZA

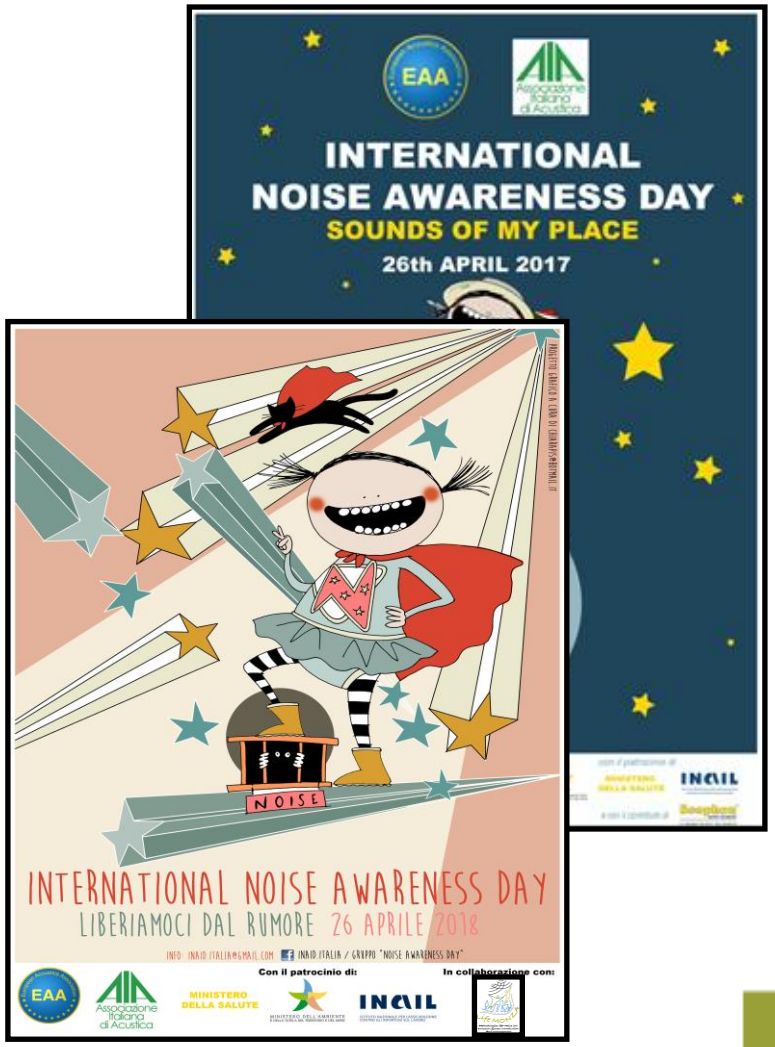
QUARTIERE LIBERTÀ

Bottom Up Actions

Alternating school-work Programs
with Carlo Porta Institute:

- **21 students**
- **15 meetings**





Bottom Up Actions

APP structure

City Games

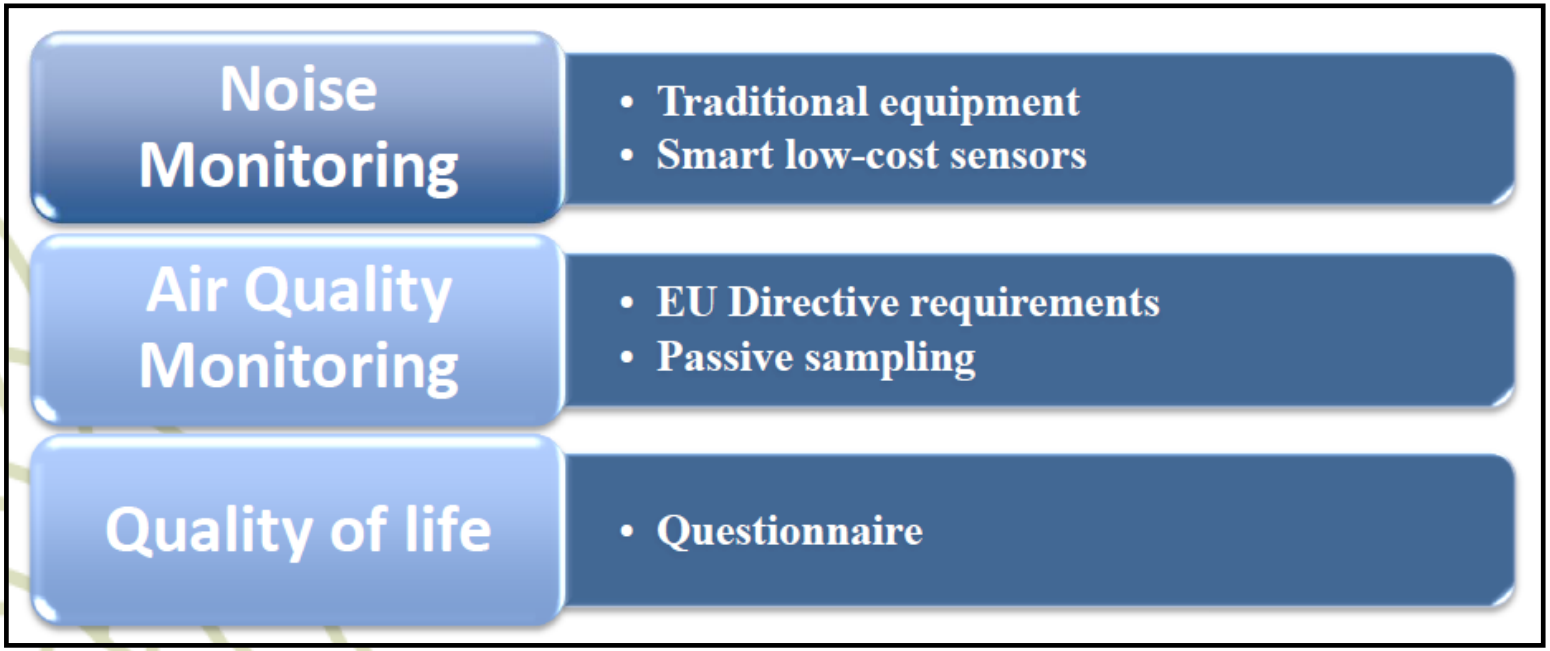
- Pedibus
- Walking time within the LEZ zone
- Biking time within the LEZ zone

Green actions

Green points

Monitoring activities

Objective: reduction of the average noise levels in the pilot area of Libertà district, with positive complementary effects also on the air quality and benefits on well-being conditions of inhabitants.



Noise Monitoring in pilot area

Noise Monitoring

- **Smart low-cost sensors**
- **Traditional equipment**

Development of a new smart noise monitoring system (SNMS) as a continuous monitoring network in the ante and post-operam scenarios (1+1 year)

At the end of the project, the prototype will be given for free to the city of Monza that will take care of using it for monitoring activities in the 3 years after LIFE period

Periodic checks to be performed using sound level meters of class I precision

Noise Monitoring in pilot area

The State of the art analysis was based on the following relevant low cost monitoring system experiences:

- DREAMsys
- Smart monitoring networks designed by Ghent University
- SENSEable Pisa
- Life DYNAMAP
- Barcelona Noise Monitoring network
- Low-cost monitoring systems based on smartphone devices – Regional Environmental Agency of Piemont
- …

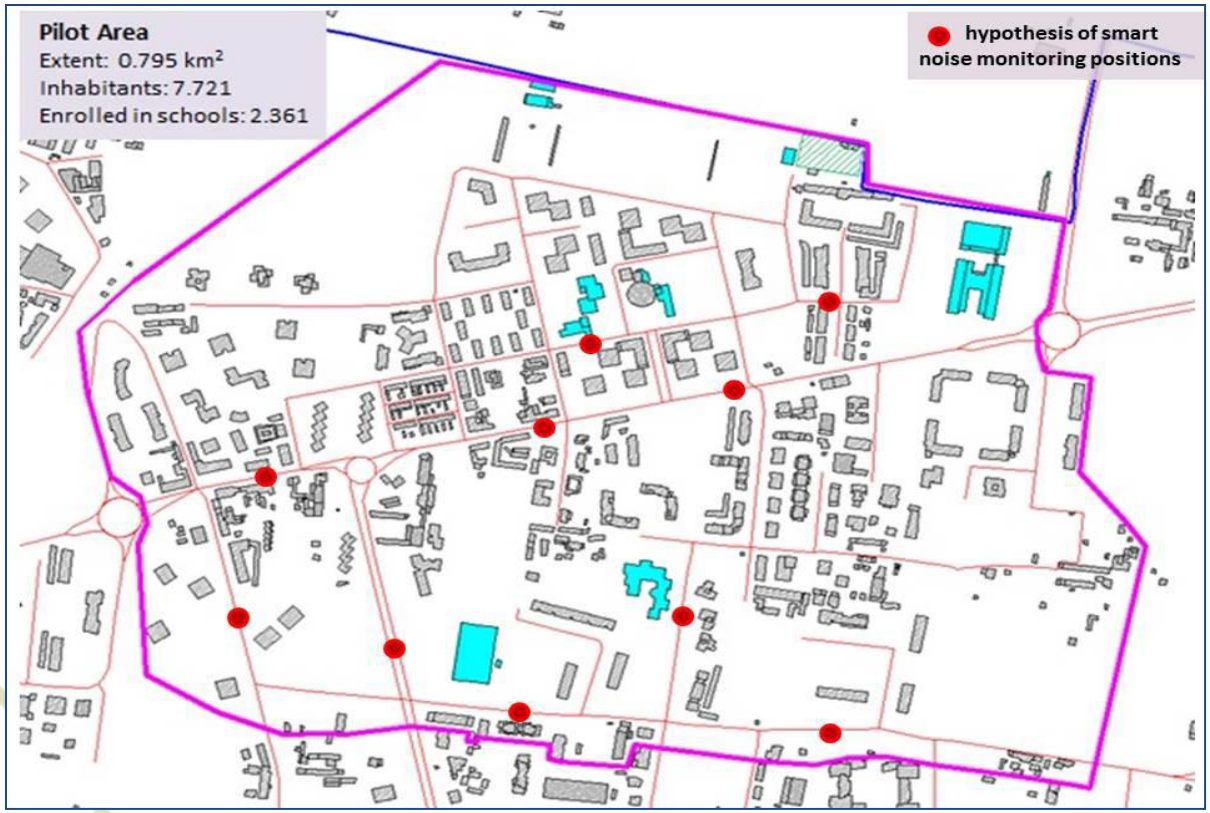
Noise Monitoring in pilot area

Results: an **Abacus** on smart noise low-cost monitoring networks fully available at **www.lifemonza.eu**

Smart low cost noise monitoring systems	
main characteristics arising from analyzed projects	
Short /long term noise measurement	long term noise measurement
Embedded pc monitoring system /Units with microcontroller and digital signal processor	Embedded pc monitoring system
Type of microphones	MEMS microphones ¼ - inch condenser low cost microphone
Time basis acquisition	Different values. In most frequent cases =1 sec;
Acoustic dynamic range	70 dB
Acoustic Measure range	Different ranges. 30 (40)-100 (110) dB(A)
Acoustic frequency range	20 Hz-20 kHz
Floor noise value	30-35 dB(A)
Tolerance	LAeq ±2 dB(A)
Acoustic indicators	In all cases studies: L_{Aeq}, L_{A10}, L_{A50}, L_{A90}; In some cases studies: L_{A01}; L_{Ceq}, M_{60}, M_{70}, N_{cn}
Spectral data	1/3 octave
Calibration	Periodic calibration
additional characteristics	
weatherproof	Applied in all case studies
connectivity	WiFi/3G/4G
possibility of audio recording	Applied in some case studies
other properties	Extensible with temperature/humidity sensors, air pollution monitoring sensors, GPS logging etc; battery for energy storage.
Size of PCB assembly	10mm < x < 10 mm
Shape of PCB	Optimized to avoid diffraction effects
pilot area of implementation	
Urban/Suburban	Urban and sub-urban areas
Territorial scales	Different dimensions, from medium to large scale; (most frequent dimension in urban area: ≈1,00 km^2)
Number of stations	Different situations. For areas of medium spatial dimensions, in most cases, from 5 to 20 units

Noise Monitoring in pilot area

10 monitoring stations have been installed in the pilot area of Libertà district



Noise Monitoring in pilot area

Main technical specifications:

- 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 registered 1 second based to permit the recognition of unusual events in the post analysis phase
- timing for data transmission: data will be sent every hour
- data transmission network: 3G

Main electroacoustic specifications:

- floor noise < 35 dB(A)
- frequency response to pure tone at 31.5, 40, 50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000, 2500, 3150, 4000, 5000, 6300, 8000 Hz within the class I specs $\pm$ 1dB

Noise Monitoring in pilot area

Main hardware specifications:

- controller: low power microcontroller able to perform IIR digital filtering for A-weighted level calculation and FFT for 1/3 octave band level calculation
- power supply: solar panel (max expected size 60cm x 60cm, effective expected size 30cm x 35cm) and battery for energy storage
- sensor type: ¼ or ½ inch low cost microphones with removable rain protection
- possibility of installation: on façade or on streetlight, height 4 m

Noise Monitoring in pilot area

Two procedures have been applied to verify the noise monitoring system performance:

- Preliminary check (during the first two months)
- Long term check (every four months during two years period)

Noise Monitoring in pilot area

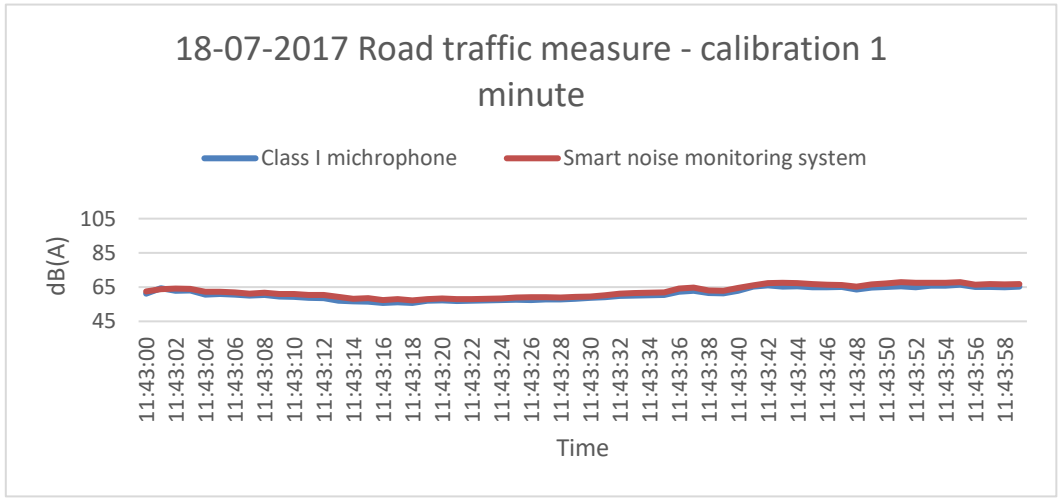
Procedures to check the performance maintenance

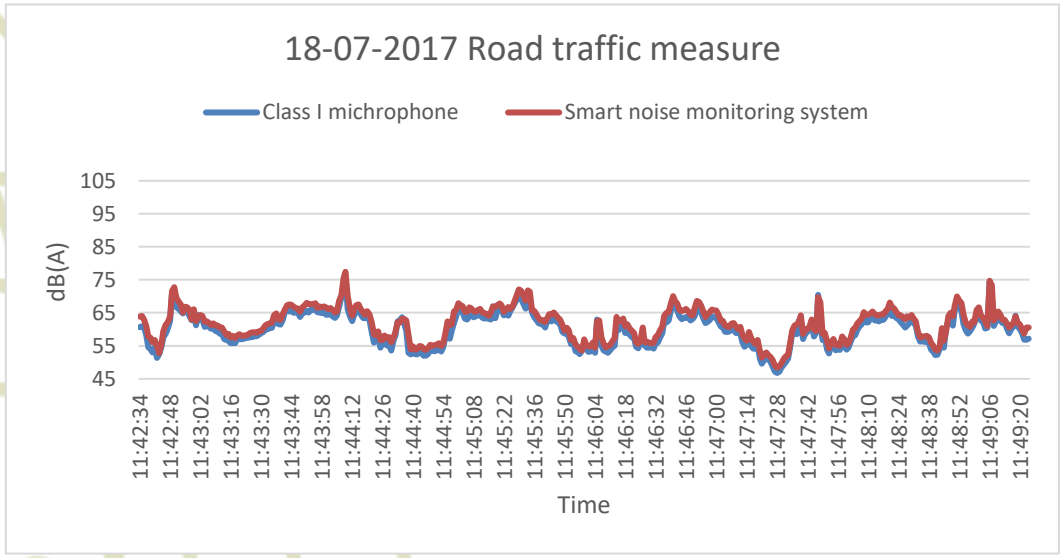
The challenge of the low cost sensors consists of performance maintaining during long term periods. Two time-stability checks, one-week based, are proposed:

1 – **a calibration check @ 1 kHz** (by using a sound pressure class I calibrator). *Requirements for preliminary check: sound pressure level within 0,5 dB from the calibration level*

2 – **a comparison between LAeq,60s obtained from low cost sensor and class I equipment** recording an environmental noise in the range 45/105 dBA.
Requirements for preliminary check: difference between the two systems within 1,5 dB(A)

Noise Monitoring in pilot area





Monitoring methods and activities tested in pilot area: Air Quality

Air Quality Monitoring

- EU Directive requirements
- Passive sampling

Air Quality monitoring within the pilot area is in progress, according to requirements provided by Directive 2008/50/EC

Also, the low cost and easy operation of the **diffusive sampling technique** will be used for a large scale air pollution surveys with a **high spatial resolution**.

In order to **compare the spatial variability of air pollution** before and after the *NLEZ* implementation, NO_2 and benzene land use regression models in a defined urban area of Monza of about 4 km², including the noise *LEZ*, will be developed.

Monitoring methods and activities tested in pilot area: Survey

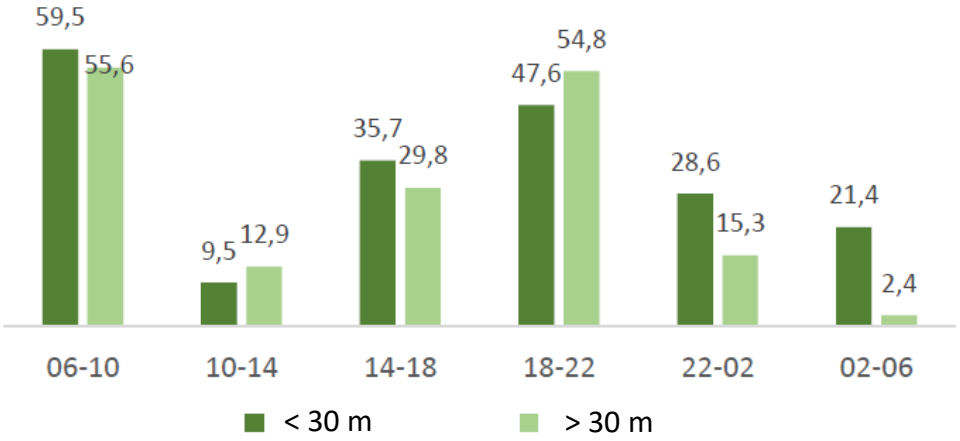
Quality of life

- questionnaire

Structure of the questionnaire

- socio-demographic data
- building (location, noise exposure, time spent at home)
- quality of life in the district (opinion on social, economic and environmental aspects)
- perception about air quality
- perception about noise
- health and life quality
- transport mobility situation
- potential effects of LIFE MONZA project on local system aspects

Annoyance caused by exposition to noise in different time slots and at different distances from Viale Libertà (%)



Questionnaires filled in almost 177, equal to about 31% of the sample (570 expected). Further actions about the questionnaire administration are in progress, in order to guarantee the expected number of compiled copies.

The global index

TYPOLOGY	DESCRIPTION	PARAMETER	UNIT
NOISE	Average value on the noise LEZ area	Lden	dB(A)
	Average value on the Viale Libertà buffer (30 m)	Lden	dB(A)
	Average value on the Viale Libertà buffer (30 m)	Ld	dB(A)
	Average value on the Viale Libertà 30 m buffer	Ln	dB(A)
	% of people exposed to Lden values > 65 dB(A) in the n	%	/
	% of people e 55 dB(A) in th		
	% of people e dB(A) in the V		
	% of people e 55 dB(A) in th		
AIR QUALITY	Particular mat		
	Particular mat		
	Other air pollu		
	Greenhouse g		
SOCIO-ECONOMIC	Com		
	People er		
	Se		
	People emp		
CLIMATE	Areas poter change cover		

TITOLO/RIFERIMENTO	AUTORE	TIPOLOGIA INDICATORE	VARIABILI CONSIDERATE
Analisi costi-efficacia e costi-benefici applicata alle misure di mitigazione sonora – AIA 2014	Bellucci	Indicatori applicabili agli interventi di risanamento acustico nell'ambito dei piani d'azione. CEA, valutazione costi/efficacia. CBA, valutazione costi/benefici, $NPV = \sum_{n=0}^{N} \frac{b_n - c_n}{(1+r)^n}$ Modalità di valutazione dei costi (diretti e sociali) e dei benefici dovuti all'intervento acustico.	CEA: acustiche CBA: acustiche, sociali, sanitarie
City Noise-Air: an environmental quality index for cities – Sustainable Cities and Society 4 (2012) 1-11	Silva, Mendes	City Noise-Air (noise Quality Index)= 0.5xCityNoise + 0.5xCityAir Introduzione e applicazione al caso pilota di Viana do Castelo.	City Noise-Air: CityNoise (Lden), CityAir (CO, NO2, PM10, C6H6, O3)
Urban quality evaluation by means of acoustic indicators and indexes: validation of an acoustic quality index – AIA-DAGA 2013 *Urban quality assessment by means of indicators and indexes: application of an acoustic quality index and analysis of other significant indexes for smart cities evaluation* – ICSV20 (2010) *Acoustical indicators and index for urban quality evaluation* – ICA 2010	Magrini et al.	City Noise-Air (noise Quality Index)= 0.5xCityNoise + 0.5xCityAir $NQI = \sum_{i=1}^{N} I_i K_i$ N= n° range, K= peso range CityNAC= Kn·CityNoise + Ka·CityAir + Kc·CityClimate Confronto tra City Noise e NQI nel caso pilota di Peretola e Porta al Prato.	City Noise-Air: CityNoise (Lden), CityAir (CO, NO2, PM10, C6H6, O3) NQI: Lden, veicoli/d, percentuale popolazione esposta
Building spatio-temporal environmental quality index: the case of Madrid – Statistica Applicata Vol. 21, n. 2, 2009	Montero et al.	Pena Distance (DP2): 1-D, matrice distanze tra valore assunto dal singolo indicatore in un certo tratto censuale ed il valore limite di riferimento 2- DF, D normalizzata rispetto alla varianza dei singoli indicatori 3- DP2, DF in cui si eliminano eventuali correlazioni tra variabili singole (scelta dell'ordine con cui valutare la correlazione) Applicazione dell'indice al caso pilota di Madrid.	Acustiche: LAeq Qualità aria: SO2, CO, NOx, NO2, PM10, O3
Novel methods for Assessing Urban Air Quality: combined Air and Noise Pollution Approach – Journal of Atmospheric Pollution, 2015, Vol.3, No. 1, 1-8	Chowdhury et al.	Analisi dati di letteratura ed evidenza di una correlazione, seppur non molto netta, tra rumore e inquinanti atmosferici dovuti al traffico. Influenza delle condizioni meteo sugli inquinanti atmosferici e del volume e della densità del traffico sulle variabili acustiche. $\mathrm{CEF(T)} = \sum_{i=1}^{P} w_i \frac{E_s^k(i) - E_t^k(i)}{E_t^k(i)}$ City Noise-Air (noise Quality Index)= 0.5xCityNoise + 0.5xCityAir	Acustiche: LAeq Qualità aria: CO, VOCs, benzene

Conclusions

Contribution of the project to policy implications at National and Local level in terms of:

- ✓ Harmonization and simplification process among transposition decrees of EU Directives concerning noise and air pollution.
- ✓ Development of a common method for establishment and management of *NLEZ* and related guidelines, as a proposal to be adopted by national legislation
- ✓ More knowledge about impacts and benefits due to NLEZ introduction
- ✓ Enforcement of the dialogue between public institutions and citizens

Thanks for your kind attention

Methodologies fOr Noise low emission Zones introduction And management

For further information visit the official web-site:
www.lifemonza.eu