UNIVERSITÀ DEGLI STUDI FIRENZE
DIEF DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

With the contribution of the LIFE Programme of the European Union

LIFE15 ENV/IT/000586 – MONZA

Euronoise 2018 Crete

Hersonissos - Crete, Greece
27 – 31 May 2018

The smart noise monitoring system implemented in the frame of the Life MONZA project

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SUMMARY

1. Recall about the Life MONZA project and the pilot area where the monitoring activities are being performed

2. Results of the state of the art analysis about low cost monitoring systems

3. Details about the designing phase and the prototype configuration

4. Procedures to periodically check the noise monitoring system performances

5. In progress results

LIFE MONZA PROJECT

Project
LIFE15 ENV/IT/000586
with contribution of EU Commission

Program
LIFE 2014-2020.

Call
LIFE *Environment and Resource efficiency* 2015

Life MONZA
Methodologies fOr Noise low emission Zones introduction And management

LIFE MONZA
(**M**ethodologies
f**O**r
Noise
low emission **Z**ones
introduction
And management)

ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

COMUNE DI MONZA

UNIVERSITÀ DEGLI STUDI FIRENZE

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PERFORMED ACTIVITIES 1/2

The following different monitoring activities will be performed in the pilot area in both the ante and post operam scenarios:

- Noise Monitoring
- Air Quality Monitoring
- Quality of Life Monitoring

PERFORMED ACTIVITIES 2/2

Noise Monitoring

- Smart low-cost sensors
- Traditional equipment

Development of a new smart noise monitoring system (SNMS) to be used 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 three years after LIFE period

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

SNMS - STATE OF THE ART ANALYSIS (1/2)

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
- …

SNMS - STATE OF THE ART ANALYSIS (2/2)

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

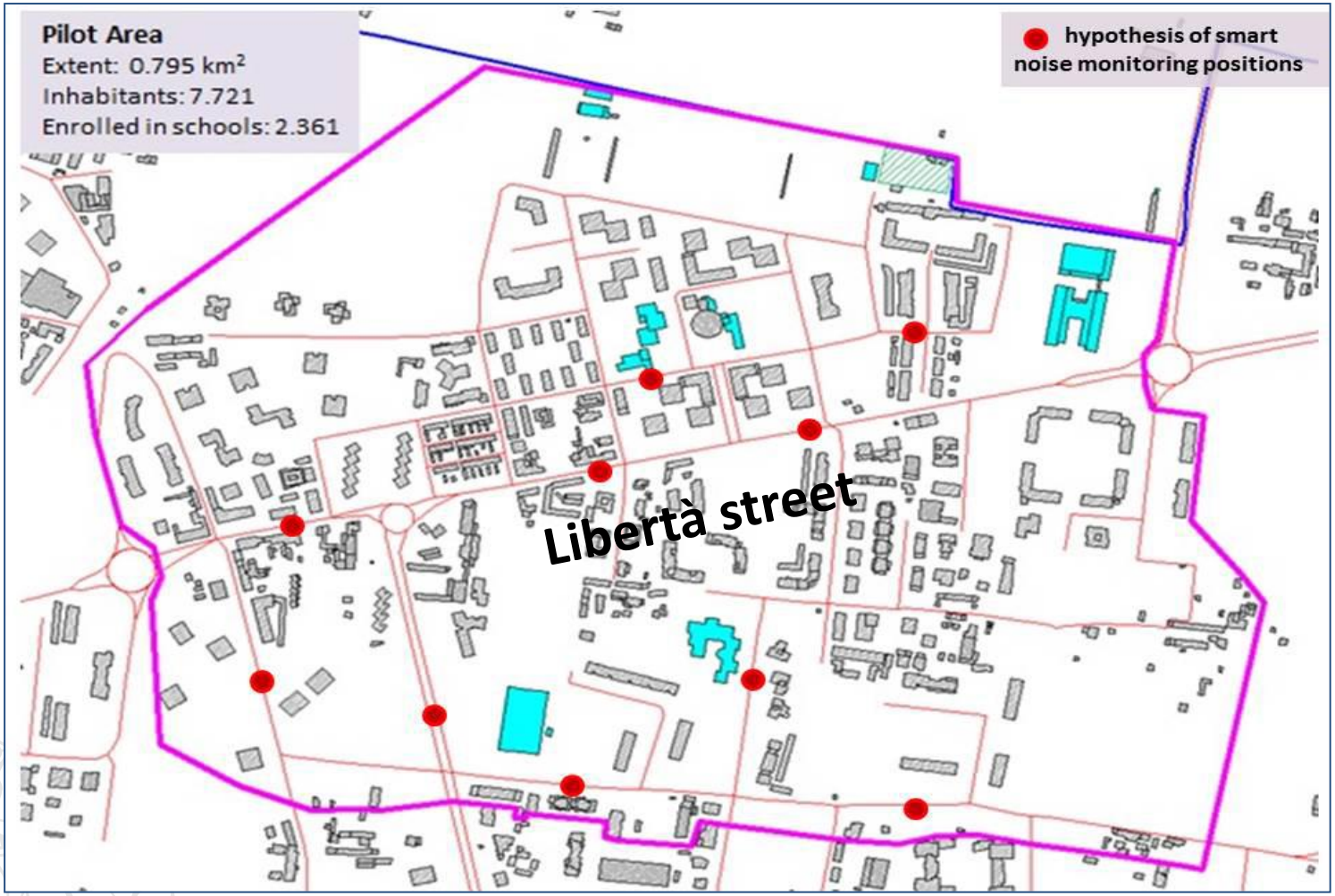
LIFE MONZA – THE PILOT AREA

Libertà district is identified as a hotspot in the Action Plan of the city of Monza.

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

SNMS of LIFE MONZA – DESIGN PHASE (1/3)

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



SNMS of LIFE MONZA – DESIGN PHASE (2/3)

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

SNMS of LIFE MONZA – DESIGN PHASE (3/3)

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

SNMS of LIFE MONZA – NEW PROCEDURES FOR PERFORMANCE VERIFICATION (1/3)

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)**

At the current time, three on site verifications were performed in July and November 2017 and in March 2018.

SNMS of LIFE MONZA – NEW PROCEDURES FOR PERFORMANCE VERIFICATION (2/3)

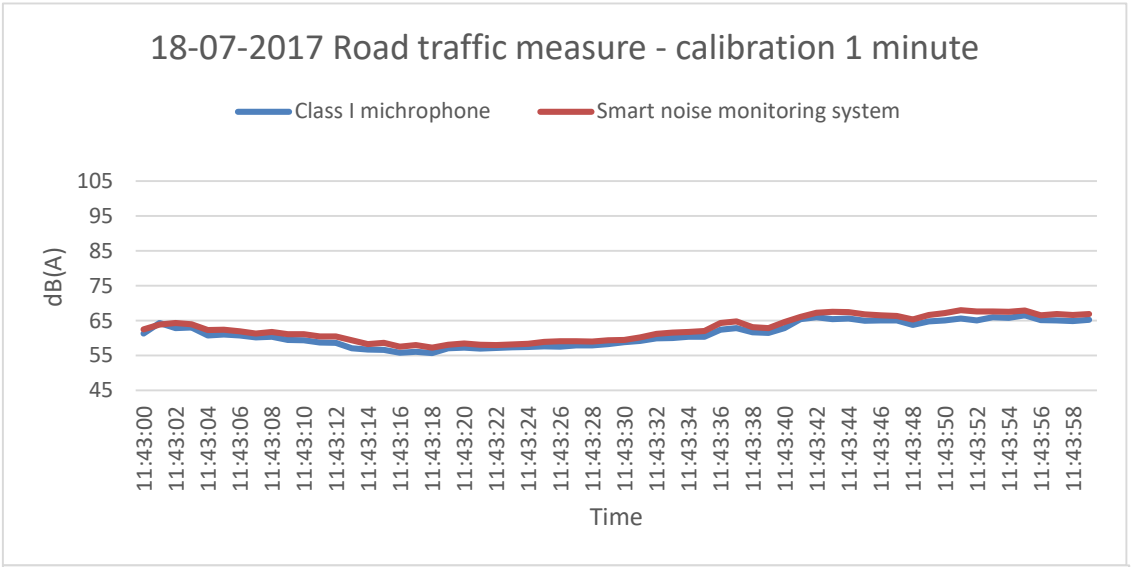
Procedures to check the performance maintenance

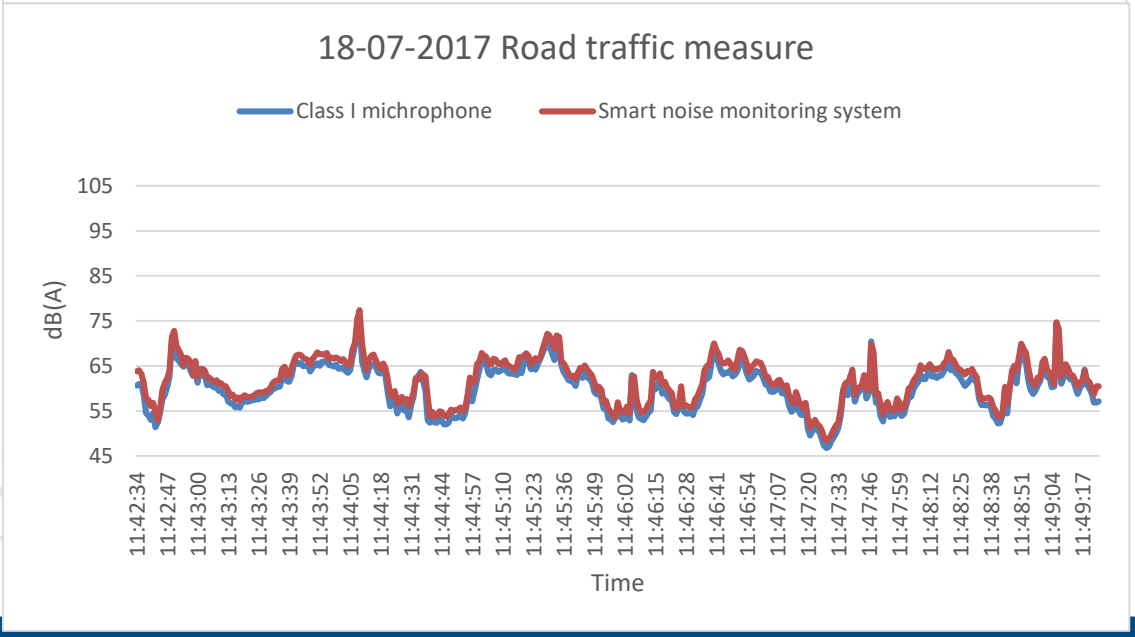
The challenge of the low cost sensors consists of performance maintaining during long term periods. Two time-stability checks, one-week based, are proposed:

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)

SNMS of LIFE MONZA – NEW PROCEDURES FOR PERFORMANCE VERIFICATION (2/2)

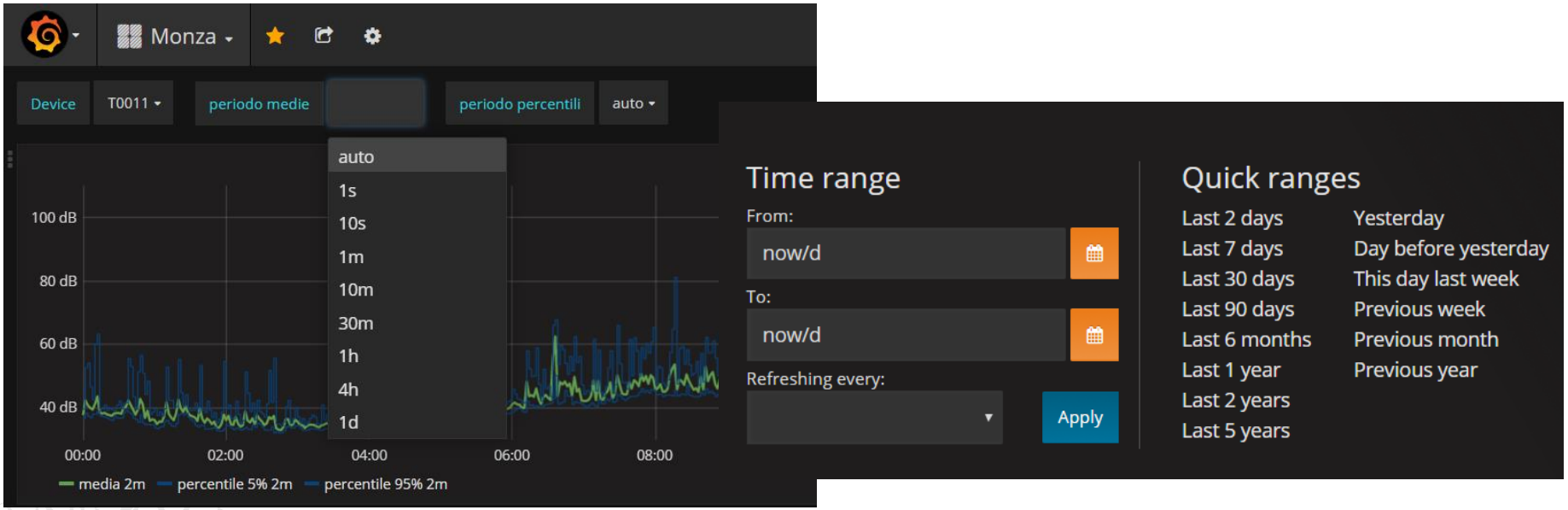




IN PROGRESS RESULTS 1/3

The SNMS started collecting data from June 2017 and has been continuously working.

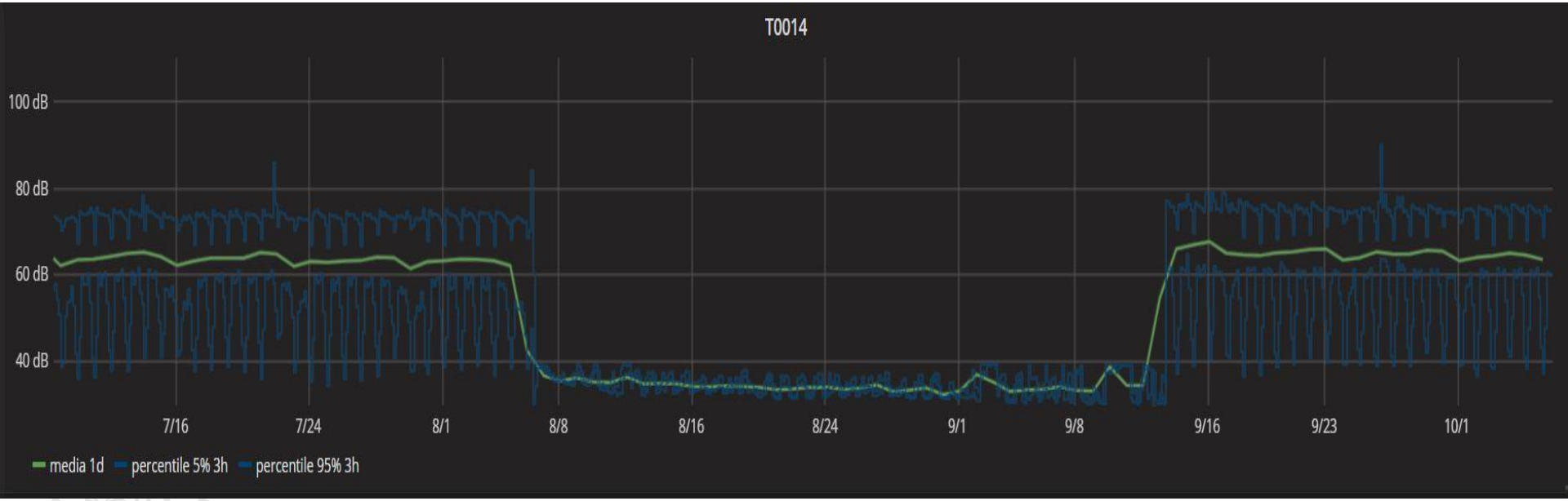
A web interface has been developed aiming to make possible to view and download data referred to a user-defined time period.



IN PROGRESS RESULTS 2/3

The system has proven to be robust.

After a significant weather event a microphone broke. From the web interface it was possible to verify the event (signal interruption) and to replace the sensor.



IN PROGRESS RESULTS 3/3

After the first checks, it was found that all MEMS microphones, adapted to a ½ inch support (not to the ¼ inch one), during the initial running-in phase show a reduction in sensitivity.

However, the sensitivity seems to stabilise over time after the first life period.

It is necessary to define the sensitivity of each sensor over time and use it to correct the raw collected data.

With reference to new sensors, it is planned to carry out a preliminary phase of break-in of the MEMS microphones during the production phase.

CONCLUSIONS

Smart low-cost noise monitoring systems seem to be able to ensure a satisfactory quality output measurement data.

In the frame of the noise monitoring activities of the LIFE MONZA project, a smart noise monitoring network has been designed and developed.

Some procedures to periodically verify the performance maintenance have been proposed and firstly used to test the prototype system.

Periodic long term on-site verifications have made it possible to check the system's operating status over time (problem of sensitivity reduction).

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Thanks for your kind attention!

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