

Mini-symposium  
Noise and Health  
12 October 2018 - DCMR EPA Schiedam

# How to achieve a healthier city

## Developments and solutions

Raffaella Bellomini, Sergio Luzzi

Vie en.ro.se. Ingegneria



# How to achieve a healthier city ?

Developments

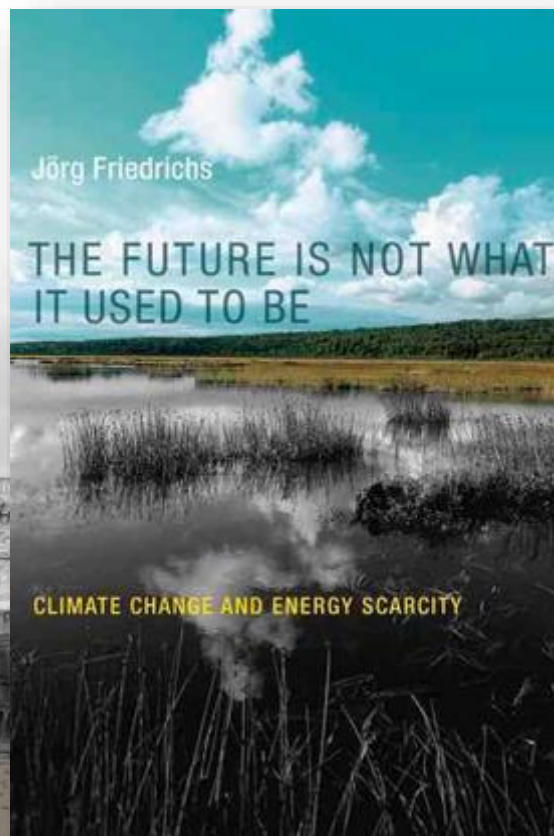
Solutions

Other Solutions



# “The future is ... not what it used to be”

Paul Valery, 1937  
Paul Strand, 1970



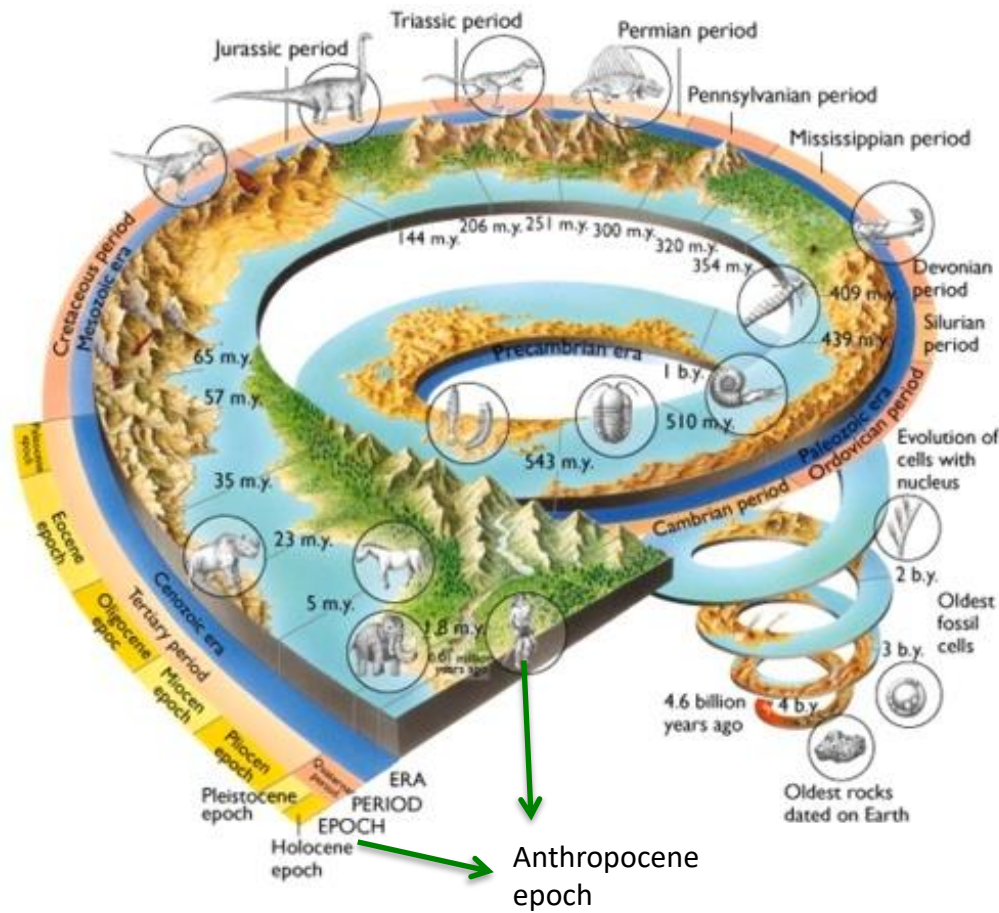
Jörg Friedrichs, 2013





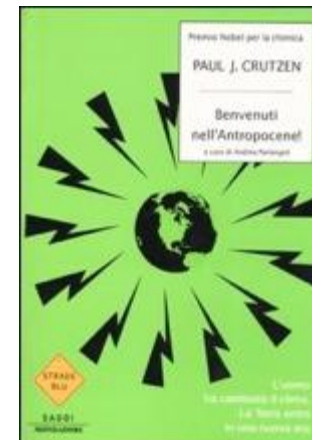
# Anthropocene

The Anthropocene is a new epoch dating from the beginning of significant human impact on the Earth's geology and ecosystems.



Paul Crutzen, "Welcome to the Anthropocene", Mondadori (2000)

J. Davies, "The Birth of the Anthropocene", UC Press (2016)



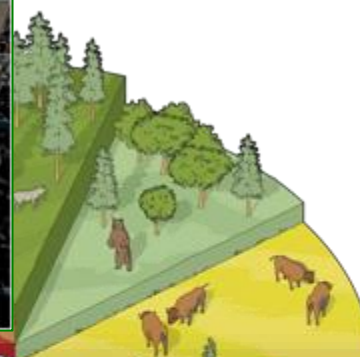
Holocene 11.700 years ago – 1950  
 Anthropocene 1950 - today

# Habitat

**Habitat** in Latin language means "he lives".

**Habitat** is the place whose characteristics can allow a given species to live, develop, reproduce itself.

**Habitat** affects quality of life



Cities represent **the most diffused Habitat for human species** in the Anthropocene



# Habitat is unhealthy EU data

The EEA reported that more than 100 million European citizens are affected by noise levels harmful to their health. This means that noise pollution remains relevant to the European citizens.

The WHO confirmed – based on its ongoing scientific work and now published guidelines - that noise remains a serious threat to human health, leading to stress, disturbing our sleep and even causing cardiovascular diseases.

The Environmental Noise Directive has not yet fully delivered on its objective due to delayed application, even if first good results arose from the noise action planning implementation.

[https://ec.europa.eu/info/events/noise-europe-2017-apr-24\\_en](https://ec.europa.eu/info/events/noise-europe-2017-apr-24_en)

# Habitat is unhealthy EU data

EU and National Governments have a number of legislative instruments to regulate noise at source for infrastructure, but there is a need of considering also other issues, like industrial noise, construction noise, recreational noise, neighbourhood noise, as they present high safety concerns.

Urban planning is one of the best approach to combat noise

# Habitat is unhealthy **WHO** data

## How many people are affected?

- about 40% of the population in EU countries is exposed to road traffic noise at levels exceeding 55 dB(A);
- 20% is exposed to levels exceeding 65 dB(A) during the daytime;
- more than 30% is exposed to levels exceeding 55 dB(A) at night.

Scientific and epidemiological studies demonstrate that health impacts from environmental noise are very significant.

<http://www.euro.who.int/en/health-topics/environment-and-health/noise/data-and-statistics>



# How to achieve a healthier city ?

## Developments

## Solutions



# New landscapes and soundscapes

A new habitat has been defined in the last decades

Sounds, noise and annoyance are part of the human experience

New human health conditions can be found in the immersive landscapes and soundscapes of urban areas

Perception is multisensory and the sound component becomes a very important element of:

- landscape use
- landscape design
- landscape control and preservation



## The human condition

René Magritte – Oil on canvas  
Simon Spierer Collection, Geneva, Switzerland

# Acoustics and Acousticians for healthier cities

Developers of noise maps and noise action plans, acoustic planners and designer of actions and solutions for urban areas and buildings, can apply holistic approaches to noise mitigation and reduction of annoyance, protecting existing soundscapes and creating new comfortable soundscapes in urban spaces,

In designing buildings and interiors, architect and acousticians can apply an holistic approach, based on the principle of maximizing the pleasantness of places and the global satisfaction of people, optimizing the Cost/Benefit ratios.

A common objective:

- removing or reducing sounds “out of places”;
- making possible the listening of good (pleasant, comfortable) sounds.

# Holistic chains (wheels)

## Life Cycle Assessment



Source: Saint Gobain (2017)

## Circular economy



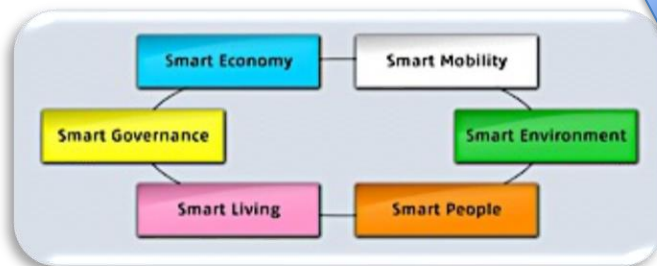
Source: Ellen Mac Arthur Foundation (2016)

## Global Comfort



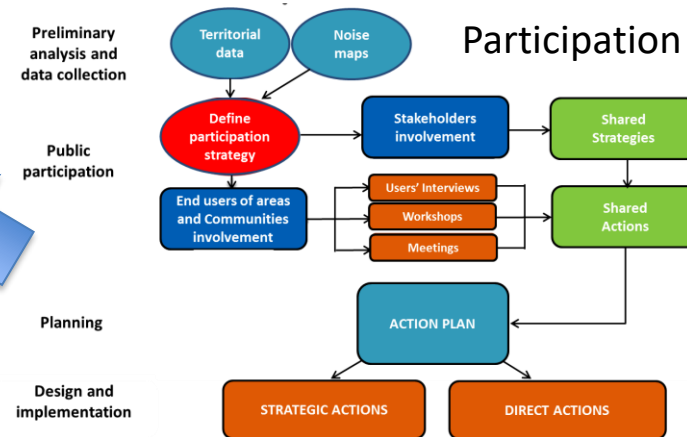
Source: Luzzi et al. (EuroNoise 2018)

## Smartness



Source: Luzzi et al. (ICSV 2016)

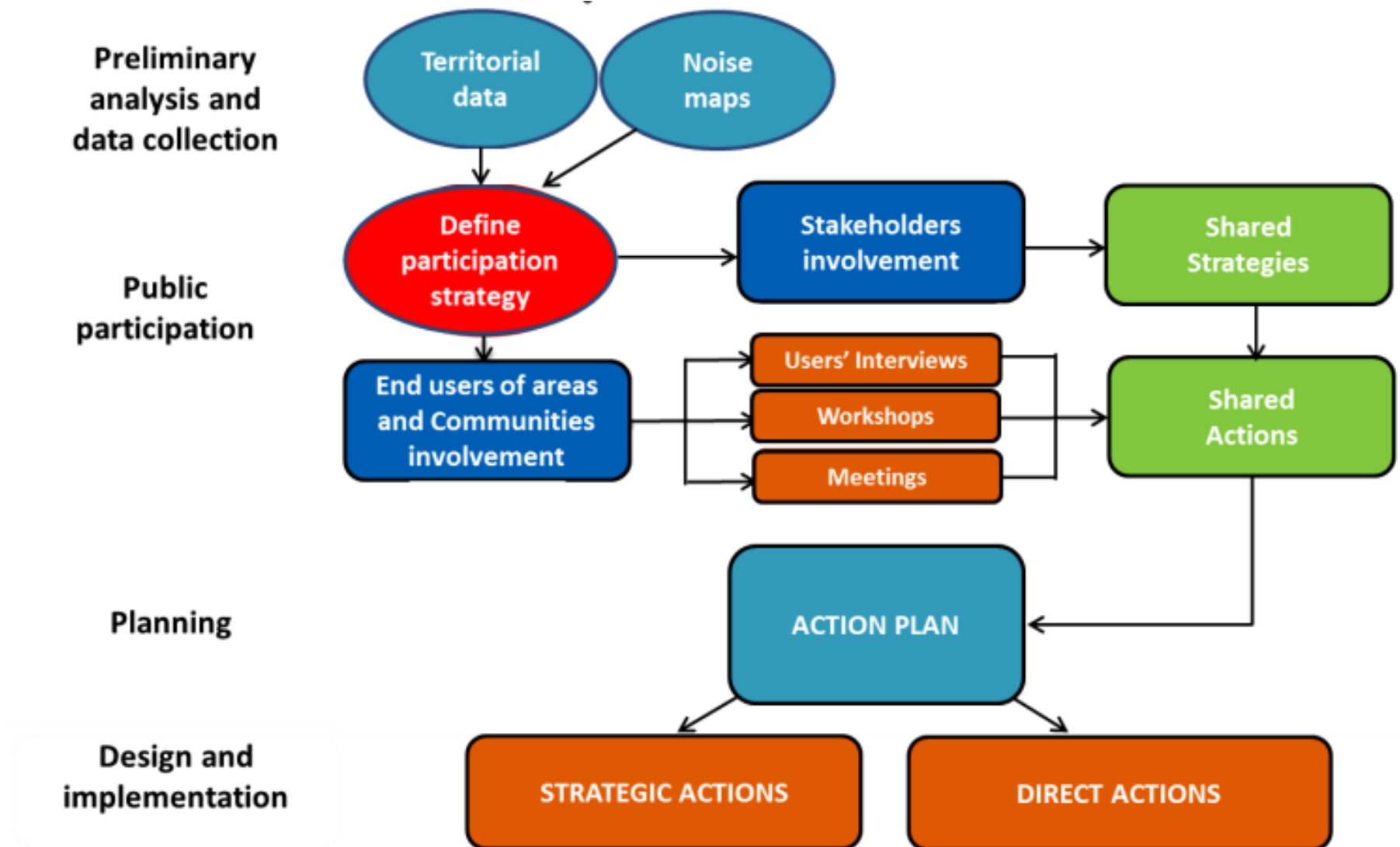
## Participation



Source: Luzzi et al. (Inter-Noise 2016)

**Not just words... keywords**

# Participatory planning and design



Example of Participatory Design Scheme for Noise Action Plans as required by EU END Directive



# Global Comfort approach for holistic design of healthy cities

Smartness & Comfort  
Indicators

$S_1, S_2, S_3, S_4$

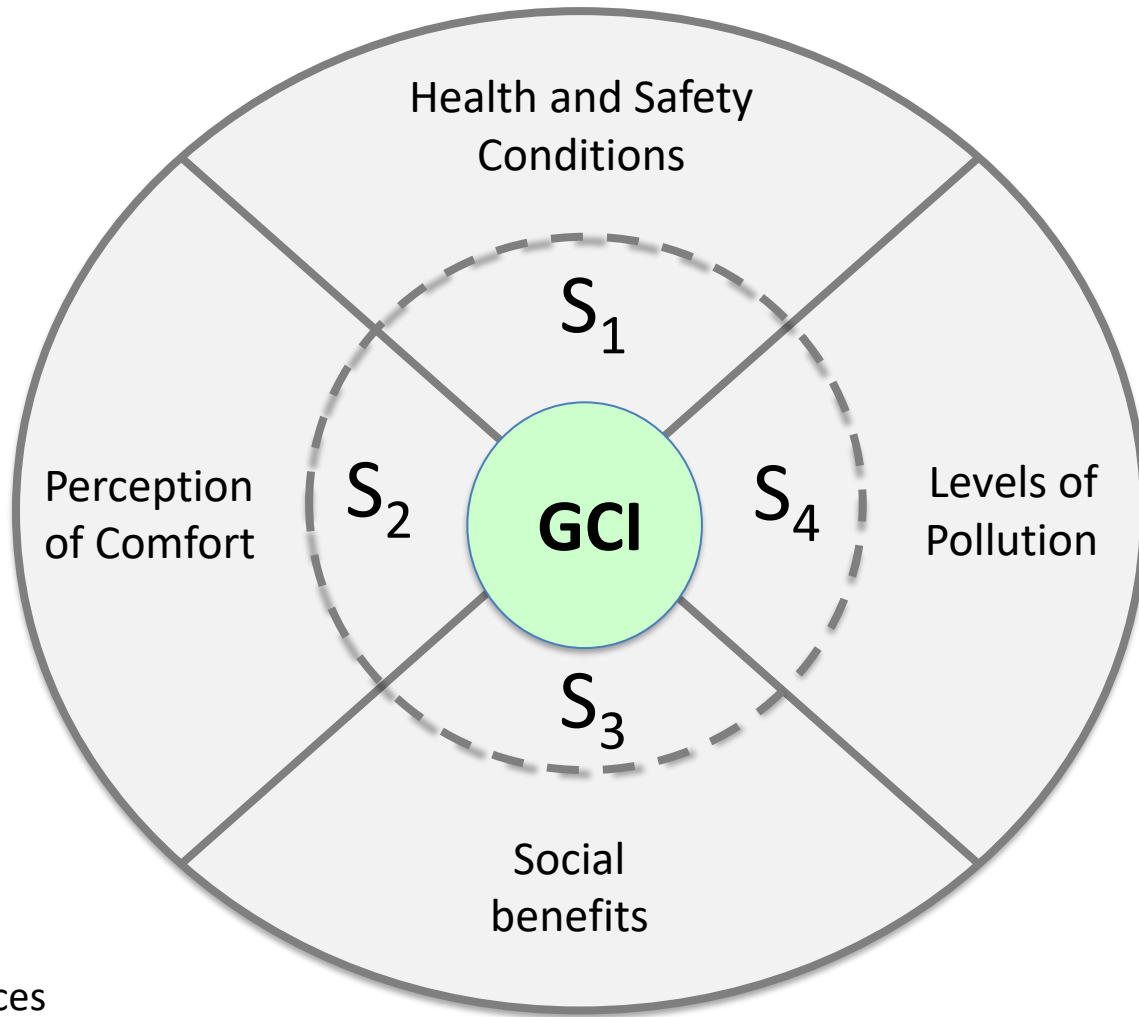


**GCI**

Global Comfort Index

For each category an indicator is defined

- level of pollution,
- level of objective health and safety
- level of perceived pleasantness of places
- level of social benefits



# Global Comfort index

For each category (and indicator) a set of variables representing sub categories of Smartness and Comfort can be defined



Variables may represent:

- levels of pollutant (existing or goals): noise, lights, air quality,...
- levels representing health and safety (existing or goals): risk assessment results, TLV,...
- levels of measurable objective comfort/discomfort categories: noise, temperature, ergonomics...
- levels of perceived pleasantness (questionnaires, meetings, survey): security, visual, annoyance, thermal comfort,...
- levels of social benefits: cultural, recreational, welfare, ...

$S_{i1}, S_{i2}, \dots, S_{in}$   
specific comfort variables  
for the sub-categories  
 $i=1, \dots, 4$



Smartness & Comfort  
Indicators

$S_1, S_2, S_3, S_4$



**GCI**

Global Comfort Index

# Global Index for holistic design

The relative indicators for the categories of smartness and comfort:

$S_1, S_2, \dots$

are calculated as:

$$S_i = F_i (s_{i1}, s_{i2}, \dots, s_{im})$$

where

$s_{i1}, s_{i2}, \dots, s_{im}$

are the specific comfort variables for the sub-categories

## Cost

is a weighted sum, which takes in account direct cost, social costs and induced costs from serendipic actions

$$Cs = F_c (C, cs1, cs2, \dots, ci1, ci2, \dots)$$

## Benefit

is defined by considering the primary Benefit and the added values of different (objective, subjective) quantifiable serendipic variables

$$Bs = F_b (B, bs1, bs2, bs3, \dots)$$

the Global Index for holistic design is then defined as:

$$GI = F(GCI, Cs, Bs) = F (S_1, S_2, \dots, Cs, Bs)$$

# How to achieve a healthier city ?

## Developments

## **Solutions**

## Other Solutions





## WATCH LIVE.

Noise in Europe. 24 April 2017, Brussels, Belgium

[Watch live](#)

9:00 - 16:00 GASP:

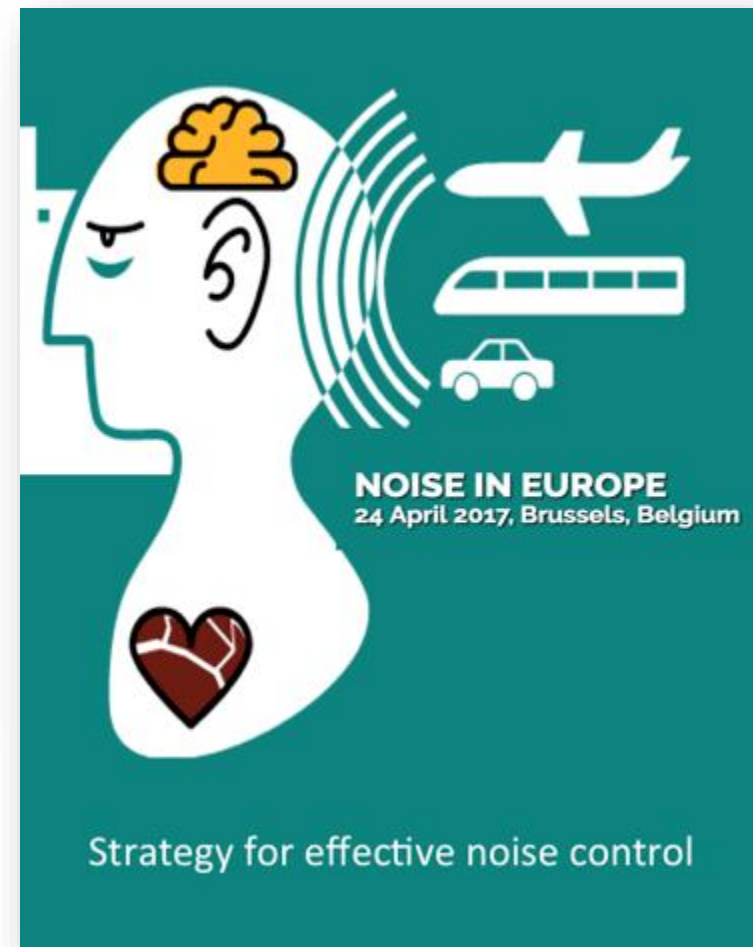
<https://webcast.ec.europa.eu/noise-in-europe>

14:00 - 16:00 JENK:

<https://webcast.ec.europa.eu/noise-in-europe-jenk>

14:00 - 16:00 MANS:

<https://webcast.ec.europa.eu/noise-in-europe-mans>



<http://www.euconf.eu/noise-conference/watch-live.html>



## From conference conclusion:

### «Traditional solutions»

Action plans with clear commitments and better integration into other planning process are important.

Research and development of new materials, technical solutions and new transportation systems are key elements to ensure sustainable transportation.

There are a number of promising options to combat road noise, such as low noise pavements, but also traffic management and noise barriers.

Robust criteria for public procurement and asset management are needed. Traffic management measures need to be evaluated, which would include new vehicle technologies.

A sustainable approach to noise barrier design and procurement is needed.

### «Other approaches»

The concept of smart cities can help minimize environmental noise.

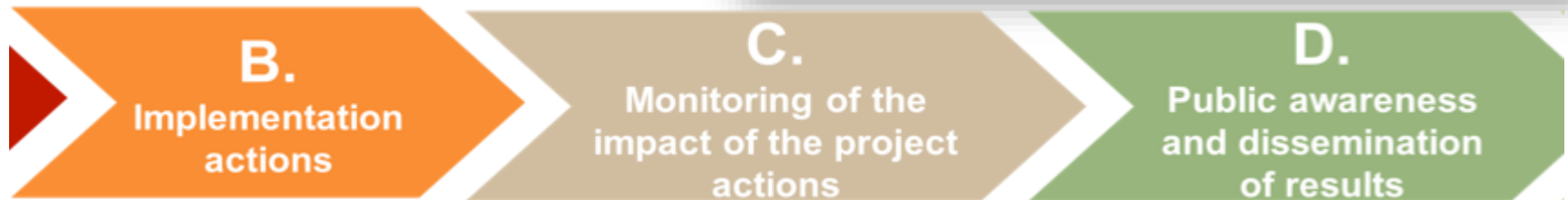
There are many links between strategic actions and solutions for environmental noise and other relevant urban planning actions.

# Urban Planning and Design for Global Comfort

## Noise Low Emission Zones



### The Life Monza Project



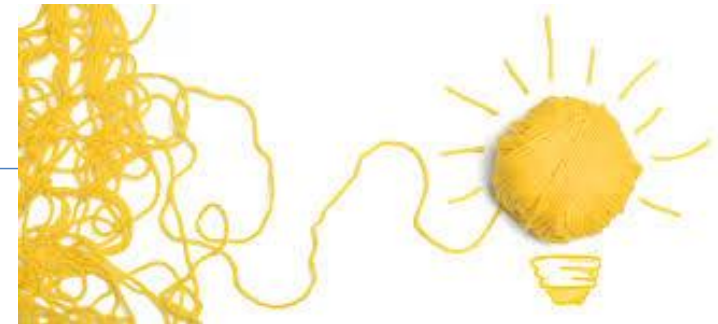
- ✓ **B1** TOP-DOWN actions planning in the pilot area
- ✓ **B2** BOTTOM-UP actions planning in the pilot area and public and stakeholders information and participation
- ✓ **B3** Prototype of monitoring system for Noise LEZ design - data analysis techniques definition
- ✓ **B4** Pilot area actions implementation
- ✓ **B5** Monitoring and data collection for impact assessment
- ✓ **B6** Noise LEZ Guidelines

- ✓ **C1** Monitoring of the impact of the project actions. The monitoring activities in the pilot area will be carried out up to three years after the project end

- ✓ **D1** Information and awareness raising activities regarding the project to the general public and stakeholders
- ✓ **D2** Technical dissemination activities to stakeholders could usefully benefit from project's experience

Project by Life Monza consortium:  
ISPRA, University of Florence, Vie en.ro.se. Ingegneria, City of Monza (2017)

- ✓ **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 proposition**
  - ✓ **Public involvement**
- **Combined effects of pollutant**
  - **smartness**
  - **Health promotion**
  - **Global index**
  - **Participation**



## Traditional approach for noise reduction in the pilot area “TOP-DOWN” interventions

- ✓ Road traffic restrictions:
  - Heavy trucks > 3.5 tons (6 months).
  - Heavy trucks > 7.5 tons (after)
- ✓ Viale Libertà's asphalt replacement

*Works for asphalt laying started on 17 September 2018*



## Non traditional approach – combined monitoring / smartness

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

- Traditional equipment
- Smart low-cost sensors

### Air Quality Monitoring

- EU Directive requirements
- Passive sampling

### Quality of life

- Questionnaire



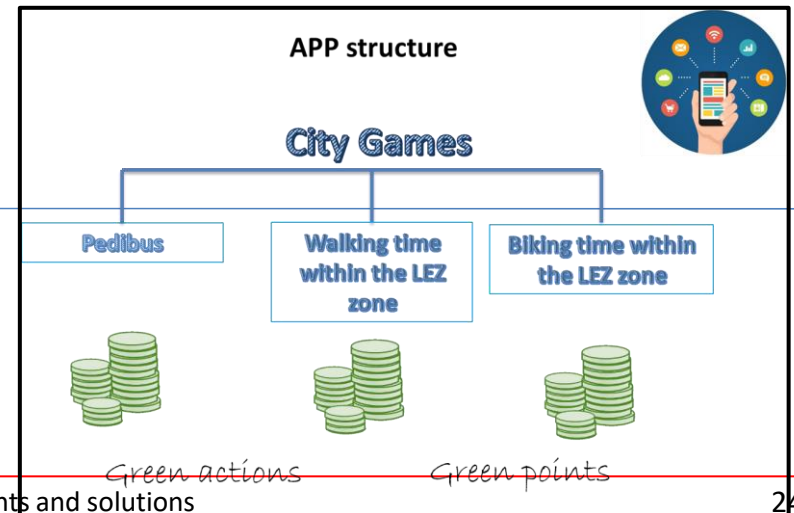
# Non traditional approach – people involving – participation / smartness

Public involvement, meetings  
organization, ideas contest (MONZA)



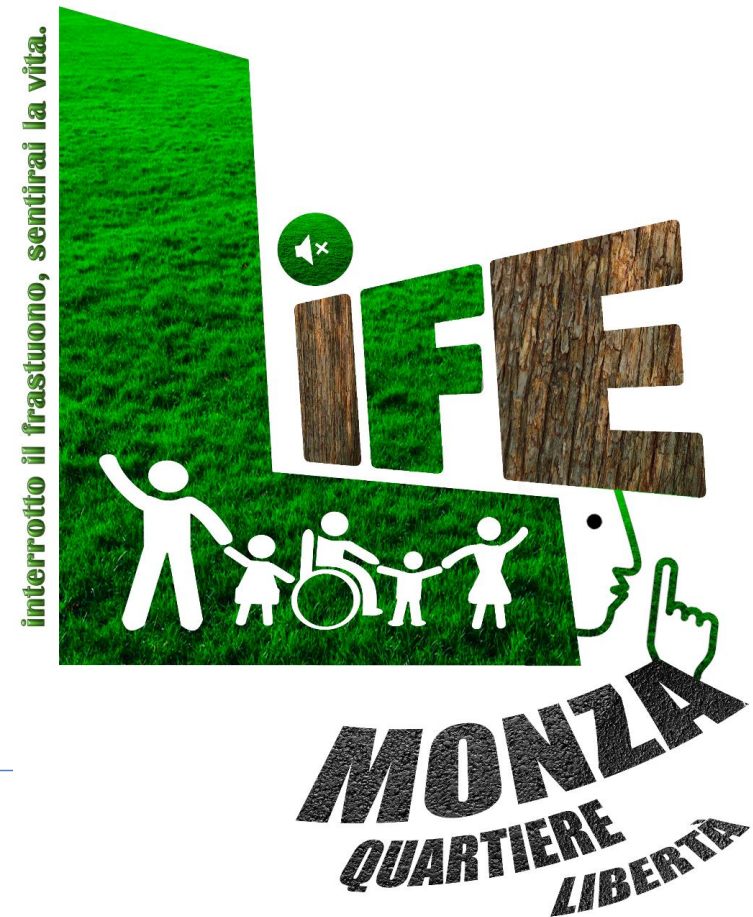
Administration of questionnaire about health  
and mobility habits/noise perception - Ongoing  
About 200 questionnaires collected so far (February  
2018)

Public involvement: environmental  
aspect (VIENROSE)



## Non traditional approach – people involving – participation / smartness

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



# Non traditional approach – questionnaires for health promotion

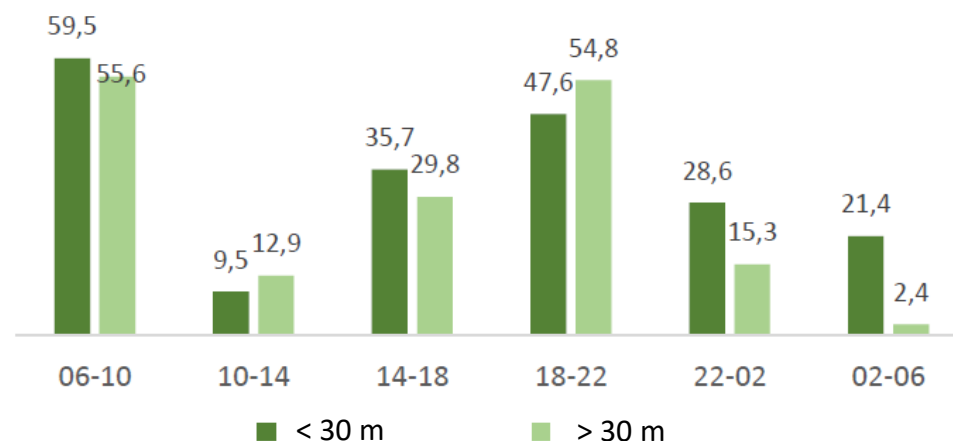
Quality  
of life

• 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.

# Non traditional approach – 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 noise LEZ area            | %         | /     |
|          | % of people exposed to Lnight values > 55 dB(A) in the noise LEZ area          | %         | /     |
|          | % of people exposed to Lden values > 65 dB(A) in the Viale Libertà 30 m buffer | %         | /     |

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



# How to achieve a healthier city ?

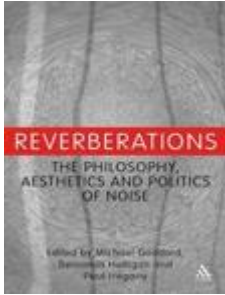
## Developments

## Solutions

## Other Solutions







*“Noise permeates our highly mediated and globalized cultures. Noise is not a merely sonic phenomenon but an essential component of communication and information system”.*

Michael Goddard, *Reverberations: the philosophy aesthetics and politics of noise*, Continuum Publ. 2012



*“Wherever we are, what we hear is mostly noise. It disturbs us. When we listen to it, we can find it fascinating”*

John Cage, ABC Interview, 1968

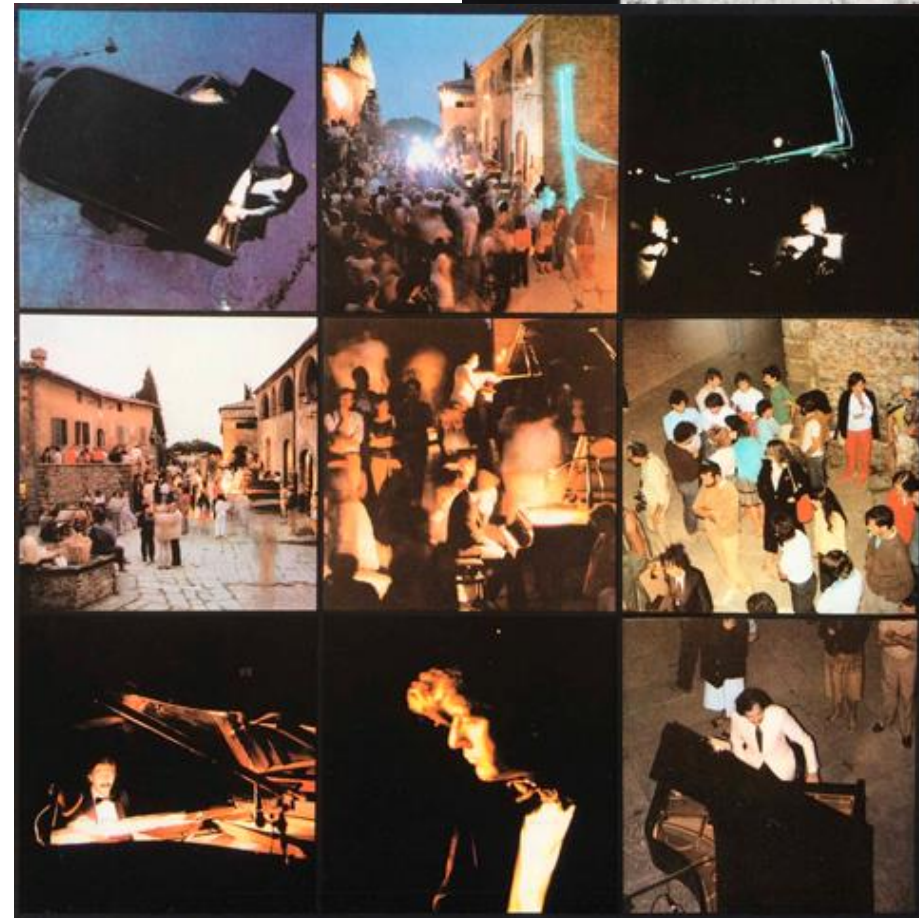
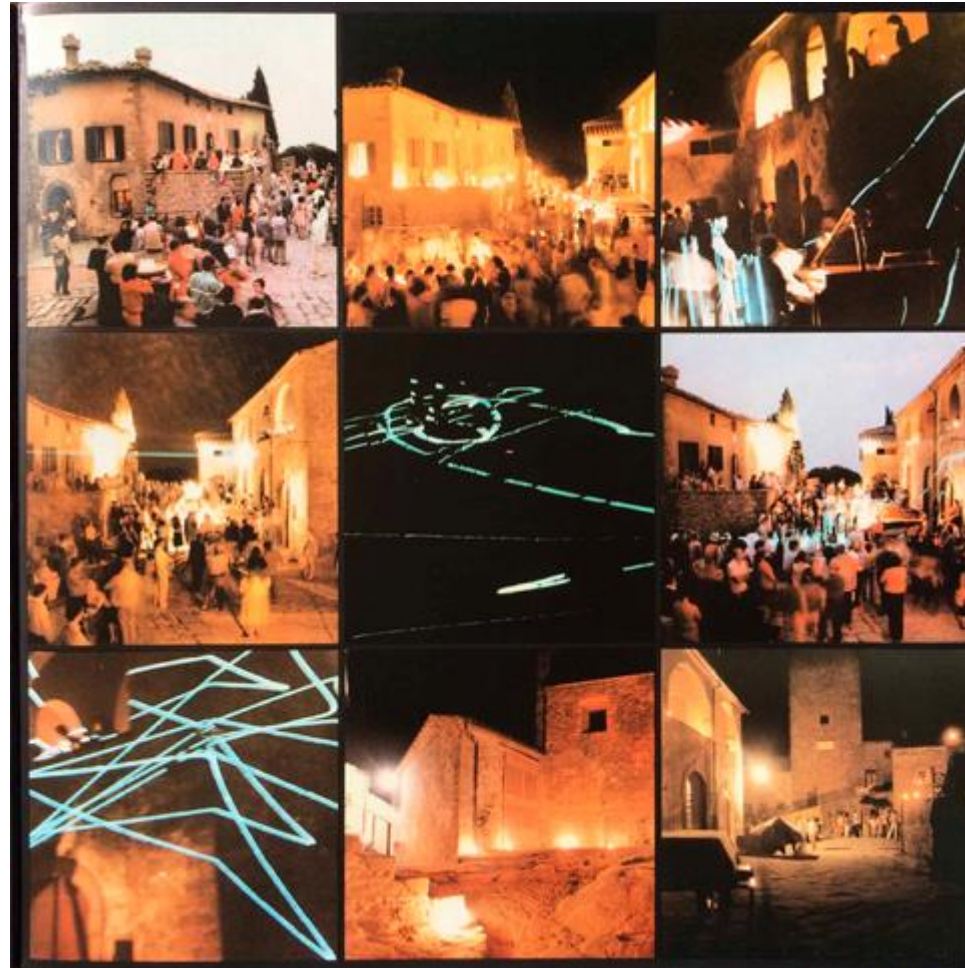


*Will the slow swaying of the leaves  
in the spring breeze  
ever turn out to be **annoying**  
if associated with listening to a Pavane?  
And if associated with the Ride of the Valkyries ?  
  
(Y. Ando)*



# Urban planning and Design for Global Comfort

## Sounding cities





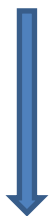
# Urban planning and Design for Global Comfort – Sounding cities



# Soundwalks in sound enriched places

## Standard method:

Exploring, measuring and perceiving the soundscape as it is

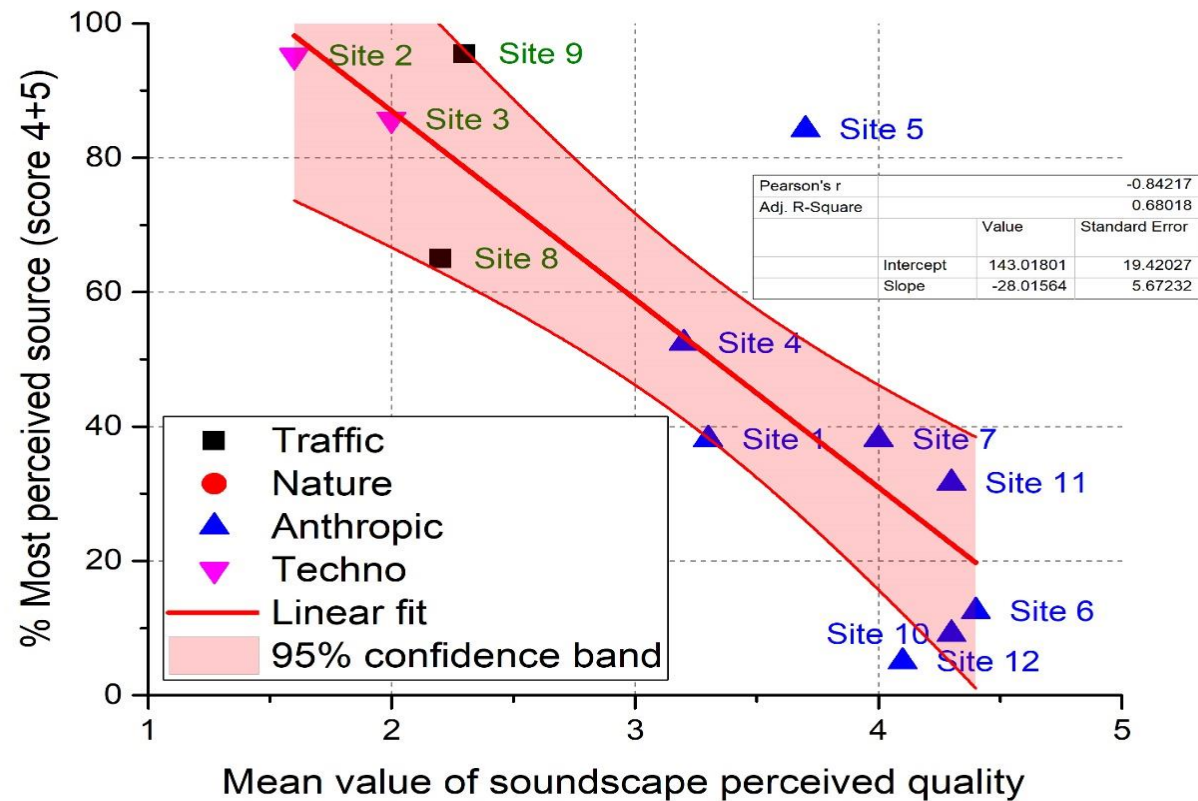


## Innovative idea:

“Switch on” the city through “sound excitements”, changing noisy or anonymous places into sounding places.  
Ask people about the perceived difference between the original and the “activated” place.

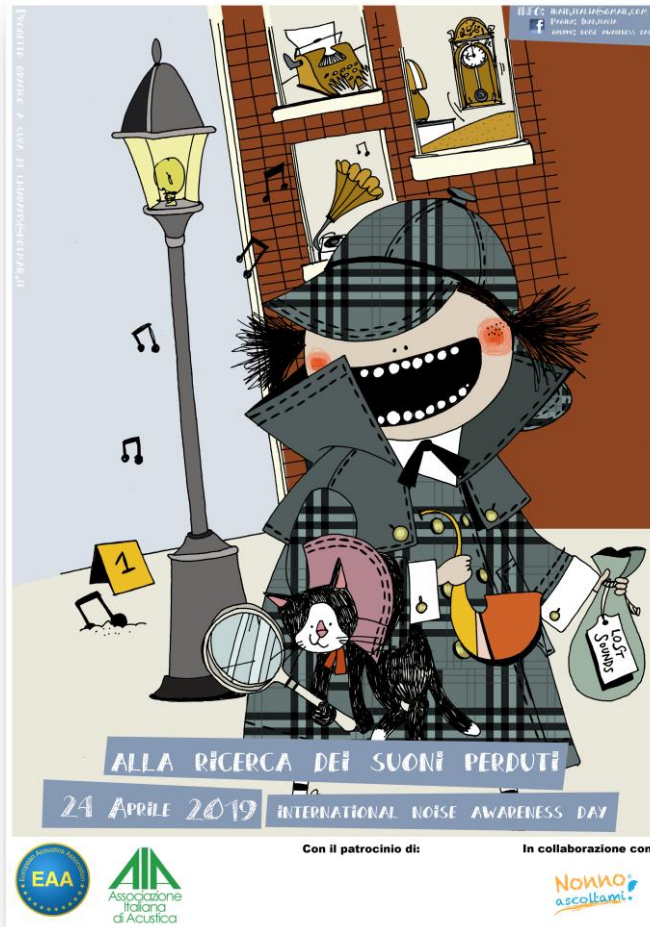
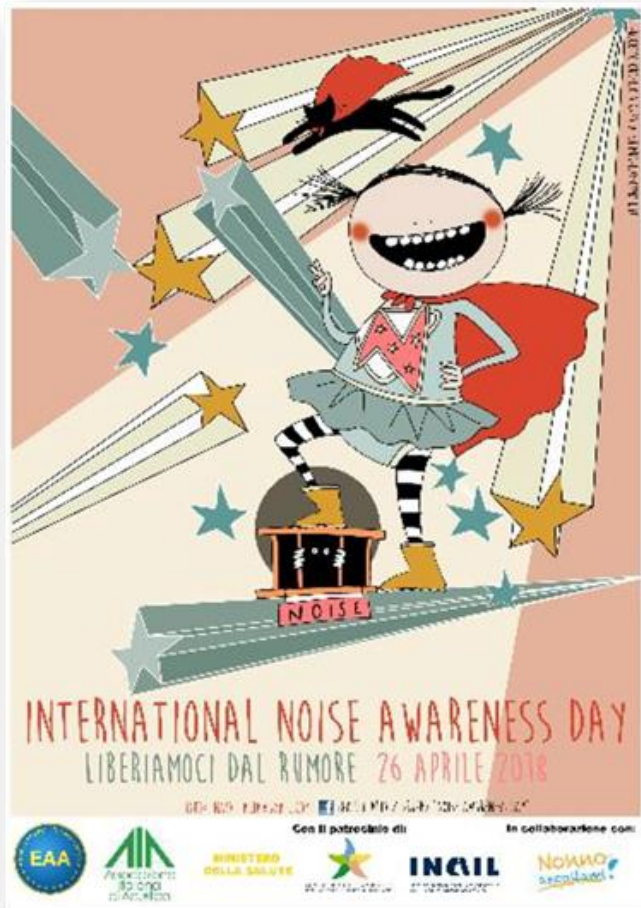


## Wilcoxon test of significance





The International Noise Awareness Day (INAD) is celebrated every year in many countries to spread knowledge and awareness on noise exposure in communities and, in particular, in schools.





[illegible]



## Among the INAD IN EUROPE activities...

Preparation and distribution of presentations for schools and other organizations (Museums, Cultural centers etc.) around Europe, to be used in systematic courses, workshops and other events organized by the National Societies aiming at raising the awareness of the students and young people about noise effects on health and well-being.



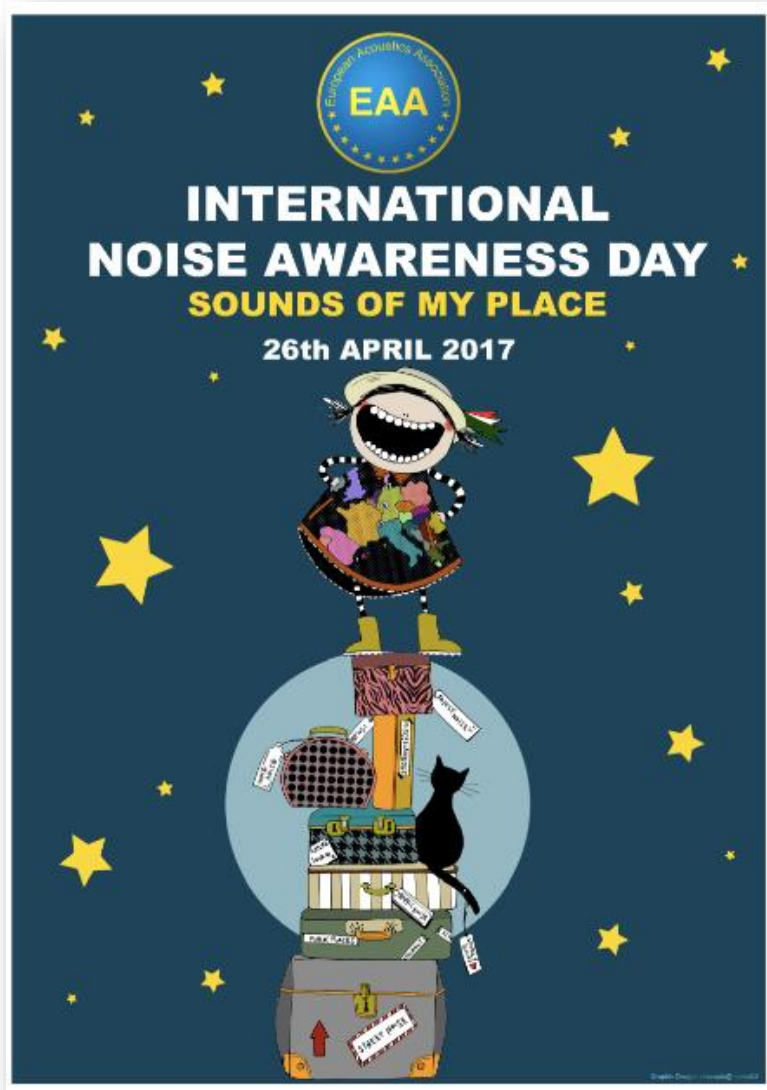


## Among the INAD IN EUROPE activities...

Production and distribution of the stories of Noisella. In 2017 the video-cartoon “Noisella in the sound space” has been widely distributed among European schools and it is available on Youtube.







Again in 2017, the European Acoustics Association (EAA) together with European National Associations of Acoustics organized a series of events aimed to involve young people, classrooms and schools.



The initiative was called INAD IN EUROPE and the main topic was “SOUNDS OF MY PLACE”



Among the EAA activities...

Production and distribution of the film “Sounds of my Place (Sounds of Europe), collecting interviews and other INAD materials





## Among the INAD IN EUROPE activities...

The organization and management of two Pan-European competitions for primary and high schools: pupils and students of all European schools were invited to produce original audio, video, drawings and texts on the subject “Sounds of my place”.

Hundreds of items were submitted from many European students, classrooms and schools (globally more than 4.000 items participated)

For each country, three finalist, selected by the National Jury, participated at the Pan European final competition.

The experts' jury and the popular jury (via social networks) selected best items for each category.

The proclamation of winners was made in Boston in the frame of Acoustics 2017 Congress, jointly organized by ASA and EAA.

It is still possible to watch all the materials produced by European students for the Pan-EU competitions on Facebook event “Inad in Europe”.

| SPAIN     | Individual | Group | Full Class / Full School |
|-----------|------------|-------|--------------------------|
| Primary   | 460        | 33    | 13 full classes          |
| Secondary | 95         | 64    | 19 full classes          |
| TOTAL     | 555        | 97    | 32 full classes          |
| SLOVENIA  | Individual | Group | Full Class / Full School |
| Primary   | 194        | 4     | 30 full classes          |
| Secondary | 3          | 3     | 4 full classes           |
| TOTAL     | 197        | 97    | 134 full classes         |
| ITALY     | Individual | Group | Full Class / Full School |
| Primary   | 152        | 8     | 7 full classes           |
| Secondary | 289        | 8     | 15 full classes          |
| TOTAL     | 441        | 16    | 22 full classes          |



# Summary

The global comfort holistic approach is based on the idea of planning and designing urban areas and buildings safeguarding people's safety, health, and serenity, respecting the laws of nature and harmonious development.

In this integrated approach, acoustics plays an important role as one of the founding elements of the man-habitat-environment system.

In planning strategies and designing solutions for urban development a set of variables representing smartness and pleasantness can be defined, representing comfort level categories in terms of visual, thermal, acoustic, safety, energetic, cultural, social, welfare, etc.

In the global comfort approach to noise control and noise mitigation, costs and benefits of actions are calculated as weighted sums which take in account different variables, allowing to achieve the primary objective of the design with one or more free secondary added benefits.

Awareness and participatory design should be a part of the definition and implementation of this scheme, where action planners and solutions designers collect stakeholders and users opinions on strategic issues, useful for planning and designing phase.

.

# Summary

In Europe, despite the existence of the Directives and the trend of the European Countries to take measures aiming at controlling the noise exposure, the individuals are not fully aware of the risks of their exposure to noise and they are not, as a group, determined to take all the necessary actions to reduce noise in its origin.

In other words there is a need for further collaboration between policy makers and citizens in order to achieve the goal of a quieter world.

In this scenario, the EAA can give a relevant contribution. The INAD IN EUROPE experience, developed by the European Acoustics Association in 2017, represent a clear confirmation of this concept and a good and concrete example of how much the international coordination can maximise the result of awareness campaigns.

.

# THANK YOU

[www.vienrose.it](http://www.vienrose.it)  
[sergio.luzzi@vienrose.it](mailto:sergio.luzzi@vienrose.it)  
[raffaella.bellomini@vienrose.it](mailto:raffaella.bellomini@vienrose.it)