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Acoustical indicators and index for urban quality evaluation

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ABSTRACT

In the urban health evaluation, the environmental comfort (thermo-hygrometrical, acoustical and lighting comfort and IAQ) represents a fundamental aspect to quantify the influence of the climate and of the human activities on the men's health. The correlations among outdoor comfort, urban landscape and architectural features offer wide perspectives, as they could represent very useful means to give a qualitative and quantitative judgment on the existing real estate or to choose the major actions for the restoration of the urban environment. To obtain urban health global judgment, all the playing factors must be correctly weighted and associated. An analysis based on homogeneous quantities is needed, avoiding multiplying judgment scales and using, for example, one scale for each involved parameter comparable with the others. To quantify and correlate the various environmental elements, a first attempt was performed aimed at a global assessment on the basis of a mutual judgment system. In this paper a proposal of schematisation based on indicators and index has been developed. With the definition of them, relating to the acoustical outdoor comfort evaluation, it is possible to obtain a global quality environment evaluation considering also other aspects like, for example, thermo-hygrometrical and atmospheric pollution effects. First analyses to validate the method on the basis of experimental and simulated sound pressure levels have been developed. Moreover, noise level data, traffic and population density were considered as basic parameters on which it is possible to develop single indicators and a global acoustic quality index. In the meantime a subjective investigation was performed, to correlate the values of the acoustical index to the individual sensation of the people living in the zones of the investigation.

GENERALITIES

Urban quality depends on a huge number of factors that can regard very different fields like architecture (e.g. volumes, forms, colours, paths, quality and quantity of green), culture and society (e.g. existence of political activities, or culture and aggregation activities) and environment (e.g. temperature, relative humidity, solar radiation, wind etc). Useful information about urban quality could be obtained from citizens' health negative impacting factors analyses. However these data are often available only in extreme events (e.g. human casualties or hospitalizations increase).

Lots of parameters based on these factors can be used in order to define and quantify urban health. Up to date the majority of investigation is directed to analyse each factor on its own, without considering how they can be combined in order to define urban quality. For example there are lots of evaluations based on landscape classification or on open space technical design (related to local weather, solar radiation and building layout).

Recently [1,2,3,4] a new approach is oriented to define a large-scale study methodology able to obtain a more complete judgment of urban health, considering various involved aspects. To obtain urban health global judgment, the significant playing factors must be correctly weighted and associated. Furthermore an analysis based on homogeneous quantities is needed, avoiding multiplying judgment scales but using, for example, one scale for each involved parameter.

Hence this work develops a methodology based on the formulation of various indicators referred to significant parameters that occur to calculate a new global index, the Acoustical Quality Index (AQI).

Therefore the purpose of this study is to analyse the possibility to define a series of indicators and one single index for acoustical outdoor comfort evaluation, in order to integrate it in a wider perspective of quality environment evaluation considering other aspects like, for example, thermo-hygrometrical and atmospheric pollution effects.

Local authorities can fruitfully use this kind of instruments in order to verify and plan urban development. This methodology however can be utilised to collect information on a larger scale (regional, national) to assess the urban quality, and also on a single man scale, to support the urban planner making choices to modify the design of outdoor spaces.

THE USE OF INDICATORS

The use of indicators for environment phenomena description is internationally acknowledged. For example, environmental evaluations could be done in a simplified way [5] using analysis procedures based on particular indicators that allow to obtain information, easy to understand, from a huge quantity of parameters (unprocessed data).

This "indicators" methodology enables the quantitative evaluation of wide number of heterogeneous elements, involved in the global judgment of urban quality.

An indicator is able to describe and quantify a phenomenon or a particular environment state: it can refer to one or more than one parameters and its meaning goes beyond the mere parameter value.

Indicators should be chosen in order to describe significant environment impacts to evaluate existing situation and to quantify and plan necessary interventions. Indicators have to be enough sensible at the variations of the parameter on which they're built on, in order to reflect properly correlated environment impacts. In this scheme, measurement units should not be attributed to indicators, even if often in practice quantitative parameters are named "indicators".

If the aim of the application is a detailed description of the environmental quality, very high number of indicators is needed to describe the various situations. But an efficient use of this methodology should avoid information redundancy and overlapping, and on another side it should support different fields indicators integration.

The elaboration of various indicators is an index. An index generally could be deduced by different criteria (i.e. mathematical algorithms, superposition of thematic maps, and so on): in the present analyses, index evaluation is based on the research of an optimal weighted association of indicators.

Hence it is necessary to clearly define indicators association and comparison methods, controlling as well, as more as possible, the abstraction level process.

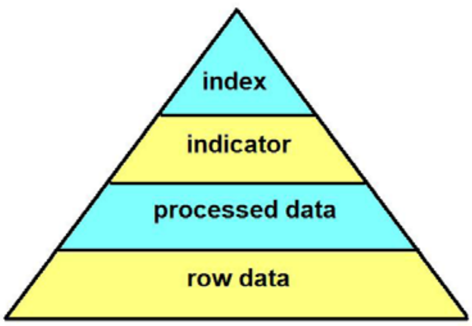

Figure 1. The information pyramid

The information pyramid (Figure 1) starts from the collection of row data: their processing allows to obtain a set of information that are significant in each single field. The use of processed data to obtain an indicator leads to a more efficient comparison among heterogeneous parameters on the basis of the same scale (i.e. 0-100).

Particular attention must be paid to indicators composition and aggregation in order to obtain simple index, representative of the studied situation. It's very simple, indeed, to consider not significant indexes because of wrong simplifications or excessive approximations.

This kind of problem approach (definition of a single index by weighted association of indicators) is nowadays object of urban and architectural studies. In the field of urban studies there are already available lots of indicators, that can be assembled in a unique global quality index referred to a judgment scale from 0 to 100.

Thanks to this method, environmental quality evaluation could be developed considering various aspects like physical, architectural, urban, social-cultural and health perceptions and could be quantified by a single quality index.

The huge number of environmental evaluation indicators can be reduced into an essential pool of elements. Such schematization could be very efficient to quantify a multiplicity of heterogeneous parameters effects.

Qualitative and quantitative parameters can therefore be considered together referred to the same scale: on one side judgment scale of qualitative aspects may enclose 4-5 levels (optimum, good, sufficient, not sufficient) and may give a global number judgment in a range from 0 to 100. On the other side quantitative aspects must be expressed with a corresponding scale to obtain homogeneous evaluation.

It's very important to define suitable aggregation methods, because in this way it's possible to analyse together qualitative and quantitative parameters.

INDICATORS AND INDEXES: "ACOUSTICAL" STATE OF ART

The studies on the aggregation of heterogeneous parameters are not frequently available: various indicators are represented by the values of single parameters and the definition of index and indicator is not often clearly differentiated.

Assuming the levels shown in Figure 1, the use of a global index for the evaluation of noise pollution is considered. This methodology is not common for the urban environment characterization, nevertheless it could be very useful for the aggregation with other significant elements for the evaluation of outdoor environmental comfort. This kind of aggregation scheme could describe a comprehensive view of urban quality, based on the evaluation of heterogeneous aspects (physical environmental parameters, qualitative analyses, etc.) [7,8].

The indicators elaborated in the noise pollution field [6] are referred to noise levels (in dB) in the category of Emission and in the category of Health and Security in working places.

From studies carried out by WHO (World Health Organization) [9], as in other documents concerning the use of indicators for the description of environmental phenomena, the primary interest is the quantification of the percentage of population exposed to the various noise levels, in relation with a specific source (traffic, train, airports etc.).

For the monitoring of the urban sustainability, the European Commission has established the supervising of a set of indicators: 5 compulsory indicators and 5 optional ones. Among these last ones, the indicator number 8 represents the Noise Pollution.

In accordance with the realisation of strategic acoustic maps considered by the European Directive 2002/49/CE [10,11], it is necessary the evaluation of various parameters such as:

- → an acoustic descriptor and its overcoming of a limiting value;
- → the estimated number of housing, schools, hospitals of a specific area that are exposed to specific values of the acoustic descriptor;
- → the number of persons that are noise exposed in a specific area.

In the Directive, "noise indicator" means a physical scale for the description of environmental noise, which has a relationship with negative effects on human health.

The acoustic descriptors considered as "indicators" are mainly L_{den} (day-evening-night level), for the determination of the global noise (annoyance), and L_{night} (night level), for the determination of the sleep disturbance.

The estimation of the noise impact is carried out quantifying the number of person in residential building exposed to each of the bands of values of L_{den} and L_{night} in dB shown in Table 1, evaluated 4 m above the ground on the most exposed façade, separately for noise from road, rail and air traffic, and from industrial sources.

Table 1. Ranges considered for the definition of noise pollution indicators L_{den} and L_{nigh}

range	L_{den}	L_{night}
1	55 – 59	50 – 54
2	60 – 64	55 – 59
3	65 – 69	60 – 64
4	70 – 74	65 – 69
5	> 75	> 70

The European Commission may develop guidelines to provide further guidance on the provision of information on the basis of the reports on the noise situation received, referred to:

- → the percentage of population exposed to the indicated noise levels,
- → the estimated total number of dwellings (in hundreds),
- → the total urban site area (in km^2)
- → the estimated total number of people (in hundreds) living in each of these areas.

However this kind of information represents a collection of fragmented data, not comparable each other in a global assessment. This approach can result exhaustive not to describe a complex situation such as urban sites, but only to compare homogeneous parameters taken in different times and zones with the imposed limits.

In this field a wide analysis on index and indicators for the environmental evaluation carried on in Italy by ANPA, the National Agency for the Environment Protection [12] can be considered as a reference point. The use of "complex indicators" was put in evidence, to deal with combined exposure of several noise sources and to consider their impact on population.

However no details are given for the definition of "complex indicators", a part from a brief comment on their possible utility. Among these indicators, the ones linked to a number of measurements above NN decibels and the interested areas above NN decibels seems more interesting (even though the correlation with the effect does not seem very clear).

No indications are given on the method of elaboration of these indicators. In addition it is also considered an evaluation methodology of noise pollution on the base of 7 main indicators, judged more representative of the treating object. Some of them are also considered in scientific European and International documents (EU 98, Dobris +3, reports of OECD on environmental indexes of '94 and '98).

In the various analyses and studies, aggregation methods of indicators, aimed to determine global indexes of evaluation, don't seem deeply developed.

In recent times a preliminary analysis carried on by researchers of the University of Pavia has elaborated some hypotheses for the proposal of a structured system about indicators and index of the acoustic quality [13,14,15]. Criteria for the realization of some indicators and a single index of the environmental noise, on the base of national laws and international directives, were analysed.

ACOUSTICAL INDICATORS AND INDEX A NEW METHODOLOGICAL APPROACH

On the basis of previous investigations, therefore, the present research starts from the calculation procedure already developed, extends the research on the basis of experimental and simulated data and applies the indicators calculation to a more appropriate intervals subdivision (4 or 5 intervals depending to the indicator considered).

To define the indicators therefore each parameter row data are analysed and the parameter incidence ($i_{\%}$) is calculated for each range considered for of the parameter variation.

A relative weight (k) is attributed to each interval, assigning the maximum value (100) to the best comfort condition and lower values to increasing discomfort conditions till the lowest value (0), corresponding to the worst comfort condition.

The indicator is calculated with the following expression:

$$I = \Sigma_i \, i_{\%i} \, k_i \qquad (1)$$

In order to define the global quality index, it has been established to choose firstly the significant indicators, I, then to associate the appropriate weight factor, K, to each one and to make the final indicators aggregation. The global quality index here proposed takes into account the contribution of environmental noise, road traffic and population density, in terms of the acoustical indicator, the traffic indicator and the population indicator. It will be indicated as Acoustical Quality Index AQI:

$$AQI = \Sigma_i \, I_i \, K_i \qquad (2)$$

Generally, the parameter L_{den} (with reference to the indications of the European Commission) can be considered as reference to calculate the **acoustical indicator I_A**.

However, in the present analyses, existing national reference parameters have been used. In fact, even if the methodology could be applied considering European noise levels and limits, it has been applied to the two cases described in the following paragraphs referring to the Italian noise level limits [16, 17]. The application seems more suitable to compare the results: the validation of the model used in the simulations has been performed on the basis of available experimental data referred to the same parameters. Moreover national limits are referred to different period time noise (day-night) and in the local situation the corresponding ranges appear more appropriate than the value indicated in the EU Directive, also for future investigations and comparisons with the existing noise mapping.

The relative weights k_i for the definition of the acoustical indicator are specified for the corresponding five ranges in Table 2.

Table 2. Relative weight for the definition of the acoustic indicator

Ranges		k_i [%]
1	< 51 dB(A)	100
2	51 – 61 dB(A)	80
3	62 – 66 dB(A)	50
4	67 – 71 dB(A)	20
5	> 71 dB(A)	0

Noise level data must then be processed to calculate the percentage within each range, obtaining the percentage (i%). The acoustic indicator is evaluated depending on i% and on the corresponding relative weight k_i with the expression (1). In the same way the indicators of traffic and population can be calculated.

With reference to traffic data, the **traffic indicator I_t** is classified according to four representative ranges of vehicles per hour on the streets (Table 3).

Table 3. Traffic indicator relative weights

classification	optimal	good	acceptable	poor
vehicle/h	< 300	300 - 700	700 – 1400	>1400
weight (k_i [%])	100	70	40	0

When the number of vehicles / hour in transit (raw data) is measured or evaluated, the percentage in each range (processed data) is calculated and the value of the traffic indicator can be determined. This operation is performed thanks to a sum of products between the calculated percentages and the weights shown in Table 3 (using Eq. 1).

Even if it could appear difficult to a direct comprehension of the scale, it represent a judgment of the situation, therefore the greater is the value of the traffic indicator, the lower the volume of traffic in the area and better the judgment of that area.

Regarding the **population indicator I_p** considered in the analysis, it refers to the population exposed to traffic noise: in this case a density referred to an area (population / hectare) seems less plausible than the resident people for street length, corresponding to its traffic flow, and therefore it is the parameter considered in the calculations.

The ranges assumed for the population indicator have therefore been defined with a different criterion than the others: the population data characterise each street, therefore it was related to the development of 100 linear meters street and compared with the maximum and the mean population for each 100 m that characterise the town. The results can lead to the ranges indicated for a middle size town (600000 inhabitants) in Table 4 that reports also the weights used for the population indicator.

Table 4. Population indicator relative weights

classification	optimal	good	acceptable	poor
population /100 m	< 30	30-50	50 – 100	>100
weight (k_i [%])	100	80	60	20

To aggregate the three considered indicators and to evaluate AQI (following Eq. 2), the weight factors K for each indicator shown in Table 5 are used in the following equation:

$$AQI = (I_A * K_A) + (I_p * K_p) + (I_t * K_t) \qquad (3)$$

Table 5. Weight factors to calculate AQI

Indicator	Weight factor (K_i [%])	
Acoustical I_A	K_A	50
Population I_P	K_P	25
Traffic I_t	K_t	25

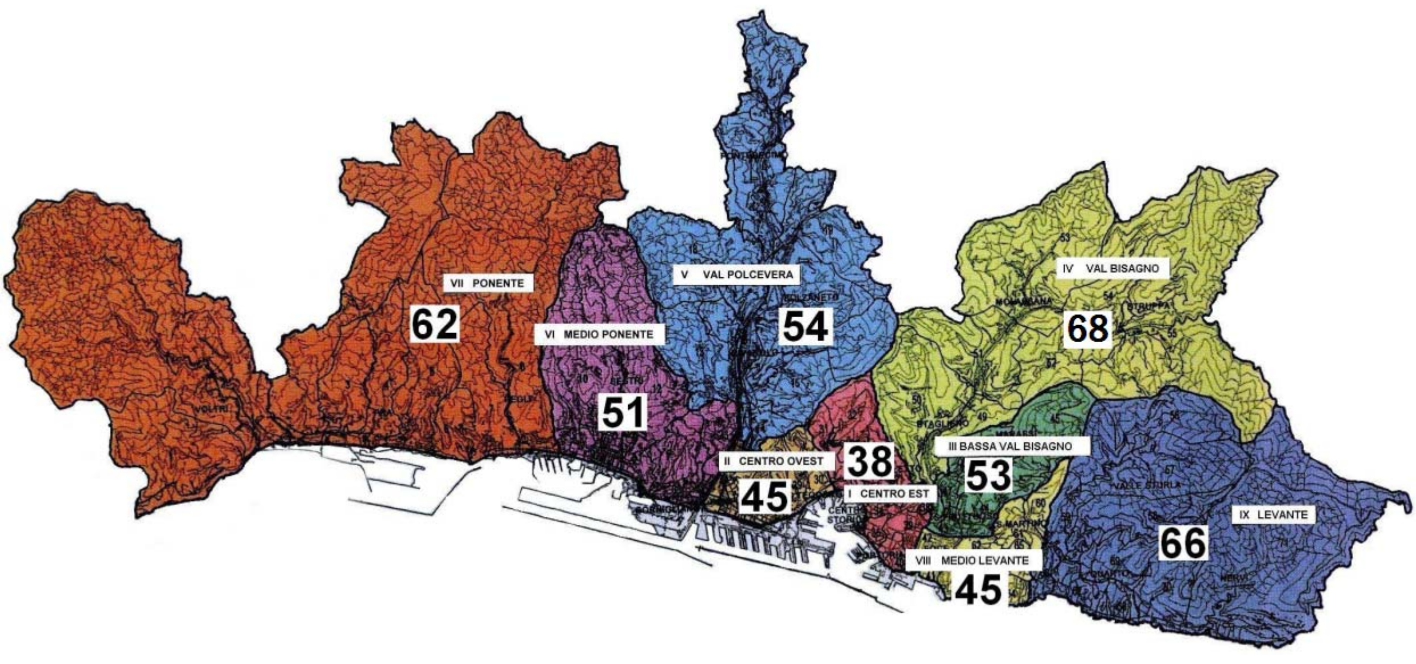

Figure 2. I_A from experimental data for the city of Genoa

ACOUSTICAL INDICATORS AND INDEX: APPLICATION OF THE METHODOLOGY

This approach to the formulation of a unique acoustical index AQI will be useful to formulate a global judgment on the environmental quality, if processed together with other indexes. Its expression must be tested in various local situations to be widely validated. Most of all further decision about the weighting factors of the three indicators in Eeq. 3 must be taken: could be considered fixed values or “locally” adjusted.

Another aspect regards the way to obtain the **acoustical indicator** that can be calculated starting from simulated or experimental values of the noise levels.

This choice can be made with reference to the indications taken by the relevant Italian legislation (Legislative Decree 194/2005): the collection of raw data must be developed with the help of sound level meters and following specific procedures outlined in the Ministerial Decree 16 March 1998.

Alternatively, the predictive models that automatically calculate the values of the noise level descriptor can be used, if validated with noise data measurements and considering appropriate significant assumptions.

In this preliminary application of the methodology, two different series of data have been considered: the elaborations of the acoustical indicator have been performed in one case on the basis of measured acoustical data, in another case simulated acoustical data were utilised. This last option requires high levels of elaboration but allows to obtain more useful information, also about the evaluation of the modifications that could be planned to reach a better AQI.

THE ANALYSIS OF THE PRESENT SITUATION BY MEANS OF MEASURED ACOUSTICAL LEVELS

The city of Genoa (located in the North-West part of Italy), represents quite unique case in which acoustic equivalent levels were measured on each corner of a square net with 300 m side length. In this case the reference parameter is assumed L_{eq} and not L_{den} as only this one was available from the measurements.

With this detail level, a wide investigation on the acoustical indicator shows globally the results resumed in Figure 2, where the town (600.000 inhabitants) has been divided into the corresponding administrative zones.

It can be highlighted that close to the commercial harbour, the acoustical indicator is lower, showing high noise levels due to the various activities. On the contrary, far from the centre, the indicator is 38-45 showing a better acoustical quality. The values increase to 62-68 with the highest level (68) in the less populated surroundings.

The analysis has been performed also in some urban streets, taking into account the measured noise equivalent level, the population density, the vehicle flux to calculate the whole acoustical quality index.

In detail, the measured noise equivalent level are considered in 11 urban streets of the city of Genoa belonging to one mainly residential zone characterized by intense traffic and other area, affected by heavy traffic, characterised by the presence of businesses, trades and offices, as well as residential buildings. In these areas, the data of population density (population exposed to noise each 100 m street length) and the traffic flow referred to the number of vehicles per hour were considered. These data were experimentally measured and provided by the administrative bodies of the town.

In this preliminary investigation, a first attempt to consider the best significant classification was performed, varying the limits of the five intervals referred to the measured equivalent noise level and not to L_{den}. The best choice appears to be the subdivision considered in Table 6.

Table 6. Relative weight for the definition of the acoustic indicator based on the experimental L_{eq} values

Ranges		k_i [%]
1	< 55 dB(A)	100
2	55 – 59 dB(A)	80
3	60 – 64 dB(A)	50
4	65 – 70 dB(A)	20
5	> 70 dB(A)	0

Also with the traffic and population indicators some attempt were performed varying the subdivisions and the best ones considered in the present analysis are indicated in the following Table 7.

Table 7. Relative weight for the definition of the acoustic indicator based on the experimental L_{eq} values

classification	optimal	good	acceptable	poor
vehicle/h	< 300	300 - 700	700 – 1400	>1400
weight (k_i [%])	100	70	40	0
population/100m	< 5	5-30	30 – 40	>40
weight (ki [%])	100	80	60	20

The Equations (1) and (2) were utilised respectively to calculate the corresponding indicators and the AQI index, for each street: the results are shown in Table 8.

Table 8. Indicators and index in some streets of Genoa

Indicator	noise	traffic	population	AQI
K	50	25	25	
Via Carrara	20.8	11.1	23.7	55.6
Via Quarto	11.3	11.5	23.9	46.7
Via Assarotti	0.0	10.2	18.6	28.8
Corso A. Saffi	3.8	6.1	23.9	33.7
Via Fieschi	1.4	19.0	21.7	42.1
Via Fiume	1.7	17.3	24.6	43.5
Via Brigata Liguria	18.8	16.9	23.5	59.1
Via XX Settembre	0.0	11.6	22.9	34.5
Via Corsica	16.0	13.2	19.0	48.2
Corso Podestà	5.0	8.6	19.7	33.3
Corso Italia	9.7	6.5	23.1	39.4
Via Isonzo	5.0	17.5	17.8	40.3

As already remarked, the highest values correspond to a better quality of urban environment. The values achieved in the mainly residential streets are above 45. The correspondence of the selected areas (roads width, buildings on one side only, presence of trees and green areas; streets with offices, residential buildings or commercial structures, etc.) with the values of the three indicators and the index is sufficiently reliable, compared with a qualitative assessment that could be considered for each zone.

Obviously this evaluation cannot be considered valid in absolute terms, as the proposed intervals attribution of the relative weights for each indicator and the weighting factors for the definition of the index must be validated on a wider scale with the comparison with a subjective investigation and with the analysis of a greater number of streets in various city contexts.

In fact many other aspects should be evaluated in relation to sound field that takes place: the presence of elements such as green areas, road width, number of lanes, design of facades, paving and other aspects certainly affects the environmental acoustic quality. In the further developments of the analyses, also these elements will be taken into account.

THE ANALYSIS OF THE PRESENT SITUATION BY MEANS OF SIMULATED ACOUSTICAL LEVELS

The following application regards another step of the analysis that was performed on the basis of simulations regarding the noise spreading in some urban areas.

In this case the acoustical indicator was calculated on the basis of L_{den} simulated by software, validated with a few measured data. This approach can be utilised in the most of cases as the availability of a wide number of measurements is a rare opportunity. Moreover the use of simulated data allows better analyses on the noise reduction i.e. by means of noise barriers, absorbent asphalt, increased speed limits, vehicle access restrictions, etc, as the simulations easily allow to compare the situation after and before the planned actions.

The simulations were performed using the Cadna-A software to calculate the values of the L_{den} in some residential areas belonging to the municipal territory of the city of Pavia (in Lombardy, close to Milan), exposed to noise sources such as traffic and rail [18] (Figures 3,4).

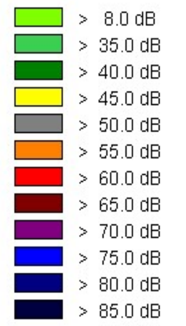

Figure 1. Legend to the simulation results

The AQI index has been tested in various areas of the town, characterized by different acoustic problems due to several sources and activities.

The simulation results were validated by comparison with the values measured in the realisation of the acoustic zoning by the municipality, obtaining always an error less than 1,5%.

The results, shown in Table 9, represent a starting point for the identification of the relative weights k_i and weight factors K_i and the various indicators considered for the development of a systematic methodology applicable in other urban configurations.

Table 9. Acoustical Indicator, subjective judgments and AQI index in some urban areas of Pavia

	I_A	Subjective	AQI	AQI_{mod}
Area 1.Corso Manzoni	**47**	**20 - 80**	**39**	**42**
Area 2.Via Tasso e Via Della Torretta	**30**	**20 - 80**	**30**	**33**
Area 3.Piazzale Minerva	**28**	**20 - 50**	**19**	**22**

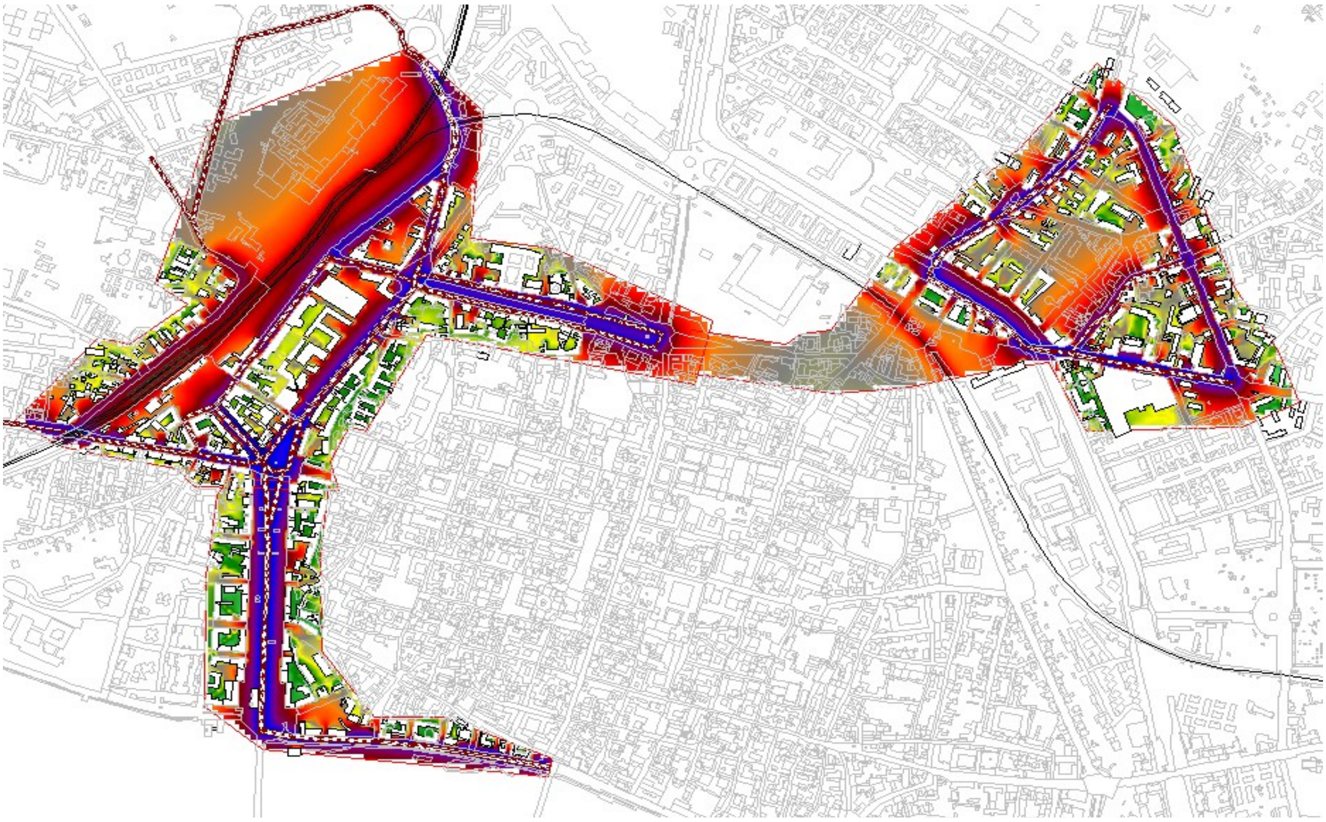

Figure 2. Areas of Pavia considered in the simulations

THE SUBJECTIVE INVESTIGATION

In the areas subdued to the analytical investigation a subjective investigation was carried on by subduing questionnaires quite to 500 students of the Faculty of Engineering of the University of Pavia. The questionnaire requests a judgment on the noise annoyance in some areas during the daytime and in the night (Figure 5).

The results (Table 9) show globally a subjective uniform assessment, in areas considered for the analysis, with an average score of 20 out of 100 in the daytime and 80 to 100 in the night. There is a significant difference between them and the AQI index and further investigations are under development to fit better the subjective investigation.

Moreover a preliminary analysis on the use of this methodology to plan noise reduction actions was performed. Corrections were simulated (replacement of the plaster of the buildings directly exposed to vehicular traffic, porous acoustic plaster, replacement of existing pavement, noise barriers between the street and the residential area, etc.). The results are processed with the same approach and are represented by the $\mathbf{AQI_{mod}}$ values in Table 9.

The comparison between AQI and AQI_{mod} shows an increase of AQI that is not as relevant as it could be expected, even if it could be understandable, considering the weight of the single indicators. In any case further investigation is planned to verify if the relative weights k_i and weight factors K_i values are really the most appropriate ones.

QUESTIONARIO SULLA QUALITA' ACUSTICA DELLE DIFFERENTI AREE RESIDENZIALI DI PAVIA

• INSERIRE UNA CROCE NEL PUNTO IN CUI E' UBICATA LA PROPRIA RESIDENZA, SE POSSIBILE INDICARNE LA VIA NEL SEGUENTE SPAZIO:

……………………………………………………………………

(IN ALTERNATIVA INDICARE UN PUNTO IN CUI SI PASSA FREQUENTEMENTE E DI CUI SI RIESCA A DARE UN GIUDIZIO ACUSTICO) .

• INSERIRE UNA CROCE IN CORRISPONDENZA DEL GIUDIZIO CHE SECONDO VOI MEGLIO RAPPRESENTA DAL PUNTO DI VISTA ACUSTICO LA ZONA IN CUI RISIEDETE, NELL'ORARIO DIURNO (7-22) ED IN QUELLO NOTTURNO (22-7):

CLASSE	GIUDIZIO	PESO	VALUTAZIONE ORARIO DIURNO (7 – 22)	VALUTAZIONE ORARIO NOTTURNO (22 – 7)
1	OTTIMO	100		
2	BUONO	80		
3	SODDISF.	50		
4	SUFF.	20		
5	INSUFF.	0		

• INDICARE CON UNA CROCE GLI INTERVALLI ORARI IN CUI SI AVVERTE MAGGIORE FASTIDIO DAL PUNTO DI VISTA ACUSTICO:

GIORNO												SERA				NOTTE							
7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6

Figure 3. Subjective investigation questionnaire

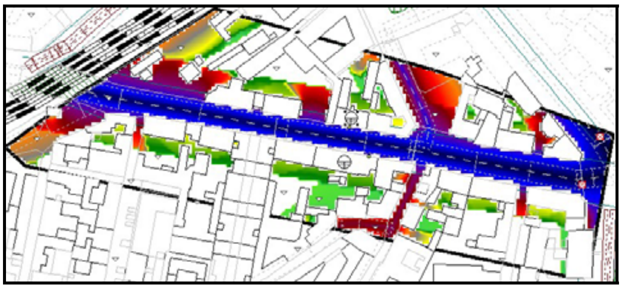

Figure 4. Area 1: simulation results

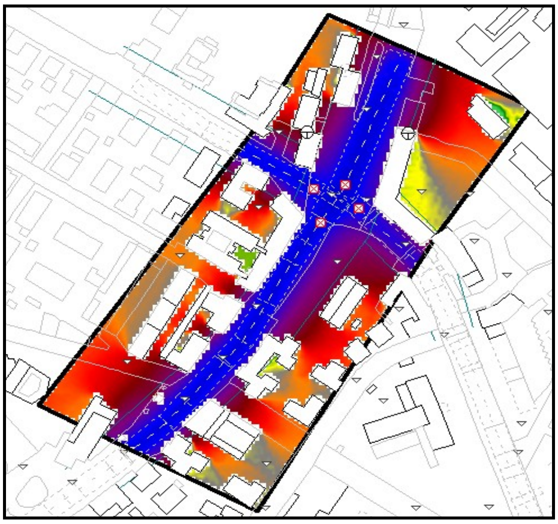

Figure 5. Area 2: simulation results

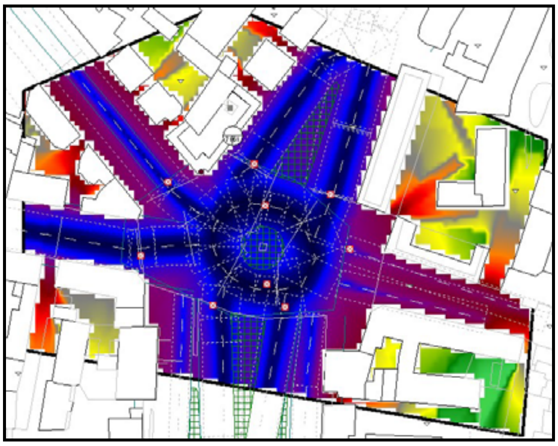

Figure 6. Area 3: simulation results

CONCLUSIONS

The ongoing research has led to an index that takes into account aspects related to population density, traffic, according to information that must be provided to the European Commission, on the basis of measured or simulated noise levels.

The evaluation index of urban quality in relation to noise pollution was calculated on the basis of objective and subjective assumptions and was tested in different areas of the same towns, characterized by different acoustic problems and their different uses. Two configurations were analysed on the basis of measured and simulated data.

The present results represent a starting point for the identification of the weighting of different indicators considered for the development of the methodology applicable in various urban situations.

The process could lead to a homogeneous overall assessment of the health conditions of the city, considering architectural-urban aspects, physical parameters and the population health.

The premises of a series of wide investigations allow to understand the high potential use of this kind of scheme for the quality assessment of a great number of elements that contribute to define the environmental human comfort in the urban environment.

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