Research Article

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A survey on the soundscape perception before and during the COVID-19 pandemic in Italy

Abstract: At the time of the COVID-19 pandemic, the impact of lockdown measures highlights changes in terms of sounds and noises present in the everyday life. The present paper deals with this peculiar and unexpected scenario as studied by means of an online survey consisting of 18 questions and distributed to residents in the Italian territory. For studying the unprecedented effect of the pandemic, participants were asked to fill the questionnaire, providing personal data, describing context and characteristics of the house in which they live and making a comparison of the lockdown soundscape with the pre-lockdown one. About four hundred questionnaires have been collected and analysed in order to define correlations between personal and perception variables. Using logistic regression models, changes have been studied during the two above-mentioned periods. It has been observed that the perception of traffic noise has increased for people over 35 years old and the noise produced by the neighbourhood has been more statistically significant for employed respondents. Future outlook might provide the spread of the questionnaire in other countries for a global evaluation of the data, to be also acquired with reference to the after-lockdown period.

Keywords: COVID-19, soundscape, noise perception, online questionnaire

1 Introduction

Soundscape can be defined as "acoustic environment as perceived or experienced and/or understood by a person or people, in context" [1]. It is a perceptual constructor [2] which strongly interacts with the other senses. Understanding how common people experience the spaces of everyday life, how they perceive them and what values and meanings are attributed to them are important aspects to take into account in order to challenge the predominance of a vision-centred paradigm and support the aim at gaining a holistic approach to urban planning [3]. On the acoustics side, the perceptive role is played by the auditory system. The latter is essential for a deeper and wider perception of the surrounding environment as listening increase the awareness of the notion and evaluation of soundscapes [3]. In fact, its primary task is linked with the definition of sound sources, allowing their identification and behaviours [4]. The soundscape approach may lead to plan the acoustic environment of cities in a holistic way, supporting wellbeing and health of inhabitants. Particularly, it is observed that improved quality of life on urban and rural areas is not the direct consequence of the reduction of sound levels. For this reason, the soundscape multidisciplinary approach to the management of the acoustic environments becomes relevant, focusing on personal perception [2].

In previous researches, the perception of soundscape has been mainly focused on public spaces and has been evaluated in a scenario in which people were in direct contact with the (outside or inside) place they were invited to assess.

As an example, for tourists' and citizens' wellbeing purposes, a study on soundscape was carried out in the area of Colosseum, Roman Forum and Palatine Hill in Rome [5]. The area is surrounded by very busy roads and intense anthropic activities and it is included among the areas most sensitive to noise. Measurements were conducted inside and outside the area and a questionnaire was distributed to 212 subjects in nine different sites in order to collect subjective opinions among with correspondent binaural recordings. The results have been compared in correlograms related to subjective responses and acoustic and psychoacoustic parameters and show a negative or poor correlation between acoustic and psychoacoustic parameters and subjective ratings. This confirms the need for a holistic approach in evaluating the sonic environment which should

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take into account all the factors influencing the subjective appraisal. Another research [6] explores the Perceived Restorativeness Soundscape Scale (PRSS) in two downtown cafes in Montréal, Canada. The questionnaire includes, in addition to the PRSS interpretation, questions related to the individual, the environment and the interaction of the two. The results show that participants did not focus only on sounds, although a preference in acoustics related terms is observed. Therefore, defining a subjective measure for a singular sense is unlikely when multiple sensory stimuli are available.

Compared to study [2], where the questionnaires have been distributed in order to analyse the subjective effects on noisy outside areas, the above-mentioned research [6] refers to an indoor setting. Despite soundscape is commonly referred to outside areas, this new field of application may be considered more in-depth.

In regard to indoor soundscape investigation, as stated in [7], the acoustic design should not be limited to noise control but should follow a perceptual and multisensory approach. In this framework, holistic design plays an important role. In particular, the design should take into account building occupants' preference and needs thanks to integrated participatory practices.

Thinking of common spaces seems to be anachronistic, in the pandemic framework which has minimized outside activities and increased home life for people: COVID-19 is producing positive and negative indirect effects, as explained in [8] and [9]. According to [9], in fact aspects such as improvement in air quality, clean beaches and environmental noise reduction have been particularly evident in China, USA, Italy, and Spain, countries that have been significantly affected by the pandemic. However, at the same time, it is noted that the hygienic conditions required by governments for the control of COVID-19 spread demand the use of a large number of disposable materials. The latter produces domestic and medical waste and slows down the recycling process. On the other hand, as expected, the main unequivocal implications are related to air pollution. As a matter of fact, the reduction of car use and the break of anthropic and industrial activities have led to a decrease in terms of $PM_{2.5}$ and NO_2. This is proved by the images, elaborated by ESA, comparing the levels of concentration of NO_2 in China and Europe in the lockdown time with data collected in the same period in 2019 [10]. In addition, the European Environment Agency (EEA) has developed a display that tracks the average weekly concentrations of NO_2, PM_{10} and $PM_{2.5}$, in order to assess how this unexpected break has affected air pollution concentrations in Europe [11]. It is crucial to underline that other factors, such as the weather conditions, may positively influence the reduction in terms of pollutants. Therefore, the results are not only affected by the interruption of anthropic activities.

Concerning vehicular traffic, the sensors positioned along the main street of the Libertà district in Monza (Italy), characterised by high traffic flows, prove the changes that occurred in noise levels trends before and during the lockdown phase and in the equivalent months of the previous year [12]. The smart noise monitoring network has been continuously collecting noise data since June 2017, therefore the latter are a solid environmental indicator for stating that the social restrictions, due to the pandemic, have determined a reduction in terms of weekly average L_{den} values between 6 and 10 dB. In other cities, where there has been a significant spread of COVID-19, some studies concerning the environmental impact of the pandemic have been carried out as well. This is the case of Madrid [13] where the lockdown has altered the acoustic environment of the city in relation to changes in noise levels; as well as in Rome, where the adoption of strong and severe measures involved a decrease of 64.6% of private vehicles in the city (during March-April 2020) [14]. During the lockdown, several initiatives, aimed at studying the current peculiar acoustic environment, have been carried out in many countries, such as Japan [15, 16], UK [17] and France [18]. An assessment on French sound environment [18] has been carried out by Acoucité – the soundscape and noise observatory of Greater Lyon. Two kinds of evaluation were considered. On the one hand, the collection and analysis of data from 21 sound monitoring stations, during the French lockdown and for the following 2 weeks, showed a significant decrease in sound levels. On the other hand, an online survey was distributed to obtain information about the inhabitants' perception of sound environment during the lockdown period (3242 filled in questionnaires were collected). As expected, as the sound monitoring stations revealed a decrease in terms of noise levels, corresponding pleasantness of the soundscape is perceived by residents, who define the sound environment with positive adjectives, such as calm, pleasant, peaceful.

Nevertheless, a significant reduction has been noticed even in air, rail and ship traffic. According to the data analysed by EUROCONTROL [19], the air traffic situation on Week 15 (6-12 April 2020) counts 3,259 flights in Europe, with a reduction of flights of 89.3%, compared with the equivalent period in 2019. This means a suspension of 190,871 flights. The described situation is quite steady in the analysed period (previous and following weeks). In Athens International Airport [20], a check has been possible thanks to the permanent noise monitoring stations, which allow comparing the recordings for the years 2018, 2019 and 2020. The emergence of the pandemic has influenced the popula-

tion flows by reducing the number of flights and generating a positive impact on the environmental noise climate of the wider area of the airport.

Similar considerations may be done on shipping [21]: data have been studied, for example, in "Foreseeing the Transportation Modal Shift". The work has been carried out within the "COVID-19 Custom Script Contest by Euro Data Cube", a competition organized during the COVID-19 crisis by the European Space Agency (ESA), in coordination with the European Commission.

As mentioned, in the lockdown scenario, where traffic is nearly suspended, people are expected to spend most of their time at home, carrying out domestic and remote working activities. For this reason, the impact of noise caused by means of transport is reduced and it is possible to hear sounds produced by nature which were previously covered by noisy anthropic activities.

The present paper deals with the evaluation of the peculiar and unexpected scenario which has been constituted after the spread of COVID-19 by means of the submission of an online questionnaire. This initiative has been promoted by the Acoustical Society of Italy (AIA) and Vie en.ro.se Ingegneria. Differently from previous studies and due to the peculiar historical period, in the present research, the soundscape perception is mainly intended as personal evaluation of the outside acoustical environment in the pre-lockdown period and in the lockdown one, as perceived in an indoor space as the respondents' houses.

2 Methods

2.1 Questionnaire design and distribution

The structure of the questionnaire consists of 18 questions divided into 5 sections:

1. *Personal data*, to collect subject data in relation to age, gender, place of living, education and employment;
2. *Context analysis*, for the definition of health condition during COVID-19 quarantine;
3. *Dwelling,* for questions related to the features of the dwelling;
4-5 *Perception of the environment*, where the same questions are asked for a direct comparison of the pre-lockdown and the lockdown period.

The schematic structure of the questions is displayed in Table 1 while the full questionnaire template in English language is made available in Appendix I. Different ques-

tion types have been used: (a) "Select one", a multiple-choice question where only one answer can be selected; (b) "Geopoint", a collection of GPS coordinates; (c) "Integer", the input is an integer; (d) "Question matrix", a group of questions displayed in a matrix form. Regarding the scales adopted in the questionnaire, for sections 4 and 5 indicated in Table 1 a typical [22–24] five-level Likert scale has been adopted.

The questionnaire has been distributed in the Italian language version and was filled in by people living in Italy.

Before submitting the questionnaire, a pilot test has been carried out among a small group composed of authors' colleagues but not expert in acoustics which gave good feedbacks in the structuring and understanding of the questions.

Due to the COVID-19 epidemiological emergency, the distribution of the survey has been possible only using software for collecting and managing online data. The Kobo toolbox, free and open-source, has been used. The link for filling in the questionnaire was sent by email to all the members of AIA and shared via social networks. Consequently, the sample was based on voluntary respondents, neither based on random sampling nor based on other non-probabilistic methods.

2.2 Data analysis

395 questionnaires were collected between 27th March to 16th June 2020, although only 323 were statistically analysed. The remaining questionnaires were considered invalid as no statistically significant data had been entered (in many cases just the date and time of the start of the filling in were present).

Most of the questionnaires have been filled between the end of March and the first part of April 2020, so in a period in which respondents could easily remember how they perceived the soundscape before the lockdown period. Moreover, also according to the pilot test that has been carried out among a small group composed by authors' colleagues no difficulties were met in distinguishing between the soundscape before and during the lockdown period and in remembering related differences which in many cases were evident.

Mainly two typologies of statistical analysis have been carried out on collected data: descriptive analysis and logistic regression models.

Table 1: Contents of the questionnaire

Section	*Question*		*Question type*
1. PERSONAL DATA	1:	Age	(a)
	2:	Gender	(a)
	3:	Place of living	(b)
	4:	Education	(a)
	5:	Employment	(a)
2. CONTEXT ANALYSIS	1:	Families/friends under trustee lockdown or quarantine for COVID-19	(a)
3. DWELLING	1:	Type of dwelling	(a)
	2:	Number of flatmates	(c)
	3:	Year of dwelling construction	(a)
	4:	Acoustic improvements after the construction	(a)
PERCEPTION OF THE ENVIRONMENT	1:	Noise coming from outside the house	(a)
	2:	Type and intensity of sounds heard from home	(d)
	3:	Annoyance of sounds heard from home	(d)
4. QUESTIONS RELATED TO THE PERIOD BEFORE THE DPCM 11 MARCH 2020: Italian management of the COVID-19 epidemiological emergency /	4:	Intensity and origin of sounds coming from the neighbourhood	(d)
	5:	Annoyance of sounds coming from the neighbourhood	(d)
	6:	Description of soundscape	(d)
	7:	Assessment of soundscape	(a)
	8:	Relevance of soundscape in relation to the context	(a)
5. QUESTIONS RELATED TO THE CURRENT PERIOD (lockdown period)	9:	Overall assessment of soundscape	(a)

2.2.1 Descriptive analysis

Descriptive analysis, as usually adopted as the initial starting point for any quantitative analysis of collected data, allows the transformation of raw data into a form that makes them easy to understand and manipulate in order to generate deeper information.

In the current study, the frequency distribution of the answers referred to the personal data section and dwelling section have been evaluated. Moreover, the percentage of given answers and the difference between the lockdown period and the period before COVID-19 emergency have been calculated for sections number 4 and 5 indicated in Table 1.

2.2.2 Logistic regression models

For a deeper investigation, the answers to sections "Questions related to the period before the DPCM 11/03/2020 and to the lockdown period" (sections number 4 and 5 reported in Table 1) have been compared in relation to data collected under sections number 1, 2 and 3 indicated in Table 1. As a matter of fact, the variation in terms of sounds and noise and, consequently, in the soundscape and landscape perception may be due to the abovementioned unprecedented situation, as well as it may be correlated with other parameters such as the personal data and the characteristics of the dwelling.

For studying the change in noise perception in the period before and during lockdown, the answers have been analysed with three types of scenario: the noise perception decreases, the noise perception increases, the noise perception remains the same. Because of the interest in the variation of noise perception, the dependent variables have been dichotomized. The dependent variable takes value 0 if the noise perception in the period before the lockdown is higher than the noise perception in the period during the lockdown or in the case the noise perception is the same in the two periods but the answer is "absent" or "low". Conversely, the dependent variable takes value 1 if the noise perception in the period before the lockdown is lower than the noise perception in the period during the lockdown or in the case the noise perception is the same in the two periods but the answer is "reasonably loud", "quite loud" or "very loud". Choosing a binary variable allows using

a classical logit model in order to study the relationship between the covariates, linked to the individuals or to the house, and the dependent variable.

Regression methods have become an integral component of any data analysis concerned with describing the relationship between a response variable and one or more explanatory variables. For the current analysis, since the outcome variable is binary, logistic regression models have been used. This type of models provides a powerful technique for analysing data involving binary responses and several explanatory variables and are characterized by an extremely flexible and easily used function [25].

For the statistical analysis concerning logistic regression models, Stata statistical software has been used.

To study the possible combination in the perception of the sound environment, the answers to Question 2 – *Type and intensity of sounds heard from home* (in particular: road traffic, nature sounds and neighbourhood sounds), Question 7 – *Assessment of soundscape* – and Question 9 – *Overall assessment of soundscape* have been used as dependent variables. In order to use logistic models, dependent variables have been dichotomized, considering if a change has been observed in the answers given in the two periods, pre- and during the lockdown. The response variables assume two values: 0 – when there has been an improvement during the lockdown compared with the previous period – and 1 – for a worsening in the perception. Regarding Question 2, if the subjects (*i*) perceive a reduction in traffic noise or neighbourhood sounds and an increase of nature sounds, the response variable assumes the value 1. On the other hand, if subjects respond they hear more traffic noise and neighbourhood sounds and fewer nature sounds than before, the dependent variable assumes the value 0. Instead, if the answer remains unchanged, the dependent variable assumes the value 1 for the categories "absent" and "low" and 0 otherwise, in the case of traffic noise and neighbourhood sounds. Concerning nature sounds, in the case of unchanged response, the response variable assumes the value 1 for the categories "quite loud" and "very loud" and 0 otherwise. Regarding Questions 7 and 9, if the quality of the perceived soundscape or the overall assessment of the environment improves, then the response variable assumes the value 1, otherwise, if a worsening is observed it assumes the value 0. If the response remains unchanged, the dependent variable takes the value 0 in the case of the categories "not at all" and "slightly" and 1 otherwise. Once the five variables that are used as dependent have been dichotomized, a different regression is performed for each of these variables.

For traffic noise, the resulting logit model is:

$$logit\left(y_{traffic}\right) = \alpha_i + \beta_1 age_i + \beta_2 emp_i \qquad (1)$$

where α_i is the constant term, age_i is a vector that represents the age of the subject divided into four categories (<35, 36-50, 51-65, and 66+), emp_i is a vector that represents the employment position of the respondent divided into six categories (self-employed, public sector employee, private company employee, student, not working, and other). The category "not working" includes retired and unemployed people.

For nature sounds, the resulting model is:

$$logit\left(y_{nature}\right) = \alpha_i + \beta_1 age_i + \beta_2 emp_i \qquad (2)$$

where α_i is the constant term, age_i and emp_i are the same covariates as in the model of traffic noise.

For the neighbours sounds the resulting model is:

$$logit\left(y_{neighbours}\right) = \alpha_i + \beta_1 tdwe_i + \beta_2 emp_i \qquad (3)$$

where α_i and emp_i are the constant term and a vector indicating the employment done by the individual, as above-mentioned. The covariates $tdwe_i$ is a vector that indicates the typology of the house, this variable is divided into three categories (apartment, detached house, townhouse).

As regards the question related to the assessment of the quality of the perceived soundscape, the resulting model is:

$$logit\left(y_{sound\_ass}\right) = \alpha_i + \beta_1 nflat_i + \beta_2 envapp_i \qquad (4)$$
$$+ \beta_3 pleas_i + \beta_4 annoy_i$$

where α_i is again the constant term and $nflat_i$ is a vector representing the number of people living with the respondent, this variable is made up of five categories (0, 1, 2, 3, and 4+). The variable $envapp_i$ is a vector indicating the appropriateness of the sound environment categorised into three categories, depending on whether there was a worsening, an improvement or the response remained unchanged. The last two vectors, $pleas_i$ and $annoy_i$, represent the adjectives pleasant and annoying, present in question six. These two covariates are made by reparametrizing the five response categories in just three. The value 1 indicates that the respondent finds deterioration in the quality of the sound environment, value 2 indicates that the perception of the quality of the sound environment remains unchanged and value 0 indicates an improvement in the quality of the sound environment.

In the end, for the question related to the overall assessment of the environment, the resulting model is:

$$logit\left(y_{ove\_env}\right) = \alpha_i + \beta_1 envapp_i + \beta_2 env\_ass_i \qquad (5)$$
$$+ \beta_4 pleas_i + \beta_5 chao_i$$

where α_i is the constant term, $envapp_i$ is, as in the previous model, a vector variable indicating any change in the relevance of soundscape in relation to the context. The variable env_ass_i is a vector indicating any change in the assessment of the quality of the soundscape. Even this latter covariate is categorised into three categories, dependent on any change in response between the pre- and during the lockdown period. Finally, the last two covariates $pleas_i$ and $chao_i$, represent the adjectives "pleasant" and "chaotic" present in question six. These two variables are categorised into three categories, as described for the adjectives "pleasant" and "annoying" in the previous model.

3 Results

For each question, the total number of valid questionnaires (323) has been considered. In each table, answers not provided by respondents for each specific question are indicated as "not given".

3.1 Descriptive analysis

Concerning the sections "personal data" and "dwelling", the results show the number of male participants is slightly higher than the female ones (157 versus 162) and the ma-

jority of the subjects are in an age range between 20 and 65 years old. All the respondents have at least a middle school diploma, while most of the sample has at least a bachelor's degree and is employed in the public sector. The employment categories introduced in the questionnaire and reported in Table 4 have been chosen mainly according to standard categories identified in previous literature studies [26, 27]. In the current case, some more detailed categories have been considered (*e.g.* private company/public sector employee) in order to facilitate the respondent and to avoid doubts that could not be easily solved during the filling since it has not been carried out in presence but online. Moreover, most of the respondents spent the lockdown in an apartment and in dwellings built before 1970. The significant discrepancy of the time frames in the year of dwelling construction categories has been considered as a result of the analysis of the Italian urban fabric and the legislative

Table 2: Frequency distribution of subjects' age

Age	
options	frequency
>80	1
66-80	14
51-65	105
36-50	78
20-35	122
<20	1
Not given	2

Table 3: Frequency distribution of subjects' education data

Education	
options	frequency
Master	18
Doctorate	37
Bachelor's Degree	167
High School Diploma	94
Middle School Diploma	5
Not given	2

Table 4: Frequency distribution of subjects' employment data

Employment	
options	frequency
Retired	24
Researcher / Professor	32
Teacher	8
Shop Keeper	3
Worker	3
Private Company Employee	38
Public Sector Employee	94
Self-employed	56
Unemployed	4
Student	47
Other	13
Not given	1

Table 5: Frequency distribution of the number of flatmates the subjects share the dwelling with

How many people do you share your home with?	
options	frequency
7 people	1
6 people	1
5 people	7
4 people	24
3 people	82
2 people	75
1 person	72
Alone	34
Not given	27

Table 6: Frequency distribution of the type of dwelling where the subjects live in

	What type of house do you live in?	
options in English/Italian	*explanation*	*frequency*
Apartment/*Appartamento in condominio*	An accommodation located in a flat complex that borders other apartments (above, below and to the side).	195
Detached House/*Casa indipendente*	An independent house, which does not directly border other buildings.	82
Townhouse/*Casa a schiera*	An accommodation that borders other houses on the sides.	46

Table 7: Frequency distribution of the year of subjects' dwelling construction

In which years was the house you live in built?	
options	*frequency*
After 2000	46
1990 - 2000	37
1970 - 1990	73
Before 1970	155
Not available	12

Table 8: Frequency distribution of the acoustic improvements of the dwellings

After construction, have any acoustic improvements been made to your home (*e.g.* change of windows, construction of counter walls, etc.)?	
options	*frequency*
Yes	137
No	148
Not available	38

Table 9: Distribution among Italian regions where questionnaires have been filled in

Where do you live?	
Italian region	*percentage*
Calabria	0.40%
Campania	0.40%
Emilia-Romagna	6.85%
Friuli-Venezia Giulia	0.40%
Lazio	2.42%
Liguria	1.21%
Lombardia	10.48%
Marche	0.81%
Molise	0.40%
Piemonte	4.44%
Puglia	0.81%
Sardegna	0.81%
Sicilia	0.81%
Toscana	37.50%
Trentino-Alto Adige	18.55%
Umbria	3.23%
Valle d'Aosta	4.84%
Veneto	5.65%

framework in the field of acoustics. As a matter of fact, from the 90s, laws at national and regional level have been published. The main reference is Decree of the President of the Council of Ministers of December 5, 1997 "Determinazione dei requisiti acustici passivi degli edifici" (Determination of passive acoustic requirements of buildings). In the light of this fact, it was considered more appropriate to reduce the time frame from 1990 to today.

For the question concerning the type of dwelling where the subjects live in, three options have been given: apartment, detached house, and townhouse. These three categories aim to underline if the dwelling is located close to other proprieties and therefore which kind of noise may be mainly transmitted through the air. As a matter of fact,

an "apartment" is an accommodation located in a flat complex that borders other apartments (above, below, and to the side); a "detached house" is an independent house, which does not directly border other buildings; and a "townhouse" is an accommodation that borders other houses on the sides.

Furthermore, only 34 subjects live alone, whereas the remaining shared the dwelling with flatmates during the lockdown.

In Tables 2–8, the frequency distribution of the answers referred to the personal data section and dwelling section is shown.

With reference to Table 8, the acoustic improvements have mainly interested the replacement of windows

Figure 1: Distribution of people who filled in the questionnaire in Italy.

(glasses and frames) and in a few cases refurbishment has led to the addition of footfall sound insulation mat, insulation coating and false ceiling.

In Figure 1, the locations of the respondents are marked with coloured spots. It shows that questionnaires have been mainly filled-in in North and Central Italy. In the most significant cities, the number of collected questionnaires is displayed within the coloured spot, otherwise, it means it was filled in by only one person.

From the geographical coordinates, the place of living of respondents has been defined. Therefore, the Italian regions where the questionnaires came from are shown in Table 9. Most of the respondents are from Tuscany (93 filled-in questionnaires), where Vie en.ro.se Ingegneria is based, Trentino-Alto Adige (46), and Lombardia (26). The latter is one of the regions most affected by the pandemic.

3.2 Comparison between before the DPCM 11/03/2020 period and the lockdown period data

In this paragraph, results concerning answers provided in relation to the two periods are reported. As a matter of fact,

Table 10: Comparison between the lockdown period and the period before COVID-19 emergency regarding the perceived outside noise

	How loud was/is the noise coming from the outside that you heard/hear from your home?		
options	*period before COVID-19 emergency*	*lockdown period*	*difference*
Extremely	3.41%	0.62%	−3%
Very	10.53%	2.48%	−8%
Moderately	32.20%	8.36%	−24%
Slightly	47.37%	61.30%	14%
Not at all	6.19%	26.93%	21%
Not given	0.31%	0.31%	0%

Table 11: Comparison between the lockdown period and the period before COVID-19 emergency regarding the type and the intensity of sounds coming from outside the house

To what extent and what kind of sounds could/can you hear from your home?					
period before COVID-19					
options	Road traffic	Rail traffic	Overflights	Nature sounds	Neighbourhood Sounds	Mechanical/ electrical sounds
Not given	1.55%	3.10%	3.72%	0.93%	1.24%	2.17%
Not at all	9.29%	67.49%	38.70%	8.36%	5.26%	29.10%
Slightly	36.22%	18.89%	40.56%	27.55%	33.13%	38.08%
Moderately	32.20%	8.67%	11.15%	35.29%	34.67%	21.05%
Very	13.00%	1.24%	5.57%	21.98%	21.05%	8.36%
Extremely	7.74%	0.62%	0.31%	5.88%	4.64%	1.24%
lockdown period					
options	Road traffic	Rail traffic	Overflights	Nature sounds	Neighbourhood Sounds	Mechanical/ electrical sounds
Not given	1.24%	2.17%	1.86%	1.55%	1.24%	2.17%
Not at all	43.96%	78.33%	77.71%	4.95%	10.53%	50.46%
Slightly	40.25%	15.17%	17.34%	17.03%	42.11%	31.89%
Moderately	8.36%	3.10%	2.48%	34.06%	26.63%	8.67%
Very	2.17%	0.93%	0.62%	26.32%	13.00%	5.88%
Extremely	4.02%	0.31%	0.00%	16.10%	6.50%	0.93%
difference					
options	Road traffic	Rail traffic	Overflights	Nature sounds	Neighbourhood Sounds	Mechanical/ electrical sounds
Not given	−0.31%	−0.93%	−1.86%	0.62%	0.00%	0.00%
Not at all	34.67%	10.84%	39.01%	−3.41%	5.26%	21.36%
Slightly	4.02%	−3.72%	−23.22%	−10.53%	8.98%	−6.19%
Moderately	−23.84%	−5.57%	−8.67%	−1.24%	−8.05%	−12.38%
Very	−10.84%	−0.31%	−4.95%	4.33%	−8.05%	−2.48%
Extremely	−3.72%	−0.31%	−0.31%	10.22%	1.86%	−0.31%

the comparison between the same questions referring to the period before the DPCM 11/03/2020 [28] (Presidential Decree of the council of Ministers, which introduced further measures to manage the COVID-19 epidemiological emergency) and the lockdown period shows a statistically significant difference in the perception of the surrounding

sounds. In fact, measures such as suspension of numerous commercial activities, of restoration services, of personal service activities and the enhancement of the remote work mode have affected the soundscape. In Tables 10–15, the percentage of given answers and the difference between the lockdown period and the period before COVID-19 emergency are displayed. Therefore, an increase or a decrease

Table 12: Comparison between the lockdown period and the period before COVID-19 emergency regarding the type the sounds subjects heard from their home and considered as annoying

	How annoying do you find the sounds you could/can hear from your home?					
	period before COVID-19					
options	Road traffic	Rail traffic	Overflights	Nature sounds	Neighbourhood Sounds	Mechanical/ electrical sounds
Not given	0.93%	4.02%	3.72%	0.93%	0.93%	1.55%
Not at all	20.74%	72.76%	54.49%	79.88%	15.79%	34.06%
Slightly	37.46%	17.34%	27.86%	13.00%	41.18%	29.10%
Moderately	21.36%	3.72%	9.29%	4.02%	26.63%	19.20%
Very	12.07%	0.93%	2.79%	1.55%	10.53%	11.15%
Extremely	7.43%	1.24%	1.86%	0.62%	4.95%	4.95%
	lockdown period					
options	Road traffic	Rail traffic	Overflights	Nature sounds	Neighbourhood Sounds	Mechanical/ electrical sounds
Not given	2.17%	2.79%	2.48%	1.24%	1.86%	3.41%
Not at all	54.80%	83.28%	80.50%	79.57%	30.96%	52.32%
Slightly	25.70%	8.98%	10.84%	9.29%	32.82%	24.77%
Moderately	7.43%	2.17%	4.02%	6.81%	21.36%	12.07%
Very	7.12%	1.24%	1.24%	1.86%	9.91%	5.26%
Extremely	2.79%	1.55%	0.93%	1.24%	3.10%	2.17%
	difference					
options	Road traffic	Rail traffic	Overflights	Nature sounds	Neighbourhood Sounds	Mechanical/ electrical sounds
Not given	1.24%	−1.24%	−1.24%	0.31%	0.93%	1.86%
Not at all	34.06%	10.53%	26.01%	−0.31%	15.17%	18.27%
Slightly	−11.76%	−8.36%	−17.03%	−3.72%	−8.36%	−4.33%
Moderately	−13.93%	−1.55%	−5.26%	2.79%	−5.26%	−7.12%
Very	−4.95%	0.31%	−1.55%	0.31%	−0.62%	−5.88%
Extremely	−4.64%	0.31%	−0.93%	0.62%	−1.86%	−2.79%

Table 13: Comparison between the lockdown period and the period before COVID-19 emergency regarding the assessment of soundscape

	How do you assess the quality of the sound environment that was/is around you?		
options	*period before COVID-19 emergency*	*lockdown period*	*difference*
Not given	0.93%	0.93%	0.00%
Very poor	4.02%	1.24%	−2.79%
Poor	18.58%	5.88%	−12.69%
Acceptable	29.41%	18.58%	−10.84%
Good	34.67%	43.03%	8.36%
Very good	12.38%	30.34%	17.96%

Table 14: Comparison between the lockdown period and the period before COVID-19 emergency regarding how the soundscape is suitable for the context

options	Do you think that the sound environment around you was/is appropriate to the context?		
	period before COVID-19 emergency	*lockdown period*	*difference*
Not given	0.31%	1.55%	1.24%
Not at all	4.95%	2.79%	−2.17%
Slightly	6.19%	3.72%	−2.48%
Moderately	30.34%	21.67%	−8.67%
Very	46.75%	47.99%	1.24%
Extremely	11.46%	22.29%	10.84%

Table 15: Comparison between the lockdown period and the period before COVID-19 emergency regarding the assessment of the overall perceived environment

options	How do you overall assess (sound, vision, safety, etc.) the environment you perceived/perceive around your home?		
	period before COVID-19 emergency	*lockdown period*	*difference*
Not given	0.62%	1.24%	0.62%
Very poor	1.86%	1.24%	−0.62%
Poor	12.38%	7.12%	−5.26%
Acceptable	33.44%	18.58%	−14.86%
Good	39.63%	44.89%	5.26%
Very good	12.07%	26.93%	14.86%

of an option is shown in comparison with the previous scenario.

The soundscape out of dwellings has significantly changed due to the pandemic restrictions, which have forced people spending most of the daytime at home and have influenced the reduced use of means of transport. Therefore, this situation brought to a renewed soundscape characterized by the prevalence of nature and neighbourhood sounds (respectively 76% and 46% of the subjects defined these types of sounds as "moderately", "very" or "extremely"). Even in the previous period, nature and neighbourhood sounds were well perceived (respectively 63% and 60% of the subjects defined these types of sounds as "moderately", "very" or "extremely"), although there is a higher perception of road traffic, rail traffic, overflights, and mechanical/electrical sounds; in particular road traffic, which is considered as "moderately", "very" or "extremely" by over 50% of the participants. The above-mentioned values affect the assessment of soundscape, which has been evaluated as "good" or "very good" by 47% of the participants in the period before COVID-19 emergency versus 73% during the lockdown period. Generally speaking, the majority of the subjects evaluated the relevance of soundscape in relation to the context as "very" in both the two considered

time frames. Nevertheless, a higher number of "extremely" answers was given in the lockdown period compared to the previous one: 72 vs 37. Anyway, the overall assessment of the environment, considering acoustic, visual, and safety aspects, had a positive increase during the lockdown: 65 more people defined the overall assessment of the environment as "good" or "very good".

3.3 Logistic regression models

In this paragraph, the results of the five models, mentioned in 2.2.2, are presented. All the models, even the not reported ones, include missing categories of the covariates. In the following tables, the p-values determine which variables are statistically significant in the regression model (*p≤ 0.1, **0.01<p≤ 0.05, ***p≤ 0.01).

In general, in logit models the reference category of the covariates is the first category, but the choice is not binding. In fact, any of the modalities of the covariate can be chosen as a reference. Given the arbitrariness of the choice, there is no specific literature to guide the selection of the best reference category. In this case, the authors chose to select as the reference category the one that appeared to have a

greater difference with the others so as to be able to better interpret the data. If the reference category is changed, the validity of the model itself does not change; what changes are the coefficients that are shown. If another category was chosen, therefore, the significance of the coefficients would no longer be highlighted, which instead emerge from the comparison with the category which results in a more different behaviour from the others.

Significant differences in the region of origin of the respondents were not detected in the obtained results.

First, the traffic noise model has been analysed. For commenting on the coefficients of the resulting models, the categorization of the response variables has to be kept in mind. In fact, as specified also in the method section, these variables take value 1 (positive) both if the response given in the lockdown period is lower than that given in the pre-lockdown period, and if the response remains unchanged but is one of the two lowest categories of perception of noise. The same also applies to the 0 (negative) value that is given both if the response given in the lockdown rather than pre-lockdown is higher, and if the response remains unchanged but in the three highest noise categories.

Table 16: Coefficients of the model for the traffic noise

Traffic	Coef.	Std. Err.
Age		
36-50	1.155**	0.533
51-65	1.388***	0.529
66+	0.852	1.354
Employment		
Self-employed	−1.635**	0.734
Public Sector Employee	−1.142	0.731
Private Company Employee	−1.262*	0.754
Not Working	−1.002	1.146
Other	−0.660	1.219
Intercept	2.615***	0.598

As shown in Table 16, passing from the pre-lockdown to the lockdown period the perception of traffic noise for the subjects of both the categories "36-50" and "51-65" years old improves if compared to the one of the reference category (< 35 years old). The reference category of the Employment covariate is "student", therefore all the employment coefficients, resulting from the model, compare the job's categories with the students. The coefficients show that the category "Self-employed" and "Private Company Employee" have a negative and statistically significant value. So, for the respondent belonging to one of these two work-

ing classes, compared to a student, leads to a worsening in the perception of the traffic between the two analysed periods.

In Table 17, the results of the model regarding the perception of nature sounds are reported.

Table 17: Coefficients of the model for nature sounds

Nature	Coef.	Std. Err.
Age		
< 35	−2.117**	0.961
36-50	−1.817*	0.972
51-65	−1.716*	0.935
Employment		
Self-employed	1.856**	0.815
Public Sector Employee	2.163***	0.792
Private Company Employee	1.933**	0.842
Student	2.337***	0.857
Other	2.347**	0.962
Intercept	0.043	0.568

Differently from the traffic noise, the model of nature sounds shows that all the categories of the variable age have a negative value. This means that respect to the reference categories (66+ years of age), the other categories present a worsening in the perception of nature sounds. In this case, the reference category of the covariate Employment is no longer "Student" but "Not Working". The coefficients of this model result all positive and statistically significant, so not being in the category "Not Working" involves an improvement in the perception of nature. This means that those who are not in the non-working category (retired and unemployed) tend to hear more the sounds of nature in the period during than in the pre-lockdown period.

The link between the covariates and the perception of the neighbourhood sounds in the period pre- and during the lockdown has been analysed in the following model.

Table 18 shows that living in a detached house or townhouse respect to living in an apartment leads to an improvement in the perception of neighbourhood sounds. As for the variable "Employment", where the reference variable is again "Not Working", all the coefficients are negative and statistically significant. This means, differently from what emerged in the previous model, that not being in the "Not Working" category implies a worsening of the perception of neighbourhood noise.

In Table 19, the results of the model for the assessment of soundscape are reported. As in the previous cases, a graph of the coefficients is shown as well.

Table 18: Coefficients of the model for the neighbourhood sounds

Neighbourhood Sounds	Coef.	Std. Err.
Type of dwelling		
Detached House	0.745***	0.289
Townhouse	0.723**	0.365
Employment		
Self-employed	−0.820	0.543
Public Sector Employee	−1.03**	0.501
Private Company Employee	−1.239**	0.565
Student	−0.937*	0.561
Other	−2.657***	0.833
Intercept	1.04**	0.471

Table 19: Coefficients of the model for the assessment of soundscape

Assessment of soundscape	Coef.	Std. Err.
Number of flatmates		
1	−0.566	0.668
2	1.303*	0.793
3	0.441	0.692
4+	−0.228	0.782
Relevance of soundscape in relation to the context		
Negative	−4.094***	1.155
Unchanged	−2.417**	1.075
Pleasant Soundscape		
Negative	−1.777**	0.740
Unchanged	−0.654	0.575
Annoying Soundscape		
Negative	−2.867***	0.771
Unchanged	−1.931***	0.628
Intercept	6.471***	1.340

Looking at the coefficients of the variable number of flatmates, it is observed that only the category "2" is statistically significant. So, having 2 flatmates rather than living alone leads to an improvement in the perception of the quality of the soundscape between the period before and during the lockdown. Regarding the last three covariates (Relevance of soundscape in relation to the context, Pleasant Soundscape, and Annoying Soundscape), it is observed that all coefficients are negative and statistically significant (only the coefficient of the "Unchanged" category for the variable pleasant soundscape is not statistically significant). This means that having a negative change or not having a change in the answers to these questions involves a worsening in the perception of the quality of the environ-

Table 20: Coefficients of the model for the overall assessment of the environment

Overall assessment of the environment	Coef.	Std. Err.
Relevance of soundscape in relation to the context		
Negative	−1.495**	0.628
Unchanged	−0.603	0.522
Assessment of soundscape		
Negative	−1.203*	0.676
Unchanged	−1.555***	0.467
Pleasant Soundscape		
Negative	−1.65***	0.645
Unchanged	−0.713	0.478
Chaotic Soundscape		
Negative	0.712	0.669
Unchanged	1.351***	0.458
Intercept	3.236***	0.536

ment compared to the reference category which is "Positive" (positive change in the answer to a specific question).

An additional model has been defined for studying the overall assessment of the environment. Results are reported in Table 20.

In this model, concerning the overall evaluation of the environment, it is shown that all the coefficients of the first three covariates result negative and statistically significant (except the category "Unchanged" for the variables Relevance of soundscape in relation to the context and Pleasant Soundscape). This means, as in the previous model, having a negative change or not having a change in the answers to these questions leads to a worsening in the perception of the quality of the environment compared to the reference category which is "Positive" which means a positive change in the answer to a specific question. The covariate regarding the chaos of the soundscape presents a positive and statistically significant value for the category "Unchanged". So, in this case, not varying the answer rather than responding with a higher (positive) value results in an improvement in terms of the overall evaluation of the environment.

4 Discussion

In this paragraph obtained results are commented.

According to the outcomes of the comparison between data referring to the pre-lockdown period and those referring to the lockdown one, an overall increase in the perception of nature and neighbourhood sounds is observed.

This is strictly related to the fact that people during the lockdown were forced to stay at home and were more inclined to pay attention to those typologies of sounds. The reduction in terms of annoyance, which has been observed among most of the sounds, may have been induced by the limitation of traffic flows. Coherently, the improvement in terms of soundscape perception, passing from the first to the second evaluation period, is a direct consequence of the road, air, rail and ship traffic reduction. Moreover, the positive increase in the overall assessment of the environment suggests that a correlation is present between acoustic perception and overall environment perception.

Regarding logistic models, first of all, it is observed that during the lockdown period, compared with the pre-lockdown one, people with an age between 36 and 65 hear more traffic noise than younger ones. This statement might be correlated to a higher sensitivity of elder people in isolated sound events, which have characterized the soundscape of this period together with reduced background noise. Moreover, this age range corresponds to the working category, which has perceived more traffic noise than the students, as shown by the model. This can be explained as, in most of the cases, the working category has not reduced its tasks and has been subject to stress. Nevertheless, it has to be pointed out that the working category was not used to spend time at home. Therefore, the answer given by workers, with reference to the lockdown period, might be also influenced by the memory of the sounds they heard when they were at home, presumably in the early morning or late in the afternoon and also by the possible different context in which the living and the working environment is located.

Concerning the evaluation of the sounds of nature, those who are not in the not working category (retired and unemployed) tend to hear more nature sounds in the period during than in the pre-lockdown period. This can be due to the fact that these categories of people, not engaged in work activities, have been more likely during lockdown to pay attention to the sounds of nature, which tend to be more evident due to the reduction in road traffic.

About the evaluation of neighbourhood noise, as expected, living in a detached house or townhouse respect to living in an apartment leads to an improvement in the perception of neighbourhood sounds causing also anxiety and conflicts problems. In line with expectations, people not belonging to the "Not Working" category appear more sensitive to the noise produced by neighbourhood. This aspect may also be influenced by the evidence that they spend more time at home, therefore they are subject to uncommon sounds which are different from the office environmental noise.

Regarding the soundscape quality evaluation, data show that the respondent is more inclined to give a positive judgement if he/she does not live alone but with 2 flatmates. This can be due to the fact that tackling the lockdown period on your own can lead to a more negative view of various life aspects. Moreover, as expected, a significative relationship exists between the appropriateness, pleasantness and annoyance of the soundscape and its positive judgement.

As expected, the relationship between the perception of the soundscape and the perception of the overall environment turns out that the acoustic quality statistically significantly influences the evaluation of the environment considered as a whole.

The findings of this study have to be seen in the light of some limitations. Authors are firmly convinced that those limits need to be explained in order to be improved by themselves in future studies and also by others who may replicate an analogous study in Countries different than Italy.

The first issue concerns the sample selection, and in particular, the limited ability (mainly due to the particular situations that authors, as all researchers and technicians in the field, had to face during the lockdown period) to gain access to the appropriate type or geographic scope of participants. In this case, the people who responded to your survey questions did not truly be a random sample as respondents were mainly from Tuscany region according to the authors' location and facility to involve people in the questionnaire's filling.

Moreover, the strategy adopted for the questionnaire's submission, that consisted in sending personal invitation for a digital filling or to advertise it on websites and social networks of potential interest for the respondents (*e.g.* the one of the Acoustical Society of Italy), besides presenting several practical advantages especially in a period in which in person interviews were difficult to be carried out, limited the possibility of giving real time clarifications to the respondents.

In addition, although information has been asked in the questionnaire regarding the geographical coordinates and the typology of the dwelling of the respondents, a posteriori it can be said that a question regarding the typology of inhabited areas (city, country, suburbs, etc.) should have been added in order to try to give further explanations to some other typologies of answers (*e.g.* to question concerning the typology of noise sources heard).

Finally, since the phenomenon of Covid-19 pandemic and the related terminology were new for the respondents and also for the authors, some confusion has been generated between the words "quarantine" and "fiduciary isolation" when respondents have been asked about their potential involvement with these conditions.

5 Conclusions

COVID-19 pandemic is having a strong impact on people. Alongside the terrible toll we are paying, in terms of loss of human lives, social problems and difficulties in local and global public health management, lockdown measures have interested not only the styles of life but changes in terms of acoustic perception, as observed in this paper.

Thanks to the results of the online survey promoted by the Acoustical Society of Italy (AIA) and Vie en.ro.se Ingegneria, it has been possible to compare the changes in acoustic perception in the period before the DPCM 11 March 2020 and lockdown period (the current period at the time of filling in the questionnaire). The results have confirmed the expectation of a general reduction of annoying sounds. As a matter of fact, this time frame has produced a positive impact on people in terms of acoustic perception: during the lockdown, reduced traffic noise and remote working from home has determined an unexpected scenario.

A deepened investigation has been made using the logistic regression models, which allow correlating the given answers - referred to the period before the DPCM 11 March 2020 and the lockdown period - with the other variables. As a result, it has been observed the variation has been influenced by some opinions on the soundscapes (pleasant, chaotic and annoying), the assessment and relevance of soundscapes in relation to the context, the epoch (year) of dwelling construction, the number of flatmates the dwelling is shared with, the type of dwelling, the employment, the age and, the acoustic improvements brought to the dwelling. Therefore, the importance of evaluating a wide range of factors has emerged as fundamental for a proper analysis.

The main end-users of the designed models, and in particular of the obtained results, are especially acousticians expert in soundscape, citizen science and psychoacoustics who are interested in understanding how citizens react in relation to changes concerning the acoustic environment and especially in this specific opportunity given by the Covid-19 pandemic. Moreover, obtained data may be of some interest also for environmental experts and policy makers, in order to understand how changes in people's behaviour due to a pandemic such the Covid-19 one can lead to positive effects for the environment and in particular for the exposure to noise.

As the lockdown period is over in most of the countries, it might be interesting to change the point of view and compare the current evaluation of sounds with the previous lockdown period. In this perspective, additional analysis on how the lockdown period has changed the perception of sounds might be considered. Moreover, further development of the study for future outlook might provide to spread it in other Countries for a global evaluation of the data, translating questionnaire in English and in native languages of interesting areas of the world and adapting, as far as possible, to local characteristics of buildings and habits of people and communities.

Conflict of Interests: The authors declare no conflict of interest regarding the publication of this paper.

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Appendix I

Noise perception before and during COVID-19 pandemic

This questionnaire is promoted by the Acoustical Society of Italy (AIA), in collaboration with Vie en.ro.se Ingegneria. The objective of this questionnaire is to collect data on the perception of the sound environment in the period before the emergency from COVID-19 and the current one (lock-down period). In addition to some initial questions of a general nature, we ask you to answer 9 questions relating to the period prior to the Prime Ministerial Decree of 11 March 2020 containing further measures on the containment and management of the epidemiological emergency from COVID-19 on the whole national territory and the same 9 questions referring to the lockdown period.

We invite you to answer all the questions in the order in which they are listed, following the indications provided. This survey collects your data anonymously.

We inform you that the processing will in any case be confidential and the subsequent publication of the results will be carried out in such a way as to make it impossible to trace the answers given by the interviewed person.

PERSONAL DATA

Question n.1 – Age

○ < 20
○ 20-35
○ 36-50
○ 51-65
○ 66-80
○ > 80

Question n.2 – Sex

○ Female
○ Male

Question n.3 – Enter your location: enter your address in the "search for place or address" space and then click on the corresponding point on the map, so that the geographical coordinates of your location appear

latitude (x.y°)

longitude (x.y°)

altitude (m)

accuracy (m)
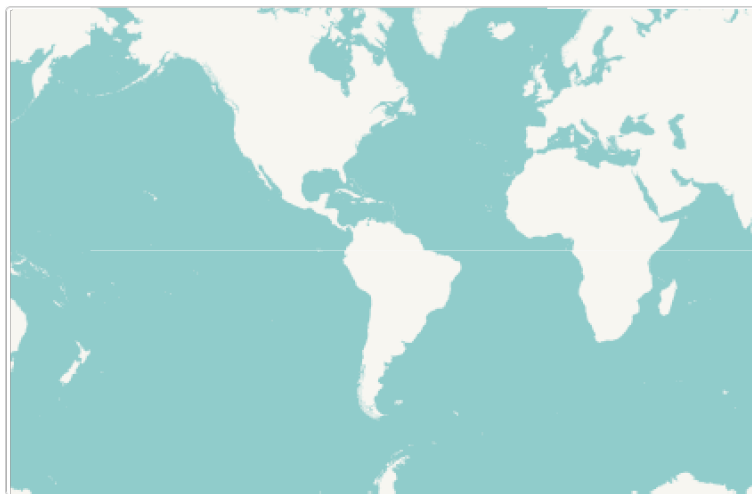
Question n.4 – Education

○ Primary school diploma

○ Middle school diploma

○ High school diploma

○ Degree

○ PhD

○ Master

Question n.5 – Employment

○ Self-employed

○ Public sector employee

○ Private company employee

○ Worker

○ Shop keeper

○ Teacher

○ Researcher / Professor

○ Student

○ Retired

○ Unemployed

○ Other

CONTEXT ANALYSIS

Question n.1 - Fiduciary isolation or quarantine from COVID-19 involved:

○ Myself

○ Only family members / rela-tives / friends

○ No one I know

○ I do not know

DWELLING

Question n.1 – What type of house do you live in?

○ Apartment

○ Detached house

○ Townhouse

Question n.2 – How many people do you share your home with?

Question n.3 – In which years was the house you live in built?

◯ Before 1970

◯ 1970 – 1990

◯ 1990 – 2000

◯ After 2000

◯ I do not know

Question n.4 – After construction, have any acoustic improvements been made to your home (e.g. change of windows, construction of counter walls, etc.)?

◯ Yes

◯ No

◯ I do not know

If yes, please specify which one/ones

QUESTIONS RELATING TO THE PERIOD BEFORE THE ENTRY INTO FORCE OF THE DPCM 11 MARCH 2020
on further measures for the containment and management of the epidemiological emergency from COVID-19 throughout the Country

Question n.1 – How loud was the noise coming from the outside that you heard from your home? (Select the option you consider as the most appropriate)

◯ Not at all

◯ Slightly

◯ Moderately

◯ Very

◯ Extremely

Question n.2 – To what extent and what kind of sounds could you hear from your home? (Select the option you consider as the most appropriate)	*Not at all*	*Slightly*	*Moderately*	*Very*	*Extremely*
Road traffic	◯	◯	◯	◯	◯
Rail traffic	◯	◯	◯	◯	◯
Overflights	◯	◯	◯	◯	◯
Nature sounds (birds chirping, wind rustling, water flowing, leaves rustling…)	◯	◯	◯	◯	◯
Neighborhood sounds (voices, movements of people, mechanical noises, …)	◯	◯	◯	◯	◯
Mechanical, electrical, (etc.) sounds coming from outside and not produced by neighbours	◯	◯	◯	◯	◯

Question n.3 – How annoying do you find the sounds you could hear from your home? (Select the option you consider as the most appropriate)	Not at all	Slightly	Moderately	Very	Extremely
Road traffic	○	○	○	○	○
Rail traffic	○	○	○	○	○
Overflights	○	○	○	○	○
Nature sounds (birds chirping, wind rustling, water flowing, leaves rustling...)	○	○	○	○	○
Neighborhood sounds (voices, movements of people, mechanical noises, ...)	○	○	○	○	○
Mechanical, electrical, (etc.) sounds coming from outside and not produced by neighbours	○	○	○	○	○

Question n.4 – To what extent and where did the noise from the neighbourhood most frequently come from? (For each direction of origin of the noise, select the option that you consider as the most appropriate)	Not at all	Slightly	Moderately	Very	Extremely
Upper floor	○	○	○	○	○
Side walls	○	○	○	○	○
Lower floor	○	○	○	○	○

Question n.5 – How annoying do you think the noise produced by the neighbourhood was? (For each direction of origin of the noise, select the option that you consider as the most appropriate)	Not at all	Slightly	Moderately	Very	Extremely
Upper floor	○	○	○	○	○
Side walls	○	○	○	○	○
Lower floor	○	○	○	○	○

Question n.6 – Express your level of agreement with the following statements, with reference to the soundscape you perceived from your home. (For each adjective select the option you consider as the most appropriate)	*Strongly Disagree*	*Disagree*	*Undecided*	*Agree*	*Strongly Agree*
Pleasant	◯	◯	◯	◯	◯
Chaotic	◯	◯	◯	◯	◯
Inspiring	◯	◯	◯	◯	◯
Boring	◯	◯	◯	◯	◯
Resting	◯	◯	◯	◯	◯
Annoying	◯	◯	◯	◯	◯
Vibrant	◯	◯	◯	◯	◯
Monotonous	◯	◯	◯	◯	◯

Question n.7 – How do you assess the quality of the sound environment that was around you? (Select the option you consider as the most appropriate)

◯ Very Poor

◯ Poor

◯ Acceptable

◯ Good

◯ Very good

Question n.8 – Do you think that the sound environment around you was appropriate to the context? (Select the option you consider as the most appropriate)

◯ Not at all

◯ Slightly

◯ Moderately

◯ Very

◯ Extremely

Question n.9 – How do you overall assess (sound, vision, safety, etc.) the environment you perceived around your home? (Select the option you consider as the most appropriate)

◯ Very Poor

◯ Poor

◯ Acceptable

◯ Good

◯ Very good

QUESTIONS RELATED TO THE CURRENT PERIOD (LOCKDOWN)

Question n.1 – How loud is the noise coming from the outside that you hear from your home? (Select the option you consider as the most appropriate)

○ Not at all
○ Slightly
○ Moderately
○ Very
○ Extremely

Question n.2 – To what extent and what kind of sounds can you hear from your home? (Select the option you consider as the most appropriate)	Not at all	Slightly	Moderately	Very	Extremely
Road traffic	○	○	○	○	○
Rail traffic	○	○	○	○	○
Overflights	○	○	○	○	○
Nature sounds (birds chirping, wind rustling, water flowing, leaves rustling…)	○	○	○	○	○
Neighborhood sounds (voices, movements of people, mechanical noises, …)	○	○	○	○	○
Mechanical, electrical, (etc.) sounds coming from outside and not produced by neighbours	○	○	○	○	○

Question n.3 – How annoying do you find the sounds you can hear from your home? (Select the option you consider as the most appropriate)	Not at all	Slightly	Moderately	Very	Extremely
Road traffic	○	○	○	○	○
Rail traffic	○	○	○	○	○
Overflights	○	○	○	○	○
Nature sounds (birds chirping, wind rustling, water flowing, leaves rustling…)	○	○	○	○	○
Neighborhood sounds (voices, movements of people, mechanical noises, …)	○	○	○	○	○
Mechanical, electrical, (etc.) sounds coming from outside and not produced by neighbours	○	○	○	○	○

Question n.4 – To what extent and where the noise from the neighbourhood most frequently come from? (For each direction of origin of the noise, select the option that you consider as the most appropriate)	*Not at all*	*Slightly*	*Moderately*	*Very*	*Extremely*
Upper floor	O	O	O	O	O
Side walls	O	O	O	O	O
Lower floor	O	O	O	O	O

Question n.5 – How annoying do you think the noise produced by the neighbourhood is? (For each direction of origin of the noise, select the option that you consider as the most appropriate)	*Not at all*	*Slightly*	*Moderately*	*Very*	*Extremely*
Upper floor	O	O	O	O	O
Side walls	O	O	O	O	O
Lower floor	O	O	O	O	O

Question n.6 – Express your level of agreement with the following statements, with reference to the soundscape you perceive from your home. (For each adjective select the option you consider as the most appropriate)	*Strongly Disagree*	*Disagree*	*Undecided*	*Agree*	*Strongly Agree*
Pleasant	O	O	O	O	O
Chaotic	O	O	O	O	O
Inspiring	O	O	O	O	O
Boring	O	O	O	O	O
Resting	O	O	O	O	O
Annoying	O	O	O	O	O
Vibrant	O	O	O	O	O
Monotonous	O	O	O	O	O

Question n.7 – How do you assess the quality of the sound environment around you? (Select the option you consider as the most appropriate))

O Very Poor
O Poor
O Acceptable
O Good
O Very good

Question n.8 – Do you think that the sound environment around you is appropriate to the context? (Select the option you consider as the most appropriate)

○ Not at all

○ Slightly

○ Moderately

○ Very

○ Extremely

Question n.9 – How do you overall assess (sound, vision, safety, etc.) the environment you perceive around your home? (Select the option you consider as the most appropriate)

○ Very Poor

○ Poor

○ Acceptable

○ Good

○ Very good

THANK YOU FOR YOUR KIND AND PRECIOUS COLLABORATION