Article title: How did "state of emergency" declaration in Japan due to the COVID-19 pandemic affect the acoustic environment in a rather quiet residential area?

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(Cover letter to the Original Submission)

Kobe, 30 May 2020

Re: Submission of a manuscript possible publication in UCL Open Environment

Dear Editor and Journal Manager

I am pleased to submit a manuscript for consideration of publication in UCL Open Environment (COVID-19 Special Issue) as an Open Commentary.

This submission reports the results and observations from my recent work made during "state of emergency" declaration due to COVID-19 pandemic and immediately after its cancellation. The work consists of noise levels measurements, some points and fixed point, and perceptual observations in rather quiet residential area in Kobe and Ashiya, Japan, which were carried by the author alone. Although the restriction of the laboratory at the university, professional precision instruments were not available, I could obtain reasonably reliable measured values using a calibrated smart devices. Therefore, at least one can understand what change was observed in acoustic environment in the surveyed area due to the "emergency state declaration", which is not exactly the same as "lockdown" in other countries.

Recently some quick reports are found in the internet reporting a large reduction of noise levels in busy area in a large cities and large infrastructures such as road traffic network, etc., however I cannot find any information about such an effect in residential area.

Therefore, it is of some value to report such an example like this manuscript.
Once again, I appreciate very much to take this opportunity, and hope that this can reach your high standard of the quality of publications.

Looking forward to hearing from you.

Kindest regards
Kimihiro Sakagami
Professor of Environmental Acoustics
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(Cover letter to Revised Version)

Dear Editors

In this revised version, I have added some results from statistical analyses (t-test, analyses of variance, etc).

Also, I added some more explanation and clarification to improve the readability of the manuscript.

Finally, I added an Endnote to comment on the further change (though it is gradually changing) after the first submission of this contribution.

I hope that the above additional information makes the manuscript more informative and readable.

Kindest regards

Kimihiro Sakagami

(Summary of the revisions)

Dear Editors and Reviewers

The author would like to express his sincere gratitude for your editorial work, and most useful comments from the Reviewers. In this revision, the following points were amended in response to the Reviewers' and Editors' comments, as well as, some further consideration including the points raised by the open comment. All revisions are marked with red font.

1. The results of the accuracy check of the device and app for measurement performed after the submission of this manuscript was added in Appendix A. The summary of the accuracy check are described, and the results are shown in Figure A1. The author considers that the results show quite reasonable accuracy and satisfactory for the present work.

2. In response to Reviewer, Mr Simone Torresin, some discussions on the results presented in the manuscript have been amended. All are marked in red. Also, in response to Reviewer, Mr Jose Almagro, the author added the above-mentioned Appendix A, and some amendments all marked in red.

3. In Concluding remarks, some comments obtained from a small survey which the author performed with his students were added in connection to the results obtained in the work presented in this manuscript.

4. Some references were added to the literature survey in response to the Reviewers' comments.

5. In response to the comments from the Editor, Figs. 2-4 are reorganised. Also, the author added Fig. 7 the comparison of the composition of noise sources is now shown. The Editor recommended to combine Figs. 5 and 6 into one bar-graph, however, the author considers that it may better to keep Figs. 5 and 6 stay, because some sources in Fig. 5 disappear in Fig. 6, and it may be reader-friendly to show each graph first as a detailed information: the author consider this can be somewhat helpful though it may be redundant a little.

Once again, thank you very much for the comments from Editors and Reviewers, the author sincerely appreciate their time and effort. The author hopes that this version satisfies the high scientific standard of UCL Open Environment.

Kind regards

Kimihiro Sakagami (Author)

Open Commentary

How did “state of emergency” declaration in Japan due to the COVID-19 pandemic affect the acoustic environment in a rather quiet residential area?

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Abstract
The COVID-19 pandemic caused lockdown in many countries. Acousticians made surveys to monitor how cities became quieter under the lockdown, mainly in the central areas of cities. However, there have been few studies on changes in the acoustic environment due to the pandemic in rather quieter residential areas. It may be expected to be different from the effect in “originally noisy” areas. Also, the effect could be different in Japan, because the “state of emergency” declaration there was different to lockdown. Considering these circumstances, this paper reports the results of noise monitoring and makes some observations on the acoustic environment in residential areas remote from city centres, to provide an example of how the acoustic environment was affected by the “state of emergency” declaration due to the COVID-19 pandemic in Japan. The results showed that the reduction of noise levels was somewhat smaller than that reported in large cities. Also, comparing the results after the cancellation of the “state of emergency”, the noise level increased again. However, observations of noise sources imply that a possible change in human behaviour may have also affected the acoustic environment.

Keywords: Acoustic Environment, Noise Level, Residential Area, State of Emergency in Japan, Lockdown, COVID-19 Pandemic

1. Background

On 16 January 2020, the first Japanese person infected with coronavirus (COVID-19) was found and then reported in newspapers a few days later [1]. Since then, the Government of Japan announced a precautionary action to the public. However, the number of infected continued to rise, and finally, on 7 April, the Government declared a “state of emergency” to seven prefectures; on 16 April, it was expanded to all prefectures, which continued until 25 May 2020, when the declaration was formally cancelled in all prefectures.

A “state of emergency” is not exactly the same as “lockdown”: under a “state of emergency”, the Government and local government can “request” or “instruct” the population not to engage in particular activities which possibly spread the infection, e.g., eating facilities had to shorten their opening hours or close until the declaration was cancelled [2]. Therefore, although people were requested to stay home unless they have essential needs or are essential workers, with careful precautions they could go out to work or go shopping.

In fact, a certain number of people worked from home, whereas some workers commuted by train, bus, or other public transport. Schools at all levels were closed and most universities switched to online classes. Therefore, it is indeed the case that, during this period, there were many fewer people even in the centre of cities, though some human activity was observed.

In short, a “state of emergency” is not as strict as “lockdown”, which occurred in many other countries. Yet, it was reported that the behaviour of people changed after its cancellation [3].

Discussions on various aspects are needed to consider urban environments after this pandemic [4,5]; however, this paper focuses on the urban acoustic environment. There are already many acousticians who reported changes in the acoustic environment, particularly noise levels, in the central areas of various cities, e.g., references [6-9].

However, in this paper, some observations on the acoustic environment in a rather quiet residential area are reported for the following two reasons: (1) Most reports concentrate on urban areas which originally had higher noise levels and discuss how noise levels are reduced, but it seems that there are fewer reports of observations in originally quiet residential areas. Given the fact that a considerably wider area of a city is categorised as residential, it is important to know what the change was like in such an area. (2) As mentioned above, Japan’s “state of emergency” is not exactly the same as “lockdown” in other countries, which means the activities and behaviours of people may have been different from those in the countries under “lockdown” in the strict sense.

Regarding the acoustic environment (and soundscape) research, Nagahata [10] published an archive of sound data recorded in Fukushima, Sendai, and Tokyo Metropolis. This archive is invaluable for further analyses, including perceptual evaluation. In this paper, only measured noise levels are presented with some noticeable perceptual features heard during the measurement. The survey was done from 13 to 28 May 2020, to compare the results during the “state of emergency” and after it was cancelled. Also, for reference, the author’s data were compared with measurements in November and December 2019 in the same area. The survey’s main purpose is to provide an example of the extent to which the acoustic environment changed during the declaration of the “state of emergency” in a rather quiet residential area, and is not intended to be generalized, as this is a case study in one limited area.

2. Surveyed area and method

Figure 1 is a map of the surveyed area, eastern edge of Kobe. All measuring points are marked in the figure. Construction sites were marked with “X”. At these points, the construction works were stopped from the end of February 2020, but in most of the sites, work resumed in early May 2020. The author does not understand the circumstances behind this fact.

This area is designated as scenic (it is prohibited to construct a building taller than five storeys) and residential (no commercial buildings are allowed). This area is occupied by mainly two-storey detached houses, but there is also a somewhat large number of small and large apartments of three to five storeys. In 2019, the noise levels of this area were surveyed as a follow-up to the author’s previous study [11], and the results demonstrated that it was rather quiet except for occasional cars passing by. For other data sets in the same area, three sets of geo-referenced sound data taken in August-October 2019 using iPhone XS and three apps (dB Meter Pro, Decibel X and SoundLog) are available in reference [11] in which instantaneous SPL (dBA, slow, peak) taken by dB Meter Pro and Decibel X and L_{Aeq} taken by SoundLog.

In the east of this area is a River, the riverbed of which is wide and open to the public, and along the river there is a rather busy street with moderate traffic volume. In the north are Route 43 and a motorway (elevated), which are quite busy, and in the far south there is another highway. From those main sources of traffic, continuous noise can be heard, though faintly, throughout the day.

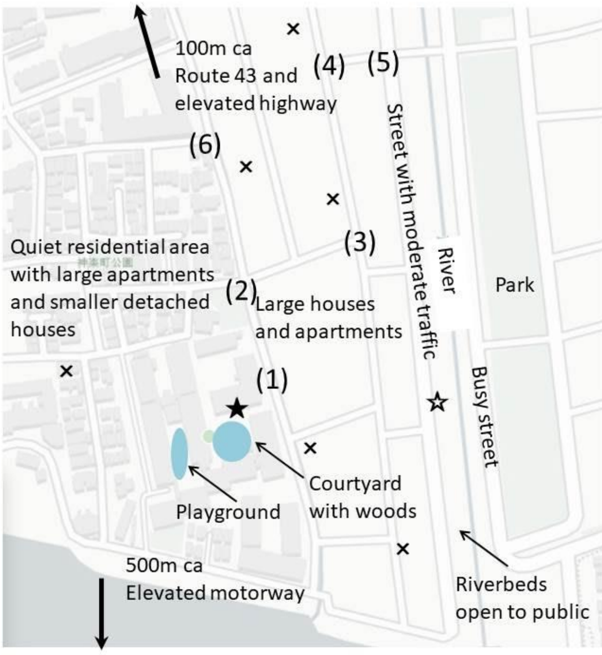

Figure 1. Map of the surveyed area (eastern edge of Kobe). The numbers (1) to (6) show measuring points. The black star is the measuring point for fixed-point observation. The white star is the measuring point for monitoring noise levels in the public space (riverbed). The X marks show construction sites.

The measurements of equivalent continuous A-weighted sound pressure level, L_{Aeq} (T=30 s) were performed by using the NoiseCapture app for Android [12] which is widely known and used as a reliable tool for noise monitoring, although it cannot replace professional Class 1 sound level meters (SLMs). The device used was an Android tablet (Teclast tPad P80X). Although the detailed check of accuracy was not performed, the NoiseCapture app is solely available for Android and is of great advantages to record the GPS data of measured points and noise source perceived, it was decided to be used for this work. The app on this device was calibrated using a Class 1 SLM before the laboratory closed due to the state of emergency.

The measurement accuracy was checked later in comparison with Class 1 SLM after the survey in a laboratory test, and it was confirmed that this measurement system could present reasonable accuracy for the present purpose (See Appendix A). Also, the short duration of the average (T=30 s) was taken because the sounds measured in this environment were almost steady state. Of course, the results below obtained by this short duration will not be suitable to compare with the data obtained by other authors, e.g., Asensio et al. [13], however, considering that the purpose of this work is limited to understanding the acoustic environment of this particular area.

3. Results and observations

3.1. The noise levels at points (1)-(6)

Table 1 shows the results of the noise levels (L_{Aeq}, T=30 s) measured at points (1) to (6). e Averaging over rather short time (T=30s) was chosen as the noise in this area hardly showed large time fluctuation and almost steady state noise. The measurement was repeated once at each point at the same hour (10-11 am). Levels larger than 60 dBA were likely to be affected by nearby construction sites and/or increased traffic volume. The levels in data taken during the emergency state (13 May 2020) were higher than those in 2019: this is likely due to the increased traffic and/or construction works. The same observation can be applied to those taken after the state of emergency was cancelled (25 May 2020). Removing the data possibly affected by construction noise, the three sets of data show some difference, but it is not very significant. For example, when the levels larger than 60 dBA were removed from all the data sets, the average levels were 50.5, 51.6, and 52.9 dBA. The relative level to the average value of 2019 survey are also shown in Table 1. This may be interpreted as that both during the "state of emergency" and after its cancellation, the noise level was in a tendency of increasing. Thus, a possible effect can be observed and interpreted as the increased traffic volume observed and construction works in this area in May 2020: During the state of emergency, a certain number of people used a car or motorbike for commuting, shopping, and travelling for various purposes, which should have increased traffic volume in this area.

Table 1. Noise levels (L_{Aeq}), dBA, at points (1)-(6).

Point	Nov and Dec 2019	13/5/2020	25/5/2020
1	52.3	45.7	44.7
2	48.6	63.7	50.1
3	53.9	64.6	61.1
4	48.5	59.3	56.9
5	65.1	55.4	59.4
6	49.3	45.9	53.5
Average 1-6	52.9	55.8	54.3
Relative level (to 2019)	0	+2.9	+1.4

For reference, previous survey in the same area (except for the point 6) in August-October 2019 [11] showed that: Instantaneous noise levels (dBA, slow, peak) were 44.8 dBA (minimum, Point 1) to 64.8 dBA (maximum, Point 5). This range roughly corresponds to the above results, which can be inferred that, though the variation due to the day is observed in Table 1, the noise levels fall into the range observed in those observed in usual state.

Although the average values seem to suggest a slightly increasing trend of the noise levels in this area during and after the state of emergency, and by observation this could be attributed to increased traffic volume and construction noises, it was not conclusive enough as the number of the measurement could not be enough and the data set was not complete.

3.2. Fixed-point observations

3.2.1. Noise levels

The L_{Aeq} at the balcony of an apartment (third floor of a five-storey building) was monitored from 13 to 19 May 2020 (during "state of emergency") and from 23 to 28 May 2020 (after the cancellation). The measurement was performed every hour from 07:00 to 19:00, and at 24:00 for reference. The measurement point faced a courtyard with many trees, and was surrounded by four premises of five-storey apartments. Therefore, this point is usually very quiet (around 40 dBA at midnight). There are occasional children's activities in the courtyard during daytime. Also, there is a playground for children in the apartment which is sometimes quite vibrant in the daytime to the early evening.

The measured values were expected to show some consistent trend; however, there is no such trend, and they randomly vary day to day. However, Sunday and Saturday show different trends from each other, and are different from weekdays. Therefore, the data for weekdays were averaged, and data for Saturday and Sunday were presented separately.

Figure 2 compares the noise levels, L_{Aeq}, duration was again taken as T=30 s as the noise showed only small time fluctuation (in some cases 10 s to avoid sudden large sounds) for weekdays (averaged for each hour) measured under the "state of emergency" and after its cancellation. As is observed, during the "state of emergency", noise levels did not show significant variation in a day and were almost constant, therefore there is no strong correlation (the correlation coefficient was R = 0.52): however, after the cancellation, the levels somewhat increased (the average difference is 2.5 dBA) except for early morning and midnight. This difference is considered as significant ($p < 0.05$, t=2.55). The large difference observed at 11:00 was considered very likely to come from construction noise in neighbouring sites.

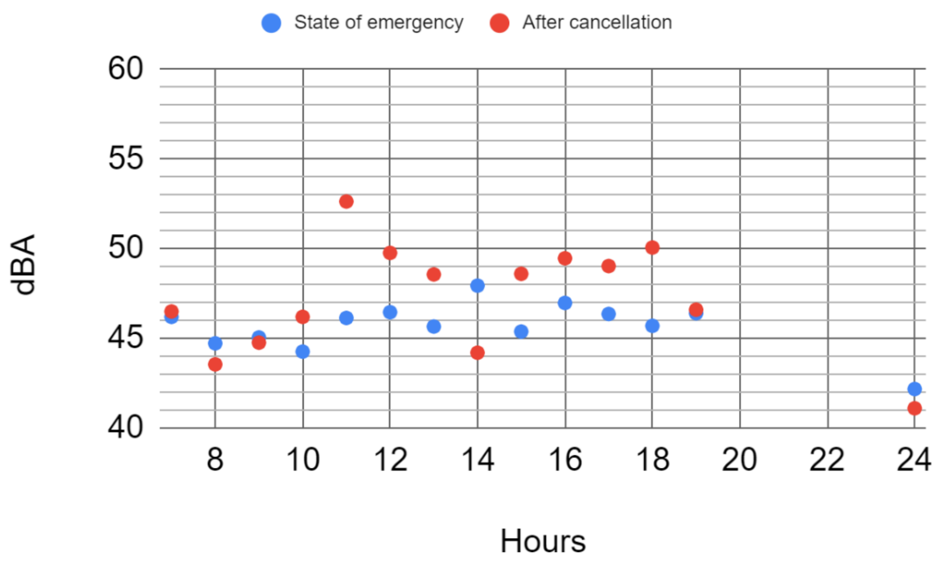

Figure 2. Comparison of the day history of the noise levels (L_{Aeq}, T=30 s) of weekdays during "state of emergency" (blue) and after its cancellation (red). The plot of each hour is the averaged value over all weekdays during the observation period.

Figures 3 and 4 show the measured values for Saturday and Sunday, respectively. Results of analyses of variance show that the difference between during and after the "state of emergency" was not significant for Saturday (p = 0.55), but somewhat significant for Sunday (p = 0.1): Although each one set was given, the noise level on Sunday after the cancellation of the declaration (average 46 dBA ca) may have been larger than during the "state of emergency" (average 44 dBA ca). Although it is hard to find a consistent tendency, Saturday can be considered to be noisier than Sunday (not statistically significant: p > 0.1). Particularly, by observation it was understood that, after the cancellation of the "state of emergency", residents tended to go out in the morning. In many cases, people tended to go out on Saturday and stay home on Sunday to recuperate for work on Monday in general. In these figures, it can be observed that this behaviour was reflected.

Putting inferences aside, considering these three graphs, we can obtain only a few observations: (1) During the "state of emergency" this area was slightly quieter, but no consistent tendency of day to day noise-level variation appeared in the results. (2) Saturday was assumed to be the noisiest day of the week in both cases.

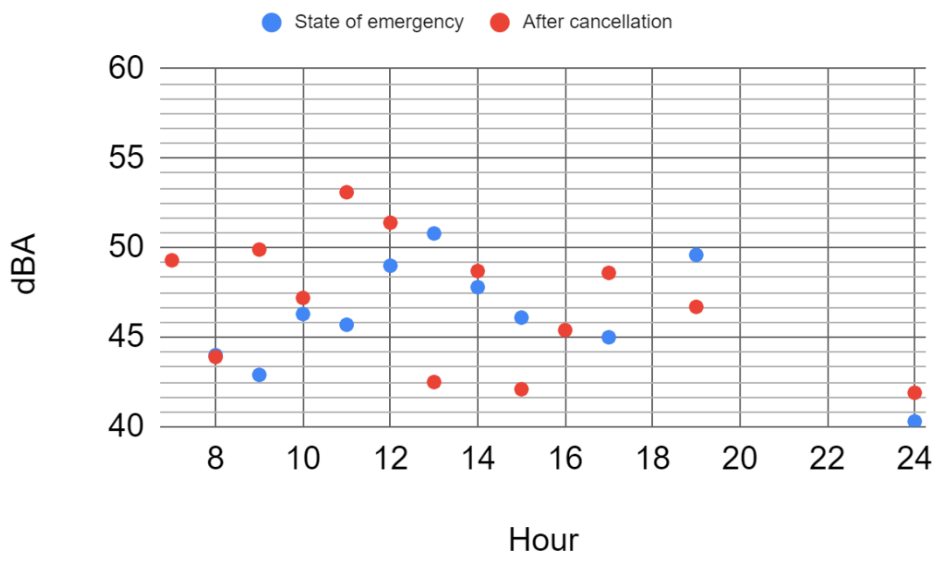

Figure 3. Comparison of the day history of the noise levels (L_{Aeq}, T=30 s) of Saturday during the "state of emergency" (16 May 2020) (blue) and after its cancellation (23 May 2020) (red).

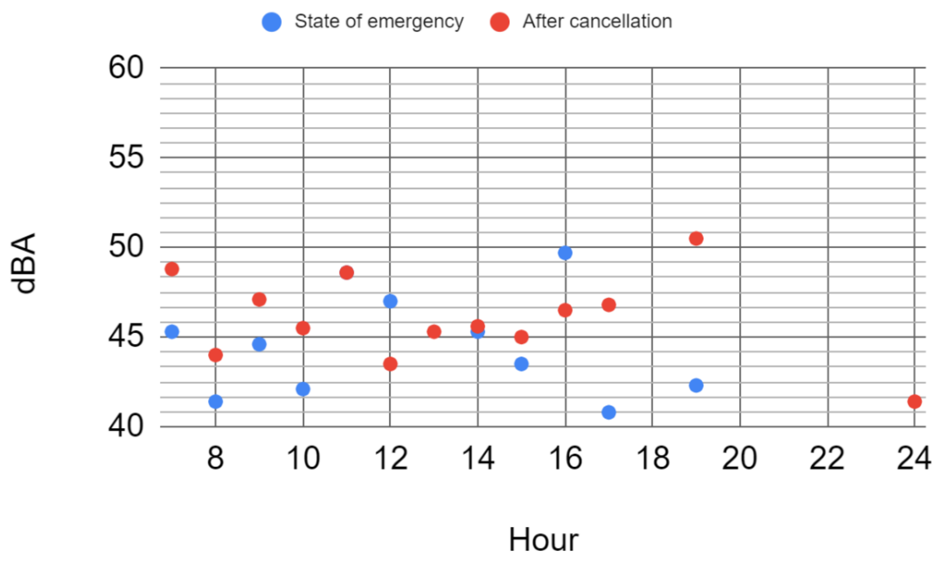

Figure 4. Comparison of the day history of the noise levels (L_{Aeq}, T=30 s) of Sunday during the "state of emergency" (17 May 2020) (blue) and after its cancellation (24 May 2020) (red).

3.2.2. Perceived noise sources

Regarding the noise sources, perceived noise sources are shown according to their percentage in Figure 5 (during the "state of emergency") and Figure 6 (after its cancellation).

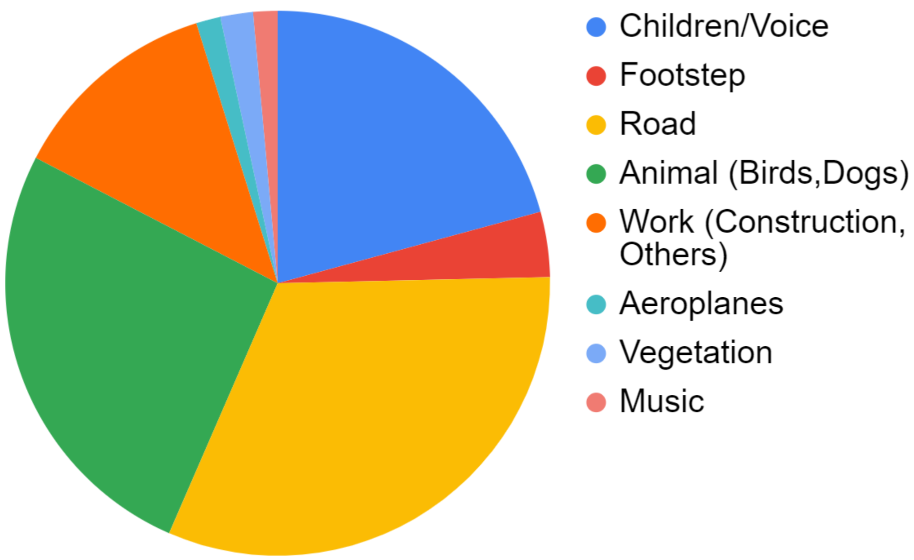

Figure 5. Main noise sources perceived during the measurements under the "state of emergency".

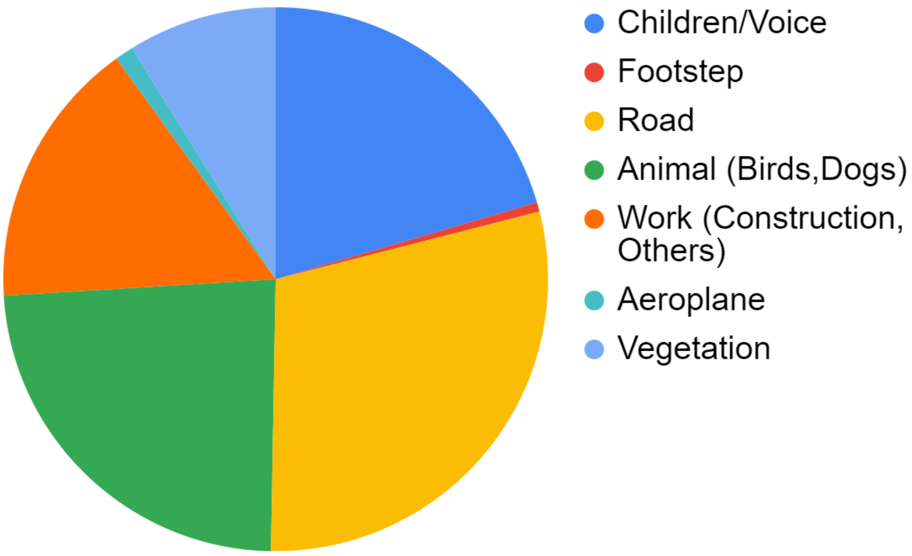

Figure 6. Main noise sources perceived during the measurements after the “state of emergency” was cancelled.

Comparing these two graphs, and also from Figure 7 in which two results are compared, it can be seen that the main noise sources are not different from each other. In this area, as mentioned in Section 2, the road traffic noise from two main traffic sources (31.9 % during the “state of emergency” and 29.3 % after its cancellation) is noticeable throughout the day, though it is not very strong; therefore, it was perceived in most measurements. Voices and children are the main sources in both cases (under declaration 20.8 %, after cancellation 20.4 %). After the cancellation of the “state of emergency”, all schools remained closed and children stayed home, which is one of the reasons why their voices were a main source. By perceptive observation, it was noted that children's voices were most dominant in the morning and early evening. This is assumed to be a result of their daily behaviour, which may change after school resumes.

As for the contribution of animals (under declaration 26.1 %, after cancellation 23.8 %), mainly birds in this area, it was more frequently and loudly perceived during the “state of emergency”. This may have been due to the variation of the noise levels of other sources, or possibly due to the relationship between the behaviours of birds and humans—as mentioned below, the river and park where birds had been often seen before were rather crowded during the “state of emergency” with people who may have finished their remote work, with families, and children not going to school; this made these places somewhat noisier, which could drive birds from the river and park.

As for some of the sources of small contribution, e.g., music was sometimes heard during the “state of emergency, however, was not heard after its cancellation. Regarding music, most heard was recorders probably played by primary school pupils. For aeroplane, the contribution was low in both cases because flights were reduced both during and after the declaration of the “state of emergency”.

In that, regarding noise source observed in the point, the main sources were not significantly changed during the “state of emergency” and after its cancellation: almost the same sounds were heard in the both periods.

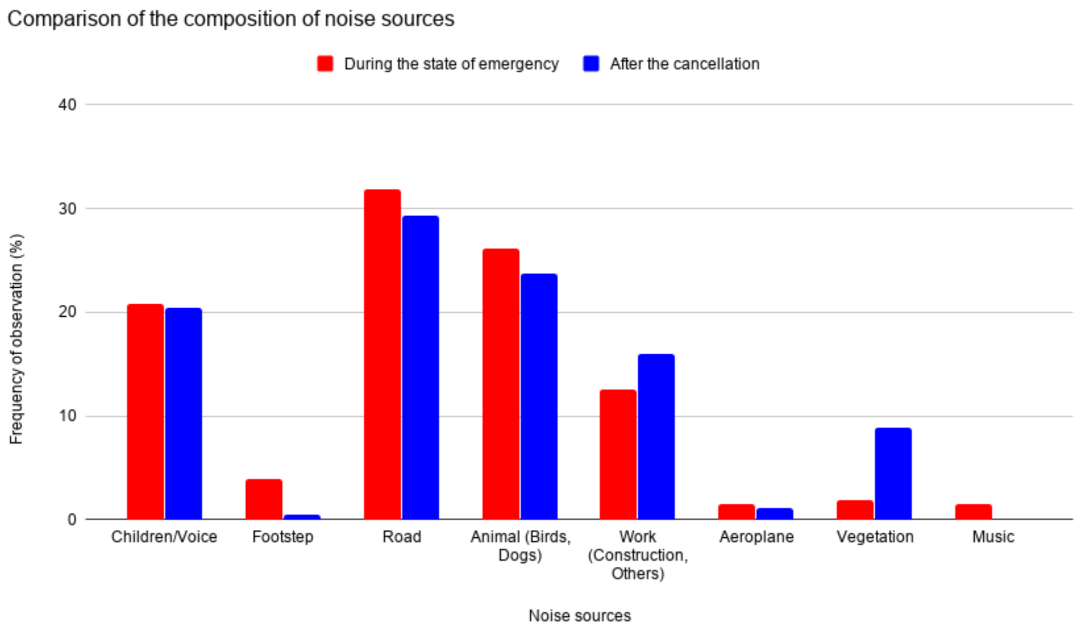

Figure 7. Comparison of the compositions for noise sources of weekdays and weekends (Figs. 5 ad 6). Note that the percentage of observation of “music” after the cancellation of the “state of emergency” was zero.

3.3. A little observation at the riverside

As mentioned above, the river and its riverbed were rather more crowded than before, with people taking walks for pleasure especially in the early evening, perhaps after a day's work. There were children during daytime and early evening, and this could also be one of the factors increasing noise levels in the surrounding area.

Table 2 shows the results of the measured noise levels (L_{Aeq}, T=30 s) at the point marked with the white star on the map in Figure 1.

Table 2. Noise levels at the fixed point on the riverside, L_{Aeq}, T=30 s, dBA.

Hour	15:30	17:30
24 May 2020	50.5	51.6

Although only a 1 dBA change was observed, early evening showed a higher level than mid-afternoon, which is in agreement with perceptive observations.

Just for an example, a photograph taken in the same point was shown in Figure 8 (at 13:57 on Saturday, 9 May 2020, during “state of emergency”). This was taken by Decibel X Pro app on iPhone XS so that a measured value of instantaneous noise level, dBA (slow, peak), was overlaid. The app on the device was calibrated with a Class 1 SLM before the closure of the laboratory due to the pandemic. Although it is a rather extreme example, it describes people’s activities on the riverbed, and the noise level was not so low as usual.

Figure 8. An example of a photograph overlaid with measured noise level (dBA, slow, peak) showing people’s activities on the riverbed. This photograph was taken in the same point as that of measurements shown in Table 2.

4. Concluding remarks

In this paper, some observations were made on the effect of the "state of emergency" due to the COVID-19 pandemic in Japan on the acoustic environment in a rather quiet residential area. Recent reports suggest that the effect of lockdown reached several dBA in most cases. However, in the area observed in the present survey, the effect was 1–2 dBA ca., i.e., during the “state of emergency” it was only slightly quieter. This effect was much smaller than the drastic reduction reported from busy area such as city centres, etc. [14]. This can be interpreted as the difference between the lockdown and state of emergency, and the behaviour of people resulting from that difference. Also, a large effect may not be possible in an originally quiet area.

For reference, the author performed a small survey to ask twelve students about the impression on the change of acoustic environment during the “state of emergency”. A few students who live in quiet area stated no significant change. However, some students claimed that it became quieter, and they became aware of neighbourhood noise such as voices, TV sounds, music, and other daily noises. Some of them claimed that it was annoying, and became rather sensitive even after the cancellation of the declaration and acoustic environment got back normal as before the “state of emergency”.

Although in this work professional precision instruments were not available due to the restricted circumstances, moreover the work was focused to just one particular area, the present results and discussions are quite limited. Therefore, the generalisation or deriving universal conclusion of these results were not intended. However, the results and observations in this work could possibly give some insights into the relationship between human behaviour and the acoustic environment. Also, the author expects that follow-up survey may give some more insight as the situations around this area are changing onward.

Endnote

Regarding the possible effect of the schools’ restart mentioned in Sec.3.2.2, on 1 June all schools (except for universities) have been resumed, however, at this moment when the author is preparing this paper, school hours are different from school to school depending the grade, level and school policies. On this point, follow up survey can be of some interest to observe possible gradual change in acoustic environment.

Appendix A: Accuracy check of Noise Capture on the used Android tablet (P80X)

After the survey a simple check of the accuracy of measured values by the system used in this work was carried out. Keeping the app and devices in the same setting and condition as was used in the measurement, a simple check was performed according to the following procedures [11]: a pink noise was emitted from a 10 cm full range loudspeaker enclosed in bass-ref cabinet. The noises emitted at various levels were measured by both the Noise Capture on the tablet and a Class 1 SLM (RION, NL-32) simultaneously. It was checked how well the measured values by both the system are in agreement. The results are plotted in Fig. A1.

As is observed, the measured values show reasonably good agreement with those by Class 1 SLM. The agreement was deteriorated below 40 dBA; however, the discrepancies were within 3 dB, which is sufficient for the present purpose in which the relative values are important and most measured values were above 40 dBA. The line in the figure is a linear regression line which almost coincides with diagonal line, and R^2 = 0.993, which is regarded to be sufficiently high in the light of the present purpose.

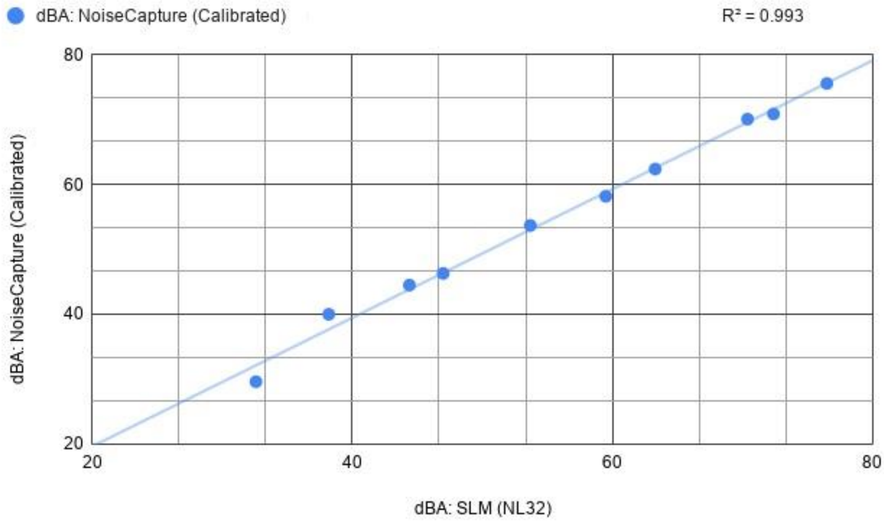

Figure A1. Results of the accuracy check of Noise Capture. Vertical Axis shows the values measured by Noise Capture, and Horizontal Axis shows those measured by Class 1 SLM (RION, NL-32). The line shows linear regression, and R^2 = 0.993

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Author contributions
All work was done by the author (K.S.).

Conflict of interest
The author declares that there is no conflict of interest.

Data availability
All data presented in this paper are available from the author upon a reasonable request.

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