SOUNDWALKS IN GOTHENBURG

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Report - Soundwalks in Gothenburg

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MARIE CURIE ACTIONS

SONORUS

In collaboration with:

Göteborgs Stad
Miljö

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1. INTRODUCTION

The present report presents the results of a series of soundwalks carried out in the city of Gothenburg as part of the *"Framtidsveckan 2015"* activities. The study was developed inside the EC project *SONORUS Urban Sound Planning* in collaboration with the *Environmental Office of the city of Gothenburg.*

The goal is to analyse the sound environment at different locations from the citizens' point of view through a series of questions while at the same time, sound recordings and acoustical indicator data is obtained. Thereby, the citizens' will have the opportunity to contribute to the present and future urban development, including urban sound planning, in the planning agenda. Moreover, the intention is to increase awareness among citizens in terms of noise exposure and sound quality, in addition to make them part of the study of their city. The soundwalks took place in October 2015.

1.1. Soundwalks and the urban sound environment

Active users in cities are the actors shaping the environment, where listening is a part of the multi-sensorial approach to urban experience. In this sense, the study of our cities demands integration within a holistic approach in the urbanisation process. The integration of urban sound planning as a self-evident part of the process is extremely needed [1]. In this regard, acoustic interventions need to be extended to exploit all the potential benefits to obtain a good sound environment, even when noise has not been raised as a matter of concern. Therefore, the use of available tools and the development of new ones will ensure a proactive urban sound planning approach.

Generally, the main objective of an acoustic intervention is defined in the regulations, which are usually considered after the urban plan project is already decided, limiting the opportunities to improve the acoustic quality, exploit all potential benefits and appropriateness of spaces. This way of work is usually restricted to the most-exposed receivers within a short-term perspective.

The increasing awareness of citizens is demanding a comprehensive and proactive understanding of the environment as an essential part of the liveability of spaces. The series of soundwalks were carried out in the city of Gothenburg to gain knowledge about how the sound environment is perceived and understood. This type of active listening tool has been widely used as an assessment method of the perception of sound environments, which evaluates the sound experience [2 - 5]

1.2. The soundwalk

The urban sound environment contributes to the overall assessment of the city, to our image of it. Moreover, experiencing a soundwalk contributes to the awareness of what activities and spatial functions could be appropriate contributes to the appropriateness this multi-sensorial approach might have to certain activities and uses, as well as local involvement in the social life [6, 7].

Listening to our cities is an exercise to be practiced by urban planners and all stakeholders involved in the city's decision-making aspects, and also by its citizens. In this regard, a soundwalk is a tool understood as a sound memory map, which will enable an evaluation of the city through the sound recordings, the acoustical data and the perception analyses. Different study points, normally between 5 and 8, compose a soundwalk. Different conditions might be used to select a possible study point in the route:

- The site might be part of a new urban development or a rehabilitation project.
- The site is a public space used by citizens and tourists.
- The site is suffering from noise pollution or is expected to suffer within the new development.
- The quality of the site is causing complaints among citizens.

In the work presented here, the soundwalk sessions were proposed as a tool to characterize the current sound environment, with the idea in mind that several of the selected sites will be object of future urban interventions.

2. SOUNDWALKS IN GOTHENBURG

For the present study, three districts in the city of Gothenburg were chosen for conducting the soundwalks. A strong collaboration between the city-district representatives, the SONORUS working group and the Environmental Office of the city was of great importance to achieve this. The work went from informing the city representatives about this opportunity, preparing the routes, the equipment, the questionnaires, spreading the information and carrying out the soundwalks.

The districts participating were Angered, Majorna-Linné and the Centre district. The routes to follow during the soundwalk were studied and established according to several interests, mainly directed toward new urban developments. For this, recommendations from the city-district representatives where included.

During the walk, the participants are invited to listen actively to the environment for a couple of minutes. After this procedure, participants are

asked to rate the sites and gather the impressions through a questionnaire; this procedure takes around 5 minutes per site. At the same time, sound recordings and acoustical indicator data are captured (using a Chalmers in-house developed acquisition tool, TAMARA, using software Matlab, a B&K 2260 sound level meter and a microphone). The operator of the technical equipment followed the soundwalk group and recorded 3-minute audio samples at each location (sample rate 51200 Hz).

For two of the three districts, the walks were performed both in the morning and in the afternoon of the same day. In the third district, the lack of afternoon participants led to a cancellation of that soundwalk.

A special opportunity appeared for the Majorna-Linné soundwalk, where the morning soundwalk was divided into two groups, one with adults and one with children. The idea of incorporating a group of children came from the city-district, which was immediately embraced by the SONORUS working group. We strongly believe that the incorporation of children as an active part in the society might be the seed of a responsible citizenship involved in societal debates, with commitment to the improvement of the built environment. We want them to feel co-responsible in the study and development of their cities. Moreover, children are considered a group at risk when it comes to noise exposure [8]. Also, they might encounter more difficulties to recognize dangerous noise exposures, as well as the inability to control their surrounding environments.

Unfortunately the number of participants in all soundwalks was low, except in the case of the children soundwalk. This fact is limiting the analysis of the outcomes to a descriptive evaluation. In the following sections we will expose several relevant facts about the results as well as some recommendations. The rest of the results are incorporated in the Appendix.

Table 1. Soundwalks in Gothenburg

District	Time	Participants
Angered	Morning (adults)	5
Centre	Morning (adults)	11
	Evening (adults)	4
Majorna-Linné	Morning (adults)	5
	Morning (children)	30
	Evening (adults)	6

2.1. The questionnaire

The questionnaire was available in both Swedish and English. The first page explains the instructions to follow the soundwalk. In this page we also highlight that the data is treated confidentially and that the participation in the

study is voluntary. Afterwards, the questionnaire included a map with the route and a short description of the spots.

The questions for each spot were collected in 2 pages. The first question asked to the participants is related to general information as sex (Q1), birth year (Q2), level of education (Q3), current employment situation (Q4) and relative sensitivity to noise (Q5) rated as “less”, “more”, “equal” or “don’t know”.

The purpose of the sixth question (Q6) is to know how often the participant visits the site, having seven different options going from “every day” to “this is the first time”. The seventh question (Q7) has 15 items, which are gathering information about the appropriateness of the place to 15 different social and recreational activities, such as “experience quietness and tranquillity”, “socialize”, “shopping”, etc. An 11 points continuous scale was used for all questions, from “not at all” (0) to “perfect” (10). Question number eight (Q8) is related to the description of the sound environment on a 11 scale (from “very bad” to “very good”). Question nine (Q9) has four sub-items inspecting the noise sources. The question here is asking about the extent that those sources are heard, going from “not at all” (0) to “dominates completely” (10). The sub-items are “road traffic”, “others such as construction noise, industrial, machines, etc.”, “sound of people”, “natural sounds”. The tenth one (Q10) is related to the first question, however, in this case the focus is on the appropriateness of the sound environment to the place. The last question (Q11) reflects the perception of eight categories related to the sound environment, including “pleasant", "chaotic", "vibrant", "uneventful", "calm", "annoying", "eventful" and "monotonous”, which are based on [5]. The questionnaire is based in the one developed by Ö. Axelsson from Stockholm University.

Table 2. Questionnaire

Question	Description
Q1-Q5	General information
Q6	Visit site
Q7	Appropriateness of the place to develop certain activities
Q8	Description of sound environment
Q9	Noticeable sound sources (4 types)
Q10	Appropriateness of the sound environment to the place
Q11	Perception of the surrounding sound environment

2.2. Noise descriptors

- **L_{Aeq}** is the equivalent sound pressure level that is describing a sound level with the same energy content as the varying acoustic signal measured.
- **L_{10}** is the level exceeded for 10% of the time. For 10% of the measurement period it has a sound pressure level above L_{10}. These higher sound pressure levels are probably due to sporadic or intermittent events.
- **L_{90}** is the noise level just exceeded for 90% of the measurement period. L_{90} is the level exceeded for 90% of the measurement period. It is generally considered to be representing the background sound or ambient level.
- **L_{10}-L_{90}** is the temporal distribution; it is how the sound environment evolves along the time.

3. ANGERED SOUNDWALK

The soundwalk in Angered consisted of 7 sites around the Angered tram stop. The route had a large variety of urban scenarios, going from busy places close to the shopping area, to parks, residential areas, different footpaths, traffic intersections, etc.

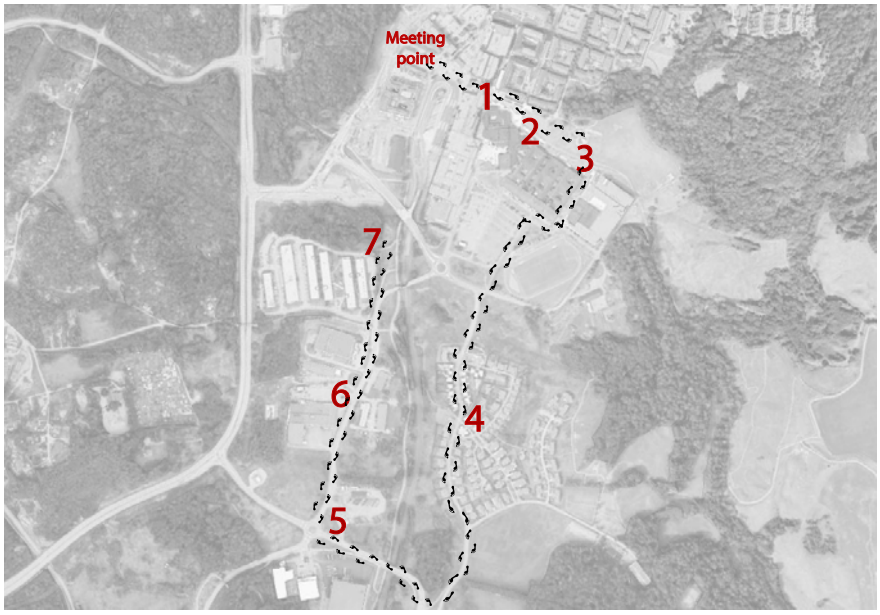

Figure 1. Soundwalk in Angered

Table 3. Description of sites: Angered soundwalk

Spot	Description
MP	Meeting point entrance Health Centre
1	Small square by the tram stop
2	Small square in a pedestrian area
3	Near the playground
4	Small square in a residential area
5	By the roundabout: new housing area planned
6	Street by industrial area
7	Intersection of two footpaths

In this soundwalk we had 5 participants, 4 women and 1 man between 61 and 32 years old working at the present moment. All of them have completed at least a higher education degree of 3 years. In terms of their sensitivity to noise, 60% said that they are more sensitive than other people, 20% less and 20% equal than others. Sites 1 and 2 were the ones were participants visited more often, being those ones corresponding to the tram stop and the small square by the market.

Table 4. Participants' visits to the sites: Angered soundwalk

Visit site	1	2	3	4	5	6	7
Every day	60%	40%					
At least once per week		20%	20%				20%
At least once per month				20%	20%	20%	
Less than once per month, but at least 10 times per year							
At least once per year, but less than 10 times						20%	20%
Less than once per year	40%	20%	20%		40%		
This is the first time		20%	60%	80%	40%	60%	60%

The description (Q8) and the appropriateness (Q10) of the sound environment are considered as related questions, whereby we study them together. The mean value for the majority of the sites is very similar between the two questions for each site. However, site number 5 has a very different assessment for these questions. Even though the description of the sound environment scored as very bad, the appropriateness to the site is rated much better [*Q8:* $\bar{x}$ *= 0,2 std(x) = 0,4 Q10:* $\bar{x}$ *= 5,2 std(x) = 4,3*]. This may be responding to the fact that the place is a roundabout intersection with not other uses and/or activities, however a new housing area is planned, which will need a careful study.

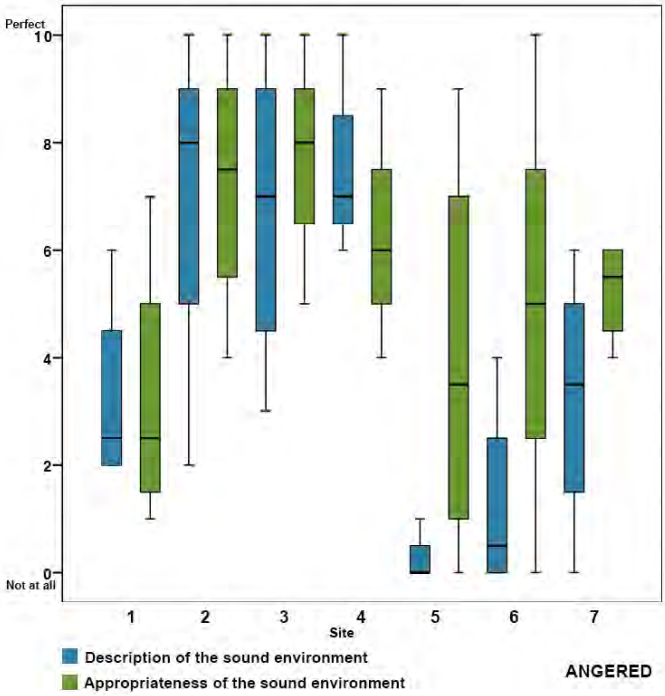

Figure 2. Description and appropriateness of the sound environment: Angered soundwalk

Site number 6 held the highest equivalent sound pressure level of all sites; the site may suffer an urban transformation in the future. Moreover, temporal variation (L_{10} – L_{90}) is around 18 dBA, while in the rest of the spots it is between 5 and 9 dBA.

Table 5. Statistical noise levels: Angered soundwalk

Angered[1]							
Site No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
L_{eq} (dBA)	56,1	50,4	47,9	45,7	65,8	72,4	56,2
L_{10} (dBA)	59,5	52,7	50,2	47,6	67,7	76,6	57,1
L_{90} (dBA)	51,5	47,1	41,7	40,7	59,7	58,5	48,1
L_{10} - L_{90} (dBA)	8	5,6	8,5	6,9	8	18,1	9

Sites 1, 7

Sites 1 and 7 had the same equivalent sound pressure level (56.1 dBA and 56.2 dBA). While the equivalent levels are similar, the indicators L_{10} and L_{90}, are respectively 2,4dB and 3,4dB higher on site 1. Their evaluation in terms of description and appropriateness of the sound environment to the site was very similar as well:

[1] Highlighted sites are compared due to reasons such as, similar equivalent sound pressure level, similar sound environment description assessments, etc.

Site 1 *Q8:* $\bar{x}$ *= 3,6 std(x) = 1,8 Q10:* $\bar{x}$ *= 4 std(x) = 2,8*

Site 7 *Q8:* $\bar{x}$ *= 3,4 std(x) = 2,2 Q10:* $\bar{x}$ *= 4,6 std(x) = 1,6*

These two sites represent very different built environments; while the first site is located near the tram stop at a square, the seventh site is next to the intersection of two footpaths between an industrial area and the tram line. For 60% of the participants, this was the first day they visited site 7, opposite to site 1, were 60% of them visit the site every day.

As seen in Figure 3, the equivalent levels on the two sites differ as much as around 10 dB on the low frequency range, something that is not evident from the single number equivalent sound pressure level (L_{Aeq}). Investigating the spectrograms of these two sites (Figure 4), it can be seen why the description of the environment is rated better on site 7 than on site 1. Site 1 appears to have more distinct events over the recorded period and more low frequency noise (which explains the difference of the L_{10} and L_{90} indicators), and constant over time humming noises around 60Hz.

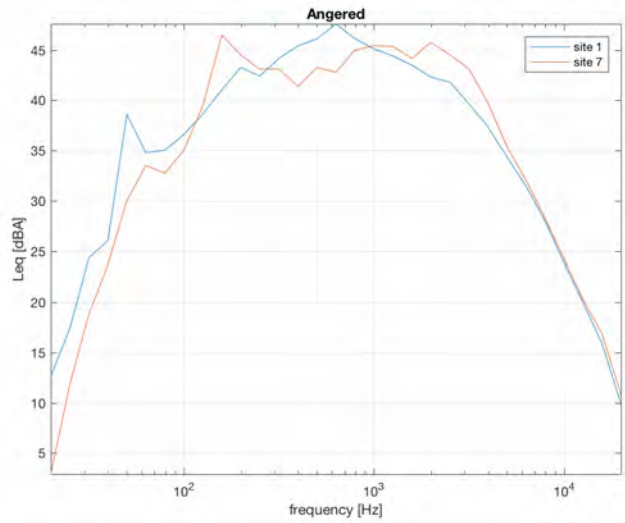

Figure 3. Frequency analysis: site 1 and 7, Angered soundwalk

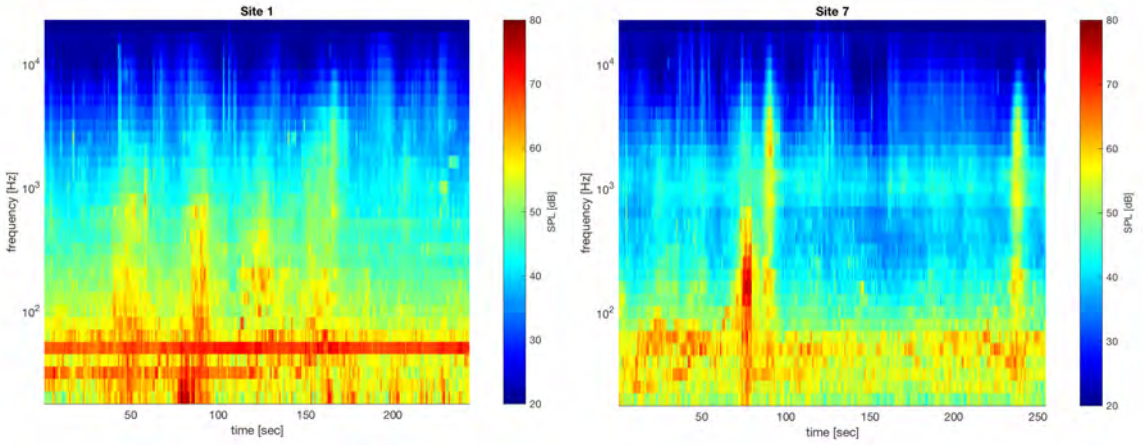

Figure 4. Spectrogram at sites 1 and 7, Angered soundwalk

As mentioned previously, site 1 is located next to the tramway stop, road traffic being the dominating sound source, where other sounds are those from construction and industrial activity. In site 7 the road traffic dominance was not as pronounced as in site 1, even though the equivalent sound pressure level was practically the same. The non-dominance of traffic noise in sites 2, 3 and 4 leads to a higher score both in terms of description and appropriateness of the sound environment (Figures 2 and 5).

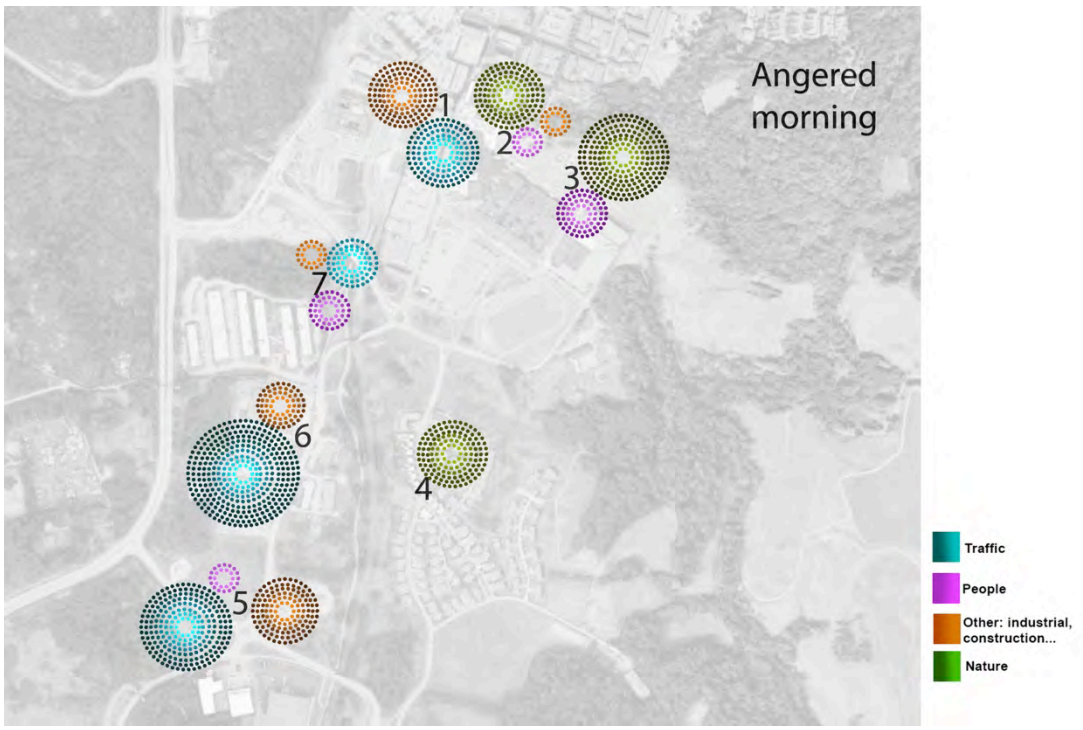

Figure 5. Sound sources dominance map. Angered soundwalk[2]

Sites 2, 3 and 4 were the ones identified as places appropriate for a higher number of activities (sites were traffic noise is not the dominant source), followed by sites 1 and 7. In sites 5 and 6, only the activity “jogging, running” made it to the list of plausible activities, with a median value of 1. As an example, site 2 is represented (Figure 6) were several outdoor activities may be performed, as “play informal games”, “hang out, chat, talk”, “picnic, barbeque”, ‘individual exercise”, etc.

[2] Maps representing the sound sources dominance: each circle corresponds to 10% of the participants, which gave a value between 7 and 10. The range goes from 0 “not hear at all” to 10 “dominates completely” for each of the four sound sources types in that particular site.

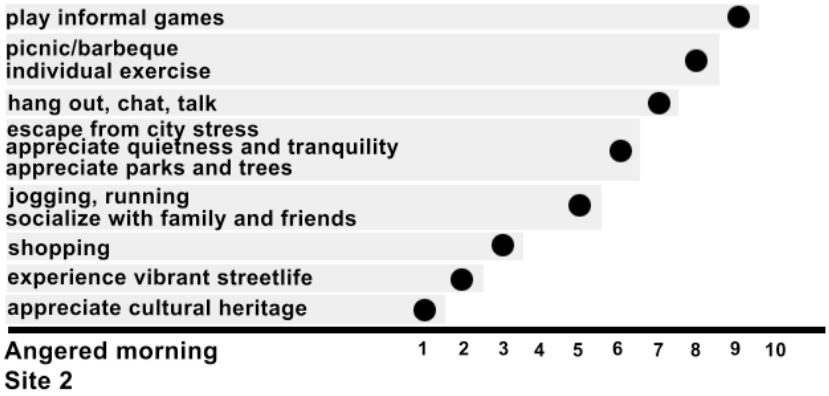

Figure 6. Activities at site 2: Angered soundwalk[3]

The majority of the participants agreed in that site number 3 was a pleasant site. The opposite occurs in site 6, where answers were more disperse than in site 3. Here, participants agreed that the place was annoying and chaotic.

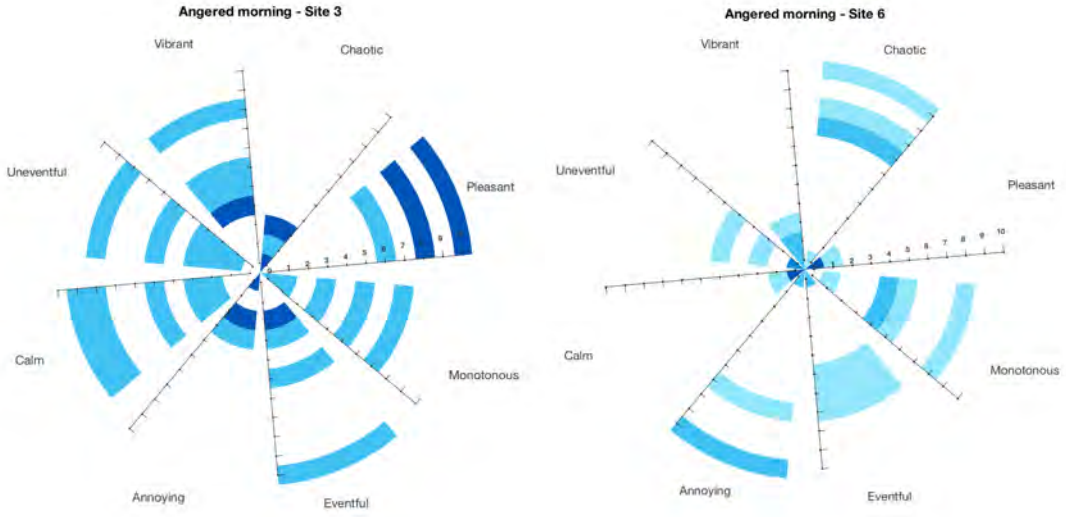

Figure 7. Perception of sound environment at Angered soundwalk, sites 3 and 6[4]

In general for this soundwalk, it seems that where the sound environment was not dominated by road traffic noise (for example in site 3), the perception of the respondents to the correspondence of the sound environment to certain adjectives was less spread than in the case the road traffic was dominating, as in site 6.

[3] Median individual responses for the different activities: 0 “not at all” to 10 “perfect”. The ones that had a value of 0 are excluded from the figures.

[4] Perception of participants: colours are normalised; light blue represents less number of participants to dark blue, representing a high number of participants

4. MAJORNA-LINNÉ SOUNDWALKS

During the same day, three soundwalks were performed in this area, two of them throughout morning time and one in the evening. The ones in the morning had one group of adults and one with children. The one in the evening was performed with adults as well.

The adults' soundwalks consisted of 8 different places around the popular streets to the east and west of the popular square named *Järntorget,* as well as within the future development area close to the river and in the linear park by the canal. This variety allows for the assessment of different urban scenarios around the neighbourhood. The soundwalk with the children followed the route through the first five sites of the adults' one.

Table 6. Description of sites: Majorna-Linné soundwalk

Spot	Description
MP	Library
1	Intersection of secondary roads (residential, commercial, public buildings…)
2	Intersection of secondary road and main road/tram (new development is planned here)
3	By the highway tunnel (new development is planned here)
4	By the river/ temporary playground (new development is planned here)
5	Popular square in the city
6	Park between roads
7	Park between canal and main road

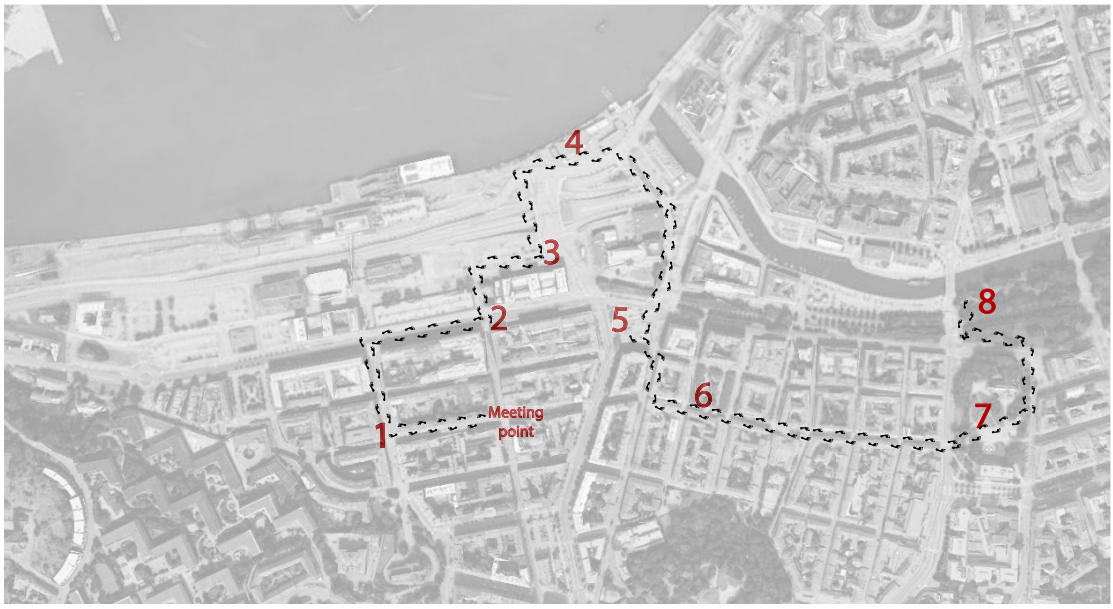

Figure 8. Soundwalk in Majorna-Linné

4.1. Morning soundwalk: Majorna-Linné

In this soundwalk we had 5 participants. Particularities for this were that for one of the participants the general information data is missing and that one of them had to leave after site number 5. Out of four participants with general data, 3 were man and 1 woman between 64 and 28 years old working at the present moment. All of them have completed at least a higher education degree of more than 3 years. In terms of their sensitivity to noise, 25% considered themselves as more sensitive to noise than other people, 25% less and 50% equal than others.

The majority of the participants seem to know the area and are visiting the sites regularly, except site number 4. This site is particularly interesting since it is placed in a future development area located by the river.

Table 7. Participants' visits to the sites: Majorna-Linné morning soundwalk

Visit site	1	2	3	4	5	6	7	8
Every day	20%	40%	40%		60%			25%
At least once per week	20%	20%	20%	20%	40%	50%	25%	25%
At least once per month	20%	20%	20%	20%		50%	50%	25%
Less than once per month, but at least 10 times per year	20%			20%			25%	25%
At least once per year, but less than 10 times	20%	20%	20%	20%				
Less than once per year								
This is the first time				20%				

In terms of the description of the sound environment, the site with the highest mean score for this soundwalk was the site number 6, which is located at a pedestrian street in a residential area with cafes and small shops. The worst one was site number 3 by the road tunnel, were a new urban development is expected. Main differences between appropriateness and description of the sound environment were found at sites 1 [*Q8:* $\bar{x}$ *= 4,6 std(x) = 2,7 Q10:* $\bar{x}$ *= 1,8 std(x) = 1,3]* and 3 [*Q8:* $\bar{x}$ *= 0 std(x) = 0 Q10:* $\bar{x}$ *= 2,6 std(x) = 4,3]*. Site 3 was rated by all participants with a very bad (0) sound environment, while its appropriateness was rated slightly better [$\bar{x}$ *= 2,6 std(x) = 4,3],* however, answers were largely spread. In general, sites to the left of *Järntorget* were evaluated with lower mean scores than the ones to the right, where road traffic is not the dominating sound source.

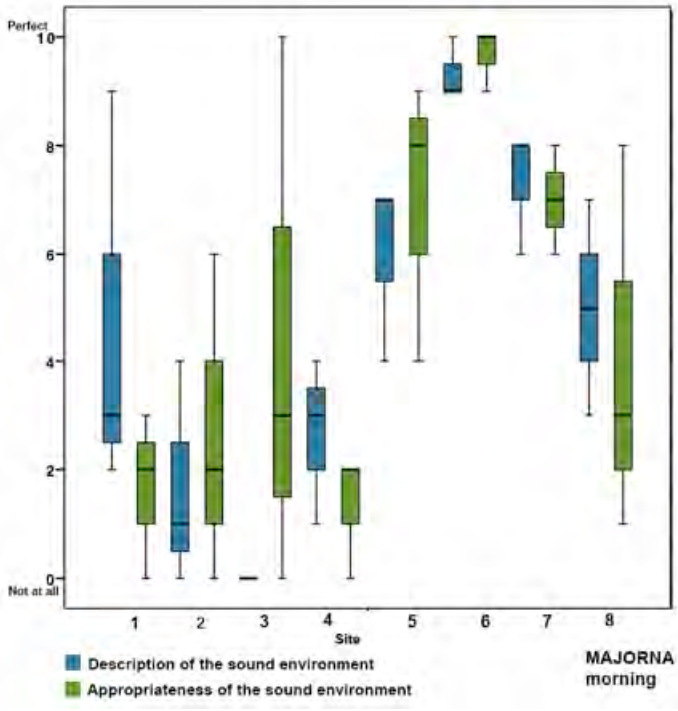

Figure 9. Description and appropriateness of the sound environment: Majorna-Linné morning soundwalk

Table 8. Statistical noise levels: Majorna-Linné morning soundwalk

Majorna morning								
Site No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Leq (dBA)	64,4	63,7	74	58,7	62	54,2	55,5	60,9
L_{10} (dBA)	67,4	66,8	76,8	61	65	56,1	57,6	63,6
L_{90} (dBA)	56,2	59	68,4	54,5	55,1	48,8	51,8	57
L_{10} - L_{90} (dBA)	11,2	7,8	8,4	6,5	9,9	7,3	5,8	6,6

A high number of sources were present at this time of the day, however traffic seemed to be the main source at sites 1-5. Sites 5-8 were dominated by nature sounds. In terms of the perception of the sound environment, site 6 was rated for the majority of participants as a “pleasant”, “vibrant” and “calm” environment, while site 3 was rated in the opposite way, being “chaotic”, “monotonous” and “annoying”. In site 3, the L_{Aeq} was 75.4 dB compared to site 6 were it was more than 20 dB lower (54.2 dB).

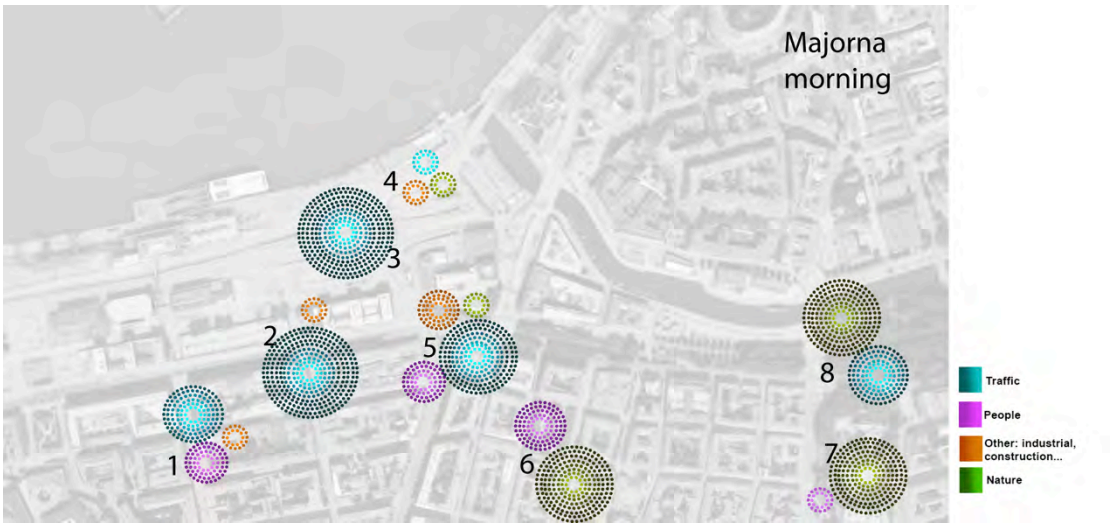

Figure 10. Sound sources dominance map. Majorna-Linné morning soundwalk

In terms of the characterisation of the sites, the majority of the participants highlighted the spot 3 as a chaotic, monotonous and annoying place. Contradictions are found in terms of eventful and uneventful characteristics, being both of them present. Contrary, site 6 holds a pleasant, vibrant and calm scenario, where eventfulness is also present.

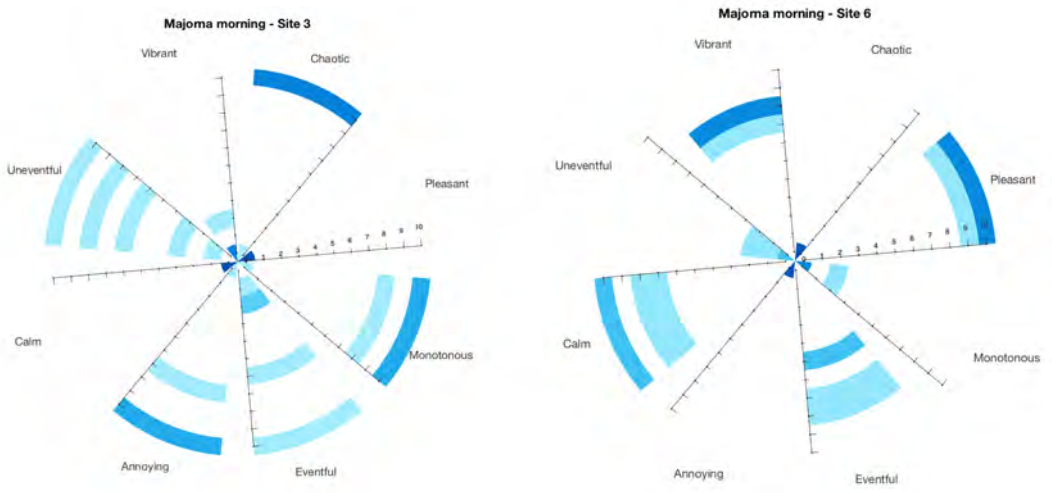

Figure 11. Perception of sound environment at Majorna-Linné morning soundwalk, sites 3 & 6

In terms of the activities one can perform in this area, site 6 and 7 had a high range of activities. Site 6, located at a pedestrian street in *Haga* neighbourhood, had a median value of 10 (in a scale from 0-10) for 6 activities.

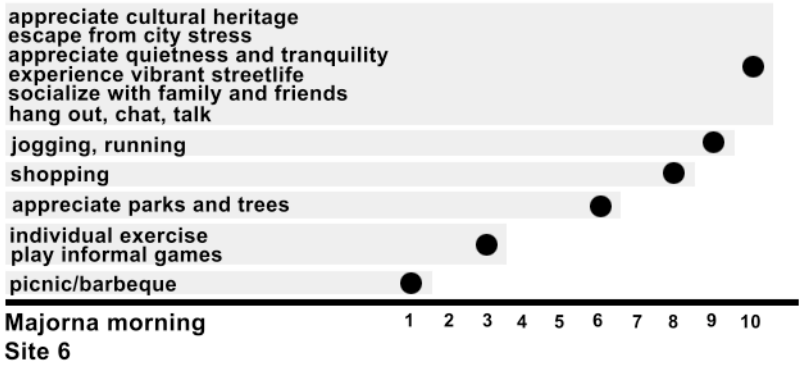

Figure 12. Activities at site 6: Majorna-Linné morning soundwalk

On the contrary in site 3, located next to the road traffic tunnel, participants answered that not a single of the listed activities can be performed in such site. This fact becomes particularly important since the area were spots 3 and 4 are located, is the area subjected to the study of a new urban development, based in a residential use.

Site 8, located at the linear park in the city had a L_{Aeq} of 60,9 dB. This might interfere with the activities that one may perform there, where the highest median level was 7 for activities such as “socialize with family and friends”, “appreciate parks and trees”, “escape from city stress” and “play informal games”. Contrary, in the park where site 7 is located, the equivalent sound pressure level was 55,5 dBA, and activities such as “escape from city stress” were rated with a median value of 4. Here, the highest median score was 8 for “appreciate parks and trees”. It seems that even though both are parks, the location, the spatial structure and the surrounding environment had an influence in the activities that one can performed, being more appreciated as a restoration place the park next to the water canal located closer to the city centre, than the one with a lower equivalent sound pressure level.

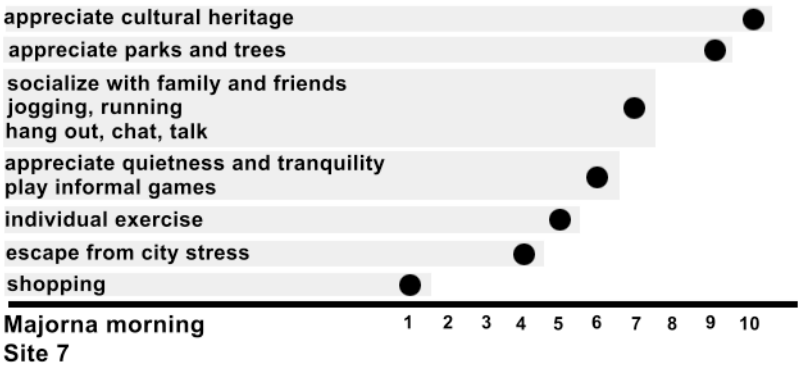

Figure 13. Activities at site 7: Majorna-Linné morning soundwalk

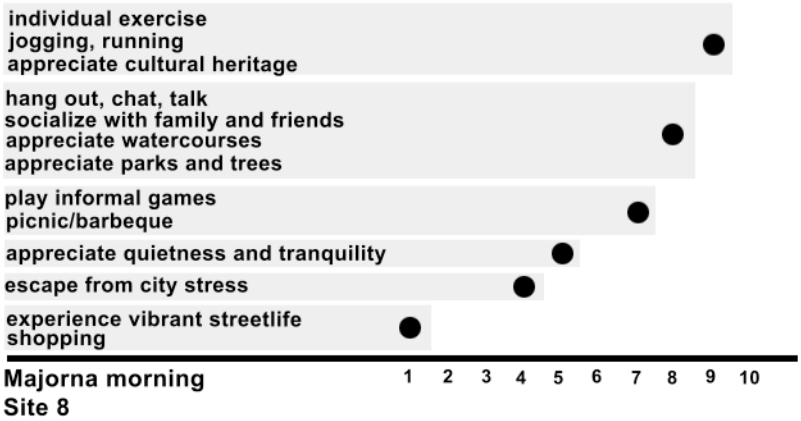

Figure 14. Activities at site 8: Majorna-Linné morning soundwalk

4.2. Morning soundwalk with children: Majorna-Linné

In the soundwalk 30 children from 5th grade participated. The route followed consisted of the first five sites from the soundwalk with adults. Due to safety reasons, at site number 3 the children were placed on a sidewalk and not directly on top of the road tunnel, leading to an equivalent sound pressure 10 dBA higher in the adults' soundwalk. In the rest of the sites, the differences were between 0,2 and 2 dBA. This soundwalk was performed minutes before the one with the adults.

Based on [5], an especially designed questionnaire for children was developed, incorporating the Bradley-Lang scale [7]. The questions were divided in 3 main topics related to the description of the sound environment (Q1), the sources heard (Q2) and the appropriateness of the sound environment to the place (Q3).

Table 9. Questionnaire description: Majorna-Linné morning children soundwalk

Question	Description
Q1	Description of sound environment
Q2	Noticeable sound sources (4 types)
Q3	Appropriateness of the sound environment to the place

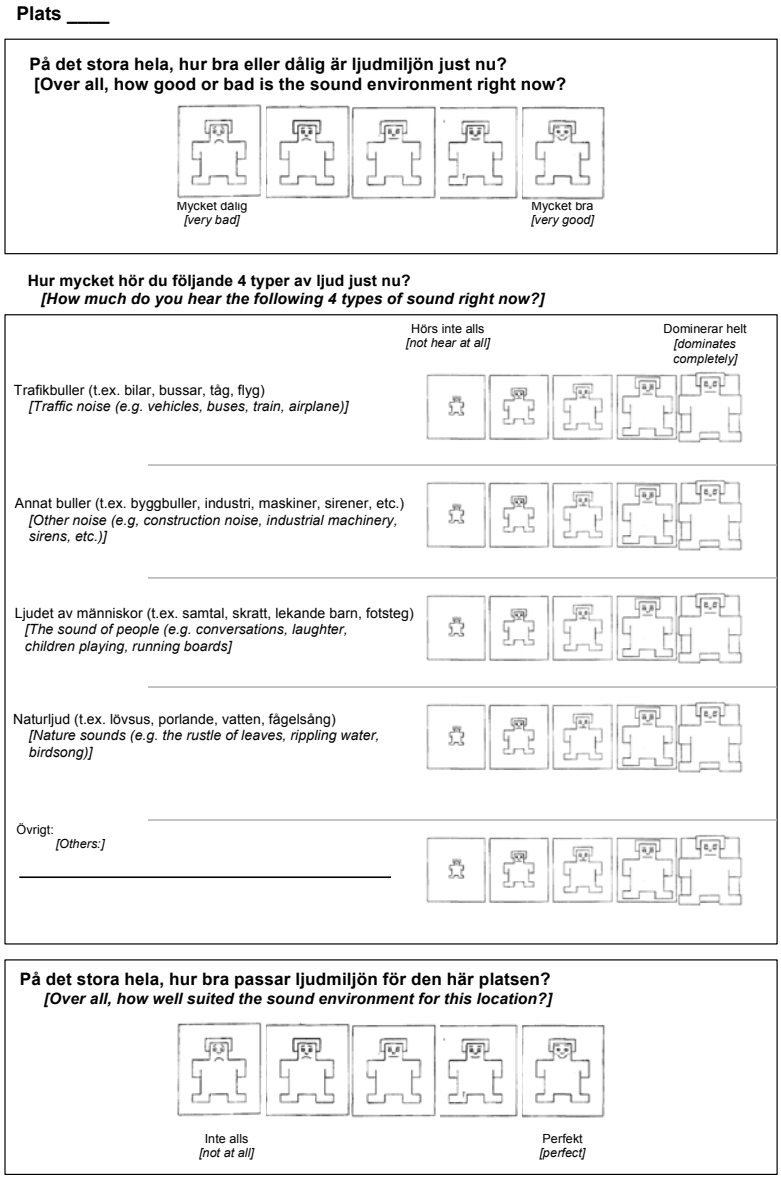

Figure 15. Questionnaire for children: Majorna-Linné morning children soundwalk

Table 10. Statistical noise levels: Majorna-Linné morning children soundwalk

Majorna morning_children					
Site No.	**1**	**2**	**3**	**4**	**5**
Leq (dBA)	64,7	63,9	63,9	58,3	60
L_{10} (dBA)	67,9	65,9	66,1	60,7	62,8
L_{90} (dBA)	56,5	58,7	59,7	54,1	55,6
L_{10} - L_{90} (dBA)	11,4	7,2	6,4	6,6	7,2

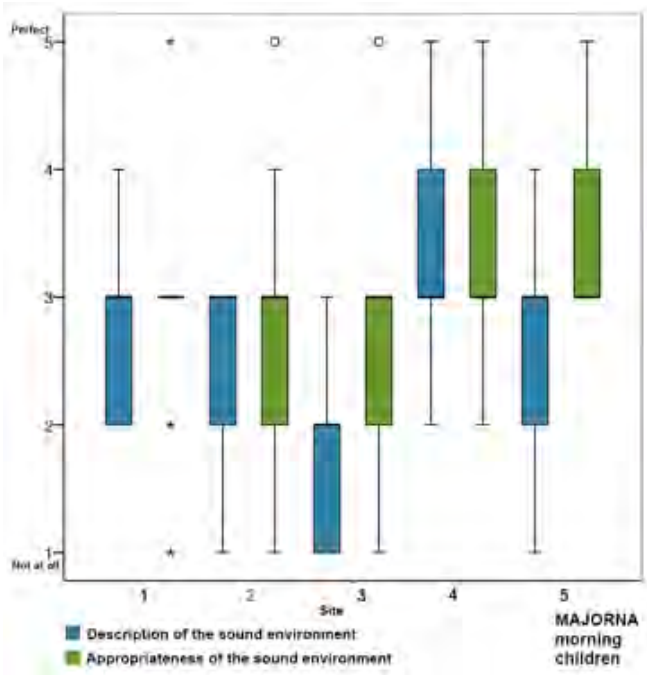

Figure 16. Description and appropriateness of the sound environment: Majorna-Linné morning children soundwalk

In terms of appropriateness and description of the sound environment, there is significant mismatch between them. This should not be directly compared with results from adults' soundwalks as perception compared to younger ages differs. The largest mismatch was in site 3 where mean value for the description of the sound environment was 2.1 (*std = 0,8*) and for the appropriateness was 2.8 (*std = 1,2*).

Sites 2,3

Sites 2 and 3 have exactly the same equivalent sound pressure levels (63,9 dBA) as well as similar L_{10} (65,9 dBA and 66,1 dBA). L_{90} though differs as much as 1dB and showed on the low frequency components of the equivalent levels. Looking at the spectrograms of the sites, it is observed a lot more low frequency content on site 3, and while that might be negative for a sound environment, it is perceived as more appropriate for the specific site

comparing to site 2. That is to say that site 2 might have less low frequency components, but the functionality of the space is not matching to the current sound environment. These low frequencies most possibly are sourced from the nearby traffic road and tram vehicles.

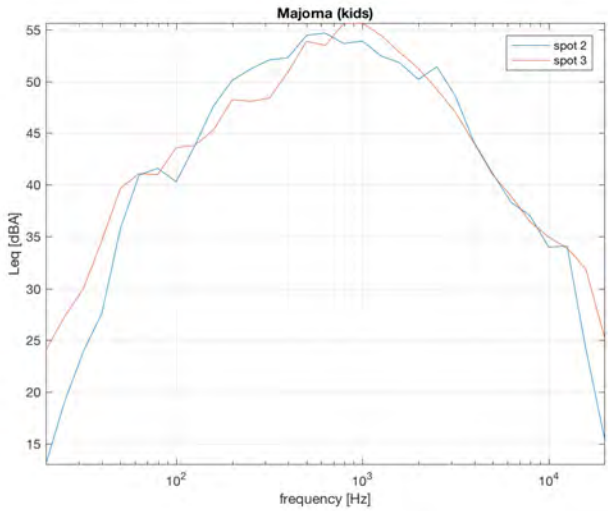

Figure 17. Frequency analysis: site 2 and 3, Majorna-Linné morning children soundwalk

The second set of questions (Q2) corresponds to the study of the sound sources heard. Figure 18 shows the percentage of responses marked as dominating noise source (4 and 5) on a scale of 1 to 5. It may be inferred that the differences between the sites' sound environment description and the perception of them is related to the types of sources heard and its dominance. The best description and perception of appropriateness of the sound environment was scored at site 4 (10 children described it as good or very good, and 12 children perceived that it was appropriate to the place). Contrary, in site 3 none of the children described the place as good or very good, and just 5 of them perceived the sound environment as appropriate.

Compared to the presence of sound sources, children tend to score their dominance lower than adults.

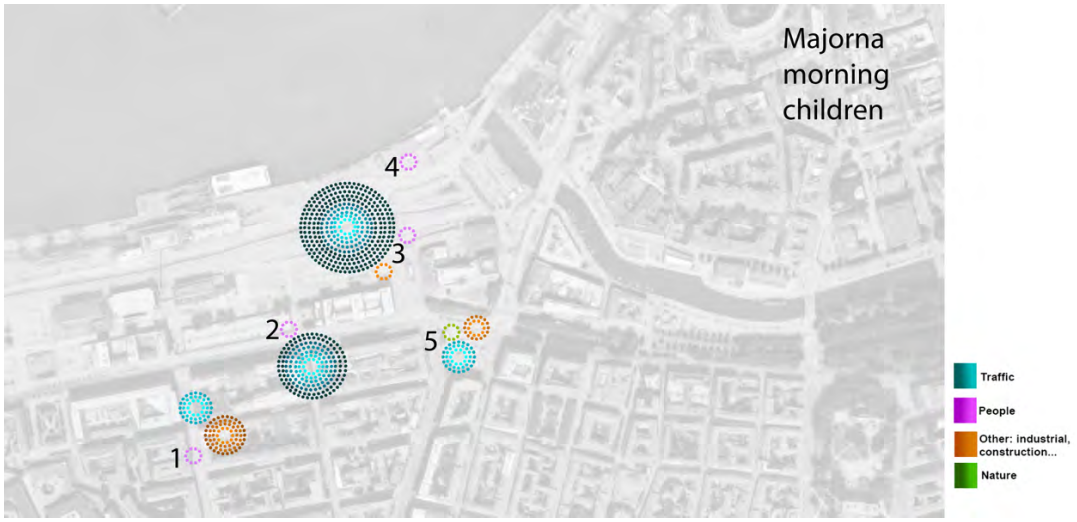

Figure 18. Sound sources dominance map. Majorna-Linné morning children soundwalk

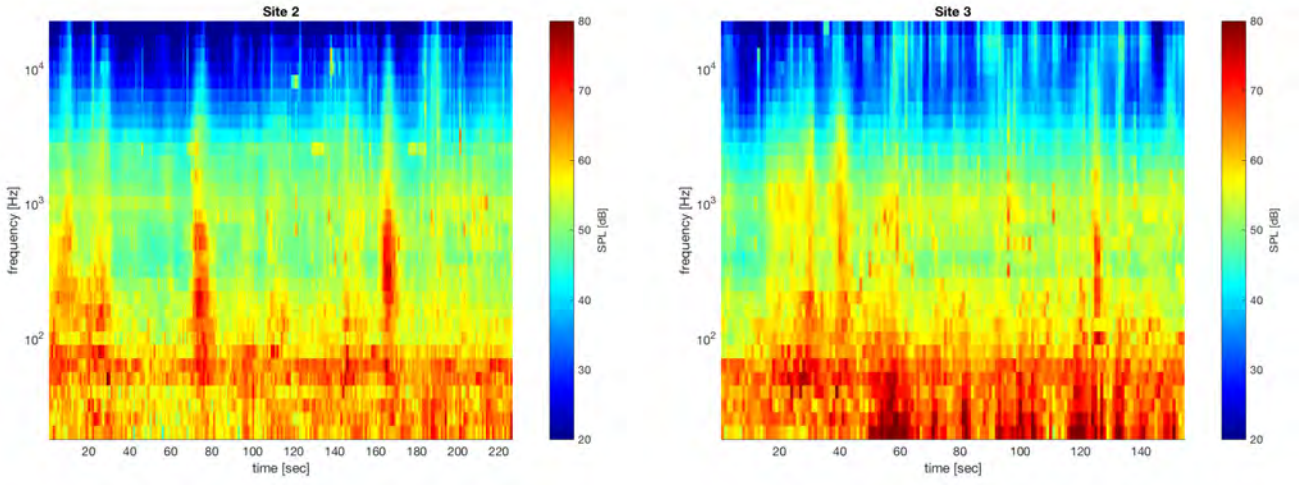

Figure 19. Spectrogram at sites 2 and 3, Majorna-Linné morning children soundwalk

Table 11. Difference between adults and children: Majorna-Linné morning soundwalk

	Difference (adults – children)				
Sites	1	2	3	4	5
Leq (dBA)	-0,3	-0,2	10,1	0,4	2
L_{10} (dBA)	-0,5	0,9	10,7	0,3	2,2
L_{90} (dBA)	-0,3	0,3	8,7	0,4	-0,5
Q1*	-1,8	-3,8	-4,6	-4,2	-0,8
Q3*	-4,6	-3,2	-3,6	-4,8	-1,5

*mean value for both Q1 and Q3; the scores gave by the children were transformed to scale 0-10

Even though the equivalent sound pressure level in sites 1, 2 and 4 were practically the same, children tend to describe the sound environment and its appropriateness with higher scores. The same situation happens in site 3, were equivalent sound pressure level was 10 dBA higher in the adults' soundwalk. Site 5 (*Järntorget*), held higher L_{Aeq} values in the adults' case (2 dBA), however, this site is the one were Q1 and Q3 scores are very similar in both soundwalks. These differences may attend to the fact that children are less aware or more benevolent to the judgement of the sound environment. It is remarkable that the standard deviation for Q1 and Q3 is around 1 in the case of the children, while in the adults fluctuate from 0 to 4.

4.3. Evening soundwalk: Majorna-Linné

Six participants, 5 male and 1 woman between 74 and 27 years old participated in the evening soundwalk. All of them have completed at least a higher education degree of 3 years or more. In terms of their sensitivity to noise, 17% rated as more than other people, 33% as less and 50% as equal than others.

The majority of the participants seem to know the area, however, they are not visiting it in their daily routine.

Table 12. Participants' visits to the sites: Majorna-Linné evening soundwalk

Visit site	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Every day		17%						
At least once per week	17%							
At least once per month		17%	50%	17%	50%	50%	17%	
Less than once per month, but at least 10 times per year		33%		33%	33%	50%	50%	60%
At least once per year, but less than 10 times	17%	17%	33%	50%	17%		17%	20%
Less than once per year	50%	16%					16%	20%
This is the first time	16%							

The site with the highest mean score in terms of the description of the sound environment was again site 6 [$\bar{x}$ *= 6,7 std(x) = 2,8*], and the worst one was site 3.

The answers related to the description (Q8) and the appropriateness of the sound environment (Q10) scored very similar for each site, except site 3, where appropriateness of the sound environment to the place scored higher than the description of it [*Q8* $\bar{x}$ *= 0,3 std(x) = 0,8 Q10* $\bar{x}$*= 2,8 std(x) = 2,6*]. It seems that expectations were not to high for this site, since it is a road tunnel

and busy roads crossing the intersection, being mainly a connecting area between other places.

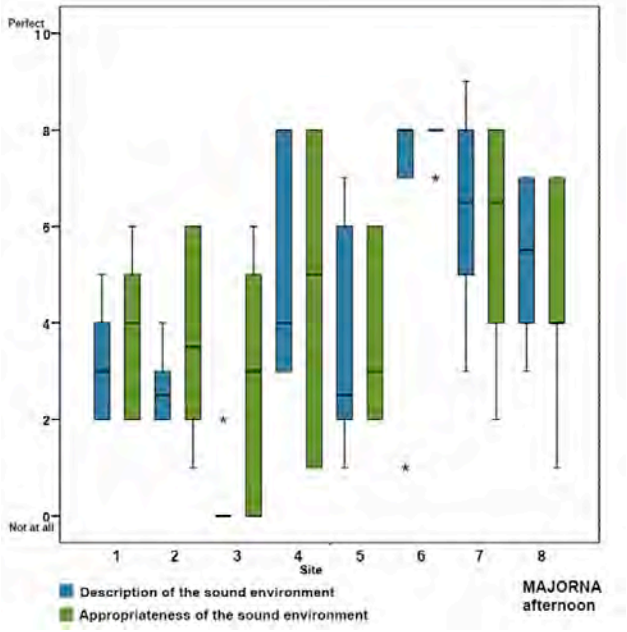

Figure 20. Description and appropriateness of the sound environment: Majorna-Linné evening soundwalk

Table 13. Statistical noise levels: Majorna-Linné evening soundwalk

Majorna evening								
Site No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Leq (dBA)	64,7	60,8	75,4	56,9	62,6	52,7	52,8	56,9
L_{10} (dBA)	67,1	63	79,1	60	65,4	55,4	54,8	59,2
L_{90} (dBA)	54,8	56,6	68	52,5	56,1	46,1	49,4	51,5
L10 - L90 (dBA)	12,3	6,4	11,1	7,5	9,3	9,3	5,4	7,7

Sites 6, 7

Between sites 6 and 7, the first one located in a pedestrian area and the second one at a park located at a higher ground level from the surrounding roads. The appropriateness of the sixth site was rated with the highest mean value [$\bar{x}$ = *7,8 std(x) = 0,4*], and for the park was [$\bar{x}$ = *5,8 std(x)* = 2,4]. Both L_{Aeq} values were the same (52,7 and 52,8 dB) and the description of their sound environments was very similar [site 6: $\bar{x}$ = *6.7 std(x) = 2.8 site 7:* $\bar{x}$ = *6,3 std(x) = 2,4*]. However, L_{Aeq} over the frequency range shows differences up to 5dB for high frequencies and 8dB for low ones, meaning that the character of the sites differs substantially. Also, as seen on the spectrograms, there is more low frequency background noise on site 7, and the ratings for description and appropriateness of the sound environment are

higher on site 6, regardless the fact that more sound events are occurring. It seems that the low frequency components have a higher impact in the perception of the sites.

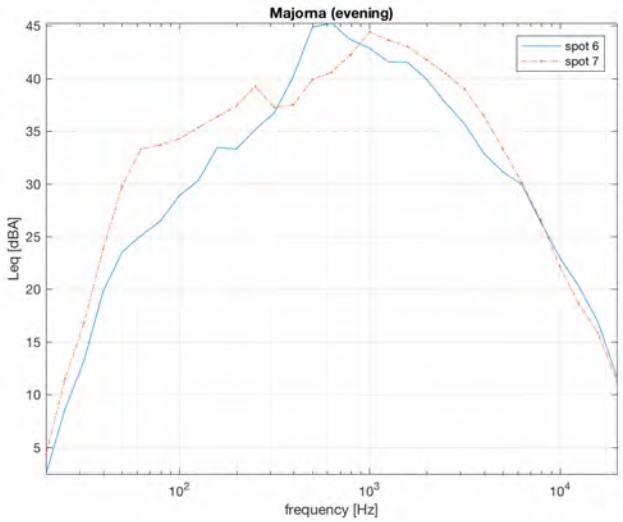

Figure 21. Frequency analysis: sites 6 and 7, Majorna-Linné evening soundwalk

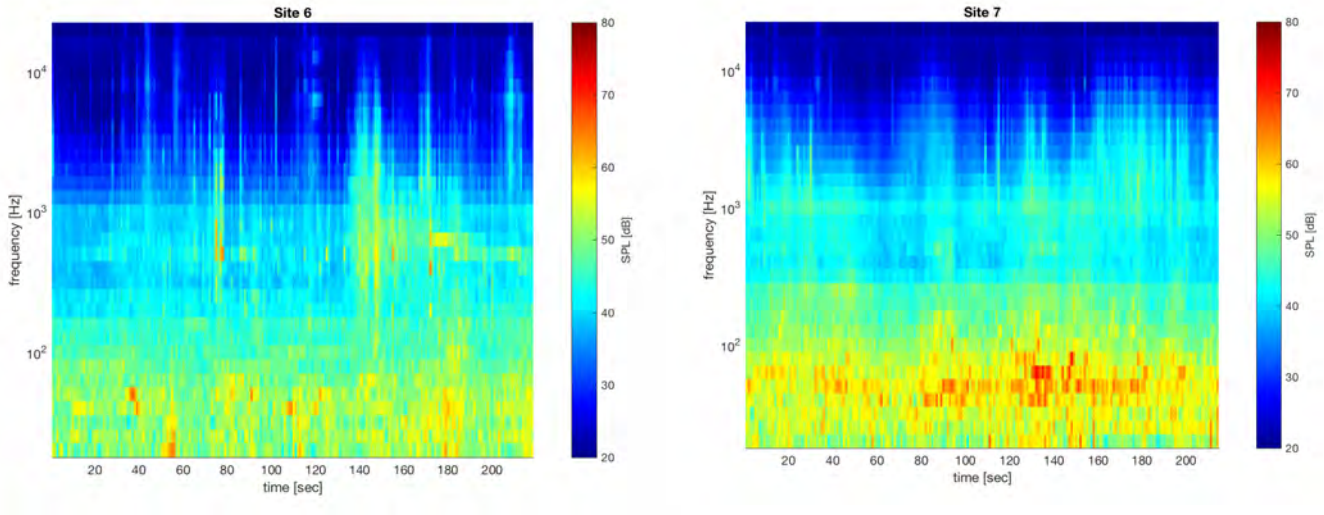

Figure 22. Spectrogram at sites 6 and 7, Majorna-Linné evening soundwalk

The sound sources dominating at this place in the evening were mainly road traffic noise, except for site 6, which is a pedestrian road. For sites 6 and 7, only 20% of the participants said that road traffic was dominating (values between 7-10 in the 0-10 scale). This behaviour varied substantially in the morning, were more sound sources were present.

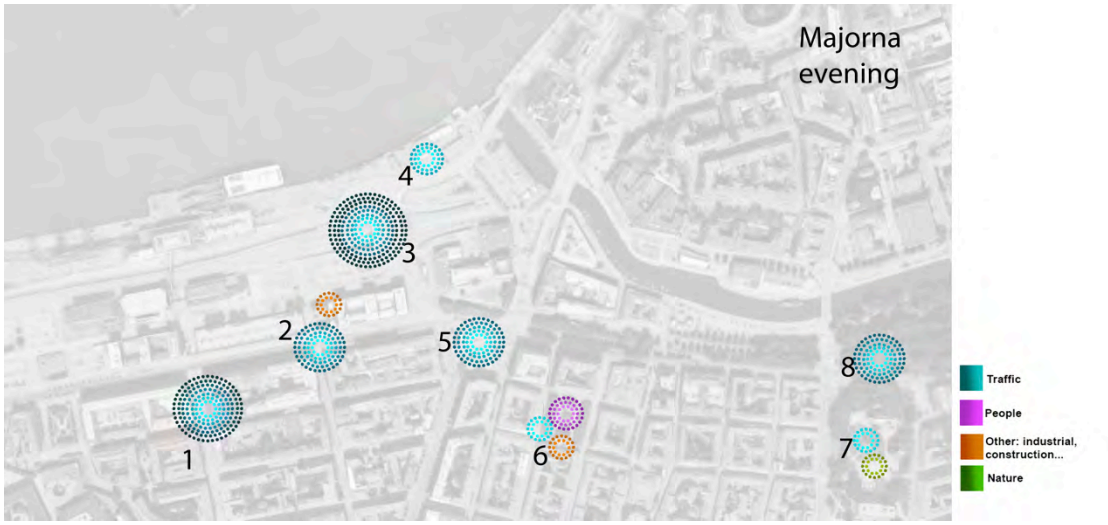

Figure 23. Sound sources dominance map. Majorna-Linné evening soundwalk

Although both of the sites gave low ratings on the chaotic character of the sound environment, site 6 is perceived as less annoying, uneventful, more pleasant and calm, than site 7 (Figure 24). Morning and evening assessment remains similar (Figure 11 and 24), however, for example at site 6, during the evening period, the place is not characterised as a vibrant one as it does in the morning, but as an uneventful. During the evening, this neighbourhood is almost empty, while during the day is a touristic place, with cafes and shops.

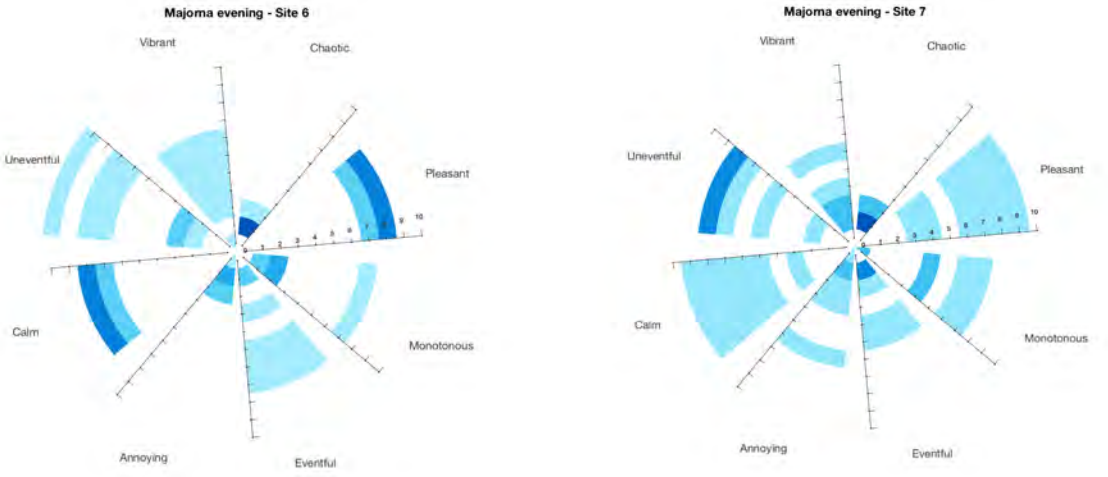

Figure 24. Perception of sound environment at Majorna-Linné evening soundwalk, sites 6 and 7

In site 6 (Figure 25) activities such as “escape from city stress”, “socialize with family and friends” and “appreciate cultural heritage” were rated with a median value of 8; at site 7, the activity with the highest median value (9) was “appreciate parks and trees” and “escape from city stress” was scored with a median value of 4. In both sites, L_{Aeq} was the same (52,7 and

52,8 dB), however, time variation, represented by L10-L90 was higher in site 6 (9,3 dBA) than in site 7 (5,4 dBA).

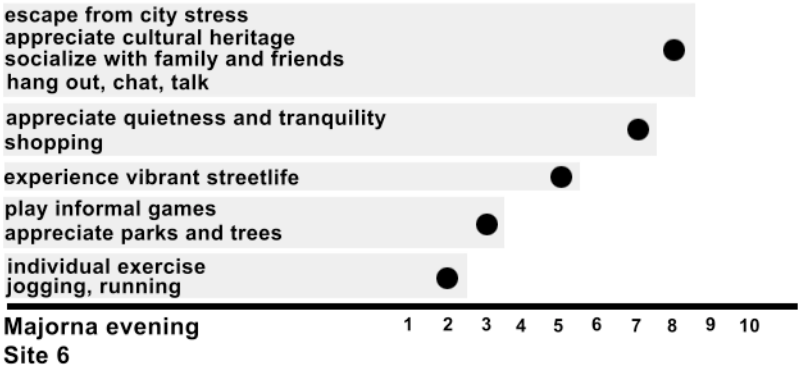

Figure 25. Activities at site 6: Majorna-Linné evening soundwalk

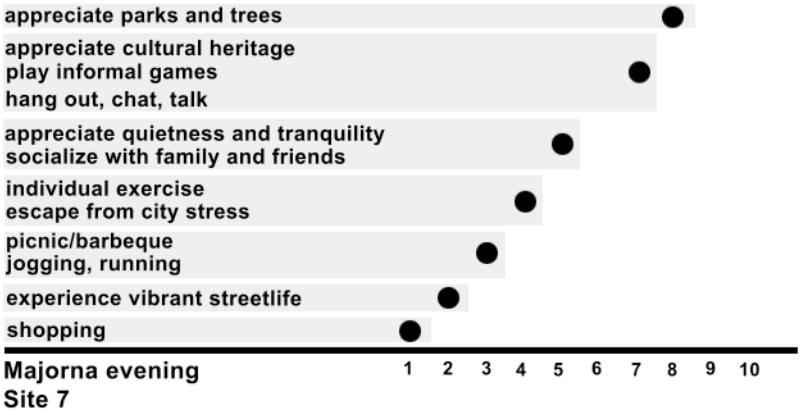

Figure 26. Activities at site 7: Majorna-Linné evening soundwalk

Sites 4, 8

Sites 4 and 8 were both located near the water, where site 4 is located close to the river and site 8 close to the canal. Both sites had the same L_{Aeq} at that moment (56,9 dB) as well as similar L_{90} and L_{10} values and their mean values for description and appropriateness of the sound environment. Their sound character though is different as seen below, where the low frequency range differs as much as 6 dB.

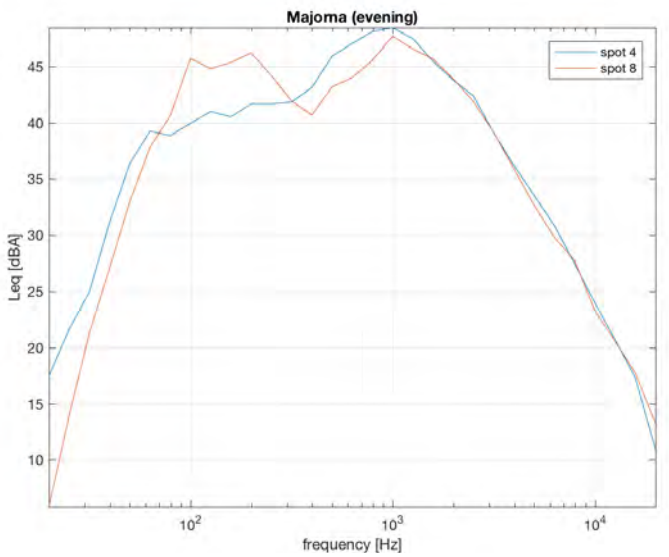

Figure 27. Frequency analysis: sites 4 and 8, Majorna-Linné evening soundwalk

As also seen on the spectrogram, site 4 has higher low and high frequency levels as well as more frequent events over the recorded period, holding the same L_{Aeq} levels. This contrasts with the characterisation of their sound environment, where site 4 is perceived calmer and less eventful than site 8.

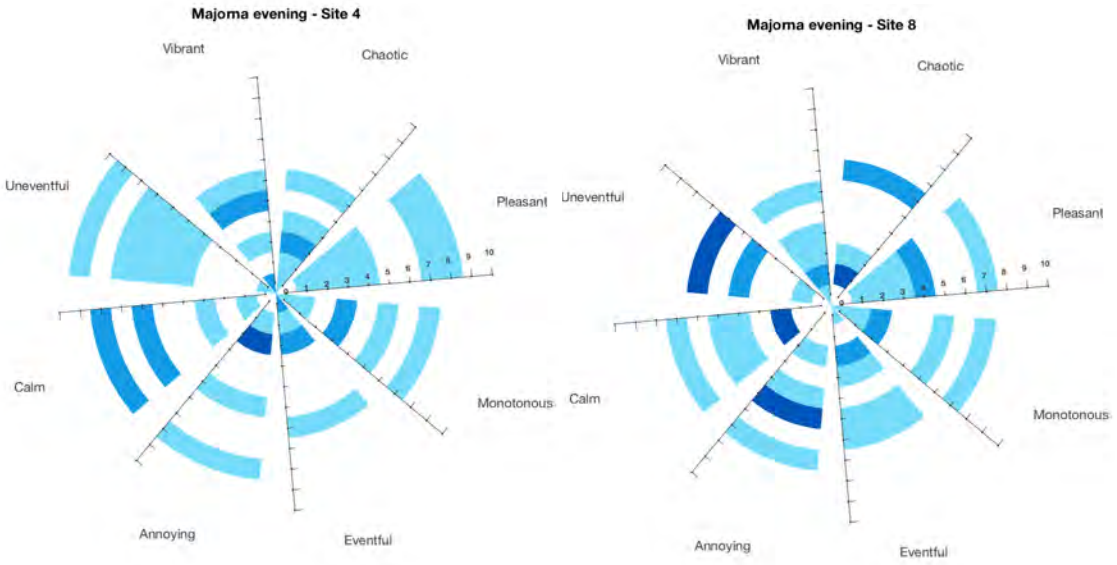

Figure 28. Perception of sound environment at Majorna-Linné evening soundwalk, sites 4 and 8

Comparing the morning and the evening soundwalk and its characterisation, both follow the same trends, however, for example, participants do not highlight site 6 as a vibrant place in the evening, while in the morning period they do. This spot is located at a commercial street with traffic restrictions;

during the evening time, the street has no activity and barely anyone is walking around. However, difference in the equivalent sound pressure levels is1,5 dBA for these two periods, with similar differences for L_{A10} and L_{A90}.

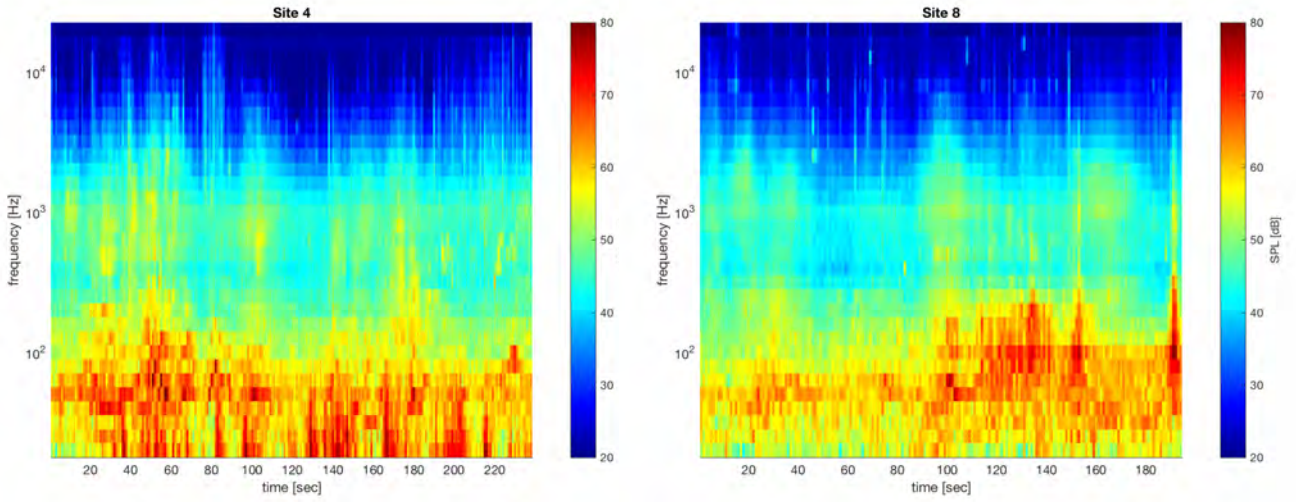

Figure 29. Spectrogram at sites 4 and 8, Majorna-Linné evening soundwalk

5. CENTRE SOUNDWALKS

Two soundwalks were performed in this area during the same day, one during the morning and one in the evening. The routes were the same for both soundwalks, with 8 sites around the city centre, going from busy areas as commercial ones, to parks, squares close to main roads, calm squares, etc.

Table 14. Description of sites: Centre soundwalks

Spot	Description
MP	Central station
1	Busy square by train station
2	Park (location: close to playground) Only in the morning soundwalk
3	Square between park entrance and main road
4	Small square by the canal
5	Square by main road (meeting point)
6	Pedestrian road: commercial area
7	Square by shopping mall between tram stops
8	Inside the shopping mall

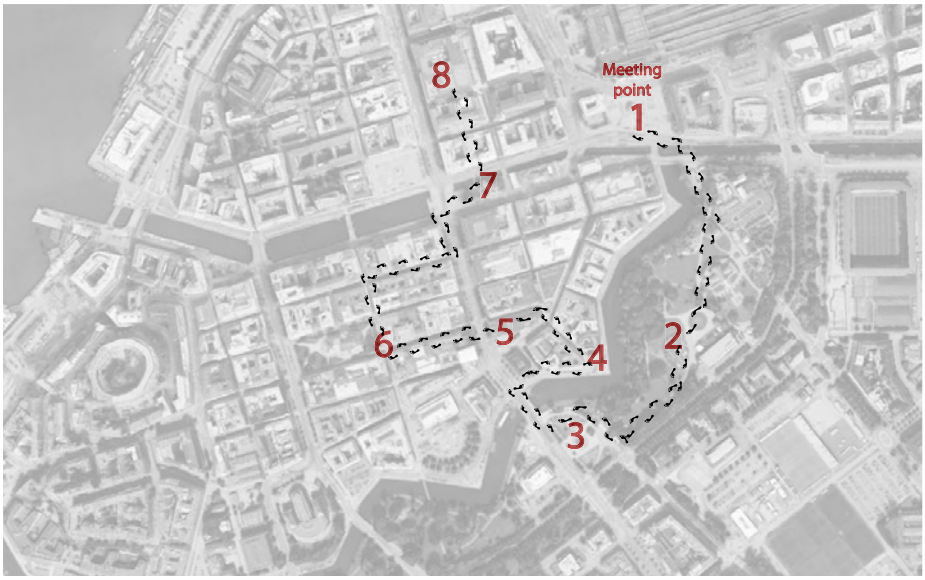

Figure 30. Map Centre soundwalk

5.1. Morning soundwalk: centre

During the morning period, 12 participants attended. General data is missing for one of them, however, among the rest of participants, 6 were men and 5 women between 25 and 61 years old. 20% of them have completed a higher education degree of less than 3 years and 80% a higher education degree of 3 years or more. In terms of their sensitivity to noise, 27% rated as more sensitive to noise than other people, 9% as less and 55% as equal than others and 9% do not know.

The majority of the participants know well the area, however, the park in site 2 and the small square at site 4 are the less visited.

Table 15. Participants' visits to the sites: Centre morning soundwalk

Visit site	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Every day	27%		9%		10%		20%	10%
At least once per week	46%		28%		60%	40%	40%	50%
At least once per month	27%	18%	9%	18%	10%	40%	40%	30%
Less than once per month, but at least 10 times per year		18%	27%		10%	10%		10%
At least once per year, but less than 10 times		46%	27%	55%	10%	10%		
Less than once per year		18%		27%				
This is the first time								

The sound environment was evaluated positively in the majority of the sites [$\bar{x}$ = *3.5 to 7.2*]. The appropriateness of that sound environment to the place was rated even higher [$\bar{x}$ = *5.4 to 8.3*].

The main differences in terms of the relation between description of the sound environment and its appropriateness were found at sites 1 [Q8: $\bar{x}$ = *3,5 std(x) = 0,8 Q10:* $\bar{x}$ *= 7 std(x) = 1,3*], 5 [Q8: $\bar{x}$ *= 5 std(x) = 1,9 Q10:* $\bar{x}$ *= 6,6 std(x) = 2,1*], 7 [Q8: $\bar{x}$ *= 4,8 std(x) = 2,4 Q10:* $\bar{x}$ *= 6,7 std(x) = 2,5*], and 8 [Q8: $\bar{x}$ *= 5,6 std(x) = 2 Q10:* $\bar{x}$ *=8,2 std(x) = 1,6*]. However, the range is much smaller for all sites than for example in the soundwalk held in Angered. Here, none of the sites scored more than 8.

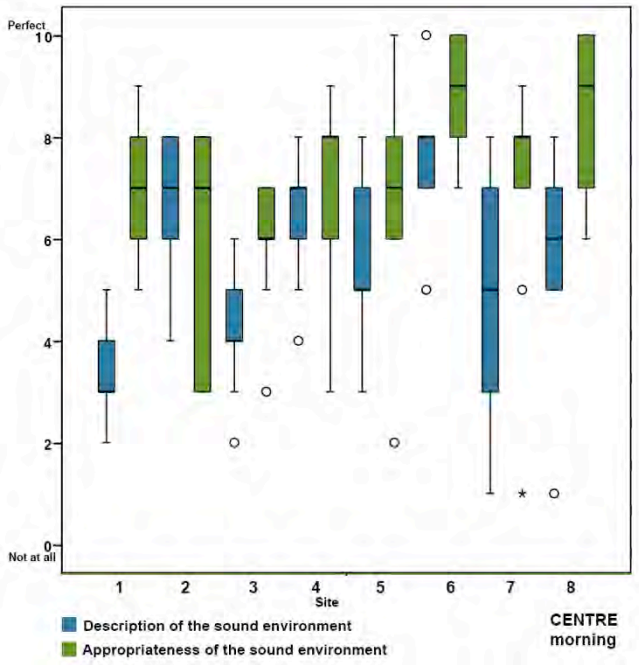

Figure 31. Description and appropriateness of the sound environment: Centre morning soundwalk

Table 16 shows the levels recorded from the sites. Equivalent sound pressure levels were between 53 and 64 dBA.

Table 16. Statistical noise levels: Centre morning soundwalk

Centre morning								
Site No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Leq (dBA)	64,4	53,5	58,3	53,6	60,9	61,4	61,9	63,8
L_{10} (dBA)	64,7	55,4	61,9	54,7	65	64,7	63,8	65,7
L_{90} (dBA)	59,1	50,2	52,4	51,3	55	56	58,7	61,5
L_{10} - L_{90} (dBA)	5,6	5,2	9,5	3,4	10	8,7	5,1	4,2

Sites 2 and 4

Specifically, on sites 2 and 4, their single number L_{Aeq} level is almost the same (53,5 and 53,6 dBA respectively). Their evaluation though, regarding the description of the sound environment is different, were site 2 was rated with a higher value [Q8: $\bar{x}$ *= 6,6 std(x) = 1,8 Q10:* $\bar{x}$ *= 4,5 std(x) = 1,6*]. Site 2 is a big park located in the middle of the city, while site 4 is a square by the river canal, where vehicles are barely present. Looking at the L_{Aeq} over the frequency range for these sites, it can be noted that site 2 has up to 4 dB differences on the high and low frequency range. Frequencies around 1 kHz on site 4 are higher while around 50 Hz are lower. This might serve as a possible explanation of the description of the sound environment. Furthermore, as it can be seen on the spectrogram of these sites, site 2 has a more uniform sound environment over time, i.e. lower contributions on the middle and low frequency range.

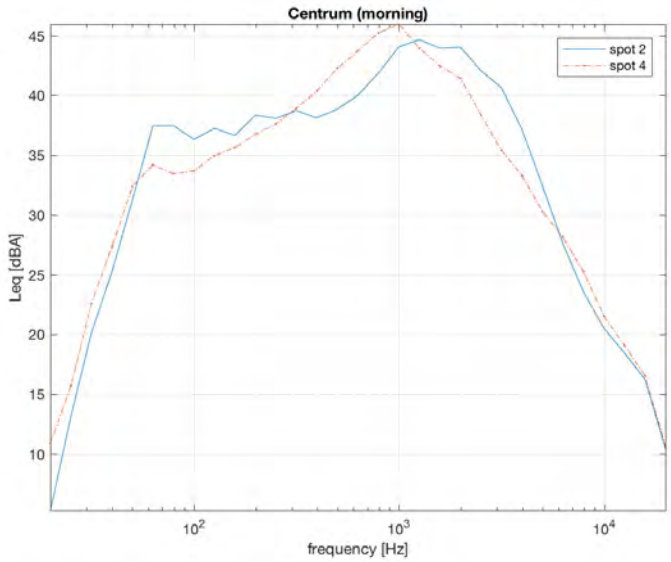

Figure 32. Frequency analysis: sites 2 and 4, Centre morning soundwalk

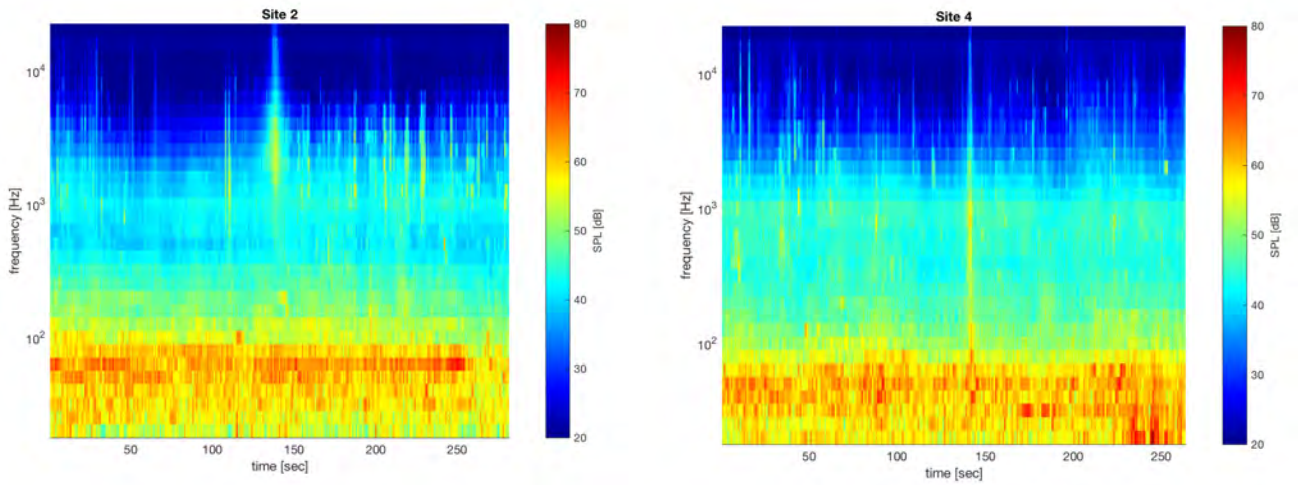

Figure 33. Spectrogram at sites 2 & 4, Centre morning soundwalk

Sites 6 and 7

For sites 6 and 7, description and appropriateness of the sound environment were different, even though the had also very similar L_{Aeq} value (61,4 and 61,9 dB), while their L_{A10} and L_{A90} values differ similarly as on sites 2 and 4. Site 6 was description of the sound environment perception *(site 6: $\bar{x}$ = 7,2 std(x) = 1,7, site 7: $\bar{x}$ = 4,8 std(x) = 2,4).* Here, their main difference can be seen mainly on the low frequency range up to 120 Hz. Their spectrograms show that there is similar amount of foreground events (impacts). However, on site 6 there is almost non-existent low frequency background noise, which seems logical considering the morphology of the sites. Site 7 sound environment is rated less appropriate, and evaluated worse than the one of site 6, but the evaluation differences between them are not proportional to difference of the sound sources perceived on each site (Figure 35).

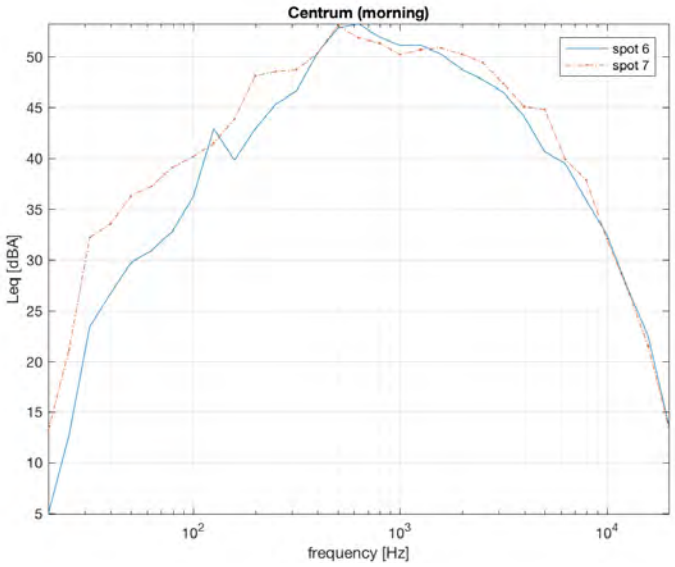

Figure 34. Frequency analysis: sites 6 and 7, Centre evening soundwalk

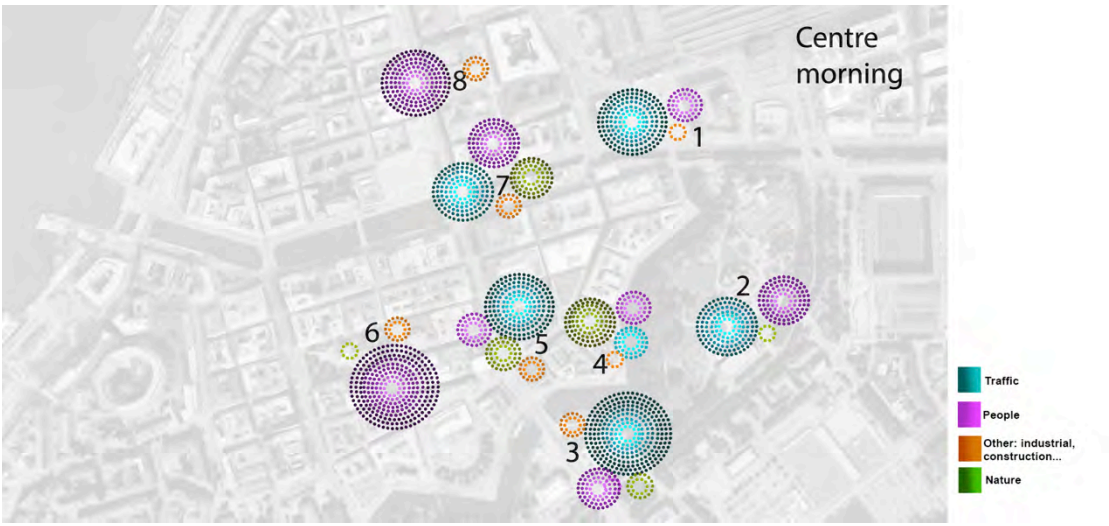

Figure 35. Sound sources dominance map. Centre morning soundwalk

That is to say that the sound environment of site 5, in which traffic noise is dominating, is not necessarily worse because of the noise source (in contrast, site 6 is mainly dominated by people), but it is because of the character of the noise source. Changing for example the traffic noise character here, like adjusting driving speed and directions, or creating a sound environment fitting to the functionality of the site, might give ratings similar to the one of site 6 that is considered better (site 6 is a pedestrianised crossroad and site 7 is a central traffic crossroad with pedestrianised nearby roads). By looking at the distribution of answers on the character of the sound environment. I can be seen that the answers follow similar trend, although for site 7 the answers are more spread. The main differences here are that site 7 is perceived more annoying and less pleasant than site 6.

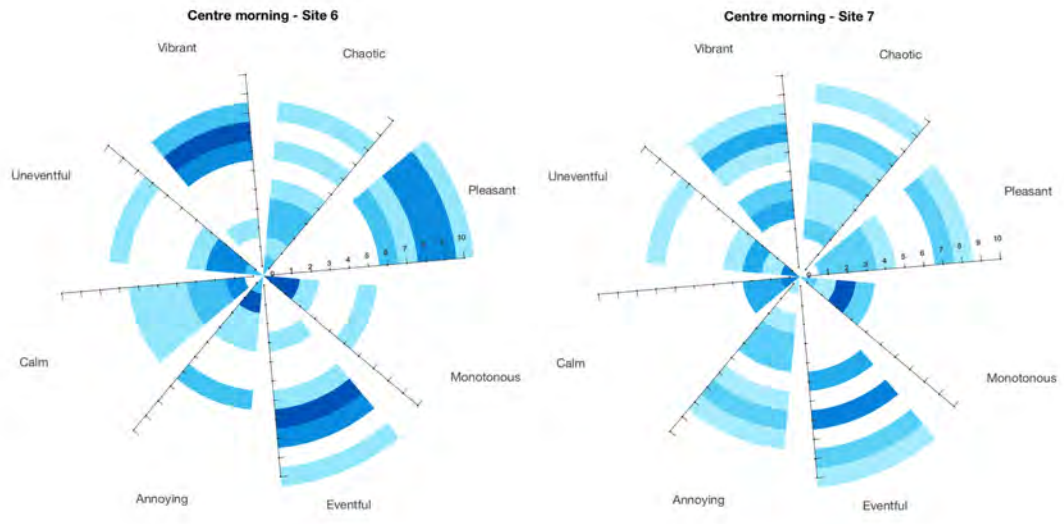

Figure 36. Perception of sound environment at Centre morning soundwalk, sites 6 & 7

5.2. Evening soundwalk: centre

Four participants attended the evening soundwalk. Two of them were men and 2 women between 68 and 36 years old. 75% of them have completed a higher education degree of more than 3 years. All of them think they are equally sensitive to noise as other people.

The majority of the participants know well at least 6 out of 7 sites; the square in site 3 is the less visited one. At this time of the day was not possible to access site number 2, since the park closes in the afternoon.

Table 17. Participants' visits to the sites: Centre evening soundwalk

Visit site	**1**	**3**	**4**	**5**	**6**	**7**	**8**
Every day	25%					25%	
At least once per week	75%	25%	50%	75%	100%	50%	75%
At least once per month			50%	25%		25%	
Less than once per month, but at least 10 times per year		25%					
At least once per year, but less than 10 times		25%					25%
Less than once per year		25%					
This is the first time							

Equivalent noise levels were in general lower than in the morning study.

Table 18. Statistical noise levels: Centre evening soundwalk

Centre evening							
Site No.	**1**	**3**	**4**	**5**	**6**	**7**	**8**
L_{eq} (dBA)	60,2	50	53,8	60,1	52,9	60,8	61,3
L_{10} (dBA)	63,2	51,7	56,8	63,7	52,3	63	63,8
L_{90} (dBA)	54,4	47,3	48,5	51,9	43,5	55,1	57,4
L_{10} - L_{90} (dBA)	8,8	4,4	8,3	11,8	8,8	7,9	6,4
Difference morning-evening							
L_{eq} (dBA) difference	4,2	8,3	-0,2	0,8	8,5	1,1	2,5

Main differences between the description and the appropriateness of the sound environment were found at site 1 [*Q8: $\bar{x}$ = 2,5 std(x) = 0,6 Q10: $\bar{x}$ = 4,5 std(x) = 3,4*], site 5 [*Q8: $\bar{x}$ = 3,8 std(x) = 0,5 Q10: $\bar{x}$ = 5,3 std(x) =*

1,7], and site 8 [*Q8:* $\bar{x}$ *= 4,7 std(x) = 1,6 Q10:* $\bar{x}$ *= 6,8 std(x) = 2,8*]. However, the range is much smaller for all sites than the one at the morning evaluation, as well as the one performed in Angered.

The one with the highest mean value was site 6 for both description and appropriateness of the sound environment. This site is located in a commercial street were road traffic is restricted.

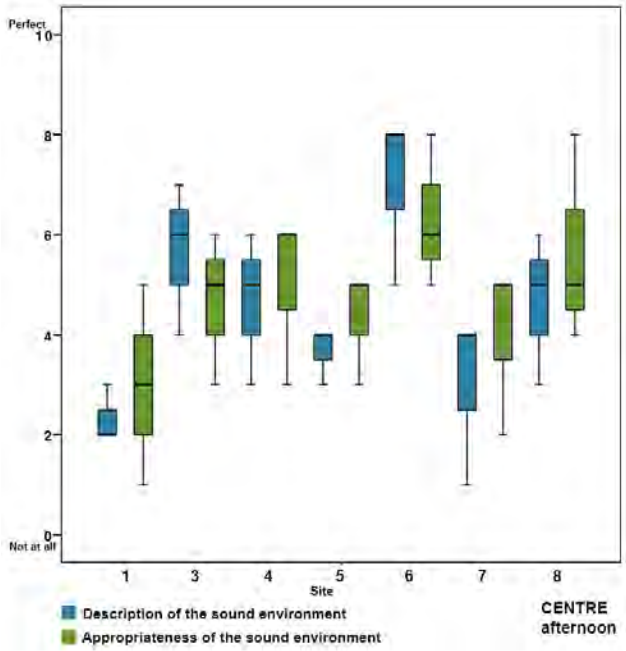

Figure 37. Description and appropriateness of the sound environment: Centre evening soundwalk

Sites 1, 5 & 7

Here, the sites 1, 5 & 7 are explicitly presented and compared due to the fact of their similar L_{Aeq} levels (see Table 17). The site 8 has similar levels, however it is omitted from this comparison, as it is an indoor environment; for its comparison with outdoors environments more parameters and data are needed in hand.

The description of the sound environment for site 1 [$\bar{x}$ *= 2,5 std(x) = 0.6*], site 5 [$\bar{x}$ *= 3,8 std(x) = 0,5*] and site 7 [$\bar{x}$ *= 3 std(x) = 1,4*] ranges between 2,5 and 4, meaning that the three sites have been perceived as having a bad sound environment. In terms of the appropriateness of the sound environment to the place, site 1 [$\bar{x}$ *= 4,5 std(x) = 3,4*], site 5 [$\bar{x}$ *= 5,3 std(x) = 2*] and site 7 [$\bar{x}$ *= 4 std(x) = 1,4*] is valued slightly better that the description, with ranges between 4 and 5,3.

In all 3 sites values for L_{Aeq} differ less that 1 dB, something that is also true for the indicator L_{10}. L_{90} on the other hand is 54,4 dB, 48,5 dB and 43,5 dB for the sites 1, 5 and 7 respectively. These levels resemble here background and constant noise along the time of the recordings. As seen on the spectrograms, site 5 has less background noise components making the peak events more distinct. All of the three sites follow similar patterns on events occurrences, as also indicated by L_{10}.

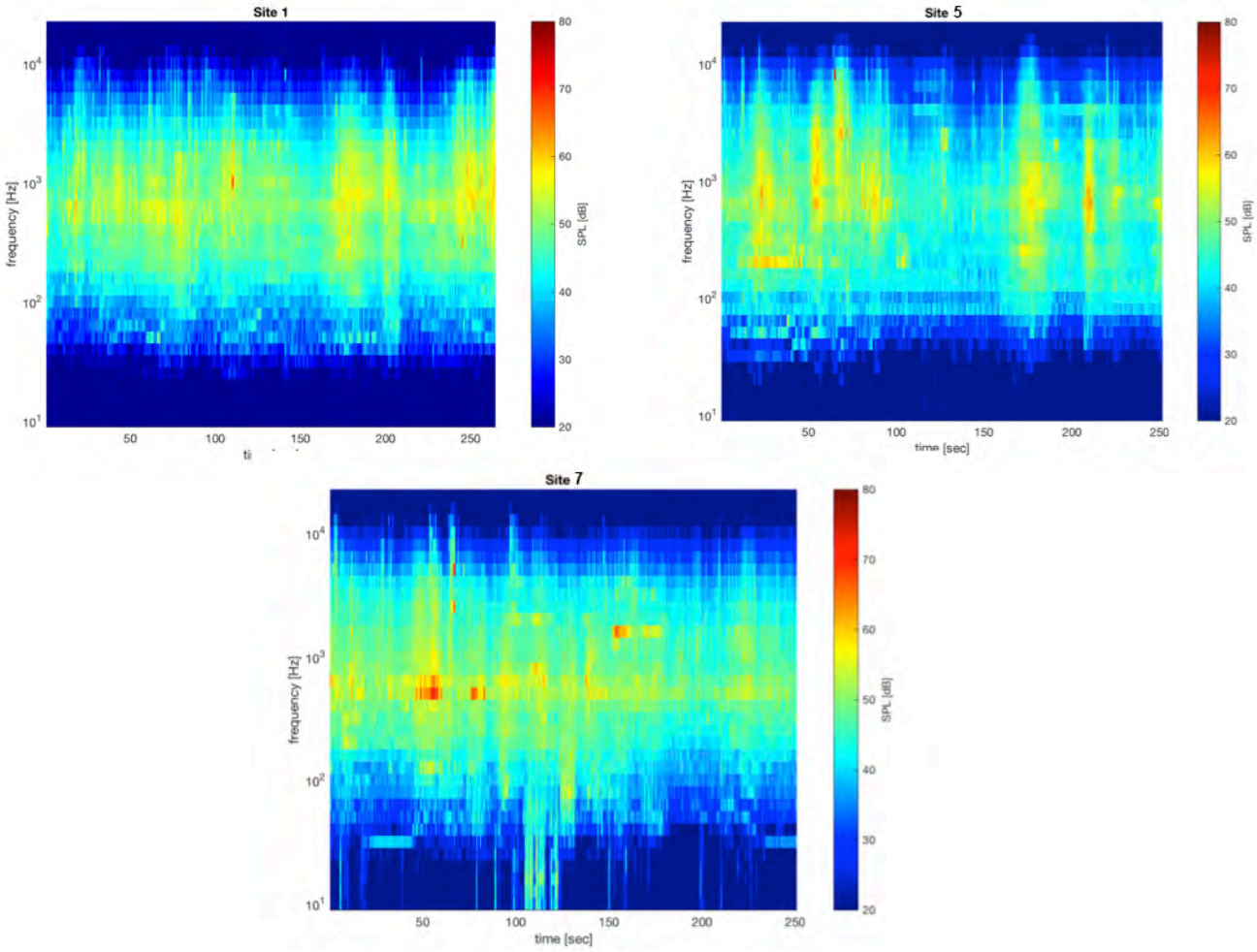

Figure 38. Spectrogram at sites 1, 5 and 7, Centre evening soundwalk

The background noise difference on these sites can be a possible factor of the characterisation of the sound environment. As seen on the distribution of answers below, more people characterised site 5 as eventful but also chaotic. Comparing to sites 1 and 7, these characterisations are more spread along the ratings' range. Other characterisations of the sound environment follow similar patters. This might be due to the fact that the character, event frequency and spectral distribution of the sound environment are similar along these sites.

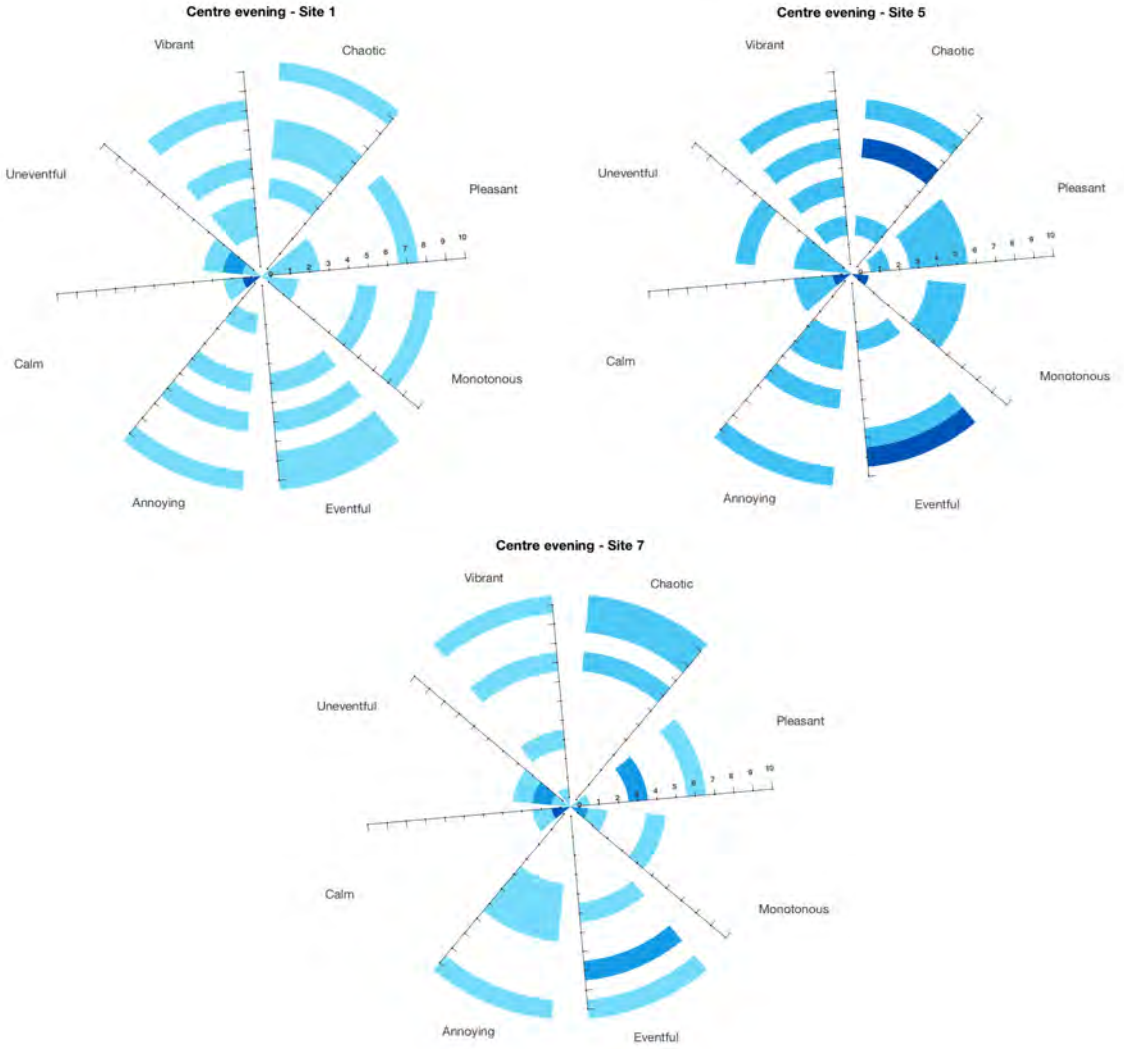

Figure 39. Perception of sound environment at Centre evening soundwalk, sites 1, 5 & 7

More activities were found to be able to perform during the morning period than in the evening. Also, there were ranked higher. For example, at site 5 only three activities were ranked with a median value between 7 and 10 for the evening period, while in the morning five activities were included. In both soundwalks, the activities “escape from city stress”, “jogging, running” and “individual exercise” were scored with a median value of 1.

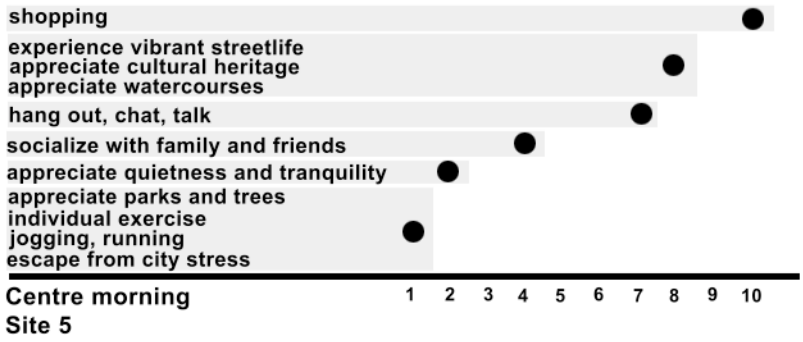

Figure 40. Activities at site number 5. Centre morning soundwalk

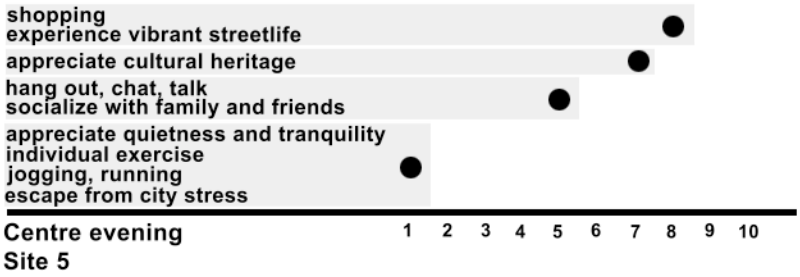

Figure 41. Activities at site number 5. Centre evening soundwalk

The sound sources' dominance was smaller than in the morning period, were the sources present were scored higher (between 7 to 10 in the dominance scale). For example, site 3 and 6 had a lower equivalent sound pressure level (around 8 dBA), while other sites as 4, 5 and 6 had almost the same equivalent level in the morning and in the evening. The sites with a larger variation are located very close to a busy road in the city.

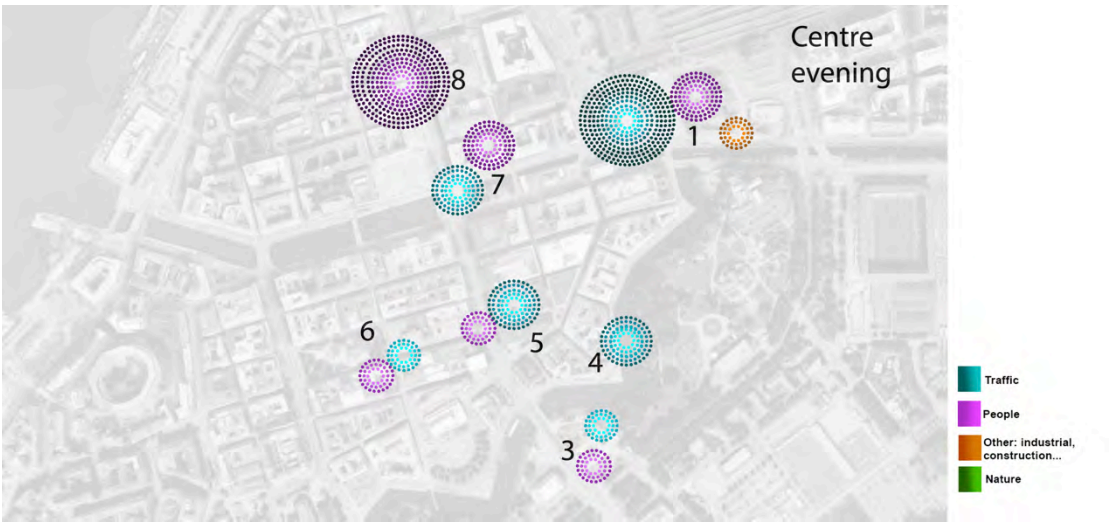

Figure 42. Sound sources dominance map. Centre evening soundwalk

Discussion

Even though the number of participants does not allow further conclusions about the soundwalks, the next paragraphs attempt to highlight certain interesting points of each of them.

In the case of Angered, the participants did not know well the sites. The description of the sound environment and its appropriateness was distinguished among participants. In these cases, even though the sound environment was perceived as poor, its appropriateness corresponds to its spatial function, e.g. roundabout with no surrounding activities, etc. In sites where traffic noise was not dominating, the perception of the sound environment was ranked as better, obtaining mean values above 7 (0-10 scale). Moreover, in these sites the number of outdoor activities that may be performed was higher. Moreover, the appropriateness of the sound environment to the place was also rated higher, with a large agreement among participants. In the appropriateness of the sound environment answers, the difference respect to the ones where traffic noise was the dominating source was not as large as in the description answers.

Two sites with the same equivalent sound pressure level, temporal variation ($L_{10} – L_{90}$) and perception of the sound environment but different built environments, offered very different spectrograms, where in one of them traffic noise, mainly due to the tramway, was dominating during the recordings, together with sources such as construction one.

The morning soundwalk around the city centre holds an interesting comparison. Sites with almost the same equivalent sound pressure levels had very different dominance sound sources, perception and characterisation. The first site is a commercial street with traffic restrictions (site 6), and the second one is a central square in between the tram and bus stops (site 7). Perception of the sound environment was ranked well in the case of the commercial street. In this case, the dominating sound source was people sounds, while in the case of the central square, a mixture of sound sources was present, where traffic was the dominating one. A number of activities may be performed at both sites, however, the commercial street scenario ranked better in terms of feasibility of performing them.

In the soundwalk performed in the city centre in the afternoon, the site that was perceived as better in terms of the sound environment was again number 6, located at a commercial street with traffic restrictions. In this soundwalk, three sites showed practically the same equivalent sound pressure level; the one with the higher temporal variation (L10-L90) was the one with the highest mean value in terms of perception of the sound environment. However all three sites showed a very bad sound environment (mean values from 2.5 to 3.8). In the site with the larger temporal variation, a large number of participants characterised it as eventful but also chaotic.

From the Majorna-Linné soundwalks the characterisation of the sites at different times of the day is highlighted. For example, site number 6, situated at a touristic but calm commercial street with traffic restrictions and equivalent sound pressure levels around 53-54 dBA was marked as a pleasant and calm site by the majority of the participants. However, only during the morning was it characterised as a vibrant place, since at night-time its human activity is practically non-existent.

During the evening recordings, sites 4 and 8 are compared. Both sites are located close to the water, however, site 4 is an “empty” space that will be subjected to an urban transformation into a residential area, while site 8 is on a linear park in a consolidated urban area that gives access to the city centre. Here, site 4 has higher low and high frequency levels and more frequent events than site 8, however, both of them hold the same equivalent sound pressure level. This contrasts with the characterisation of their sound environment, where site 4 is perceived calmer and less eventful than site 8.

In the case of the children soundwalk, their judgement in terms of perception and appropriateness of the sound environment is a higher grade than in the case of the adults. This may be due to their difficulty to recognize dangerous noise exposures and the differences in scale, since the children scale was a 5-point scale, which was transformed for present comparisons. Source dominance was evident for both soundwalks in site number three, located by the tunnel road. Even though both were performed almost simultaneously, the dominance of sound sources was less pronounced in the children soundwalk. Moreover, children assessment follows similarities with adults in terms of the importance of the multi-sensory experience of the built environment. In this sense, the same equivalent sound pressure level and similar temporal variation (L_{A10} - L_{A90}) was described differently in terms of sound environment perception.

As stated in the introduction of this report, listening is part of the multi-sensorial approach to urban experience. In this sense, the type of source dominating the environment becomes relevant. For example, in the cases where traffic is the dominating sound source in the recordings, the participants characterised the place as not calm, or pleasant or vibrant, while annoying. In these sites, equivalent sound pressure levels are ranging from 66 to 75 dBA. However, there is no consensus in the participant’s answers in case the place is located in an environment as a park, a square, a meeting point with a large number of activities and possible spatial uses to be performed. The only consensus is in the lack of calmness. Here, characteristics as pleasant started to gain weight. The equivalent sound pressure level in these cases is lower (58 to 60 dBA).

This study attempts to take further steps in the integration of urban sound planning in the planning process in the city of Gothenburg. The increasing awareness of citizens is demanding a proactive appreciation of the environment. In this regard, soundwalk participants become part of the city-

making process. We strongly believe that urban interventions must include potential benefits to improve the quality of spaces, including acoustic factors beyond regulations, having in mind a long-term perspective.

Acknowledgements

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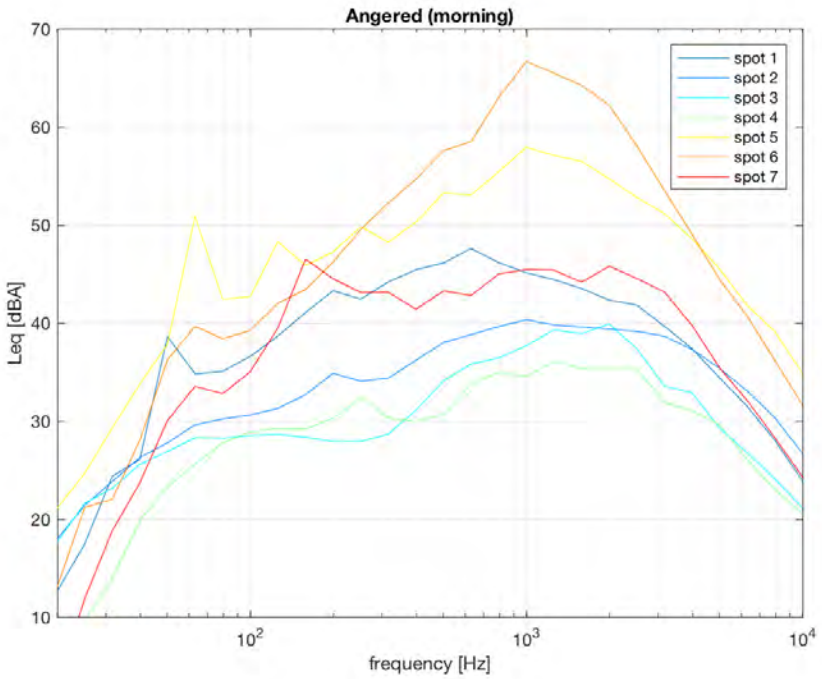
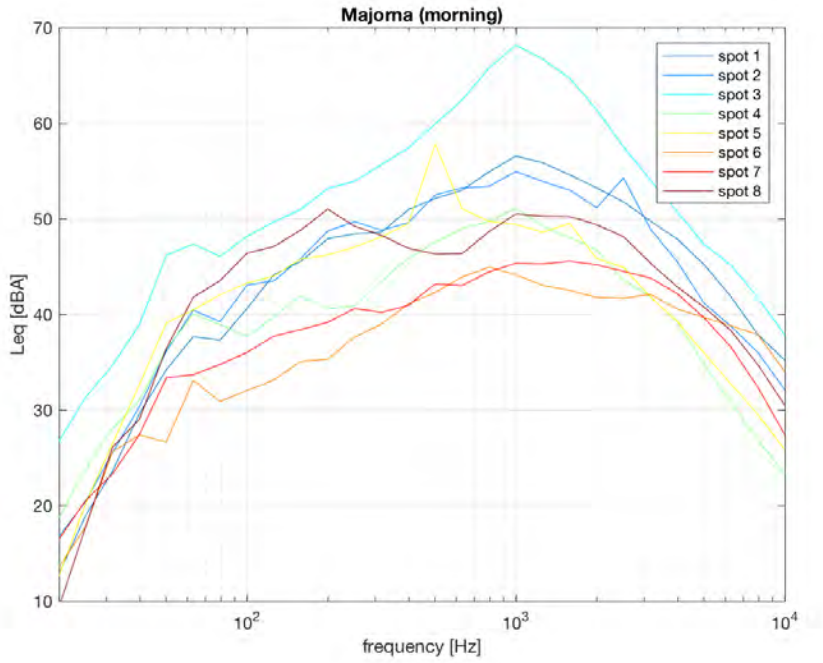
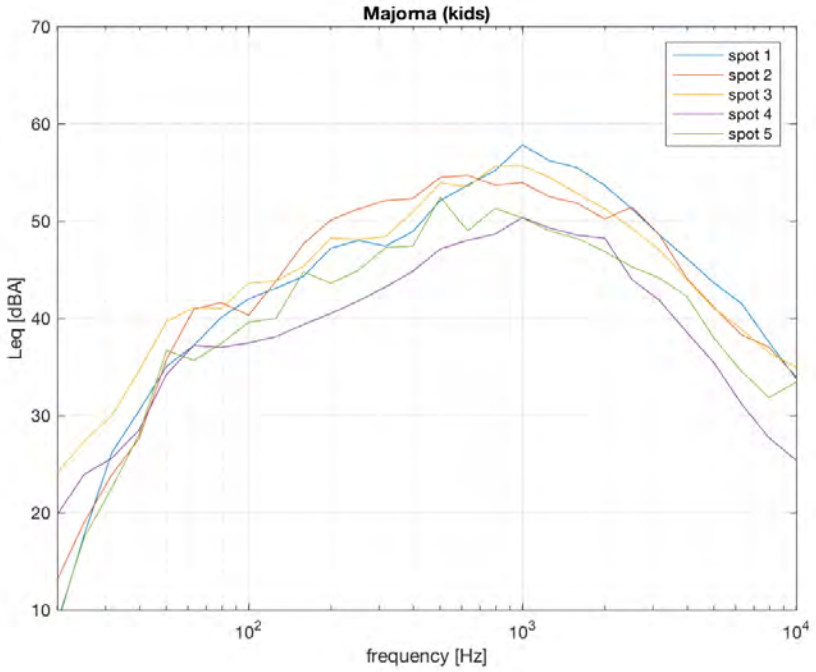
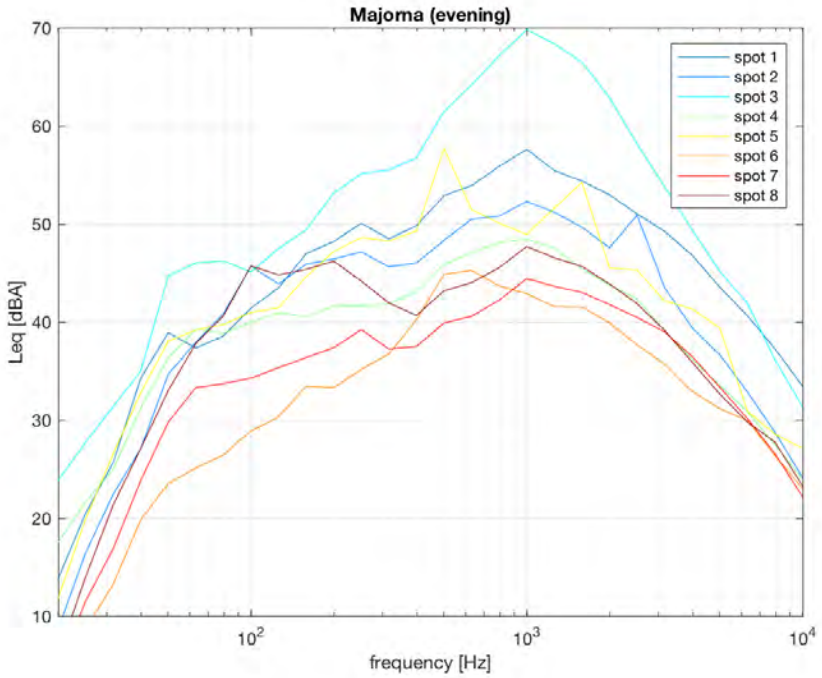
APPENDIX

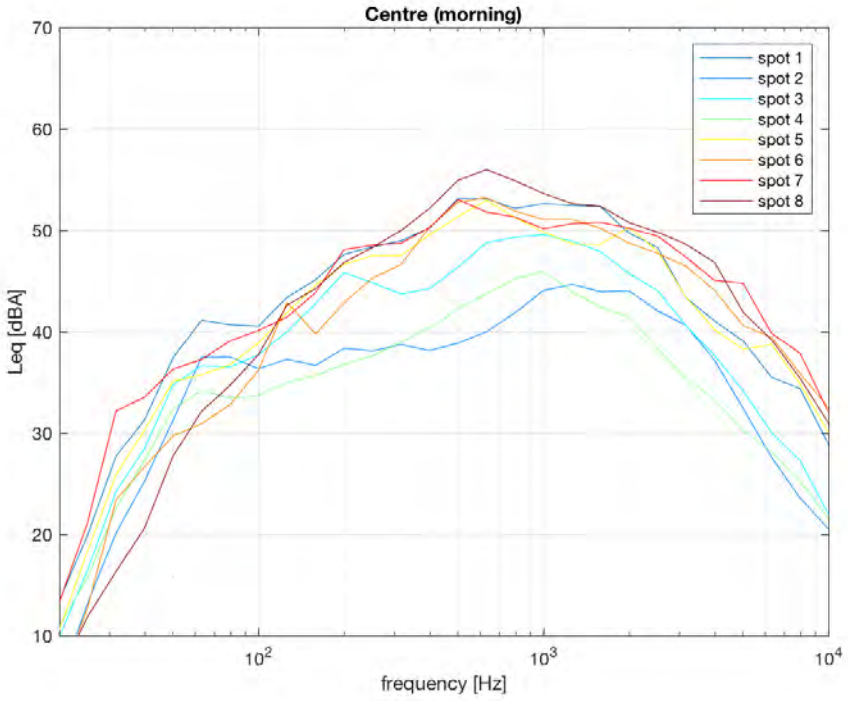
A1. Equivalent sound pressure level (LAEq)

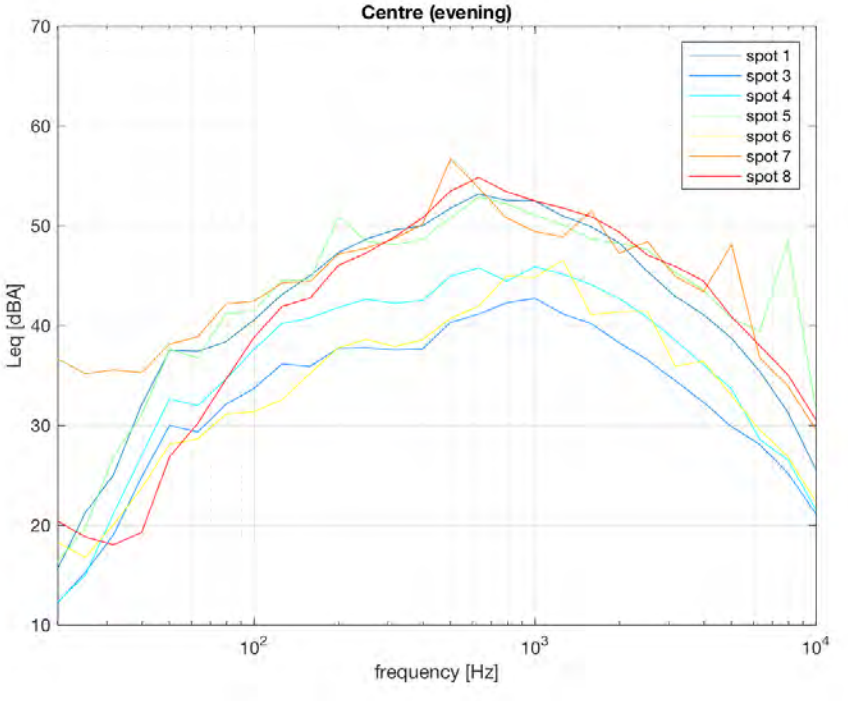





Majorna (kids)
spot 1
spot 2
spot 3
spot 4
spot 5
Leq [dBA]
frequency [Hz]
70
60
50
40
30
20
10
10^2
10^3
10^4


Majorna (evening)
spot 1
spot 2
spot 3
spot 4
spot 5
spot 6
spot 7
spot 8
Leq [dBA]
frequency [Hz]
70
60
50
40
30
20
10
10^2
10^3
10^4


Centre (morning)
spot 1
spot 2
spot 3
spot 4
spot 5
spot 6
spot 7
spot 8
Leq [dBA]
frequency [Hz]
70
60
50
40
30
20
10
10^2
10^3
10^4


Centre (evening)
spot 1
spot 3
spot 4
spot 5
spot 6
spot 7
spot 8
Leq [dBA]
frequency [Hz]
70
60
50
40
30
20
10
10^2
10^3
10^4

A2. Equivalent sound pressure level and temporal distribution

Angered morning							
Site #	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Leq (dBA)	56,1	50,4	47,9	45,7	65,8	72,4	56,2
L10 (dBA)	59,5	52,7	50,2	47,6	67,7	76,6	57,1
L90 (dBA)	51,5	47,1	41,7	40,7	59,7	58,5	48,1
L10-L90 (dBA)	8	5,6	8,5	6,9	8	18,1	9

Majorna morning with children					
Site #	**1**	**2**	**3**	**4**	**5**
Leq (dBA)	64,7	63,9	63,9	58,3	60
L10 (dBA)	67,9	65,9	66,1	60,7	62,8
L90 (dBA)	56,5	58,7	59,7	54,1	55,6
L10-L90 (dBA)	11,4	7,2	6,4	6,6	7,2

Majorna morning								
Site #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Leq (dBA)	64,4	63,7	74	58,7	62	54,2	55,5	60,9
L10 (dBA)	67,4	66,8	76,8	61	65	56,1	57,6	63,6
L90 (dBA)	56,2	59	68,4	54,5	55,1	48,8	51,8	57
L10-L90 (dBA)	11,2	7,8	8,4	6,5	9,9	7,3	5,8	6,6

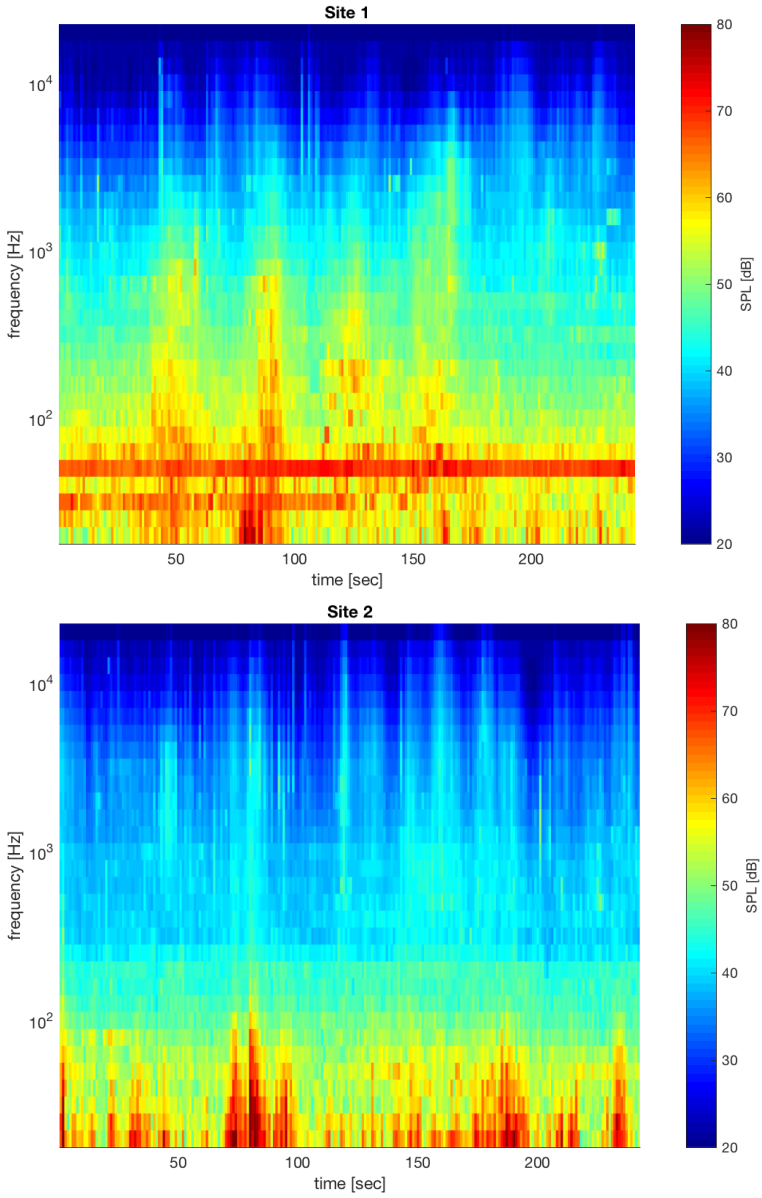
Majorna evening								
Site #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Leq (dBA)	64,7	60,8	75,4	56,9	62,6	52,7	52,8	56,9
L10 (dBA)	67,1	63	79,1	60	65,4	55,4	54,8	59,2
L90 (dBA)	54,8	56,6	68	52,5	56,1	46,1	49,4	51,5
L10-L90 (dBA)	12,3	6,4	11,1	7,5	9,3	9,3	5,4	7,7

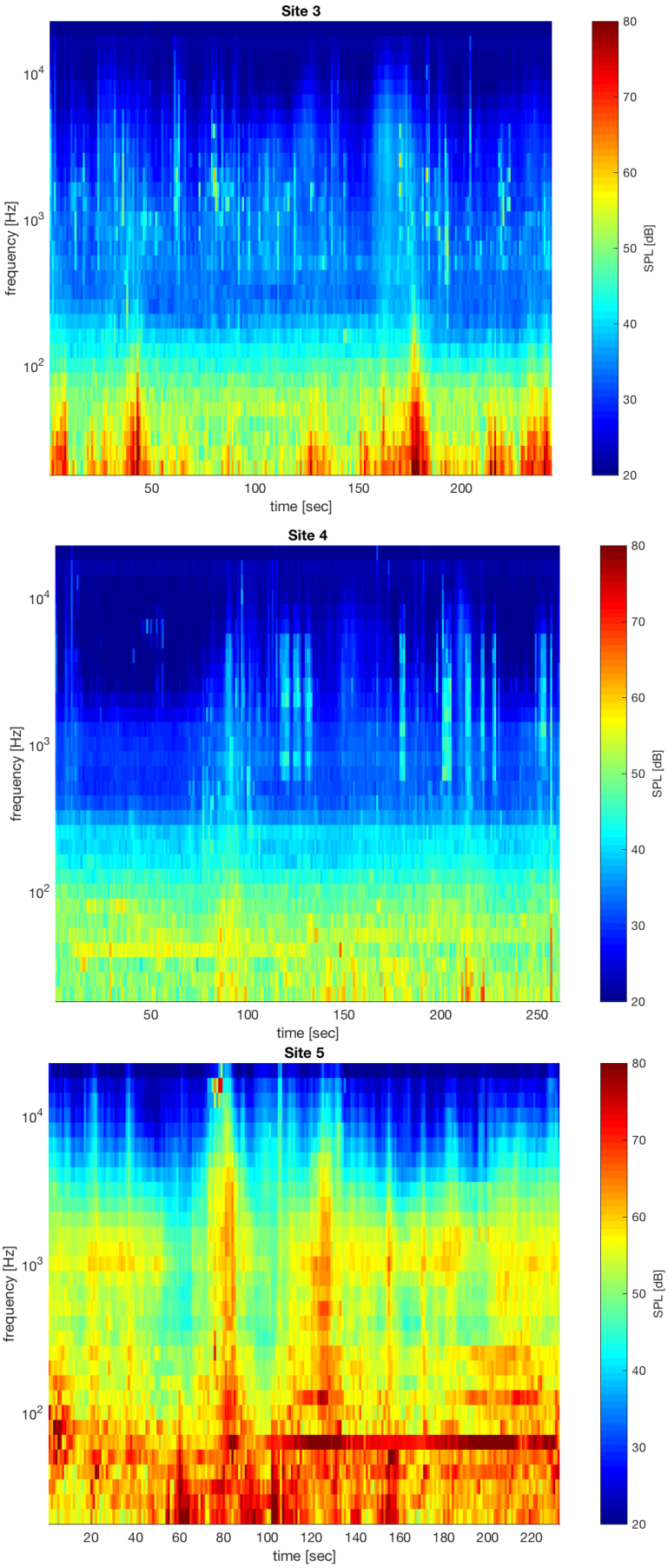
Centre morning								
Site #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Leq (dBA)	64,4	53,5	58,3	53,6	60,9	61,4	61,9	63,8
L10 (dBA)	64,7	55,4	61,9	54,7	65	64,7	63,8	65,7
L90 (dBA)	59,1	50,2	52,4	51,3	55	56	58,7	61,5
L10-L90 (dBA)	5,6	5,2	9,5	3,4	10	8,7	5,1	4,2

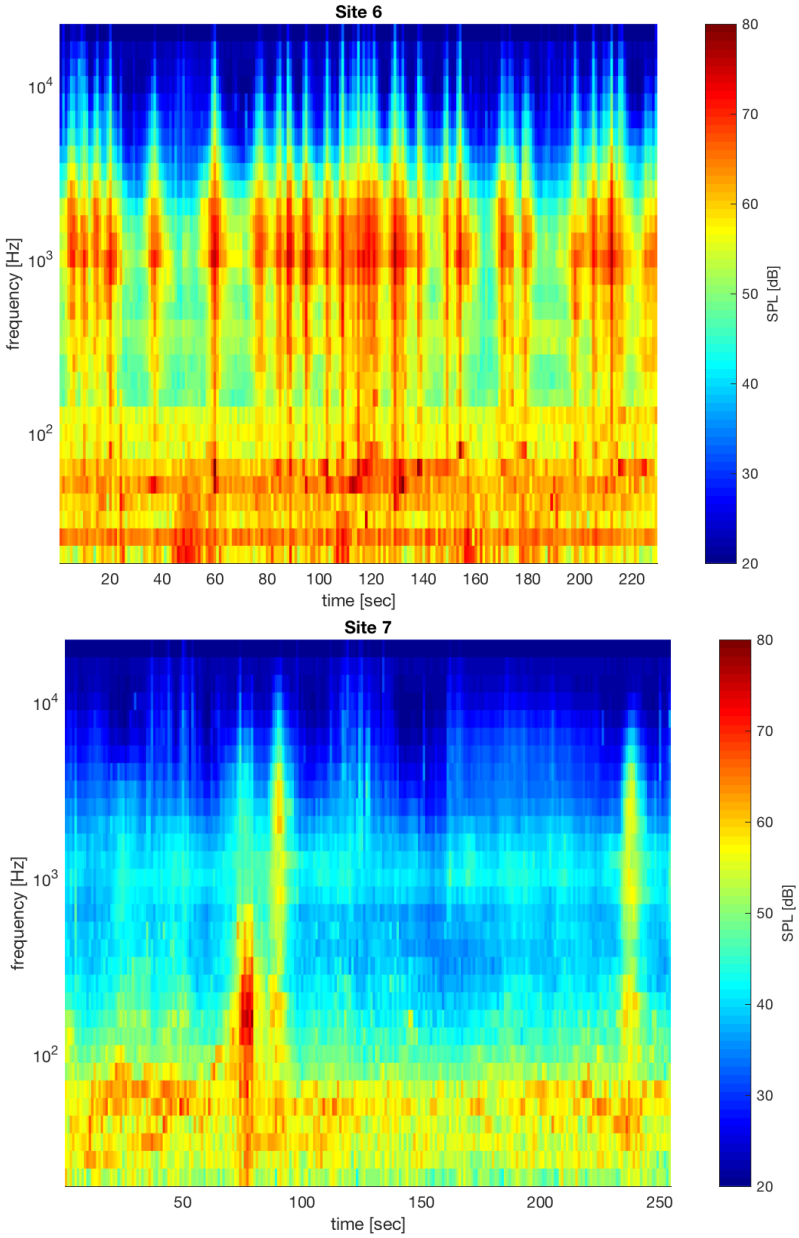
Centre evening							
Site #	**1**	**3**	**4**	**5**	**6**	**7**	**8**
Leq (dBA)	60,2	50	53,8	60,1	52,9	60,8	61,3
L10 (dBA)	63,2	51,7	56,8	63,7	52,3	63	63,8
L90 (dBA)	54,4	47,3	48,5	51,9	43,5	55,1	57,4
L10-L90 (dBA)	8,8	4,4	8,3	11,8	8,8	7,9	6,4

A3. Spectrograms

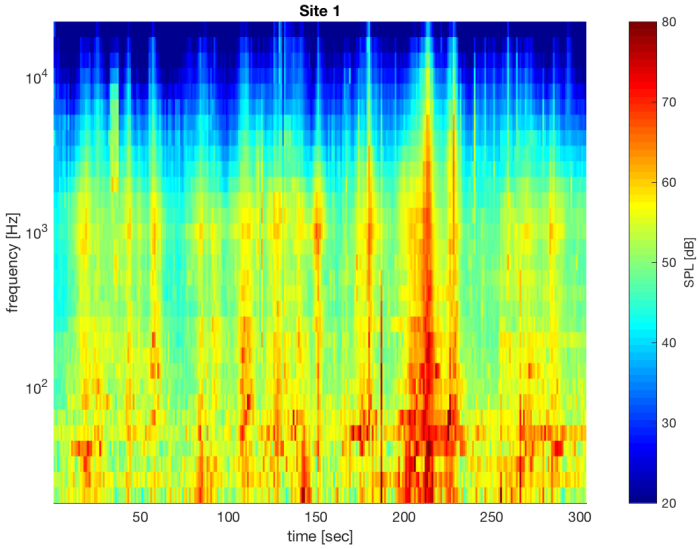
Angered morning

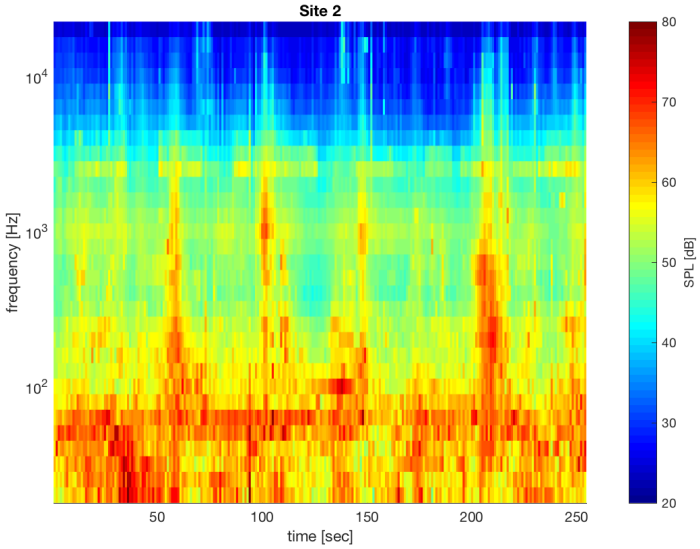


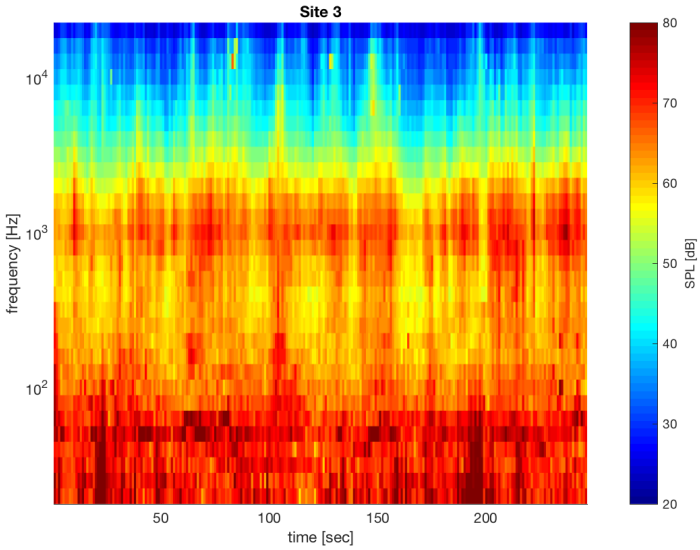

Site 3
frequency [Hz]
10^4
10^3
10^2
50
100
150
200
time [sec]
SPL [dB]
80
70
60
50
40
30
20
Site 4
frequency [Hz]
10^4
10^3
10^2
50
100
150
200
250
time [sec]
SPL [dB]
80
70
60
50
40
30
20
Site 5
frequency [Hz]
10^4
10^3
10^2
20
40
60
80
100
120
140
160
180
200
220
time [sec]
SPL [dB]
80
70
60
50
40
30
20

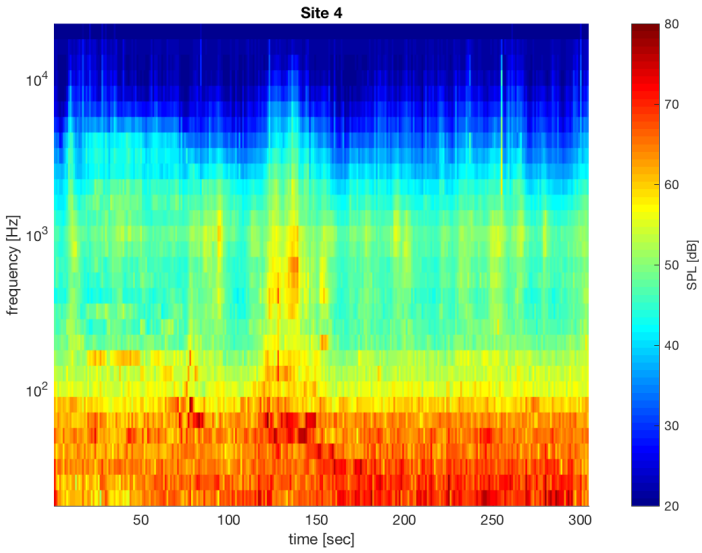

Site 6
frequency [Hz]
10^4
10^3
10^2
20 40 60 80 100 120 140 160 180 200 220
time [sec]
80 70 60 50 40 30 20
SPL [dB]
Site 7
frequency [Hz]
10^4
10^3
10^2
50 100 150 200 250
time [sec]
80 70 60 50 40 30 20
SPL [dB]

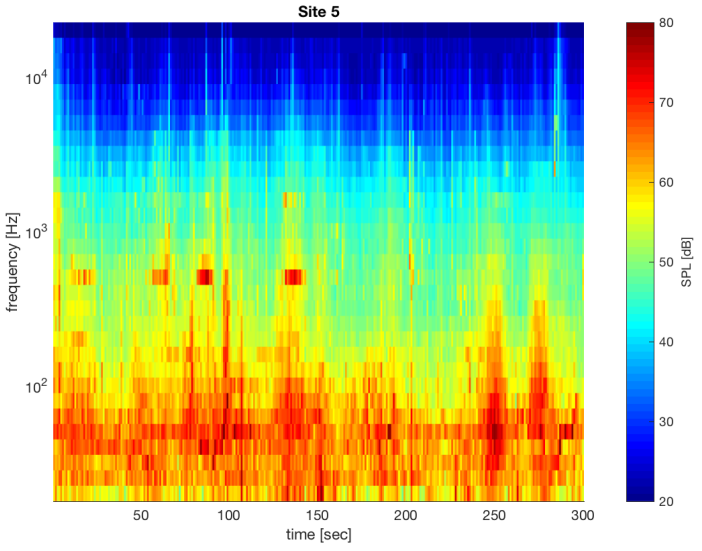
Majorna-Linné morning

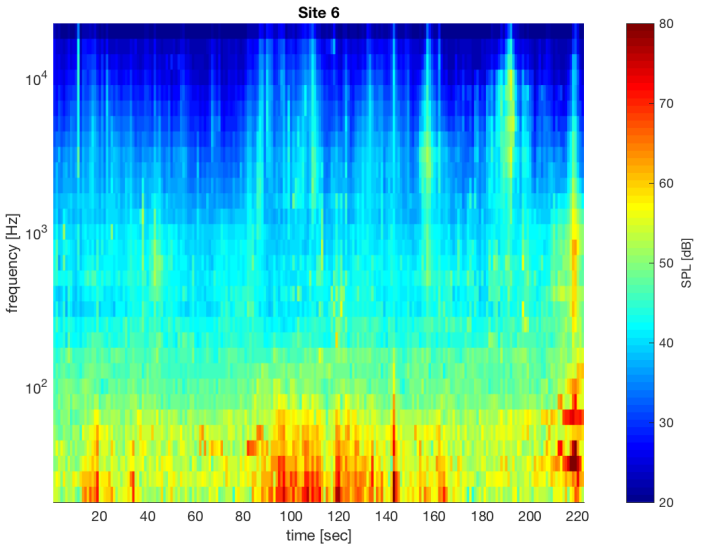


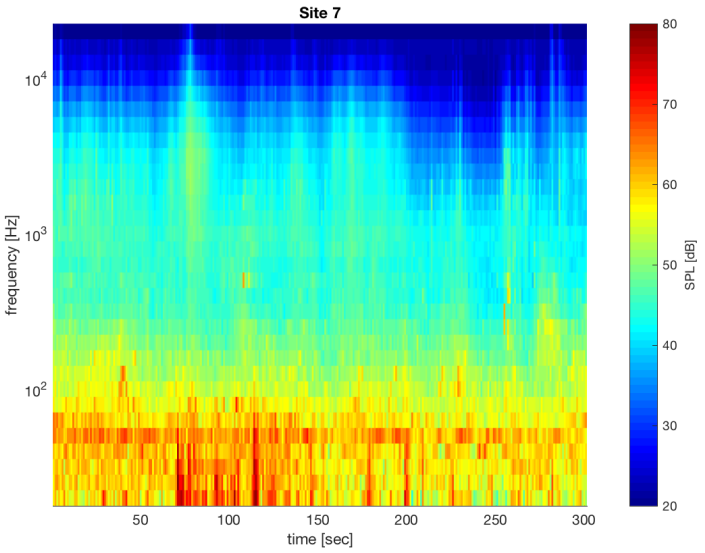


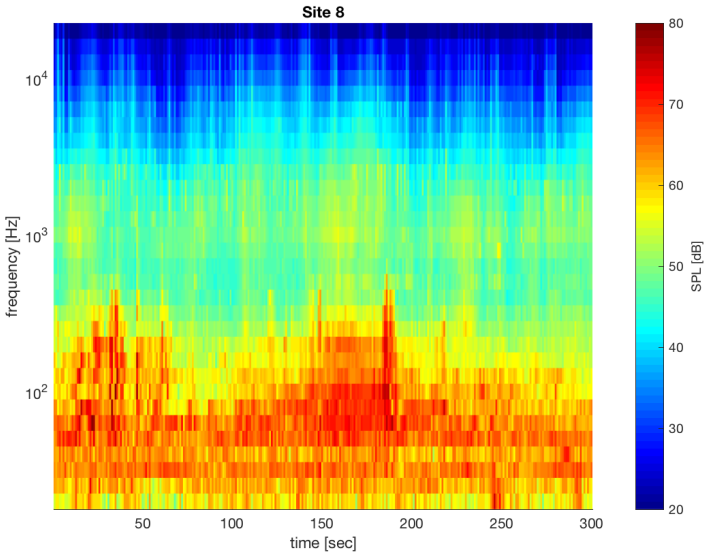



Site 4
frequency [Hz]
time [sec]
SPL [dB]

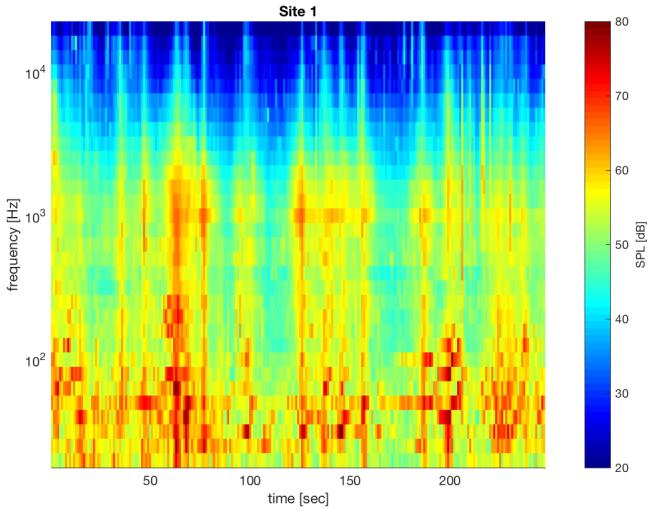

Site 5
frequency [Hz]
time [sec]
SPL [dB]

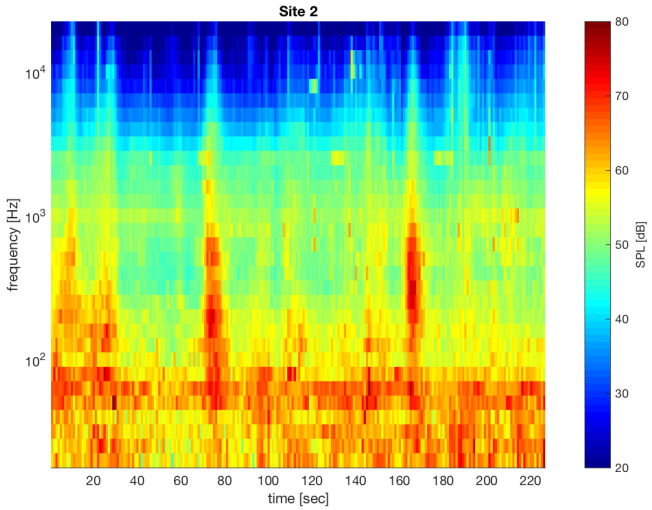

Site 6
frequency [Hz]
time [sec]
SPL [dB]

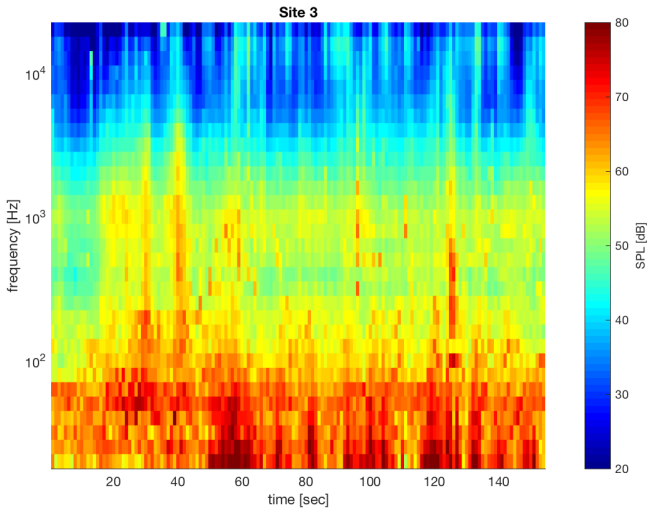

Site 7
frequency [Hz]
10^4
10^3
10^2
50
100
150
200
250
300
time [sec]
80
70
60
50
40
30
20
SPL [dB]

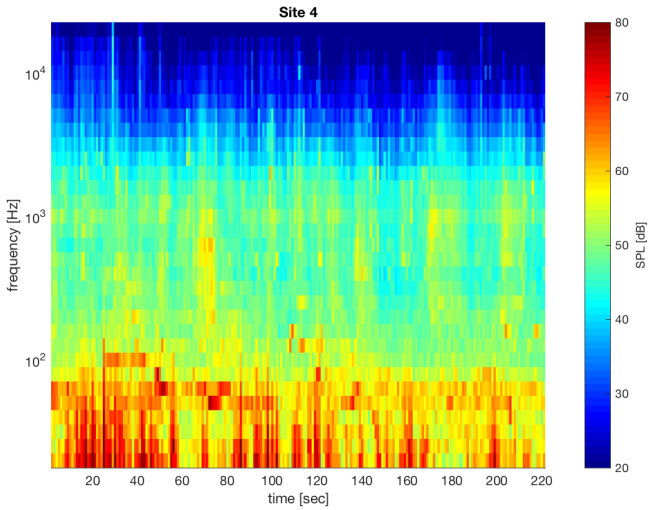

Site 8
frequency [Hz]
10^4
10^3
10^2
50
100
150
200
250
300
time [sec]
80
70
60
50
40
30
20
SPL [dB]

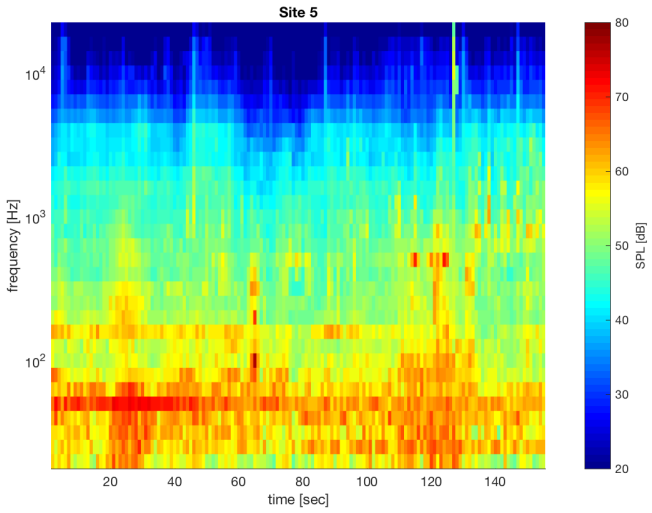
Majorna morning: children



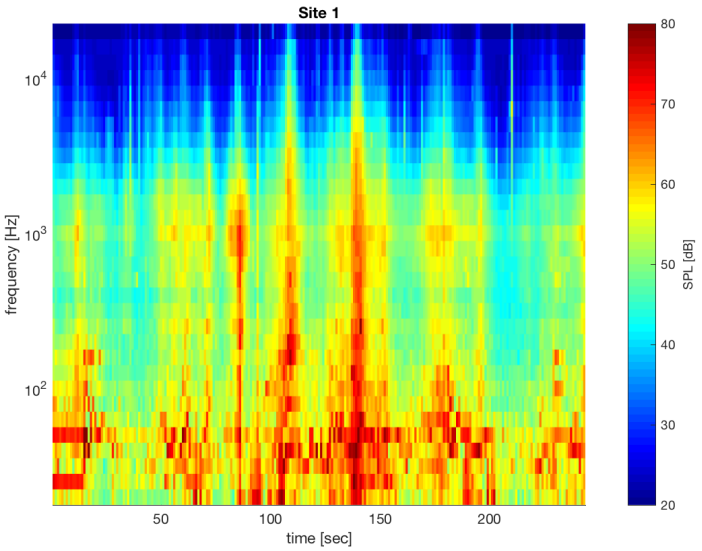


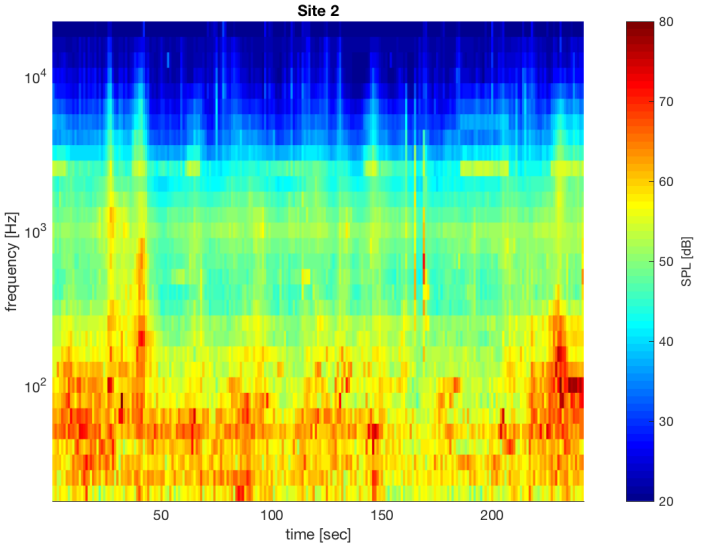


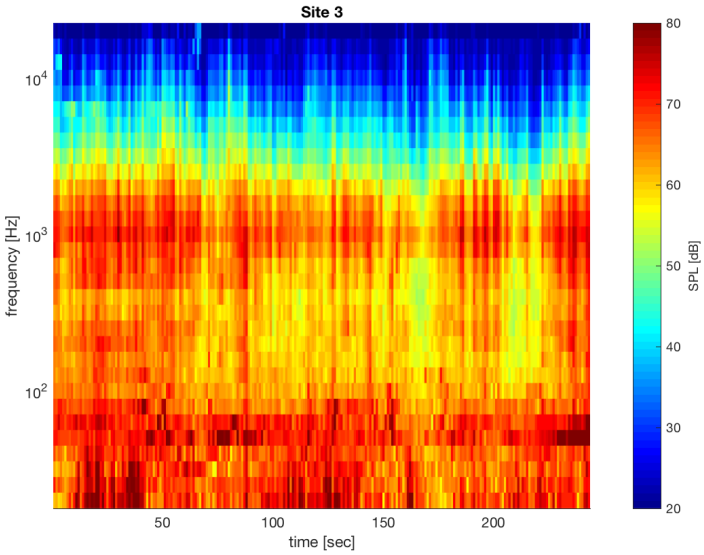

Site 4
frequency [Hz]
10^4
10^3
10^2
20 40 60 80 100 120 140 160 180 200 220
time [sec]
80 70 60 50 40 30 20
SPL [dB]

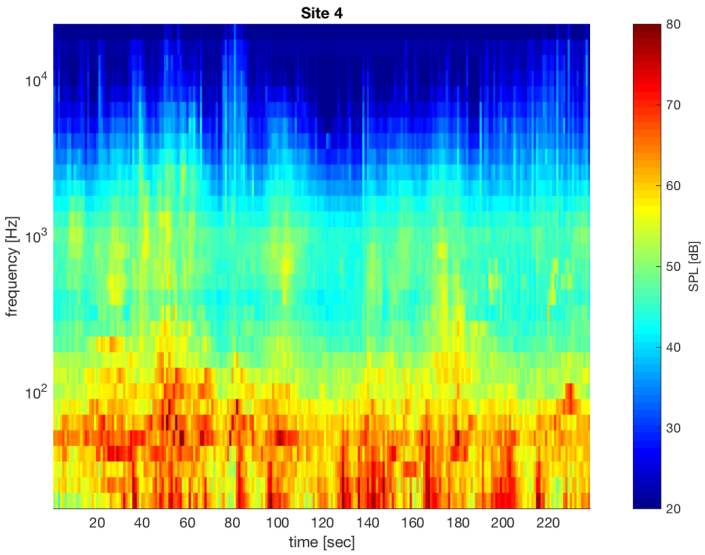

Site 5
frequency [Hz]
10^4
10^3
10^2
20 40 60 80 100 120 140
time [sec]
80 70 60 50 40 30 20
SPL [dB]

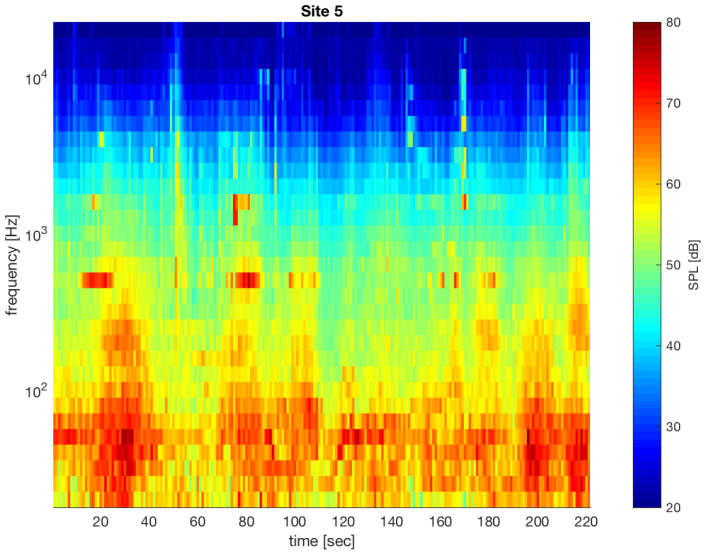
Majorna-Linné evening

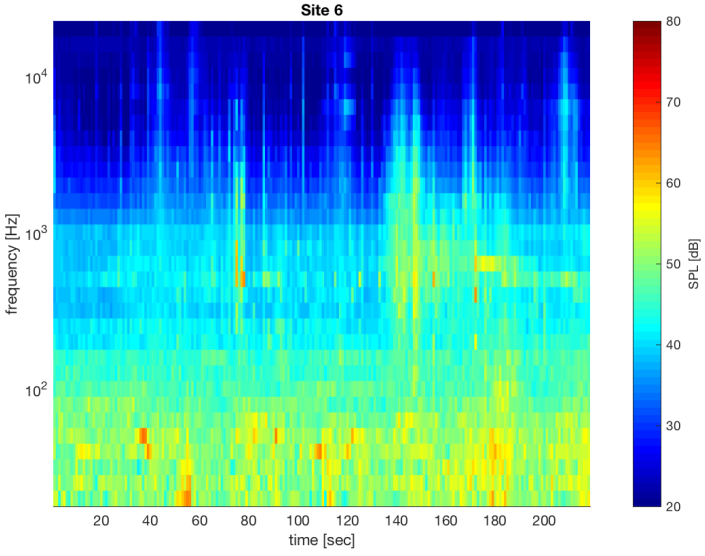







Site 4
frequency [Hz]
10^4
10^3
10^2
20 40 60 80 100 120 140 160 180 200 220
time [sec]
80 70 60 50 40 30 20
SPL [dB]


Site 5
frequency [Hz]
10^4
10^3
10^2
20 40 60 80 100 120 140 160 180 200 220
time [sec]
80 70 60 50 40 30 20
SPL [dB]


Site 6
frequency [Hz]
10^4
10^3
10^2
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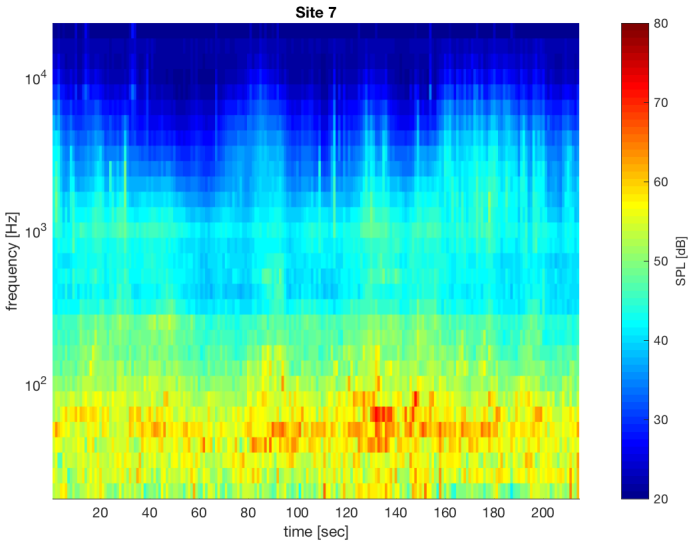
time [sec]
80 70 60 50 40 30 20
SPL [dB]


Site 7
frequency [Hz]
10^4
10^3
10^2
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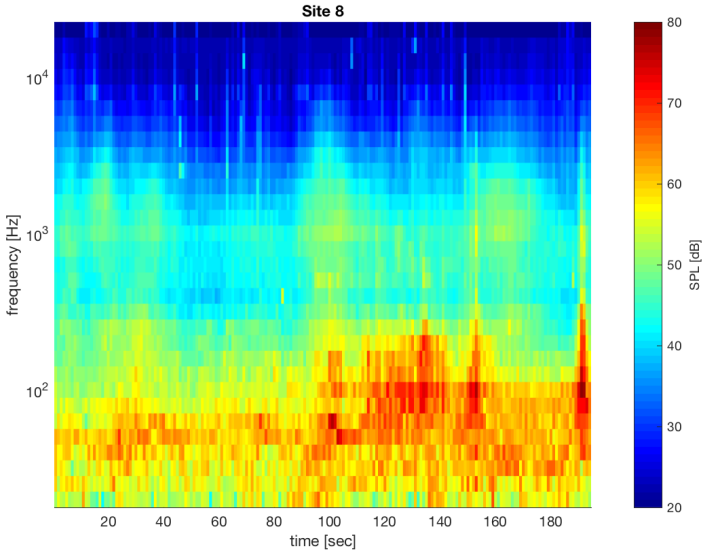
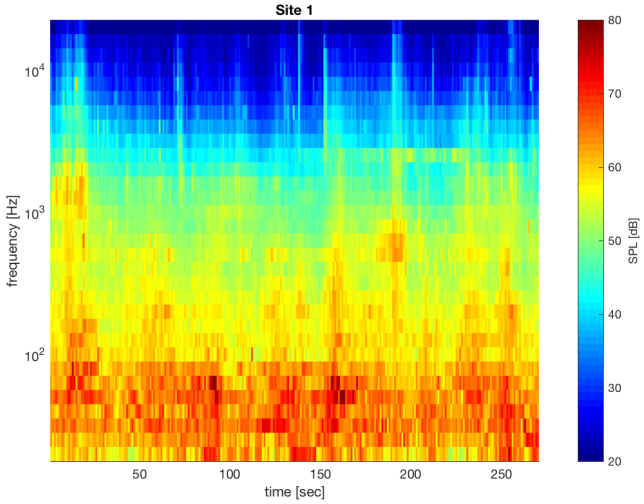
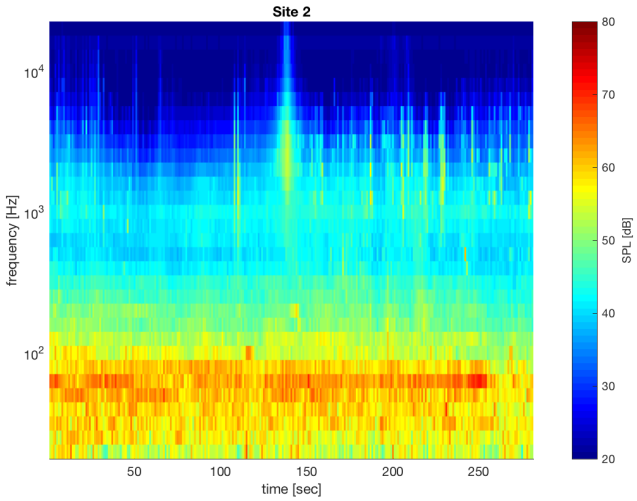
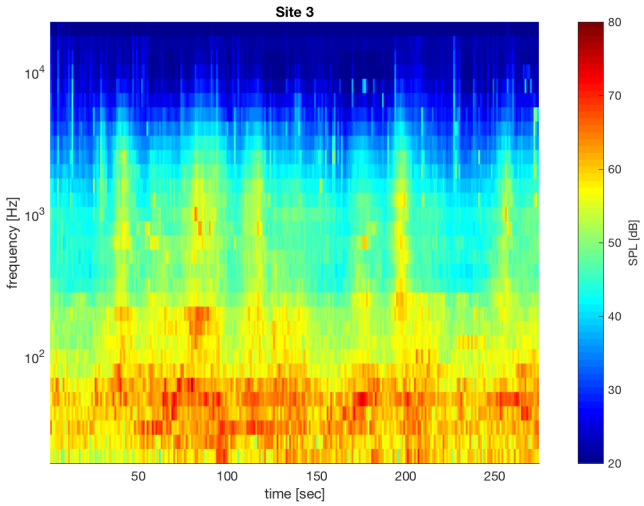
time [sec]
80 70 60 50 40 30 20
SPL [dB]

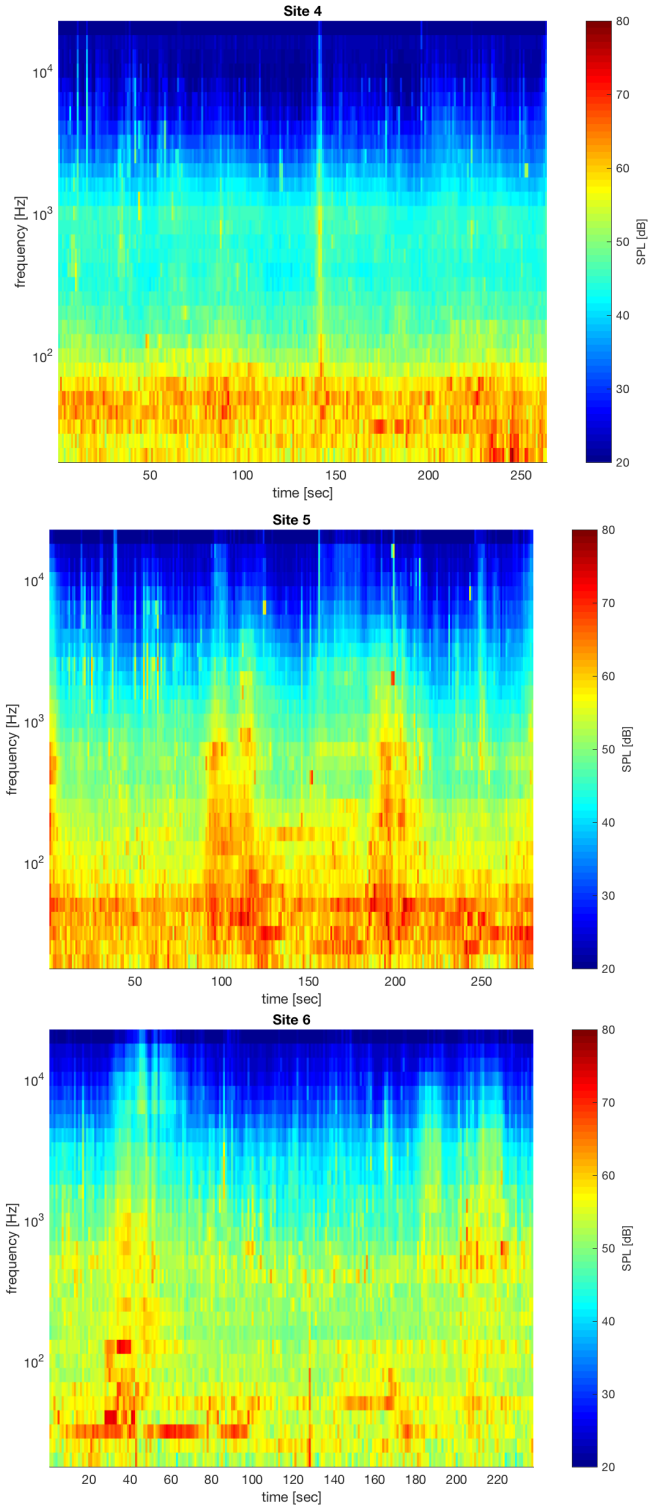

Site 8
frequency [Hz]
10^4
10^3
10^2
20 40 60 80 100 120 140 160 180
time [sec]
80 70 60 50 40 30 20
SPL [dB]

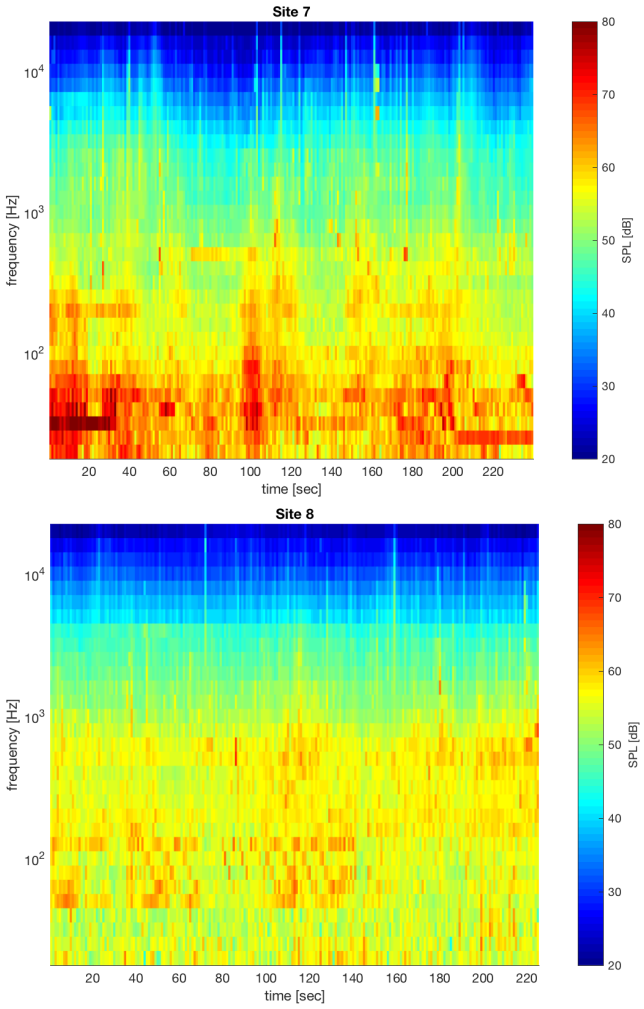
Centre morning



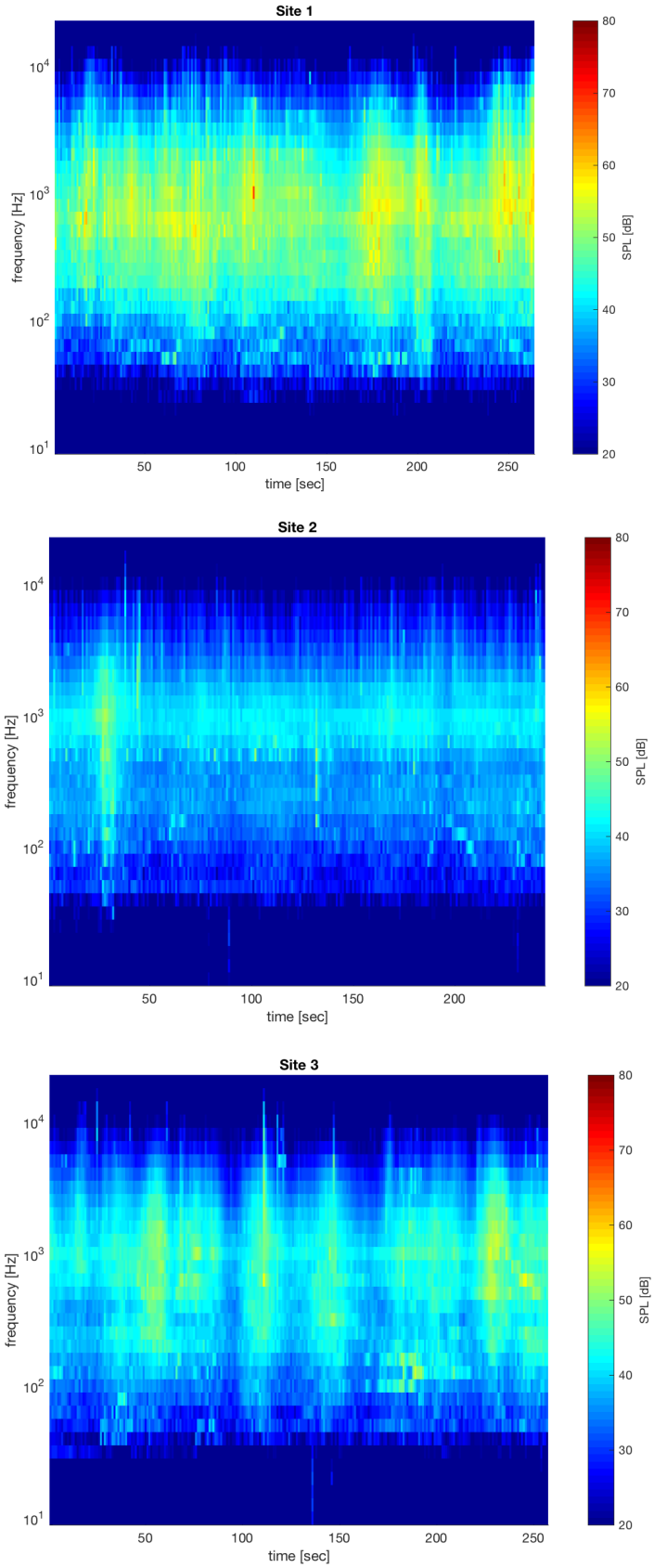


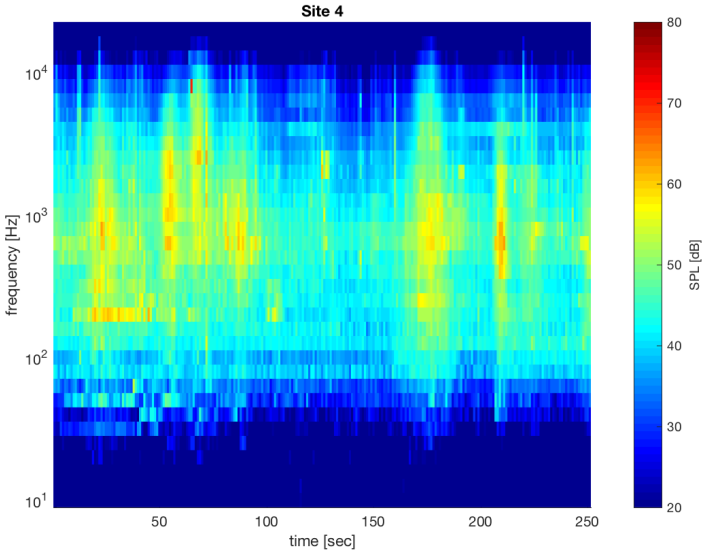


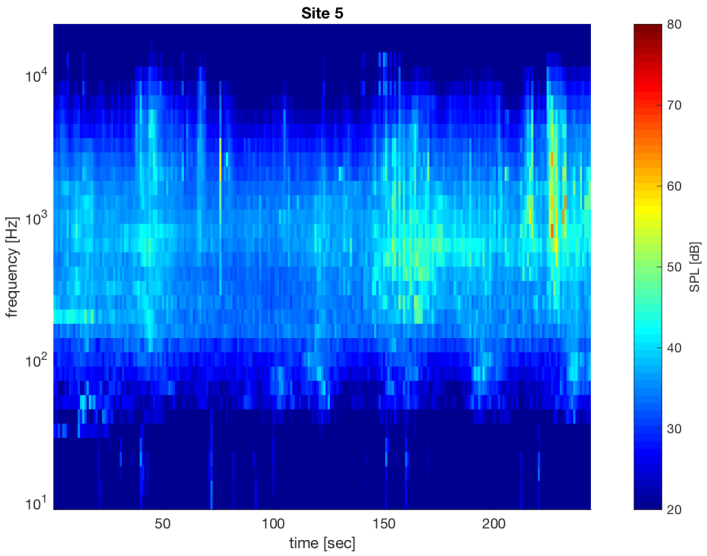

Site 4
frequency [Hz]
time [sec]
SPL [dB]
Site 5
frequency [Hz]
time [sec]
SPL [dB]
Site 6
frequency [Hz]
time [sec]
SPL [dB]

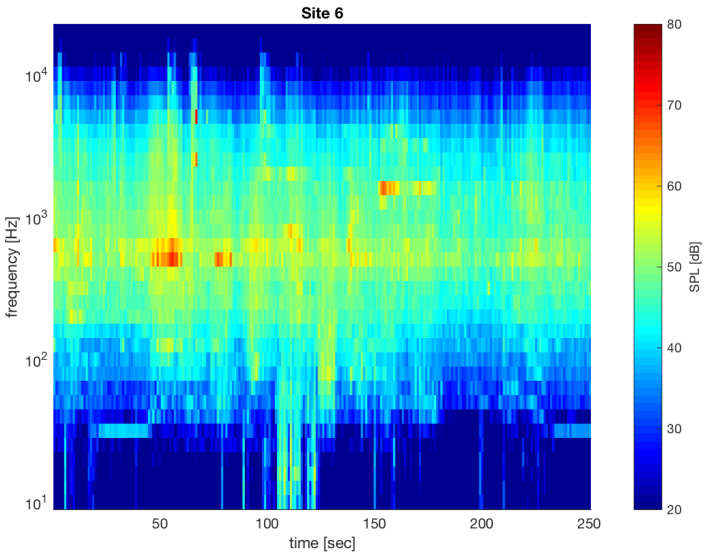

Site 7
frequency [Hz]
10^4
10^3
10^2
20 40 60 80 100 120 140 160 180 200 220
time [sec]
SPL [dB]
80 70 60 50 40 30 20
Site 8
frequency [Hz]
10^4
10^3
10^2
20 40 60 80 100 120 140 160 180 200 220
time [sec]
SPL [dB]
80 70 60 50 40 30 20

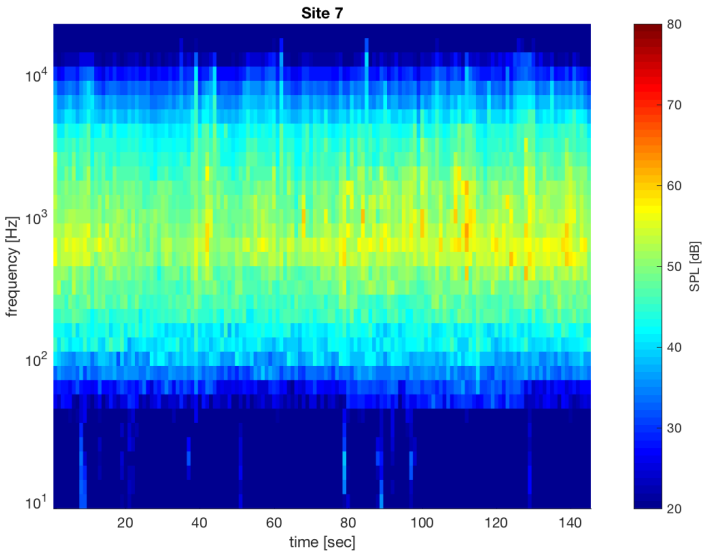
Centre evening




Site 4
frequency [Hz]
time [sec]
SPL [dB]

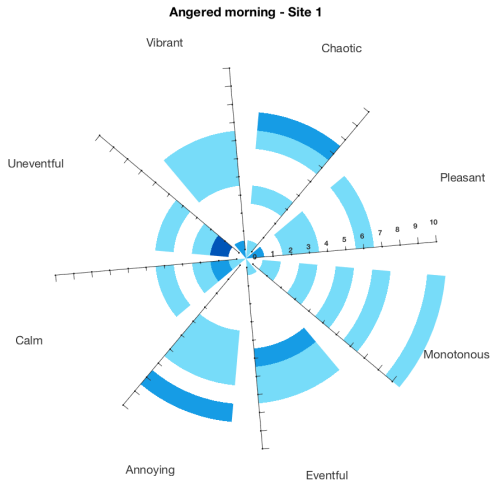

Site 5
frequency [Hz]
time [sec]
SPL [dB]

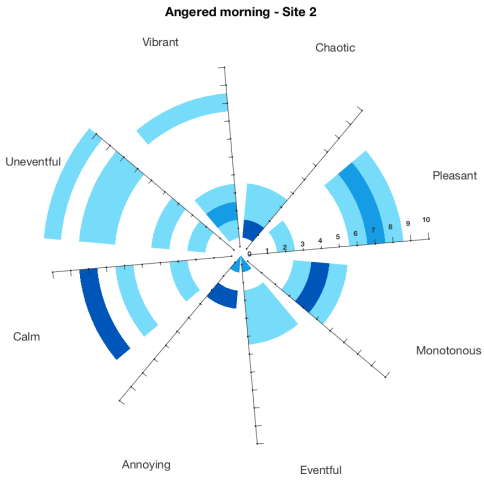

Site 6
frequency [Hz]
time [sec]
SPL [dB]

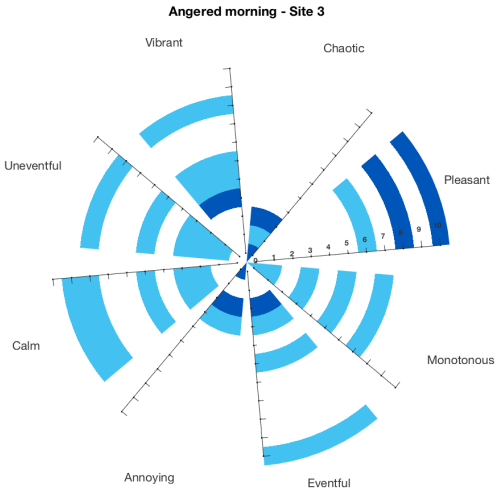

Site 7
frequency [Hz]
10^4
10^3
10^2
10^1
20
40
60
80
100
120
140
time [sec]
80
70
60
50
40
30
20
SPL [dB]

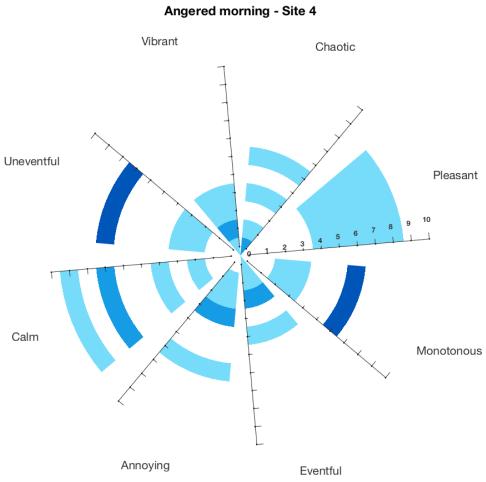
A4. Sound environment attributes

Angered morning



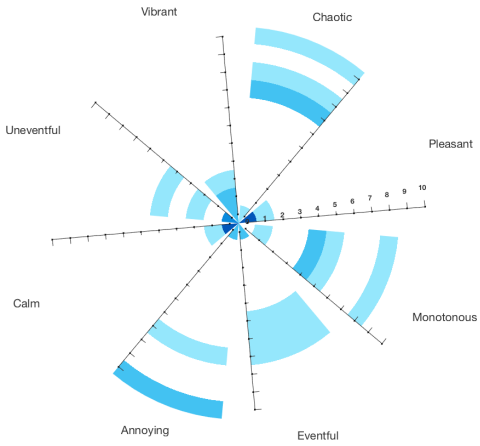




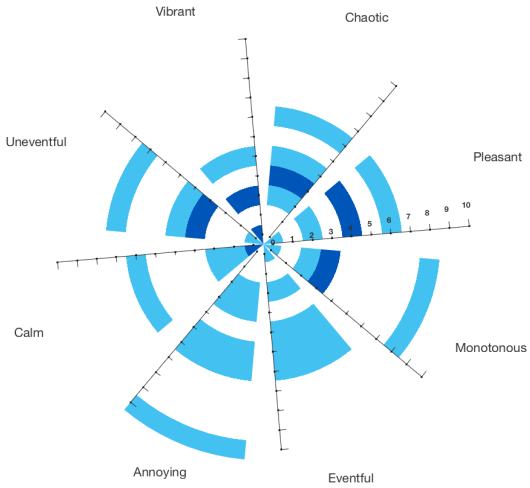


Angered morning - Site 5

Angered morning - Site 6

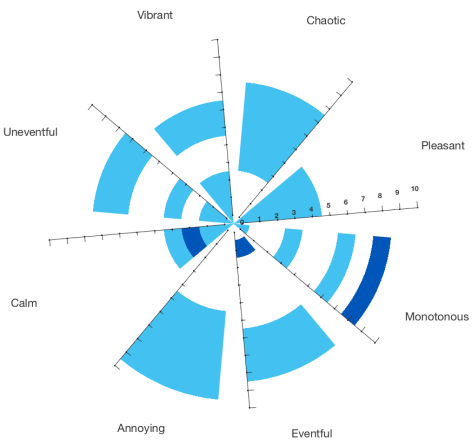


Angered morning - Site 7

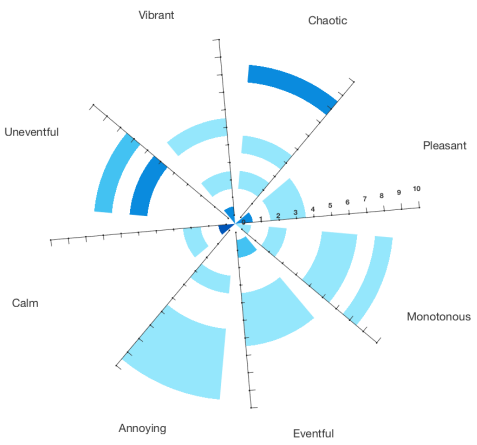


Majorna morning

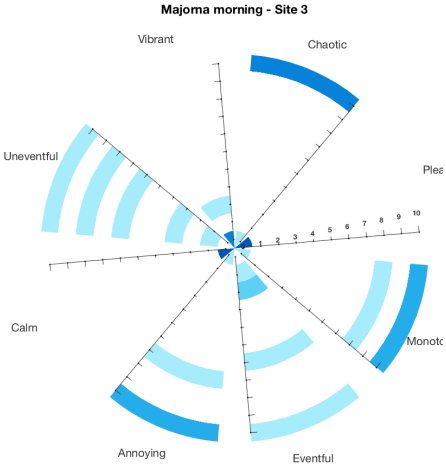
Majorna morning - Site 1



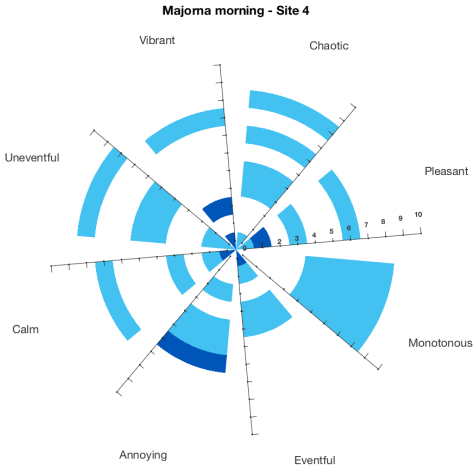
Majorna morning - Site 2



Majorna morning - Site 3

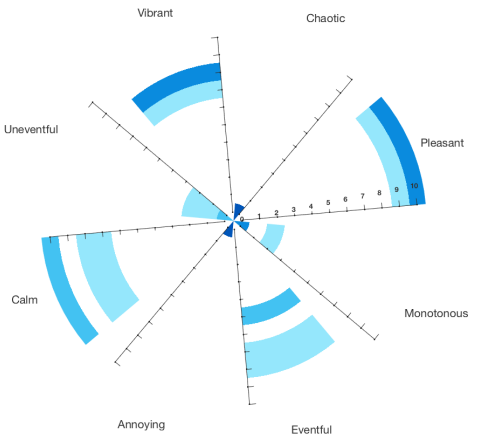


Majorna morning - Site 4

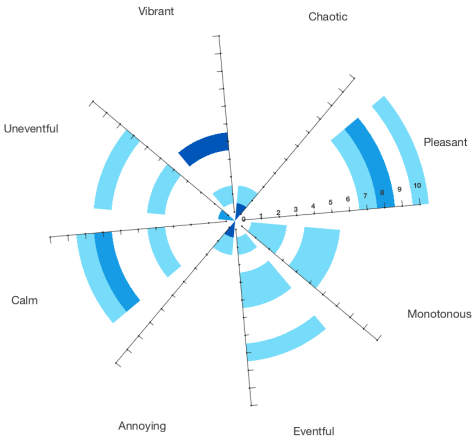


Majorna morning - Site 5

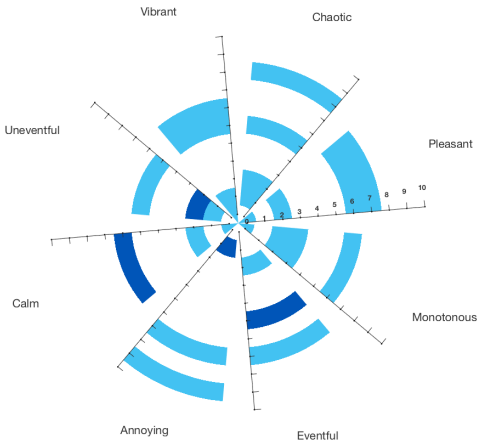
Majorna morning - Site 6



Majorna morning - Site 7



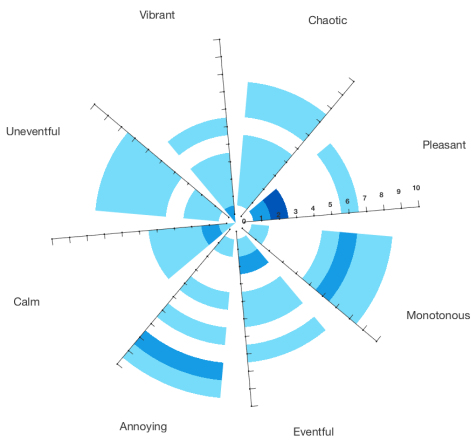
Majorna morning - Site 8



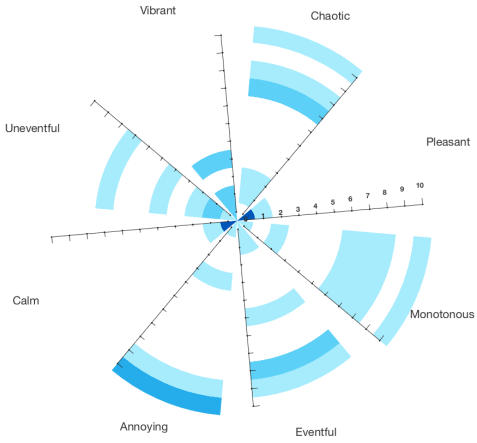
Majorna evening

Majorna evening - Site 1

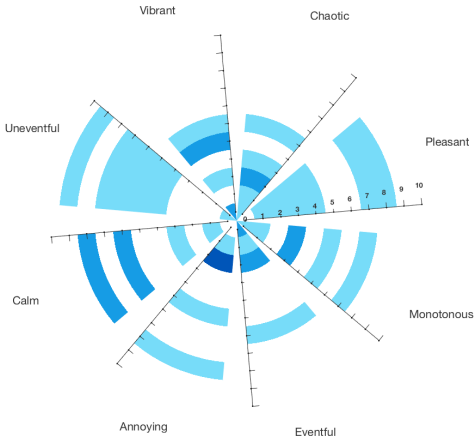
Majorna evening - Site 2



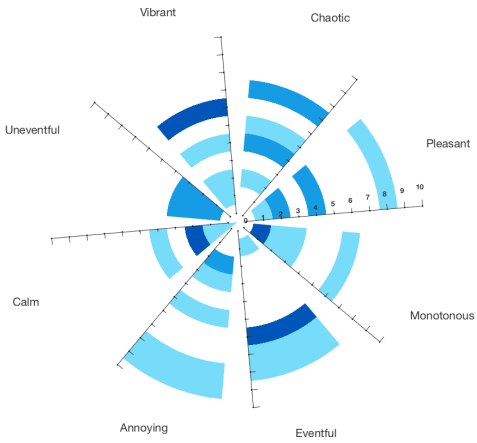
Majorna evening - Site 3



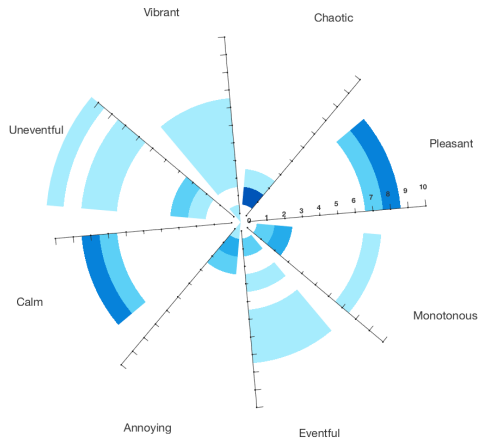
Majorna evening - Site 4



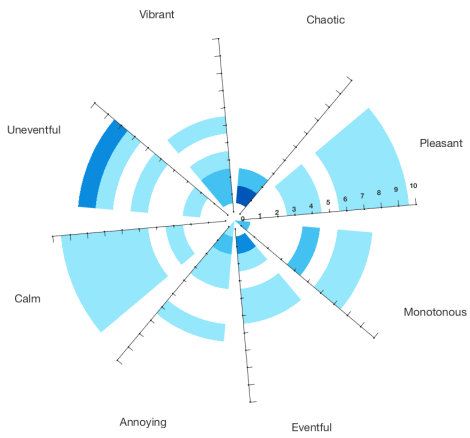
Majorna evening - Site 5



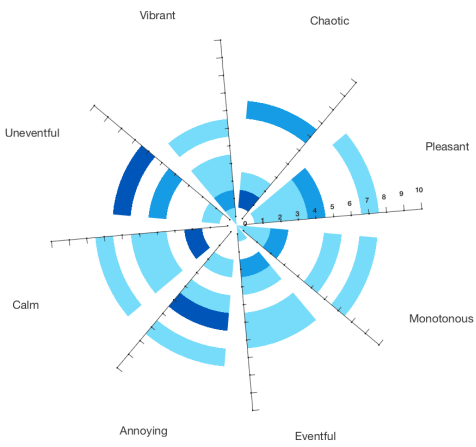
Majorna evening - Site 6



Majorna evening - Site 7

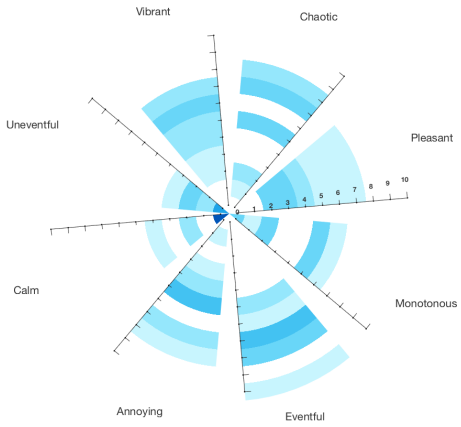


Majorna evening - Site 8

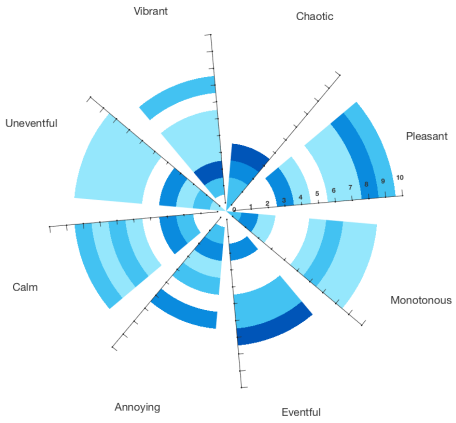


Centre morning

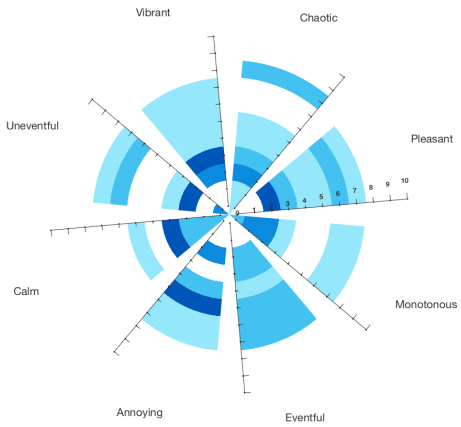
Centre morning - Site 1



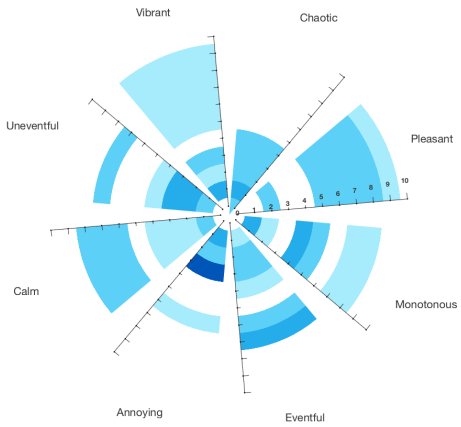
Centre morning - Site 2



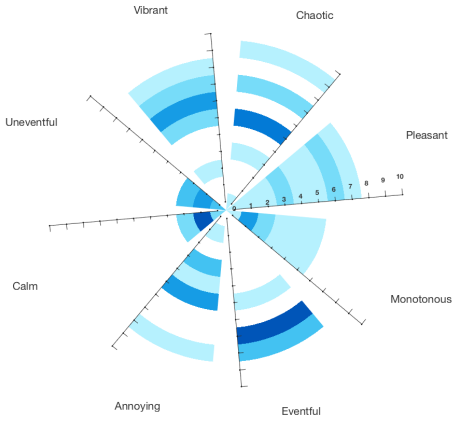
Centre morning - Site 3



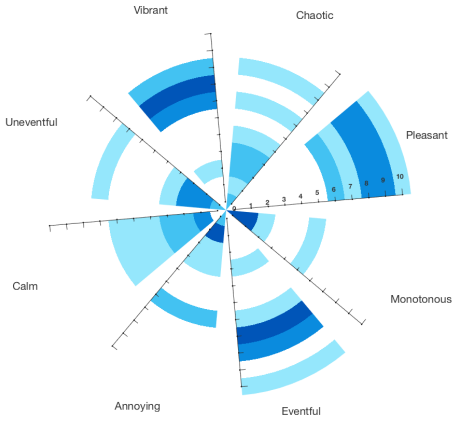
Centre morning - Site 4



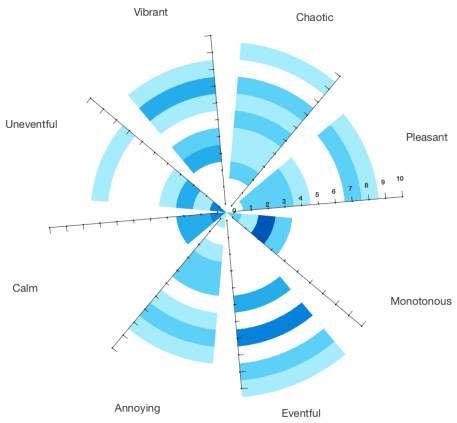
Centre morning - Site 5



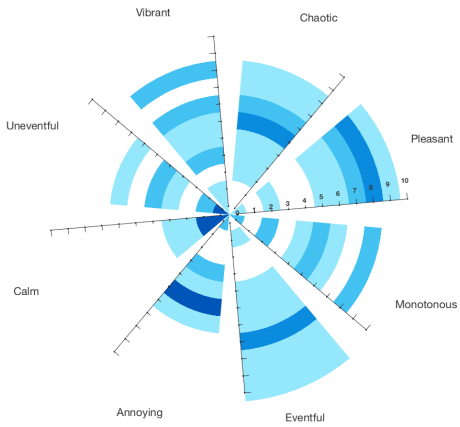
Centre morning - Site 6



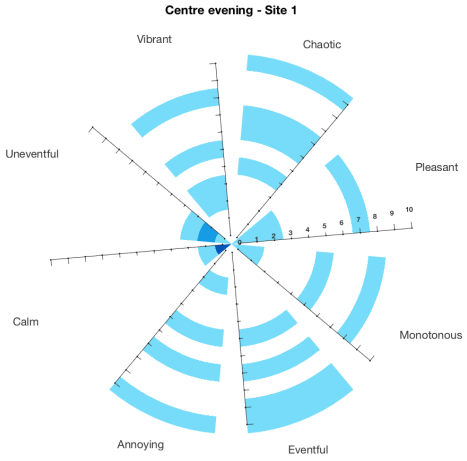
Centre morning - Site 7

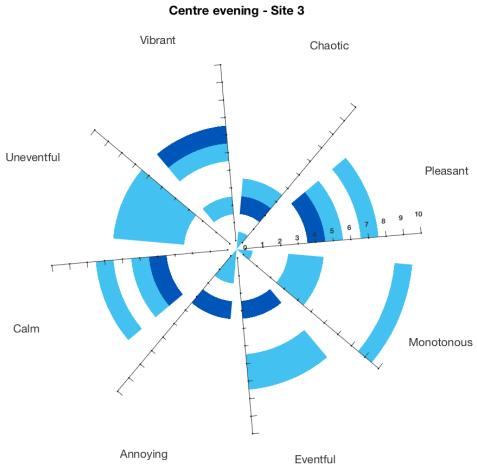


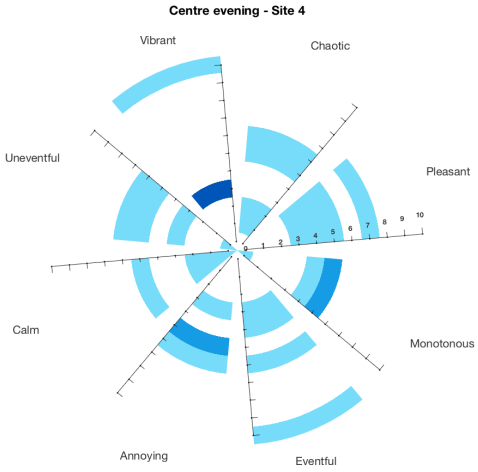
Centre morning - Site 8

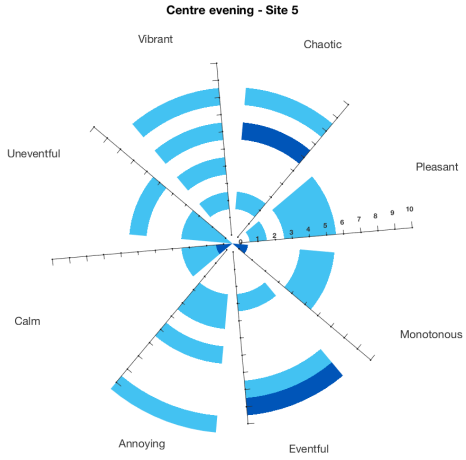


Centre evening

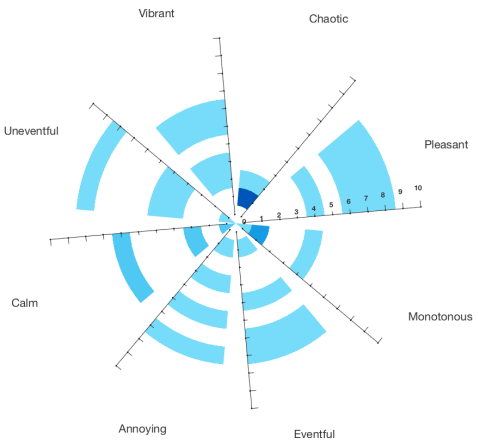




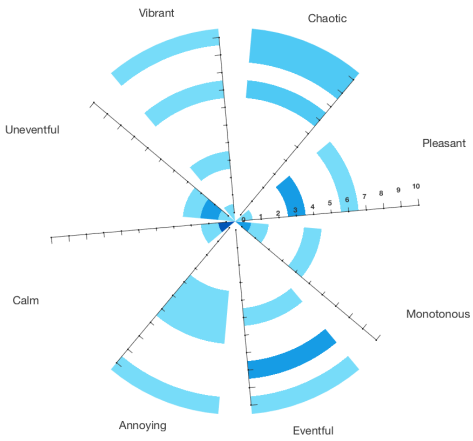




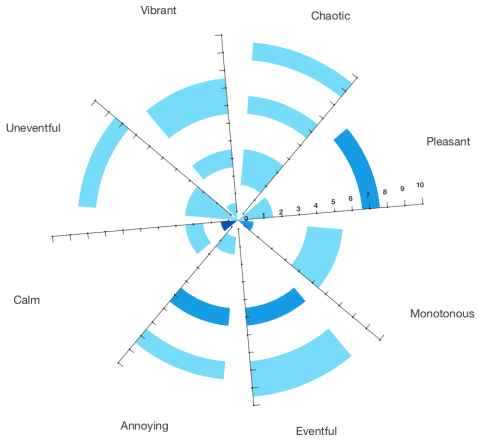
Centre evening - Site 6



Centre evening - Site 7

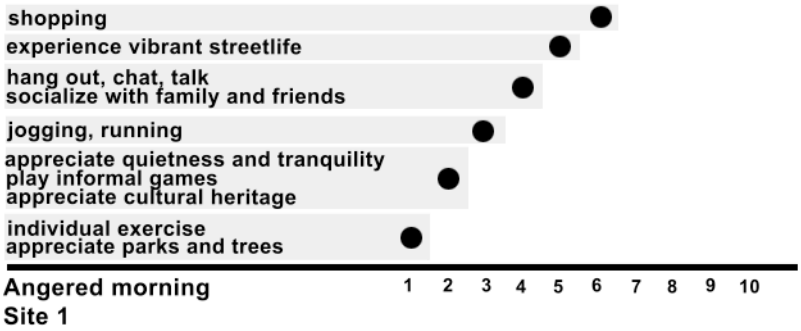


Centre evening - Site 8

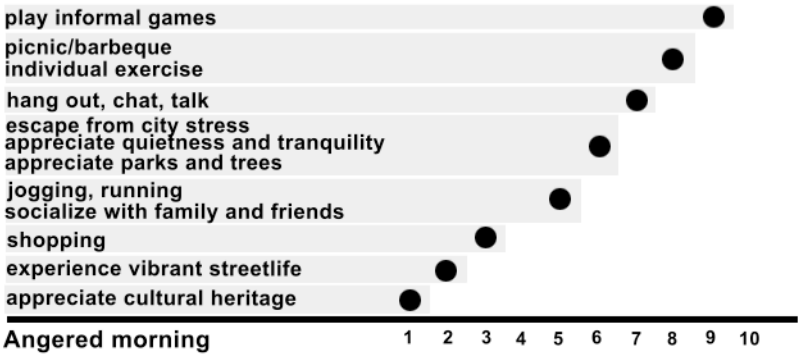


A5. Activities

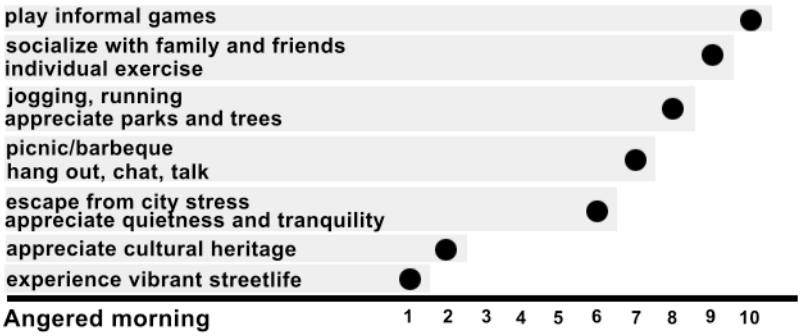
Angered morning



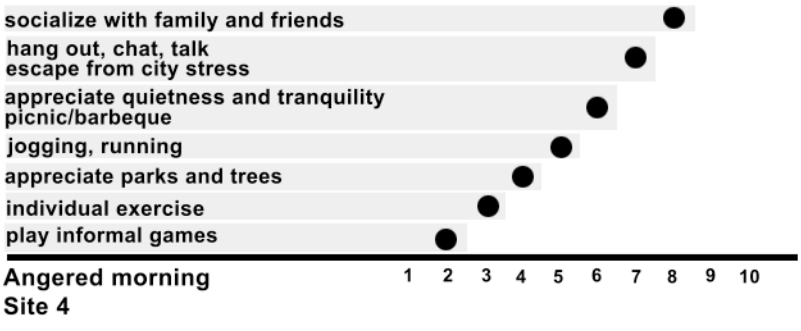
Site 1



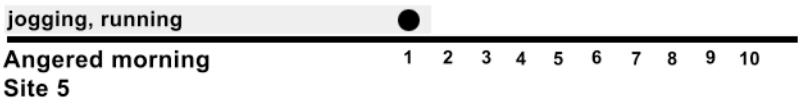
Site 2



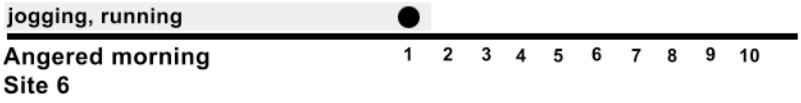
Site 3



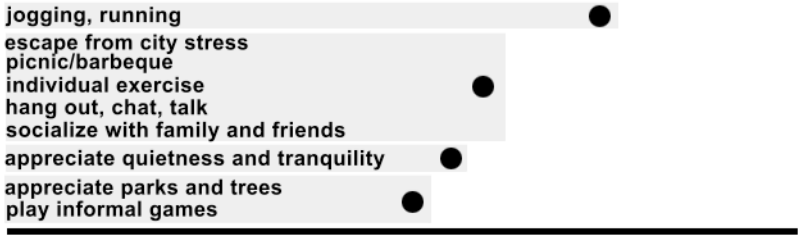
Site 4



Site 5

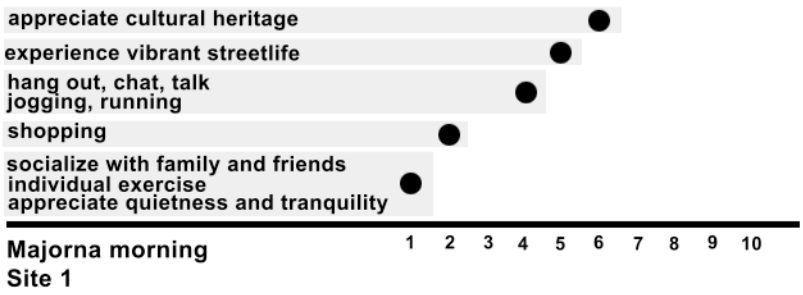


Site 6



Site 7

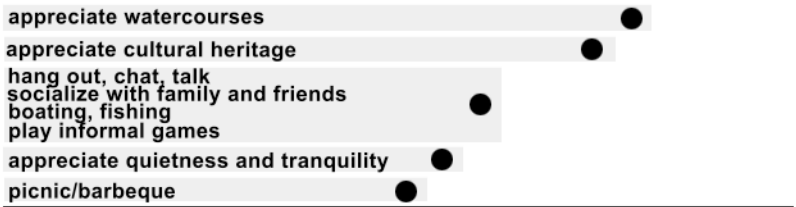
Majorna morning



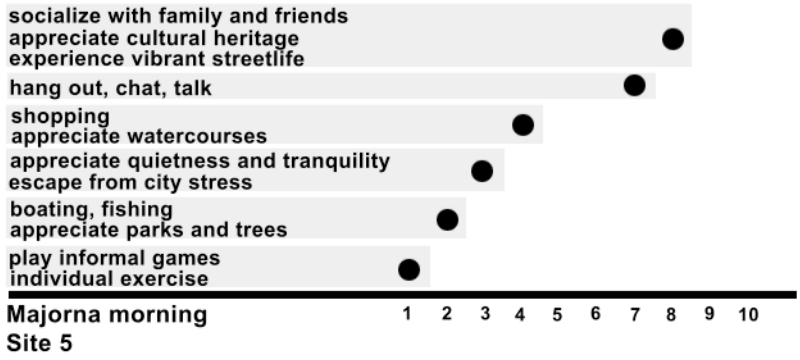
Majorna morning
Site 1

Majorna morning
Site 2

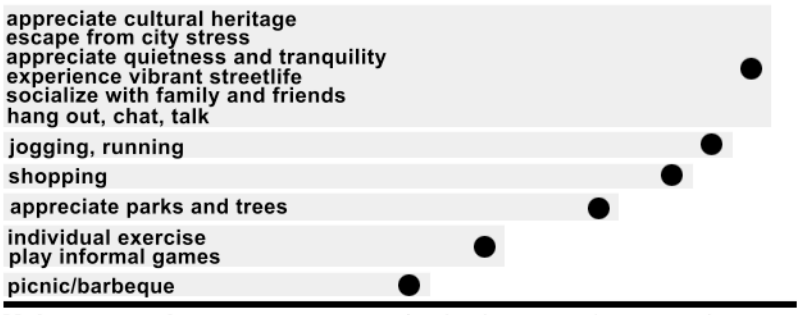
Majorna morning
Site 3



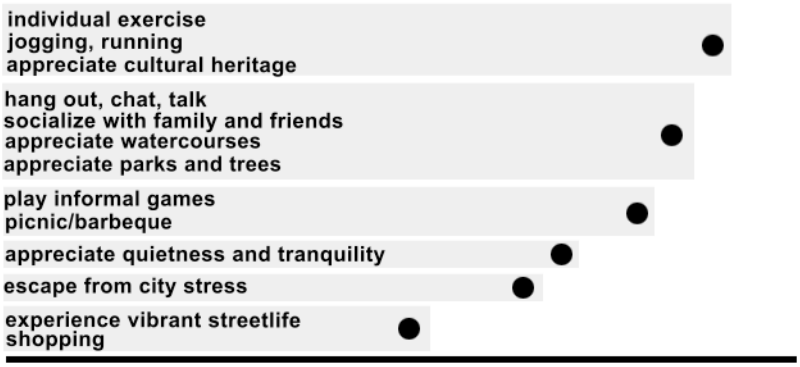
Majorna morning
Site 4



Majorna morning
Site 5

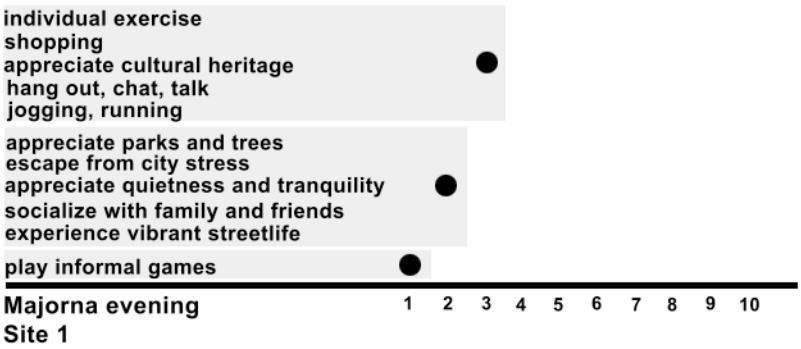


Majorna morning
Site 6

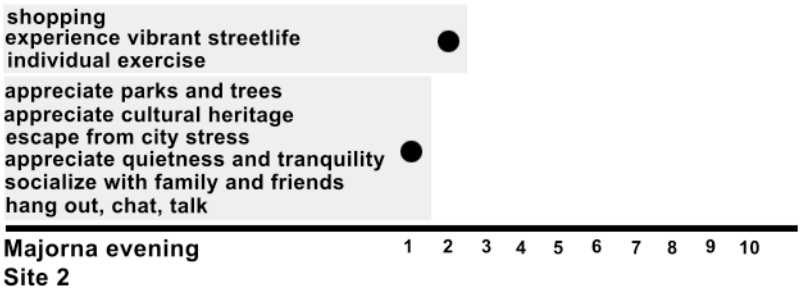


Majorna morning
Site 8

Majorna evening

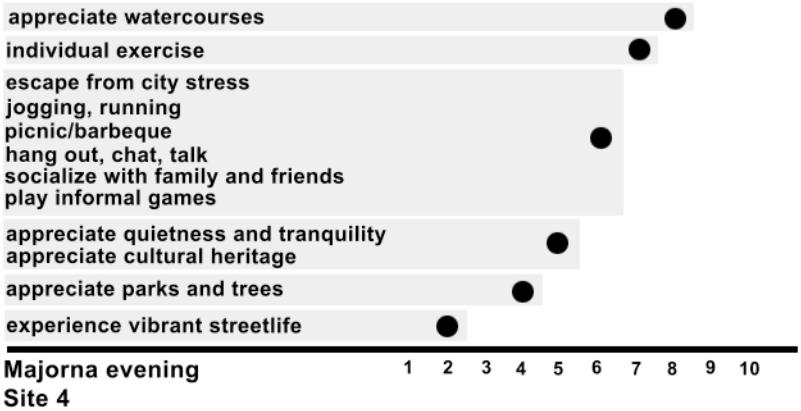


Site 1

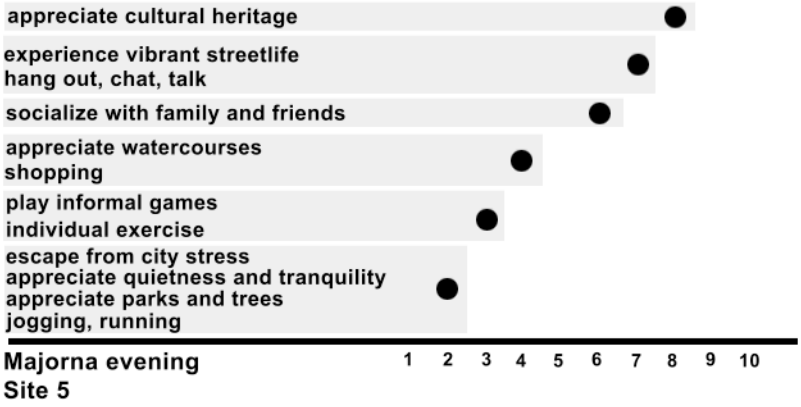


Site 2

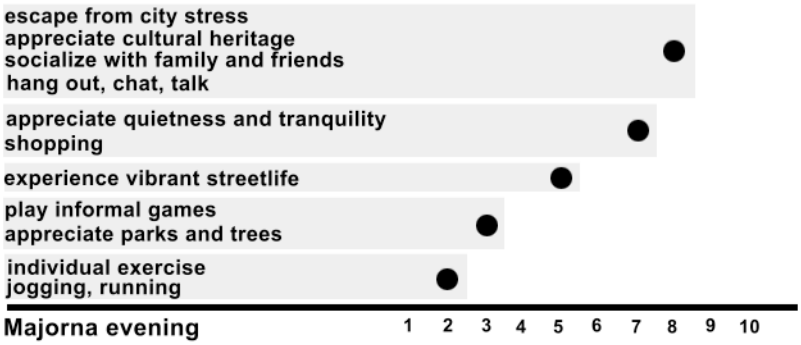
Site 3



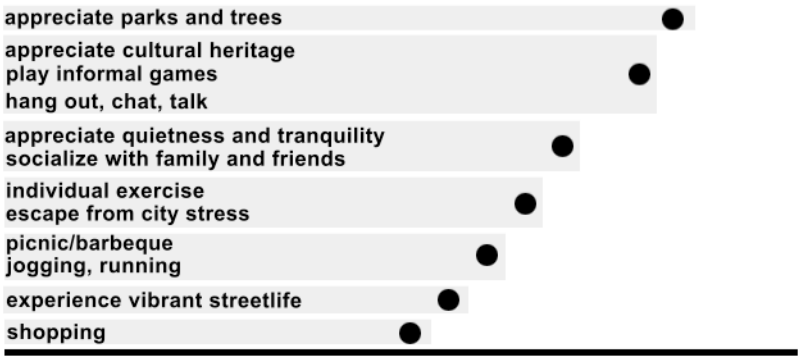
Site 4



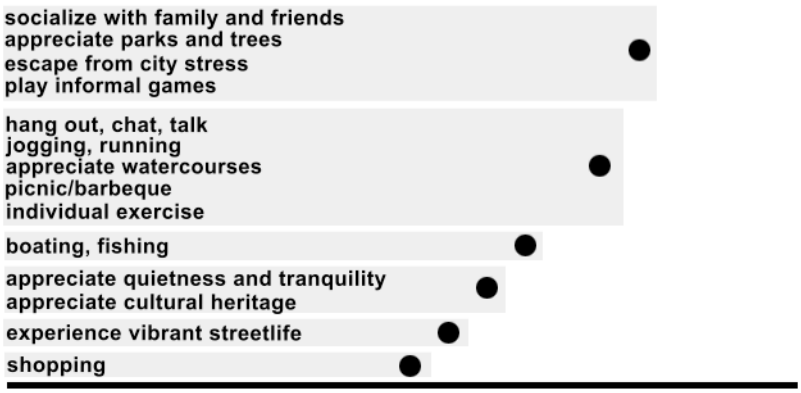
Majorna evening
Site 5



Majorna evening
Site 6

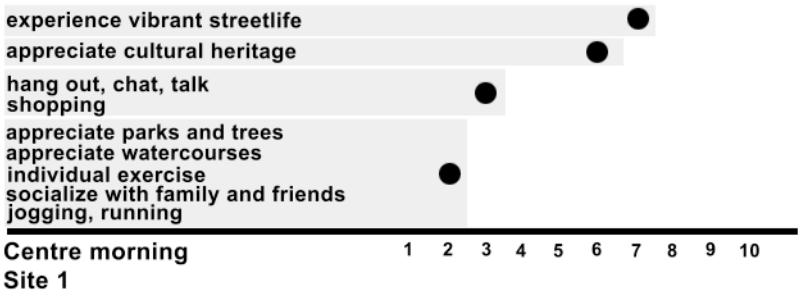


Majorna evening
Site 7



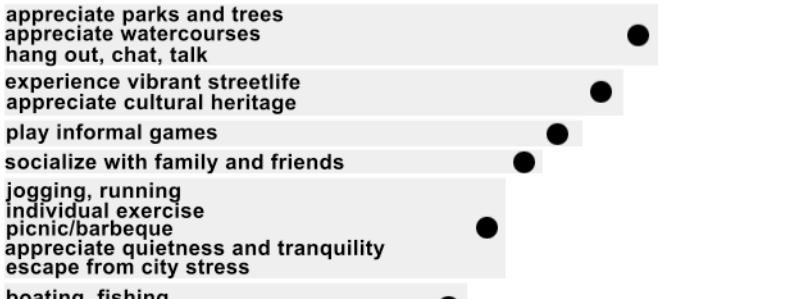
Majorna evening
Site 8

Centre morning

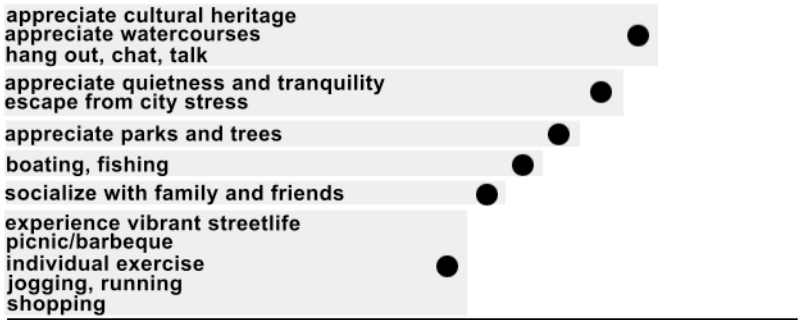


Centre morning
Site 1

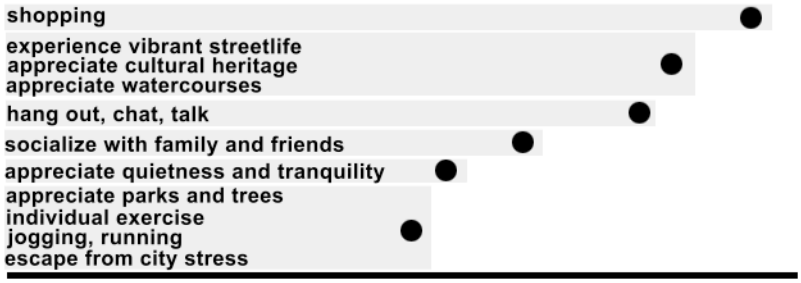
Centre morning
Site 2



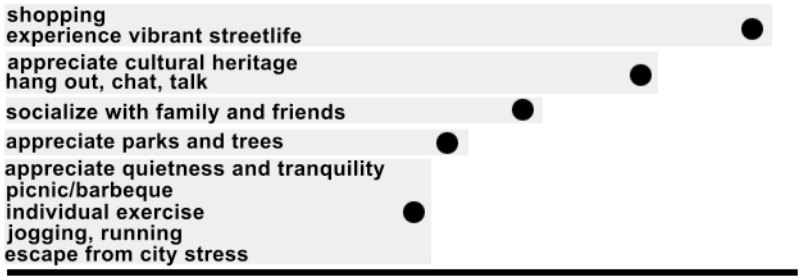
Centre morning
Site 3



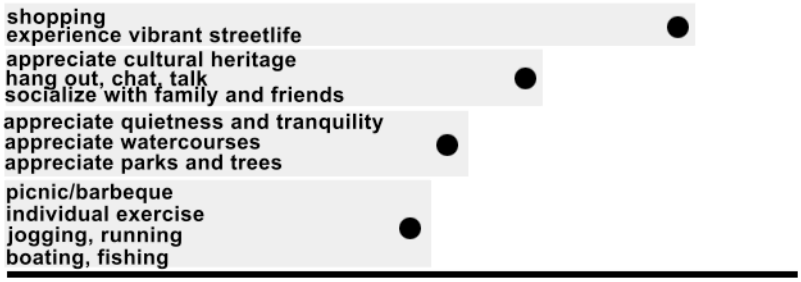
Centre morning
Site 4



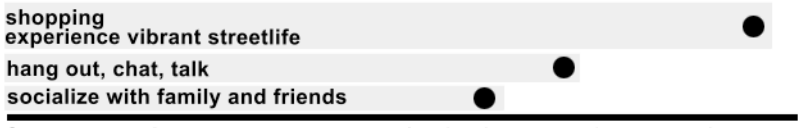
Centre morning
Site 5



Centre morning
Site 6

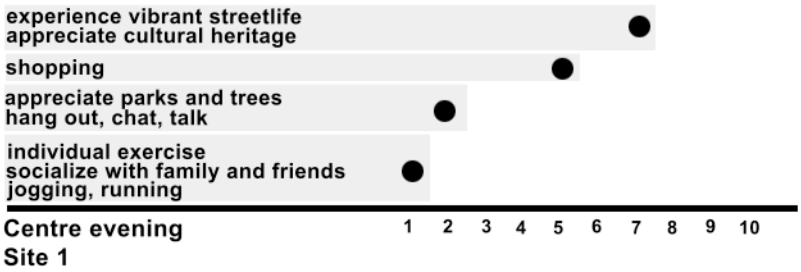


Centre morning
Site 7

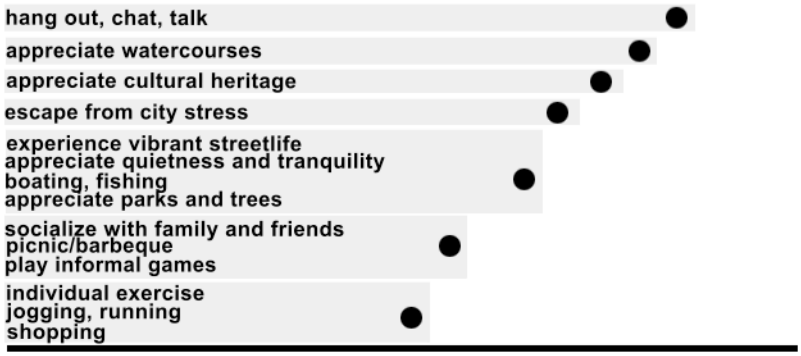


Centre morning
Site 8

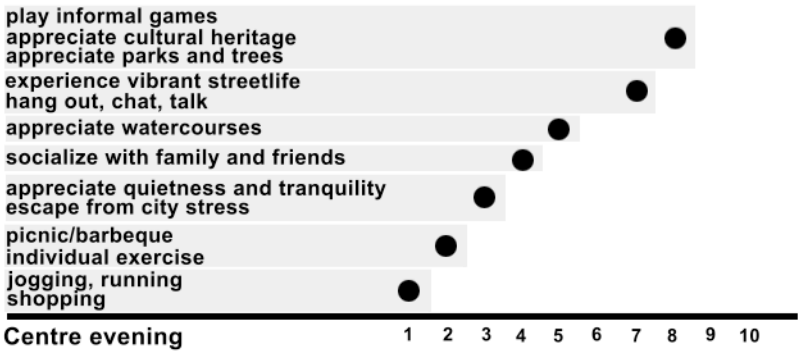
Centre evening



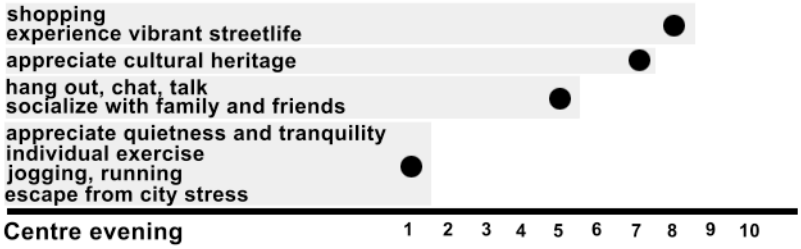
Centre evening
Site 1



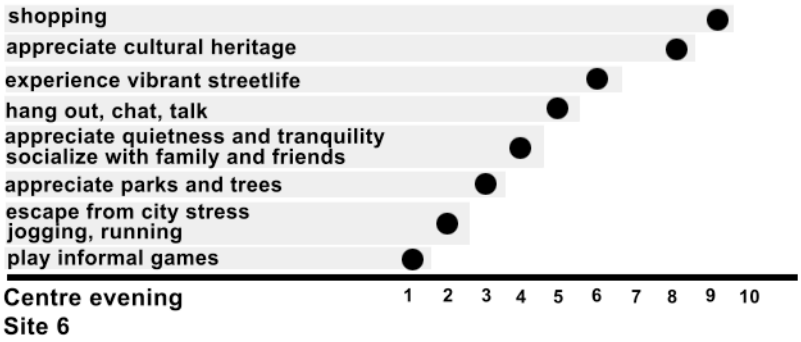
Centre evening
Site 3



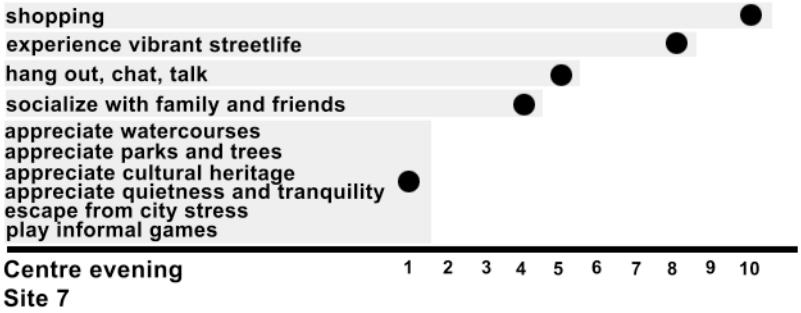
Centre evening
Site 4



Centre evening
Site 5



Centre evening
Site 6



Centre evening
Site 7

Centre evening
Site 8

A6. Statistical mean and median values

Angered soundwalk: morning							
Question related to	**Sound environment description**						
Site #	1	2	3	4	5	6	7
Mean	3,6	7,2	7,4	7,2	0,2	1	3,4
Median	3	8	8	7	0	0	4
Std, Deviation	1,82	3,03	2,97	1,64	0,45	1,73	2,19
Question related to	**Appropriateness of the sound environment to the place**						
Site #	1	2	3	4	5	6	7
Mean	4	7,8	8,2	6	5,2	5	4,6
Median	3	8	8	6	5	5	5
Std, Deviation	2,83	2,49	2,05	1,87	4,32	4,08	1,67

Majorna soundwalk: morning								
Question related to	**Sound environment description**							
Site #	1	2	3	4	5	6	7	8
Mean	4,6	2,2	0	3	5,2	9,5	8	5,5
Median	4	2	0	3	6	9,5	8	6
Std, Deviation	2,70	1,79	0,00	2,12	2,17	0,58	1,63	1,92
Question related to	**Appropriateness of the sound environment to the place**							
Site #	1	2	3	4	5	6	7	8
Mean	1,75	3,2	2,6	2,4	6,2	9,75	7,25	4,75
Median	2	2	0	2	7	10	7,5	5
Std, Deviation	1,26	3,11	4,34	2,70	2,59	0,50	0,96	3,30

Majorna soundwalk: morning with children										
Question related to	**Sound environment description**					**Appropriateness of the sound environment to the place**				
Site #	1	2	3	4	5	1	2	3	4	5
Mean	2,88	2,71	2,09	3,32	2,71	2,93	2,85	2,81	3,35	3,45
Median	3	3	2	3	3	3	3	3	4	3
Std, Deviation	0,78	0,81	0,85	0,89	0,90	1,00	0,97	1,18	1,03	0,80

Majorna soundwalk: evening								
Question related to	**Sound environment description**							
Site #	1	2	3	4	5	6	7	8
Mean	3,17	2,67	0,33	5	3,5	6,67	6,33	5,33
Median	3	2,5	0	4	2,5	8	6,5	5,5
Std, Deviation	1,17	0,82	0,82	2,37	2,43	2,81	2,16	1,63
Question related to	**Appropriateness of the sound environment to the place**							
Site #	1	2	3	4	5	6	7	8
Mean	3,83	3,67	2,83	4,67	3,67	7,83	5,83	4,5
Median	4	3,5	3	5	3	8	6,5	4
Std, Deviation	1,60	2,07	2,56	3,14	1,97	0,41	2,40	2,26

Centre soundwalk: morning								
Question related to	**Sound environment description**							
Site #	1	2	3	4	5	6	7	8
Mean	3,45	6,55	4,45	6,36	5	7,2	4,78	5,6
Median	3	7	4	7	5	7,5	5	6
Std, Deviation	0,82	1,81	1,64	1,43	1,94	1,69	2,44	2,01
Question related to	**Appropriateness of the sound environment to the place**							
Site #	1	2	3	4	5	6	7	8
Mean	7	5,45	5,36	6,91	6,6	8,3	6,7	8,2
Median	7	7	6	8	7	8,5	7,5	8,5
Std, Deviation	1,34	2,66	1,63	1,97	2,12	1,64	2,45	1,62

Centre soundwalk: evening							
Question	**Sound environment description**						
Site #	1	3	4	5	6	7	8
Mean	2,5	5,75	4,25	3,75	7	3	4,67
Median	2,5	6	4	4	7,5	3,5	5
Std, Deviation	0,58	1,26	1,50	0,50	1,41	1,41	1,53
Question related to	**Appropriateness of the sound environment to the place**						
Site #	1	3	4	5	6	7	8
Mean	2,5	5,75	4,25	3,75	7	3	4,67
Median	2,5	6	4	4	7,5	3,5	5
Std, Deviation	0,58	1,26	1,50	0,50	1,41	1,41	1,53