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Education in Soundscape - A seminar with young scientists in the COST Short Term Scientific Mission „Soundscape - Measurement, Analysis, Evaluation“

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ABSTRACT

A short term scientific mission initiated through Cost TD0804 was carried out for evaluation, measurement and analysis of soundscapes. Several young researchers were introduced in binaural measurement technology, enhanced sound analysis, evaluation techniques, procedures and had the opportunity to perform field and laboratory tests. For the course measurement technology and workstations were available and a team of experienced researchers trained and supported the young researchers. In collaboration with qualified soundscape researchers short case studies including measurement, analysis, evaluation, and classification of defined environmental areas was carried out. The teaching was based on educational modules of the different research steps. This education concept will be presented and discussed based on experiences of both the teachers and the young scientists. Acknowledgements: COST TD 0804: Soundscape of European Cities and Landscapes.

THE COST NETWORK ON SOUNDSCAPE OF EUROPEAN CITIES AND LANDSCAPES

The main objective of the COST Action TD (Transport and Urban Development) 0804 is to provide the underpinning science for soundscape research and make the field go significantly beyond the current state-of-the-art, through coordinated international and interdisciplinary efforts [1]. It promotes soundscape concepts and approaches into current legislations, policies and practice with the general aim at improving and preserving the sonic environment. Moreover, it promotes health and sustainability, brings it into practice, conveys cultural uniqueness and diversity and tries to enhance the quality of life. In the context of the COST Action TD 0804 the soundscape research is understood as a timely paradigm shift in that it considers environmental sounds as a 'resource' rather than a 'waste'. Since, the importance of soundscape research has been recognised by governmental organisations and national funding bodies in Europe, it is important to develop concepts and guidelines to bring the soundscape approach into practice.

The Cost Action TD 0804 has started in 2009 and will be active for a period of 4 years. The main objectives are contributions to (1) an improved understanding and exchanging know how in the scope of soundscapes, to (2) collect and document soundscape data, to (3) harmonize current methodologies and to develop new indicators, to (4) create and design soundscapes, and finally to (5) outreach and train early-stage researchers.

Initially 25 participants from 16 COST countries and 7 partners outside Europe including USA, Canada, Australia, Japan, Korea, Hong Kong, and China actively took part in the COST action. Now the number of members increases to 35 representing 18 COST countries. More information can be found on the website «http://soundscape-cost.org».

COST (European Cooperation in Science and Technology) is an European instrument supporting cooperation among scientists and researchers across Europe [2]. It is an intergovernmental framework for European Cooperation in Science and Technology, allowing the coordination of research on a European level. It provides a platform for European scientists to cooperate on a particular project and exchange expertise. COST provides the COST Actions with financial support for joint activities such as conferences, short-term scientific exchanges and publications.

A SHORT TERM SCIENTIFIC MISSION WITHIN THE COST NETWORK ON SOUNDSCAPE OF EUROPEAN CITIES AND LANDSCAPES

The aim of Short Terms Scientific Missions (STSM) in the context of a COST Action is to contribute to the scientific objectives of the respective COST Action, strengthening the network and fostering collaboration. The STSM "Soundscape – Measurement, Analysis, Evaluation" was carried out from March, 22 to 26 2010 in Aachen, Germany run by the STSM coordinators Brigitte Schulte-Fortkamp, Klaus Genuit and André Fiebig. Eight applicants were allowed to participate in the workshop, who also actively contributed to this paper. The STSM was financially supported by COST.

The focus of the STSM lied on performing soundscape experiments in field and laboratory as well as on the conduction of interviews including the collection, analysis and interpretation of the data. For it, soundwalks, acoustical measurements, listening tests in-situ and in laboratory, narrative, in-depth interviews were performed.

EDUCATIONAL MODULES OF THE DIFFERENT RESEARCH STEPS

Educational module 1 – Concepts and terms

The concepts of soundscape were theoretically introduced with all its aspects that make it an interdisciplinary field of science. The general aspects of theory and practical use of measurement technology were presented as well as the methods of final evaluation (interviews, observations, laboratory studies). Here, general soundscape concepts and term notions, intensively discussed in preceding COST meetings and conferences, were introduced and discussed.

Moreover, preparations were made for the planned studies, such as soundwalks, which should be carried out in and around Aachen city. The participants were familiarized with the locations, measurement equipment and evaluation sheets.

Educational module 2 – Measurements

Binaural measurement technologies as well as beamforming technologies were introduced and measurement setups discussed taking into account existing guidelines and regulations for the measurement of environmental noise. Shortcomings of the conventional way of measuring environmental noise were intensively discussed [3].

The participants were familiarized with different forms of interviews commonly used in soundscape research and were encouraged to execute interviews themselves. Moreover, parts of the performed interviews were systematically analyzed.

Educational module 3 – Analysis and evaluation

A comprehensive sound analysis was introduced as a tool for objective analysis of sound recordings. Here, the application and interpretation of psychoacoustics beyond simple dB(A) considerations in the context of environmental noise research was presented and discussed.

A special focus of the module was on the interpretation of test results. How can the results be interpreted, what can the researcher learn from the remarks given by the test subjects, how can design targets be derived from subjective evaluations and acoustical data? Answers to the mentioned questions were jointly developed.

RESULTS OF CASE STUDIES PERFORMED DURING THE "STSM"

Few case studies investigating the soundscapes of Aachen were performed by the participants of the STSM during the workshop. The different investigations were also accompanied by the workshop coordinators. It has to be mentioned that because of the small group size statistically significant results cannot be presented here; however the general approach, the chosen procedures as well as the tentative results are presented to point out the strength of the soundscape approach and the great scientific endeavours of the young researchers.

Soundwalks

A soundwalk was carried out by two groups of participants examining different locations in Aachen city by walking in opposite directions. Eight sites with different characteristics were chosen along a route starting from a historical gate, called Ponttor, to the city center ending with a historical fountain (see fig. 1). The soundwalk was performed from 6 to 8 p.m. on Wednesday, 24 March. At each location the sound was recorded and the impressions as well as assessments were written down by participants on an evaluation sheet.

At each location, each of the two groups carried out recordings with duration of three minutes using a mobile frontend with a binaural headset. The measurements were done with fixed orientation of headset and a fixed position. Simultaneously, one participant has taken photos of the location, and all participants have used all senses for their subjective evaluations. The two groups conducted the soundwalk by walking in opposite directions, group 1 started at P1 and at the same time group 2 begun the soundwalk from P8.

Figure 1. Eight investigated locations during a soundwalk through the city of Aachen

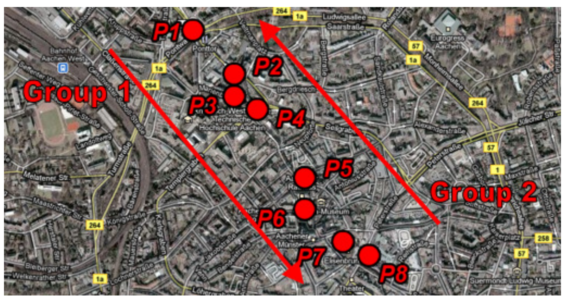

Figure 2. Measurement locations (see fig. 1) and walking directions of group 1 and group2

For the subjective aspects of the soundwalk, an evaluation sheet which includes perceived loudness and unpleasantness scales was filled out in situ for each location by the participants. The scales were five point continuous rating scales. In addition, on the evaluation sheet participants were requested to note their feelings and thoughts they had during their presence in that location.

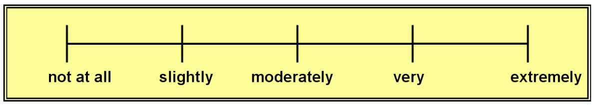

Figure 3. Applied 5-pt continuous category scale for in-situ assessments for the evaluation of "How loud is it here?" and "How unpleasant is it here?"

Table 1 shortly describes the main characteristics of the different measurement locations.

Table 1. Short description of soundwalk locations

Position	Description
1	Close to the historical city gate with a high traffic road at traffic lights
2	Entrance to a pedestrian zone full of restaurants and bars, still influenced by traffic noise
3	In a pedestrian zone
4	Pedestrian zone with a high traffic road at traffic lights
5	Historical square near Rathaus with cafeterias and a fountain
6	Large urban square between Rathaus and cathedral without commercial activities
7	"Green area" surrounded by shops
8	Besides an historical thermal fountain near a street only for public transportation

RESULTS OF THE SOUNDWALK

Although the recordings of the different locations made by the two groups were time-shifted, the sound "fragments" of the investigated soundscapes showed comparable properties and patterns. For example, there was a time delay of 2 hours between the 3 minutes recordings of the measurement location "1". Nevertheless, both short-term measurements gave a comparable impression of the sound of soundscape. Figure 4 indicates the noise similarities between the measurements of a location on the basis of the spectra (here a variable frequency resolution was used).

To investigate (dis-)similarities of the different recordings a cluster analysis considering all 16 recordings was performed. Here, the Ward method was applied to compute clusters of the investigated sites. Input variables were only psychoacoustic properties of the measured soundscapes. Each soundscape was considered twice in the cluster analysis, since both groups measured the same locations at different times.

Several corresponding pairs were identified using this statistical method, which indicate that even the three minutes recordings contain already typical acoustical elements (described with psychoacoustical parameters) of the respective urban space (see fig. 5).

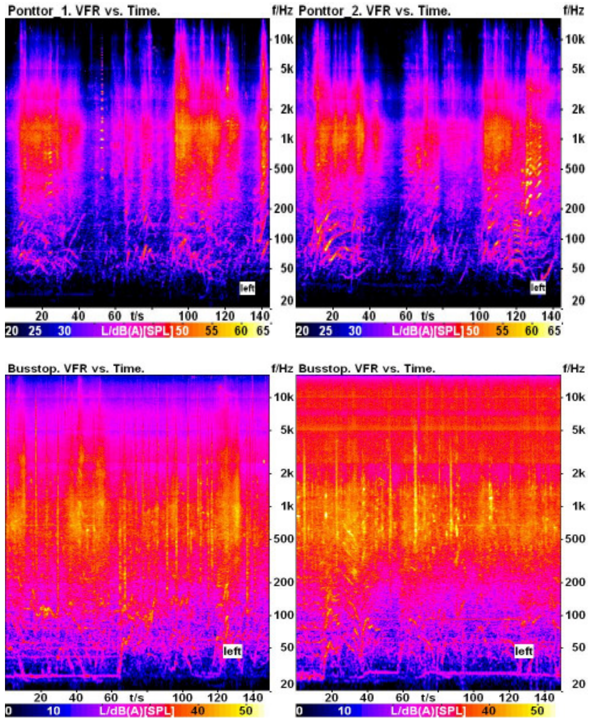

Figure 4. Comparison of the spectra of time-shifted recordings of the measurement locations P1 and P8; VFR vs. time

The cluster "6" and "14" represent the location "large urban square". "1" and "9" display "the historical city gate with a high traffic road at traffic lights". Another cluster is "4" and "12" representing the "pedestrian zone with a high traffic road at traffic lights", which shows the smallest linkage distance. It is easy to understand this phenomenon, since the time delay between these measurements was only 15 minutes. Another interesting phenomenon can be observed in the dendrogram. Several sounds were clustered, such as "4", "12", "8", "10", "2", "16" as well as "3", "15", "11", "13", "5" and "7". The expected pairs representing the same measurement locations all lie within the clusters. The red cluster includes environmental noises with a higher amount of traffic noise as well as commercial activities. In contrast to it, the turquoise cluster contains sounds representing relatively quiet urban areas without traffic noise, but with a lot of noise caused by talking people. The single clusters "1", " 9" and "6" and "14" cannot be assigned to the other clusters, because of their acoustical peculiarities.

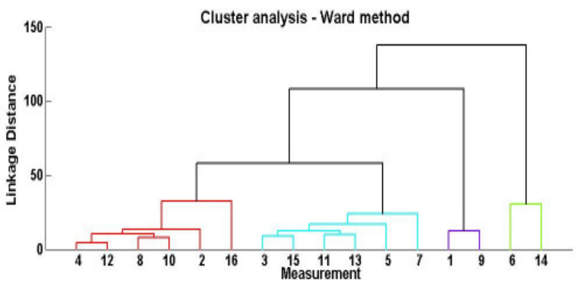

Figure 5. Cluster analysis of the measurements using the ward method

Although this statistical approach of identifying similarities between acoustical properties of soundscapes is very artificial and neglects completely other moderators, such as visual elements and context, it already gives the first indications with respect to a potential classification of the soundscapes.

Subjective ratings of loudness and unpleasantness and acoustical parameters

Figure 6 shows a scatter plot of rated loudness and unpleasantness and the respective trendline. The results indicate that a certain relationship exists between loudness and unpleasantness, as experienced by the subjects during the soundwalk. However, it is clear that loudness is not the only parameter that has an influence on unpleasantness, being only an assessment of the amount of acoustic energy received and recognized by the human ear.

On the other hand, unpleasantness has a much broader background and is only partially evoked by loudness. The key to understand how people feel about (un)pleasantness of soundscapes lies not only in the sounds they experience, but also in the stimuli received by other senses, such as visual information, smells, etc.

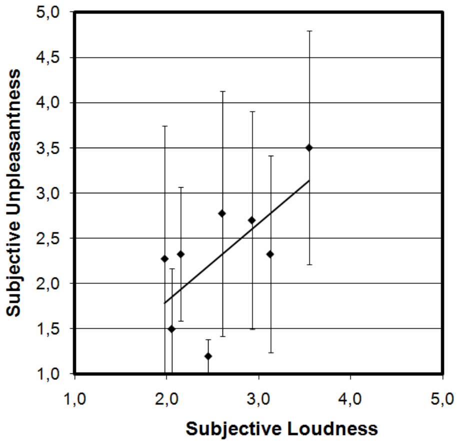

Figure 6. Subjective loudness vs. subjective unpleasantness, as rated by test subjects during soundwalk

Furthermore, the way people assess unpleasantness is closely related to their way of thinking [4]. For example, some subjects judged a busy intersection by its intended purpose and decided that it is not particularly unpleasant because they know that in real life they will spend only a small amount of time at such location and then move on. On the other hand, some subjects applied a long-term way of thinking and assessed unpleasantness by asking themselves how unpleasant such a location would be if they had to live there. As a consequence, the grades they gave for the same location differed significantly.

In order to find linear relationships between the average subjective grades and acoustical parameters, the corresponding Pearson correlation coefficients were calculated. It should be noted that the absolute values of correlation coefficients must exceed 0.707 in order to be statistically significant at the 0.05 level for the given sample size N = 8 locations and non-directional significance testing. Non-directional significance test was used because a strong negative correlation between subjective grades and objective parameters is equally important as the strong positive correlation. The occurrence of positive or negative correlation is closely related to the way the objective parameters are defined, as well as the way the grading system is established in questionnaires used in the soundwalk.

In order to verify the findings about the relationship between subjective loudness and unpleasantness, Pearson correlation coefficient was calculated for two sets of corresponding subjective grades and was found to be 0.67 for group one, which leads to the conclusion that a linear relationship can be established between these two subjective parameters, but it is not statistically significant at the given significance level. However, considering both groups the correlation between these two subjective parameters considerably decreases. This finding seems to support previous conclusions that loudness is only partly responsible for evoking unpleasantness.

The correlation coefficients between subjective ratings and few acoustical quantities are shown in Table 2. The statistically significant ones are highlighted (*). The results show that subjective grades of loudness can be associated with and described by objective values of loudness, but apparently also by other objective parameters that can be related to intensity or energy. For instance, sound pressure levels in octave bands centred at 63 and 125 Hz correspond well to subjective grades of loudness, which is not surprising because a major part of traffic noise spectrum is located within these two bands. On the other hand, an equally strong negative correlation exists between subjective loudness and the speech intelligibility index (SII), due to the fact that loudness is inversely proportional to the values of SII.

Table 2. Correlation coefficients between subjective and acoustical parameters

	Subjective loudness	Subjective unpleasantness
SPL (dB)	0,86*	0,40
SPL (dBA)	0,82*	0,55
SPL (dBC)	0,90*	0,53
N (sone)	0,86*	0,64
S (acum)	0,71*	0,41
L_{oct125} (dB)	0,88*	0,67
L_{oct63} (dB)	0,94*	0,65
SII (%)	-0,88*	-0,62
Tonality (tu) HP 500Hz>	-0,12	-0,76*

In contrast to loudness, the unpleasantness ratings cannot be put in a statistically significant relationship with any of the basic objective parameters listed above.

Analysis of the subjective impressions

In general, a model could be developed in order to relate the subjective grades of unpleasantness with the values of selected acoustical parameters and to offer general guidelines about the initial course of action required for improving the soundscape of a given location. However, it is questionable whether such a simple model has a good predictive capability for future observations. Moreover, it is unlikely that it can adequately explain the reasons why people experience unpleasantness the way they do, because it relies only on the results of sound analysis and does not take into account other important aspects that can have an impact on unpleasantness. Therefore, a thorough analysis of the subjective impressions that people wrote down during the soundwalk is necessary in order to gain a deeper insight in this problem.

The comments made by the subjects at each location provide decisive information to the scale ratings of loudness and unpleasantness. Several indications can be found within these comments, such as aspects of perception, association, justification or further conceptions. For example, an interesting phenomenon represents the outlier (2.4, 1.2) shown in Figure 6. This point is located far away from the linear regression line. Moreover, the standard deviation of the grades given for unpleasantness is the smallest at this particular point, which suggests that everyone agreed to say it was a pleasant location despite the fact that the overall sound was not soft. The explanation of this common agreement arises from the comments. This point corresponds to a public park (P7) near

Elisenbrunnen in the touristic medieval city centre of Aachen. In order to compare the different statements, a classification of the words meaning was done, and the results lead to ordinal categories ranging from simple description to interpretational advices for personal adaptation. The first category of comments contains simple descriptions. This category can be divided in two subcategories: description of the location itself and description of the individual perception. In the first case, the test subjects simply wrote what they saw, such as "*children playing*", "*green*", or "*water*". The second type of description shows the expression of their feelings without further explanations. For instance, at Elisenbrunnen Park one of the subjects wrote: "*I recognized the fountain after two minutes acoustically*". The second category contains rating statements, by which the location is assessed. It includes impressions like "*relaxing*" or "*pleasant*", but also evaluations of facts, for example "*here is nearly no more traffic noise*". The next category consists of interpretations of the situation by bringing up associations of ideas or places like "*Paris*". On the other hand, it also includes deeper thoughts, such as "*the park is full of life*", wherein descriptions and interpretations are combined to evaluate the place. The final category of impressions involves the self-projection in particular locations. Advices for personal adaptation were given, such as "*the perfect place for talking with friends, eating ice-cream*". In the description part, a distinct sound component is mentioned by several participants at Elisenbrunnen Park: "*a little jazz music*", "*music pieces*", "*saxophone and drums, music*". This repeated presence shows the importance of this event and the strong influence it had on the listeners. It correlates with the limited standard deviation shown on graphic 6. Moreover, positive appreciation which explains the low values of grades given for unpleasantness is given by rating adjectives like "*pleasant*", "*relaxing*" or, related to the music, "*beautiful*". Furthermore, the notified negative aspects are weakened and oriented on the background: "*distant low frequency bus noise*", "*here is nearly no more traffic noise*". This acceptance of noise is more emphasized with the following impression: "*some young guys create extra sound on the shingle but defensively*". Not only it is considered as sound rather than noise, but also the intention of making it is forgiven. The late afternoon relaxed atmosphere has a dominant influence, even if the other components are still present. These are evaluated more on the loudness scale than on the unpleasantness scale, which offers an explanation for statistical insignificance of the correlation coefficient between these two parameters.

The standard deviations of ratings given for unpleasantness at other locations are quite large. They can also be explained by studying the statements and, in particular, the opposite points of view different subjects have. These large differences result from different background of the participants and different experiences they have with life in the city, which result in specific expectations each subject has. For example, people who live in big cities expect a loud environment, particularly near or in crowded streets. Since the city of Aachen is rather small compared to big cities, the estimate of loudness given by such subjects will be lower. This is reflected in comments such as "*very quiet for an inner-city*" or, in case of an intersection, "*the sound is appropriate in the context of the basic purpose of this location*". Moreover, the way of thinking differs, some of the subjects estimate individual locations as external and detached spectators, whereas others base their assessment on the possible use they could make of such locations, as an internal actor. However, different types of use could lead to different appreciations of the location. Some of the participants assign a certain purpose to a place, for example at the end of a street full of coffee bars and restaurants at dinner time: "*a very cozy place that invites me to stay*". On the other hand, it is possible to envisage a long-term use like living there, "*I wouldn't like living here because of traffic noise, people who are staying outside at night drinking coffee*". The presence of restaurants is also mentioned as a source of noise, but only for people who do not use these. Finally, every person is able to "fade out" certain events and aspects. It depends on the activity and the concentration as well as personal values. The location of the Aachen's Cathedral is a good example. Behind the cathedral there is a public square, the Katschhof, with a good view on the cathedral. During the evaluation of this location, some visitors of the square were listening loud music. The discrepancy between the cultural and historical meaning of the cathedral and the modern music does not have the same effect on the test subjects' minds. The contrast between the cathedral and the music can be too large to be acceptable ("*it disturbed me*", "*idiot shouting and playing music, inappropriate for this particular location*") or it could be noticed and weighed against "*the cathedral creates a mighty silence, which cannot be disturbed by some stupid puns*".

In conclusion, the detailed analysis of comments is a significant part of the study. As soundwalk is a tool to analyze the quality of life, it is important to collect and analyze judgments. On the basis of verbalized impressions it is possible to get access to the subjects' minds [5]. Moreover, it enables to detect relevant criteria which make a certain place pleasant or not. This information could be a valuable help in order to emphasize the positive aspects of a place and to derive efficient actions to avoid unwanted noise. Moreover, it helps to explain deviations in ratings and assessments and gives an interpretation on what the collected "numbers" mean [6].

Subjective ratings of loudness and unpleasantness and "source recognition"

In this approach, besides the subjective ratings on a scale and acoustical parameters, specific keywords noted in the evaluation sheets over the different test subjects were counted and analysed. The further analyses have been done according to a triangulation model, considering qualitative and quantitative aspects of the soundwalk. The qualitative analyses have been carried out by extraction of data from the evaluation sheets. Keywords were extracted from the comments of the participants and computed according to their occurrences per location. Table 3 displays a Pearson correlation matrix, which was constructed to detect relations between the (psycho-) acoustic parameters and subjective ratings as well as the number of keyword occurrences.

Table 3. Correlation matrix of acoustic parameters, subjective ratings and sources (number of keyword occurrences per location)

high traffic	low traffic	birds	voices	steps	bells	HVAC	Music	fountain	construction noise	"cocktail noise"	
0,69	-0,30	0,33	-0,76	0,33	-0,28	-0,06	-0,06	-0,25	-0,25	0,11	SPL
0,65	-0,46	0,21	-0,73	0,29	-0,19	0,03	0,03	-0,10	0,06	0,18	SPL_A
0,78	-0,48	0,45	-0,72	0,13	-0,33	-0,09	-0,09	-0,19	-0,03	0,12	N_{avg}
0,78	-0,43	0,50	-0,71	0,13	-0,41	-0,14	-0,14	-0,28	-0,11	0,15	N_5
0,40	-0,21	-0,01	0,01	-0,26	0,22	-0,27	-0,27	0,60	0,54	0,13	S
0,77	-0,57	0,47	-0,82	0,17	-0,28	0,08	0,08	-0,29	-0,09	0,03	R
-0,60	0,42	-0,10	0,65	-0,30	0,15	0,01	0,01	-0,02	-0,17	-0,20	SII
0,40	-0,22	-0,01	-0,69	0,47	0,02	0,13	0,13	-0,12	-0,22	0,29	RA
0,90	-0,44	0,48	-0,57	0,06	-0,38	-0,26	-0,26	0,07	0,11	-0,02	Loud
0,90	-0,61	0,50	-0,75	0,23	-0,41	0,05	0,05	-0,07	0,02	-0,36	Unpleasant

For acoustic and psychoacoustic parameters, as expected high correlations were detected between perceived loudness and N_5, N_{ave} and sound pressure levels, while negative and significant correlations were found between speech intelligibility index (SII) and the judgment of loudness.

With respect to the analysed keywords relations between the given judgments and noted sound sources were observed. Figure 7 shows the counted numbers of keywords mentioned per location. Using these keywords, it is possible to create a simple "source profile" of each investigated site. It seems that even on the basis of the very small data base, each site has its specific sources constellation. The derived quantitative values of sources recognized can also be applied for correlation analyses with the subjective ratings of loudness and unpleasantness. High and positive correlation values have been found between the keywords "*high traffic*" and the judgments of loudness and unpleasantness while negative correlation coefficient values have been detected between the keywords "*low traffic*", "*voices*" and "*bells*". It implies that high traffic has an effect on unpleasantness but low traffic noise has not automatically a significant (positive) effect on pleasantness. Human voices, and "*cocktail sounds*" (restaurant noise), bells which are obviously related to social activities have a negative effect on unpleasantness, increasing the "vibrancy" of the location. It has to be mentioned that the test subjects were not explicitly instructed to note the recognized sources during the measurement interval, but rather to spontaneously note everything which come their in minds.

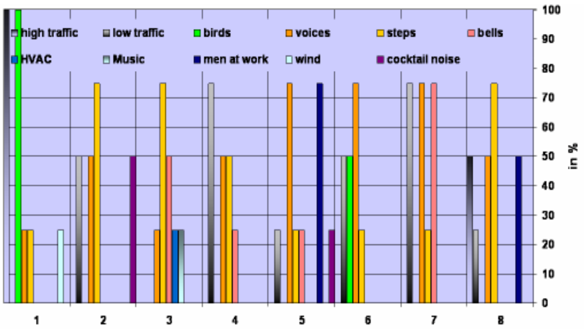

Figure 7. Classification of locations by means of "source recognition" (the bars indicate the number of noted sources per test subject in percent; 100% corresponds to all test subjects have noted this keyword)

All in all, the occurrence and noticeability of specific sound sources are closely connected to the given loudness and unpleasantness judgments in-situ. This phenomenon appears almost regardless of the actual physical contributions of the respective sources to the overall sound.

COMPARISON OF LABORATORY AND FIELD TEST ASSESSMENTS

Besides the soundwalk a laboratory test was conducted using the sounds recorded at all eight locations visited during the soundwalk. The same subjects who participated in the soundwalk took part in the experiment. Since the laboratory represents a neutral and controlled space, the subjects were asked only to grade the loudness and unpleasantness of the sounds reproduced to them. The average subjective grades of loudness and unpleasantness obtained in the experiment are compared to the ones obtained in field during soundwalk. Few comparisons are shown in figure 8 and 9.

The presented examples show that the subjects tended frequently to give higher grades of both loudness and unpleasantness in the laboratory. There are a number of possible reasons for this phenomenon. The analysis of subjective grades given for loudness reveals that rating deviations occurred between the evaluations given in laboratory and field.

A possible reason for this could be the lack of context and the impossibility to see and experience the actual sources responsible for the sounds in the soundscape of a certain location.

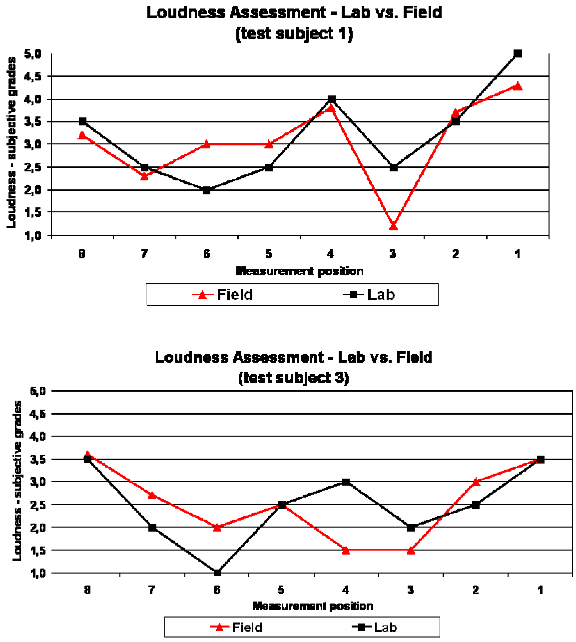

Figure 8. Subjective grades of loudness exemplarily for two test subjects (obtained during soundwalk and in laboratory) (5 represents "extremely loud", 1 stands for "not at all loud")

However, it was observed that the subjects are quite capable of assessing the loudness of sounds, or at least the relative differences in loudness, both in the laboratory and in the field. Correlation coefficients between objective loudness and appropriate subjective grades, with values ranging from 0.86 to 0.94, seem to support these findings.

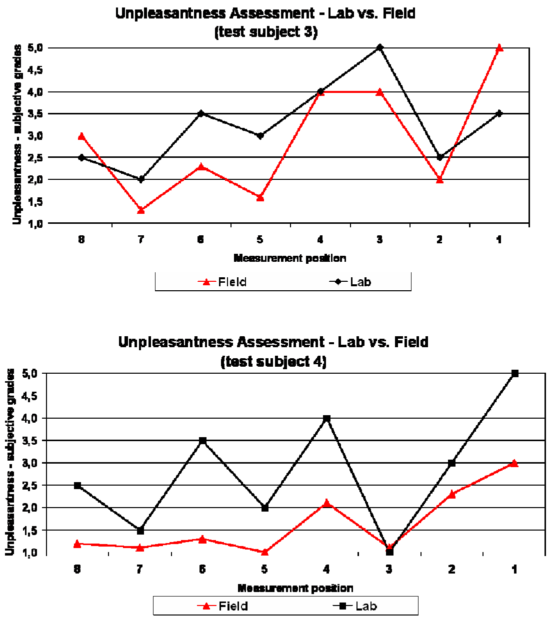

Figure 9. Subjective grades of unpleasantness exemplarily for two test subjects (obtained during soundwalk and in laboratory) (5 represents "extremely unpleasant", 1 stands for "not at all unpleasant")

As for unpleasantness, the results shown in figure 9 indicate that there are a few similarities in the way people experience this particular feeling when evoked by sound, which are reflected in the grades they gave during tests. It was stated above that between acoustical quantities and the subjective ratings in the field context no significant correlation was found. In the laboratory the unpleasantness ratings, of course, differ from the ratings made in the field experiment. However, several similarities can be found between the ratings, although the test subjects must base their ratings only on the presented acoustical information. No further information was provided, such as context, pictures, descriptions of the places, etc. A reasonable explanation for this phenomenon could be that the subjects could easily recognize the presented acoustic sceneries at which each sound was recorded because they remembered specific sounds and events that took place at each location. Thus, they used more information than only the isolated acoustical stimulus.

Moreover, it is possible to study the general relationship between the considered evaluation criteria in the field and laboratory context. Table 4 shows the correlations between loudness and unpleasantness related to the field and laboratory experiment. The results indicate that a weak relationship exists between loudness and unpleasantness. Concerning the ratings obtained during the soundwalk the relationship between judged loudness and felt unpleasantness of the soundscape was even lower. As mentioned above, loudness is not the only parameter that has an influence on unpleasantness. This is especially true for sensations in realistic situations with a lot of multimodal input. In laboratory it can be observed that with increasing loudness impression the unpleasantness increases. In a soundscape, the criteria "loudness impression" and "unpleasantness assessment" seems to be lesser connected.

Table 4. Correlation coefficients between unpleasantness and loudness ratings given in field and laboratory (all single evaluations considered (64))

	Field experiment	Laboratory experiment
loudness vs. unpleasantness (correlation coefficient)	0.52	0.61

All in all, it can be summarized that, although most of the sounds were recognized and the real location could be assigned, considerable differences in loudness as well as unpleasantness ratings were observed. Unfortunately, in few cases there is even no general trend derivable. For example, the displayed results of the test subjects 1 and 3 regarding the perceived overall loudness were very different with respect to the measurement position 6. A kind of tendency can be observed for most of the unpleasantness ratings, they were frequently higher in the laboratory experiment than in the field situation. Possibly, real life experiences "explain" occurring noise events, whereas in the laboratory setting the occurring events can neither be anticipated nor assigned to specific causes and sources. However, the observed tendencies cannot be generalized, since in the presented case study only a small test group took part.

CONCLUSIONS

During the short term scientific mission few case studies including the measurement, analysis, evaluation, and classification of defined environmental areas were carried out. The described education modules were very helpful with respect to the subsequent application of the tools and approaches in the soundscape case studies. In fact, the realization of a soundscape investigation, where several researchers with different socio-cultural as well as disciplinary backgrounds were engaged, turned out to be very efficient, since several dimensions and facets were explored only identifiable by using different perspectives. Therefore, it appears imperative to make further efforts for interdisciplinary collaboration in soundscape projects in order to gain a deeper understanding of soundscape perception.

The results of the case studies document several conflicts, which arise frequently in the context of environmental noise research and are evidence for the need of the soundscape approach. Assessments collected in laboratory experiments cannot simply be transferred to daily-life experiences. The subjects reported that several aspects are of importance with respect to their (noise) evaluations, which are completely neglected in artificial, out of the original context listening tests. The analysis of the recognized sound sources and of the given comments can effectively help to classify soundscapes beyond simple level considerations. It was found that (psycho-)acoustic parameters are of significance with respect to the evaluation of a soundscape. However, the analysis of the acoustic quantities alone cannot explain the complex feelings towards soundscapes. They depend also on aspect like context, source constellation, visual elements or acoustical socialisation of the subject. The case studies have shown that a careless application of a certain test method as well as a blind interpretation of its results, as done in several conventional noise annoyance studies, are insufficient and can lead to results with a low external validity. Potential test biases must be analysed and have to be elaborately discussed. All in all, to determine valid, reliable results a combination of different methods seems appropriate. The application of quantitative as well as qualitative methods can be reasonable, since the use of a broad basis of data can lead to most significant results and conclusions.

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