Quiet Urban Areas: repositioning local noise policy approaches – questioning visitors on soundscape and environmental quality

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Current practices about selection, assessment and management of quiet urban areas in European countries appear to be fragmented and widely varying, or even lacking. Although the EU Directive 49/2002/CE on Environmental Noise (commonly abbreviated END) and national (nature, noise or urban planning) policy instruments set requirements on the delineation and management of these areas of 'good acoustic environment'.
The QUADMAP project (QUiet Areas Definition and Management in Action Plans), financed by the EU programme LIFE+, aims at developing a harmonized methodology for selection, assessment and management of quiet urban areas (QUAs). Best practices, lessons learned and empirical study data are assessed in order to define – acoustic and other – parameters relevant for the perception and evaluation of quiet urban areas by the citizens. Tools will be available for local stakeholders, such as (noise policy) decision makers, urban planners, and citizens, in order to assess and manage QUAs. The project's objective is to reposition current approaches and facilitate a transition to sustainable, multi-sector and multi-facet policy instruments. This paper presents preliminary results regarding one of the assessment tools, i.e. questioning visitors on soundscape and other qualities of the quiet (urban) area.

1 INTRODUCTION

Soundscape research is gaining much interest from a diverse range of scholars and researchers. International conferences address the topic in technical sessions and academic journals regularly publish newest insights from all over the world.
An ISO working group started working since some years on standardized approaches and recently proposed to define soundscape as ''perception of the acoustic environment as perceived by people in that place, in context''. The next phase in the working group's activities will consist of standardization of soundscape research and methodologies[1]. The forthcoming paper by T. Gjestland will probably prove a good basis for further discussions on standardized approaches, and is eagerly looked for.

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As Lam et al.[2] state, knowledge of which soundscapes people prefer and what affects their preferences is instrumental in defining soundscapes of ''good quality''. The EU Environmental Noise Directive is not very clear and specific on these definitions, although recognizing the need to protect areas of good acoustic quality. Reasons given are to provide retreat from urban stress and to recuperate psychologically. Research of, for example, the Dutch Health Council[3] has underlined these positive, health and stress-reducing, effects of green and quiet areas.

The Environmental Noise Directive distinguishes quiet urban areas and quiet natural areas. Abundant research has been published on urban public spaces or quiet urban areas. Examples are Schulte-Fortkamp[3] with a specific focus on the local experts, and Adams et al.[4] on noise policy and sustainable urban soundscapes, and Payne et al.[5]. In addition, there is an increasing number of conference proceedings and papers on soundscape research in urban areas describing the approaches applied. Examples are Weber[6] on methodologies for assessing soundscapes of parks in Rotterdam, Nilsson and Berglund[7] in Sweden, Brambilla and Maffei[8] in Italy.
With respect to quiet natural areas or the countryside Lam et al.[2] refer to various studies on outdoor recreationists' experience, and add their insights based upon a Hong Kong study.

In this paper the main focus will be on the methods applied for assessing the soundscape relying on peoples' perception. Undeniably however, physical measurements, e.g. measurements of (psycho)acoustic indicators, are required as well, and as such are part of the author's research of the soundscape of the quiet, natural areas in the province of South Holland as well as in last year's research in parks in the city of Rotterdam.
Notably, there seems to be abundant discussions and convergence on the – (psycho)acoustic – indicators to be measured, and literature discussing measurement approaches and variables. Nevertheless, limited scholarly discussions can be found on field survey approaches, assessing human perceptions. Soundwalks, open interviews, creativity and design 'contests' or questionnaires, have been applied. However, discussions on for example research design or the structure of questionnaires seem to be limited available. This paper attempts to initiate discussing and sharing experience and lessons learned.

2 QUIET AREAS AND QUADMAP

2.1 Quiet areas studies applying soundscape approaches

During the last months up to a year, DCMR has conducted two studies on quiet areas and the perception of the soundscape and environmental quality of selected pilot areas. In spring 2011 three parks in Rotterdam have been assessed, varying in seize from 1 ha - 2 ha to more than 200 ha. Methodological lessons learned have been used for improving the subsequent study in two nature areas in the province of South Holland at the end of 2011. These nature areas, open meadows situated near cities, are 2.700 ha and 12.700 ha in seize.

The aim of these studies was to characterize and assess quiet areas and recommend methodologies for future research. As became evident after the first round of noise mapping and action planning according to the END, most local governments lack practical experience as regulations regarding quiet urban areas until the END was issued did not exist. Regarding nature areas, although, regional governments (in Dutch: provinces) have implemented policies regarding quiet areas decades ago.

The Dutch Environmental Management Act requires competent authorities to delineate and protect quiet natural areas (in Dutch: stiltegebieden), comprising at least the following types of areas: (i) protected nature areas , and (ii) wetlands as designed by the Ramsar Convention. Quiet natural areas should have a certain seize, tranquility and added value for recreation or fauna. Finally, the quiet natural area are delineated guaranteeing noise levels not higher than 40 dB Lden. However, despite these 'regulative requirements' limited practical experience nor tools are available on assessing and characterizing natural quiet areas.

2.2 The QUADMAP project

The QUADMAP[9] project (QUiet Areas Definition and Management in Action Plans), financed by the EU programme LIFE+, aims at developing a harmonized methodology for selection, assessment and management of quiet urban areas (QUAs). Best practices, lessons learned and empirical study data are assessed in order to define – acoustic and other – parameters relevant for the perception and evaluation of quiet urban areas by the citizens. In addition, so-called interventions, such as redesign of the area or the use of low noise road surfaces, will be implemented in a number of selected pilot areas. Aim of these case studies is to test the methods regarding the identification and classification of critical perception parameters, developed in the project, in situ and evaluate the applicability of the methods in the identification and instrumentation quiet urban area management. Tools will be available for local stakeholders, such as (noise policy) decision makers, urban planners, and citizens, in order to assess and manage QUAs.
Coordination of the project is at the University of Florence; project partners are DCMR, city of Firenze, VieEnROSe, Tecnalia, the city of Bilbao and BruitParif. As the QUADMAP project runs from 1 September 2011 until 1 September 2014, it will be aligned to the follow up studies in Rotterdam and South Holland, and vice versa.

2.3 Methodology

In the studies in Rotterdam and the nature areas human perception of the soundscape of the selected areas is assessed based upon acoustical data as well as human perception response data in situ. Responses were measured by questionnaires, with approximately 50 interviews successfully completed per site and thus approximately 250 respondents in total.
Interviews were conducted by students, in the selected areas. The surveys targeted visitors aged 18 years or above; some living in the vicinity of the area and others visiting the areas for specific reasons (for the first time or frequently). The overall response rate was almost 100%, as limited or none of the people asked for the interview were unwilling to cooperate. The field surveys were conducted on weekdays in spring (in the parks in Rotterdam) and fall (in the nature areas); this might have influenced the results because of the relatively cold(er) weather during those seasons compared to doing research in summer time.
The data obtained were analyzed using Statistical Package for the Social Science (SPSS) for Windows version 17.0. Statistical analyses consisted of Pearson, Spearman and ANOVA analyses. Aim of these analyses is to define relationships between human preferences and perceptual variables using correlation and stepwise regression analysis, similar to Lam et al[2]. A secondary aim of these analyses is to assess which questions, answers and coding mechanisms prove to be practical in usage *and* provide sufficient scientific evidence to base conclusions.

During both studies, acoustic measurements have been carried out. The analyses of the park data have been presented by Weber[6]; the analyses of the nature areas measurements will follow later in 2012. In that stage relationship between human preference and various acoustical variables will be assessed. These (acoustical) analyses will therefore not be part of this paper.

2.4 Questionnaire

The questionnaire applied in the field survey is based upon work from COST Action Soundscape[10]. The structure of the questionnaire is as follows:

(i) general questions on: reason, frequency, duration, companionship, day of week, time of day of the visit;
(ii) questions on sound(scape): characterization of soundscape, audibility of sound sources, annoyance from sound sources, pleasantness of sound sources, acoustic quality;
(iii) questions on the environmental surroundings, the natural area: environmental quality, characterization of the area e.g. tranquility, natural quality, safety, pleasantness;
(iv) questions on personal data: male/female, age, education, occupancy, zip code;
(v) questions on living conditions: distance between home and natural area, acoustic quality at home, annoyance from sound sources at home

Most of these questions have closed, easy to code, answer categories or scales ranging from 1 to 5 (so-called Lickert scale). In addition, a few open questions were added, asking the visitors which improvements they would like to propose regarding the soundscape and the quiet area itself. The aim of these latter questions is to provide the city of Rotterdam and the province of South Holland with specific suggestions for management and improvement of the quiet urban respectively natural areas, from the specific points of view and expectations of the visitors

3 RESULTS

3.1 Soundscape quality

Berglund et al.[11] defined verbal descriptions of soundscape qualities to be applied in, for example, soundwalks. The verbatim proposed are the following:

Unpleasant – pleasant
Uneventful – eventful
Chaotic – quiet
Boring – exciting

In assessing the acoustic environment in urban parks in Rotterdam[6] these descriptions have been translated into Dutch and applied in interviewing citizens. During that study respondents seemed to be distracted and misled by some verbal descriptions, such as the Dutch translation ''opwindend'' of ''exciting'' and the dichotomy of uneventful – eventful. Therefore in the study in the quiet natural areas the description ''spannend'' instead of ''opwindend'' was used, as well as ''kalm'' instead of ''stil'' (for quiet). The respondents in this study felt more comfortable with these descriptions of the acoustic environment.

As Figures 1 and 2 illustrate, the descriptions ‘weinig afwisselend’ and ‘afwisselend’ (uneventful – eventful), depicted with a 180 degree edge, have a strong negative correlation, which makes this a strong pair of verbal descriptions. In addition, the verbatim have high descriptive value, as can be concluded from the length of the lines (the longer, the more descriptive the question or variable is). This is the case for both pilot study areas.

We found similar negative correlations for the descriptions ‘hinderlijk’ and ‘plezierig’ (literally translated in English this would read annoying – pleasant) and ‘chaotisch’ and ‘kalm’ (chaotic – calm) although the latter pair is less correlated (the edge is less than 180 degrees). Interestingly, both pairs of verbal descriptions are more descriptive in the parks than in the nature areas. But nevertheless, the verbatim seem applicable and statistically sound in both types of quiet areas.

Finally, the translation of the verbal description of ‘exciting’ still seems to be problematic despite the change of the word ‘opwindend’ to ‘spannend’ in the second field survey and the fact that respondents in the field survey in the nature areas found no difficulties in applying this description. Both verbatim have no correlation with the opposite verbatim ‘monotonous’ (see the edge of 90 degrees and the red circles depicting these dichotomies in the figures below). This might mean a different (translation of the) pair of verbal descriptions is needed.

3.2 Sound source categories

As discussed by Brown[12] preservation of high acoustic quality in natural areas is required for protecting wildlife. As such intrusion from human-generated sounds should be prevented. Another objective of maintaining the quality of the soundscape in natural areas is human appreciation, enjoyment and positive effects on stress and other negative health effects. In questioning users of these areas preferred sounds, in contrast to the frequently applied, ISO standardised question on noise annoyance, sounds of moving water, sounds of nature, and sounds of other people. The same line of argumentation might be applied for quiet urban areas, as recent studies indicate that these areas can function as a refuge for daily stress and area to relax, reflect or have some physical exercise.

Respondents in the study areas were asked to indicate whether specific sound sources were audible during the visit of the area. Sound sources applied are the following: (i) traffic sounds, (ii) mechanical sounds, (iii) human sounds, and (iv) nature sounds. Note, no qualification of the audible sounds is requested in this question.

As can be concluded from Table 1 respondents in the parks indicated that both traffic as well as nature sounds were audible, and to a lesser account human sounds. The relatively high score on nature might be an indicator for the perception of the soundscape, as will be discussed in the next section (3.3 Acoustic environment). The respondents in the nature area indicate that specifically nature sounds were audible, although traffic sounds were recognized as well. The difference in audibility between these two sound source categories is, not surprisingly, larger than in the urban areas.

3.3 Acoustic environment

In order to assess perception of the afore mentioned sound sources, the respondents were asked to indicate whether certain sound sources were considered annoying and/or pleasant (in two separate, closed questions ranking from 1 (do not agree at all) to 5 (agree fully).

Some interesting preliminary conclusions can be drawn from these analyses. First, in the nature areas we find no correlation between annoyance of various sound sources and pleasantness of these sound sources see Figure 4). This is depicted as the almost perfect 90 degree edge of most lines. Only one exemption is found, that are motorized 2-wheelers that have a strong negative correlation. A remark should however be made, that is that the pleasantness of this sound source is hardly discriminative as is illustrated in Figure 4 (short line, red circled).

Second, in the parks in Rotterdam we find a more complex and scattered picture (see Figure 3). Although in general we can conclude that most sound sources are not correlated regarding pleasantness and annoyance caused. In correlating these sound sources with soundscape quality descriptions, the following picture underlines the complexity (see Figure 5). For example, traffic sounds correlate significantly with the soundscape quality descriptions ‘pleasant’ and ‘calm’. Statistical cross checking is in line with this conclusion, as Kendall’s tau-b shows significant correlation of ,356 for traffic sounds and pleasantness. Until now, we were not able to find an explanation based upon our empirical data.

Third, considering discriminative power of the various sound sources used in the questions on pleasantness and annoyance we see differences for both types of quiet areas. In the parks discriminative sound sources (the longer lines) are the following: music (both annoying and pleasant); airplane (pleasant); water (pleasant); animals (pleasant); ‘citysounds’ (pleasant); road traffic (annoying); people (annoying) and scooters (annoying). In the nature areas the following discriminative sound sources were found: people, children and water which were all relevant in the questions on annoying and pleasant. And finally, water and birds were highly discriminative regarding annoyance. Note, a discriminating variable is not similar to having a high score on this question. Thus, for example, water and birds, which we often assume as pleasant sounds, are highly discriminative in the question on annoying sounds. This means that most respondents gave this question a similar score (and probably stating that these sounds are not annoying at all). On the other hand, we see very limited discrimination for construction noise in the parks (see red circle). This is surprisingly, as during the field survey a lot of construction work was going on and the student conducting the interviews personally noted this sound during all interviews. Despite audibility of the sound, in the range of other sound sources construction sounds were found, in this survey, of limited interest.

In sum, from this assessment we might conclude that the following sound sources should – at least – be incorporated in the questionnaire, that is road traffic, scooters, music, people (and children), water, birds, and in an urban surrounding ‘city sounds’.

3.4 Appreciation

The questionnaire comprised questions on the overall quality of the natural area as well; after the acoustic/soundscape questions. Variables such as cleanliness, safety, natural features, visual appearance and tranquility were included, and were scored on a Lickert scale from 1 (fully disagree) to 5 (fully agree).

From these analyses, again, some interesting conclusions can be drawn (see Figures 6 and 7). First, no correlation is found between cleanliness/safety/pleasantness with the overall appreciation of the nature areas nor its soundscape. Significant correlations regarding these nature areas (picture at the right, see clusters in circle), though, are found between visual appreciation and tranquility, and between appreciation of the area, sound quality and natural features.

Second, in the parks correlations, though not surprisingly, differ from the nature areas. In the parks significant correlations are found regarding visual appreciation and natural features. A preliminary conclusion might be that specifically in urbanized areas these natural features are more appreciated and positively valued than in nature areas (where these natural features are abundantly available and regarded 'a condition sine qua non' for these areas). In this line of reasoning, the significant correlation between soundscape quality and tranquility perfectly fits. All variables, in addition, being highly discriminative.

Our preliminary conclusions, based upon both field surveys, are that in quiet urban areas soundscape (in this case 'balanced audibility' of specific sound source categories, supportive to a perception of tranquility) and natural features are crucial features for the appreciation of its characteristics and the (positive) perception of the area's acoustic and environmental climate. Whereas in nature areas, specifically tranquility (as characterization of the area's soundscape) and natural features are required for guaranteeing overall appreciation of these areas by its users.

4 FUTURE STEPS

During the next months field survey data will be combined and evaluated with the data from the acoustic measurements. As Brown[12] stated, the context of the acoustic experience is critical, and as such loud sounds of wanted sounds might be appreciated whereas low sounds of unwanted can be annoying and unpleasant for the humans visiting the natural area. These sound sources, to be distinct in various categories of sources as well as wanted versus unwanted sounds, will have to be identified. This is specifically critical as managing soundscapes in a place involves the planning and design of the acoustic environment that have relevance to the perception of the acoustic environment of those people who use that space. Or as Brambilla recently stated, the study on soundscapes should include subjective ratings on how the soundscape is perceived by the people experiencing it, considering also the different motivations (residents, tourists…) where applicable. This is also important for the selection of mitigation actions aimed not only to reduce the noise levels but also to improve the acoustic environment towards a better matching with people's expectancy.

As a consequence the further analysis will have to pay specific attention to possible differences in appreciation and perception of the natural areas by the different ''users''. This fits the approach promoted by Brigitte Schulte-Fortkamp[13] claiming that ''local experts are those people in action that live in a certain area under scrutiny and provide their expertise e.g. through evaluation processes such as sound walks and different kind of open interviews. [This] will give a focus for the analysis of the acoustical as well as qualitative data.[..] The attitude and the listener's expectations and experiences are significant parameters which have to comprehend the different perceptions and evaluations with regard to specific stimuli completely.
Moreover the knowledge people have concerned the area they are living in is of most importance.''

The results of the study will be evaluated regarding the approach applied and further improvements will be implemented in the methodology as well as flow into the QUADMAP project and the development of methods and guidelines for quiet urban area delineation, characterization and management.

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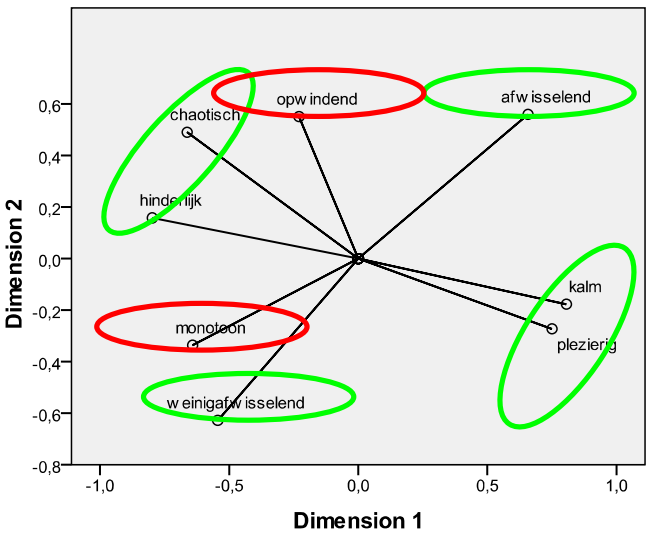
Table 1: Audibility of sound source categories in parks and in nature areas

	Traffic	Mechanic	Human	Nature
Parks Rotterdam				
Mean	3,39	2,18	2,53	3,05
Std. Dev.	1,10	1,44	1,04	1,13
Nature areas				
Mean	2,79	1,81	2,12	4,16
Std. Dev.	1,43	1,13	1,19	1,00



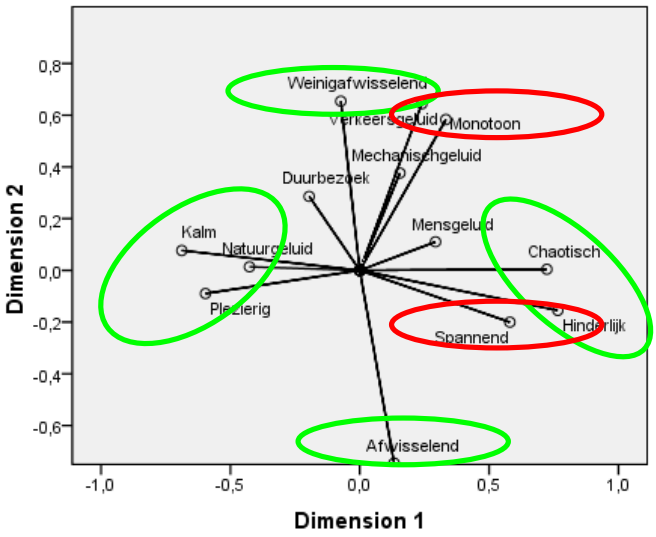


Fig. 1 and 2 -Categorical Principal Component Analyses of soundscape qualities in quiet urban areas (left) and quiet nature areas (right).

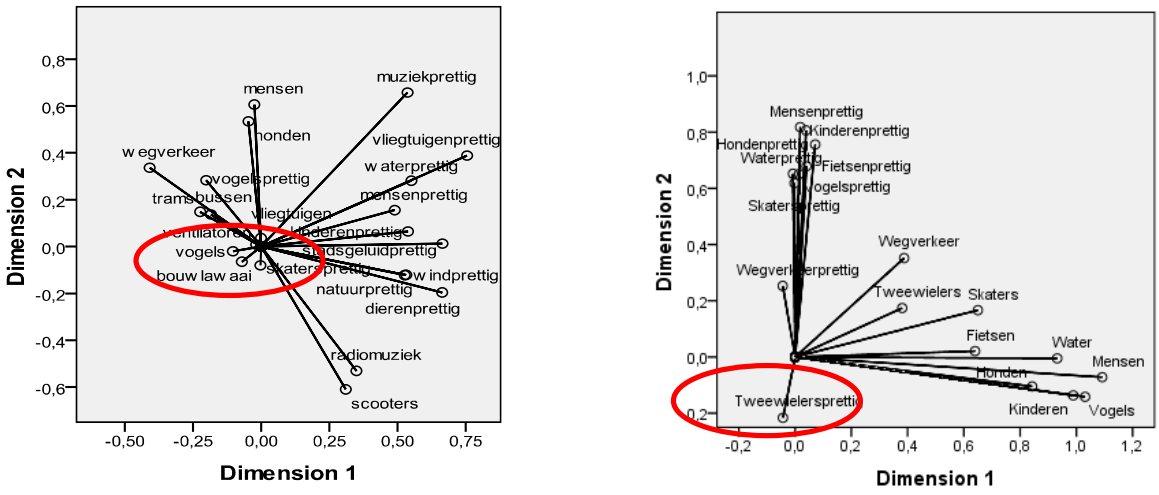


Fig. 3 and 4 -Categorical Principal Component Analyses of annoyance and pleasantness of sound sources in quiet urban areas (left) and quiet nature areas (right).

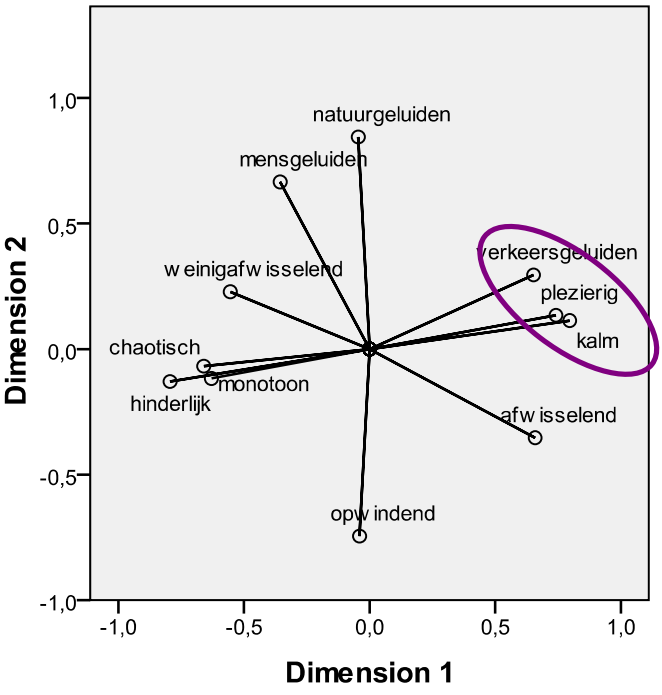


Fig. 5 -Categorical Principal Component Analyses of traffic sound sources and soundscape qualities in quiet urban areas

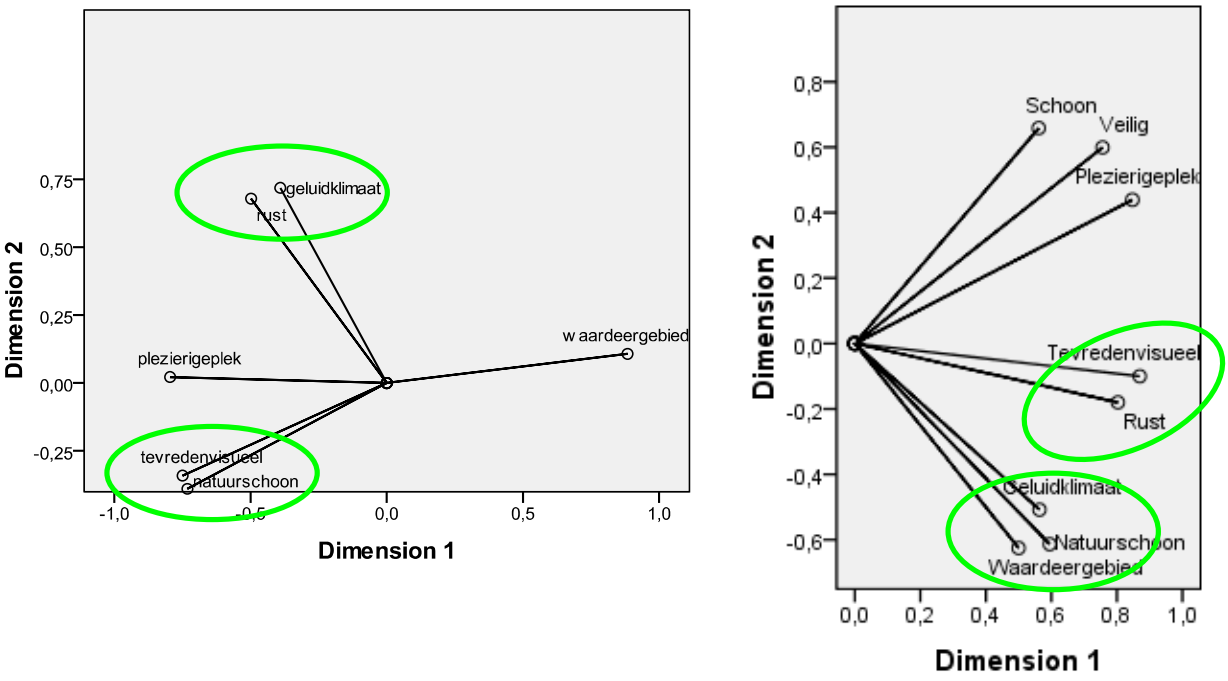


Fig. 6 and 7 -Categorical Principal Component Analyses of environmental and spatial qualities in quiet urban areas (left) and quiet nature areas (right).