

Mini Surveys on noise annoyance and moderators for perception of road noise

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OVERVIEW

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1 Preface

This report has been produced as a part of the FAMOS project. FAMOS responds to the questions of the Conference of European Road Directors (CEDR) call in 2018 on Noise and Nuisance: Psycho-Acoustics: Improved Understanding of People's Subjective Reactions to Road Noise.

WHO has estimated that about 1.2 million healthy life-years are lost annually in Europe due to road traffic noise. About half of these can be related to the subjective element: annoyance. This is a huge challenge for the National Road Administrations. Analyses of results from noise surveys reveal that only about 1/3 of the variance in the annoyance response is caused by the noise level itself, whereas the other 2/3 are determined by so-called non-acoustic factors. This means that the annoyance response can be altered within wide limits without doing any changes to the actual noise level. So, when road administrations have used all the technically feasible and economically possible measures, the noise impact can still be reduced by making changes in the non-acoustic factors known to moderate the annoyance response.

The objective of FAMOS is to quantify how different factors modify people's subjective reactions to road traffic noise. The project uses scientific methods to find, extract and analyse data from existing annoyance surveys. The most promising findings will be tested experimentally by the use of questionnaire studies, listening testing in the laboratory and soundscape measurements/sound walks. The results will be used to develop a handbook on how "moderators" can be used by road administrations to reduce noise annoyance.

FAMOS is the acronym for "FActors MOderating people's Subjective reactions to road noise". The project is carried out over two years and started in December 2019. The project consortium consists of three partners:

- FORCE Technology in Denmark (Project leader)
- LÄRMKONTOR in Germany
- SINTEF in Norway

The report has been produced within Work Package WP 2 of the project, which deals with "Analysing data and hypotheses testing" and is led by FORCE. This report presents the results of a mini survey performed in Hamburg. The report is produced by Sebastian Eggers from Lärmkontor as mile-stone M.2.3 of the FAMOS project. The report has been reviewed by Truls Gjestland from SINTEF for quality assurance. The CEDR Transnational Road Research Programme funded by Belgium – Wallonia, Denmark, Ireland, Netherlands, Norway, Sweden and United Kingdom has financed the FAMOS project.

2 Introduction

2.1 Background

The annoyance from road traffic noise is a challenge for the National Road Administrations. Only a part of the variance in the annoyance response is directly related to the noise level, and the rest determined by factors not related to the noise exposure. This means that the noise annoyance may be lowered without doing any changes to the actual noise exposure, when the influence of these non-acoustic factors is known.

The purpose of FAMOS is to quantify how different moderators modify people's subjective reactions to road traffic noise. In Work Package 1 an international literature study has been performed [1]. One of the results was to develop a list of moderators that can have an influence on people's subjective reactions to road traffic noise.

As a possible tool for further analysis, mini surveys were planned as part of the FAMOS project as a mean to analyse the effect of non-acoustic factors in Work Package 2. This report presents the results of the mini surveys with focus on moderators related to greenery, visibility and expectations.

The original plan was to find suitable locations for surveys before and after a change in the overall situation. This may have been a change in greenery (e.g. cutting down trees), a major change in the road traffic volume (increase due to detours or decrease due to construction work) and so on.

Moderators considered in the survey include:

1. Quality of surroundings of the dwelling
2. Presence of vegetation or greenery situated between and near the road and the people exposed to the noise.
3. Visibility of road and traffic for the people exposed to the noise.
4. Information channels
5. Expectations

2.2 Purpose

The main purpose for mini surveys in this project was to have an assessment on moderators and the local response in a not yet considered location. It was also planned to investigate the possibility for using mini surveys for measuring the effect or relevance of moderators in specific scenarios along roads and highways.

3 Survey areas

It became evident during the preparation phase of the project, that it was hard to find suitable locations at all (knowing about the measures to be planned) and similarly difficult to get the surveys done in time. As the timeframe of the project was limited, no suitable situation could be located in time for a planned survey. Thus, the survey layout changed to a broader perspective, assessing changes that had already happened.

Suitable locations with similarities but other distinct differences were found in the proximity of the A7 motorway in Hamburg, Germany. With more than 100,000 vehicles per day, this motorway is one of the most frequented motorways in Germany. Plans for a necessary enlargement of the motorway (going from three lanes per direction up to in some parts more than five lanes) resulted in a high level of necessary noise mitigation measures. Final plans for the A7 motorway resulted in three coverings (tunnels) of the motorway with a length of 560 to 2.300 meters.

3.1 Tunnel Schnelsen

This tunnel is located in the north of Hamburg. With a length of 560 meters it covers the A7 in an area with residential buildings of medium density directly next to the A7 motorway. Since June 2018, the traffic was moved completely into the tunnel as the construction of the second part begun. This resulted in a noise level reduction next to the former motorway of more than 20 decibels.

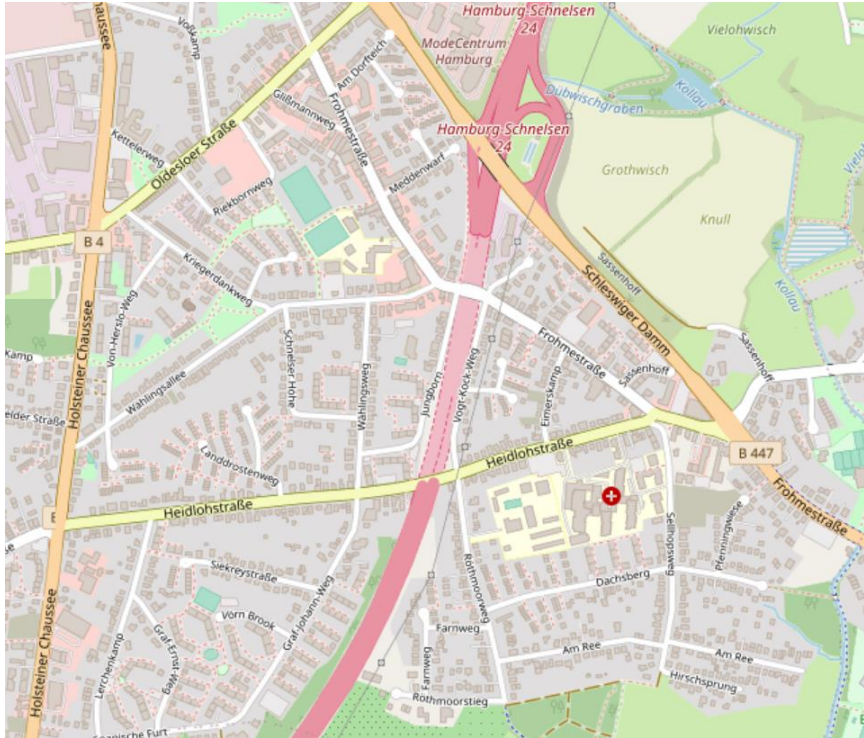


Figure 1 Map of the Schnelsen survey area (© OpenStreetMap contributors, base map and data from OpenStreetMap and OpenStreetMap Foundation)



Figure 2 Visualization of the Schnelsen covering (Source: DEGES/V-KON.media)

3.2 Tunnel Stellingen

Started short after the Schnelsen tunnel, the tunnel Stellingen is longer (890 meters) and is located near the probably most frequented part of the A7 in Hamburg with now 10 lanes. Traffic was moved into the first part of the tunnel in April 2019. The traffic noise was reduced by more than 20 decibels in some parts along the tunnel. The second part was opened in 2021, although not all lanes are accessible due to ongoing construction outside of the tunnel. The area surrounding the tunnel is a residential district with medium density.

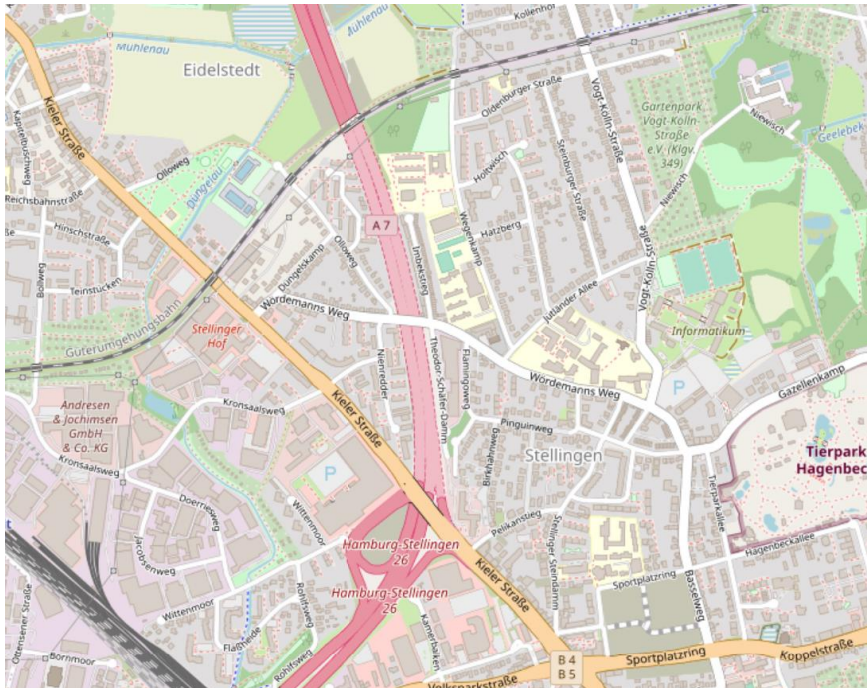


Figure 3 Map of the Stellingen survey area (© OpenStreetMap contributors, base map and data from OpenStreetMap and OpenStreetMap Foundation)



Figure 4 Visualization of the Schnelsen covering (Source: DEGES/V-KON.media)

4 Survey and questionnaire

4.1 Targeted address of survey participants

Contrary to the original plan, due to the Corona virus the survey had to be changed from partial interview combined with paper surveys to a contact less design. For this purpose, an online survey was developed, comprising 24 questions with several sub-items. For information of residents, a postal mailing was carried out. An information flyer was designed (see Figure 5), giving short information on the project. However, the topic "noise" was not mentioned (besides the company name LÄRMKONTOR) to avoid a strong bias.



Figure 5 Flyer for postal mailing

4.2 Postal distribution / choice of survey area

For postal distribution, the service of "Deutsche Post" (German postal services) was used. Distribution can be carried out according to delivery areas, each in size of about 600 households. The areas chosen can be seen in Figure 6 and Figure 7. A total of about 5,000 households were selected for postal mailing. The mailing was carried out beginning around March 17th within about 1.5 weeks (time varies between the areas, the date is estimated by the response). In addition to the postal mailing, a short notice in a local gazette was placed end of March.

Until April 5th, 185 responses were collected. About 160 responses were valid (answers to questions), at least 140-150 valid responses were given to all questions, the final questions of the survey were answered 142 times (fully finalized surveys). For analysis, all answers with sufficient information on the data points analysed were used, not considering missing answers on the non-relevant data points.

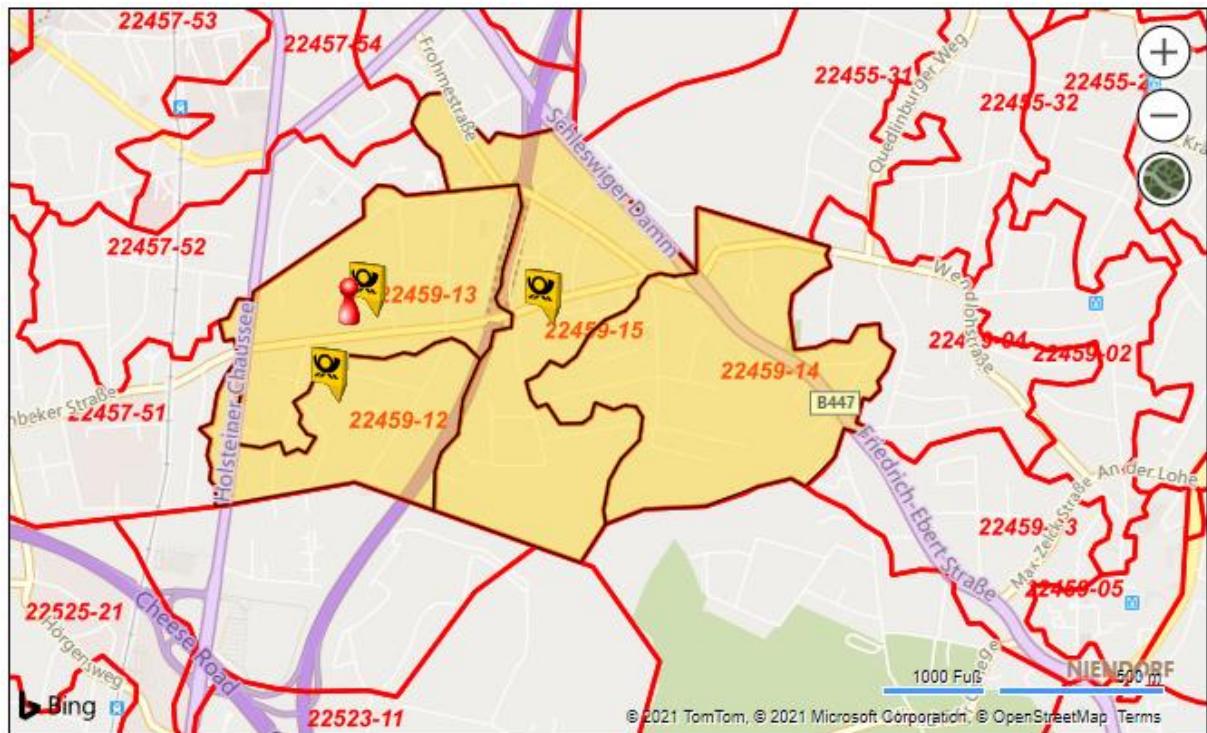


Figure 6 Selection for postal distribution - Schnelsen

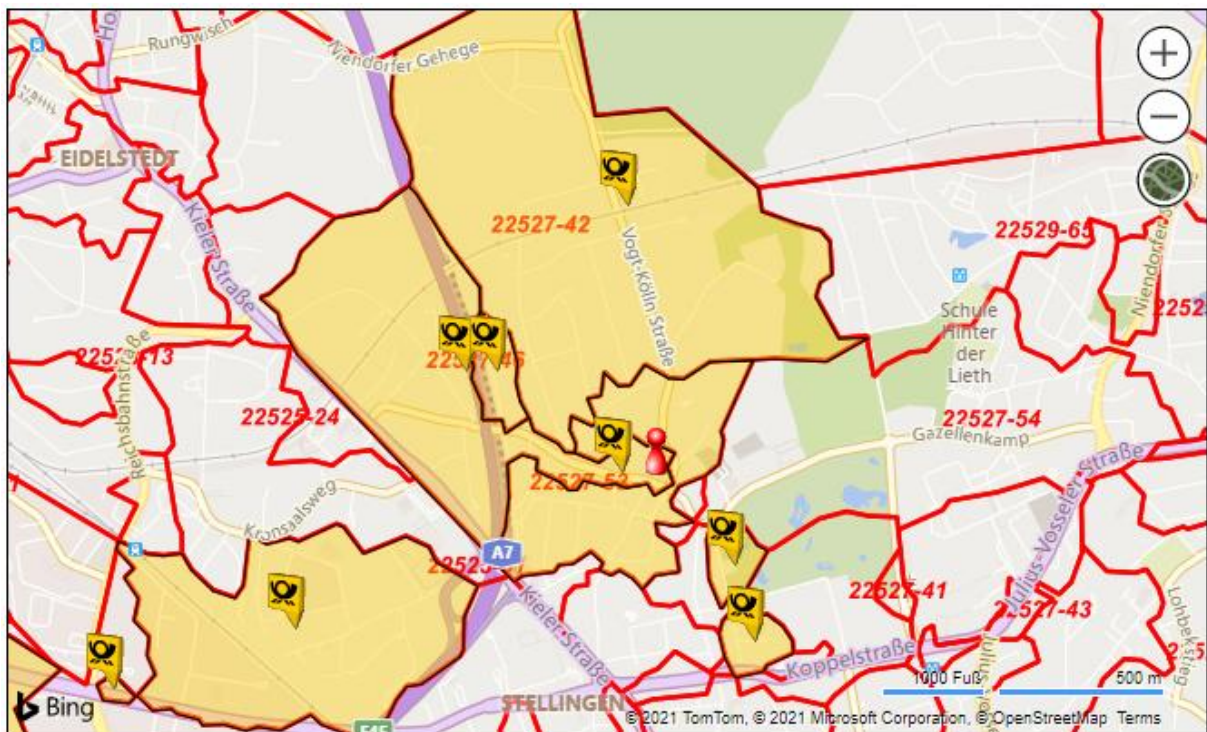


Figure 7 Selection for postal distribution - Stellingen

4.3 Questionnaire

The flyer had a link to an online questionnaire that could be opened in a browser either on a PC or on a smartphone. The presentation was optimized based on the device used, with a touch friendly interface on smartphones.

The questionnaire itself consisted of 24 questions, grouped on three pages, and an additional introduction and a page after completion. The groups were:

- Living conditions, question 1-10
- Motorway A7 and the covering, questions 11-20
- Private data (age, gender, tenancy), questions 21-24

All questions (translated) are documented in Appendix 1.

4.4 Noise data

The noise data was obtained from the A7 covering planning process. Noise levels were calculated for multiple receivers for each building with relevant A7 noise levels. Both noise situations with and without covering were analysed.

As no detailed information on exact building locations could be determined from the questionnaires, both the response on the survey area (which was grouped by streets with similar noise levels close to the A7 or areas in greater distance) and the response on distance from the A7 motorway were used to obtain the noise levels. For each area, the noise levels were summarized in dependency of the distance. The maximum level for each building was used in each case. The noise level of each respondent was then assessed by this relation, giving a possible maximum noise level on the dwelling before and after the covering.

5 Results

5.1 General aspects of respondents

Among all respondents, for gender an almost equal distribution between male and female was discovered. For age¹, a higher number of respondents above 60 was seen, the proportion of people below 35 years was comparable low. The results show that there were little to no responses of younger people or children living with their parents (younger than 20 years). Other concepts than mailings are necessary to address their annoyance. About 60 % of the respondents are owner of the residence, 40 % are tenants, comparable to the area that shows a mixture of houses with multiple dwellings and single houses.

¹ Due to changes in the test design, the classes on "age" do not have the same width. It is highly recommended to have equal-sized classes in further surveys!

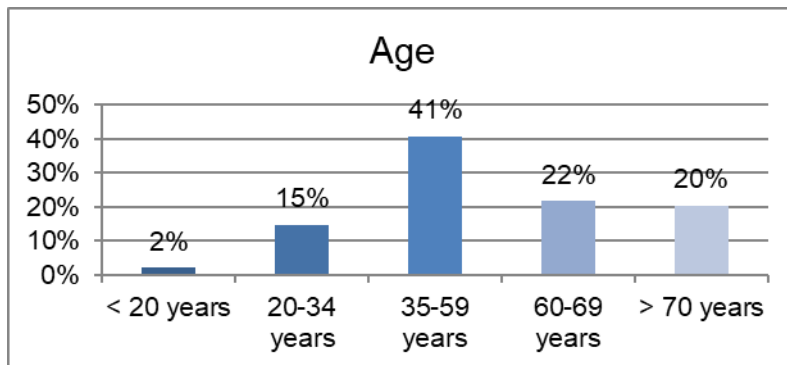


Figure 8 Age distribution of respondents

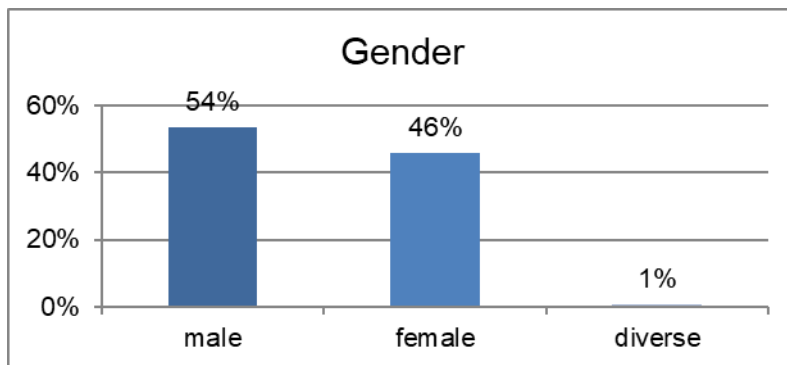


Figure 9 Gender distribution of respondents

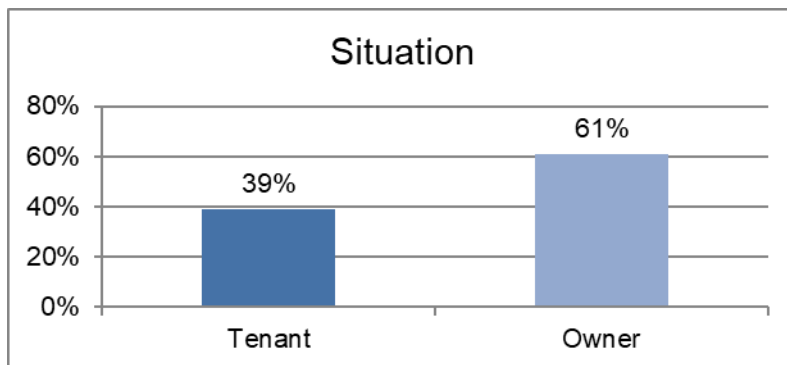


Figure 10 Tenancy / ownership of respondents

5.2 Noise annoyance in general

As for overall annoyance, two questions were placed. The question about noise annoyance in the last 12 months at the beginning of the survey (question 3), about noise annoyance before construction at the end (question 19 of 24) to avoid biased responses. Overall, a clear shift can be seen from higher to lower annoyance (). The perceived change in noise levels is also mainly a reduction (Figure 13).

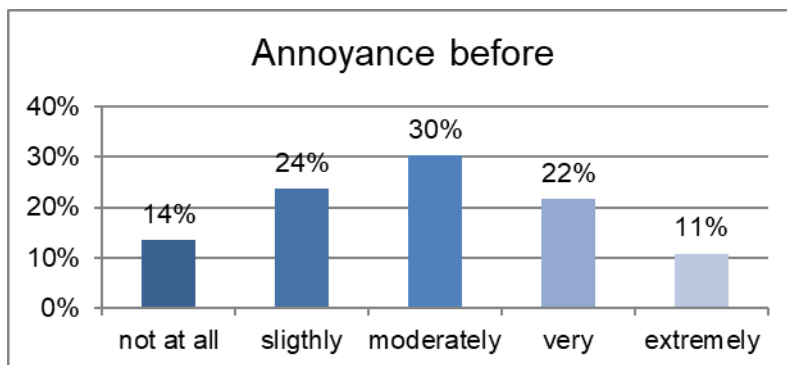


Figure 11 Noise annoyance before beginning of construction

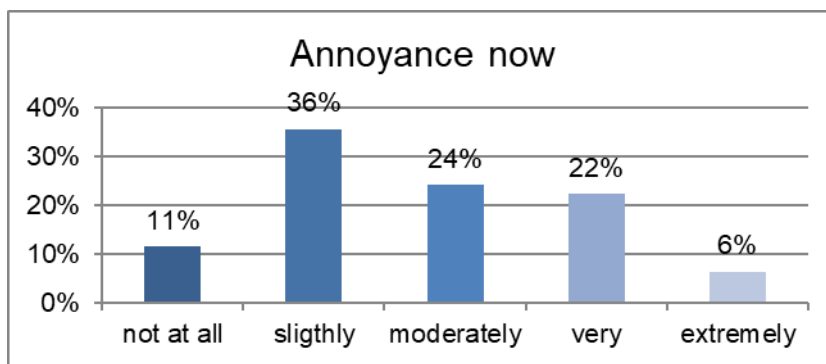


Figure 12 Noise annoyance after completion of construction

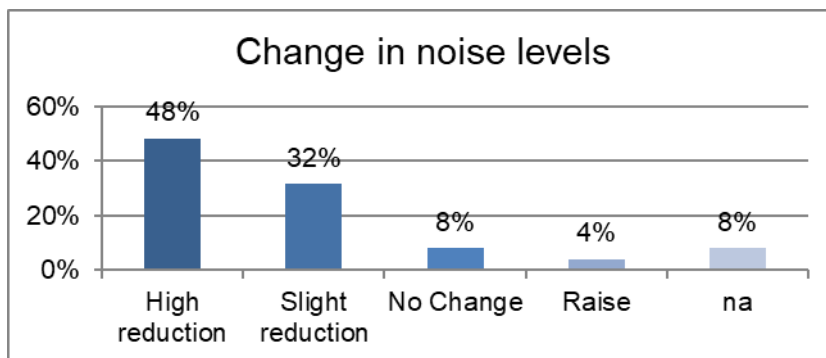


Figure 13 Perceived change in noise levels

In addition to the perceived and reported change in noise levels (Figure 13), the change in reported annoyance before and after construction of the coverings was analysed. The change in annoyance is shown in Figure 14 for the total noise. For a point above the black line, the annoyance changed to a higher level of annoyance, below the line, the annoyance was reduced. It can be seen that for higher annoyance beforehand most current annoyance is lower.

Although, the annoyance of people that were "not at all annoyed" before now changed to "slightly" and even "very" in a notable number of cases. Also, the annoyance of people "slightly annoyed" before changes to a higher level in several cases.

Regarding changes from “not annoyed at all”, a detailed evaluation was carried out:

- In four of this six changes to “very”, the A7 motorway was at a distance of 500-2.000 m, only in two cases below 100 m.
- In seven of eight cases with change to “slightly”, the A7 motorway was at a distance of about 300-500 m.

Based on these numbers, the annoyance seems to be influenced from other noise sources than the A7 motorways. For most respondents (13 of 14), the A7 motorway was not the only most disturbing noise source but rather of lower influence. For the changes from “slightly annoyed” to a higher annoyance, no clear trend regarding distances or dominating noise source could be found.

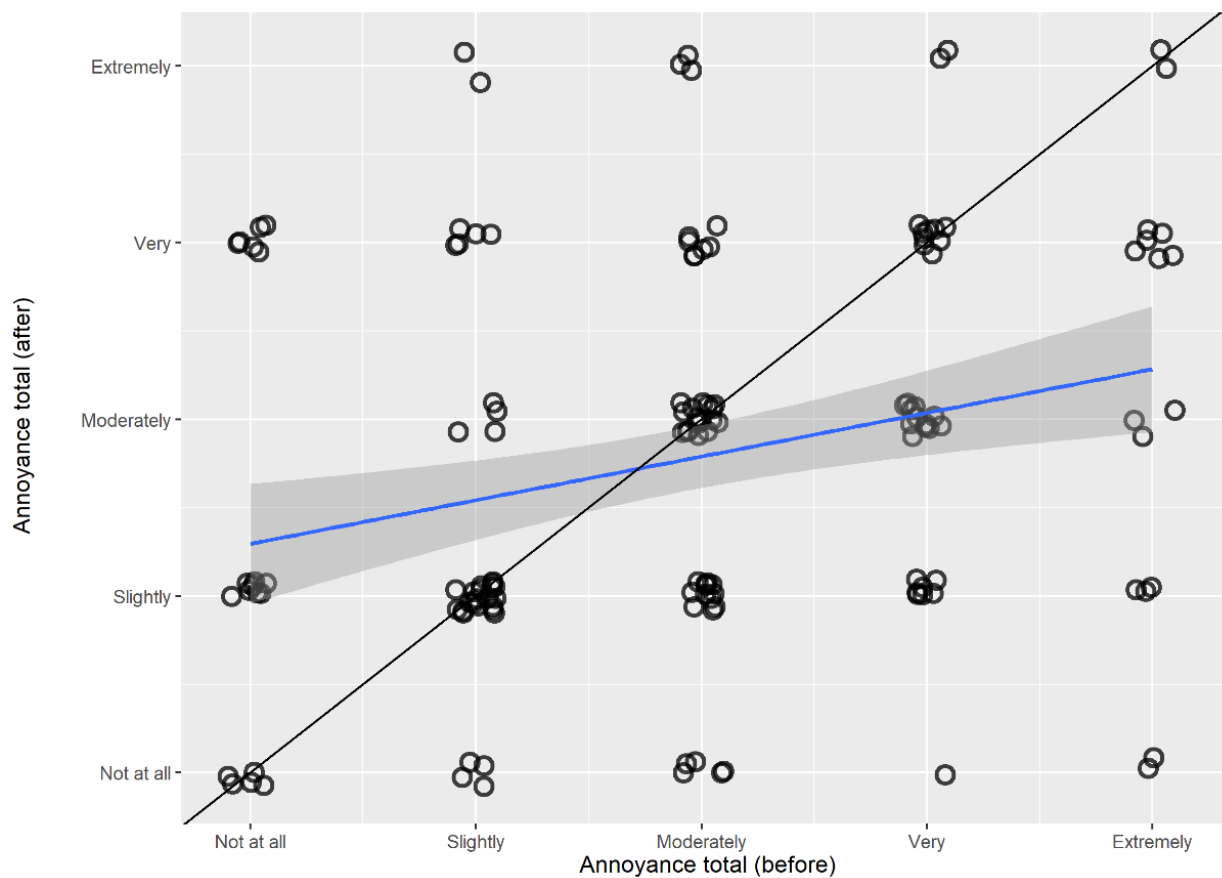


Figure 14 Changes in annoyance (overall) (jitter added for better identification)

5.3 Sources of noise annoyance

To determine the source of noise that contributes to the overall noise annoyance, question 3 was followed by a matrix of possible influences (question 4). The overall noise annoyance is added in Figure 15 but was not part of question 4. As a relevant number of households was investigated that was not in close proximity to the A7 motorway, the influence of other sources can clearly be seen. The overall noise annoyance is just partly influenced by the A7 motorway, leading to a higher annoyance by other sources.

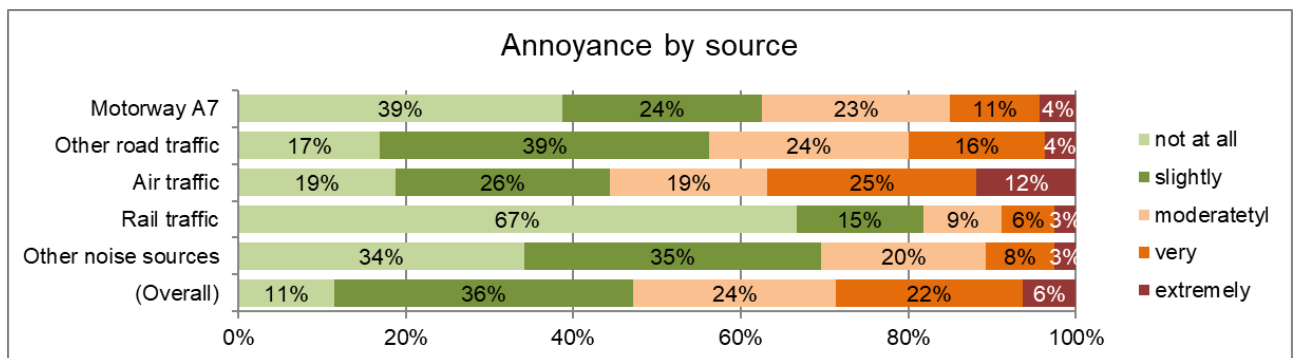


Figure 15 Annoyance by source

As for air traffic, the area at the Stellingen tunnel is located beneath a flight path to Hamburg airport with the runway about 3 km north. Thus, the noise expected reach comparable high levels as motorway noise or noise from other major urban roads.

Regarding railway noise, the same area at Stellingen is partly near a major railway line. However, only few buildings of the survey area are located in a distance of less than 1,000 meters. Most buildings are screened from railway noise. At Schnelsen, only a suburban railway line is in proximity to the area, but no buildings of the survey area are closer than about 300 meters. For all other buildings, screening by buildings results in low noise levels anticipated.

As a first conclusion, the overall noise annoyance seems lower than the maximum of noise annoyance by the dominant noise source. Regarding road traffic, the major impact of the A7 motorway has only local effects, the annoyance caused by other roads exceeds that of the A7.

5.4 Silence

As one factor that expresses the overall quality of living condition, the "silence" (or "quietness") in vicinity of the dwelling was asked in question 2. Results show that perceived silence is depending on the perceived annoyance of noise from A7 motorway (Figure 17) rather than depending on the absolute noise level of A7 motorway (Figure 18).

This was expected as both reactions are subjective. For a good perceived silence, either the annoyance due to a major road has to be lowered or other sources contributing to overall annoyance have to be dealt with. As an example, in Figure 16 most answers of "very bad" perceived silence (red dots) are visible at around 50 dB(A) of A7 motorway noise. However, in three cases the annoyance by the A7 motorway was answered "not at all", three cases "moderately" and four cases "very" or "extremely". On the other hand, only few cases of "good" or "very good" perceived silence are found at locations where the annoyance due to the A7 motorway exceeds "moderately".

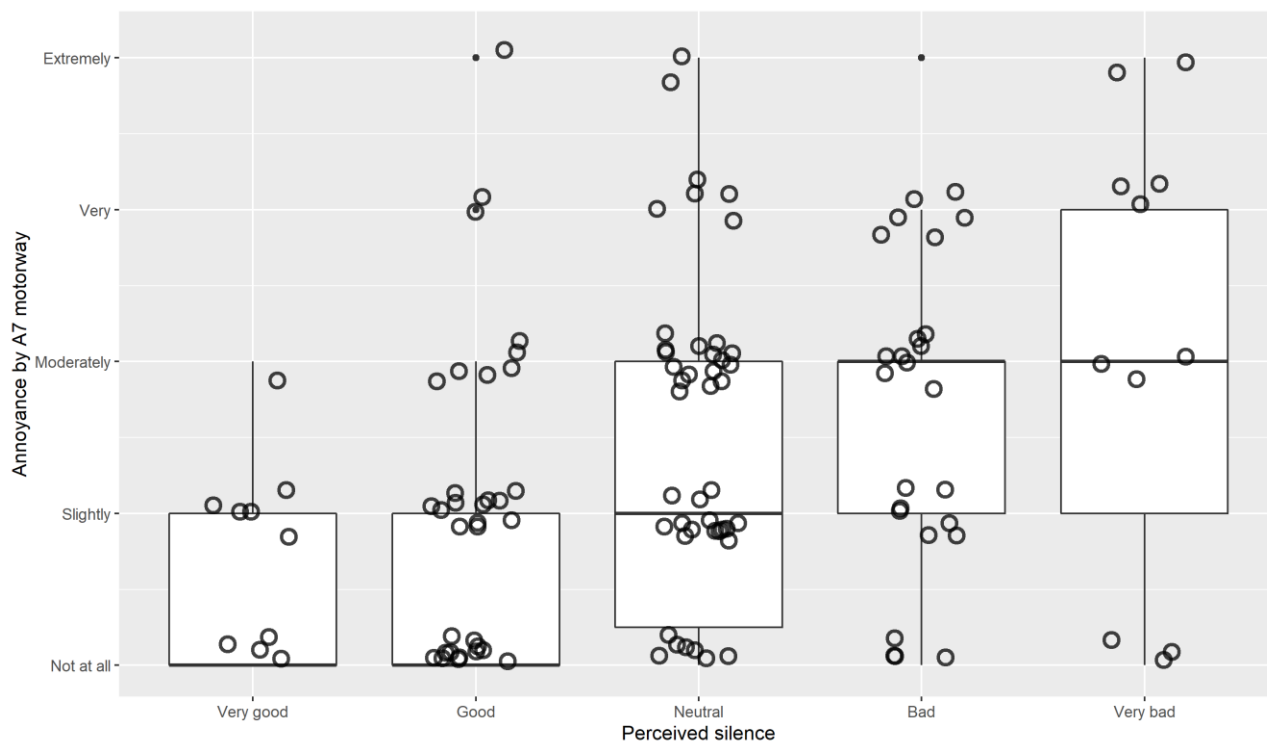


Figure 17 Perceived silence and annoyance by A7 motorway
(jitter added for better distinction)

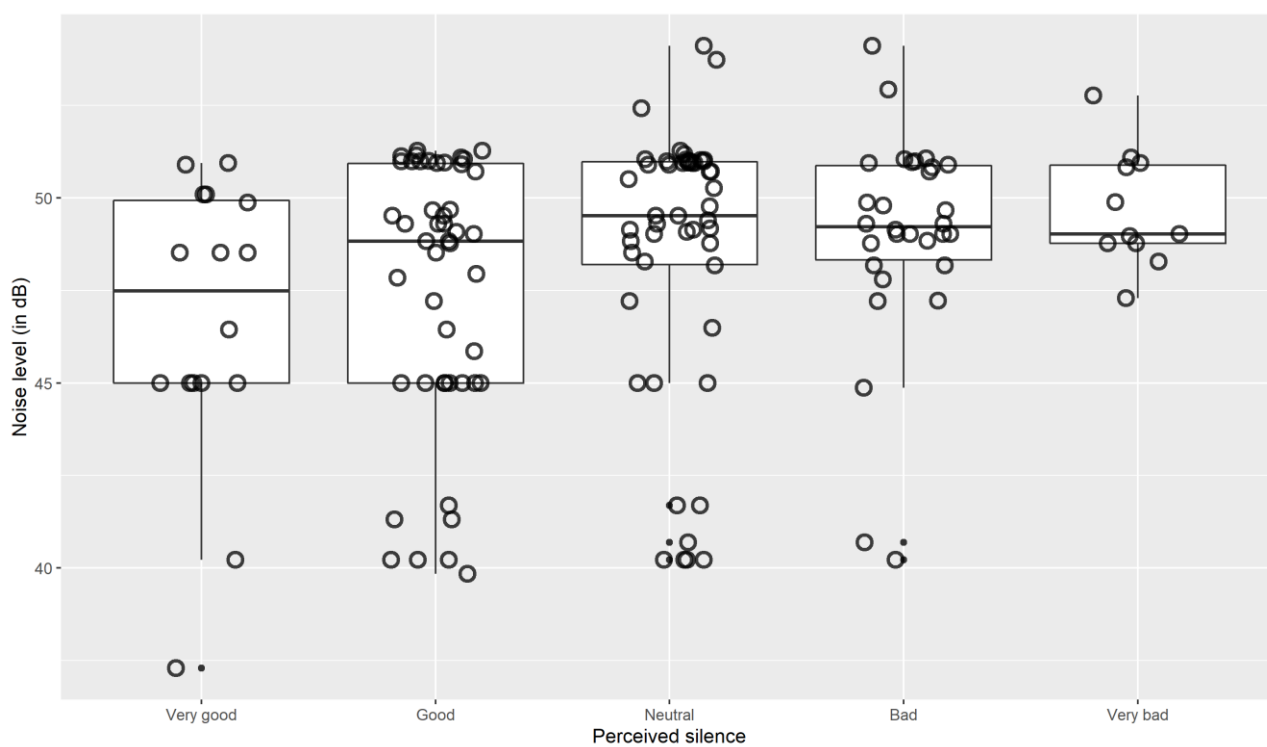


Figure 18 Perceived silence and noise levels of A7 motorway
(jitter added to "perceived silence" for better distinction)

5.5 Visibility and greenery

As one of the possible moderators that can affect people's subjective response to noise, visibility and greenery were part of the survey design. The importance could also be analysed by the response shown in Figure 19 on the importance of greenery. It was highly expected to have greenery on the cover instead of plain concrete structures or other uses.

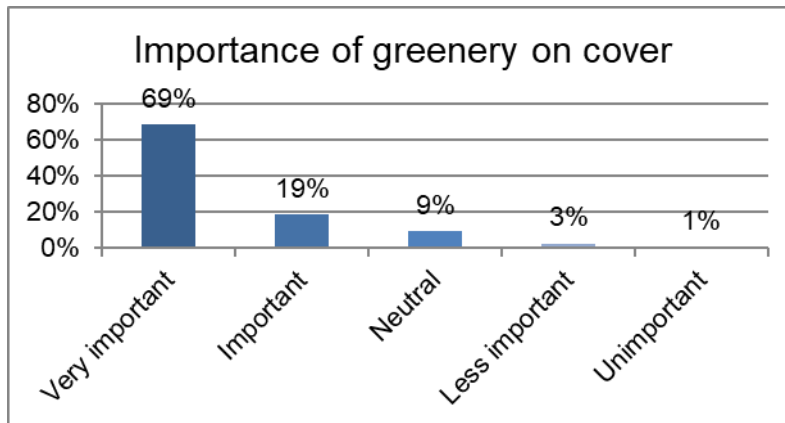


Figure 19 Importance of greenery

One question covered the overall visibility of the A7 motorway, about one third of the respondents had no blocked view to the A7. For about two third, the view was blocked (Figure 20), mainly by buildings (about 55 percent of all respondents), but also greenery (about 31 percent of all respondents).

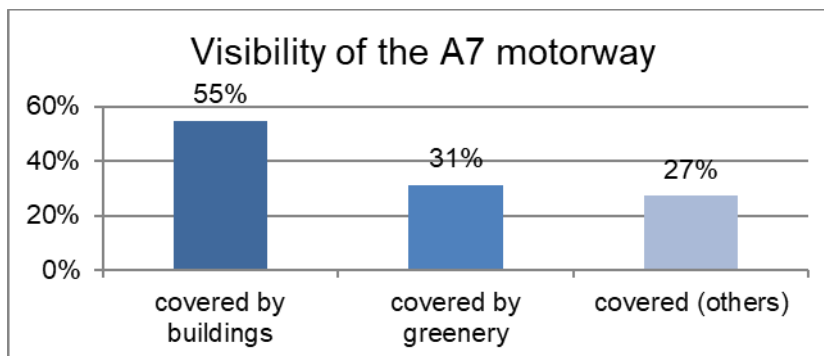


Figure 20 View to A7 covered (multiple answers possible)

One question focused on direct effects caused by the covering mentioned by the respondents (Figure 21). About 89 % of the respondents had no direct effect which is easily explainable by the distance to the covering. For about 8 % of the respondents, the covering resulted in deconstruction of former visible noise barriers which could lead to a possible improvement of the property (better view, more sunlight). For about 4 % the quality of view was reduced. This can be caused by the covering that in some situations exceeds the ground level, the visibility is then similar to a concrete barrier. Less than 3 % of respondents were affected in that way that their property size was reduced, and the covering was moving closer to the residential building.

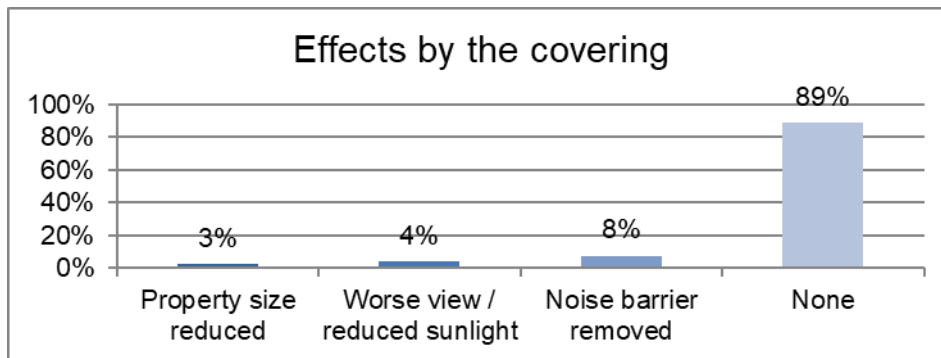


Figure 21 Direct effects of the covering on the property and building (multiple answers possible)

When analysing the effects of visibility and greenery, a small but constant dependency can be assumed. For those cases where the view is blocked by any obstacle (Figure 22) or specifically blocked by greenery (Figure 23), the annoyance seems lower. However, the effect is not significant due to the low number of responses.

Although the effect seems more distinct for a blocked view (all kinds of obstacles) it can be the result of lacking details on the exact location of the building and/or rooms. For analysis, only the maximum noise level was considered depending on the distance to the A7 motorway, thus dwellings oriented only towards a silent side and/or with a blocked view may result in lower noise levels that also result in lower annoyance. For greenery, the effect on noise levels is mostly negligible, so the change in annoyance only derives from subjective responses.

For visibility from sleeping rooms (Figure 24) or multiple rooms in a dwelling (Figure 25), the effect is more distinct. As can be seen from both figures, the annoyance increases with visibility.

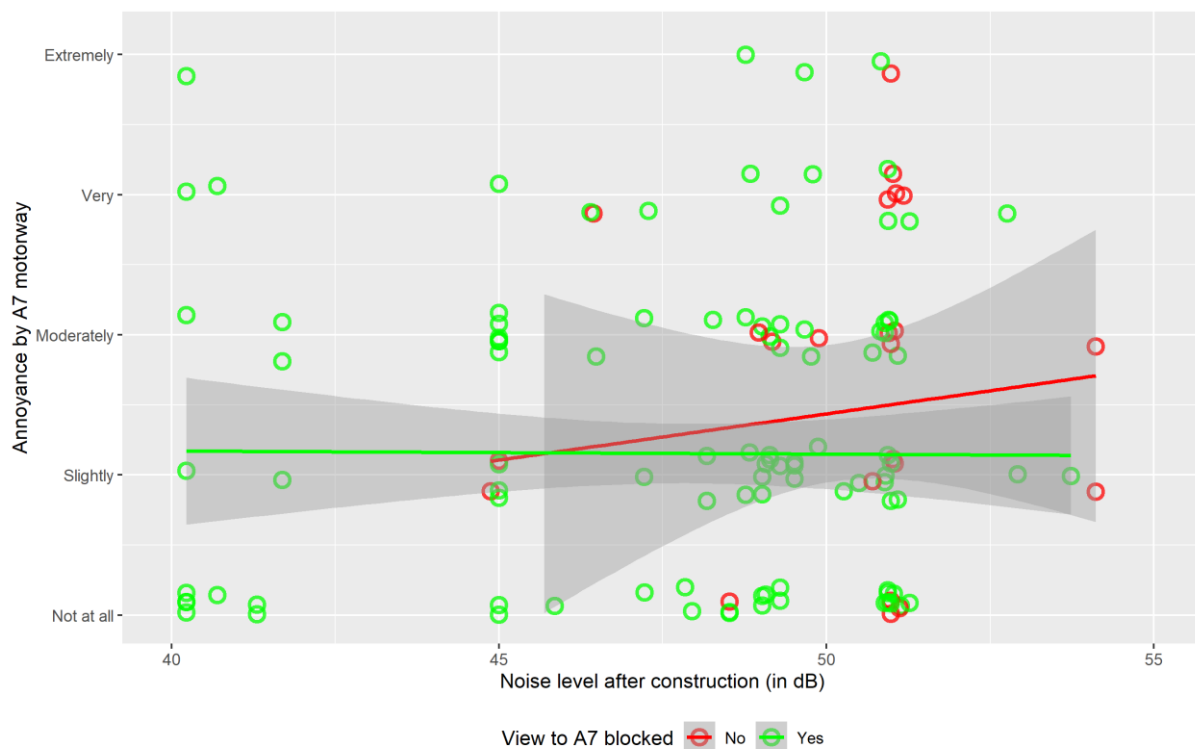


Figure 22 Annoyance by A7 motorway dependent on noise level and blocked view (jitter added to "annoyance" for better distinction)

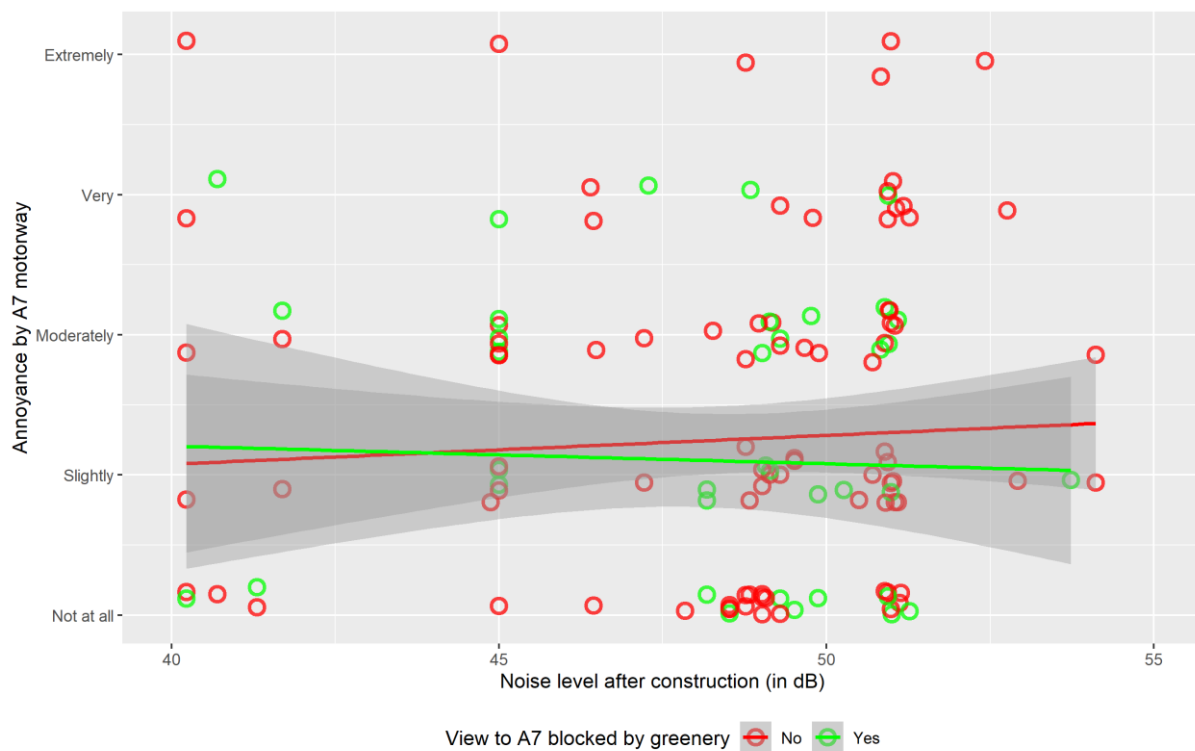


Figure 23 Annoyance by A7 motorway dependent on noise level and blocked view by greenery (jitter added to "annoyance" for better distinction)

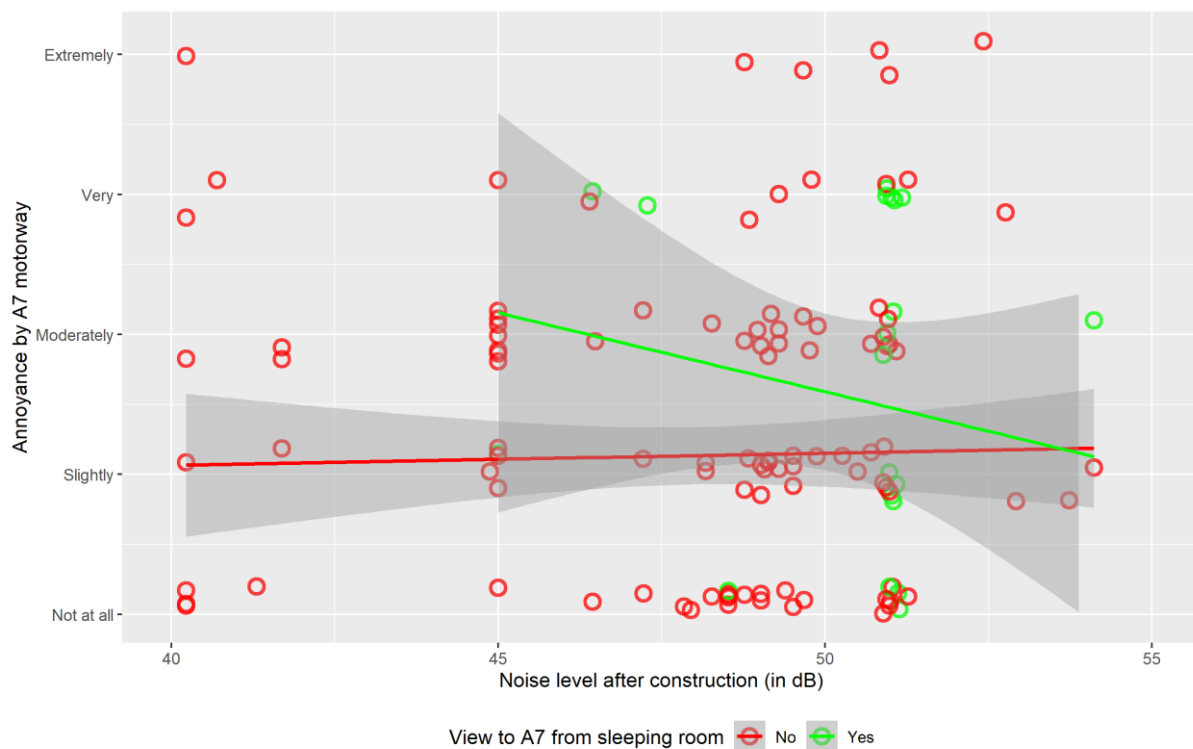


Figure 24 Annoyance by A7 motorway dependent on noise level and visibility from sleeping room (jitter added to "annoyance" for better distinction)

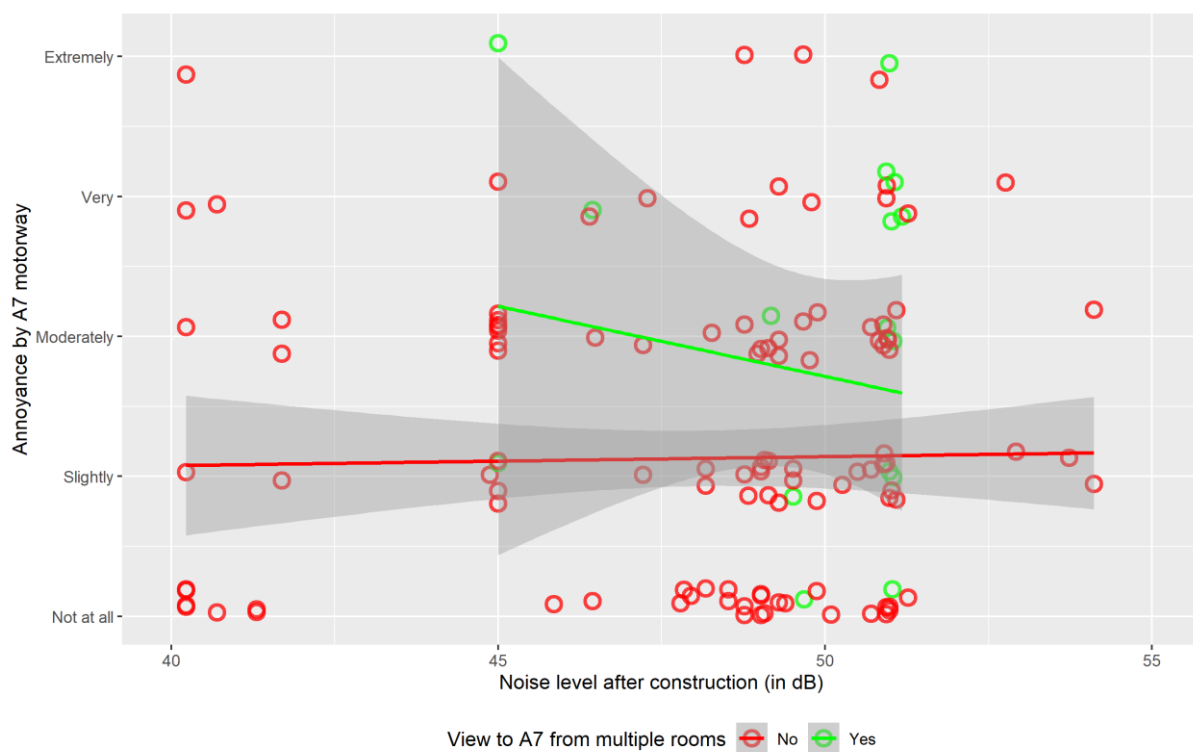


Figure 25 Annoyance by A7 motorway dependent on noise level and visibility from multiple rooms (jitter added to "annoyance" for better distinction)

5.6 Expectations

Questions about expectations show that most people expected different kinds of improvement by the A7 covering (Figure 26). About 90 % expected a reduction in noise levels, and in most cases, expectations were met (Figure 27). Only few people experienced a lacking improvement.

An analysis of the response of met expectations on lower noise levels over the noise level change (Figure 28) shows that most answers fall into the band of a reduction of 0-10 dB. Noise level change of only a few decibels cannot be perceived by most people, especially not in direct comparison (between "before" and "after", several months or even years passed). So, it can be assumed that communication of "lower noise levels" led to an exaggerated expectation that could not be met in a relevant number of cases.

An effect maybe connected can be observed for expectations that the situation worsens. Less than 5 % (of 116 responses) expected this outcome, but a high number of respondents (about 48 % of 101 responses) answered that their expectations (that would be "the situation does not get worse") was not met! However, the reason for a worsening situation was not given (lack in response options).

For some topics, the response on expectations met are not clear. This might be connected to low controllability (air quality) for one part of the topics as well as the not completed construction work and the ongoing view on construction sites (greenery).

An analysis met expectations on more greenery shows a possible small improvement in Figure 29. For those with met expectations on more greenery, indication is given that the annoyance of the A7 motorway is slightly lower.

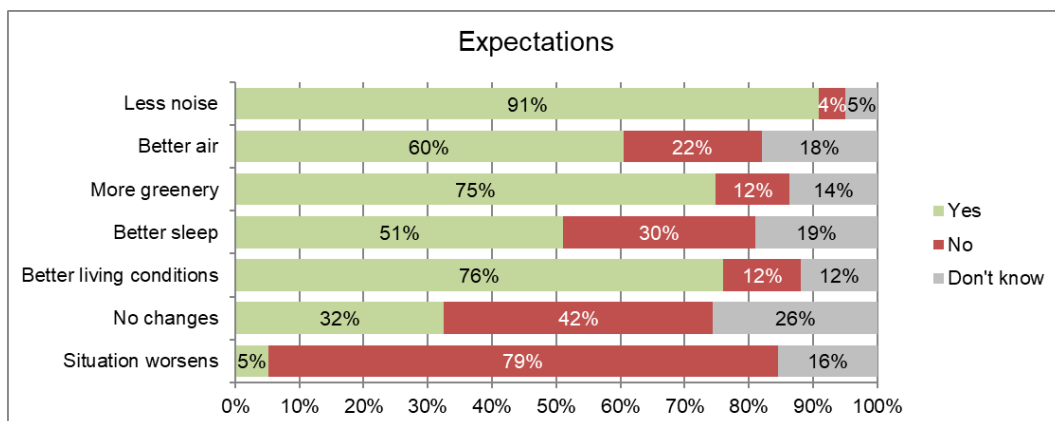


Figure 26 Expectations on the effects of the A7 covering.

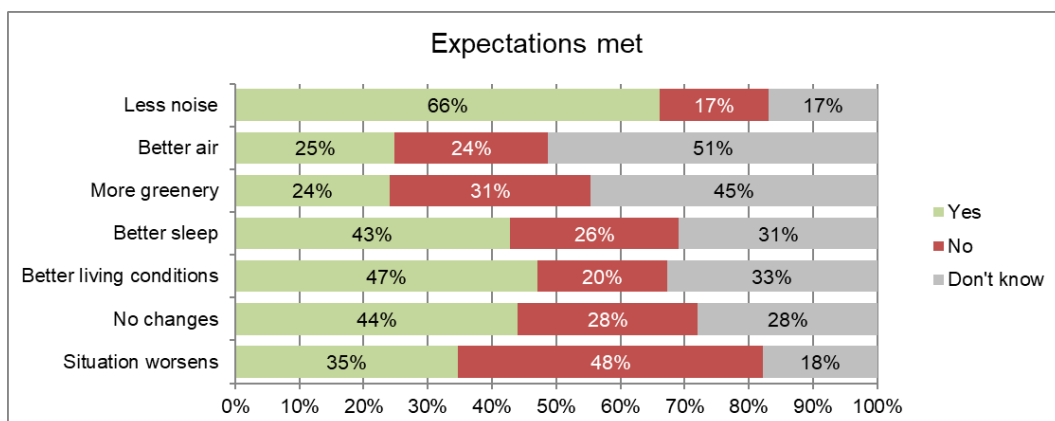


Figure 27 Expectations met on the effects of the A7 covering.

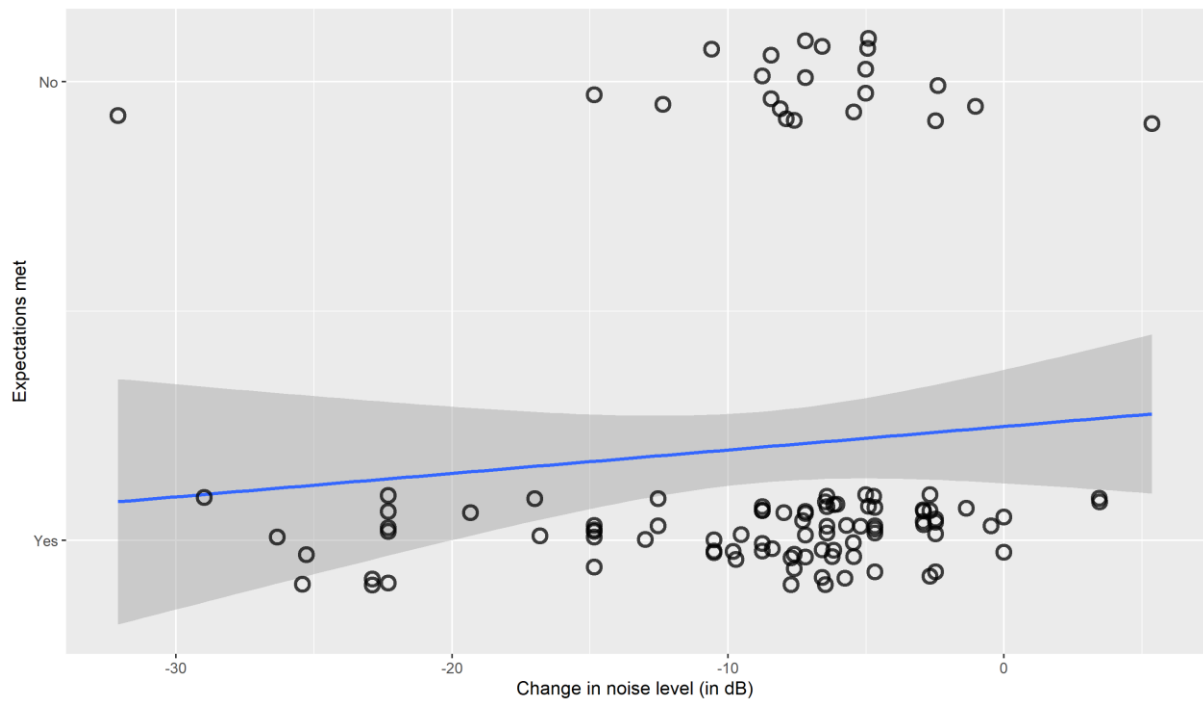


Figure 28 *Expectations met on lower noise depending on change in noise levels (jitter added to "expectations" for better distinction)*

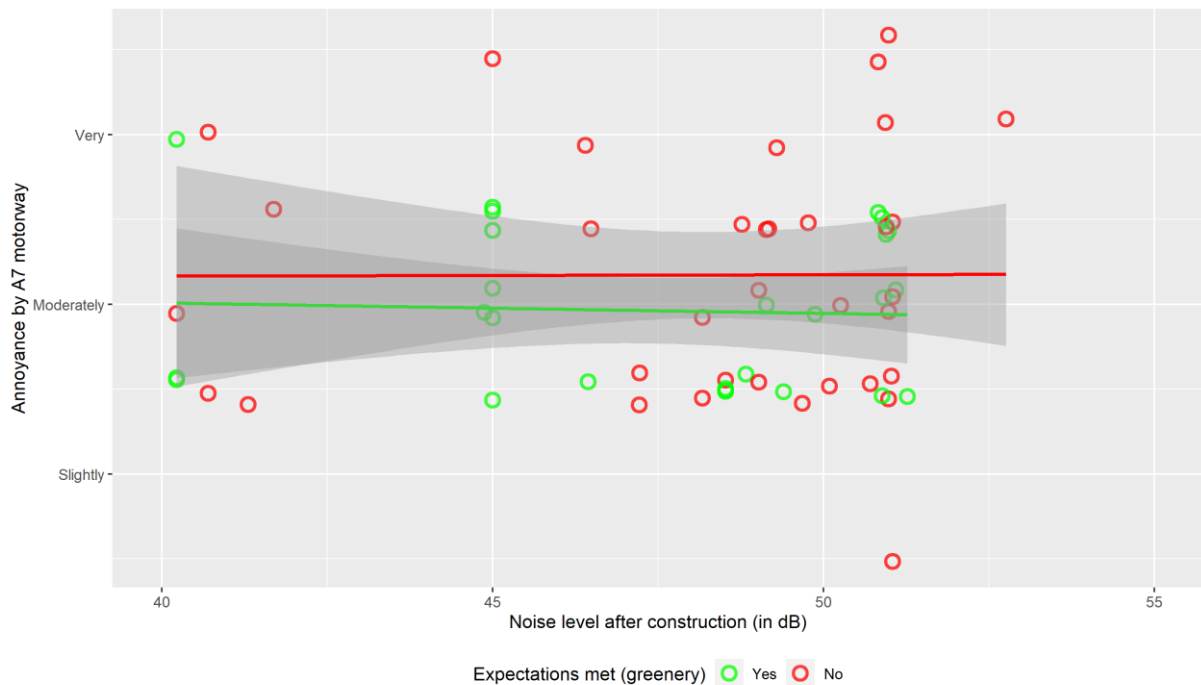


Figure 29 *Expectations met on greenery and annoyance by A7 motorway (jitter added to "annoyance" for better distinction)*

5.7 Information

One block of questions involved the perceived quality of information by several sources, as authorities, site offices, press coverage and citizens initiatives. As for the latter, the option of a covering instead of noise barriers was driven by citizens initiatives². There were also initiatives against the project (e.g. from allotment holders close to the A7, that were planned to be moved onto the covering), but their web site has been inactive for the past several years.

A part of the results is shown in Figure 30. More than 30 % each, as well a local site office close to the construction site as information from citizens initiatives was not perceived by the respondents. For the local site office, the aim was mainly to enable dialogue with residents close to the A7 during the construction process to deal with complaints on the resulting construction noise. The largest coverage was achieved by the press, only 3 % of the respondents got no information by this source.

The best quality of information can be seen coming from the press (40 % "good" or "very good") or local authorities (37 %). If considering the high number of people that were not informed by the local site office (e.g. they did not visit due to the distance or did not even know about it), the 25 % of at least "good" informed people come close to the quality of press and authorities.

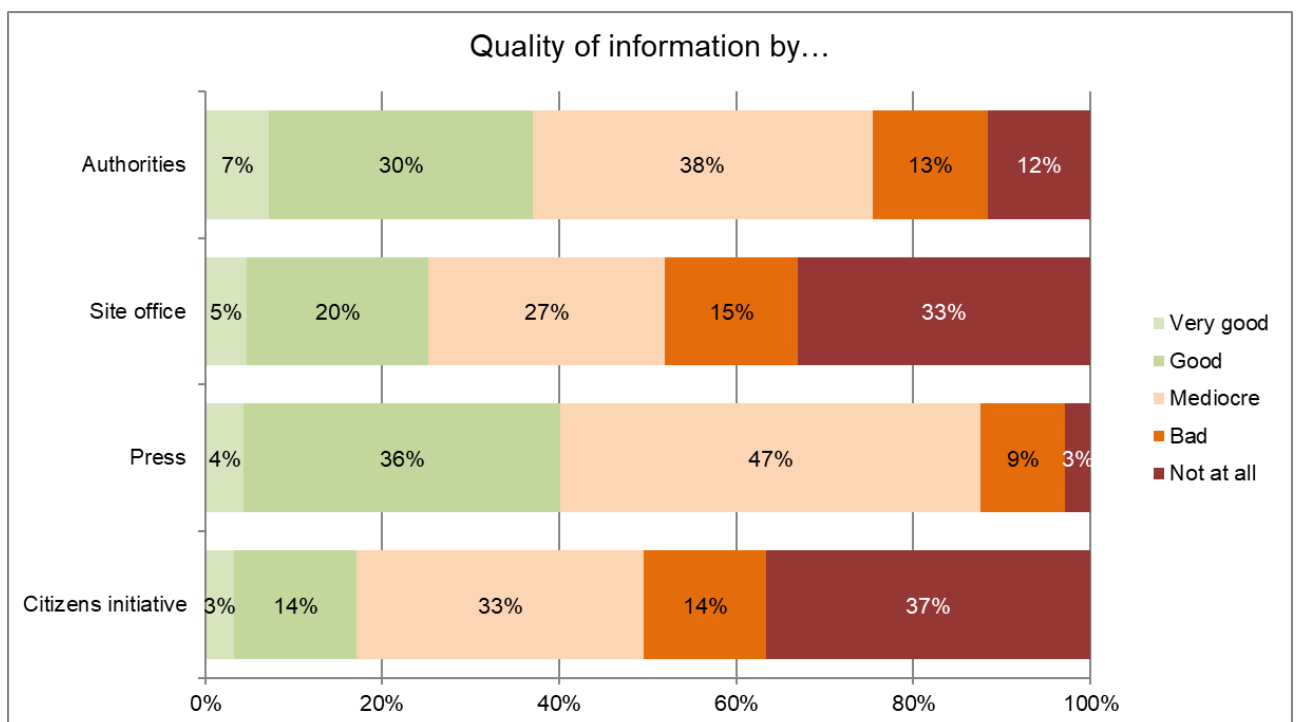


Figure 30 Quality of information by different sources

² <http://www.ohnedachistkrach.de/> and <http://www.stellinger-deckel.de/>

Further in-depth analysis was discontinued as the number of respondents seemed too low to give good quantitative results. For about 100-150 respondents, divided by five possible quality measurements, only a handful of respondents remains in each category, leading to highly volatile curves on annoyance reaction. The overall reaction indicates that the annoyance is slightly higher with bad information. The dependency is thus unclear: is the reaction worse due to bad information, or is the perceived information worse due to higher perceived annoyance (influenced by other factors).

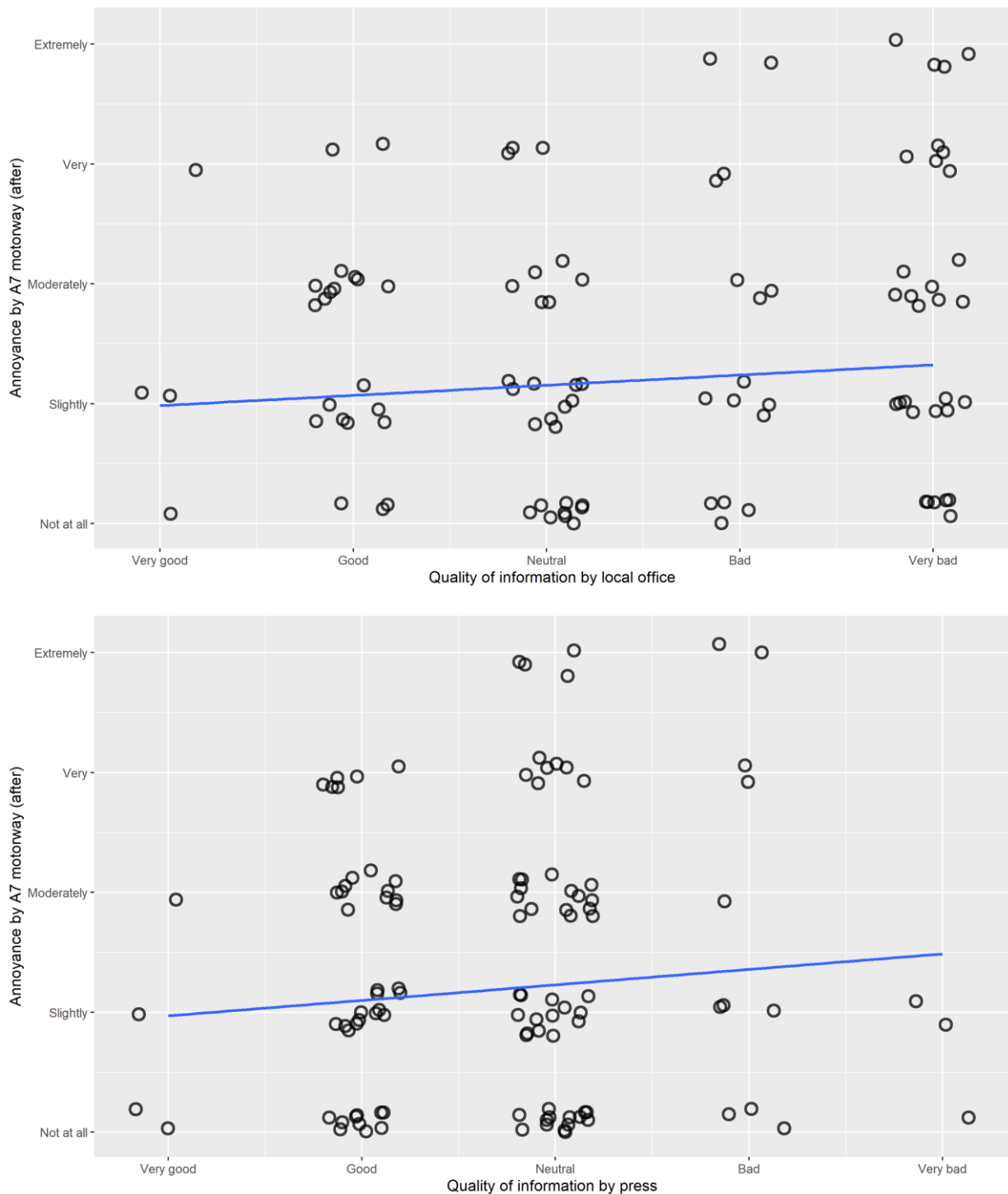


Figure 31 Annoyance and quality of information by local office or press (jitter added for better distinction)

6 Conclusions

In addition to the literature sources, a mini survey was planned within the FAMOS project. The execution was delayed due to the corona virus situation in Germany in 2020 and thus the design of the survey had to be modified compared to first planning.

As a result of the survey design as just a "mini survey" with limited extent and the non-personal address of respondents, both the number of respondents was limited and the quality on noise information (by exact location) was low. Therefore, a real quantitative analysis was not performed. Instead, a general correlation and a confirmation of earlier project results was assessed.

As for noise annoyance in general, the responses mostly showed an expected outcome although several respondents reported a higher annoyance although the noise levels were supposed to be reduced. The A7 motorway as a major noise source was, as expected, a major contributor to noise annoyance. The overall noise annoyance was however lower than the individual annoyance from single sources.

For visibility and greenery, results showed a tendency towards a lower annoyance with blocked views. The effect is small but still visible for a blocked view by greenery. Visibility will increase the annoyance especially when traffic is visible from the sleeping room or multiple rooms.

A major influence on annoyance was also identified by expectations and expectations met. For noise level changes, a noise level reduction of less than 10 dB led to a relevant number of respondents that perceived expectations that were not met regarding noise reduction.

Regarding information channels, press was identified as the option with highest coverage and good quality, however direct information by authorities (mailings, flyers, website) also showed a high quality in information.

Overall, the results showed that moderators previously identified in the FAMOS project had a contribution to the perceived noise annoyance. A quantification on the effect, i.e. changes in noise level, in CTL or similar, cannot be derived due to the low coverage.

The results also suggest that mini survey may a useful tool for investigating relevant moderators that contribute to annoyance from traffic noise. It shall be considered:

- Postal mailings can give a good control on coverage and can address more people than via electronic mailing (for which the addresses of possible respondents must be known beforehand).
- Costs for the questionnaire itself are negligible.
- For future comparison, a common set of questions should be used.
- The exact assessment of the location of a dwelling is difficult due to privacy reasons and concerns, thus the reliability of noise levels is low.
- Statistical confidence would increase with a higher number of respondents. For the given questionnaire, about 150 respondents result in a high uncertainty.

Appendix 1

Questions and response options from the questionnaire

Translated, original in German.

Question 1 -

How satisfied are you with your living situation overall?

Question 2 -

How do you rate the following factors in your living environment

- Proximity to shopping
- Proximity to utilities (doctors, schools/kindergartens, Other)
- Quietness
- Greenery in the neighborhood
- Transportation accessibility

Question 3 -

Thinking back over the past 12 months, how disturbed or bothered have you felt overall by noise?

Question 4 -

Regardless of your overall impression, once you think about the last 12 months, how much have you felt disturbed or annoyed by noise from the following noise sources?

- A7 motorway
- Other road traffic
- Air traffic
- Rail traffic
- Other noise sources

Question 5 -

How far is your apartment/house from the A7 (as the crow flies)?

Question 6 -

In which street do you live?

Question 7 -

Is the A7 motorway visible from your apartment/house?

- No, and that is –
 - obscured by buildings
 - obscured by vegetation (trees, bushes)
 - because of other obstructions
- Yes, and that is from:
 - Kitchen
 - Living room
 - Bedroom
 - Other

Question 8 -

Is any room oriented towards the A7 motorway?

- No
- Yes
 - Kitchen
 - Living room
 - Bedroom
 - Other

Question 9 -

What do you think about car traffic in general?

- Car traffic is useful
- Car traffic is dangerous
- Car traffic is convenient for users
- Car traffic is harmful to the environment

Question 10 -

What do you think about car traffic on the A7?

- Car traffic is useful
- Car traffic is dangerous
- Car traffic is convenient for users
- Car traffic is harmful to the environment

Question 11 -

What did you think when it was announced that the A7 was getting a lid here in Schnelsen? –

- I was very pleased
- I was worried about the construction work
- Can't remember
- Didn't care
- Other
- Input for other

Question 12 -

Is there any impact on your property due to the construction of the covering? –

- Property reduced in size
- Diminished view / shading
- Noise barrier eliminated
- None

Question 13 -

Were you affected by construction noise during the construction process?

- No
- Yes (with rating)

Question 14 -

Evaluate the information about the upcoming construction work due to the A7 lid construction by the responsible agencies. How well did you feel informed? –

- Administration/authorities
- On site (construction office or similar)
- Press
- Citizens' initiatives
- Other

Question 15 -

Were there any public events or similar where you were informed about the upcoming construction works?

Question 16 -

What other information channels, if any, did you use? –

- Newsletters (email)
- Information letters (mail)
- Website
- Letters to residents
- Other and namely

Question 17 -

What expectations did you have regarding the A7 lid? And which of these, if any, were fulfilled? Please tick each (multiple answers possible) –

- less noise
- cleaner air
- more green
- better sleep
- better quality of living overall
- Nothing changes for me
- It is getting worse

Question 18 -

How important is a design of the lid with green spaces to you?

Question 19 -

Thinking back to the time before construction of the lid began, how disturbed or inconvenienced were you by noise overall?

Question 20 -

If you put it all together again: How has the noise pollution here with you changed as a result of the A7 lid?

Question 21 -

How long have you lived in your current location?

Question 22 -

Do you live for rent or do you own your own apartment/house?

Question 23 -

Gender

Question 24 -

Age